1

sideration on Benthic Marine Algae (except the Diatoms) along the Romanian Black Sea Coast

Adrian BAVARU*, Alexandru S. BOLOGA** and Hilarius V. SKOLKA**

*University of Constanta, RO-8700 Constanta (Romania)
**Romanian Marine Research Institute, RO-8700 Constanta (Romania)

More than a century has passed since seaweeds were studied or the first time on the Romanian Black Sea coast by SCHAARSCHMIDT (in KANITZ, 1879-1881). The first works consist only of ne identification of marine algae. The period of rigourous cientific study of the Romanian marine algal flora was begun by EODORESCU (1907) and carried on by CELAN over a period of five ecades between 1935-1983.

TARNAVSCHI and OLTEAN (1956, 1958) published a review in two arts on terrestrial and marine alga groups identified in Romaia.

Following contributions related to Cyanophyta (GRUIA, 1968) nd macrophytes (SKOLKA, 1969), complete lists of benthic marine lgae in Romania were compiled by BAVARU, concerning the Cyanoyta, Chlorophyta, Phaeophyta and Rhodophyta (1977a), and the naeophyta and Rhodophyta with the publication of the second olume of the "Treatise on Algology" (1977b).

Recent contributions on the marine macrophytobenthos have been eviewed by BOLOGA (1987).

Several decades ago the algal flora showed a much higher umber of species, subspecies and varieties compared to those ound in coastal waters. The most abundant genera are Enteroorpha, Cystoseira, Ceramium and Laurencia. A continual decrease n algal diversity and biomass becomes evident upon analyses of ne literature. This result is most dramatically illustrated by ne almost complete disappearance of the formerly productive elts of the perennial brown alga Cystoseira barbata (Good. et ood.) J.Ag. which formerly played an important ecological role.

These taxonomic studies represent the known inventory of arine macrophytes in Romania. They revealed the presence of umerous new species both along the Romanian coast and in other ocations in the Black Sea. In addition Gelidiella antipae Celan as identified as a new species.

Some species were erroneously considered as new taxa. These nclude Ectocarpus caliacrae Celan (actually a development stage f Desmotrichum undulatum (J.Ag.) Reinke), or Laurencia lacustris olka (= L. caspica A. Zin. et Zaberzh.).

According to the present requirements of botanical nomenclaure (BOUDOURESQUE and PERRET-BOUDOURESQUE, 1987) a synthesis of ne inventory of benthic marine algae has been prepared. Compared o the total of 36 Cyanophyta, 47 Chlorophyta, 2 Xanthophyta, 30 naeophyta and 75 Rhodophyta observed along the Romanian shore eginning in 1935, only about 18, 21, 1, 13, and 41, respectively, remained after 1960. Since 1980 even fewer taxa have been ound, although it is possible that, as in the case of marine olluscs, new species may have recently entered the region.

References:

AVARU A., 1977a - Adnotari la lista speciilor de alge din dreptul litoralului românesc al Marii Negre. Hidrobiologia, 15, 65-78.
AVARU A., 1977b - Speciile de alge rosii si brune din dreptul litoralului românesc al Marii Negre. Originea lor. in Tratat de algologie (S.Peterfi & A.Ionescu, eds.), 2, Ed.Acad.RSR, Bucuresti, 279-289.
OLOGA A.S., 1987 - Annotated bibliography on the macrophytobenthos along the Romanian Black Sea coast (1881-1986). Cercetari marine, 20.
OUDOURESQUE C.F. and PERRET-BOUDOURESQUE M.M., 1987 - A checklist of the benthic marine algae of Corsica. GIS Posidonia publ., Marseille, 1-121.
RUIA L., 1968 - Considerations to the knolwedge of the Cyanophycae of the Romanian Black Sea littoral. Trav.Mus. d'Hist.Nat.Gr.Antipa, 8, 217-224.
ANITZ A., 1881 - Plantas Romaniae hucusque cognitas, enumerat Augustus Kanitz: Algae auctore Julio Schaarschmidt, Pars I, Claudiopoli, 1879-1881, 151-268.
KOLKA H.V., 1969 - A propos de la repartition des Algues macrophytes le long de la côte roumaine de la mer Noire. Rev.Roum.Biol., Ser.Bot., 14, 5, 303-308.
ARNAVSCHI I.T. and OLTEAN M., 1956 - Materiale pentru un conspect al algelor din R.P.R. Analele Univ.C.I.Parhon - Bucuresti, Seria St.Naturii, 12, 97-149.
ARNAVSCHI I.T. and OLTEAN M., 1958 - Materiale pentru un conspect al algelor din R.P.R.-II. St. Cerc.Biol., Seria Biol.veget., 10, 3-4, 269-290.
EODORESCU E.C., 1907 - Materiaux pour la flore algologique de la Roumanie. Beihefte Bot.Centralbl., 21, 2, 103-219.

B-I2

Le Spectre Chorologique de la Macroflore Benthique du Littoral Roumain de la Mer Noire

Adrian BAVARU

Lycée "M. Eminescu", Contanta (Roumanie)

B

Les données existentes en ce sens sont des plus incomplètes, d'où l'impossibilité de réaliser une délimitation précise de l'aire de dispersion de certaines espèces.

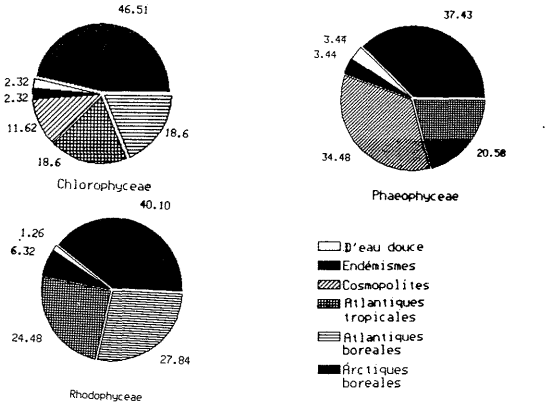
Prenant comme point de départ la littérature de spécialité publiée par les soviétiques, notamment l'ouvrage de A.D. ZINOVA (1967), nous estimons qu'aux bords roumains, la flore d'algues comporte les éléments suivants:

1. Les éléments atlantiques-arctiques-boréaux infiltrées par la Méditerranée le long des glaciations, ou après l'écroulement du Bosphore. Deux catégories y ont le dessus:
   a) atlantiques-boréales, des espèces d'eaux tempérées ou froides, qui dans la Méditerranée touchent leur limite sud: *Blidingia marginata, Bryopsis plumosa, Cladostephus verticillatus, Striaria attenuata, Callithamnion corymbosum, Lomentaria clavellosa* et
   b) atlantiques-tropicales: *Bryopsis hypnoides, Chaetomorpha aerea, Cystoseira barbata, Dilophus fasciola, Callithamnion granulatum, Dasya baillouviana*. En ce qui concerne la troisième catégorie:
   c) arctico-boréales, il y en a que nous pouvons considérer comme des reliques arctiques: *Urospora penicilliformis, Phyllophora truncata*, celle-ci n'étant pas présentes dans la Méditerranée, et d'autres, comme *Ulothrix flacca, U. pseudoflacca*, sont considérées dans la Méditerranée commes des reliques glaciales (FELDMANN, 1937). Les éléments arctiques-boréaux et atlantiques boréaux sont inclus par beaucoup d'auteurs dans une notion plus large - circumboréal et respectivement circumtropical.
2. Les reliques sarmatiques: Tout en réalisant l'étude de la flore algologique de la Mer Caspienne, on peut discuter de la présence de ces éléments aux bords de la mer Noire. Ainsi, par exemple, *Laurencia lacustris* rencontrée par SKOLKA (1961) dans l'un des lacs saumâtre du littoral, s'est avéré être *L. caspica* (BAVARU, 1977). Il paraît aussi que *Ceramium fastigiatum*, enregistrée par M. CELAN (1959) comme une forme de *C. elegans*, et que nous avons rencontrée uniquement dans des zones à eau radoucie et dans les lacs du littoral soit toujours une relique ponto-caspienne (la confirmation en serait de la retrouver dans la mer Caspienne). Moi et M. CELAN, nous considérons que la forme curieuse d'*Ectocarpus siliculosus*, rencontrée dans le bassin du port de Mangalia et publiée en 1967 doit être rapportée à *E. caspicus*. Dans l'ouvrage de A.D. ZINOVA (1967) on rencontre une série d'endémismes caspiennes avec l'appélation spécifiques de "caspica" ou "caspicus" (*Polysiphonia caspica, Dermalithon caspicum*) et que l'on pourrait découvrir dans la mer Noire aussi, notamment dans les eaux peu radoucies de la côte roumaine des embochures du Danube.
3. Des éléments cosmopolites, représentés par des espèces euryhalines, rencontrées presque dans toutes les mers du globe, comme par exemple: *Enteromorpha compressa, E. prolifera, Acrochaete viride*.

Scytosiphon lamentaria est une espèce cosmpolite bipolaire, se retrouvant dans toutes les mers froides et tempérées des deux hémisphères.

4. Des éléments douceâtres, provenant des eaux douces sont moins nombreux. On peut citer *Rhizoclonium riparium* et *Chroodactylon ornatum*.

En Synthèse, nous présentons les trois diagrammes du spectre chorologiques des algues macrophytes du littoral roumain de la mer Noire.



REFERENCE

BAVARU A. - 1977 - Adnotari la lista speciilor de alge din dreptul litoralului românesc al Marii Negre. Hidrobiologia, 15, Editura Academiei R.S.R., Bucuresti: 65-78.

BAVARU A. - 1977 - Speciile de alge roşii şi brune din dreptul litoralului românesc al Marii Negre. Originea lor. In: Tratat de algologie (S. PETERFI and A. IONESCI, eds.), 2, Editura Academiei R.S.R., Bucuresti: 279-289.

SKOLKA H. - 1961 - Doua specii noi de rhodophycee cu o interessanta adaptare dulcicola. Hidrologia, 3, Editura Academiei R.S.R., Bucuresti: 104

ZINOVA A.D. - 1967 - Opredelitel vodoroslei Iujnih Morei SSSR. Izd. Nauka, Moskova-Leningrad.

B-I3

B

Trace Metals in Adriatic Seaweeds from the Istrian Coast

Ivka M. MUNDA

Biological Institute, Slovene Academi of Science and Arts, Ljubljana (Yugoslavia)

The northern Adriatic is heavily polluted by both domestic sewage and industrial discharges. Increased concentrations of heavy metals in coastal waters were reported (Branica, 1978).

Due to high accumulation factors and ability of strong binding of metals seaweeds are valuable indicators in metal pollution studies. Metals present in algae are, however, related to the problem of water pollution monitoring.

In this study the concentrations of Mn, Zn, Cd, Cu and Pb were determined by atomic absorption spectrometry (AA 6 Techtron Varian). Samples were collected in the rocky eulittoral and sublittorally at Piran and Rovinj. Both seasonal and perennial species from differently polluted sites were studied. Differences in accumulation capacity between species and genera were considered as well as seasonal and habitat-conditioned variations in trace metal content. Five to ten paralleles were taken for each species during sampling. Results are means of three replicates and are expressed as ug.g of dry weight.

The trace metal content in the surface water at Piran during spring (April) was: 60 ug.l of Zn, 6 $ug.l^{-1}$ of Mn, > 0.5 $ug.l^{-1}$ of Cd, > 2 $ug.l^{-1}$ of Cu and > 1.5 $ug.l^{-1}$ of Pb. In spite of the fact that the concentration of Zn in seawater was notably higher than that of Mn, the concentration of the latter was two to three times higher that that of Zn, in some cases even more. The toxic metals Cd, Cu and Pb were found in low concentrations in the investigated material, with few exceptions. Looking at the algal material as a whole, results indicated that Mn concentrations in the tissue were the main distinguishing characteristic between the taxonomic groups as well as in seasonal and habitat-conditioned variations. Variations in the Zn content were less pronounced and did not always follow the same trend as the Mn content. The toxic metals showed no definite trends of variations and tended to be elevated in some taxonomic groups (representatives of the Scytosiphonales, Dictyotales Gelidiales and in some crustose corallines).

Among the brown algae the perennial *Fucus virsoides* exhibited a relatively high Mn content (ranging from 97 to 475 $ug.g^{-1}$ for the Piran material and from 28 to 44 $ug.g^{-1}$ for that from Rovinj). It increased from winter towards summer, with a peak in August and subsequent decline in autumn. Seasonal variations in Zn content were less pronounced (ranges from 40 to 74 $ug.g^{-1}$). In the Rovinj material the Mn content was lower than in that from Piran. Differences were less conspicuous regarding the Zn content. Among other fucoid species belonging to the genus *Cystoseira* a high Mn content was found in the eulittoral *Cystoseira compressa*, whereas in the sublittoral fucoids it was notably lower. It seems, however, likely that the eulittoral fucoids accumulate more Mn and also Zn that the sublittoral ones. The Cd content in the fucoid species varied between 0.3 and 0.7 $ug.g^{-1}$, that of Cu between 2 and 10 $ug.g^{-1}$ and of Pb between 2 and 6 $ug.g^{-1}$. In representatives of the Sphacelariales (*Halopteris scoparia*) and Dictyotales (*Dictyota dichotoma, Dictyopteris membranacea, Padina pavonica*) a high Mn content was notable, especially in *Padina*. Also in these samples both Mn and Zn concentrations were lower in the Rovinj material than in that from Piran. Elevated concentrations of toxic metals in representatives of the Dictyotales were most obvious in the Pb content, which ranged from 5 to 11 $ug.g^{-1}$, while that of Cu was between 3 and 8 $ug.g^{-1}$. A high Pb concentration was also found in *Halopteris scoparia*. Of the Scytosiphonales, *Scytosiphon lomentaria* and *Colpomenia sinuosa* were collected in rather polluted sites. It was obvious that the accumulation of Mn and Zn increases towards the end of the vegetative period in *Scytosiphon* and that the Mn content was again higher in the Piran than in the Rovinj material. The oposite was true for the Zn content. Exceptionally high values for Pb and Cu were found in the Scytosiphonales from Rovinj (22 to 69 $ug.g^{-1}$ Pb and 9 to 22 $ug.g^{-1}$ Cu). They are possibly related to an intensified pollution at the immediate sampling sites.

Among the red algae pronounced differences in metal concentrations between the taxonomic groups were obvious. In *Porphyra leucosticta* from a brackish habitat (Lim) low Zn and Mn concentrations were obvious (23 and 15 $ug.g^{-1}$ respectively) and the Cu content was slightly elevated. In the rest of the red algae both Zn and Mn concentrations were higher than in Porphyra. In *Jania rubens* and *Corallina officinalis* the Mn content was high and exceeded the Zn content by two to four times. Also in *Corallina* the Mn content in the Rovinj sample was lower than in that from Piran, whereas the Zn content was on the same level. The Pb content of both species was elevated in summer (8 and 11 $ug.g^{-1}$). Among representatives of the Gelidiales, *Gelidium pusillum* and *Pterocladia capillacea*, even higher concentrations of Mn and Zn were observed (214 and 217 $ug.g^{-1}$ of Mn and 60 and 73 $ug.g^{-1}$ of Zn). In both species the Pb content was elevated to 15$ug.g^{-1}$, whereas the Cu content was high only in the eulittoral *Gelidium pusillum* (15 $ug.g^{-1}$). Both species were collected at different seasons and littoral levels. Similarities in their trace metal content might suggest that taxonomic relationships might be of primary importance for the affinities of seaweeds to dissolved metals. A similarity in metal levels was also observed among representatives of the Ceramiales, *Ceramium ciliatum* and *Laurencia obtusa*. The Mn and Zn concentrations in both species were similar (75 and 85 $ug.g^{-1}$ of Mn and 23 and 17 $ug.g^{-1}$ of Zn), hence lower than in the rest of the red algae investigated. Similarities between the two related species were also obvious in their contents of toxic metals, which were low. All the red algae observed exhibited a low Cd and relatively high Pb content. Like in the brown algae, it became obvious that the Mn content was the main distinguishing characteristic between the taxonomic groups and that among the Gelidiales and the coralline algae, also the elevated Pb content was outstanding.

Only a few samples of green algae were included in our study. Mixed samples of diverse *Enteromorpha* species were collected eulittorally where they form continuous mats. They occur in several subsequent generations during the year, which is reflected in their metal levels. The Mn content was highest in summer and again lower in the Rovinj than in the Piran samples. Slightly elevated Pb values in spring and autumn are noteworthy (8 and 9 $ug.g^{-1}$). Samples of *Cladophora dalmatica* and *Ulva rigida* from Rovinj exhibited similar Zn, Mn and Pb contents, but were collected during different seasons of the year. As a contradiction of the above statment that taxonomic relationships are outstanding in the ability for trace metal accumulation, the two *Codium* species, *Codium vermillara* and *Codium effusum*, were totally different. This relates to the Mn and Zn contents (36 and 82 $ug.g^{-1}$ Mn in the former 349 $ug.g^{-1}$ Mn in the latter).

In spite of several experimental studies on trace metal accumulation in seaweeds (e.g. Munda, 1979,1982 etc.) this contribution yields information on their metal content under unstable field conditions, reflecting metal pollution in the North Adriatic shelf area.

REFERENCE

BRANICA, M. 1978. Distribution of ionic Cu, Pb, Cd and Zn in the Adriatic Sea. Thalassia Jugoslavica, 14(1/2): 151-155.

B-I4

Résultats de Missions Algologiques en Méditerranée Orientale (Turquie)

S. CIRIK* et OZTURK**

*Institut des Sciences et de Technologie Marine, Université de Dokuz Eylül, P.K. 478, 35213 Izmir (Tu
**Ecole Supérieure des Produits Aquatiques, Université d'Istanbul, Beykoz/Istanbul (Turquie)

La végétation marine benthique des côtes de la Méditerranée en Turquie est peu c
Les travaux algologiques sur cette région ne sont pas nombreux (CİRİK, 1986, UYSAL
1980, ZEYBEK, 1969). Cette région pourtant contient un grand nombre d'espèces interes
aussi bien du point de vue systematique que phytogéographique.

En 1978 et 1979 nous avons étudié, d'une manière saisonnière, en formant une
scientifique, les divers aspects biologiques (y compris la flore marine) et sedimentolo
de la baie d'Akkuyu près de Mersin (UNSAL et al 1980). Depuis cette période jusqu'
jours, nous avons fait des récoltes soit par dragage soit par plongée, d'une m
sporadique, sur les côtes de la Méditerranée en Turquie. Nos stations de récoltes (st.1-
st. 2-Taşucu, st. 3-Akkuyu st. 4-Alanya, st. 5-Kemer, st. 6-Fethiye, st.7-Knidos) vont
frontière syrienne jusqu'à la mer Egée.

La région d'étude présente toutes les caractéristiques du climat méditerraneen. L
grande partie des côtes sont rocheuses, en calcaire, favorisant les developpements d'
Les phanérogames marines sont développées dans les zones sableuses.

Les espèces marines de cette côte et leur répartition sont influencées par les
chaudes de la Méditerranée Sud. Les espèces tropicales, comme Liagora farinosa, L. vi
Galaxaura oblongata, Digenea simplex, Sargassum vulgare, Acetabularia acetat
Anadyomene stellata, sont assez abondantes. De plus certainement à cause du canal de S
voit de plus en plus dans plusieurs stations, certaines espèces comme Halophila stipula
Caulerpa racemosa, qui sont originaires de l'Ocean Indien, et absentes en Méditer
occidentale.

Dans ce travail, nous avons donné un bref aperçu de la répartition des espèces vé
que l'on peut rencontrer au niveau supralittoral, mediolittoral, et à l'horizon superie
l'infralittoral.

Au cours de nos missions algologiques nous avons récolté et déterminé 186 es
d'algues et 4 phanerogames marines. Parmi ces plantes, 123 espèces de Rhodophycé
espèces de Phaeophycées, 22 espèces de Chlorophycées et 5 espèces de Cyanoph
constituent respectivement 66,13%, 19,35%, 11,83% et 02,69% du nombre total d'es
déterminées.

La répartition verticale des espèces et des peuplements dans nos stations se rap
beaucoup de celle observée sur les côtes égéenne et sur les côtes syriennes (CİRİK,
MAYHOUB, 1976). Comme nous l'avons déjà indiqué plus haut, les espèces à affinité c
sont assez abondantes dans les différents étages.

REFERENCES

CİRİK, Ş., 1979-Note préliminaire sur les divisions bionomiques de la côte égéenne
Turquie. Rapp. Comm. Int. Mer Medit, 25/26, 4:147-149.

CİRİK, Ş., 1986- A propos de la végétation marine de la baie d'Akkuyu (Mersin-Turquie
5 ème Colloque d'Optima, İstanbul, 13p.

MAYHOUB, H., 1976-Recherches sur la végétation marine de la côte syrienne.
expérimentale sur la morphogenèse et le développement de quelques espèces peu cor
These d'Etat, Caen, France.

UNSAL, S., BAŞOĞLU, S., CİRİK, Ş., et BENLİ, H.A., 1980-Oceanographic s
(Biology-Sedimentology) Akkuyu Bay(Mersin, Turkey). E.U. Inst. Mar. Sci. Tech. İzmir, I
code No: TEK/77/2, Turquie.

ZEYBEK, N., 1969-Algues Marines des côtes de Bodrum à Finike (en turc) TÜBİTAK Proje
No: TBAG, 24 Ankara, Turquie.

I5

sence of Sieve Plates in *Cystoseira* (Fucales, Fucophyceae)

Amelia GOMEZ GARRETA and M. Antonia RIBERA

Laboratorio Botanica, Facultad Farmacia, Universidad Barcelona (Spain)

The presence of sieve plates in the cells of Fucophyceae been observed by a number of authors, in particular in Lamiiales (PARKER & HUBER, 1965; SCHMITZ & SRIVASTAVA, 1974, 5, 1976; SIDEMAN & SCHEIRER, 1977) and Fucales (BISALPUTRA, 6, FULCHER & McCULLY, 1968; MOSS, 1983; FIELDING **et al.** 1987). latter works deal principally with diferent species of the us **Fucus** but, on the other hand, no description of these uctures have been found in species of the genus **Cystoseira.** only data for **Cystoseira** are two photographs of the sieve tes in **C. stricta** (pictures by L. and M. Pellegrini) shown by ARDY-HALOS **et al.** (1984).

This study deals with the description of sieve plates in **editerranea.** The samples were collected in Blanes (Gerona, NE in) in February 1990. In the preparation for TEM a number of es from the middle zone of the cauloid of this species were arated and fixed in 4% paraformaldehyde and 4% gluteraldehyde 0.1 M sodium cacodylate buffer in sea water for 2 hours. The ples were washed four times in the buffer and post-fixed osmium tetroxide (1%) in the same buffer for 1 hour. The imens were dehydrated through a graded acetone series and edded in Spurr's resin. Cut sections were then post-stained in nyl acetate and lead citrate, and examined with a Phillips 301 . The sieve plates were observed in the cells of the inner tex.

The thickness of the sieve plates is about 0.41 um (0.33-- 1 um). This value is slightly higher than the values found by er authors in other species of Fucales and Laminariales (0.2 FIELDING **et al.**, 1987 for **F. vesiculosus, F. serratus** and **F. alis;** 0.3 um: FULCHER & McCULLY, 1971 for **F. vesiculosus;** 0.2 SCHMITZ & SRIVASTAVA, 1975 for **Alaria marginata;** 0.2-0.4 um: EMAN & SCHEIRER for **Laminaria saccharina**). The pores have a meter of aproximately 0.11 um (0.10-0.12 um). This value is ier than the estimates values measured by other authors in **us** spp. (0.037 um: BISALPUTRA, 1966 for **F. evanescens;** 0.04 FIELDING **et al.**, 1987 for **F. vesiculosus, F. serratus** and **F. alis;** 0.05 um: FULCHER & McCULLY, 1971 for **F. vesiculosus**) lower than the values found in Laminariales (0.11-0.30 um: MITZ & SRIVASTAVA, 1975 for **A. marginata;** 0.70 um: SIDEMAN & EIRER, 1977 for **L. saccharina;** 2.40-6.00 um: PARKER & HUBER, 5 for **Macrocystis pyrifera**).

MOSS (1983) considered the pattern of pores in the sieve tes of **F. vesiculosus** to be irregularly distributed while LDING **et al.** (1987) suggest that the pores have an even disbution across the plate. Our observations tend to agree with se of the former author, as the pores in the plates of **C. iterranea** appear much more irregularly and infrequently disbuted than those of **F. vesiculosus** (FIELDING **et al.**, 1987), a t which can also be readily seen in one of the photographs of se plates in **C. stricta** (L'HARDY-HALOS **et al.**, 1984).

Studies of the part of the cell wall where the sieve tes are located are currently being undertaken. We can state, ever, that the plasmalemma fibres, which pass through the es, connect with the inner layers of the cell wall and penete them. The same observation has been reported by FIELDING **et** (1987) for **Fucus** spp.

NOWLEDGMENTS

s research was sponsored by the C.I.C.Y.T. (Comisión Intermiterial de Ciencia y Tecnologia).
observations were carried out in the Electronic Microscope vice of the Barcelona University.

ERENCES

ALPUTRA, T. 1966. Electron microscopic study of the photoplasmic continuity in certain brown algae. **Can. J. Bot. 44**:89-93.

CHER, R.G. & M.E. McCULLY. 1968. Histological studies on the genus **Fucus**. III Fine structure and possible functions of the epidermal cells of the vegetative thallus. **J. Cell. Sci. 3**:1-16.

LDING, A.H., P.L. CARTER & C.A. SMITH. 1987. Sieve plates in **Fucus**: a reappraisal of size and pore distribution. **Phycologia 26**(4):501-504.

ARDY-HALOS, M.Th., J.P. LARPENT, J. GAILLARD, L. et M. PELLEGRINI. 1984. Morphogenèse expérimentale chez les algues. **Rev. Cytol. Biol. végét. Bot., 7**:311-362.

S, B.L. 1983. Sieve elements in the Fucales. **New Phytol. 93**:433-437.

ER, B.C. & J. HUBER. 1965. Translocation in **Macrocystis**. II Fine structure of sieve tubes. **J. Phycol. 1**:172-179.

MITZ, K. & L.M. SRIVASTAVA. 1974. Fine structure and development of sieve tubes in **Laminaria groenlandica** Rosenv. **Cytobiologia 10**:66-87.

MITZ, K. & L.M. SRIVASTAVA. 1975. On the fine structure of sieve tubes and the physiology of assimilate transport in **Alaria marginata. Can. J. Bot. 53**:861-876.

MITZ, K. & L.M. SRIVASTAVA. 1976. The fine structure of sieve elements of **Nereocystis lutkeana. Amer. J. Bot. 63**:679-693.

EMAN, E.J. & D.C. SCHEIRER. 1977. Some fine structural observations on developing and mature sieve elements in the brown alga **Laminaria saccharina. Amer. J. Bot. 64**:649-657.

B-I6

The *Posidonia oceanica* (L.) Delile Meadows of Egyptian Waters Preliminary Survey

H.-M. MOSTAFA, Y. HALIM, M. ATTA and A.-N. KHALIL

Oceanography Department, Faculty of Science, Alexandria University, Moharrem Bay, Alexandria (Egypt)

A survey of the *Posidonia oceanica* beds along the Egyptian coast has been carried out since 1986. The work is focussed on the growth dynamics of the plant and on its associated fauna and flora. Preliminary results are reported. *Posidonia oceanica* communities represent the most productive of all marine ecosystems in the south eastern Mediterranean waters along the Egyptian coast from the Lybian desert in the west to El Arish in the east (Fig. 1), as well in the north west Mediterranean (Molinier and Picard, 1952).

The western desert coast is characterized by large meadows of *Posidonia* exposed to open sea, to waves and water currents. The leaves are healthy, long, green all over and with only a slight epiphytic cover. The animal associations are also poor. Dead mattes of old *Posidonia* meadows are found covered with sand near green meadows in shallow areas (3-6 meters depth). The green meadows of *Posidonia* at shallow depths (5-8 meters) are patchy and scattered while the deeper meadows cover more extensive areas. Aleem (1955) mentioned the presence of two parallel belts of *Posidonia* in the western area off El Agami, the first, a shallow bed at 8-10 meters depth was interspersed with *Cymodocea*, while the second at 20 meters depth was occupied mainly by *Posidonia*. The present survey showed the existence of both belts but the second at 26 meters. Aleem (1955) also reported that *Posidonia* beds were most abundant at Burg El Arab, 50 km west of Alexandria, where the sediment is of coarse calcareous sand completely devoid of fixed algae. Thelin *et al.* (1985), located and studied *Posidonia* near the El Dabba area, west from El Alamein, at depths down to 27 meters. They gave some data about extension, leaf biometery, flowering and leaf epiphytes. Meadows are also extensive in Mersa-Matrouh harbour, where the Red Sea eel-grass *Halophila* sp. is also recorded (Aleem, 1955). Shallow *Posidonia* meadows were also located at Sidi Abd El Rahman, west of El Alamein.

The *Posidonia* meadows in front of Alexandria are formed in scattered patches located in the semi-closed bays specially at Miami, El Asafra and Montazah, (Fig. 1). The patches are found at depths ranging between 5-7 meters and are in most cases protected by rocks but subjected to the eastward flowing current. They are also subjected to direct and indirect organic pollution from city effluents. Adults leaves are heavily covered with epiphytes and are yellow-green to brown-green in colour. Heavy associations of animal groups inhabit the meadows. Some of these associations are reported elsewhere in this volume (Amphipoda, Polychaeta). Aleem (1955), reported the area between Rosetta and Damietta (delta coast) to be scarse in *Posidonia* meadows, *Cymodocea* being more frequent. From Port-Said to El-Arish, *Posidonia* meadows are abundant, located at the few rocky places between the two Ports.

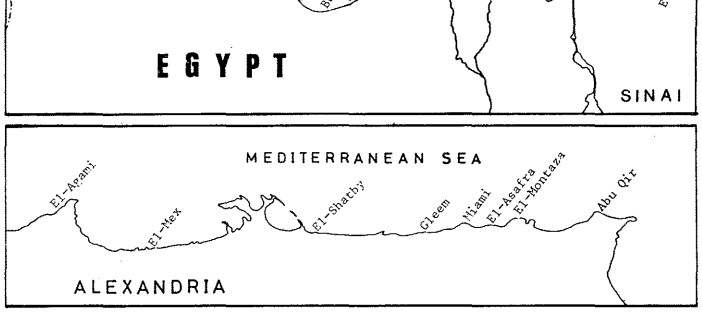


Fig. 1 - Showing Different Locations Along The Egyptian Coast.

REFERENCES

ALEEM, A.A., 1955 - Structure and evolution of the sea grass communities in the south eastern Mediterranean. In: Essays in the Natural Sciences in Honour of Captian Allan Hancock. Univer. of S. Calif. Press, Los Angeles. Cal.: 279-298.

MOLINIER, R. and J. PICARD, 1952 - Recherches sur les Herbiers de Phanérogames marines du littoral Méditerranéen Français. Ann. Inst. Océan. Paris, 27: 157-234.

THELIN, I., R.A. MOSSE, C.F. BOUDOURESQUE and R. LION, 1985 - Le benthos littoral d'el Dabaa (Méditerranée, EGYPT). 11. L'herbier à *Posidonia oceanica*. Rapp. Comm. int. Mer Médit., 29 (5): 247-248.

B

Evaluation of *Posidonia oceanica* Primary Production using Lepidochronological Analysis : preliminary results

Gérard PERGENT

LBMEB, Faculté des Sciences de Luminy, 13288 Marseille Cédex 09 (France)

When *Posidonia oceanica* (L.) Delile leaves die, only the blade falls away, the sheatting base remains attached to the rhizome and is then called a "scale" (PERGENT, 1987; PERGENT et al., 1989). These scales shown cyclic variations in their thickness and anatomy along the rhizome, each cycle corresponds to a one year period. The study of these chronological cycles is termed **lepidochronology** (PERGENT, 1987).

The presence of morphometrical correlations between scale and blade parameters (MOSSE, 1985; PERGENT, 1987) makes it of interest to test the possibility of establishing a method to give rough estimates of primary production based upon lepidochronological data. A method of this kind should be much less time consuming than classic methods (e.g. ^{14}C, ZIEMAN's leaf marking).

A study is actually in progress in three sites around Ischia Island (gulf of Napoly). The objective of this work is to make a comparison between results obtained by lepidochronological analysis and by the leaf marking method.

The length of blades which have lived above a given scale (sheating base) is established using the significant correlation existing between leaf length (L) and sheath lenght (SH) (MOSSE, 1985; PERGENT, 1987). In this way, a linear regression is determined, using phenological data, for each site L = f(SH).

The leaf density (weight par surface unit) shows variations according to age and birth period (THELIN et GIORGI, 1985). The parameter to be taken into consideration is final density, just before shedding. The mean leaf density is measured over a one year period.

By using the leaf renewal cycle, determined by lepidochronology, it is possible to identify the number and length scales formed during a given period of the year (PERGENT, 1987; PERGENT and PERGENT-MARTINI, in press).

For a given year and shoot, it is possible to evaluate the primary production of leaves from the following parameters :

N = mean number of leaves formed during a one year period.
SC = mean length of scales during a one year period.
L = mean length of previous leaves (L = f(SC)).
D = mean aged leaf density.

In addition, rhizome production, which is generally low (3% of total production in PERGENT, 1987), can be determined by weighting the rhizome section corresponding to the determinate one year period.

For leaf production (PL), the formula is : $PL = N \times L \times D$

The leaf primary production is evaluate in three sites of Ischia island (Tab. I).

	Mean Depth (m)	Number of leaves per year	Scale length SC (mm)	Regression line L = f(SH)	Leaf length L (mm)	Leaf density D (mg/cm)	Leaf production (g dw/shoot)	Shoot density (m²)	Leaf production (g dw/m²)
Site LA05	-5	7.1	39.9	y=30.6x-794	426.7	4.9	**1.48**	473	**702.2**
Site LA10	-10	5.3	41.9	y=21.2x-466	422.2	4.5	**1.01**	351	**353.4**
Site LA20	-20	6.6	40.7	y=16.2x-323	336.0	4.1	**0.91**	253	**230.1**

Table I : Evaluation of primary production (in g dry weigth per shoot and per m^2) in Ischia, using lepidochronological analysis.

Our results are consistant with the values obtained in previous works using leaf marking method :

- In the same site (Ischia, -4 m depth) WITTMANN and OTT (1982) found a net leaf production of 1.2 g dry weight per shoot (our results are 1.48 g dry weight per shoot), and WITTMANN (1984) found a net leaf production of 667 g dry weight per m^2 (our results are 702 g dry weight per m^2).
- In Port-Cros Bay, France (-1 to -2 m depth), THELIN and GIORGI (1984) found a net leaf production ranges from 1.2 and 1.8 g dry weight per shoot.

Evaluation of primary production from lepidochronological data appears to be a feasible target. It should be possible to evaluate very quickly primary production of *Posidonia oceanica* meadow in a given site and perhaps to follow its variation over a given period of time (previous years).

Acknowledgement :
This study has been supported by Commission of the European Communities as a part of the programme "A FUNCTIONAL APPROACH TO THE *POSIDONIA OCEANICA* ECOSYSTEM OF THE MEDITERRANEAN".

References :
MOSSE R.A., 1985 : *Mise au point d'une méthode rapide d'évaluation de la production primaire de Posidonia oceanica.* Contrat IFREMER, Lab. Ecol. Benthos, Fac. Sci. Marseille : 0-32.
PERGENT G., 1987 : *Recherches lépidochronologiques chez Posidonia oceanica (Potamogetonaceae). Fluctuations des paramètres anatomiques et morphologiques des écailles des rhizomes.* Thèse Doct. Océanol., Univ. Aix-Marseille II : 1-853.
PERGENT G., BOUDOURESQUE C.F., CROUZET A., MEINESZ A., 1989 : Cyclic changes along *Posidonia oceanica* rhizomes (Lepidochronology) : Present state and perspectives. *Marine Ecology*, 10 (3) : 221-230.
PERGENT G., PERGENT -MARTINI C., in press : Some applications of lepidochronological analysis in the seagrass *Posidonia oceanica*. *Botanica marina.*
THELIN I., GIORGI J., 1984 : *Production de feuilles dans un herbier superficiel à Posidonia oceanica, évaluée par une méthode dérivée de la méthode de Zieman.* International Workshop Posidonia oceanica Beds, Boudouresque C.F., Jeudy de Grissac et Olivier J. edit., GIS Posidonie publ., 1 : 271-276.
WITTMANN K.J., 1984 : Temporal and morphological variations of growth in a natural stand of *Posidonia oceanica* (L.) Delile. *Marine Ecology*, 5(4) : 301-316.
WITTMANN K.J., OTT J.A., 1982 : Effects of gropping on growth in the Mediterranean seagrass *Posidonia oceanica* (L.) Delile. *Marine Ecology*, 3(2) : 151-159.

Utilisation de la technique du Krigeage en cartographie benthique intérêt et limites

Gérard PERGENT

LBMEB, Faculté des Sciences de Luminy, 13288 Marseille Cédex 09 (France)

Le krigeage est une méthode d'interpolation stochastique de données réellement observées sur le terr permettant de tracer des lignes d'égale intensité d'un paramètre (MATHERON, 1969). Cette méth utilisée dans le domaine terrestre en géologie (KRIGE, 1966) en hydrologie (GAMBOLATI & VOI 1979) et en écologie (THIOULOUSE *et al.*, 1985), permet d'optimiser le traitement cartographiqu minimisant d'une part les pertes d'informations et d'autre part l'effort d'échantillonnage.

A ce jour cette technique a été utilisée, avec succès, en écologie marine pour suivre la distributior paramètres, présentant une répartition continue (peuplement ichtyologique *in* FRANCOUR MARCHADOUR, 1989). Au niveau benthique, la densité des faisceaux de *Posidonia oceanica* Delile et leur recouvrement ont été représentés par krigeage : des cartes d'isodensité ou d'isorecouvren de l'herbier ont ainsi été réalisées (SCARDI *et al.*, 1989; FRANCOUR & MARCHADOUR, 1989).

La tentation d'utiliser une telle technique, qui apparaît très rentable (effort d'échantillonnage réduit, re cartographique immédiat, méthode d'interpolation statistique et non empirique), est grande, surtout a l'apparition sur le marché de logiciels "près à l'emploi" qui ne nécessitent aucune connaissance statisti préalable mais n'apportent aucune précision quant à l'erreur d'interpolation engendrée (e.g. Surfer é par Golden Software, où le variogramme ne peut être visualisé).

Or, l'emploi de cette technique nécessite un certain nombre de précautions et elle apparait inadaptée c plusieurs domaines, tout particulièrement pour l'établissement de cartes biocénotiques :

- Du fait de la discontinuité des peuplements, l'interpolation par la méthode du krigeage induit "effets de ceintures" qui modifient de façon importante la surface des peuplements considéré intercalent des biocénoses inexistantes (Figure 1). En effet, il n'existe pas de successions ordonnées c la répartition des biocénoses en milieu marin (PERES & PICARD, 1964; BOUDOURESQUI MEINESZ, 1982). Si dans un secteur, nous observons la succession des peuplements suivants : (i) sa (ii) matte morte de *Posidonia oceanica*, (iii) herbier dégradé à *Posidonia oceanica* et (iv) herbier con à *Posidonia oceanica*, que l'on peut coder respectivement 0, 1, 2 et 3, dans un secteur voisin, l'her continu (code 3) peut être en contact avec une zone de sable (code 0); l'interpolation par krige intercalera, entre ces deux peuplements, une ceinture de matte morte (code 1) et une ceinture d'her dégradé (code 2) qui n'existent pas, et qui réduiront d'autant la surface des peuplement réellen présents (Figure 1).
- Pour un même secteur, le résultat de l'interpolation sera différent en fonction de la g d'échantillonnage (Figure 1). La reproductibilité de la méthode n'est donc pas assurée, et un suiv l'évolution des peuplements cartographiés n'est pas envisageable.

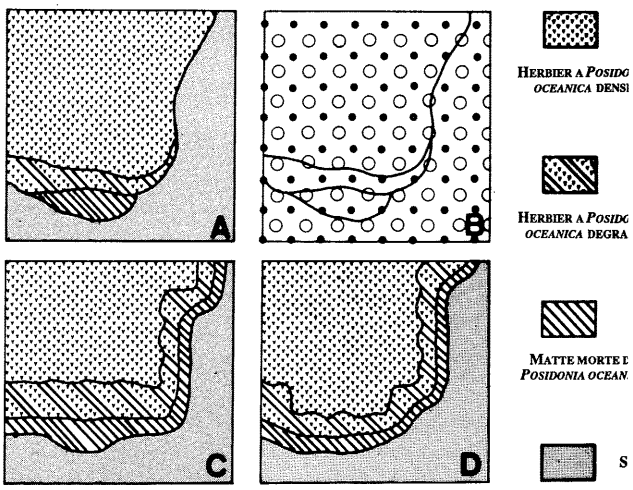


Figure 1 : Interpolation par la méthode de krigeage d'une carte théorique (A). La grille d'échantillonnage permet d'obtenir deux interprétations C (●) et D (○).

- La surface sur laquelle se fait l'interpolation, notamment lors de l'utilisation de ces logiciel correspond pas à la surface réellement étudiée mais généralement à un rectangle, dont une p correspond à la terre, ce qui biaise l'interpolation ("effet de bord"). L'emploi d'un "cache" sur les surf où l'interpolation ne doit pas avoir lieu (partie émergée) ne résout pas ce problème, et permet uniquer de ne pas faire figurer de peuplements marins sur la terre ferme.

Références :
BOUDOURESQUE C.F., MEINESZ A., 1982 : Découverte de l'herbier de Posidonie. *Cah. Parc nation. i Cros*, 4 : 1-79.
FRANCOUR P., MARCHADOUR M., 1989 :. Les fonds marins, et en particulier l'herbier à *Posidonia ocea* aux alentours du port de la Pointe-Rouge (Marseille). GIS Posidonie, édit., Marseille : 1-48.
GAMBOLATI G., VOLPI G., 1979 : Groundwater contour mapping in Venice by stochastic interpolator Theory. *Water Resour. Res.*, 15, 2 : 281-290.
KRIGE D.G., 1966 : Two dimensional weighted moving average trend surface for ore evaluation. *Journ. S. Inst. Min. Metall.*, 66 : 13-38.
MATHERON G., 1969 : Le krigeage universel. *Cah. Cent. Morphol. Math.*, 1 : 1-83.
PERES J.M., PICARD J., 1964 : Nouveau manuel de bionomie benthique de la Méditerranée. *Rec. Trav. Stn. Endoume*, 31(47) : 1-137.
SCARDI M., FRESI E., ARDIZZONE G.D., 1989 : Cartographic representation of sea-grass beds ; Applicati a stochastic interpolation technique (Kriging). International Workshop on Posidonia I Boudouresque C.F., Meinesz A., Fresi E. & Gravez V. edit., GIS Posidonie publ., 2 : 9p.
THIOULOUSE J., HOULLIER F., ONILLON J.C., 1985 : Variables régionalisées et dénombrements d'insec cas unidimentionnel. *C.R. Acad. Sc. Paris*, 301(9) :423-428.

}-I9

Standard Procedure for the study of *Posidonia oceanica* Leaf Litter

Christine PERGENT-MARTINI*, Gérard PERGENT* and Javier ROMERO**

*LBMEB, Faculté des Sciences de Luminy, 13288 Marseille Cédex 09 (France)
**Departamento de Ecologia, Facultad de Biologia, Universidad de Barcelona, 08028 Barcelona (Espana)

/hile leaf litter is recognized as one of the key compartments in the dynamics of terrestrial ecosystems)LSON, 1963; KARKANIS, 1975), for the Posidonia oceanica bed it has only been studied sporadically /ITTMANN *et al.*, 1981; FRANCOUR, 1990).

.s part of a general survey of the functioning of the Posidonia oceanica ecosystem ("A functional pproach to the *Posidonia oceanica* ecosystem of the Mediterranean"), a standard procedure has been 'orked out for determining the structure, chemical composition and fragmentation and degradation ıechanisms of *Posidonia* leaf litter.

ampling is carried out by scuba diving, using a suction device. A quadrat 35 cm square is set up in a omogeneous area that is representative of the Posidonia bed under investigation. Within this quadrat, the ving leaves are cut off at a height of 3 to 5 cm from the base and removed, and the shoots are counted. he leaf litter is collected in bags (1 mm mesh). Sampling is repeated three times for each station. The mples are transported from the sampling site to the laboratory in damp medium.

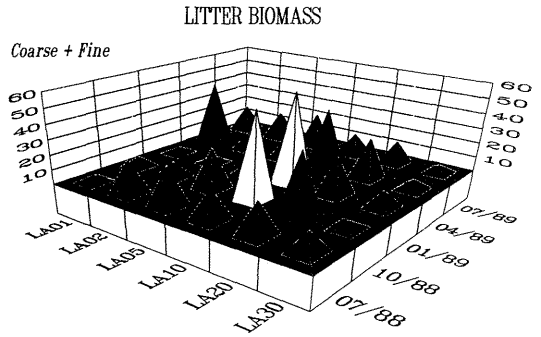
ı each sample, non-litter elements (eg. living leaves, shell debris, algae, animals etc) are removed by nd. Dead rhizomes, with or without scales, and whole scales are separated from the litter, and constitute e RHIZOME FRACTION. Sorting by gravity is carried out to separate the litter from the sediment, which is scarded. Two sieves of different mesh size are used to sort the litter into a COARSE FRACTION (leaves nger than 8 mm) and a FINE FRACTION (leaf debris of between 1 mm and 8 mm).

he three fractions obtained for each sample are placed in the dryer at a temperature of 70°C, until a nstant weight is obtained (usually 48 hours). After drying, the samples are weighed on precision scales mg).

eaf fragmentation experiments are carried out in situ. Aged adult leaves, that are still in place in the oots, are collected and brought back to the laboratory. They are weighed (sub-samples of 30 +/- 0.5 g) d placed in bags (1 mm mesh) sealed with strips of Velcro. The bags are returned to the environment neath the leaf cover in series of three. The series of bags are collected after a predetermined period of ne (1, 2, 3, 4, 8, 12, 16 and 24 weeks). The samples collected are separated into three size classes : aves with a length of > 5 cm (LARGE LEAVES) ; leaves with a length of between 5 cm and 8 mm (BROKEN EAVES), and leaf debris of between 8 mm and 1 mm (DEBRIS). Each fraction is dried in the dryer at 70°C onstant weight), then weighed.

he totality of the samples is powdered (pulveriser) and sieved (0.63 um mesh). The CHN content (Micro HN Determinator, CHN 800), the percentage of ash (Thermolyne Sybron type 2000, 8 hours at 550°C) d the Phosphorus content (Induction Coupling Plasma, after acid digestion according to DELGADO, 986) are measured for each fraction.

ur preliminary results (ROMERO *et al.*, sous-presse) would appear to suggest that the distribution tterns of leaf litter are subject to considerable variation according to the depth, time and site of mpling. At Ischia (Italy), leaf litter maxima (coarse fraction + fine fraction) are found at intermediate pths (Figure 1).



gure I : Mean litter biomass (in mg dry weight per quadrat) at Ischia (Italy), at various depths according to sampling date.

n investigation of degradation in situ, at -5 m and -20 m, has shown that depth does not appear to have y influence on the rate of degradation. On the other hand, the rate of degradation does depend on the ne of year of the investigation (higher degradation rate in July). The curve of decline is of the ponential type :

$y = \exp^{(-0.0066 x + 1.63)}$: - 5 m - October 1988 experiment.
$y = \exp^{(-0.0087 x + 1.78)}$: - 20 m - July 1988 experiment.

knowledgements : This study was made possible by financial support from the European Communities Commission and valuable assistance from the staff of the Ischia laboratory (Italy).

ferences

ELGADO, O., 1986. - Contenido de fosforo de los tejidos de fanerogamas marinas del Mediterraneo y su relacion con la dinamica de cada especie. *Oecologia Aquatica*, 8 : 139-151.

ANCOUR, P., 1990. - *Dynamique de l'écosystème à Posidonia oceanica dans le Parc National de Port-Cros. Analyse des compartiments matte; litière, faune vagile, échinodermes et poissons.* Thèse doctorat, Université Paris VI, 280 p.

ARKANIS, M., 1975. - Decomposition of litter of various species of deciduous trees and its effect in soil environment. *Fragmenta Floristica et Geobotanica*, 21 : 71-97.

SON, J.S., 1963. - Energy storage and the balance of producers and decomposers in ecological systems. *Ecology*, 44(2) : 322-331.

OMERO, J., PERGENT, G., PERGENT-MARTINI, C., MATEO, M.A., REGNIER, C., sous presse. - The detritic compartment in a *Posidonia oceanica* meadow : litter features, decomposition rates and mineral stocks. *Marine Ecology*.

ITTMANN, K., SCIPIONE M.B., FRESI E., 1981. - Some laboratory experiments on the activity of the macrofauna in the fragmentation of detrital leaves of *Posidonia oceanica* (L.) Delile. *Rapp. P.V. Réun. Commiss. internation. Explor. sci. Médit.*, 27(2) : 205-206.

B-I10

The Regression of *Posidonia oceanica* Meadows in El Campello (Spain)

J.-L. SANCHEZ LIZASO, J.-E. GUILLEN NIETO and A.-A. RAMOS ESPLA'

Institut d'Ecologia Litoral, Ctra. Benimagrell s/n. 03560 El Campello. Alicante (Espana)

B

ABSTRACT

The regression of *Posidonia oceanica* meadows has been studied along a 7 km coastal sector on the El Campello littoral. Changes of shallow *Posidonia* beds in the last 30 years are described. Deep *Posidonia* meadow is badly damaged due to illegal trawling. The first symptoms of trawling are detected at 13 m depth. But the deeper we go, the more degraded the meadow gets, reaching densities under 1 sh/m^2. Dead *Posidonia* is seen even suggest at 29 m depth. In order to protect the deep meadow, we suggest as a feasible solution the installation of artificial reefs.

INTRODUCTION

Posidonia oceanica meadow regression has been studied by a great number of scientists (see PERES, 1984). Studies on the effects of illegal trawling in *Posidonia* beds have been carried out in the Tyrrhenian Sea (ARDIZZONE & MIGLIUOLO, 1982; ARDIZZONE & PELUSI, 1983, 1984).

If we concentrate on Spain's situation, we can state that trawling has been forbidden since 1962 at less than 50 m for the whole year (*Orden de 7 de julio de 1962, Reglamento de la pesca de arrastre a remolque. B.O.E. N° 16*). In summer trawling is even forbidden at less than 130m depth (*Orden de 30 de julio de 1975 sobre pesca de arrastre en el Mediterraneo. B.O.E. N° 193*). However, trawling ships often work on *P. oceanica* meadow at less depth.

MATERIAL AND WORKING METHODOLOGY

This piece of research was conducted on a 7 km coastal sector at El Campello (Alicante, SE of Spain). In order to complete this study we carried out nine perpendicular transects to the coastline from the upper level of the *P. oceanica* meadows to a depth of 29m and, in addition, several precise dives. The obtained points were positioned by means of a sextant and enfilades to the coast (RAMOS, 1984). The reconstruction of the *Posidonia*'s upper level was made with the aid of aerial photographs taken in the years 1956, 1978 and 1987.

RESULTS

Two little breakwaters have been built in the area of research, between 1956 and 1987. If we compare the aerial photographs, we can clearly see that shallow *Posidonia* meadows have moved back. The greatest regression appears in the north of Cala Baeza and La Coveta, between 1978 and 1987. At the same period the little port of Cala Baeza was filled up, and now boats cannot tie up in this port.

Deep *Posidonia oceanica* meadow is destroyed due to illegal otter trawling. The depth at which the first trawling symptoms appear increases gradually from north to south. In the northern part of the studied area, which is off Carritxal beach, the first degradation symptoms were observed at 13 m depth; in the intermediate sector, at Cala Baeza, they appear at either 15 or 16 m; finally, in the southern part, Barranc d'Aigues-Morro Blanc, at 17 m depth. At this depth 0.5 m wide channels parallel to the coast line are detected as well as pulled up rhizomes on account of the mechanical effect of trawl boards.

As we go deeper, channels become more frequent and wider; there seem to be more pulled up rhizomes and the proportion of dead matte increases. *Posidonia* meadow density decreases quickly until it reaches values under 1 sh/m^2. From 22 m depth, the sea bottom presents a desolating sight; there are very few *Posidonia* spots and a great mass of dead matte frequently covered with light layers of sediments. *Posidonia oceanica* remains have been detected at 25 m depth at Carritxal and even at 29 m depth between Barranc d'Aigues and Morro Blanc.

CONCLUSIONS

Regression in a shallow *Posidonia oceanica* meadow due to coastal line modifications is seen. More serious seems to be the regression due to illegal trawling.

It is believed that along 7 km of coast, 290 Has of *Posidonia* meadow have been destroyed due to otter trawling. Unfortunately all the province of Alicante seems to be threatened by the same devastating problem.

Moreover several unpublished issues point out that the *Posidonia* meadow at Tabarca's island, La Vila Joiosa and El Campello is largely altered or destroyed at a depth which may fluctuate between 13 and 24 m. Likewise, according to some fishermen, the same thing is happening at other ports in the province of Alicante.

Vigilance committees have clearly proved to be inadequate and insufficient in the battle against illegal trawling and its ravaging effect on *Posidonia oceanica*. In our view, the only feasible solution to this problem is to install artificial antitrawling reefs, like those installed in Tabarca's Marine Reserve (Ramos *et al.*, in press).

REFERENCES

ARDIZZONE, G.D. & MIGLIUOLO, A. 1982. Modificazioni di una prateria di *Posidonia oceanica* (L.) Delile del Medio Tirreno sottoposta ad attività di pesca a strascico. Atti XIII Congr. Soc. Ital. Biol. Mar., Cefalù, It. su Nat. sicil., S.IV, VI (Suppl.): 509-515.

ARDIZZONE, G.D. & PELUSI, P. 1983. Fish population exposed to coastal bottom trawling along a Tyrrhenian Sea. Rapp. Commis. internation. Explor. sci. Mer Médit., Monaco: 107-110.

ARDIZZONE, G.D. & PELUSI, P. 1984. Yield and damage of bottom trawling on *Posidonia* meadows. International Workshop on *Posidonia oceanica* beds. Boudouresque C.F., Jeudy de Grissac A. & Olivier, J. (edit.) G.I.S. Posidonie publ. 1 Fr: 63-72.

PERÈS, J.M. 1984. La regression des herbiers a *Posidonia oceanica*. International Workshop on *Posidonia oceanica* beds. Boudouresque, C.F.; Jeudy de Grissac, A. & Olivier, J. (edit.) G.I.S. Posidonie publ. 1 Fr: 445-454.

RAMOS A.A. 1984. Cartografia de la pradera superficial de *Posidonia oceanica* en la bahia de Alicante (SE, Espana). International Workshop on *Posidonia oceanica* beds. Boudouresque, Ch. F.; Jeudy de Grissac, A. & Olivier, J. (edit.) G.I.S. Posidonie publ. 1 Fr: 57-61.

RAMOS *et al.* (in press).

B

Leaf Biomass and Production of *P. oceanica* at Spanish Eastern Coast

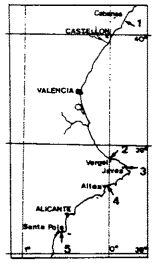
J.-L. ESTEBAN, I.-M. GINER, V. BENEDITO, J. TORRES, R. CAPACCIONI and A.-M. GARCIA-CARRASCOSA

Invertebrates and Marine Biology Laboratory, Department of Animal and Cellular Biology and Parasitology, Faculty of Biological Sciences, Valencia University, 46100 Burjasot, Valencia (Spain)

P. oceanica is the most important phanerogam in the Mediterranean Sea. Its role as primary producer and as ecological system has been repeatedly enhanced. Measures of leaf production allows to discern its real importance in the energetic processes at the shallow coastal systems, and gives a parameter to evaluate its conservation stage as a reflect of its growth capacity.

MATERIAL AND METHODS

This paper gives leaf biomass and production values of orthotropic shoots, at five meadows with different structure, whose particular characteristics are briefly pointed out:



1. - P. oceanica meadow over mixed substrata on sand and gravel coast, at CABANES. Study area: Upper limit area. Terrace and deeper mat between rock blocks. 3 to 5 m depth. 560 sh/m² density. No apparent alterations.
2. - P. oceanica reef at exposed areas at VERGEL. Study area: External front area, 0.5 to 1.5 m depth, 1200 sh/m² density. Alteration by water pollution and touristic use.
3. - P. oceanica bed over rock substratum at SAN ANTONIO CAPE. Study area: Homogeneous bed over a rock floor, 5 to 6 m depth. 479 sh/m² density. No apparent alteration but sudden increase of sedimentation rates in early summer.
4. - Stable P. oceanica meadow on roky coast at ALTEA. Study area: Elevated terrace 2 m depth and bottom mats 4 m depth. Complicated morphological structure but no alterations.
5. - P. oceanica reef at sheltered areas at SANTA POLA bay. Study area: External front and central area, 1.5 to 2.5 m depth. 400 sh/m² density. Alterations caused by regeneration of the beach with fine sediments, and intense touristic use.

More detailed description of the meadows in (5).

Orthotropic shoots were marked bimonthly at each place. A hole were made through all leaves in a shoot with a hypodermic needle. 15 shoots were analyzed for each period. Leaves were separated and numbered following the GIRAUD (7) classification. Each leaf was cut into three parts: The Basal part (B), situated down the original mark level. The Nev part (A) is the elongation of the leaf, situated between the actual position of the hole and the original level. And the distal part (K), that is the rest of the leaf blade.

Epiphytes were cleaned with a razor blade and length and width were measured for each part, and weighted after drying at 60 ºC, 24 h.

Locality	depth	Biomass gr DW / shoot P+B	B+J	A+J	Mean	Production gr DW /sh. day P+B	B+J	A+J	O+J	total	gr/year	Author
Santa Pola			592		356	423			5.6	2.4	1182	This work
Vergel		167	397		214	268		1.4	3.5	1.7	994	"
C.d.Antonio			520		257	359			3.7	1.4	1163	"
Altea			498		178	329		1.5	3.5	1.5	796	"
Cabanes			568		217	483			3.5	1.8	1.1	1199	"
I. Hedas	5			799	339	594			6.8	0.5	1470	ROMERO	1985
Iechia	4		1127		254	820		10.6		2.0	2722	????	1981
Cerceda	10		158	411		787			10.7	1.4	1718	RAT	1959
Port Cros PE	0.75			887	271	510		6.2	-8.2	7.5	1200	THELIN &	1984
"	PJ	0.2	579		154	354		5.5		0.7	909	THELIN &	1984
"	BPP	2.2		766	288	889			10.4	1.3	1850	"	
Carry	3			625	208	381						AUGIER & CRISTIANI	1984
"	6			736	128	456						"	
Assumet	3	291		527		384						"	
"	6			625	250	388						"	
Endoumetes	6		506		288	387						"	
"	2		305		13	176						"	
"	6		387		97	242						"	
P. Carry	3		453		210							"	
Iechia	5		963		250	517						MARTELLA &	1984

Table 1. Leaf biomass and production extreme seasonal values

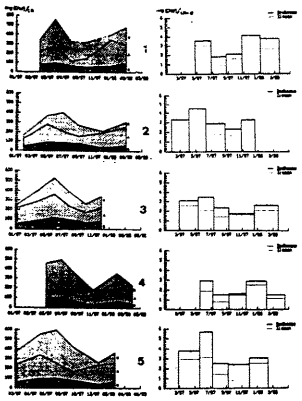


Figure 1. Leaf biomass (left) and production rates (right) per shoot at Cabanes (1), Vergel (2), San Antonio (3), Altea (4) and Santa Pola (5).

Biomass was calculated for each leaf part.

Production was calculated by ZIEMAN method (14) as the mean dry weight of the new parts (A) per shoot, and reestimated taking in account range changes and variations in density following the BEDHOMME et al. method (3).

CONCLUSIONS AND DISCUSSION

- Leaf biomass and production of Posidonia oceanica at Eastern Spanish coast are included into the range of values reported from other places of the Mediterranean (Tab 1).
- Annual variation of leaf biomass follows the same pattern at the five localities studied, increasing from Autumn to Summer. Low biomass values of B (Basal parts with ligules) and K (leaf blade of old leaves) reflects high leaf fall in autumn. At the opposite, during summer, formation of ligules is active and B biomass is high.
- Leaf production always exists. Minimal values are in Summer, and high values are reached in Spring and Autumn. In Autumn most of the production is caused by leaf elongation as suggest low differences between values obtained by both methods (3,14). In Spring changes in density of leaves are important and these differences are greater.
- At Cabanes, high autumn production rates could be related to optimal stage of conservation of this meadow. Its stable structure with a developed rhizome system allows a great capacity of storage of reserve substances (11) that supports leaf growth when disfavourable conditions are present (low temperatures and light intensity), adopting an adaptation strategies for competition with its epiphytes (9).
- At Altea, there must be similar conditions, but a hard winter storm caused strong damage to the meadow structure, tearing out many leaves and complete shoots and rhizomes (Only six shoots could be restored in this time). This fact produced lost of alive leaf material and rhizome reserves, showing low biomass and productions values in winter.
- At Santa Pola, there is a high level of alteration and the meadow is in a constant degradation-regeneration process, and even though there are important production rates, the growth pattern must be mostly regulated by environmental conditions (light and temperature).
- At San Antonio Cape, a sudden increment of sediment rates could alter the growth cycle of shoots (4), appearing as intermediate between both kind of meadows.
- At Vergel, intense hydrodynamic conditions may be the cause of low leaf biomass and production. Most of its growth energy must be directed to shoot division. In this way the barrier reef maintain a high shoot density (1200 sh/m²) to resist the constant wave action.

BIBLIOGRAPHY

1. AUGIER, H.; CRISTIANI, G., 1984. GIS Posidonie publ. Pr., 1:245-254.
2. RAT, D., 1984. Aquat. Bot., 20:43-64.
3. BEDHOMME, A.L.; THELIN, I.; BOUDOURESQUE, C.F., 1983. Bot. Mar., 26:35-43.
4. BOUDOURESQUE, C.F.; JEUDY DE GRISSAC, A; HERIBERT, A., 1984 GIS Posidonie publ.,Pr., 1:185-191.
5. ESTEBAN, J.L. (1985) Dinámica, Ciclo de Hojas y Producción foliar en praderas de P. oceanica, del Litoral de la Comunidad Valenciana (Mediterraneo Occidental). Tesis de Licenciatura. Universidad de Valencia. 142 pp.
6. GARCIA-CARRASCOSA, A.M.; SOLER, J.; BORONAT, J.; GIMER, I.M.; ESTEBAN, J.L.; BAGUAR. J., (1985) Las praderas submarinas de P. oceanica en el litoral de la Comunidad Valenciana: etc. Institució Valenciana d'Estudis e Investigació, Generalitat Valenciana. (Informe Proyecto de Investigación).
7. GIRAUD, G., 1979. Rapp. Comm. int. Mer. Médit., 25/26(4): 215-217.
8. MATILLA, L.; OTT, J.A., 1984. GIS Posidonie publ., Pr., 1:119-127.
9. OTT, J.A., 1979. Mar. Biol., 1:59-104.
10. OTT, J.A., 1980. Mar. Ecol., 1:47-64.
11. PIRC, H., 1984. GIS Posidonie publ. Pr., 1:227-234.
12. ROMERO MARTINENGO, J., 1985. Estudio ecológico de las fanerógamas marinas de la costa catalana: Producción primaria de Posidonia oceanica (L.) Delile en las islas Hedas. Tesis Doctoral. Univ. Barcelona, 261 pp.
13. THELIN, I.; GIORGI, J., 1984. GIS Posidonie publ. Pr., 1:271-276.
14. ZIEMAN, J.C., 1974. Aquaculture, 4:139-143.

Distribution and Preliminary Evaluation of the State of the *Posidonia oceanica* on the Coasts of the Gulf of Valencia (Spain, Western Mediterranean)

V. BENEDITO, J. TORRES, I.-M. GINER, J.-L. ESTEBAN, R. CAPACCIONI and A.-M. GARCIA-CARRASCOSA

Invertebrates and Marine Biology Laboratory, Department of Animal and Cellular Biology and Parasitology, Faculty of Biological Sciences, Valencia University, 46100 Burjasot, Valencia (Spain)

The studied sector of shoreline corresponds to all the coasts from Vinaroz (in the south of Ebro's Delta) to San Antonio Cape (Alicante). There are several works about this area (1, 2).

This study has been realized during two years and it is based on the realization of perpendicular transects to the coasts in scuba-diving with a one-man hydroplane. There was an average of 3 Km distance between the transects, from level 0 to 20 m depth. This precisely allows us to estimate the state of the meadows, and to observe the substitution facies distribution.

The substitution facies are almost exclusively those of Cymodocea nodosa, Caulerpa prolifera (5), Dyctiopteris membranacea and those of photophilic algae in sheltered areas biocoenosis (3, 4).

Four sectors can be diferentiated on this coast:

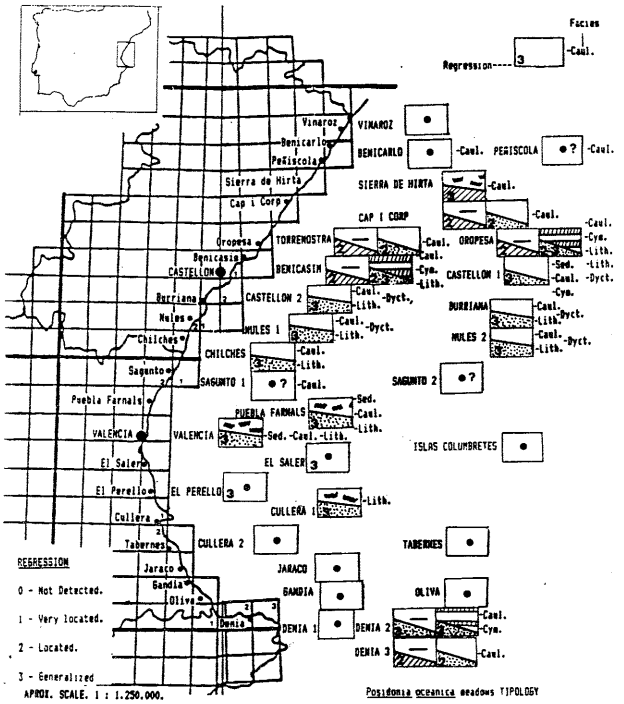
- Vinaroz-Torrenostra sector. There is a significative influence of the Ebro river in all this zone, because of the long-shore transport carries the materials fron the river towards the south.

A general lack of P. oceanica can be observed. Only small enclaves of it remain in Alcocebre.

- Torrenostra-Mijares river sector. On this strip of the coast, P. oceanica meadows are continuous and their represenLation is good althoug there is a general regression. This regresion is especially important in the superior limits, where substitution facies of C. prolifera can be normally settled. This alga together with D. membranacea forms large recoverings up to 9 m depth in the shallow zones of meadows in Castellón.

- Mijares river-Valencia sector. There are very degradated meadows in this sector. And in their inferior limits a great proliferation on concretionated masses of Lithothamniaceae onto dead rhizome terraces can be observed.

- Valencia-San Antonio Cape sector. This shoreline zone is under the influence of great fresh-water flows because it is a coast of lagoons. Moreover, big amounts of sediments are also poured here through the great number of rivers that run into it. P. oceanica meadows are completely lost; sometimes buried by sediments and some others due to hard tempests. And concretionated masses of Lithothamniaceae can be also found onto dead terraces in deep areas. In the far south of this sector (Vergel-Denia sector) P. oceanica meadows are found and also form barrier-reffs which go parallel along 2 Km of the coast approximately. And they are in a state of clear regression.



BIBLIOGRAPHY:

(1) ALONSO MATILLA, L. A.; CARRETERO, J. L.; GARCIA CARRASCOSA, A. M., 1987. Monografia de la Coselleria d'Obres Publiques, Urbanisme i Transports. Generalitat Valenciana.
(2) COSTA, M.; GARCIA CARRASCOSA, A. M.; MONZO, F.; PERIS, J. B.; STUBING, G.; VALERO, E., 1984. Publicaciones del Excmo. Aymto. Castellón de la Plana. 209 pp.
(3) MOLINIER, R., 1959. Vegetatio. 9(3-5): 121-312.
(4) MOLINIER, R.; PICARD, J., 1952. Annales de l'Institut Océanographique. T. XXVII: 157-234.
(5) PERES, J. M., 1967. Oceanogr. Mar. Biol. Ann. Rev., 5:449-533.

I13

stribution and Preliminary Evaluation of the State of the *Posidonia oceanica* Meadows on the Coasts of Alicante (Spain, Western Mediterranean)

. TORRES, I.-M. GINER, V. BENEDITO, J.-L. ESTEBAN, R. CAPACCIONI and A.-M. GARCIA-CARRASCOSA

ertebrates and Marine Biology Laboratory, Department of Animal and Cellular Biology and Parasitology. Faculty of Biological Sciences, Valencia University, 46100 Burjasot, Valencia (Spain)

The studied area includes the coasts of Alicante between San Antonio Cape o south of Roig Cape.

The P. oceanica meadows are widely represented along this coast, and there e also several works about their distribution and state. Some of these works e focused on certain especific places (7) (8) and some others are more extensi (3). With this work we try to give more recent information about the meadows this area, that can also be useful to show what the evolution is in the last w years.

The work in the sea was developed during last two years. It consisted of the alization of perpendicular transects to the coast in scuba-diving with an one- n hydroplane from the level 0 to 20 m depth. In cliff areas, 27 m approximately n be sometimes reached.

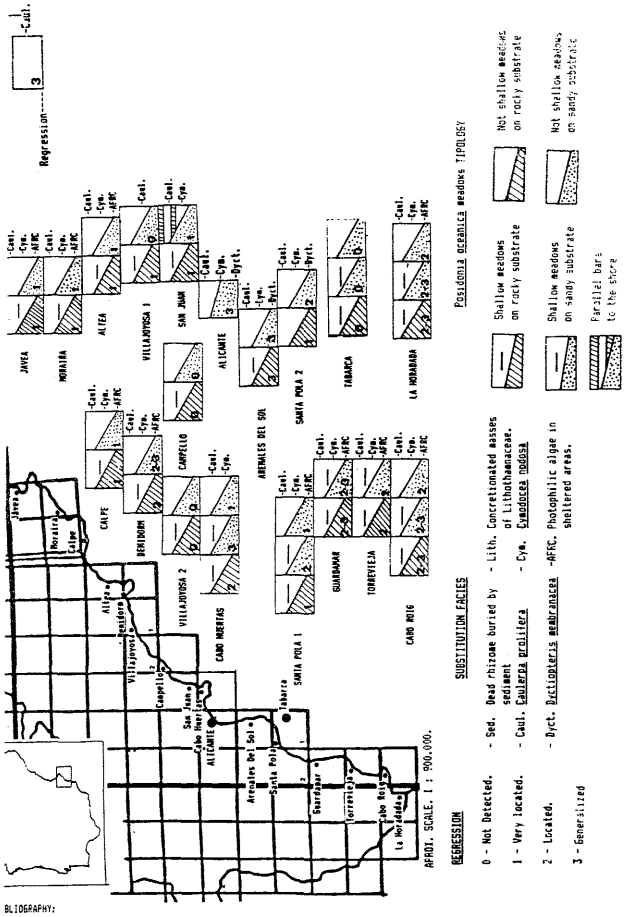
Along the coast of Alicante the meadows are broadly distributed and there e many places where this biocoenosis reaches its climax state. This agrees with calities that not only have less density of human populatio but also have a all industrial activity or even none. The Marine Reserve of Tabarca, Negro pe-Calpe sector and south of Benidorm-Campello can be pointed out.

In general, the superior limits of the meadows start nearly in the shoreli- . In this way, important P. oceanica recoverings can be already found in the rst meters of the infralitoral zone on sandy and rocky coasts of a smooth ope. These shallow zones of the meadows are the most degradated, and substitu- on facies corresponding to photophilic algae in sheltered areas, facies of ctiopteris membranacea (4) (5), of Caulerpa prolifera and of Cymodocea nodosa) are settled on them. C. prolifera and D. membranacea form very dense and rge recoverings in Arenales del Sol and south of Santa Pola. Apart from these terations of the upper limits, these meadows are in very good conditions in eper areas. In the plunging type cliffs this phanerogam grows from the bases of e rocky wall itself.

The places where the lower limits of the meadows are above 20 m depth are st a few. Although the coverings with mud from this depth is very common, and adows are more deteriorated.

Except certain localities, several symthoms of alterations can be observed l along the coast. Whereas in many places these alterations are local, in ot- rs they are getting quite generalized like in the Alicante-Arenales del Sol ctor for example.

It is important to mention that meadows form barrier-reefs (5) in some pla- s of this coast, although they all are in clear regression.



BLIOGRAPHY:

) COSTA, M.; GARCIA CARRASCOSA, A. M.; MONZO, F.; PERIS, J. B.; STUBING, G.; VALERO, E., 1984. Publicaciones del Excmo. Ayto. Castellon de la Plana. 299 pp.

) GARCIA CARRASCOSA, A. M., 1988. En: Guia de la Naturaleza de la Comunidad Valenciana, 211-248 pp. Sanchis Moll, E. J. (Ed.). Servicio de publicaciones del Institut Valencià d'Estudis i Investigacio. Generalitat Valenciana. 662 pp.

) GARCIA CARRASCOSA, M.; SOLER, J.; BORONAT, J.; SAGUAR, J.; ESTEBAN, J. L.; GINER, I. M., 1988. Informe Proyecto Investigacion, Institució Valenciana d'Estudis i Investigacio, Generalitat Valenciana.

(4) MOLINIER, R., 1959. Vegetatio. 9(3-5): 121-312.

(5) MOLINIER, R.; PICARD, J., 1952. Ann. Inst. Oceanogr. Monaco. 7 (XVII): 157-234.

(6) PERES, J. M., 1967. Oceanogr. Mar. Biol. Ann. Rev. 5: 449-532.

(7) RAMOS, A., 1984. Int. Workshop Posidonia oceanica Beds, Gis Posidonie publ., Fr. 1: 57-61.

(8) RAMOS, A., 1985. En: La reserva marina de la isla Plana o Nueva Tabarca. pp: 111-148. Ayuntamiento de Alicante-Universidad de Alicante. 194 pp.

B-I14

Posidonia oceanica Barrier-Reefs at Spanish Eastern Coasts. Preliminary Data

J. TORRES, A.-M. GARCIA-CARRASCOSA, V. BENEDITO, J.-L. ESTEBAN, I.-M. GINER and R. CAPACCIONI

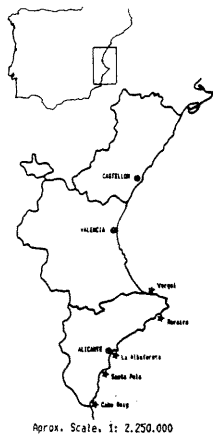
Invertebrates and Marine Biology Laboratory, Department of Animal and Cellular Biology and Parasitology, Faculty of Biological Sciences, Valencia University, 46100 Burjasot, Valencia (Spain)

B

INTRODUCTION.

Posidonia oceanica meadows form, at shallow waters, some formations known as barrier-reefs, which are described by several authors from diverse areas of the Mediterranean (MOLINIER & PICARD, 1952; MOLINIER, 1959; PERES, 1967). According to CAMP (1989) there is not this kind of formation at the spanish mediterranean coasts, although RAMOS (1983) denoted the existence of one barrier-reef in the south of Huertas Cape.

However, in recent explorations, five of these formations have been detected in the coast of Alicante (Vergel, Portet de Moraira, Albufereta de Alicante, Santa Pola and Roig Cape-Pilar de la Horadada). Also has been confirmed their absence in the coasts of the Gulf of Valencia.



Aprox. Scale. 1: 2.250.000

The characteristics considered by us to recognize this barrier-reefs are the following:

- The rhizome stratum at the upper limit of P. oceanica meadow rises up from the sedimentary substrate, reaching to such a level that the leaves of P. oceanica are close to the water surface.
- These elevated terraces form the reef front with a parallel disposition to the coast, and located at some distance from shoreline (50-100 m).
- The reef front acts as a breakwater, leaving behind it a sheltered area rather like a lagoon. This lagoon is characterizated by a high mud and sandy-mud deposition rate, and (usually are present) by the frecuent existence of Caulerpa prolifera and Cymodocea nodosa recoverings.

RESULTS.

VERGEL.- At this locality, the barrier-reef forms a continuous bar parallel to shoreline along 5-6 Km, from Punta de los Molinos to the east of the harbour of Denia. The breakwaters of this harbour are located onto the same reef front, breacking its structure.

The reef front is 100 m far from shoreline. The rhizome terraces reach 3 m height and are crossed by channels of different dimensions.

This barrier-reef shows a general regression process due to pollution, intensive touristic pressure and recent beach regeneration works. In most of its extension only remain disperse high density patches of alive shoots (1200 sh/m²), prevailing substitution facies of Caulerpa prolifera and photophilic algae populations recovering the dead rhizomes. However the high developement of the rhizome terraces of the front maintains the barrier-reef structure.

In some areas the lagoon reaches 4 m depth and there are some dense Cymodocea nodosa meadows. Recently the sedimentation rate has been increased by the beach regeneration works, producing an important mud deposition.

The most important feature of this barrier-reef is its location at an open coast with high hydrodynamic conditions, by its direct exposure to the prevalent (east) and strongest (north, northeast) winds.

PORTET DE MORAIRA.- This small bay is lightly closed by a width extension of shallow rhizome terraces of less than 1 m height, that form a low defined reef front. In this barrier-reef the sedimentary channels runs through both sides of the bay. The lagoon is very shallow and does not present vegetal recovering. This bay is used as a natural harbour and the anchorage of sportive boats damages the P. oceanica barrier-reef.

SANTA POLA.- The barrier-reef forms a continuous banner of 50 m width and 3 km length, parallel to shore. The prerecifal lagoon has been artificially filled with fine sediments to improve turistic use of the beach causing a serious damage to the structure. Most of the lagoon populations have been directly burrowed under the sediment and the abundant mud fraction is easily carried out by water movement producing a high water turbidity that limites photosythetic activity of P. oceanica. Moreover deposition of mud burrows the alive shoots at the reef front.

At the inner part of the reef the dead rhizome are recovered by Caulerpa prolifera, photophilic algae and disperse Cymodocea nodosa patches. At the reef front there are several sedimentary pot-holes, with important mud deposits in the bottom (up to 70 cm) and dense patches of Caulerpa prolifera recovering the rhizome walls.

ALBUFERETA DE ALICANTE.- This barrier-reef was extended from the south of Huertas Cape to the Albufereta beach, forming a bar parallel to the coast (RAMOS, op. cit.). Nowadays it is very regressioned, only remaining some dead rizome terraces near the Albufereta sportive harbour, and a small front at the western part of the Huertas Cape.

The construction of the harbour and the enlargement of the Almadraba beach have contributed to the regression of the P. oceanica barrier reef, due to they have been realized onto the reef front.

ROIG CAPE-PILAR DE LA HORADADA.- At this area the barrier-reef is formed by rhizome terraces of 3 m heigth with abundant sedimentary pot-holes and channels. At the north sector there are areas of alive shoots between width extensions of dead rhizome terraces which are recovered by photophilic algae, and by Cymodocea nodosa and Caulerpa prolifera. The latter is very frequent in the pot-holes. Towards south the terraces form a continuous front parallel to the coast, with less amount of dead rhizome on which is settled the recovering mentioned above.

At the lagoon exists an important mud deposition and a Cymodocea nodosa and Caulerpa prolifera cover. This barrier-reef shows a good conservation stage, although nowadays the regression symptoms are very apparent due to the increase of urban pressure.

BIBLIOGRAPHY:

CAMP, J. 1989. In: Historia Natural dels Països Catalans, Vol. 14. Fundación Enciclopedia Catalana.

MOLINIER, R. 1959. Vegetatio, 9 (3-5): 121-312.

MOLINIER, R. & PICARD, J. 1952. Annales de l'Institut Oceanographique, 27: 157-234.

PERES, J.M. 1967. Oceanogr. Mar. Biol. Ann. Rev., 5: 449-533.

RAMOS, A. 1983. In: Hombre y medio natural en Alicante. Secretariado de Publicaciones Universidad de Alicante. pp. 73-84.

Etude Lépidochronologique de *Posidonia oceanica* dans la région d'Alger (Algérie) : Données Préliminaires

Rachid SEMROUD*, Souad MEZEGRANE** et Latifa SOLTANE**

*L.B.M.E.B., Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)
**I.S.N., Université des Sciences et de la Technologie H.B., BP.39, El Alia, Bab-Ezzouar, Alger (Algérie)

B

Dans le cadre d'une étude générale de l'écosystème à *Posidonia oceanica* de la région d'Alger, nous nous sommes appliqués à mettre en oeuvre une nouvelle méthode d'investigation des herbiers : la lépidochronologie. Cette technique, basée sur les variations d'épaisseur des écailles, présentes le long des rhizomes (PERGENT *et al.*, 1989), permet d'appréhender la structure et la dynamique actuelles et passées de l'herbier (nombre de feuilles produites par an, vitesse de croissance et production de rhizome, paléofloraison...).

Les prélèvements ont été effectués dans deux stations (Tamentefoust et Marsa), situées à l'Est de la baie d'Alger, de part et d'autre du cap Matifou. En Avril 1989, 10 rhizomes orthotropes ont été récoltés, à chaque station, en scaphandre autonome, à 2 et 8 mètres de profondeur.
L'étude lépidochronologique de ces rhizomes est réalisée selon le protocole décrit par PERGENT (1987).

Les principaux paramètres étudiés sont (i) l'épaisseur moyenne des cycles (amplitude); (ii) le nombre d'écailles par cycle (période); (iii) la date d'inversion des cycles; (iv) la vitesse de croissance et la production de rhizome (Tableau I).

	Station Marsa		Station Tamentfoust	
	(- 2 m)	(- 8 m)	(- 2 m)	(- 8 m)
Densité de l'herbier (faisc./m²)	476.0	172.0	275.0	114.0
Epaisseur des cycles (µm)	573.6	666.4	594.0	707.3
Nombre d'écailles par cycle	9.2	9.8	8.7	9.0
Vitesse de croissance des Rhizomes (mm)	7.2	12.7	6.8	7.0
Production de Rhizome (mg ps / Rh . an)	63.3	123.2	88.8	72.3
Production de Rhizome (g ps / m² . an .)	30.1	21.2	24.4	8.2

Tableau I : Principaux paramètres lépidochronologiques de l'herbier à *Posidonia oceanica* de la région d'Alger.

Les résultats que nous obtenons sont comparables à ceux relevés dans la littérature (Tableau II), pour des stations situées à des profondeurs équivalentes.

Toutefois, l'épaisseur moyenne des écailles semble plus importante que pour les autres localités étudiées. Le nombre d'écailles par cycle, que nous observons, est toujours plus important, que les valeurs avancées par les autres auteurs, ce qui a pour conséquence une production de rhizome beaucoup plus élevée (123 mg de poids sec par rhizome et par an à la station Marsa - 8 m).

	BOUDOURESQUE et al., 1983		PERGENT 1987				PERGENT et al., 1988
	Galeria (- 8 m)	Port-Cros (- 2 m)	Port-Cros (-2m/-11m)	Banyuls (-2m/-12m)	Izmir (-2 m)	Kerkennah (- 2 m)	Marseille (- 8 m)
Densité de l'herbier (faisc./m²)	470	640	645 / 317	1163 / 335	510	600	550
Epaisseur des cycles (µm)			530 / 508	492 / 600	616.0	613.0	
Nombre d'écailles par cycle			7.9 / 7.1	7.6	7.0	7.8	8.1
Vitesse de croissance des Rhizomes (mm)			6.7 / 7.6	8.6 / 6.4	7.5		11.9
Production de rhizome (mg ps / Rh . an)	76	43	59.4 / 80.2	51.3 / 57.8			
Production de rhizome (g ps / m² . an)	42	28	38.3 / 25.4	59.7 / 30.9			

Tableau II : Différents paramètres (densité de l'herbier, nombre d'écailles par cycle, épaisseur moyenne, vitesse de croissance et production de rhizomes) de l'herbier à *Posidonia oceanica*, relevés dans la littérature, pour différentes localités et profondeurs.

Remerciements : Nous remercions Christine et Gérard PERGENT pour leur participation à la mise en forme de ce document.

Références bibliographiques :

BOUDOURESQUE C.F., MEINESZ A., PERGENT G., 1983. Mesure de la production annuelle de rhizomes dans l'herbier à *Posidonia oceanica* à Port-Cros (Var) et Galeria (Corse). *Rapp. P.V. Réun. Commiss. internation. Explor. sci. Médit.*, Monaco, 28 (3) : 135-136.

PERGENT G., 1987. *Recherches lépidochronologiques chez Posidonia oceanica (Potamogetonaceae). Fluctuations des paramètres anatomiques et morphologiques des écailles des rhizomes.* Thèse Doct. Océanol., Univ. Aix-Marseille II, Fr. : 1-853.

PERGENT G., BOUDOURESQUE C.F., CROUZET A., MEINESZ A., 1989. Cyclic changes along *Posidonia oceanica* rhizomes (Lepidochronology) : Present state and perspectives. *Marine Ecology*, 10 (3) : 221-230.

PERGENT G., PERGENT C., FRANCOUR P., 1988. *Cortiou état zéro. Reconnaissance des herbiers. Mise en place des balisages.* DETSE et GIS Posidonie, Marseille, Fr. : 1-107.

Phénologie de *Posidonia oceanica* dans la région d'Alger (Algérie) : Données Préliminaires sur la Biométrie Foliaire

Rachid SEMROUD*, Naïma BENKORTEBY** et Fatima-Zohra TAMOUZA**

*L.B.M.E.B., Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)
**I.S.N., Université des Sciences et de la Technologie H.B., BP.39, El Alia, Bab-Ezzouar, Alger (Algérie)

La phénologie des herbiers à Posidonia oceanica est bien connue dans le bassin Nord de la Méditerra (GIRAUD et al., 1977; ROMERO-MARTINENGO, 1985; PANAYOTIDIS, 1986; CALTAGIRO 1986; PERGENT et PERGENT-MARTINI, 1988). En revanche, les données concernant les côtes No Africaines sont fragmentaires ou très anciennes (MOLINIER et PICARD, 1953; FARGHALY DENIZOT, 1984; PERGENT et PERGENT-MARTINI, 1988).
L'analyse de la phénologie des herbiers à *Posidonia oceanica*, que nous avons entrepris sur le litto algérien, est une première approche qui s'inscrit dans un programme plus vaste d'étude fonctionnement de cet écosystème si largement représenté sur nos côtes.

Les deux stations étudiées sont situées à l'Est de la baie d'Alger de part et d'autre du cap Matifou :
La station de Tamentefoust (ex La Pérouse) à l'interieur de la baie correspond à une zone calme bien protégée.
La station de Marsa (ex Gembart) à l'Est du cap est située dans une zone à fort hydrodynamism Pour chaque site, les prélèvements sont réalisés, en plongée en scaphandre autonome, à deux profonde (2 et 8 mètres). Chaque récolte est constituée de 5 réplicats de 15 rhizomes orthotropes, terminés par faisceau vivant, et distants d'1 mètre les uns des autres. 75 faisceaux ont ainsi été récoltés, tous les tr mois, entre Avril 1988 et Juillet 1989.
L'étude phénologique de ces faisceaux est réalisée selon le protocole décrit par GIRAUD (1977).

Les principaux paramètres étudiés sont (i) le nombre de feuilles adultes et intermédiaires; (ii) la biométr foliaire (longueur, largeur, longueur de la base); (iii) le coefficient A (% de feuilles ayant perdu leur ap *in* GIRAUD, 1977); (iv) le Leaf Area Index (Tableau I).

	Station Marsa		Station Tamentfoust	
	(-2 m)	(-8m)	(-2 m)	(-8m)
Densité (Nombre de faisceaux par m²)	476	172	275	114
Nbre moyen de Feuilles par Faisceaux	5.8	6.3	5.9	5.8
Longueur moyenne des Feuilles (en mm)				
Feuilles adultes	176.0	391.6	217.0	287.9
Feuilles intermédiaires	173.0	276.2	173.0	197.2
Largeur moyenne des Feuilles (en mm)	10.8	11.2	11.0	10.3
Longueur moyenne de la Base (en mm)	27.3	41.7	33.3	32.3
Coefficient "A" moyen (en %)				
Feuilles Adultes	98.7	96.9	99.9	91.0
Feuilles intermédiaires	51.1	34.5	38.3	26.7
Global (Ad. + Int.)	76.5	67.7	70.4	59.7
Leaf Area Index moyen/ Faisceaux (en cm²)	108.2	238.9	122.5	150.2
Leaf Area Index moyen/ m² (m²/m²)	5.2	4.1	3.4	1.7

Tableau I : Principaux paramètres phénologiques de l'herbier à *Posidonia oceanica* de la région d'Alger.

Dans l'ensemble, nos résultats sont comparables aux données de la littérature pour des stations situées des profondeurs équivalentes (Tableau II). Toutefois, il faut noter que la largeur des feuilles e généralement plus élevée que dans les autres localités (Tableau II) avec des feuilles pouvant atteindre mm de large à Marsa et 13 mm à Tamentfoust.

	GIRAUD et al., 1977		BAY, 1978	CALTAGIRONE, 1986		PERGENT et PERGENT-MARTINI, 1988				
	Corse	Cassis	Corse	Italie		Turquie	Port-Cros		Banyuls s/mer	
	(-10 m)	(-10 m)	(-10 m)	(-2 m)	(-10 m)	(-2 m)	(-2 m)	(-11 m)	(-2 m)	(-12 m)
Nbre Feuilles/ Faisc.	6.0	5.2		7.7	8.0	6.4	5.8	5.4	5.1	5.4
Long. Feuilles (mm)										
F. adultes				406.4	670.5	355.0	401.0	395.0	115.0	303.0
F. intermédiaires						239.0	306.0	258.0	111.0	201.0
Larg. Feuilles (mm)				9.6	10.0	9.7	9.8	10.4	8.3	9.8
Long. Base (mm)				32.9	38.0	28.2	32.9	34.9	17.1	27.0
Coef. "A" (%)										
F. Adultes						74.0	64.6	27.5	94.9	56.8
F. intermédiaires						11.2	27.0	3.8	41.7	14.4
Global (Ad. + Int.)						48.1	51.2	19.2	79.4	44.4
L. A. I. / Faisc. (cm²)	469.2	410.8		298.6	510.0	130.0	153.0	133.0	37.0	72.0
L. A. I. / m²/m²	51.6	18.6	11.8	14.5	20.7	6.7	9.9	4.2	4.3	3.9

Tableau II : Caractèristiques phénologiques (Nbre de feuilles/faisceaux, biométrie, Coefficient "A", et L.A.I.) relevées dans littérature, pour différentes localités et profondeurs.

Références bibliographiques :

BAY D., 1978. Etude *in situ* de la production primaire d'un herbier de Posidonies (*Posidonia oceanica* (L.) Delile) de la ba de Calvi-Corse. *Progr. Rép. Stn. Océanogr. Stareso, Univ. Liège*, Belg., 18 : 6 p non num. + 1-251.
CALTAGIRONE A., 1986. *Fauna epifita della Posidonia oceanica (L.) Delile di P.Ta Garavano (Ventimiglia). Idroidi briozoi.* Tesi di Laurea, Universita' degli studi di Torino : 1-154.
FARGHALY M., DENIZOT M., 1984. *Posidonia oceanica (L.) Delile on the eastern coasts of Libya.* International Worksho Posidonia oceanica Beds, Boudouresque C.F., Jeudy de Grissac A., Olivier J. edit., GIS Posidonie pub Fr., 1 : 419-422.
GIRAUD, G., 1977. *Contribution à la description et à la phénologie quantitative des herbiers à Posidonia oceanica (L Delile.* Thèse Doctorat 3ème cycle, Univ. Aix-Marseille II : 1-150.
GIRAUD G., BOUDOURESQUE C.F., MARCOT-COQUEUGNIOT J., MEINESZ, A., VERLAQUE, M., 1977. Indic foliaires de *Posidonia oceanica* (Linné) Delile en Corse et dans la région marseillaise. *Rapp. P.V. Réu Commiss. internation. Explor. sci. Médit.*, 24 (4) : 131-132.
MOLINIER Roger, PICARD J., 1953. Etudes biologiques sur les herbiers de Phanérogames marines à l'Ouest d'Alger. *Bul Stn. Aquicult. Pêche Castiglione*, 4 : 7-34.
PANAYOTIDIS P., 1986. Influence de la floraison sur le cycle de renouvellement des feuilles de *Posidonia oceanica* (L Delile, dans le golfe de Saronikos (Mer Egée, Grèce). *Rapp. P.V. Réun. Commiss. internation. Explo sci. Médit.*, 30 (2) : 6.
PERGENT G., PERGENT-MARTINI C., 1988. Phénologie de Posidonia oceanica (Linnaeus) Delile dans le bassi Méditerranéen. *Ann. Inst. océanogr. Paris*, N.S., 64(2) : 79-100.
ROMERO-MARTINENGO J., 1985. *Estudio ecológico de las Fanerógamas marinas de la costa Catalana : producció primaria de Posidonia oceanica (L.) Delile en las islas Medes.* Tesis Doct. Facultad Biol. Univ. Barcelo : 1-261.

B-I17

Live *Posidonia oceanica* in a Corraligenous Algal Bank at Sulana Bay, Corsica

Charles F. BOUDOURESQUE*, Charles H. BIANCONI** and Alexandre MEINESZ***

*L.B.M.E.B., Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)
**Parc Naturel Régional de la Corse, Galeria, Haute Corse (France)
***Environnement Marin Littoral, Université de Nice, 06034 Nice Cédex (France)

The depth of Posidonia oceanica (L.) Delile prairie lower limits seems to be more constant than previously thought, at least in the western Mediterranean basin : 34-36(38)m around Port-Cros Island, France (HARMELIN and LABOREL 1976), 30-32(39)m around Ischia Island, Italy (COLANTONI et al. 1982), and 35-37 m in Elbu Bay, Corsica.

At Sulana Bay (South of Elbu Bay), beneath the lower limit of the P. oceanica prairie, scattered P. oceanica shoots were discovered living within a coralligenous algal bank of Pseudolithophyllum cabiochae Boudouresque et Verlaque (Rhodophyta, Corallinaceae), 43-44 m depth : 20-30 shoots/100m² ; some of them were collected in July, 1984. They consist of a live rhizome (pink on section) 10-20 cm long with a single (rarely 2-3) leaf bundle, tightly wedged into coralligenous crevices, but not definitely attached or rooted. Leaves are rather short (40-50 cm) and 9-10 mm width. A lepidochronological analysis of rhizome scales (leaf sheaths remaining on rhizomes after limb shedding) was performed ; a sharp decline of the rhizome growth rate occurs in 1976 for rhizome Nr 1 (Table I) ; this decline is gradual (1974 to 1976) for rhizome Nr 2 ; the rhizome Nr 3 is of special interest because of its shape (Fig. 1) : the part corresponding to years 1971 to 1978 is horizontal ; nevertheless, the scale arrangement, together with the number of scales per year, clearly indicate that this part of the rhizome was not creeping but vertical, at the time when leaves corresponding to present scales were alive ; beneath the bend (year 1979), scale arrangement and number of scales per year are in accordance with the in situ vertical position of the rhizome.

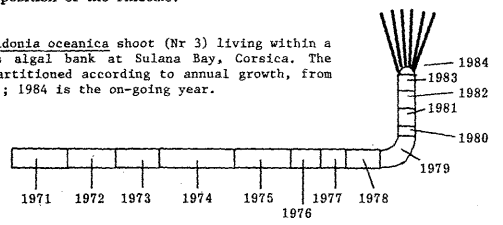


Fig. 1 : Posidonia oceanica shoot (Nr 3) living within a coralligenous algal bank at Sulana Bay, Corsica. The rhizome is partitioned according to annual growth, from 1971 to 1983 ; 1984 is the on-going year.

It is hypothesized that the material studied corresponds to drifting rhizomes uprooted during storms in shallow prairies ; the sharp or gradual decline in growth rate (associated or not with bending of the rhizome) could indicate the year of arrival : 1974 (rhizome Nr 2), 1976 (Nr 1) and 1979 (Nr 3). The partial recovery of the growth, together with the successful setting of new branchs, which occurs in 1982 and 1983 (Nr 1 and 2) seem to mean that the transplantation stress is over.

Rhizome Nr	1		2		3	
Year	S	L	S	L	S	L
1983	8	6*	10	10°	5	4
1982	10	5	10	9°	6	5
1981	6	2	8	5*	6	5
1980	8	2	6	4*	4	3
1979	8	3	8	6	10	10
1978	6	2		9	8	9
1977	8	2		7	6	7
1976	8	4		9	8	8
1975		8		12		15
1974		7		13		20
1973		8		23		12
1972		8		28		13
1971		6		23		15
1970		6		23		
1969		6		26		
1968		7				
1967		6				
1966		7				
1965		7				
1964		9				
1963		7				

Table I : Lepidochronological analisis of P. oceanica rhizomes (Nr 1, 2 and 3). The on-going year (1984) is removed. S = number of scales per year. L = lenghening of the rhizome (mm/yr). * = occurrence of a dead branch. ° = occurrence of a living branch. At the lower part of rhizomes, scales were in bad condition : their number, which may prove to be inaccurate, is omitted.

The survival of drift shoots for up to 10 years, several meters below the lower limit of genuine prairies, is not inconsistent with the generally accepted opinion that this lower limit corresponds to the seagrass compensation depth ; dealing with a species in which growth is exceedingly slow and life span covers several centuries, even millenia, compensation depth must be estimated over long periods. A shower of rooted shoots probably lands nearly everywhere after storms ; the coralligneous banks offer them the opportunity of being wedged into crevices ; although it is clear that they do not develop even small beds, they are able to survive and to grow, but they probably do not survive unfavorable periods (e.g. years with poor light balance). As a result, the presence of scattered P. oceanica shoots within coralligenous banks of Sulana is not to be regarded as a downward spreading of the P. oceanica prairie, or as relics left by the upward retreat of this prairie ; HARTOG's (1977) hypothesis, which suggests that the slow upward spreading of coralligenous banks after the last glacial period and the rise of the sea level is not completely over, is not supported by our results.

ACKNOWLEDGEMENTS : This work was supported by the French Ministère de l'Environnement, the Parc Naturel Régional de la Corse, the EEC "Functional approach to the Posidonia ecosystem of the Mediterranean" programme and GIS POSIDONIE. The authors are endebted to Jean Robert LEFEVRE for diving assistance and to Anthony McKENNA for checking of the English text.

REFERENCES

COLANTONI P., GALLIGNANI P., FRESI E., CINELLI F., 1982. Patterns of Posidonia oceanica (L.) Delile beds around the Island of Ischia (Gulf of Naples) and in adjacent waters. P.S.Z.N. Marine Ecology, Germ., 3 (1) : 53-74.

HARMELIN J.G., LABOREL J., 1976. Note préliminaire sur la morphologie de l'herbier profond de Posidonies Posidonia oceanica (Linné) Delile, à Port-Cros. Trav. sci. Parc natl. Port-Cros, Fr., 2 : 105-113.

HARTOG C. den, 1977. Structure, function and classification in seagrass communities. Seagrass ecosystems. A scientific perspective, C. P. Mac Roy and C. Helfferich edit., Dekker publ., USA : 89-121.

B-I18

Le Réseau de Surveillance des Herbiers de Posidonies mis en place en Région de Provence-Alpes-Côte d'Azur (France)

Charles F. BOUDOURESQUE*, Mary-Christine BERTRANDY**, Eric BOULADIER***, Paule FORET****, Alexandre MEINESZ*****, Gérard PERGENT * et Pierre VITIELLO*

*LBMEB, Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)
**CELCOP, Service Maritime des B.d.R., 3, Quai du Port, 13002 Marseille (France)
***GIS Posidonie, Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)
**** CAPVAR, DDE, 244 Avenue Infanterie de Marine, 83070 Toulon Cédex (France)
***** Laboratoire Environnement Marin Littoral, Faculté des Sciences, 06034 Nice Cédex (France)

Les herbiers à Posidonia oceanica (Linnaeus) Delile constituent l'un des écosystèmes les plus importants de Méditerranée pour l'économie générale de ses espaces littoraux : (i) production primaire considérable, exportation d'une grande partie de cette production (sous forme de détritus) vers d'autres écosystèmes ; (ii) abri, site d'alimentation, frayère ou nurserie pour de nombreuses espèces ; (iii) stabilisation des fonds sableux et contrôle du profil d'équilibre des rivages sableux (BOUDOURESQUE et MEINESZ, 1982 ; MAZZELLA et al., 1986 ; etc). Un peu partout en Méditerranée, et principalement au voisinage des grands centres industrialo-portuaires, les herbiers à P. oceanica ont régressé, dans des proportions parfois considérables ; les causes en sont la pollution, les aménagements littoraux, la trop forte pression d'ancrage ou de chalutage, la modification des flux sédimentaires et le déséquilibre du fonctionnement de l'écosystème (BOURCIER, 1982 ; ARDIZZONE et PELUSI, 1983 ; MEINESZ et al., 1985 ; etc).

Au cours de la dernière décennie, d'importants efforts ont été accomplis le long du littoral PACA (Provence-Alpes-Côte d'Azur), dans le cadre du PAL (Plan d'assainissement du littoral) : limitation des rejets de polluants, stations d'épuration, rejets en profondeur (MEINESZ et al., 1985). Il est apparu nécessaire de surveiller l'évolution des herbiers à P. oceanica et de leurs limites pour savoir si leur régression se poursuit. En considérant l'herbier comme un indicateur biologique de la qualité globale des eaux, cette surveillance permet en outre de vérifier l'efficacité des efforts accomplis.

C'est la raison pour laquelle le Conseil Régional PACA a mis en place, à partir de 1984, le "Réseau de Surveillance Posidonie". Celui-ci s'appuie sur une collaboration originale entre (i) les élus (Conseil Régional, Conseil Général des Alpes-Maritimes), (ii) les services de l'Etat (Services Maritimes et DDE des Bouches-du-Rhône, du

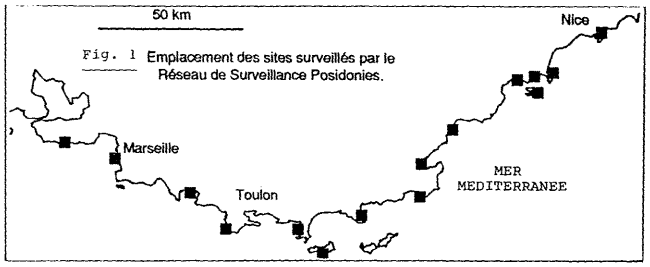


Fig. 1 Emplacement des sites surveillés par le Réseau de Surveillance Posidonies.

Var et des Alpes-Maritimes) et (iii) les Universites de la région. La maîtrise d'ouvrage est assurée par le GIS Posidonie.

La mise en place du Réseau de Surveillance Posidonie est maintenant terminée. Il comporte (Fig. 1) 12 balisages profonds et 12 sites superficiels de surveillance par photographies aériennes ; d'Ouest en Est : Carry-le-Rouet, Prado (Marseille), La Ciotat, Le Brusc, Giens, Porquerolles, Saint-Aygulf, Bormes, Cap Lardier, Grimaud, Cannes, Iles de Lérins, Golfe-Juan, Bacon et Villefranche-sur-Mer. Les balisages sont installés en profondeur, à la limite inférieure de l'herbier ; chaque balisage est constitué par une série de 12 balises en béton (50 kg), à 5 m d'intervalle ; elles sont photographiées selon un processus rigoureusement standardisé (Fig. 2) ; elles servent en outre de repères pour des observations et des prélèvements complémentaires (granulométrie du sédiment, densité des faisceaux, biométrie, lépidochronologie, biomasse des épiphytes, etc). En ce qui concerne la limite supérieure de l'herbier, des photos aériennes sont prises selon un processus standardisé (altitude, objectif, heure, etc) ; elles sont ensuite traitées pour corriger les déformations dues à la paralaxe (ortho-photoplans) ; sur chaque site, des vérités-mer permettent de sélectionner une dizaine de structures et d'en identifier la nature (intermattes, sable, matte morte, tombants de matte) et la position. Le retour sur chaque site (balisages profonds et sites superficiels) s'effectue avec un pas de temps de trois ans.

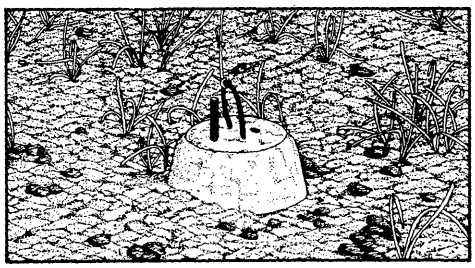


Fig. 2 : Schéma, d'après une photo, d'une balise à la limite inférieure de l'herbier. On distingue les faisceaux de feuilles. Site de Carry-le-Rouet (Bouches-du-Rhône). Dessin : Fabrice DI SANTO.

REFERENCES

ARDIZZONE G.D. et PELUSI P., 1983. Regression of a Thyrrhenian Posidonia oceanica prairie. Rapports et Procès-Verbaux des Réunions de la Commission internationale pour l'Exploration scientifique de la Méditerranée, 28 (3) : 175-177.

BOUDOURESQUE C.F. et MEINESZ A., 1982. Découverte de l'herbier de Posidonie. Cahiers du Parc national de Port-Cros, 4 : 1-3 + 1-79.

BOURCIER M., 1982. Evolution au cours des quinze dernières années des biocoenoses benthiques et de leurs faciès dans une baie méditerranéenne soumise à l'action lointaine de deux émissaires urbains. Téthys, 10 (4) : 303-313.

MAZELLA L., SCIPIONE M.B., GAMBI M.C., FRESI E., BULA M.C., RUSSO G.F., DE MAIO R., LORENTI M. et RANDO A., 1986. Le praterie sommerse del Mediterraneo. Laboratoire d'Ecologie du Benthos, Stazione zoologica di Napoli édit., Ital. : 1-63.

MEINESZ A., BOUDOURESQUE C.F., JEUDY DE GRISSAC A., LANARE J.P., LEFEVRE J.R. et MANCHE A., 1985. Aménagement et préservation du milieu marin littoral en région Provence-Alpes-Côte d'Azur : Bilan et perspectives. Colloque franco-japonais d'Océanographie, Marseille, 1 : 133-142.

B

B-I19

Reproductive cycle of *Posidonia oceanica*

Lucia MAZZELLA and Maria Cristina BUIA

Laboratorio di Ecologia del Benthos, Stazione Zoologica di Napoli, 80077 Ischia (Italy)

Studies on the reproductive cycle of Posidonia oceanica were conducted in situ in a meadow off Lacco Ameno, Ischia (Gulf of Naples) along a depth transect from 1m to 32m for several years. Occurrence of both flowering and fruiting were recorded over a long temporal scale. Simultaneous measurements of leaf biomass and production were performed in different stands of the same meadow.

P. oceanica flowering had occurred almost every year since 1979. Fruiting was not always recorded, and dead inflorescemces at an initial fruiting stage were often found. Between shallow (up to 15m) and deep stands (from 15m to 28m) P. oceanica showed a persistent phase-difference, whereby there was a flowering delay of about two months in the deep meadows, always following the summer maximum temperature. In shallow beds the first flowers were usually recorded in September, occasionally at the beginning of October. In the deep meadows this stage was observed in November or beginning of December. Fruit developed from December to March-April in shallow stands, and from February to May-June, sometimes to July, in deep stands (Fig. 1). After fruit maturation, this floats on the water surface transported by water movements and once opened, the seed might germinate in areas far from the mother meadows. Germination was studied only once at environment light and temperature. This phenomenon seems to be succesfull and almost 70% of collected fruits germinated. At the time of collection (end of May) the seeds already beared the cotyledon, very young leaves and a primitive root. This finding excludes seed dormancy. After one month the seedlings had an average of 5 leaves and 2 roots per shoot. The maximum leaf number (11) in seedlings kept in an aquarium was found after 3 months (August) following germination (BUIA & MAZZELLA, in press).

In situ, production of new leaves on mature plants occurs almost continuosly. However the maximum leaf appearence was recorded from August to October in shallow stands and from October to November in deep stands. The leaf growth also showed a persistent phase-difference between stands at different depths. Two peaks in leaf production have been found at 5m, one in October-November and one in March-April for the shallow plants, while for the deep plants only one peak has been recorded in April-June. The lowest growth rate was found to be in summer at shallow stands and in autumn for deep ones. In shallow meadows the highest leaf biomass was consequently found from March to June reaching 965mg per shoot, while at deep stands the maximum was reached from April-May to July-August with 899 mg per shoot. The lowest values of biomass were found from September to November in shallow waters, after the period coinciding with maximum leaf shedding and after the minimum growth rate, and from November to February in the deep stations, preceeding the maximum growth period (Fig. 2a, 2b). These minimum biomass values seem to coincide with the appearence of flowers. The epiphyte biomass trends reflected those of the leaves, but in following years great differences in values were found in both stations (Fig. 2a, 2b) (BUIA et al., in press).

Rhizome growth, followed in a shallow stand of the same prairie, differed according to rhizome type. The plagiotrope rhizome had a **growth** of 4.1cm per year while the orthotrope showed an elongation of **1.5-1.8**cm per year (PIRC, 1983). In the same stand, similar findings

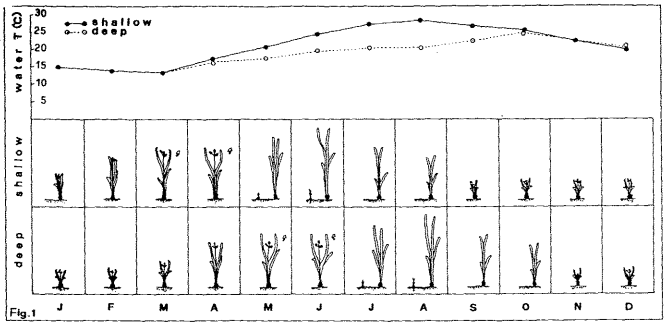


Fig.1

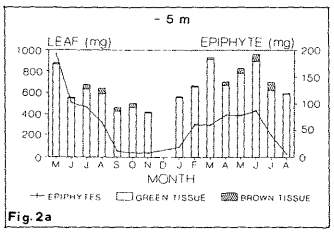


Fig.2a

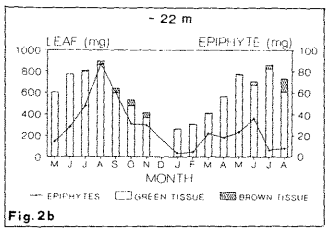


Fig.2b

were recorded by WITTMANN (1984): yearly production of 274mg per shoot for plagiotrope rhizomes and 30mg for the orthotropes.

Temperature and quantum irradiance changes during one year seem to regulate the reproductive cycle of P. oceanica. Moreover, sedimentation rate can be of fundamental importance for growth processes.

REFERENCES

BUIA, M.C. & L. MAZZELLA, 1990. Reproductive phenology of the Mediterranean seagrasses Posidonia oceanica (L.)DELILE, Cymodocea nodosa (UCRIA) ASCHERS., and Zostera noltii HORNEM. Aquat.Bot.(In press).

BUIA, M.C., ZUPO, V. & L. MAZZELLA, in press. Primary production and growth dynamics in Posidonia oceanica. P.S.Z.N.I.: Marine Ecology.

PIRC, H., 1983. Below ground biomass of Posidonia oceanica (L.) DELILE and its importance to the growth dynamics. Proc. Inter.Symposium on Aquatic Macrophytes: 177-181.

WITTMANN, K.J., 1984. Temporal and morphological variations of growth in a natural stand of Posidonia oceanica (L.) DELILE. P.S.Z.N.I.:Marine Ecology, 5(4):301-316.

B-I20

A Compared Phenology between the Mar Menor (Murcia, S.E. Spain) seaweeds and the Mediterranean ones

I.-M. PEREZ-RUZAFA

Departamento de Biologia Vegetal I, Facultad de Biologia, Universidad Complutense de Madrid (Espana)

Mar Menor is a coastal-lagoon placed in the South East of Spain. Its area is about 135 Km² and its deepest profundity is 6.5 m. The salinity varies between 42‰ and 49‰ along the year. Its water is oligotrophic and the temperature varies between 9ºC minimum and 31ºC maximum (PEREZ-RUZAFA, 1989).

A research on 75 benthic macrophytes species has been carried out in the period 1985-1987. They were taken from 124 samples: 40 in Spring (March-November), 46 in Summer (June-August), 18 in Autumn (September-November) and 20 in Winter (December-February). The patterns carried out by CORMACI et al. (1984) in their study about the reproduction in East Sicily Ceramiales has been followed. The comparation has been made with the phenology data given by FELDMANN (1937-42), RIBERA (1983), BARCELO (1987) and SOTO (1987).

Summer has been the season with the highest number of species (60 taxa) present in the zone, followed by Spring (54 taxa), Winter (45 taxa) and Autumn (38 taxa). Only 26 of the 75 studied taxa fit to the vital-cycles described for the Mediterranean sea. All the rest choose different strategies in order to adapt themselves to the notable seasonal dynamism of the lagoon.

During the warmest mounths the number of taxa with a tropical affinity increases (Acetabularia calyculus, Alsidium corallinum, Spyridia filamentosa, etc). The presence of Boreal taxa, however, hasn't been observed during the Winter period.

Other taxa have been only observed in the lagoon when they are more frecuent in the Mediterranean sea. We are talking about Wrangelia penicillata, Antithamnion cruciatum, Stypocaulon scoparium, Dictyota dichotoma, Boergeseniella fruticulosa and Callithamnion corymbosum. During the cold mounths Padina pavonica, Alsidium corallinum, Cystoseira compressa and C. ercegovicii disappear from the lagoon.

Species that are fertile during the whole year in the Mediterranean sea tend to be unfertile or just disappear in the lagoon during Autumn-Winter. That is the behaviour of Fosliella farinosa, Chondria tenuissima, Herposiphonia secunda, Titanoderma litorale and Chylocladia verticillata.

In other cases the species usually loose some parts of their thallus during Autumn and Winter. This is the strategy of Sphacelaria rigidula, S. tribuloides, Gelidium crinale y Cladophora spp.

Cladophoropsis modonensis, Acetabularia acetabulum y Siphonocladus pusillus are fertile during the warm season in the Mediterranean sea. In the lagoon they have a precocious development (February-March), related to the swift rissing of the temperature of the lagoon.

Ectocarpus siliculosus, an opportunist species appears in Mar Menor in Autumn and Spring, when the pioneer communities settle the lagoon.

In the Mediterranean sea (Figure 1) the presence of the taxa is almost stabilized (77-86‰) along the year. In the lagoon a deep seasonal fluctuation appears (79-89‰ in Spring-Summer to 54-56‰ in Autumn-Winter).

A light decrease of the maximum fertility can be observed in this lagoon comparing it with the Mediterranean sea (55‰ in the Mediterranean sea and 47‰ in Mar Menor). The presence and fertility have a similar behaviour, we mean that in the Mediterranean sea the fertility index is stabilized (55-44‰) and in Mar Menor we can see a clear seasonality (47-49‰ in Spring-Summer and a 20-17‰ in Autumn-Winter).

The plants that settle these environments modify their phenologic behaviour from the one that they have in the close Mediterranean sea. In Mar Menor we can see a clear unfavorable period during Autumn-Winter specially in Rhodophyceae, they are reduced to a 24% in the cold mounths. In the Mediterranean sea the maximum decrease is in Autumn (68‰).

The percentage of annual taxa against the perennial ones is, here, higher than in the Mediterranean sea. MATHIESON & PENNIMAN (1986) observed the same in the stuary of New Hampshire (USA).

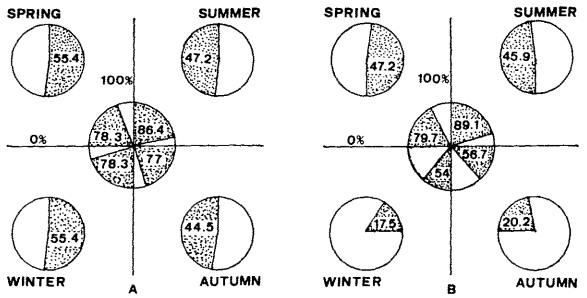


Figure 1. Percentages of taxa present in each season (large circle) and percentage of fertile taxa in each season (small circle) in the Mediterranean sea (A) and Mar Menor (B).

REFERENCES

BARCELO, C. 1987. Estudi de la flora bentònica marina del Pais Valencià. Tesis Doctoral. Universidad de Barcelona.

CORMACI, M., DURO, A. & FURNARI, G. 1984. On reproductive phenology of Ceramiales (Rhodophyta) of East Sicily. Bot. Mar. 27:95-100.

FELDMANN, J. 1937-1942. Recherches sur la végétation marine de la Méditerranée. La côte des Albères. Les algues marines de la côte des Albères. I-IV. Imprimiere Wolf. Rouen.

MATHIESON, A.C. & PENNIMAN, C.A. 1986. Species composition and seasonality of New England seaweeds along an open coastal-estuarine gradient. Bot. Mar. 29:161-176.

PEREZ-RUZAFA, I.M. 1989. Fitobentos de una laguna costera. El Mar Menor. Tesis Doctoral. Universidad de Murcia.

RIBERA, M.A. 1983. Estudio de la flora bentónica marina de las islas Baleares. Tesis Doctoral. Universidad de Barcelona.

SOTO, J. 1987. Estudio floristico, corológico, autoecologico y sinecologico de las algas bentónicas marinas del sureste de la peninsula Ibérica. Tesis Doctoral. Universidad de Málaga.

B-I21

Cycle de Bioaccumulation du Cu, Cd et Cr dans les écailles de *Posidonia oceanica*

P. PANAYOTIDIS , P. MAKRIS et V.-A. CATSIKI

Centre National de Recherche de la Mer, 16604 Agios Kosmas, Athènes (Grèce)

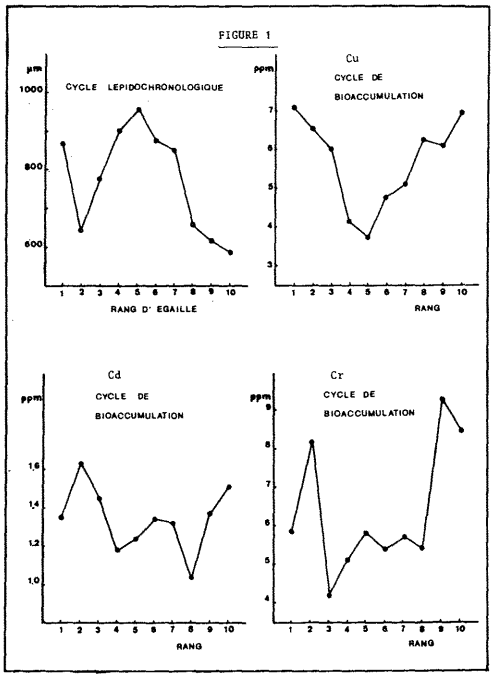
L' existence de variations cycliques de l' épaisseur des écailles du rhizome de P. oceanica, décrites par Pergent et al. (1983) sous le terme de lépidochronologie, nous a conduit à la rédaction d' un protocole experimental (Panayotidis & Makris, 1989), permettant l' étude du cycle annuel de bioaccumulation de métaux lourds par la plante.

Nous présentons ici les premiers résultats de bioaccumulation du Cu, Cd & Cr dans les écailles dont l' âge a été determiné à l'aide de l' analyse lépidochronologique.

Des rhizomes orthotropes de P. oceanica ont été recoltés à Agios Kosmas (Saronikos, Grèce), vers 3 m de profondeur. Les récoltes ont été effectuées en plongée le 28/4/88.

Nous avons numéroté dix écailles (de 1 á 10) en fonction de leur position sur le rhizome. L' écaille se trouvant juste en dessous de la première feuille porte le rang n°1. Les écailles du même rang ont été par la suite regroupées en dix lots pour le dosage des métaux lourds (UNEP, 1982).

FIGURE 1



La Figure 1 montre la comparaison du cycle lépidochronologique avec les cycles de bioaccumulation du Cu, Cd & Cr. Les concentrations des métaux Cu & Cr dans les écailles presentent une corélation negative significative avec l' épaisseur des écailles. En ce qui concerne le Cd, le cycle annuel de bioaccumulation presente le même aspect général, mais la corrélation de la concentration avec l' épaisseur des écailles n' est pas significative.

Nous pouvons donc conclure que l' étude de bioaccumulation du Cu, Cd & Cr dans les écailles du rhizome de P. oceanica, dont l' âge a été déterminé à l' aide d' une lépidochronologique, soutienne l' hypothese d' un cycle annuel de bioaccumulation de ces métaux lourds par la plante.

PANAYOTIDIS P. & MAKRIS P., 1989. The technique of lepidochronology of Posidonia oceanica as a posible way to identify heavy metal and radioelement pollution. Posidonia Newsletter, 2 (1): 51.

PERGENT G., BOUDOURESQUE C.F. & CROUZET A., 1983. Variations cycliques dans les écailles des rhizomes de Posidonia oceanica. Trav. sci. Parc nation. Port Cros, Fr. 9:107-148.

UNEP, 1982. Determination of total Cd, Zn, Pd & Cu in selected marine organisms by atomic absorption spectrometry. Reference methods for Marine Pólution Studies, n°11:1-21.

B-I22

Bioaccumulation of Heavy Metals in *Posidonia oceanica* (L.) Delile and *Cymodocea nodosa* (Ucria) Aschers. at an uncontamited site in the East Coast of Spain

C. SANCHIZ* , V. BENEDITO* , A. PASTOR** and A.-M. GARCIA-CARRASCOSA*

*Department of Animal Biology, Zoology (Invertebrates) and Marine Biology, Faculty of Biology,Burjassot, Valencia (Spain)

**Department of Analytical Chemistry, Faculty of Chemistry, Burjassot, Valencia (Spain)

B

Introduction and methodology.

The scarce bibliographic references to heavy metal content in mediterranean seagrasses give data on mercury (Augier et al., 1976, 1977, etc.) and other metals (Catsiki et al., 1987). Despite the fact that in these works heavy metal concentrations are compared in different seagrass species and different fractions of the plants, knowledge in this field is still incomplete, since there are no data on some important elements, like Pb or Zn.

In the present study, we compare Hg, Cd, Pb and Zn concentrations in sediment, detached dead leaves and several anatomic parts of **Posidonia oceanica** and **Cymodocea nodosa** collected at an uncontaminated site (Punta dels Molins, Dénia, Alacant, Spain) in November 1989.

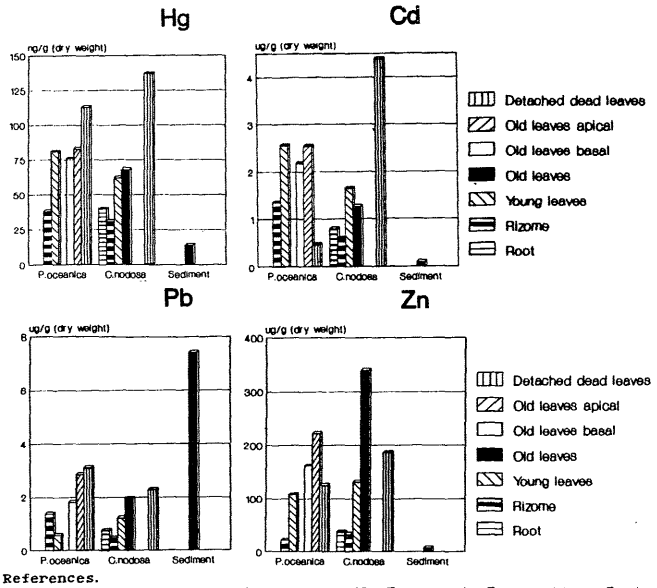
Plants were fractionated at the laboratory into roots, rizomes, young leaves and old leaves for **Cymodocea nodosa** and rizomes, young leaves, basal parts of old leaves and apical parts of old leaves for **Posidonia oceanica**. All the leaves (included detached dead ones) were scraped to remove epiphytes and rinsed with ultrapure water. Analysis was carried out with Perkin Elmer AAS equipment on the <250 µm fraction of lyophilised sediments and on lyophilised plant material after warm digestion with concentrated nitric acid.

Results and discussion.

Values obtained for sediment are comparable to levels found at uncontaminated zones of the Mediterranean (Hernández et al., 1985). All the metals except lead were more concentrated in the plant organs than in the sediment. The metal concentration in the different parts of the plant, in both species, increased generally in the order: **rizomes < roots <= young leaves <= old leaves** (in **P. oceanica, basal parts < distal parts**) **< dead leaves**; as was also found by Augier et al., 1976, 1977; Catsiki et al., 1987; Lyngby & Brix, 1989; etc. Values for both species were quite similar, but with some difference. Whereas concentration of Cd in **C. nodosa** is much higher in dead leaves than in old leaves, the opposite is the case in **P. oceanica**. This can be due to the fact that a considerable amount of cadmium, unlike other metals, is contained in the soluble fraction of the leaves (Fabris et el., 1982), and lost during their senescence (Lyngby & Brix, 1989), while a new cadmium could be adsorbed by the empty walls of decomposing cells. Specific differences in the amount of cadmium contained in that soluble fraction and in chemical characteristics of detritus could explain the differences observed.

Values of Hg and Cd content in the two species can generally be considered similar to those found by other authors, mentioned above, at uncontaminated zones of the Mediterranean.

Pb and Zn levels are comparable to the ones found in other seagrass species in other geographic regions with a low degree of contamination (Ward, 1989; Nienhuis, 1986).



References.

AUGIER, H.; GILLES, G.; RAMONDA, G. 1976. Trav. sci. Parc nation. Port-Cros., Fr., 2: 23-28.

AUGIER, H.; GILLES, G.; RAMONDA, G. 1977. C. R. Acad. Sc. Paris, t. 285 (19 décembre 1977). Série D: 1557-1560.

CATSIKI, V. A.; PANAYOTIDIS, P.; PAPATHANASSIOU, E. 1987. Posidonia Newsletter, 1 (2): 21-30.

FABRIS, G. J.; HARRIS, J. E.; SMITH, J. D. 1982. Aust. J. Mar. Freshw. Res. 33: 829-836.

HERNANDEZ, F.; PASTOR, A.; MEDINA, J.; BEFERULL, J. B.; BARBERA, J.C. 1985. Thalassographica, 8: 71-82.

LYNGBY, J. E.; BRIX, H. 1989. Hydrobiologia 176/177: 189-196.

NIENHUIS, P. H. 1986. Mar. Pollut. Bull., 17 (11): 508-511.

WARD, T. J. 1989. Biology of Seagrasses. A. W. D. Larkum, A. J. McComb, S. A. Shepherd (eds.) Elsevier, 1989: 797-820.

B-II1

B

Facteurs agissant sur la germination de *Cymodocea nodosa*

Gilberte CAYE et Alexandre MEINESZ

Laboratoire d'Environnement marin littoral, Parc Valrose, Université de Nice, 06034 Nice Cédex (France)

Sur le littoral du Sud-Est de la France, à Port-Cros, à Golfe Juan, dans la Baie des Anges à Nice, les graines de *C. nodosa* (Ucria) Ascherson persistent en abondance toute l'année dans le sédiment des herbiers. L'abondance des graines dans le sédiment est lié à la densité des herbiers, variant de 220 graines par m2 dans l'herbier dense de Golfe-Juan à moins de 100 graines par m2 dans les autres sites (CAYE et MEINESZ, 1985).

Cependant, en dépit de cette relative abondance des graines en réserve dans le sédiment, les observations concernant la germination de cette espèce *in situ* sur le littoral français sont exceptionnelles. Au contraire, à Ischia (Italie du sud), des germinations abondantes de *C. nodosa in situ* ont été signalées (PIRC *et al.*,1983).

Les résultats d'un ensemble d'expériences menées en aquarium et *in vitro* sur les facteurs agissant sur la germination de *C. nodosa* sont exposés dans cet article.

1 - Longévité des graines.

Dans les herbiers, les graines de *C. nodosa* de l'année précédente sont encore abondantes à l'automne ce qui montre qu'elles ont peu ou pas germé et qu'elles peuvent survivre dans le sédiment au moins un an.

En aquarium, cinq expériences réalisées de 1983 à 1986 ont montré une survie maximum de 16 à 18 mois après la date de maturation des graines en novembre. Pendant toute cette période, les graines sont capables de germer si les conditions sont favorables.

2 - Effet de la salinité.

Dans l'eau de mer, à la salinité normale (37 à 38%°), le pourcentage de germination de *C. nodosa* est faible et la germination est très lente (1,24% en 1 an), soit 2 graines par m2 dans un herbier dense et moins d'une graine par m2 dans les autres sites du littoral français.

Dans l'eau saumâtre, en fonction de la salinité, la germination est plus ou moins lente, échelonnée et partielle : à la salinité de 27%°, les premières germinations apparaissent le 22ème jour et atteignent un maximum proche de 30% en 50 jours, par la suite les plantules se développent normalement.

Dans l'eau douce, les graines de *C. nodosa* germent massivement et très rapidement (100% en 4 jours) mais les plantules dépérissent rapidement.

3 - Effet de la température

La germination de *C. nodosa* est d'autant plus rapide et importante à faible salinité (10%°) que la température est élevée. Cependant, seules les températures comprises entre 17 et 24°C sont compatibles avec un bon développement des plantules. A des températures plus froides, le développement est retardé ou arrêté, il reprend éventuellement si la température augmente. A des température très élevées (supérieures à 25°C), les plantules dépérissent (CAYE et MEINESZ, 1986).

4 - Effet du sédiment

A Ischia, des expériences de germination à la salinité de l'eau de mer ont montré que le sédiment de l'herbier était plus favorable à la germination de *C. nodosa* que le sable quartzeux (PIRC et al., 1986).

Une expérience a été réalisée à Nice avec des graines provenant d'Ischia et de Golfe Juan, à la salinité de l'eau de mer, dans des pots vides et dans des pots contenant du sédiment provenant d'un herbier de Cymodocée. Pour les graines de Golfe Juan la germination en 2 mois fut nulle pour les deux traitements; pour les graines d'Ischia sans sédiment la germination fut nulle, mais dans le sédiment la germination atteignit 12% en 2 mois.

5 - Rôle de la variabilité génétique

Les Cymodocées sont dioïques, la pollinisation est donc croisée et la reproduction de type hétérogamique. En principe, ce type de reproduction favorise la vigueur (hétérosis) et accroît la variabilité génétique. Effectivement, la vigueur de cette espèce se manifeste dans la croissance des axes plagiotropes qui est parfois très rapide atteignant plus d'un mètre par an (CAYE et MEINESZ, 1985).

Différentes observations dans la morphologie et les modalités de germination des graines de *C. nodosa* indiquent l'existence d'une large variabilité génétique. Dans l'herbier dense de Golfe Juan, les graines présentent une grande variabilité de leur forme générale (ovale ou circulaire) et du développement des crêtes. Dans des conditions non optimales de salinité et de température, la germination est échelonnée et ne concerne qu'une partie des graines, un certain nombre d'entre elles ne germant pas. Ces résultats signifient qu'il existe des différences individuelles dans l'aptitude des graines à germer.

Ces différences de comportement des graines à la germination apparaissent de façon encore plus évidente si on compare la germination de deux lots de graines prélevés dans des peuplements éloignés géographiquement. A Ischia les graines de *C. nodosa* germant fréquemment *in situ*, germent également en laboratoire à la salinité de l'eau de mer avec un pourcentage optimal de 54% (PIRC *et al.*, 1983). Les graines de Golfe Juan germent apparemment peu *in situ;* en laboratoire, le pourcentage de germination à la salinité de 38%° est également faible (1% en 1 an). Une expérience comparative sur la germination des graines de Golfe Juan et d'Ischia menée en aquarium à la salinité de 10%°, à la température de 20°C, a montré que les graines d'Ischia germent avec un pourcentage de 53% et celles de Golfe Juan avec un pourcentage de 97% en 14 jours. Ainsi, l'abaissement de la salinité déclenche la germination des graines de *C. nodosa* prélevées dans l'herbier de Golfe Juan, mais cet effet n'est pas prouvé pour les graines de l'herbier de *C. nodosa* d'Ischia.

Le nombre de graines parvenant à germer dans un peuplement de *C. nodosa* varie en fonction de nombreux facteurs : la densité du peuplement, la saison (rôle de la température), la salinité, le sédiment et surtout la variabilité génétique, particulièrement large chez cette espèce dioïque et concernant à la fois la morphologie et la physiologie de la graine.

REMERCIEMENTS

Nous remercions vivement Madame L. MAZZELLA qui nous a adressé des graines de *C. nodosa* d'Ischia. Ces travaux ont été réalisés grâce à un contrat GIS Posidonie délivré par le Ministère de l'Environnement..

REFERENCES

CAYE, G., MEINESZ, A., 1985. Observations on the vegetative development, flowering and seeding of *Cymodocea nodosa* (Ucria) Ascherson on the Mediterranean coasts of France. Aquat. Bot., 22 : 277-289.

CAYE, G., MEINESZ, A., 1986. Experimental study of seed germination in the seagrass *Cymodocea nodosa*. Aquat. Bot., 26 : 79-87.

PIRC, H., MAZZELLA, L., RUSSO, G.F., 1983. Record of *Cymodocea nodosa* (Ucria) Aschers. fruiting in a prairie of the isle of Ischia (Gulf of Naples). Rapp. Comm. Int. Mer Medit., Monaco, 28 : 121-122.

PIRC, H., BUIA, M.C., MAZZELLA, L., 1986. Germination and seedling development of *Cymodocea nodosa* (Ucria) Ascherson under laboratory conditions and "in situ". Bot., 26 : 183-190.

B-II2

Belowground Necromass Dynamics in Estuarine Stands of the Seagras *Cymodocea nodosa*

J. ROMERO, M. PEREZ, T. ALCOVERRO, P. BORRULL, C. SANCHEZ and M.-A. MATEO

Departamento de Ecologia, Facultad de Biologia, Universidad de Barcelona, Diagonal 645, 08028 Barcelona (Spa

Introduction

Belowground biomass accounts for a significative part of total biomass and production in seagrass stands (ZIEMAN & WETZEL, 1980). The decay of this biomass occurs within the sediment, leading to a necromass accumulation. This accumulation can be relevant to the nutrient cycling and/or trophic structure of the ecosystem. Nevertheless, data on this topic are relatively scarce (PIRC, 1983; FRANCOUR, 1990; ROMERO et al., in press). The aim of this paper is to make a quantitative approach of these aspects in the Cymodocea nodosa ecosystem focussing on three items: (i) the evaluation of the dead organic matter stock from both roots and rhizomes; (ii) the estimation of its turnover and decomposition rates and (iii) the assessment of the variability of these parameters depending on nutrient availability and stand age.

Methodology

The work was conducted at the Alfacs Bay (Ebro river Delta, NE Spain), a shallow bay with freshwater inputs. Sampling was performed in summer (Agust-September) using a hand-held corer with a 200 cm2 base, pushed into the sediment to a depth of 30 cm. After collection, the samples were rinsed in situ, and sorted into living rhizomes, dead rhizomes, living roots and dead roots. Weight of each fraction is expressed as dry weight.
Samples were taken in (a) a continuous meadow in a nutrient poor zone; (b) patches of different ages in a nutrient poor zone and (c) a continuous meadow in a nutrient rich zone. The age of the patches was estimated using both CAYE & MEINESZ (1985) criteria and plastochrone interval (PEREZ & ROMERO, in press). This method allows also to estimate root and rhizome production (PEREZ & ROMERO, in press).

Table I. Stocks of belowground biomass and necromass (g/m2).

	Rhizomes		Roots	
Zone	Living	Dead	Living	Dead
(a)	256	127	105	104
(b)	96	19	48	44
(c)	125	78	38	9

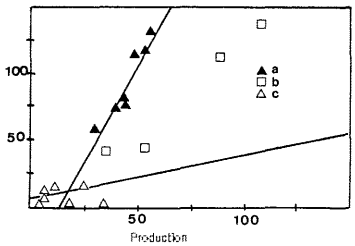


Fig. 1. Root production (x-axis) against root necromass (y-axis). (g/m^2/year and g/m^2.)

Results and discussion

The data are summarized in table I. The main contribution to the belowground biomass corresponds to the living rhizomes. In general, dead stocks are in the same order of the living biomass; its variability depends on the different accumulation rates. The following model for root/rhizome litter accumulation is proposed:

$$dL/dt = P - kL \qquad \text{(eq. 1)}$$

where L is the necromass (litter) stock, P the annual production (gdW.m-2.y-1) and k the decomposition rate (years-1).
The steady-state (dL/dt=0) is characterized by L=1/k*P. That is, the plotting of the litter stock of a given compartment against its production rate must give a straight line under the steady-state assumption, whith a slope of the reciprocal of the decomposition rate. Data for roots are represented in figure 1. The points corresponding to the old, continuous meadow in the nutrient-poor zone fits the linear model (r=0.95, n=8), giving an estimation of k=0.34 y-1 (half-decomposition time= 2 years). Points from the continuous meadow of the nutrient-rich zone follows a different equation with a lower goodness of fit (r=0.55, n=6), giving an estimation of k=3.03 y-1 (half-decomposition time=0.2 years), which agrees with the general acceptance of the fact that high nutrient levels enhances decay. Finally, the data from the younger patches do not fit a linear model.
From eq. 1, the necromass for a given yearly production (assuming no interannual fluctuations) in the steady state is P/k. If k<1, this "equilibrium necromass" is reached in more than one year. This can be modelled in a quite simple way:

$$L(i)=P+(1-k)L(i-1)$$ where L(i), L(i-1) are the litter stocks at time i and i-1, respectively.

For k=0.34 y-1, the running of the model shows that the steady-state is reached after 4-5 years, so for the younger patches, we expect dead root stocks well below the values predicted by the linear model (fig. 1). Conversely, if k>1, the steady state can be reached in less than one year. This implies that one year is an unadequate time basis for the description of this phenomenon, and that seasonal variations can severely affect the results. In the nutrient-rich zone, the fact that root necromass is in all the cases below root producction gives support for a decomposition rate k>1, but the proposed estimation of k=3.03 must be contemplated with caution.
For the rhizomes, only the data from the continuos meadow in the nutrient poor zone conform to the linear model, but with low correlation vales (r=060, n=8), that can be explained by a decay rate (k=2.43) higher than one.
Althought the data presented are preliminary, some provisional conclusions can be drawn. In the nutrient-poor areas, the decomposition rate of belowground material of the Cymodocea stands under study are low relatively to the ones estimated for the aboveground parts (leaves; see HARRISON, 1989). This results in an accumulation of organic matter in the sediment, mostly in the form of dead roots. In more eutrophic areas, the root decay is greatly enhanced, leading to a lower dead matter accumulation and thus a higher recycling rate. In the necromass compartment, equilibrium is reached when inputs (from the death of living parts of the plant) balances outputs (from decomposition). This equilibrium can be shifted by nutrient levels, as stated, but it also takes some time to be achieved. Necromass development to an steady-state value can be interpreted as a succesional process within the plant stand development.

References

CAYE, G. & MEINESZ, A., 1985. Aquatic Botany, 22:277-289.
FRANCOUR, P., 1990. Thèse 3ème cycle, Université Paris VI.
HARRISON, P.G., 1989. Aquatic Botany, 23:263-288.
PEREZ, M. & ROMERO, J. in press. Marine Ecology (submitted)
PIRC, H., 1983. Proc.Int.Symp.Aq.Macrophytes, 177-181
ROMERO, J.; PERGENT, G.; PERGENT-MARTINI, C.; MATEO, M.A. & REGNIER, C., in press. Marine Ecology, submitted.
ZIEMAN, J.C. & WETZEL, R.G., 1980. In PHILIPS & MCROY. Garland, N.Y.

I3

g-Term Changes in the Northern Adriatic Marine Phanerogam Beds

Nevenka ZAVODNIK and Andrej JAKLIN

"Ruder Boskovic" Institute, Center for Marine Research, 52210 Rovinj (Yugoslavia)

In the Adriatic Sea, due to a lack of comparable information on distribution abundance of species population, long-term fluctuations in benthic communities d seldom be appropriately explained. The previous thorough research of Benacchio 8) and our recent studies have made possible an evaluation of the changes in ributional patterns of northern Adriatic marine phanerogam species which have rred in this area over a half century span.

Research was done alonf the Istrian coast, and in a part of the Quarner ipelago, *i.e.* around the Cres, Losinj, Susak and Unije islands. At more than a red coastal transects and some peculiar stations skin and SCUBA diving methods employed. In addition, the material sampled by dredge was also considered.

Sufficient comparable data are available only for the following three erogam species: *Posidonia oceanica* (L.) Del., *Cymodocea nodosa* (Ucr.) Asch., and *era noltii* Hornem.

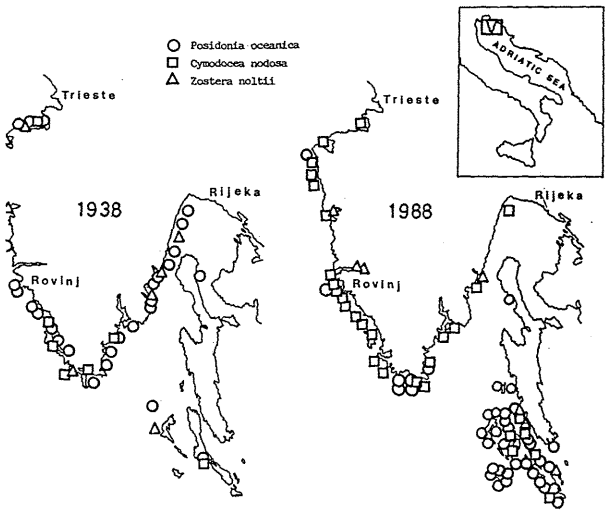
Fifty years ago *Posidonia oceanica* was a common species of many localities of area explored (Fig. 1). Nowadays, the western Istria *Posidonia* beds have ely been made extinct, except for poor remains in the environs of Umag and nj. Around the south Istrian promontory and islands studied the beds are still ly well developed although local decrease processes have been noted.

Cymodocea nodosa is at present well distributed in the entire area, except in steep sloping bottom of the Quarner area. The plants are growing well, cially at sites characterized by oozy sand and enlarged input of particulate cials.

Zostera noltii is at present limited only to a few sheltered and shallow areas acterized by sandy-oozy sediment and lower salinity conditions. Its beds are ily not dense, and in some places, during the low tide, are exposed to cation.

In comparison with the old data of Benacchio (1938) it becomes evident that the past 50 years *Posidonia oceanica* beds have drastically declined in Istrian s, and *Zostera marina* has been largely made extinct. On the other hand, *Zostera i* beds have mostly remained unaffected, while the area of *Cymodocea nodosa* has y extended. At some sites, this species has definitely occupied areas long ago ated by *Posidonia oceanica* (Zavodnik, 1983).

The reasons for the alterations described are no doubt manifold: direct tion effects, however, could be attributed only locally. A more important n lies perhaps in an increased siltation, and changed light conditions affected enlarged water turbidity as suggested by Ghirardelli *et al.* (1973).



ig. 1. Occurrences of marine phanerogams.

ENCES

CHIO, N., 1938. Osservazioni sistematiche e biologiche sulle Zosteraceae Alto Adriatico. Thalassia, 3 (3): 3-41.

RDELLI, E., G. OREL & G. GIACCONE, 1973. L'inquinamento del Golfo di Trieste. Mus. Civ. Stor. nat. Trieste, 28: 431-450.

NIK, N., 1983. Prilog poznavanju flore morskih alga i cvjetnica zapadne obale . Biosistematika, 9 (1): 1-13.

B-III1

Amphipods and Molluscs of the circalittoral enclaves onto dead terraces of degradated *Posidonia oceanica* Meadows on the Coast of Alboraya (Spain, Gulf of Valencia, Western Mediterranean)

I.-M. GINER, A. MARTI, V. BENEDITO, J.-L. ESTEBAN, J. TORRES, A.-M. GARCIA-CARRASCOSA and R. CAPACCIONI

Invertebrates and Marine Biology Laboratory, Department of Animal and Cellular Biology and Parasitology, Faculty of Biological Sciences, Valencia University, 46100 Burjasot, Valencia (Spain)

B

The epigraph of circalittoral enclaves refers to those structures originated by sciaphilic biogenous accretion onto soft substrate rhizomes or *P.oceanica* rhizomes remains.

On the coast of Alboraya, and in general in the Gulf of Valencia, the ascension of circalittoral biocoenosis towards shallower waters can be observed. This ascension is due to water turbidity levels, rising as a result of high anthecold pressure that this zone presents (urban, industrial, turistic and agricultural activities).In the studied area these concretionated masses use dead terraces of degradated *P. oceanica* meadows for their instaliment and the lower limit of their bathymetric range oscillates between -10 and -12 m.

The installation of these structures on *P. ceanica* meadows occurs, as is described by (18), in those deep meadows with medium leaf density or in shallow ones with high leaf density, where sciaphilic environments can be found. However the *P. oceanica* meadows, in Alboraya, presents a high regression degree with a very low shoot density (1-2 shoots/m^2 at -10 m) and is therefore unable to create sciaphilic biotopes on its own. Then the reason why these concretionated masses appear at shallow levels is because of the turbidity conditions of the sea-water. In fact, in shallower areas (2-3 m depth) Secchi disk disappears at 1m depth and in even offshore deeper areas (around -17 m) it does at 6-7 m.

These structures rise 30-40 cm from the bottom, and they are more frequent on the corniches that delimit the pot-holes and channels. Concretionated masses are built by the action of calcareous algae (*Pseudolithophyllum expansum, Lithophyllum mamillosum* and *Mesophyllum lichenoides*) and by hard structures of porifera and bryozoans, which include shell remains, sediment of diverse texture. *P. oceanica* rhizoma fibril remains, etc .. They are covered by an important sciaphilic flora (*Peyssonnelia* sp., *Udotea petiolata, Halimeda tuna, Codium bursa, Sphaerococcus coronopifolius*, etc.) and fauna (*Eunicella cavolinii, Pentapora fascialis, Myriapora truncata, Halocynthia papillosa*, etc.).

Amphipod fauna, studied by (13), shows a first stock which is formed by the species *Iphimedia serratipes, Lysianassa pilicornis* and *Pseudoprotella phasma* that have been previously mentioned from coralligenous bottoms 9, 11, 19. The second stock is constituted by *Microdeutopus algicola* a species with affinity to hard substrates with vegetal coverage. The third one is represented by species with wide ecological distribution: *Gammarella fucicola* (1) (5) (6) (10) (11) (14), and *Corophium sextonae*, which is presented in the whole biocoenoses at the studied zone except in SGCF. *Leucothoe richiardii* and *Atylus massiliensis* form a stock of species that come from biotopes around. The former comes from rhizome terraces of *P. oceanica* (3) (8), and the latter from sandy biocoenoses (2). The last stock is constituted by a form of *Maera* sp. whose peculiar features don' t allow us to assign it to any of the nine species known from the Mediterranean (7). In the studied area, *Maera* sp. appears exclusively with an important density on these enclaves.

Refering to molluscan fauna, described by (4), there is a first group formed by *Clanculus cruciatus, Diodora graeca, Raphitoma echinata, Turbona cimex, Columbella rustica, Chauvetia minima, Chama gryphoides* and *Muricopsis cristata* previously mentioned in the Coralligenous (18) (20) (15) (16). The second stock is formed by greater numerous species distributed fauna (*Tricolia pullus, Rissoa violacea, Jujubinus exasperatus, Clanculus jussieui, Venerupis pullastra, Glans trapezia*, etc..) characteristic of *P. oceanica* meadows. The third stock shows a faunistic group characterized by species with affinity to hard substrates (*Arca noae, Musculus costulatus, Gastrochaena dubia* and *Lithophaga lithophaga*).

The colonization of circalittoral populations in less deep zones is demostrated by the localization of these shallow circalittoral biogenous enclaves, and by the unusual existence between -6 and -11.5 m at the studied area, of important populations of the amphipod *Lembos angularis* species characteristic of deeper muddy bottoms (8) (3).

In the present study the lower limit of *P. oceanica* meadows, located at -25 m fifteen years ago, have been found at 17-18 m depth. This ascension of the lower limit is probably due to the increment of the turbidity conditions mentioned above. These higher sciaphilic conditions and the existence of dead terraces of *P. oceanica* rhizomes, have conditioned the gradual rising of Coralligenous towards shallower depths. In fact, wide zones with coralligenous blocks of about 2 m height, forming continous strings, are found up to the -20 m isobat.

BIBLIOGRAPHY.

(1) BELLAN-SANTINI (D.), & LEDOYER (M.), 1973.- *Téthys*, 4 (4), pp.399-934.
(2) BELLAN-SANTINI (D.), KARAMAN (G.), KRAPP-SCHICKEL (G.), LEDOYER (M.), MYERS (A. A.), RUFFO (S.) & SCHIECKE (U.), 1982.- *Mém. Inst. Oceanogr.* Monaco, 13, pp.1-364.
(3) CHEVREUX (E.), 1910.- *Mém. Soc. Zool. Fr.* 23, pp.145-285.
(4) GINER (I.M.), 1989.- Tesis de Licenciatura, Facultad de Biologicas, Universitat de Valencia. 225p.
(5) HARMELIN (J.G.), 1964.- *Rec. Trav. Sta. mar. Endoume*, 51 (35), pp.43-106.
(6) JACQUOTTE (R.), 1962.- *Rec. Trav. Sta. mar. Endoume*, 44 (29), pp.27-42.
(7) KARAMAN (G.) & RUFFO (S.), 1971.- *Mem. Mus. civ. Stor. nat.*, Verona. 19, pp.113-176.
(8) KRAPP-SCHICKEL (G.), 1975.- *Boll. Mus. civ. Stor. nat.*, Verona, 11, pp.91-118.
(9) KRAPP-SCHICKEL (G.), 1976.- *Bull. Zool. Mus. Univ.*, Amsterdam, 5 (5), pp.31-45.
(10) LEDOYER (M.), 1962.-*Rec. Trav. Sta. mar. Endoume*, 25 (39), pp.117-235.
(11) LEDOYER (M.), 1968.- *Rec. Trav. Sta. mar. Endoume*, 60 (44), pp.125-295.
(12) LEDOYER (M.), 1970.- *Bull. Inst. oceanogr.Monaco*, 69 (1406), pp.1-32.
(13) MARTI (A.), 1989.- Tesis de Licenciatura, Facultad de Biologicas, Universitat de Valencia, 152p.
(14) MASSE (H.), 1962.- *Rec. Trav. Sta. mar. Endoume* , 42 (27), pp.221-259.
(15) PEREIRA, 1980.- *Com. Prim.Congr. Nac. Malac.*, Madrid, pp.79-84.
(16) PEREIRA, 1985.- *Actas II Simp. Ibér. Estud. Bentos Mar*, 3, pp.243-251.
(17) PÉRES (J.M.), 1967.-*Oceanogr. Mar. Biol. Ann. Rev.*, 5, pp.449-533.
(18) PERES (J.M.) & PICARD (J.), 1964.- *Rec.Trav. Sta. Mar. d'Endoume*, 31 (47), pp.5-137.
(19) RUFFO (S.) & SCHIEKE (U.), 1979.- *Boll. Mus. Stor. nat.*, Verona, 5, pp.401-429.
(20) SPADA (G.), SABELLI (B.) & MORANDI (V.), 1973.- *Conchiglia*, 9 (3-4), pp.29-67.

Amphipods and benthic biocoenosis on the Coasts of Alboraya-Albuixech (Spain, Gulf of Valencia, Western Mediterranean)

A. MARTI , I.-M. GINER and A.-M. GARCIA-CARRASCOSA

Invertebrates and Marine Biology, Laboratory, Department of Animal and Cellular Biology and Parasitology, Faculty of Biology, University of Valencia, 46100 Burjassot, Valencia (Spain)

B

The studied zone, north of Valencia city, corresponds to a typical sandy coast ecosystem of 5 km length. This area is suffering an important anthropic pressure (residual waters flows, fisheries, and urban, industrial, touristic and agricultural activities) which originates a general regression. Harbours and breakwaters, are the hard substrates that can be found there.

GINER (1989) studied the infralittoral biocoenosis distribution based on the molluscan fauna, and MARTI (1989) using information from amphipod fauna contributes to a better characterization of these biocoenosis in the area.

Different methods have been used to take samples of the different types of biocoenosis such as scoop net, Aberdeen double side anchor dredge, Agassiz trawl and scraped surfaces 25x25 cm, from 21 stations (15 from soft substrates and 6 from hard ones). The location of these stations were chosen on purpose to define the whole conditions of the studied area.

RESULTS.

SUPRALITORAL ZONE.

* LDL biocoenosis:

It can be found along the shoreline. The sediment is formed by a mixture of pebbles and fine sand, on which masses of several types of organic debris and Posidonia oceanica rhizome fibrils are located. This biocoenosis is characterized by the existence of high density populations of Orchestia platensis together with sporadic specimens of Talorchestia deshayesii.

MEDIOLITORAL ZONE.

* AP biocoenosis:

Species mentioned by LEDOYER (1968), BELLAN-SANTINI & LEDOYER (1973) from shallow algae populations and from high polluted areas as Jassa marmorata, Corophium acutum, C. insidiosum, Caprella aquilibra and Elasmopus rapax have been located on artificial rocky substrates at the study area. Among all of them, the last species characterizes the Mytilus galloprovincialis and Corallina elongata facies, and it is only found in those facies at the studied area.

INFRALITTORAL ZONE.

* SFHN biocoenosis:

It has a very slow specific richness, with only dispersed individuals from nearby biocoenosis, Corophium sextonae, Harpinia pectinata, Siphonocoetes sabatieri and Urothoe poseidonis can be found. It may be due to the sensitiveness of this group to highly polluted waters, pointed out by DAVIN (1981), and to the artificial structures settled --harbours, breakwaters, urban effluents-- which also alter the hidrological and sedimentary factors.

* SFBC biocoenosis:

It reaches 9-10 m depth where the upper limit of the P. oceanica meadows is settled. The existence of Perioculodes longimanus, Pariambus typicus, Ampelisca brevicornis, Leucothoe incisa, Microprotopus maculatus and Urothoe poseidonis helps to the precise characterization of this biocoenosis.

High densities of Siphonocoetes sabatieri and Gammarus crinicornis, typical species from low salinity environments, are found in some sectors of this biocoenosis under the influence of fresh-waters flows. Fluctuations in the populations of these species can be observed, and there is a substitution from S. sabatieri to G. crinicornis in winter probably due to the variability of the hidrological and sedimentary factors and to the opportunist nature of them.

* Posidonia oceanica meadows:

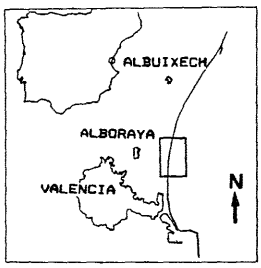
It shows a high regression degree (1 or 2 shoots/m2 to -10 m) buried by sandy sediment where dense Caulerpa prolifera patches are developed. This biocoenosis is characterized in the sampled area by Ericthonius punctatus, Maera inaequipes, Orchomene humilis and by Leucothoe richiardii which are found in the meadow and in the enclaves of biological sciaphilic concretionated algae and porifera. All these species have been already mentioned in the rhizome terraces of P. oceanica (CHEVREUX, 1910; HARMELIN, 1964; LEDOYER, 1962; LEDOYER, 1968).

* SGCF biocoenosis:

It is found in big pot-holes and channels in the P. oceanica meadows. The existence of Monoculodes carinatus. Pontocrates arenarius, Ceradocus semiserratus, Guernea coalita y Socarnes erythrophtalmus, characterizes this biocoenosis perfectly.

* Enclaves of circalitoral biological concretionated masses:

They are developed on the dead rhizome terraces of P. oceanica. These enclaves are identified by the presence of Iphimedia serratipes, Lysianassa pilicornis and Pseudoprotella phasma, typical species of circalittoral zone and coralligenous bottoms, and also by the exclusive localization of an unidentified species of Maera.



Map of the studied zone

BELLAN-SANTINI, D., 1971. Rapp. P.-v. Run. Comm. int. Explor. Scient. Mer Méditerr. 20: 221-223.
BELLAN-SANTINI, D.; LEDOYER, M. 1973. Téthys. 4 (4): 899-934.
CHEVREUX, E., 1910. Mém. Soc. Zool. Fr. 23:145-285.
DAUVIN, J.L., 1981. Esturin. Coastl. Shelf Sci. 14: 517-531.
GINER, I.M., 1989. Tesis de Licenciatura. Facultad de Biológias. Universitat de València. 225 pp.
HARMELIN, J.G., 1964. Rec. Trav. Sta. mar. Endoume. 51 (35): 43-106.
LEDOYER, M. 1962. Rec. Trav. Sta. mar. Endoume. 25 (39): 117-235.
LEDOYER, M. 1968. Rec. Trav. Sta. mar. Endoume. 60 (44): 125-295.
MARTI, A., 1989. Tesis de Licenciatura. Facultad de Biológicas. Universitat de València. 152 pp.

The food web of *Posidonia oceanica* beds around the Island of Ischia (Gulf of Naples -Italy) : a new trophic index

Valerio ZUPO

Stazione Zoologica di Napoli - Laboratorio di Ecologia del Benthos - Punta S. Pietro, 1, 80077 Ischia (Italia)

The Posidonia oceanica system, characterized by high productiv and biomass partly exported to other coastal systems, supports a v complex food web (Chessa et al., 1982). Many trophic studies can need to define the energy flow through the system: gut cont analysis, calorific measurements, weight data, trophic groups analys etc (ref. Kikuchi et Peres, 1977). The trophic behaviour of mac zoobenthic species sampled by a bottom trawl in different prairies analyzed and a new index is proposed as a feeding behaviour descript The use of such an index allows for a precise description of feeding habits of a species and is useful in direct spat representations and multivariate analysis techniques.

Twelve samples were obtained in different Posidonia prairies around island of Ischia: the first 6 in winter, the others in summ collected at depths ranging from 15 to 25 meters with a bottom tr with a 2 cm mesh, deep frozen and then fixed in 70% alcohol. The contents of each species in each sample were identified, quantified means of an arbitrary code ranging from 0 to 4 (0=absent; 4=v abundant) and recorded in a matrix "species/food items". A multivari analysis was performed on such data to define the principal compone of the trophic model in the studied prairies (fig.1). It is a fact t generally, in such analysis, the observation points are ordered mai on the first two axes, one of which can be mainly related to prey si while on the second the food items are ordered according to type -pl or animal- of prey. If the principal components of such trophic mod are these, it is possible to redescribe the species on the basis these factors. The species were coded on the basis of a two di parameter calculated as follows:

- the first digit represents the feeding habit -vegetarian carnivorous- of the species and is calculated by the formula:

$$\text{first digit} = (\Sigma V - \Sigma C)/\Sigma M$$

whe

V=abundance of vegetal items; C= abundance of carnivorous ite M=abundance of each considered item. In such a way we can distingu omnivorous organisms (first digit close to 0), pure carnivores (fi digit close to -1), pure herbivores (first digit close to 1).

- The second digit represents the size scale of the prey and calculated by the formula:

$$\text{second digit} = \ln\left(\Sigma (PS_i \times N_i)/\Sigma M\right)$$

whe

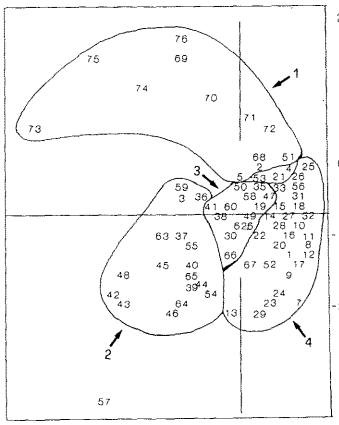
PS_i= mean prey size (size measured in mm or in mg) of prey "i"; N_i= abundance; M= as defined previously. The use of logarithmic sc allows to discriminate microphagous organisms, eating prey items l than 1 mm (second digit negative) from macrophagous ones (second di with positive values).

A total of 76 species were collected, while 26 food items w identified in the gut contents. A matrix was then compiled on the ba of the trophic code and it is possible to see that, plotting different species on a x-y system using the two digits of the code descriptors, a model very close to the multivariate one is obtained. particular we observe that the principal clusters showed by a P.C are reproduced in the new code based trophic model (fig. 1 and Species can be then grouped into trophic categories as shown in fig to be analyzed by common mathematical methods and such groups are far better descriptors then those generally defined only on an empi basis. As one can observe, the two representations -using the items and trophic index plotted- directly provide a single model of prairie, in which the importance of vegetarian and detritivo organisms is assessed. Predators are represented only by a few spe of fishes plotted in the second quadrant. The model obtained is us to classify the 96 considered species into calculated tro categories as far as the trophic index calculated for each species be considered relatively constant of any ecosystem, while t position in a multivariate analysis model depends on the contribut of other observations considered.

The trophic index described can be considered a valid solution compare data resulting from different investigations and may be use define the differences observed in the feeding behaviour of a spe studied on different temporal or spatial scales. The use of this i allows to get over the first ordination model, given that food it are generally ordered on the basis of size and qualitative compone Our research can thus be directed in the definition of measurable comparable trophic groups and food web models.

P.C.A.

Fig. 1



Classification by two digits co

Fig

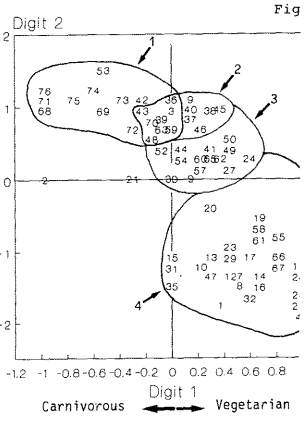
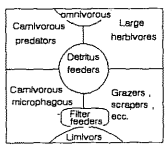


Fig.3



Refere

CHESSA L.A., E.FRESI, SOGGIU L.,1982.Primi sulla rete trofica dei consumatori in una teria di Posidonia oceanica (L.) Delile.B Mus.Ist.Biol.Univ.Genova,50 suppl.,156-
KIKUCHI T. ET PERES J.M.,1977.Consumer eco of sea-grass beds.In:Seagrass Ecosys Ed. by P. Mc Roy-Dekker Inc.New York:147

B-III4

Relationships between Trophic Structure and Diel Migrations of Isopods and Amphipods in a *Posidonia oceanica* Bed of the Island of Ischia (Gulf of Naples -Italy)

Maurizio LORENTI and Maria Beatrice SCIPIONE

Stazione Zoologica di Napoli - Laboratorio di Ecologia del Benthos - Punta S. Pietro, 1, 80077 Ischia (Italia)

The complexity of trophic webs in highly productive seagrass systems is related to the multiplicity of the available microhabitats. Diel migrations of seagrass animals along the plant vertical axis represent a microhabitat shift that is a response to both biotic and abiotic factors (Ledoyer, 1962; Greening & Livingston, 1982); feeding requirements versus hiding are one explanation for such shifts (Kitting, 1986).

Isopods and Amphipods are among the major components of Posidonia oceanica vagile fauna (Scipione et al., 1983; Mazzella et al., 1989) and play a fundamental role in trophic webs, both as consumers (Scipione, 1989; Gambi et al., in prep.) and as food for predators (Chessa et al., 1982; Khoury, 1984; Sparla, 1989). Species of these two taxa are also responsible for important diel migrations. Therefore relationships between migrations and feeding habits warrant investigation.

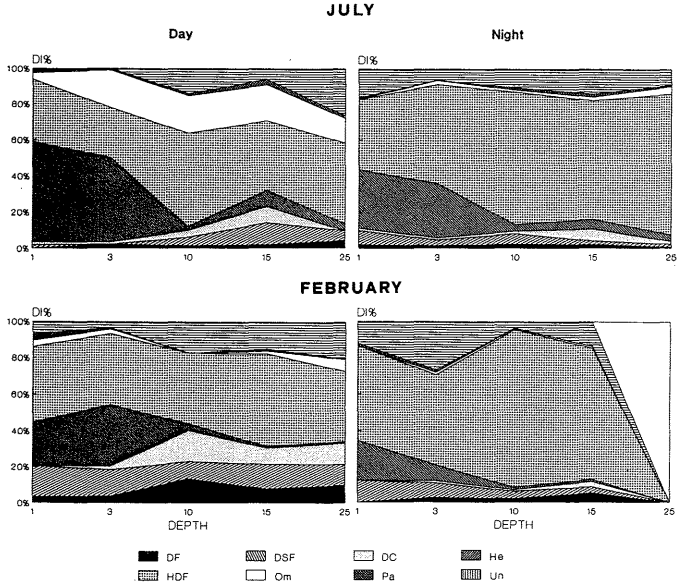
In this framework, research on different taxa of P.oceanica vagile fauna were undertaken, of which the present study is a part. Samples were collected by hand net along a depth gradient (1, 3, 10, 15 and 25m) in Lacco Ameno prairie (Island of Ischia), both daytime and nighttime, in July 1981 and February 1982. Trophic analysis was performed on 9 categories identified according to the literature: Deposit Feeders (DF), Deposit- Suspension Feeders (DSF), Deposit Feeders- Carnivores (DC), Herbivores (He), Detritus Feeders (DeF), Carnivores (Ca), Herbivores- Deposit Feeders (HDF), Omnivores (Om) and Parasites (Pa); species on which information is lacking were designated Unidentified (Un).

Seventeen species of Isopods and 77 of Amphipods were identified.

Total abundance of Isopods in night samples shows increases over day samples from 80 to 996 ind. in July and from 72 to 547 ind. in February. In July, of the 15 recorded species, a clear migrant behaviour was shown only by HDF species (Idotea hectica, Zenobiana prismatica, Cymodoce emarginata and C.hanseni) and Ca species (Jaeropsis dollfusi and Paranthura nigropunctata). In February, of the 16 recorded species, only C.emarginata and C.hanseni show defined patterns. On the whole, the bulk of migrant Isopods is formed by HDF, strongly dominated by C.hanseni juveniles; their quantitative dominance rises from 61% (day) to 86% (night) in July and from 62% to 94% in February. Depth- related zonation of migrant species does not appear to vary significantly between day and night; in particular, C.hanseni, which determines trends of HDF, shows an increasing pattern with depth.

Amphipods reach the highest abundance in night samples both in July (51 species; 2,378 ind.) and February (38; 1,534) in comparison with day samples of July (33; 857) and February (63; 809). The most represented trophic groups were He (mostly Amphithoe helleri, A.ramondi and Hyale schmidti), which are dominant in superficial stations, mainly in July (57.81%), and which show an increase (from 166 to 326 ind.) from day to night; HDF, mostly represented by Aora spinicornis, Apherusa chiereghinii and Dexamine spinosa, are present along the whole transect, mainly at intermediate and deep stations, and show a massive increase from day to night samples, considering both months, from 310 to 1,211 ind., also at 1m, where they become dominant in February (42.5%). The other trophic groups are less represented and only DF and DSF show an increase in night samples, the latter at shallower stations. Some species, as Amphilochus picadurus, Peltocoxa gibbosa and Apherusa vexatrix, which show a deep distribution at daytime, are well represented at night in the shallower stand.

On the whole, He and HDF are strongly dominant both at night and day and diel migrations are generally undertaken by species belonging to these two groups (Fig. 1). The increase at night of plant feeders may be the result of a migration towards food sources located at the upper layers of the canopy, such as epiphytic micro- and macroalgae of leaf blades. Diel variation in vertical distribution is probably due to a number of factors which act equally all along the transect, such as predation, and to others which seem to be more limiting at shallow stands, such as light intensity and temperature. Based also on observations made for other phanerogams (Nagle, 1968), at the level of the leaf stratum HDF seem to play a major role in the energy transfer to higher trophic levels, a role that was formerly underestimated.



References

Chessa L.A., E.Fresi & L.Soggiu, 1982. Boll. Mus. Ist. Biol. Univ. Genova, 50 suppl.: 156-161.

Gambi M.C., M.Lorenti, G.F.Russo, M.B.Scipione & V.Zupo, in prep. P.S.Z.N.I.: Marine Ecology.

Greening H.S. & R. J. Livingston, 1982. Mar. Ecol.- Prog. Ser., 7: 147-156.

Khoury C., 1984. Int. Workshop Posidonia oceanica Beds, GIS Posidonie Publ., 1 : 335-347.

Kitting C.L., 1986. Contr. Mar. Sci. Univ. Texas, 27 suppl.: 227-243.

Ledoyer M., 1962. Rec. Trav. St. Mar. Endoume, 25: 173-224.

Mazzella L., M.B.Scipione & M.C.Buia, 1989. P.S.Z.N.I: Marine Ecology, 10(2): 107-12.

Nagle J.S., 1968. Contr. Mar. Sci. Univ. Texas, 13: 105-144.

Scipione M.B., 1989. Oebalia, 15(1), N.S.: 249-260.

Scipione M.B., E.Fresi & K.J. Wittmann, 1983. Rapp. Comm. int. Mer Médit., 28(3): 141-142.

Sparla M.P., 1989. Oebalia, 15(1), N.S.: 269-278.

B-III5

The *Posidonia oceanica* (L.) Delile Meadows of Egyptian Waters. Amphipods from the Alexandria Meadows

M. ATTA and Y. HALIM

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

B

Seasonal collections of the Amphipods of a Posidonia meadow at 5-7 m depth were carried out in 1987-1988 in Miami Bay, Alexandria, the samples were collected from 100 cm^2 quadrates using a rectangular frame. The population composition, abundance, richness, diversity index and evenness were determined.

The Posidonia beds, with their associated communities are of considerable importance along the Mediterranean infralittoral zone of Alexandria region, but very little information is available about their ecosystem. Scellenberg (1936) mentioned eleven species associated with Posidonia meadows off the coast of Alexandria. Latter, Atta (1985) identified 14 Gammaridean and 3 caprellidean Amphipods associated with the meadows.

A total of 27 species (Gammarideae and Caprellideae) were identified from a total of 9570 individual/m^2. Amphilochus manudens, Amphithoe rubricata, Aora spinicornis and Lembos karamani are new records for Alexandria waters. Maera inaequipes ranks first in abundance (22%).in the meadows followed by Ericthonius brasiliensis (20%), Jassa marmorata (18%), Elasmopus pectenicrus (16%), Corophium acherusicum (5%), Microdeutopus obtusatus (5%), Amphithoe ramondi (3%), Caprella acanthifera (2%), Leucothoe spinicarpa (2%), Hyale prevosti (1%), Corophium sextonae (1%). Several other species occurred regularly but in small numbers. Schellenberg recorded also Ampelisca unidentata, Tritaeta gibbosa and Amphithoe helleri.

Comparison with other Mediterranean localities shows that 18 species are common to most Mediterranean Posidonia beds including the Alexandria meadows (Scipione and Fresi, 1984; Scipione and Chessa, 1986; Krapp-Schickell, 1976; Schellenberg, 1936; Atta, 1985 and present records). The relative abundance of the species however is variable and depends on the depth and proximity of the meadows from the coast. According to Ledoyer (1966) the "typical" Posidonia community is the deep one. The present study shows "contagion" of the investigated beds by intruding Amphipod species from the nearly infralittoral rocky communities, in addition to the typical Posidonia species. The numerical abundance and the number of species were significantly much greater in Spring than during other seasons, this is reflected also by the richness (R). Diversity (H'), however, increases in Winter as shown in Table 1.

Table 1. Total number of species and individual/m^2, diversity index (H', Shannon & Weaver), richness (R, Margalef), evenness (J', Pielou) at different seasons in Alexandria meadow.

Season	No.of species	number of individual/m^2	H'	J'	R
Spring	24	3240	1.93	0.61	2.85
Summer	17	3390	1.80	0.64	1.97
Autumn	15	2220	2.00	0.74	1.82
Winter	14	720	2.11	0.80	1.98

Acknowledgement

The first author is gratful to Dr. Roger Lincoln, British Museum of Natural History (Crustacea section) for his guidance during her stay in 1983. The authors are also thankful to Mr. H. Mansour and Dr. S. Hosny for their cooperation.

References

Atta, M.M. (1985). Ph.D. Thesis, Alex. University, EGYPT. 316 pp.

Krapp- Schickel, G. (1976). Bull. Zool. Mus. Univ. Amst., Netherl., 5 (5): 31-45.

Ledoyer, M. (1966). Rec. Trav. Stn. Mar. Endoume, Fr., 57 (41): 135-164.

Scipione, M.B. & Chessa, L.A. (1986). Rapp. Comm. Int. Mer Medit. 30 (2): p 9 .

Scipione, M.B. & Fresi, E. (1984). International Workshop Posidonia oceanica Beds. GIS Posidonia publ., Fr., 1: 319-329.

Schellenberg, A. (1936). Notes & Memoires, No. 18: 1-27.

The *Posidonia oceanica* (L.) Delile Meadows of Egyptian Waters. Polychaetes from the Alexandria Meadows

M. ATTA , Y. HALIM and H. MANSOUR

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

B

The Polychaete fauna of a Posidonia stand located at Miami Bay (Alexandria) have been investigated in the frame of a current project on the study of the Posidonia oceanica ecosystem in Egyptian waters. Samples were collected seasonaly by Scuba diving from a meadow 5-7 m deep from 1000cm^2 using a metal frame. The samples yielded a total of 8080 individuals/m^2, distributed between 24 species, 16 Errantia and 8 Sedentaria. Their diversity H'(Shannon-Weaver), richness (Margelef), evenness J(Pielou) and relative abundance were calculated (Table 1).

Thirteen species contributed 95.5% of the population. Dasychone lucullana was leading with 31% and common in all seasons on the rhizomes. It was followed by Platynereis dumerilii (14%) and Eurythoe complanata (11%), Cirratulus cirratus (10%), Nereis laevigata (6%), Syllis variegata (6%), Syllis alternata (5%), Lumbriconereis funchalensis (4%), Lepidonotus clava (3%), Staurocephalus rudolphii (2%), Lepidonotus squamatus (1%), Capitella capitata (1%) and Syllis gracilis (1%). Eleven other species contribute 1%.

Ergen (1986) found Nereis zonata, Platynereis dumerilii and Nereis pelagica to be the most common Polychaetes associated with P. oceanica meadows of Izmir Bay, while Colognola, Gambi and Chessa (1984) showed that a "typical"Polychaete community associated with Posidonia oceanica leaves could not be identified. All species found are characteristic of other different environments most species identified in Alexandria meadow differ from those reported from the Gulf of Naples, except Platynereis dumerilii which seems to prefer the shallow stands. Although some of the genera identified in Alexandria meadows are correspond to those of the Gulf of Naples such as Syllis, Nereis, Leptonereis, Hydroides, the species are completely different.

Table 1. Total number of species and individuals/m^2, diversity index, evenness, richness at different seasons in Alexandria meadow.

Season	No.of species	No.of individual/m^2	H'	J'	R
Spring	20	1790	2.22	0.74	2.54
Summer	19	3220	2.30	0.78	2.23
Autumn	12	2000	1.60	0.65	1.45
Winter	10	1070	1.26	0.55	1.29

Spring and Summer were significantly more diversified in species than Autumn and Winter, their population was also more even than the Winter and Autumn populations.

The authors wish to thanks Dr. H. Hosny for his cooperation.

References

Colognola, R.; Gami, M.C. and Chessa, A. (1984). International Workshop Posidonia oceanica Beds 1: 101-108.

Ergen, Z. (1986). Rapp. int. Mer Medit 30 (2): p.19.

Polychaete Communities in the Mediolittoral and Infralittoral zones of the Western Mediterranean : two cases of study, the Balearic Islands and the Straits of Gibraltar

Rafael SARDA

Centre d'Estudis Avançats de Blanes (C.S.I.C.), Cami de Santa Barbara, 17300 Blanes (Spain)

Description of the structure of macrobenthic communities has been one of the major goals in benthic marine studies since the pioneering works. The results of macrobenthic community monitoring tipically produce larger groups of species and there is a tendency to reduce the data to group of few species which can be well correlated with those assembleges or communities. The fauna of the community can also be arranged by functionally similar groups of species (guilds) to give an idea of the interaction between the organisms and their habitat.

A faunistic study of the Benthic Invertebrate Populations of the Balearic Islands (Spanish Coast) was carried out in the Zoology Department of the University of Barcelona in 1983 and 1984. A similar study was done in the Straits of Gibraltar in 1981-1984. The main aim of these studies was to correlate the different assemblages of Annelida Polychaeta in the Mediolittoral and infralittoral zones with the surrounding vegetal zonation. Almost 200 samples of 400 cm^2 (20 cm x 20 cm) were scraped off and quantitatively studied in these works.

Light is considered as the main factor determining changes in vegetable zonation with depth in the rocky sublittoral environment. The structural organization in the Straits of Gibraltar was studied for depths between 0 and 15 m due to the strong light attenuation caused by the turbidity of the water. The very clear water of the Balearic islands mean that the critical light level is at depth of 40 m, photophilic algal species can be found in these islands at a greater depth than their homologues in the Iberian peninsula and have a wider sea-belt distributin.

Recently Abbiatti et al. (1987) and Giangrande (1988) proposed the hypothesis that polychaete zonation may be an expression of the biological conditioning of the substrata by algae rather than of the direct influence of physical factors and suggested a model based on three communities in the Romito cliff. This model fitted quite well with the observed model for the Straits of Gibraltar, Sardá (1987).

The results of these studies demonstrate the existence of six Polychaete communities associated to hard bottoms in the mediolittoral and infralitoral zones. The six communities were defined on the basis of their specific composition,trophic-functional structure, diversity and relative abundance and dominance of the species present.

(1) The mediolittoral exposed community.- (Strait of Gibraltar). R=22.2, H'=2,4. The community is dominated by few species of well adapted organisms mainly herviborous: Eulalia viridis, Syllis amica, Perinereis cultrifera, P. marionni, Platynereis dumerilii and Nainereis laevigata. (*)

(2) The mediolittoral community of Lythophyllum tortuosum.- (Balearic Islands). R=15, H'=2,6. Fabricia sabella and Platynereis dumerilii account for more than 50% of the fauna by number. These two polychaetes are accompanied by a group of common species in mediolittoral environment and the impoverished presence of the photophilic group. (*)

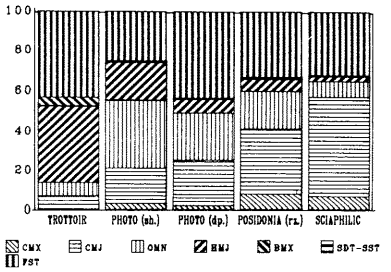
(3) The shallow photophilic community.- (Strait of Gibraltar & Balearic Islands). R=35,5, H'=3,9. The species Sphaerosyllis hystrix, Polyophthalmus pictus, Syllis prolifera, Pseudobrania clavata, Janua pseudocorrugata, Exogone naidina, Pseudobrania limbata, Amphiglena mediterranea and Platynereis dumerilii dominate the community, 70-80% of all organisms belong to those species. The community is also characterized by the absence of species favoured by mediolittoral conditions or by the coraligenous species. (*)

(4) The deeper photophilic community.- (Balearic Islands). R=31,5, H'=2,9. The community is defined with four dominant species: Exogone naidina, Pseudobrania limbata, Amphiglena mediterranea and Josephella marenzelleri. A reduced and less abundant group of the typical infralittoral species is found and a group of coraligenous species is normally present. (*)

(5) The community of rhizomes of Posidonia oceanica.- (Balearic Islands). R=61.7, H'=4,6. The Posidonia rhizomes allow colonization by a mixture of different groups of species. None of these groups has a major relative abundance. (*)

(6) The infralittoral sciaphilic community.- (Strait of Gibraltar & Balearic Islands). R=35,7, H'=3,9. A group of species including Chrysopetalum debile, Autolytus prolifer, Pionosyllis lamelligera, Syllis truncata-criptica and Spirobranchus polytrema are the most numerous although a group of lesser dominants are also important to characterize the community. (*)

The species present can be classified into eight trophic-functional groups. Substrata characteristics play an important role in allowing the appearance of different ecological niches which enables the development of living strategies. Omnivorous and Herviborous species decrease and Carnivorous species increase progressively when algal distribution becomes less abundant. Sessile filter-feeders are constantly present in the communities listed although sabellids are replaced by serpulids when strong light-attenuation is observed. Deposit-feeders and Burrowers are not common in these habitats. Percentages of organisms belonging to these groups in the communities can be observed in the figure.



REFERENCES

° ABBIATTI, M., et al. (1987).- Marine Ecology, 8(1): 33-48.

° GIANGRANDE, A. (1988).- J. Exp.Mar. Biol. Ecol., 120: 263-276.

° SARDA, R. (1987).- Inv. Pesq., 51(2): 243-262.

(*).- (R)= Average richness. (H')= Average diversity (Shannon index).

B-III8

Distribution and life cycle of *Perinereis rullieri* Pilato (Polychaeta, Nereididae), a Mediterranean Endemism

D. PREVEDELLI*, A. CASTELLI*, M. ABBIATI** and R. ZUNARELLI VANDINI*

*Dipartimento di Biologia Animale, Università di Modena, Via Università 4, 41100 Modena (Italia)
**Dipartimento di Scienze dell'Ambiente e del Territorio, Università di Pisa, Via Volta 6, 56100 Pisa (Italia)

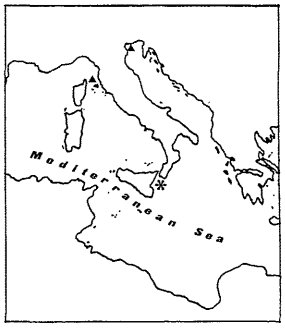
Perinereis rullieri has to date only been recorded along the Ionian coast of Sicily (PILATO, 1974); it is morphologically close to P. cultrifera, a widespread species in the Mediterranean (CAMPOY, 1982; FAUVEL, 1923). P. rullieri is distinguished from P. cultrifera chiefly by the number and size of the paragnaths and by the morphology of the spiniger setae.

During research carried out over the last year on brackish water assemblages, numerous specimens belonging to P. rullieri were found in the Venice Lagoon and along the coasts of Elba Island (Tuscan Archipelago) (Fig. 1). The distribution of this species is not therefore limited to the type locality. P. rullieri is a widespread species along the Italian coasts and presumably in the Mediterranean.

In the Venice Lagoon P. rullieri has been collected near Chioggia, on a mixed substrate containing stones, gravel and muddy sand in the intertidal zone. This habitat is very narrow and borders on areas having different hydrological and sedimentological features where P. rullieri is absent.

The life cycle of this population was studied by means of in situ and laboratory observations.

P. rullieri reaches sexual maturity when the specimens are two years old. Observations carried out over the last four years have demonstrated that spawning occurs when the water temperature reaches about 15 °C, which in the Venice Lagoon generally occurs in April. In the last two years, prevailing climatic conditions have advanced reproduction by about one month. Sexual maturity is reached without epitoky, a feature common in sea-living nereidids and sometimes observed in brackish-water species (CAZAUX, 1965; DURCHON, 1951). Reproduction takes place on the bottom, and the fertilized eggs are encapsulated by a gelatinous envelope. This anchors them to the stones forming large, green colored clumps. The trochophora, metatrochophora and nectochaeta are enclosed in the periovular gelatin. Subsequently, the nectochaeta with three setigerous segments hatches and begins free life. The hatched larvae has a mandible and complete digestive tube; feeding can begin at once even though a large supply of reserve material is present. Notwithstanding the trochus of cilia, the nectochaeta is a bottom dweller. Free life begins at an advanced stage when the larve have acquired the characteristics that permit survival in the habitat of the adult-form.



- Fig. 1 - Distribution of P. rullieri
✲- type locality
▲- new records

The developmental pattern is in agreement with general models of lecitotrophic and benthic larval development in species living in fluctuating environment (FAUCHALD, 1983). The dispersal phase is extremely limited, allowing the larva to immediately settle a suitable habitat. The reproductive and developmental pattern of P. rullieri are quite similar to those described for P. cultrifera (CAZAUX, 1969) in the Mediterranean, where even the latter reproduces without epitoky.

REFERENCES

CAMPOY A., 1982 - Fauna de Espana. Fauna de Anelidos Poliquetos de la Peninsula Iberica. Publicaciones de Biologia de la Universidad de Navarra, Serie Zoologica, 7: 1-781. EUNSA, Pamplona.

CAZAUX C., 1965 - Evolution de Perinereis cultrifera (Grube) au cours d'un cycle annuel a Arcachon. P.V. Soc. Linn. Bordeaux, 102(Sér. A, 18): 1-18.

CAZAUX C., 1969 - Etude morphologique du developpement larvaire d'Annélides Polychètes (Bassin d'Arcachon). (Phyllodocidae, Syllidae, Nereidae). Arch. Zool. Exp. Gen., 110: 145-202.

DURCHON P.M., 1951 - Les modalités de l'essaimage de Perinereis cultrifera Grube (Annélide Polychète) à Luc-sur-Mer. Arch. Zool. Exp. Gen., 88: 1-6.

FAUCHALD K., 1983 - Life diagram patterns in benthic polychaetes. Proc. Biol. Soc. Wash., 96(1): 160-177.

FAUVEL P., 1923 - Polychètes errantes. Faune Fr., 5: 1-188. Le Chevalier, Paris.

PILATO G., 1974 - Perinereis rullieri, nuova specie di Nereidi (Annelida, Polychaeta) delle coste siciliane. Animalia, 1(1/3): 25-37.

B-III9

Sur une collection de Serpulidae (Annélides Polychètes) des Côtes Marocaines

Ghazi BITAR

Université Libanaise, Faculté des Sciences, Section I Bir Hassan, Beyrouth (Liban)

Au cours de nos études des peuplements benthiques littoraux des côtes atlantiques et méditerranéennes du Maroc (Bitar, 1984, 1987), une collection de dix sept espèces de Serpulidae a été récoltée, par grattage, dans trois biotopes: biocénose des algues photophiles (Corallines, Moulières, Cystoseires, *Asparagopsis armata* et *Pyura stolonifera*), biotopes portuaires et biosénose Coralligène. Ce sont: *Serpula concharum, S. vermicularis, Hydroides dianthus*, H. elegans*, H.pseudouncinata, Vermiliopsis striaticeps*, Spirobranchus polytrema, Pomatoceros lamarckii*, P. triqueter, Josephella marenzelleri*, Filograna sp., Spirorbis marioni, Protolaeospira striata* Pileolaria militaris*, P. pseudomilitaris*, Janua* sp..

Les huit espèces marquées d'un astérique, sont nouvelles pour le Maroc. Nous donnons par la suite leurs localités, leurs biotopes et leurs répartitions biogéographiques.

-*H.dianthus*: originaire des côtes atlantiques de l'Amérique du Nord (Zibrowius, 1971), cette espèces est trouvée dans les salissures d'un remorqueur (Chouroub) en arrêt dans le port de Tanger. Nous l'avons récoltée à Beyrouth (Liban) avec, *V. striaticeps, P. lamarckii, P. pseudomilitaris*, sur trois Pélécypodes (*Pinctada radiata, Malleus regula* et *Brachidontes variabilis*) immigrés de la Mer Rouge (Zibrowius et Bitar, 1981).

-*H. elegans*: récoltée aussi bien sur la coque du remorqueur (Chouroub) que dans les deux ports (Tanger-Détroit de Gibraltar; Al Hoceima-Méditerranée). Cette espèce a une large répartition dans les mers tempérées et chaudes, en particulier dans les milieux portuaires. Elle est signalée dans divers points des côtes atlantiques africaines (Zibrowius, 1971).

-*Vermiliopsis striaticeps*: espèce fréquente dans les peuplements infralittoraux à partir des niveaux superficiels et dans les milieux portuaires. Nous l' avons récoltée dans les ports (Tanger et Al Hoceima), dans les peuplements superficiels de la plage Quemado (Al Hoceima) et dans le Coralligène de Beni- Younech (Détroit).

-*Pomatoceros lamarckii*: elle est présente dans les différents biotopes étudiés et abondante dans les Moulières. En Atlantique, elle est trouvée dans les peuplements des Algues photophiles à Rabat et ses régions sud, à Sidi R' bat (situé à 40 Km au sud d'Agadir) et sur les huitres de la lagune d'Oualidia. Dans le détroit, elle est trouvée dans le port de Tanger, dans les Corallines de Dalia (= Punta Cires) et dans les Corallines et le Coralligène de Beni Younech (= Benzu). En Méditerranée, elle est récoltée dans le port et la baie d'Al Hoceima. La seule référence à *P. lamarckii* au Maroc revient à Amoureux (1976) qui, dans les récoltes du Détroit, a signalé des individus qui pourraient se rapporcher de cette espèce.

-*Josephella marenzelleri*: cette espèce, dans le port d' Al Hoceima et le Coralligène de Beni Younech, a une large répartittion géographique (Méditerranée, Portugal, Madère, Brésil, Madagascar).

-*Protolaeospira striata*: cette espèces est trouvée sur les cailloux à Temara (15 Km au sud de Rabat), dans les Corallines de Dalia et dans le Coralligène de Beni Younech. Elle est connue également dans les grottes sous- marines.

-*Pileolaria militaris*: elle est récoltée dans les deux ports (Tanger, et Al Hoceima) et à M'diq (situé au sud de l'enclave espagnole Ceuta). Cette espèce à répartition mondiale se trouve dans divers biotopes.

-*P. pseudomilitaris*: trouvée dans le port de Tanger, dans le fouling du remorqueur (Chouroub) à M'diq et sur les huitres de la lagune d'Oualidia. Une large réparatition a été citée pour cette espèces: Villefranche, Marseille, Beyrouth, Malte, Sidney, Galapagos, Hawaii, Nouvelle Zélande, Angola, Mozambique, Japon.

Remerciements.

Je remercie H. Zibrowius pour sa contribution à l'identification des espèces.

Références.

Amoureux L., 1976. Annélides Polychètes récoltés par J. Stirn en 1969, sur les côtes marocaines du Détroit de Gibraltar. *Cuad. Cienc. Biol.*, Grenada, (5) 5 33.

Bitar G., 1984. Contribution à l'étude qualitative et quantitative du macrozoobenthos d'un peuplements de *Corallina mediterranea* Areschoug installé sur le littoral de la côte atlantique marocaine (région de Temara). *Actes, Inst. agro. vétér. Hassan II*, (4). 1. Special Zool.: 181-190

Bitar G., 1987. Etude de peuplements benthiques littoraux des côtes atlantiques et méditerranéennes du Maroc. Impact de la Pollution-Comparaisons biogéographiques. Thèse d'Etat, Univ. AIX- MARSEILLE II . 326 p., 69 Ann.

Zibrowius H., 1971. Les espèces méditerranéennes du genre *Hydroides* (Polychaeta Serpulidae). Remarques sur le prétendu polymorphisme de *Hydroides uncinata. Tethys*, 2 (3) 1970 : 691-745.

Zibrowius H., Bitar G., 1981. Serpulidae (Annelidae Polychaeta) indopacifiques établis dans la région de Beyrouth, Liban. *Rapp.Comm. int. Mer. Méd.*, 27 (2): 159-160.

Adresse actuelle: Institut des Sciences de la Nature, U.S.T.H.B BP.32 El Alia, Bab-Ezzouar, Alger, ALGERIE.

Etude descriptive du fond Coralligène d'une falaise sous-marine à Beni Younech (Détroit de Gibraltar-Maroc)

Ghazi BITAR

Université Libanaise, Faculté des Sciences, Section I Bir Hassan, Beyrouth (Liban)

B

En Méditerranée nord-occidentale de nombreux auteurs se sont intéressés aux peuplements sciaphiles et en particulier au fond Coralligène de l'horizon inférieur de la roche littoral . Ce type de fond, jamais étudié, à notre connaissance au Maroc, a fait partie d'une étude bionomique et biogéographique des côtes du Maroc (Bitar, 1987).

La station de Beni Younech (Beneu), située dans le détroit de Gibraltar (à l'ouest de Ceuta) non loin de l'entrée en Méditerranée, constitue un pan rocheux vertical. Ce dernier, montre depuis la surface jusqu'au fond (-35m) les faciès et les peuplements suivants:

Au dessus du visor, une ceinture à *Chthamalus* (*C. montagui* et *C. stellatus*) marque l'horizon supérieur du médiolittoral. Le visor, lui-même est dominé par des touffes clairsemées de *Lithophyllum tortuosum* et *Balanus perforatus*.. La phéophycée *Ralfsia verrucosa* est aussi présente vu le degré hygrométrique élevé qui y règne. Dans les endroits bien ombragés on trouve *Astroides calycularis* et *Actinia equina*.

Les deux premiers mètres portent un dense peuplement à *Corallina mediterranea*. Au dessous, s'y ajoutent les peuplements d' *Asparagopsis armata* et de *Stypocaulon scoparium*.

Vers 6 m de profondeur existe un fond précoralligène à dominance d'algues rouges *Peyssonnelia* spp. avec, par places *Udotea petiolata* et *Halimeda tuna*. Cet aspect, dominé par des algues non calcifiées, est vite suivi par le peuplement coralligène à base de Mélobésiées concrétionnantes: *Mesophyllum lichenoides* et *Lithophyllum* spp. que nous avions confondu avec *Pseudolithophyllum expansum*.

A partir de 8 m de profondeur la roche est tapissée d'*Astroides calycularis* que l'on peut trouver jusqu'à -20m. A 12 m de profondeur, un faciès à *Corallium rubrum* accompagné de *Filograna* sp., occupe le plafond horizontal d'un petit surplomb. C'est en effet, le facteur topographique de la roche et non pas la profondeur qui a favorisé l'installation à ce niveau d' un tel peuplement de grottes semi-obscures.

Entre -13 et -20 m, on trouve, en plus du faciès à *Astroides calycularis*,celui de *Parazoanthus axinellae* qui affectionne plutôt les endroits à agitation élevé et à luminosité relativement importante et celui d' *Eunicella* (*E. singularis* et *E. cavolini*) ayant une forme courte et robuste ce qui est l'indice d'un hydrodynamisme intense dans cette localité. Le faciès à *Paramuricea clavata* apparait à partir de -20 m, le poisson *Anthias anthias* y est très abondant. Une grotte existe à -15 m, dont le plafond de l'entrée est tapissé de *Corallium rubrum* et *Leptosammia pruvoti*; à l' entrée, on trouve les crevettes rouges à bandes blanchâtres *Parapandalus narval*.

A partir de -25 m jusqu'aux environs du fond , la roche verticale est tapissée de *Corallium rubrum* associé au faciès à *Paramuricea clavata* sur lesquelles se trouvent assez souvent les colonies de *Filograna* sp.. De place en place, de petites colonies clairsemées de *Parazoanthus axinellae*, sont présentes, avec des Holothurides *Holothuria* spp. qui sont beaucoup plus nombreuses que les Echinides. Ceci a été aussi observé dans les fonds (Coralligène) de l'île de Zembra en Tunisie (Jeudy de Grissac et al., 1986).

Sur le fond envasé (-35 m), nous avons trouvé la Phanérogame *Zostera marina* en épave ce qui nous a suggéré de faire une petite exploration dans l'anse de Beni Younech, En effet, cette phanérogame marine, que nous n'avons pas rencontrée, dans l'Atlantique marocain ni dans le détroit à l'ouest de Beni Younech, était présente dans cette localité en touffe clairsemées sur un fond de -5 m; on peut se demander si cette localité ne représente pas la limite ouest de sa répartition sur la côte de l'Afrique du Nord.

Par comparaison avec d'autre régions de la Méditerranée, la description ci-dessus, montre une nette ressemblance d'aspects et de faciès du Coralligène du Maroc (zone du Détroit de Gibraltar) avec celui de la Méditerranée nord occidentale. Toutefois, nous avons constaté dans notre station:

- une absence de toute construction organogène, à base d' algues, installées sous forme de boucliers, draperies, bourelets, choux-fleurs que l'on trouve sur les tombants de plusieurs localités de la Méditerranée (Laborel, 1961). Ceci est dû à l'hydrodynamisme intense qui inhibe le développement d'un tel concrétionnement.
- une pauvreté en algues molles caractéristiques du précoralligène: *Udotea petiolata* et *Halimeda tuna* par rapport à la Méditerranée nord occidentale. Une telle pauvreté est due à la température assez basse qui y règne, la présence de l'algue *Cytoseira usneoides* (espèce nouvelle pour le Maroc) depuis les premiers mètres jusqu'à -20 m donne une idée de la fourchette thermique, puisque cette Phéophycée ne prospère que dans des eaux agitées ayant une température comprise entre 15° et 18°C, L'homéothermie étant favorisée par le mélange continu des eaux (Giaccone et Bruni, 1973).
- le faciès à *Astroides calycularis* qui manque généralement en Méditerranée nord occidentale (Zibrowius, 1983) existe à Beni Younech, à partir des surplombs au voisinage de la surface jusqu' aux environ de 20 m de profondeur. Cette espèce a été rencontrée, sur la côte atlantique du Maroc, au sud du cap Spartel.

Références .

Bitar G., 1987. Etude de peuplements benthiques littoraux des côtes atlantiques et méditerranéennes du Maroc. Impact de la pollution- comparaisons biogéographiques.Thèse Doct. Etat, Univ. Aix- Marseille 11: 326 p., 69 Ann.

Giaccone G., Bruni A., 1973. Le cistoseire e la vegetazione sommersa del Mediterraneo. *Atti. Ist. Ven. Sciu Lett. Arti*, Venezia, 131: 59-103.

Jeudy de Grissac A., Ben Maiz N., Ben Mustapha K., Boudouresque C.F., Harmelin J.G., Kartas F., 1986. Caractères généraux du benthos du parc marin de l'Ile de Zembra (Tunisie). *Rapp. Comm. int. Mer. Médit.*, 30 (2) B- V1 1.

Laborel J., 1961. Le concrétionnement algal (Coralligène) et son importance géomorphologique en Méditerranée. *Rec. Trav. Stat. mar. Endoume.* 23 (37) : 37-60.

Zibrowius H., 1983. Nouvelles données sur la distribution de quelques Scléractiniaires (Méditerranéens) à l'est et à l'ouest du Détroit de Gibraltar. *Rapp. Comm. int. Mer. Méd.*, 28 (3) : 307-309.

Taxonomical and Ecological Distribution of Allelochemical Production in Benthic Mediterranean Organisms

M.-J. URIZ , D. MARTIN and X. TURON

Centre d'Estudis Avançats de Blanes (C.S.I.C.), Cami de Santa Barbara S/N, 17300 Blanes (Spain)

The chemical activity of benthic organisms has traditionally been related to different aspects of their biology, ecology, systematics, geographical distribution and evolution.

Allelopathy as an ecological phenomenon has been comparatively much less studied in the Mediterranean Sea (Amade et al., 1987) than in tropical and temperate Atlantic zones.

In this study we looked for the taxonomical and ecological distribution of the following activities - Antibacterial (BACT), Antifungic (FUNG), Antiviral (VIR), Cytotoxic (CYT) and Antimitotic (MIT) - in Western Mediterranean benthos.

800 samples were taken by SCUBA diving in October 1988 during a survey aboard the "B/O García del Cid". The zone prospected includes the Balearic Archipelago and the Columbretes Islands (Western Mediterranean). The different communities found in the 27 sampling stations, were sampled. These samples yielded a total of 225 species of benthic algae and invertebrates distributed in ten groups of communities: Communities of photophilic algae (PA), Communities of sciaphilic algae (SA), Precoralligenous (PC), Coralligenous blocks, lower side (CBL), Coralligenous blocks, upper side (CBU), Semi-obscure caves (SOC), Habitats under blocks (UB), Posidonia oceanica meadows (PM), Detritic bottoms (DB) and Euryhaline and eurytherm lagoons (EEL).

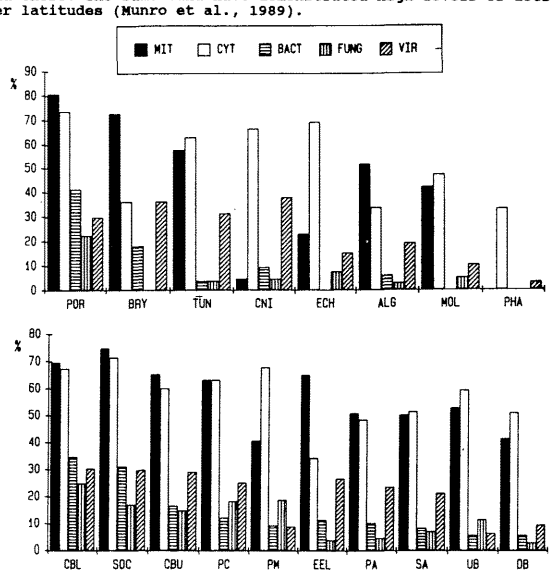
The antimicrobial activity of the crude organic extracts was tested by the diffusion method on cultures of two strains of bacteria and two of fungi. Antimitotic tests were performed on leucemic cells of mice. For antiviral and cytotoxic activities the tests were performed on Herpes simplex viruses and on vesicular stomatitis viruses.

Cytotoxic and antimitotic activities are the most abundant, and are widespread in almost all the taxonomic groups studied (Fig. 1). Porifera and Bryozoa are, generally speaking, the most active taxa, except for the cytotoxic activity which is better represented in Tunicates than in Bryozoa. Antimitotic activity is the most remarkable feature in Porifera and Bryozoa, whereas cytotoxic activity is noteworthy in Porifera, Tunicata and Cnidaria. Antibacterial and antifungic activities are well widespread only in sponges. Antiviral activity is, on the contrary, quite uniformly distributed among the taxonomic groups with a slightly higher incidence in Bryozoa, Porifera, Tunicata and Cnidaria.

Most of the resulting activities exhibit clear relationships with some structural and dynamic characteristics of the benthic communities (Fig. 2). Active species are in general much more abundant in sciaphilic/cryptic habitats (CBL and SOC) where filter-feeder, surface-dependent invertebrates dominate from either a qualitative or a quantitative point of view (Ros et al., 1985). Almost double the percentage of active species has been found in these communities in comparison with those from more photophilic environments (PA, SA, EEL, PM). This percentage reaches its lowest values in detritic communities (DB). The differences found among the photophilic communities are in general slight and they vary according to the type of activity. On the other hand, the Posidonia meadows exhibit relatively high percentages of antimitotic and cytotoxic activities, which could be influenced by the fauna associated with the rhyzome of the plant which is a rather sciaphilic one (Ros et al., 1985). The results of activities on samples from euryhalyn and eurytherm lagoons are difficult to interpret. These zones constitute a complex of different habitats that are poorly represented in our samples and require more complete studies.

On the whole, cytotoxic and antimitotic activities are the most abundant (38.6% and 39.8% of active species respectively), and are widespread in all the communities explored.

There are clear relationships between activities and taxonomic groups. Porifera, Bryozoa and Tunicata are on the whole the most active taxa. They have an important specific weight in the sciaphilic/cryptic communities and are therefore responsible for the high activity rates found there. The same taxa have demonstrated high levels of activity in other latitudes (Munro et al., 1989).



REFERENCES

AMADE, P., CHARIOU, G., BABY, C. and VACELET, J., 1987. Antimicrobial activities of marine sponges from the Mediterranean Sea. Mar. Biol. 94: 271-275.

MUNRO, M.H.G., BLUNT, J.W., BARNS, G., BATTERSHILL, R.S. PERRY, N.B., 1989. Biological activity in New Zealand marine organisms. Pure & Appl. Chem. 61 (3): 529-534.

ROS, J., ROMERO, J., BALLESTEROS, E. and GILI, J. M. 1984. Diving in Blue Water. The Benthos. Ed.: R. Margalef. Western Mediterranean. Pergamon Press. Oxford : 233-295.

B-III12

Responses of Subtidal Meiofauna exposed to a gradient of organic pollution (Gulf of Salerno, Italy)

R. SANDULLI* and M. de NICOLA-GIUDICI**

*Dipartimento di Genetica, Biologia generale e molecolare, Università di Napoli, Via Mezzocannone 8, Napoli (Italia)

**Stazione Zoologica "A. Dohrn", Villa Comunale, Napoli (Italia)

Résumé *: Nous avons analysé la structure de la méiofaune infralittorale et les paramètres chimico-physiques du sédiment dans une zone du Golfe de Naples exposée à des rejets d'eaux usées urbaines. Nous avons remarqué des altérations biocénotiques caractérisées par les réductions de certains peuplements et l'augmentation d'autres liées aux charges polluantes.*

The composition of meiofauna along an organic pollution gradient in the gulf of Salerno (Italy) was studied. Subtidal sediment samples for meiofaunal composition and physico-chemical parameters (Redox potential, particulate organic carbon, pigments) were collected quarterly at various distances from a sewage pipeline outfall at 25 meters depth. Results of the environmental analyses (Table 1) evidenciate the increasingly stressed conditions towards the outfall. Redox values are extremely low up to a distance of 50 m from the outfall and tend to increase far from it. Particulate organic carbon levels, on the other hand, are very high in proximity of the outfall and remain markedly elevated up to 100 m from it; a distinct decline is evident proceeding far away from the source of pollution.

TABLE 1 - Mean values of environmental factors ($\mu g \cdot g^{-1}$ sediment) measured into the sediment along a gradient of organic pollution.

Distance from outfall	Organic Carbon	Chl. a	Phaeop.	Redox Potential at 1 cm depth (mV)
Outfall	8765	0.27	0.91	-245
50 m	6782	1.23	1.81	150
100 m	4578	1.52	1.44	241
200 m	2374	1.88	1.38	283
400 m	748	2.03	1.57	308
1500 m	806	1.97	1.69	296

Meiofaunal data show that nematodes abundance is enhanced along a gradient of increasing organic enrichment until the environmental conditions deteriorate significantly approaching the sewage outfall, where no nematode is found. Mesobenthic and epi-endobenthic copepods (Fig. 1) showed a differential response: mesobenthic forms decrease markedly and rapidly in abundance closer to the pollution source, while the epi-endobenthic copepods increase their numbers along a gradient of increasing organic enrichment, reaching the highest densities in proximity of the sewage outfall. It is remarkable that the harpacticoid Bulbamphiascus imus, an opportunistic species previously recorded in organically enriched environments (Marcotte & Coull, 1974; Sandulli & de Nicola, 1990) composed over 92 % of the total copepod assemblage.

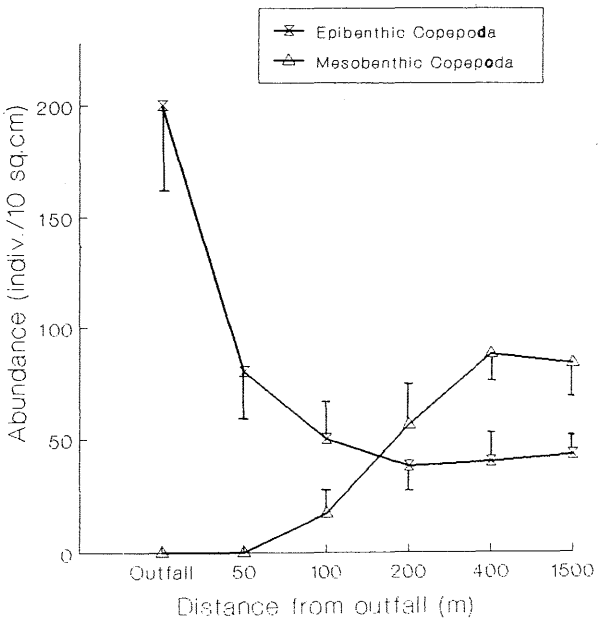


FIGURE 1 - Mesobenthic and Epi-Endobenthic Copepods abundance along a gradient of sewage pollution. Values represent means between two replicate samples, one of which is shown as bar.

From this study it is evident that the structure of meiobenthic communities along a gradient of organic pollution, results considerably altered and possibly related to the environmental parameters considered. Moreover, the evaluation of the state of such communities may be very important to environmental perturbations assessment.

REFERENCES

Marcotte, B.M. & Coull, B.C. (1974) - Pollution, diversity and meiobenthic communities in the North Adriatic (Bay of Pyran, Yugoslavia). Vie Milieu, **22**: 281-300.

Sandulli, R. & de Nicola-Giudici, M. (1990) - Pollution effects on the structure of meiofaunal communities in the Bay of Naples. Mar.Poll.Bull., **21**: 144-153.

B-III13

La Biocalcification chez le Corail rouge, *Corallium rubrum*

Marie-Christine GRILLO et Denis ALLEMAND

Centre Scientifique de Monaco, Laboratoire de Biologie Marine, Musée Océanographique (Monaco)

Depuis le Néolithique, le Corail rouge de Méditérranée (*Corallium rubrum*) fait l'objet de pêcheries intensives (Grigg, 1974). Cette espèce souffre actuellement de surexploitation aggravée encore par des problèmes pathologiques dont l'origine exacte est inconnue (Rivoire, 1987). La seule solution adoptée jusqu'à présent est la recherche de nouveaux bancs vivant à grande profondeur (supérieure à 100 m.), solution à court terme qui ne peut qu'accélérer la disparition de l'espèce.

Il est surprenant de constater que, malgré la grande valeur économique de son squelette, l'exploitation du Corail rouge n'a pas été associée à l'étude de sa biologie, qui est presque totalement inconnue (CGPM,1988). Or, l'acquisition de bases biologiques est nécessaire avant toute recherche appliquée.

Par une approche multidisciplinaire, morphologique, biochimique et physiologique, notre objectif est d'améliorer les connaissances fondamentales relatives à cette espèce afin d'améliorer ses conditions de maintien en aquarium et plus tard sa culture. Dans un premier temps l'étude de la biocalcification et de sa régulation a été abordée. Etudiée chez quelques gorgonaires, elle n'a jamais fait l'objet d'investigations poussées chez le Corail rouge. Notre travail impliquera aussi une étude comparative de ce processus chez les Octocoralliaires.

Les résultats préliminaires obtenus font l'objet de deux communications. La première présente l'état actuel de notre étude sur la morphologie des tissus et des structures calcifiées du Corail rouge. La seconde - Comité de Microbiologie et Biochimie marines - présente quelques éléments de biochimie et de physiologie.

La description morphologique des tissus et des structures calcifiées disponibles dans la littérature sont anciennes: Lacaze-Duthiers (1864), Muller (1910). Les études plus récentes concernent uniquement la morphologie des organes génitaux et le développement de la larve (Vighi, 1970, 1972). Les seules données concernant la morphologie des structures squelettiques ont été publiées par Weinberg (1976) à propos de la systématique des Octocoralliaires et par Mateu *et al.* (1986) dans une étude sur la formation de l'axe du Corail.

Les photographies de microscopie à balayage du squelette axial montrent une surface hérissée de protubérances scléritoïdes de forme très comparable aux sclérites rencontrés dans les tissus. Ce qui a jusqu'alors donné à penser que la formation de l'axe squelettique etait réalisée par la fusion des sclérites grâce à un ciment calcaire. L'origine de ce ciment n'a jamais été déterminée.

Des observations en microscopie photonique ont été réalisées dans un premier temps avant d'aborder l'étude des cellules à l'origine des structures squelettiques. Une délicate mise au point a été nécessaire afin de préparer les échantillons en vue de leur observation, ceci en raison de la fragilité des tissus (problème de fixation) et de la présence des éléments durs (sclérites et axe). Les échantillons sont coupés soit après décalcification, soit directement grâce à des méthodes inspirées de celles développées pour étudier les dents ou les os.

L'observation en microscopie photonique de coupes transversales de Corail montre que les tissus entourant le squelette axial sont formés:

- d'un ectoderme périphérique, monostratifié,
- d'une mésoglée,
- de cellules bordant un squelette axial

La mésoglée est composée de collagène (mise en évidence par coloration à la picro-fuchsine de Van Gieson), et parcourue par une trame de canalicules anastomosés à un réseau général de gros canaux longitudinaux, parallèles à l'axe, situés en position profonde. Au sein de ce tissus les sclérites sont très denses sous l'ectoderme avec lequel ils sont en contact étroit et beaucoup plus rares dans les zones profondes. Cette répartition inégale est confirmée par une microanalyse à rayons X du calcium. Les sclérites sont toujours associés à une ou plusieurs cellules très reconnaissables déjà observées chez les gorgones (Goldberg W.M. et Y. Benayahu, 1987), (Bouligand Y., comm. pers.) .

Au contact direct du squelette axial, des cellules semblent former un épithélium. L'existence de cet épithélium, pressenti par Bayer (comm. pers. 1989) n'avait jamais encore été démontré. Il est constitué de cellules en "champignon" épousant l'espace existant entre les protubérances scléritoïdes de l'axe. Ces cellules sont reliées entre elles par de fins prolongements cytoplasmiques. Leur morphologie générale rappelle les cellules à cheminées décrites chez *Veretillium* par Franc *et al.* (1974).

L'agencement des tissus ainsi décrits est beaucoup plus anarchique au niveau de l'apex de la colonie, où la forme même de l'axe est très tourmentée.

Les structures squelettiques (sclérites et axe central) montrent après décalcification la présence d'une abondante matrice organique, constituée dans une large part de mucopolysaccharides (démontré par histochimie). Cette matrice présente aussi bien dans les sclérites que dans l'axe un agencement concentrique, que l'on peut observer dans les structures squelettiques non décalcifiées en microscopie à balayage.

Dans le but de comprendre les mécanismes de formation des structures squelettiques, nous avons également étudié l'ultrastucture des scléroblastes et des cellules bordant l'axe en microscopie électronique à transmission, et localisés par histochimie deux enzymes clés dans les processus de calcification: la Ca^{++}-ATPase et l'anhydrase carbonique.

Nos résultats encore préliminaires présentent pour la première fois une étude morphologique des tissus entourant le squelette du Corail rouge. Ils démontrent, de plus, que l'accroissement du squelette axial est centripète, élaboré par l'ajout de couches concentriques de façon similaire à la croissance de *Corallium jonhsonni* (Lawniczak, 1987). Les cellules bordant l'axe pourraient être à l'origine de la formation de ce dernier. Les protubérances scléritoïdes apparaissant tant à la surface de l'axe que dans l'intérieur même de ce dernier sous la forme de demi sclérites convexes ainsi que l'absence de sclérites en voie de fusion remettent en cause l'hypothèse admise généralement d'une formation par migration des sclérites puis leur soudure . L'étude de l'ultrastructure et de la physiologie de ces cellules bordant l'axe rapprochée de celle des cellules entourant les sclérites permettra de définir les modes de formation de l'axe du Corail rouge.

REFERENCES

CGPM, 1989.-- Conseil Général des Pêches pour la Méditerranée. Rapport de la deuxième consultation technique du CGPM sur le Corail rouge de la Méditerranée. Torre del Greco, Italie, septembre 1988. *FAO Fisheries report*, n°143.

FRANC S., A. HUC et G. CHASSAGNE ,1974. -- Etude ultrastructurale et physicochimique de l'axe squelettique de *Veretillium cynomorium* : cellules, calcite, collagène . *J. Microscopie* 21 : 93 -110.

GOLDBERG , W. M. et Y. BENAYAHU ,1987. -- Spicules formation in the gorgonian coral *Pseudoplexaura flagellosa* . 1 : Demonstration of intracellular and extracellular growth and the effects of Rhutenium red during decalcification. *Bull. Mar. Sci.* 40 : 287-303.

GRIGG ,R. W., 1974 .-- Distribution and abundance of precious Corals in Hawaii. *Proc. 2nd. Intl.Coral Reef Symp.Gt. Barrier Reef Comm.*- Brisbane 2 : 235-240

LACAZE-DUTHIERS H. (1864). Histoire naturelle du Corail. J.B. Bailière et Fils eds., Paris, 371p

LAWNICZAK, A.,1987 .-- Les modalités de croissance de l'axe calcaire chez *Corallium johnsoni* (Cnidaire : Gorgonacea : Scleraxonia). *Senckenbergiana marit.* 19 (3/4) : 149-161.

MATEU G., TRAVERIA A., FONTARNAU R., MASSO C. (1986). Biodiagénesis mineralogica del *Corallium rubrum* (Linn.). *Bol. Inst. Esp. Oceangr.* 3 (4): 1-12.

MULLER ,R., 1910 .-- Uberdie bildund des Achsenskelets von *Corallium. Mitt. Zool. Stat. Neaple* 20 : 101-107

RIVOIRE , G. ,1987. Existence de champs de Corail rouge et de gorgones morts en profondeur entre Cassis et Nice. Rapport destiné à la direction des Affaires Maritimes de Méditerranée, 16p.

VIGHI , M., 1970. Ricerche sul ciclo riproduttivo del Corallo rosso (*Corallium rubrum*) del promontorio del Portofino. *Atti. Acad. Naz. Lincei. Memorie.* VIII, 10 (1): 1-26.

VIGHI , M. ,1972. Etude sur la reproduction du *Corallium rubrum* (L.). *Vie et Milieu.* 23 (1): 21-32.

WEINBERG, S., 1976 .Revision of the common Octocorallia of the mediterranean circalittoral. I. Gorgonacea. *Beaufortia* 24 (313) : 63-102 .

B

Evolution des Peuplements Macrobenthiques du substrat sableux sur le Littoral Roumain

Victoria TIGANUS

Institut Roumain de Recherches Marines, Constanta (Roumanie)

Le travail se réfère aux recherches déroulées dans l'intervalle 1983-1987 sur la communauté des sables à *Corbula mediterranea*, couvrant un réseau de 30 stations (environ 300 échantillons quantitatifs) aux profonderus de 5 m, 10 m et 20 m.

On a enregistré 74 espèces en ensemble, dont seulement six avec une fréquence au-dessus de 50%, deux avec 30-50% (Tableau 1), et 53 espèces au-dessus de 10% (31 de ces dernières dans un seul échantillon). Il y a donc une grande uniformité de la structure qualitative faunistique dans la zone étudiée: sans tenir compte de la profondeur ou de la zone, la macrofaune est représentée principalement par les 7-8 espèces à grande fréquence. De même, la structure quantitative est homogène elle aussi, se caractérisant par la domination numérique des polychètes (les quatre espèces a grande fréquence) et, comme biomasse, par celle des bivalves (principalement *Mya arenaria*) (Tableau 1).

Tableau 1. Fréquence (f%) ed dominance (D%) comme densité et biomasse des principales espèces macrobenthiques

Espèces		D% - Densites					D% - Biomasses				
	f%	1983	1984	1985	1986	1987	1983	1984	1985	1986	1987
Neanthes succinea Leuk.	89	13,5	8,5	4,2	4,6	8,8	1,9	4,1	0,4	2,0	5,8
Spio filicornis O.F.M.	90	36,7	56,3	65,2	28,3	35,8	6,5	23,9	31,1	8,1	12,1
Polydora ciliata limicola Ann.	65	28,4	14,9	0,9	16,5	4,2	4,8	3,8	0,8	8,6	1,8
Capitella capitata Fabr.	70	9,3	10,3	3,3	14,8	10,5	1,0	2,1	0,7	1,0	0,6
Cardium edule L.	57	2,7	0,6	0,6	0,8	1,7	22,1	14,3	15,9	13,1	12,7
Corbula mediterranea Costa	46	3,9	2,9	16,2	4,2	2,2	9,7	5,4	11,4	3,4	8,6
Mya arenaria L.	64	2,2	3,4	1,1	18,7	2,7	33,3	27,6	20,7	45,4	35,4
Ampelisca diadema Costa	38	5,0	0,7	0,3	0,4	0,1	2,3	2,3	1,5	0,6	0,4

Par rapport à la structure enregistrée en 1961 (1), la reprise des recherches en 1983 a mis en évidence une communauté appauvrie, formée dans la plupart des peuplements de quelques éléments tolérants (3).

Pendant la période 1983-1987 ont peut distinguer deux périodes différéntes de l'évolution de la structure de cette communauté: 1983-1985 et 1986-1987.

Au cours de la première période on constate: a) l'enrichissement qualitatif (Tableau 2); b) la croissance de la densité, plus forte à 5 et à 10 m (Tableau 3); c) la croissance de la biomasse à 5 m et sa diminution à 10-20 m, comme suite d'une régression des peuplements de *Mya* (Tableau 3); d) des changements entre les proportions des espèces dominantes, c'est à-dire l'augmentation de D% de certaines espèces caractéristiques de la biocénose, donc plus sensibles (*Corbula, Spio*) et la réduction de D% des espèces tolérantes (*Polydora, Neanthes*) (Tableau 3); e) la pénétration et l'auto-acclimatation de *Scapharca inaequivalvis* (BRUG.) (3).

Donc, pendant cette première période la communauté s'est regénéré, en raison d'une ampleur réduite des "floraisons" (2), mais la structure de la communauté reste très dégradée par rapport aux années 1960.

Au cours de la seconde période, 1986-1987, a eu lieu un nouveau processus d'appauvrissement qualitatif, ainsi que la prolifération des éléments tolérants, le phénomène étant plus intense à la profondeur de 20 m (Tableau 1,2 et 3). Cette tendance indique l'interruption du phenomène de régénération de la biocénose et la poursuite de sa dégradation, son état s'approchant de celui de 1983. La principale cause en est les fortes floraisons des mois d'été, suivies de l'installation de conditions d'hypoxie (2).

Tableau 2. Nombre d'espèces des principaux groupes d'organismes macrobenthiques

Groupe	1961	1983	1984	1985	1986	1987
Polycladidae	2	1	1	1	0	0
Mollusca	19	12	12	15	15	11
Polychaeta	24	12	11	12	12	9
Cirripedia	1	1	1	1	1	1
Cumacea	4	3	4	3	1	1
Isopoda	4	0	0	2	1	0
Decapoda	6	2	3	3	0	0
Amphipoda	17	7	11	10	3	3
Chironomida	1	1	1	1	0	0
Phoronidea	1	0	1	1	1	1
Total	79	39	44	49	34	26

Cette instabilité de la communauté, son appauvrissement, l'honogénéisation spécifique, la prolifération des éléments tolérants, attentent un grave deséquilibre écologique. Malgré l'existence d'une période de régénérationm dans l'ensemble, la dégradation de la communauté en conditions, de forte euthrophisation, à l'échelle de plusieurs années, est continue, mais son intensités varie, elle dépende de la fréquence et de l'intensité des "floraisons". L'existence de cette période de régénération indique néanmois que dans cette phase, les transformations négatives ne sont pas encore iréversibles, une amélioration des conditions du milieu pourraient déterminer, en quelques années, à la régénération presque complète de la communauté.

Tableau 3.Evolution des dénsités et des biomasses générales moyennes du macrobenthos

Année	Densités 5 m	10 m	20 m	Moyenne	Biomasses 5 m	10 m	20 m	Moyenne
1983	31.350	19.727	17.659	22.912	149,45	445,80	222,60	272,60
1984	129.760	94.671	15.700	80.044	397,59	171,06	32,12	200,30
1985	424.248	87.204	78.712	196.721	859,98	157,94	133,84	383,90
1986	37.685	19.693	12.612	23.334	430,94	99,05	44,49	191,49
1987	60.910	29.020	10.320	33.436	338,01	347,66	15,43	233,70

Bibliographie

1. BACESCU M., GOMOIU M.-T.,BODEANU N., PETRAN A., MULLER G.I., CHIRILA V., 1967 - Ecologie marina, Edit. Acad., Bucuresti, 2: 7-167.
2. BODEANU N., 1989 - A IV-a Conferinta de Ecologie, Piatra Neamt: 235-236.
3. TIGANUS V., 1983 - Rapp. Comm. int. Mer Médit., 28, 3: 205-206.

Le Programme National sur le Déterminisme du Recrutement : objectifs généraux et résultats obtenus en Baie de Banyuls

J.-C. DUCHENE et M. BHAUD

Laboratoire Arago, Université Pierre et Marie Curie, Unité Associée au CNRS (LA 117); 66650 Banyuls-sur-Mer (France)

Dans le milieu marin, on admet généralement que la continuité des cycles de vie dépend des conditions physiques du milieu, à la fois de leur valeur absolue et de leur fluctuation. Cette hypothèse de travail nécessite l'évaluation, au cours du déroulement d'un cycle de vie et de l'évolution pluriannuelle des populations, de la part respective des processus biologiques et des processus physiques. Parallèlement, l'estimation des incertitudes sur les modèles dynamiques suppose la compréhension des mécanismes mis en jeu. Deux catégories de mécanismes sont définis: la dissémination en pleine eau et le retour sur le fond.

Deux espèces d'Annélides Polychètes de la famille des Terebellidae: *Eupolymnia nebulosa* et *Lanice conchilega* ont été retenues; elles diffèrent par l'emplacement de la période de reproduction sur le calendrier saisonnier, la stratégie employée au cours de cette reproduction, la fécondité, le rapport gonado-somatique, la durée du séjour des larves dans le plancton, la répartition sédimentaire des adultes...

Afin de modéliser la dissémination larvaire et le cycle de vie de ces espèces on a choisi de collecter le maximum de données concernant les différents stades de développement de l'espèce, afin de les insérer ensuite dans un cadre physique. Cette intégration nécessite le développement de modèles de dispersion associant paramètres biologiques et physiques. A court terme les objectifs sont au nombre de trois: a) terminer l'identification des paramètres des cycles de vie des espèces modèles; b) estimer la flottabilité des larves en pleine eau; c) établir les relations larves-sédiment. A moyen terme il s'agit de reconnaitre les sources de fluctuation interannuelle des populations adultes.

L'expérimentation en laboratoire repose sur la combinaison de 7 éléments favorables. a) Le nombre de larves impliquées dans chaque expérience est toujours suffisamment élevé pour autoriser l'utilisation d'une enceinte de large volume, de l'ordre de 60 litres. b) Cette dernière, de type canal fermé, contient une eau circulant au-dessus de plaques amovibles recouvertes de substrats divers. c) La durée de l'expérience, de l'ordre de 2 jours, permet de ne pas se limiter à l'enregistrement d'une arrivée à proximité du fond, mais de prendre en compte l'établissement même de la larve sur le sédiment. d) La détection d'une réussite de l'établissement s'effectue par l'observation aisée d'un tube. e) Le synchronisme de la fixation a l'avantage de fournir un ensemble d'individus d'âge homogène. f) La durée de vie planctonique de l'espèce étant réduite, l'expérimentation peut se faire rapidement. g) L'utilisation de la photographie des substrats en place permet un comptage aisé en évitant une manipulation qui perturbe les répartitions initiales.

Chez *E. nebulosa*, le substrat remplit différentes fonctions vis à vis des larves arrivant à son contact: il donne un support de fixation dur et stable pour l'immobilisation et l'ancrage; fournit un matériel manipulable pour la construction du premier tube et contient une quantité minimale de microparticules pour la nutrition. Les limites granulométriques sont les suivantes: limite inférieure des éléments nécessaires à la fixation: 250 µm en mode calme; limite supérieure du matériel de construction: 80 à 100 µm; limite supérieure des éléments nutritifs proche de 8 µm. Dans le contexte plus large de la constitution d'un peuplement d'adultes, il se produit une sélection antérieure à l' établissement larvaire, en relation avec les capacités de choix des larves pendant une courte période. Cette sélection n'élimine pas cependant la possibilité d'une autre sélection, postérieure à l'établissement et mettant en jeu la compétition intraspécifique. Il est enfin montré que les larves sont capables de s'installer sur un substrat naturel qui n'a jamais permis la récolte d'adultes. Pour que le lieu de fixation entraîne la présence des adultes, la dissémination réduite (contrôlée à la fois par des caractères biologiques et physiques) joue un rôle essentiel.

L'observation de la larve aulophore de *L. conchilega* est faite dans une quantité d'eau suffisante pour que les conditions de déplacement soient similaires à celles du milieu naturel. La position et la stabilité de cette larve dans la colonne d'eau dépendent de la secrétion d'un cordon muqueux et non de la circulation de l'eau entre le corps de la larve et la paroi du tube. Malgré la longue durée de vie planctonique, le milieu marin n'exerce pas une action nécessairement dispersive: un suivi planctonique régulier en un même point permet de récolter les différents stades de développement: premiers tubes benthiques détritiques, tubes muqueux planctoniques occupés par des larves ayant de 1 à 5 tentacules. Certaines particularités topographiques entrainent une rétention par suite du trajet en boucle des courants comme il a été montré en baie de Banyuls. A une échelle spatiale plus réduite, au niveau de la couche limite de fond les mêmes larves exercent une capacité de choix bien réelle: elles peuvent s'ancrer sur le substrat en résistant à une vitesse de 4 cm/s ou regagner la colonne d'eau.

Une interaction des processus biologiques et des facteurs physiques du milieu est donc observée aux niveaux macroscopique et microscopique. Il n'est pas réaliste, au moins dans les conditions expérimentales utilisées, d'assimiler les stades larvaires à des éléments physiques passifs.

REFERENCES

BHAUD, M.,1990. Acquisition de la vie benthique par *Eupolymnia nebulosa* (Polychaeta, Terebellidae): dispositifs expérimentaux et premiers résultats. Vie Milieu, 40 (1):

BHAUD, M., 1990. Larval release from the egg mass and settlement of *Eupolymnia nebulosa* (Polychaeta, Terebellidae). Bull. Mar. Sc., 46 (2):

BHAUD,M. et C. CAZAUX, 1990. Buoyancy characteristics of *Lanice conchilega* larvae (Polychaeta Terebellidae). Implication for settlement. J. exp. Mar. Biol. Ecol., 136 (2):

DUCHÊNE, J.C. (sous presse). Premiers résultats sur l'étude des courants en baie de Banyuls à partir d'un système lagrangien de drogues dérivantes.

B-III16

Thanatocoenose würmienne à Bryozoaires bathyaux en Mer Tyrrhénienne

Antonietta ROSSO

Istituto di Scienze della Terra, Corso Italia, 55, 95129 Catania (Italia)

Les Bryozoaires des profondeurs bathyales de la Méditerranée sont très peu connus. Les recherches ont été effectuées essentiellement en Méditerranée méridionale (Mer d'Alboran et Golfe de Syrthe) (d'Hondt, 1977; David et Pouyet, 1979; Harmelin et d'Hondt, 1982). En outre, les échantillons proviennent, en majeure partie, de la partie supérieure de la pente continentale et ceux qui depassent 1.000 metres sont peu nombreux.

La présente note décrit la faune de Bryozoaires récoltée par un dragage effectué en mer Tyrrhénienne septentrionale, à l'Est de la Corse, sur le versant occidental des Monts Etrusques (445 - 1.265 m; 41° 41,20' N; 10° 18,50' E - 41° 41,20' N; 10° 23,00' E; Station BS 78/38; Campagne "Bacini Sedimentari" 1978) (Bacini Sedimentari, 1979; Torelli et Buccheri, 1981).

Le sédiment est une vase de couleur ocre, fluide, mélangée avec quelques fragments d'une croûte ferromanganésifère. Les restes organogènes compris dans ce sédiment sont donnés essentiellement par des Mollusques, des Brachiopodes, des Polychètes, des Coraux, des Bryozoaires et des Foraminifères en majeure partie bien préservés. Peu de fragments sont recouverts par l'enduit noirâtre d'oxyde de manganèse typique des sédiments de profondeurs. Les coquilles remplies de sédiment calcaire déjà solidifié sont relativement plus fréquentes.

La thanatocoenose à Bryozoaires est intéressante dans la mesure où elle comprend un lot important d'espèces qui caractérisent les associations bathyales actuelles de l'Atlantique oriental et, en particulier, le Golfe de Gascogne et la pente continentale au large des côtes portugaises (Région Lusitanienne).

Trente-six espèces ont été déterminées dont 9 Cyclostomida, 10 Anascina et 17 Ascophorina. Les Cyclostomes sont bien représentés malgré la grande profondeur; mais de nombreux exemplaires sont extrêmement fragmentés et ne sont identifiables qu'à un niveau générique. De même, plusieurs Anascina sont représentés seulement par très peu de fragments monozoïdaux.

Parmi les taxa déterminés à un niveau spécifique, on peut distinguer 3 groupes différents.

Le **premier groupe**, caractérisé par des spécimens d'aspect particulièrement frais, comprend seulement très peu d'espèces. Il s'agit de *Anguisia verrucosa* Jullien, *Setosellina* cf. *capriensis* WATERS, *Palmicellaria elegans* Alder et *Tessaradoma boreale* Busk. De toutes ces espèces, seule *S. capriensis* est la plus courante en Méditerranée aussi bien sur le plateau continental que sur la pente. Par contre, *P.elegans* et *T. boreale* sont des espèces de profondeur qui sont particulièrement rares en Méditerranée où elles ont été signalées très peu de fois par Gautier (1962), Harmelin (1976) et Zabala (1986), mais qui sont relativement courantes en Atlantique nord-oriental. *T. boreale*, en particulier, est une espèce sténotherme froide mais eurybate présente en Atlantique entre 70 et 3.700 mètres de fonds dont la température reste comprise entre 2 et 13° C (Cheetham, 1972 *fide* Hayward et Ryland, 1979). Enfin, *A. verrucosa*, est une espèce bathyale signalée en Méditerranée à des fonds situés à 500 mètres environ dans le Golfe de Syrthe (Harmelin et d'Hondt, 1982) et à 550 mètres, au large de Marseille (Jullien, 1882). Cette espèce est aussi assez commune en Atlantique nord-oriental où elle a été même relevée à de plus grandes profondeurs (Jullien, 1882; Harmelin, 1977).

Le **deuxième groupe** est formé par des espèces d'un aspect moins frais mais encore en assez bon état de conservation. Les espèces suivantes sont actuellement toutes vivantes en Méditerranée: *Setosella vulnerata* Busk, *Caberea boryi* (Audouin), *Tervia irregularis* (Meneghini), *Copidozoum exiguum* (Barroso) et *Sertella couchi biaviculata* Waters. Sules les trois premières sont très courantes alors que *C. exiguum* et *Sertella couchi biaviculata* n'ont été citées que très peu de fois. Leur distribution bathymétrique est relativement étendue mais les trois dernières espèces semblent être exclues de l'Infralittoral et du Circalittoral supérieur (Harmelin, 1976; Harmelin, com. pers. et données pers.inédit.).

Toutes ces espèces sont donc compatibles avec les fonds dragués et leur fragments pouvent vraisemblablement provenir du peuplement actuel.

Enfin, le **troisième groupe** est, de loin, le plus intéresant. Il est formé de plusieurs espèces dont *"Palmicellaria" inermis* Jullien, *Bugulella elegans* Hayward, *Scrupocellaria jullieni* Hayward, *Jaculina tessellata* Hayward, *Sertella* cf. *sparteli* Calvet et *"Cheilonella"* sp.de Harmelin (1977). Toutes ces espèces ont été décrites sur des spécimens provenant de l'Atlantique nord-oriental et n'ont été citées que rarement des fonds de la pente continentale ou du rebord du plateau continental (Jullien, 1882; Hayward, 1978; 1979; d'Hondt, 1974; 1975) ou, encore, dans des zones d'upwelling del'Atlantique nord-oriental (Harmelin, 1977). A ce groupe on peut ajouter *Gemellipora eburnea* Smitt et *Euginoma vermiformis* Jullien, espèces très courantes en Atlantique nord-oriental et qui, selon l'état actuel des connaissances, ont une répartition géographique plus étendue que les précédentes. En outre, ces deux espèces sont répandues à un intervalle bathymétrique plus étendu que celui des autres dans la mesure où elles sont respectivement distribuées entre 200 et 3.307 mètres et 200 et 5.150 mètres (Hayward, 1981). A noter, que les signalisations les plus superficielles se réfèrent à une station touchée par des upwellings (Harmelin, 1977).

Quelques-unes des espèces de ce troisième groupe, comme *B. elegans*, *S. jullieni*, et *E.vermiformis* , représentent une composante, peut-être endémique, de la faune à Bryozoaires de la pente continentale de l'Europe atlantique. Cet ensemble serait typique de la tranche bathymétrique correspondante à la pente continentale où elles ont été trouvées jusqu'à des profondeurs variables mais, de tout facon, inférieures à 4.000 mètres ("middle depth fauna" de Hayward, 1978). A ce groupe, on peut ajouter *J. tessellata*, *P. inermis* e *S. sparteli* lesquelles, ont, de toutes facon, une limite inférieure de distribution plus superficielle qui va de 1.000 à 1.500 mètres (Hayward, 1979).

Aucune de ces espèces n'a jamais été, jusqu'à présent, signalée en Méditerranée. Leur présence en thanatocoenoses méditerranéennes est, peut-être, à mettre en rapport avec les migrations de la faune froide d'origine atlantique qui se sont produites, à plusieurs reprises, pendant les périodes froides du Pleistocène. En particulier, l'âge de la faune examinée se rapporte au Würmien pour ce qui est de la position des sédiments considérés (Torelli et Buccheri, 1981). Les espèces du troisième groupe pourraient donc représenter un stock de Bryozoaires vivant actuellement en Atlantique nord-oriental mais qui ont aussi colonisé les milieux bathyaux de la Méditerranée pendant des phases froides du Pleistocène, en l'absence du régime d'homothermie typique de la Méditerranée actuelle. De telles espèces pourraient donc être considérées comme des "hôtes atlantiques" *sensu* Di Geronimo et Li Gioi (1980). Des faunes de signification analogue, mais appartenant à d'autres groupes taxonomiques ont été signalées récemment par le même échantillon (Di Geronimo et Zibrowius, 1983) ou dans des échantillons provenant de la même zone (Di Geronimo et Li Gioi, 1980; Di Geronimo et Bellagamba, 1985)

Bibliographie

Bacini Sedimentari (1979) - Primi dati geologici sul Bacino della Corsica (Mar Tirreno). *Atti Conv. Naz. Prog. Finalizzato Oceanografia e Fondi marini*, Roma, 5-7 Marzo 1979: 713-727.

David L. & Pouyet S. (1979) - Bryozoaires in: La Mer Pélagienne. *Géol. Médit.*, 6(1): 265-270.

Di Geronimo e Li Gioi (1980) - La malacofauna wurmiana della staz. BS 77/4 al largo di Capo Coda Cavallo (Sardegna nordorient.).Ann. Univ. Ferrara, (N.S.) Sez. 9 Sc. Geol. e Paleont. 6 (Suppl.): 123-151.

Di Geronimo I. & Bellabamba M. (1985) - Malacofaune dei dragaggi BS 77-1 e BS 77-2 (Sardegna nord-orientale. Boll. Soc. Pal. It. , 24(2-3): 111-129.

Di Geronimo I. et Zibrowius H. (1983) - Le Scléractiniaire Fungiacyatus fragilis et l'Octocoralliaire Stolonifère Scyphopodium ingolfi dans le Pléistocène de la Méditerranée. *Rapp. Comm. int. Mér Médit.*, 28 (3): 303-306.

Gautier Y.V. (1962) - Recherches écologiques sur les Bryozoaires chilostomes en Méditerranée occidentale. *Rec. Trav. Stat. Mar. Endoume* 38(24): 1-434.

Harmelin J.G. & d'Hondt J.L. (1982) - Bryozoaires Cyclostomes bathyaux des campagnes océanographiques de l'"Atlantis II", du "Chain" et du "Knorr" (1967-1972). *Bull. Mus. Nat. Hist. Nat., Paris*, s.4, 4 (sec. A)(1-2): 3-23.

Harmelin J.G. (1976) - Le sous-ordre des Tubuliporina (Bryozoaires Cyclostomes) en Méditerranée. Ecologie et systématique. *Mém. Inst. Océanogr.*, 10: 1-326.

Harmelin J.G. (1977) - Bryozoaires du Banc de la Conception (Nord des Canaries). Campagne Cineca I du "Jean Charcot". *Bull. Mus. Nat. Hist. Nat., Paris*, sér. (492), Zool., 341: 1.057-1.075.

Hayward P.J. (1978) - Bryozoa from the West European continental slope. *J. Zool.*, 184: 207-224.

Hayward P.J. (1979) - Deep water Bryozoa from the coast of Spain and Portugal. *Cah. Biol. Mar.*, 20: 59-75.

Hayward P.J. (1981) - The Cheilostomata (Bryozoa) of the deep sea. Galatea Reports: 15:21-68.

HAYWARD P.J. & RYLAND J.S. (1979) - British Ascophoran Bryozoans. Syn.Brit. Fauna, n.s., 14: 1-312.

d'Hondt J.L. (1974) - Bryozoaires récoltés par la "Thalassa" dans le Golfe de Gascogne (Campagnes de 1968 à 1972). *Cah. Biol. Mar.*, 15: 27-50.

d'Hondt J.L. (1975) - Bryozoaires Cténostomes et Cheilostomes (Cribrimorphes et Escharellidae exceptés) provenant des dragages de la Campagne océanographique Biacores du "Jean-Charcot". *Bull. Mus. nat. Hist. Nat., Paris*, sér. 3, 299 (Zool. 209): 553-600.

d'Hondt J.L. (1977) - Bryozoaires récoltés en 1972 et 1973 par les Campagnes Polymede II en Méditerranée occidentale et Thalassa 1973 dans le Golfe de Gascogne (Cheilostomes et Cyclostomes). *Cah. Biol. Mar.*, 18: 59-70.

Jullien J. (1882) - Dragages du "Travailleur", Bryozoaires. Espèces draguées dans l'Océan Atlantique en 1881. Espèces nouvelles ou incomplètement décrites. *Bull. Soc. Zool. Fr.*, 7: 497-529.

Torelli L. & Buccheri G. (1981) - Late Quaternary stratigraphy of the Sardinian Basin sediments, in: Sedimentary Basins of Mediterranean margins. *C.N.R. Italian Proj., Ocean. Bologna*: 137-186.

Zabala I Limousin M. (1986) - Fauna dels Briozous dels Paisos Catalans.*Inst. Etud. Catalans, sec. Sci.*, 84:1-833.

B-III17

Etude et mesures des facteurs abiotiques dans l'infralittoral rocheux

Jean MARINOPOULOS

Station Marine d'Endoume, Rue de la Batterie des Lions, 13007 Marseille (France)

Abstract - The study of abiotic factors,light and hydrodynamics, and the relation between factors and infralittoral assemblages of Marseille's rocky substrata allowed to understand the diversity of the assemblages.

Les peuplements de substrats rocheux de l'étage Infralittoral présentent une diversité physionomique dûe essentiellement aux facteurs abiotiques dominants; lumière et hydrodynamique (Pérès, Picard 1964). L'étude (Marinopoulos 1988, 1989) comparative des peuplements infralittoraux (0-40m), et des peuplements coralligènes (à partir de 40m) a permis de subdiviser l'Infralittoral rocheux dans la région de Marseille en Infralittoral ou horizon superficiel (0-1m), moyen (2-14m) et profond (15-40m). Des enregistrements de l'éclairement scalaire de la Radiation Active pour la Photosynthese (R.A.P., flux des photons de 400-700nm) ont été effectués au niveau des horizons et ils ont montré qu'une station donnée possède un profil topographique qui lui est propre; elle reçoit en un an un certain flux de photons, tributaire de cette individualité topographique. Ce flux de photons varie entre une valeur minimale (enregistrements hivernaux) et une valeur maximale (enregistrements estivaux), ce qui correspond à "l'amplitude maximale annuelle". Cette amplitude propre à chaque station permet de classer et de comparer les stations et les horizons de l'Infralittoral entre eux. Cette méthode évite les erreurs des méthodes basées sur des valeurs relatives et sporadiques de certains auteurs (Vasseur 1981, Jaubert 1987).

La comparaison hydrodynamique entre les peuplements se fait par le calcul du flux moyen d'énergie (kW/m) transmis par vague par unité de longueur de crête et a permis d'expliquer la diversité faunistique des peuplements superficiels. Le calcul des vitesses orbitales des particules liquides des vagues (m/s) a permis d'expliquer l'homogénéité faunistique des peuplements sub-sciaphiles.

Dans d'autres secteurs géographiques, les mêmes valeurs des facteurs abiotiques ne se trouveront pas nécessairement aux mêmes profondeurs.

L'infralittoral superficiel reçoit la presque totalité de la R.A.P mais son effet direct sur la distribution de la faune n'a pas pu être mis en évidence de façon significative. L'énergie hydrodynamique reçue par les peuplements algaux varie d'une dizaine de kW/m pour les peuplements de mode battu (*Cystoseira stricta*) à des fractions de kW/m pour les peuplements de mode calme (*Cystoseira crinita*). Les différentes stations de mode battu ont des différences d'énergie hydrodynamique d'une dizaine de kW/m qui n'influencent pas l'aspect physionomique algal. Les stations de mode calme ont des différences d'énergie hydrodynamique faibles, sans influence sur la distribution qualitative et quantitative de la faune.

Dans l'infralittoral moyen à 2m et à 12m de profondeur, il ne reste que 9 et 2% respectivement des vitesses de particules liquides de surface. Pour les mêmes perturbations en surface, à la même profondeur et pour des configurations de substrats différentes, les différences d' hydrodynamique sont de l'ordre de 60 %. Selon la profondeur, la configuration et la localisation topographique des stations, l'amplitude annuelle de la R.A.P varie du simple au double. L'amplitude et l'intensité des facteurs abiotiques s'atténuent au niveau du substrat (ombre ou écran hydrodynamique créé par les algues et les animaux sessiles érigés). Ces conditions de "sous-strate" tendent à uniformiser la distribution qualitative de la faune, et les différences quantitatives de la faune vagile sont faibles.

Dans l'infralittoral profond la R.A.P et l'hydrodynamique, ont des intensités et des amplitudes très faibles. Entre 20m et 40m, en pleine eau, il ne reste que 10% à 1 % de la R.A.P reçue à la surface; à 50m et à 70m (Coralligène) il n'en reste que 0,4 à 0,13%. Les courants littoraux sont faibles et seul le courant géostrophique (dans la région de Marseille), peut être violent (2m/s) mais de courte durée. L'écran formé par les populations denses de Gorgonaires atténuent l'hydrodynamique et diminue de 40% environ la R.A.P reçue en pleine eau à la même profondeur. Ainsi, les conditions abiotiques sont proches de celles qui règnent au niveau du Coralligène.

Les horizons de l'Infralittoral rocheux sont caractérisés par certaines valeurs moyennes de lumière et hydrodynamique. Ces facteurs n'ont pas nécessairement la même intensité dans chacune des stations référables au même horizon. Par conséquent on aboutit à une diversité physionomique des peuplements. L'horizon lui-même est la synthèse de cette diversité. La biocoenose (ici la biocoenose des Algues photophiles) elle-même est la synthèse de ces horizons.

Tableau 1 : Caractéristiques succinctes des horizons de l'Infralittoral des substrats rocheux dans la région de Marseille. (*) En dehors de l'influence des parois rocheuses. (**) Eclairement scalaire. (***) Valeurs moyennes, chaque station possède sa propre amplitude.

INFRALITTORAL	supérieur	moyen	inférieur
profondeur (m)	0-1	2-14	15-40
	au niveau du substrat		en pleine eau (*)
Radiation Active pour la Photosynthèse. (**)			
Amplitude annuelle. (***)		2 à 4m	20m
(valeurs extrêmes)	53,3 (55-1,7)	23,2 (25-1,8)	5,32 (5,5-0,18)
$E.m^{-2}.d^{-1}$		8 à 12m	40m
		10,21 (11-0,79)	0,532 (0,55-0,018)
Hydrodynamique			
Energie en kW/m			
mode battu	14 à 4,8		
mode calme	0,240 à 0,037		
Vitesse (m/s) maximale des particules liquides	20 à 0m	1,83 à 2m	
pour des vagues de hauteur significative Hs=1m	3,19 à 1m	0,40 à 12m	
Courants littoraux (m/s)		0,1	< 0,1
Courants géostrophiques (m/s)	3	2	1

Références bibliographiques

JAUBERT J., 1987. Etude de quelques interactions entre espèces et facteurs de l'environnement (lumière, température et oxygène dissous) mesurés*in situ* en milieu récifal: conception et réalisation d'instruments de mesure et protocoles expérimentaux. *Thèse Doct.es-Sciences,Univ.Nice: 2-264*

MARINOPOULOS J., 1988. Etude des peuplements Infralittoraux des substrats rocheux de la région de Marseille et facteurs abiotiques (lumière et hydrodynamique) les influençant.*Thèse Doct.es-Sciences, Univ. Aix-Marseille 2: 1-318 +annexe*

MARINOPOULOS J., 1989. Nouveaux concepts sur la structure des peuplements de l'Infralittoral rocheux.*C.R. Acad. Sci. Paris, t. 309, Série III, p. 343-349.*

PERES J.M.,PICARD J., 1964. Nouveau manuel de Bionomie benthique de la mer Méditerranée. *Rec.Trav.Sca.Mar. Endoume, 47 (31): 7-122*

VASSEUR P., 1981. Recherches sur les peuplements sciaphiles des récifs coralliens de la région de Tuléar (SW de Madagascar). *Thèse Doct.es-Sciences, Univ. Aix-Marseille 2: 1-348+annexe*

B

Zonation des peuplements de substrat rocheux de l'infralittoral

Jean MARINOPOULOS

Station Marine d'Endoume, Rue de la Batterie des Lions, 13007 Marseille (France)

Abstract - The study of infralittoral assemblages and abiotic factors,light and hydrodynamics, and the relation between factors and assemblages allowed to divide Infralittoral zone of Marseille's rocky substrata. This division is based on ecological criteria.

Les peuplements des substrats rocheux de l'étage Infralittoral présentent une diversité physionomique dûe essentiellement aux facteurs abiotiques dominants: lumière (Radiation Active pour la Photosynthèse = R.A.P) et hydrodynamique (Pérès, Picard 1964).

L'étude comparative des peuplements infralittoraux (0-40m), et du Coralligène (à partir de 40m) ainsi que des facteurs abiotiques a permis de subdiviser l'Infralittoral rocheux sur des critères écologiques (Marinopoulos 1988 et 1989). Des prélèvements (95 prélèvements en 10 stations) dans la région de Marseille, d'une superficie de 20cm x 20cm, ont été effectués aux niveaux hydrodynamiques définis par Riedl (1964). L'aire minimale calculée, pour une station donnée, est de 5 prélèvements. Outre cette subdivision, basée sur des critères écologiques, on a fait intervenir le paramètre profondeur dans le but de mieux situer, dans la région de Marseille, les différents horizons. Dans d'autres secteurs géographiques, les horizons ne se trouveront pas nécessairement aux mêmes profondeurs.

- Infralittoral superficiel ou horizon superficiel : 0-1m de profondeur
- Infralittoral moyen ou horizon moyen : 2-14m de profondeur.
- Infralittoral profond ou horizon profond : 15-40 m de profondeur (jusqu' au debut du Coralligène).

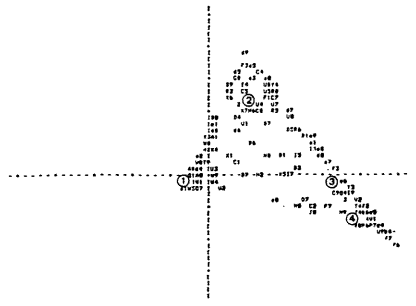
Dans l'Infralittoral superficiel, l'intensité et l'amplitude des facteurs R.A.P et hydrodynamique, sont élevées. Les peuplements algaux superficiels sont situés le long d'un gradient hydrodynamique dû à l'agitation de l'eau et ils se présentent sous plusieurs aspects différents les uns des autres du fait de la prédominance d'une espèce (Bellan-Santini 1969). L'affinité faunistique entre les peuplements situés aux extrémités du gradient hydrodynamique de cet horizon superficiel est inférieure à 20% (indice de Jaccard). Les différentes stations de mode battu sous un aspect physionomique algal identique, ont une affinité faunistique faible, mais les espèces communes ont des abondances différentes. Les stations de mode calme ont une affinité faunistique élevée (Menioui 1983). L'Infralittoral superficiel peut être considéré comme un éclatement de la biocoenose des Algues photophiles en plusieurs faciès hétérogènes qui sont fonction des conditions abiotiques.

Tableau 1 : Caractéristiques succinctes des horizons de l'Infralittoral de substrats rocheux dans la région de Marseille.

INFRALITTORAL	supérieur	moyen	inférieur
profondeur (m)	0-1	2-14	15-40
Indice de Jaccard % entre-stations.			
mode battu	30		
mode calme	60		
		60	66
Indice de Jaccard % entre-horizons.			
supérieur/moyen	31		
supérieur/inférieur		18	
moyen/inférieur		46	
Shannon-Wiener	3,12	5,37	6,2
Richesse spécifique	204	309	238

Dans l'Infralittoral moyen l'amplitude et l'intensité des facteurs abiotiques s'atténuent davantage au niveau du substrat à cause de l'ombre ou de l'écran hydrodynamique créé par les algues et les animaux sessiles érigés. Ces conditions de "sous-strate" tendent à uniformiser la distribution qualitative de la faune, et les différences quantitatives de la faune vagile sont faibles. L'affinité faunistique entre les différentes stations de cet horizon est élevée. La faune de l'infralittoral moyen est constituée, d'une part, d'espèces qui lui sont propres et qui dominent quantitativement le peuplement, et d'autre part, d'espèces originaires des autres horizons et du Coralligène ,avec de faibles abondances. Horizon charnière de l'étage Infralittoral, recevant la faune photophile et sciaphilé des substrats rocheux, l'infralittoral moyen présente une richesse spécifique et une diversité spécifique élevées.

Figure 1. Discrimination des horizons de l'infralittoral et du coralligéne à l'aide de l'analyse factorielle des correspondances. Plan factoriel (x:1,y:2). 1-infralittoral superficiel, 2-infralittoral moyen, 3-infralittoral profond, 4-coralligène. Les espèces sont codées (points de A1 à z99) (Marinopoulos 1988)]. Chaque point représente plusieurs points groupés.



L'Infralittoral profondétait considéré comme un "aspect" du Coralligène et il était rattaché à la biocoenose du Coralligène (Pérès, Picard 1964). L'horizon profond ne possède pas une faune vagile qui lui soit propre; par contre, il est caractérisé par une faune sessile. Des migrations importantes d'espèces infralittorales et coralligènes venant vers cet horizon en font un écotone entre l'Infralittoral et le Coralligène. Les échanges faunistiques de l'horizon profond avec le Coralligène sont importants. La richesse spécifique et la diversité spécifique sont élevées.

Références bibliographiques

RIEDL R., 1964. Lo studio del litorale marine in rapporto alla moderna biologia.*Atti sem. Stud. biol., 1: 1-30*

MARINOPOULOS J., 1988. Etude des peuplements Infralittoraux des substrats rocheux de la région de Marseille et facteurs abiotiques (lumière et hydrodynamique) les influençant. *Thèse Doct. es-Sciences, Univ. Aix-Marseille 2: 1-318+annexe.*

MARINOPOULOS J., 1989. Nouveaux concepts sur la structure des peuplements de l'Infralittoral rocheux. *C.R. Acad. Sci. Paris, t. 309, Série III, p. 343-349.*

MENIOUI M., 1983. Etude des peuplements algaux superficiels de mode calme des côtes de Provence (Méditerranée nord-occidentale).*Thèse Doct. 3ème. Cycle, Univ. Aix-Marseille II: 127 pp.*

PERES J.M.,PICARD J., 1964. Nouveau manuel de Bionomie benthique de la mer Méditerranée. *Rec.Trav.Sta.Mar. Endoume, 47 (31): 7-122*

BELLAN-SANTINI D., 1969 Contribution à l'étude des peuplements infralittoraux sur substrat rocheux. *Rec. Trav. Sta. mar. Endoume Bull., 47 (63): 9-294*

Eléments pour la connaissance de l'état et de l'évolution des Communautés Benthiques de l'Ouest de la Mer Noire

M.-T. GOMOIU et V. TIGANUS

Institut Roumain de Recherches Marines, Constanta (Roumanie)

Après une longue interruption, en 1983 on a repris les recherches sur le benthos du large du plateau continental roumain: on a constaté que les dérèglements écologiques survenus dans les biocénoses côtières dès le début des années '70 se sont étendus aussi vers les biocénoses des fonds plus profonds (GOMOIU, 1985), dans les zones considérées plus stables (GOMOIU, TIGANUS, 1977).

En 1989 nous avons entrepris un nouveau contrôle écologique de sondage, couvrant une superficie d'environ 17.000 km^2, entre les isobathes 30-180 m. On a prélevé plus de 60 échantillons quantitatifs de 31 stations disposées dans un réseau comprenant deux biocénoses majeures: BiMyt - biocénose des moules de profondeur (30-60 m) et BiMod - biocénose des vases blanches à *Modiolus* (60-180 m), dont les fonds au-dessous de -100 m sont très peu peuplés et appartiennent à l'étage périasoique. D'après les résultats obtenus de l'analyse des échantillons, on peut tirer les conclusions générales ci-dessous:

1. Dans l'ensemble de la zone étudiée on a enregistré 62 types d'organismes, dont 46 espèces, la plupart macrobenthiques. 28% des formes (*Neanthes succinea* Leuck., *Oridia armundi* (Olap.), *Polydora ciliata* (Johnst.), *Cardium edule lamarckii* Reeve, *Mya arenaria* L., *Spisula subtruncata triangula* (Renier), *Rissoa splendida* (Eichw.), *Eulimella acicula* (Philippi), *Megamphopus cornutus* Norm., *Tanais cavolini* M.-Edw., *Synisoma capito* (Rathke), *Cumella pygmaea euxinica* Bacescu, *Endorella truncatula* (Bate), *Actinothoe clavata* (Ilmoni) etc.) ont été rencontrées seulement en BiMyt, 11% (*Terebellides stroemi* Lars, *Cardium papillosum* Mil., *Coremapus versiculatus* (Bate), *Orchomene humilis* (Costa), *Leptosynapta iphaerens* O.F.M., *Stereoderma kirschbergi* (Heller) etc.) seulement en BiMod et 61% sont communes dans les deux biocénoses.

2. En 1989 le zoobenthos a eu en moyenne une densité de 87.000 ex.m^{-2} (85% vers, 3% mollusques, 10% crustacés et 2% autres formes) et une biomasse de 95,67 g.m^{-2} (25% vers, 68% mollusques, 1% crustacés et 6% autres formes); mais son abondance varie beaucoup d'une station à l'autre, diminuant généralement à mesure de la croissance de la profondeur (Tableau 1). Le stock total du zoobenthos de la zone étudiée a été de 1,6 millions tonnes, valeur qui permet d'évaluer une production potentielle de 5,8 millions tonnes (mais seulement 3,7 millions tonnes de biomasse fraîche utile: 62% vers, 21% mollusques, 4% crustacés et 13% autres organismes).

Tableau 1

Groupes d'organismes	30 - 60 m D-ex.m^{-2}	30 - 60 m B-g.m^{-2}	60 - 100 m D-ex.m^{-2}	60 - 100 m B-g.m^{-2}	100 - 180 m D-ex.m^{-2}	100 - 180 m B-g.m^{-2}
Vers	136310	44,89	33646	7,89	13566	0.18
Mollusques	3879	112,58	1935	34,51	2103	0,21
Crustacés	12524	0,97	7134	0,99	1678	0,06
Varia	1540	2,40	1600	10,74	110	0,09
ZOOBENTHOS TOTAL	154253	160,84	44315	54,13	17457	0,54

3. Le zoobenthos le plus abondant comme biomasse est celui de BiMyt (30-60 m); il constitue 75% du total du stock évalué en 1989. La zone typique des vases à Modiolus (60-100 m) abrite 25% du stock (dont 24% vit à 60-80 m); au-delà de la profondeur de 100 m, le benthos est très pauvre, constituant seulement 0,035% du total et étant représenté seulement par le méiobenthos.

4. Généralement, en 1989 la diversité du zoobenthos est réduite, la plupart du stock d'invertébrés des eaux du large étant constitué de seulement quelques espèces - celle qui, à une seule exception (*Melinna*) étaient autrefois très communes: *Mytilus*, *Modiolus*, *Amphiura*, *Molgula*, etc. (BACESCU et al., 1971). Il est significatif que *Melinna* (très rare autrefois, mais qui, depuis quelques années, a développé des peuplements bien représentés en nombre et en poids aux profonderus de 20-60 m) a élargi son aire vers les profondeurs de 80 m, devenant la seconde espèce importante du littoral roumain. Plus de 95% du stock total du zoobenthos de chaque biocénose étudiée revient à moins de 10 espèces qui, par leurs densité (D-ex.m^{-2}), biomasse (B-g.m^{-2}) et indice de densité (Id - racine carrée du produit f.B) calculé pour les premières 10 espèces, ont à présent une importance majeure dans la mer Noire (Tableau 2).

Tableau 2

Les premiers 10 organismes (d'après Id) dans les deux biocénoses	BiMyt D	BiMyt B	BiMyt Id	BiMod D	BiMod B	BiMod Id
Mytilus galloprovincialis (Lam.)	697	102,69	84,17	11	11,31	15,56
Modiolus phaseolinus (Philippi)	102	2,67	9,07	1290	23,02	46,22
Cardium edule lamarckii Reeve	8	3,21	9,94	-	-	-
Mya arenaria L.	1	0,81	2,50	-	-	-
Spisula subtruncata triangula (Renier)	4	2,85	6,62	-	-	-
Melinna palmata Grube	1492	42,20	64,96	170	5,40	17,56
Protodryllus flavocapitatus (Ulj.)	623	0,37	2,94	2197	1,36	9,35
Nephthys hombergy Aud. et M.-Edw.	17	0,09	-	58	0,34	4,69
Balanus improvisus Darw.	114	0,14	2,76	176	0,21	3,03
Ampelisca diadema (Costa)	12	0,07	-	44	0,16	2,38
Clunio marinus Hal. - larvae	2	0,06	-	339	8,62	15,70
Phoronis euxinicola S.-Long.	1248	1,00	9,60	74	0,06	-
Amphiura stepanovi Djak.	9	0,16	-	26	0,68	5,84
Molgula euprocta Drashe	3	0,92	2,67	4	1,28	4,29

5. Le benthos enregistré en 1989 dans les zones étudiées a beaucoup diminué en quantité et qualité par rapport aux années '60; bon nombre de formes ont disparu ou sont devenues si rares, qu'on les rencontre rarement à présent; la fréquence de certaines espèces, autrefois communes, a diminué, et la distribution quantitative des benthontes est devenue très hétérogène. Le stock du zoobenthos en 1989 a représenté 83% de celui de 1985 et seulement 26,2% de celui de 1960. Il est notable que l'étage périasoïque, qui pendant l'intervalle 1950-1960 avait des limites supérieures à 120-130 m de profondeur, s'est déplacé pendant les dernières années vers la côte, ses limites commençant pratiquement à l'isobathe de 100 m, ce qui prouve aussi l'évolution régressive du benthos pontique.

Références bibliographiques

1. BACESCU M., MULLER G., GOMOIU M.-T., 1971 - Ecologie marina, 4: 1-356.
2. GOMOIU M.-T., 1985 - Rapp. Comm. int. Mer Médit., 29, 5: 199-204.
3. GOMOIU M.-T., TIGANUS V., 1977 - Rapp. Comm. int. Mer Médit., 24, 4: 1-124.

B-III20

Sur les salissures formées en Mer Noire sur les Structures Offshores

Marian-Traian GOMOIU

Institut Roumain de Recherches Marines, Constanta (Roumanie)

Les possibilités de connaissance des salissures formées dans les zones ouvertes de la mer Noire sont devenues plus faciles par l'apparition des plate-formes de forage marin dans cette mer. Ainsi, la première évaluation de l'épibiose du large des côte roumaines a été effectuée sur la base des échantillons prélevés sur les pieds de la plate-forme GLORIA. A cette occasion on a constaté que le système épibionte formé sur les structures offshores est très abondant, avec des densités et des biomasses des organismes vivants respectivement au-dessous de 216.000 ex.m^{-2} et 36 kg.m^{-2} (GOMOIU et al., 1978).

L'emplacement de GLORIA pendant les dernières années a été à 30 km de la côte, sur des fonds de -52 m. Pour connaître l'évolution de son système épibionte pendant les 11 ans depuis la première évaluation, on a prélevé en février 1989 par plongée, des échantillons quantitatifs provenant de 10 horizons (H = 3-30 m). Les échantillons furent analysés selon la méthodologie usuelle pour l'étude du benthos. Les résultats prouvent l'existence d'une épibiose mature, relativement monotone, mais très bien développée - jusqu'à 180 kg.m^{-2} (organismes vivants et formations mortes), c'est-à-dire 2,5 fois plus qu'en 1978 (GOMOIU et al. 1978).

La communauté épibionte est très pauvre qualitativement. A côté de *Mytilus*, parmi les organismes sessiles on a fréquemment rencontré *Balanus* (larves cyprès et adultes) ainsi que des touffes d'Hydrozoaires et, plus rarement, *Mytilaster* et des restes de Bryozoaires; les formes vagiles enregistrées sont les véliconques de bivalves (probablement les mêmes moules), turbellariés, nématodes, polychètes et copépodes (Tableau 1). A quelques horizons ont été rencontrés des touffes éparses d'algues vertes (*Cladophora*) et rouges (*Ceramium*), mais sans importance quantitative. Signalons le manque d'une série de formes vagiles typiques de la zone de passage des vases à *Mytilus* à celles à *Modiolus*, formes assez fréquentes en 1978 (*Modiolus, Acanthocardia paucicostata* (Sow.), *Plagiocardium simile* (Mil.), suivies de *Mya arenaria* L., *Abra* sp., *Rissoa* sp., etc.), absence qui indique l'aggravation des conditions écologiques dans la partie ouest de la mer Noire.

Tableau 1

Organismes	Dmax	Bmax	Dmed	Bmed	Id
Mytilus galloprovincialis Lam	122616	105956,13	48152	71303,89	2670,3
Mytilaster lineatus Gmelin	856	857,50	206	91,28	52,3
Balanus improvisus Darw.	19968	216,83	3767	83,92	91,6
Hydrozoa	4992	4,00	1654	1,32	11,5
Bryozoa	+	+	+	+	+
Zoo. sessil	147576	105956,68	53778	71480,41	-
Bivalvia véliconques	8272	0,82	2737	0,27	4,6
Turbellaria	24960	14,98	3592	2,16	13,9
Nematoda	104832	0,32	15147	0,04	1,4
Polychaeta	184704	110,82	27865	16,08	40,1
Copepoda	64896	1,30	1444	0,23	4,8
Zoo. vagil	379392	127,42	60785	18,78	-
Total zoo-épibiose	526968	105962,12	114564	71499,19	-

La pauvreté qualitative est compensée par le grand développement quantitatif: en moyenne des densités (Dmed) supérieures à 114.000 ex.m^{-2} et des biomasses (Bmed) de 71,499 kg.m^{-2}. Les maxima des biomasses (Bmax) sont tellement grandes, qu'il n'y a pas de terme de comparaison au rang des populations naturelles vivant à présent en mer Noire. Dans le système épibionte analysé, conformément à l'indice de densité (Id-racine carrée du produit entre fréquence et biomasse) *Mytilus* est l'espèce la plus importante (Tableau 1).

Les moules représentent en moyenne 42% en nombre et 99,727% comme biomasse de la population épibionte; leur distribution verticale, tout comme celle des autres organismes cocénontes, est non-uniforme.L'épibiose la plus riche est rencontrée dans les horizons supérieurs; d'habitude, jusqu'à la profondeur de -15 m on enregistre les maxima du poids du système épibionte (Tableau 2: H - profondeur, TF - organismes vivants; FA - épibiose animale; autres dominantes numériques: Nema - Nematoda; Poly - Polychaeta; Cope - Copepoda).

Tableau 2 - Variations quantitatives de l'épibiose selon la profondeur

H (m)	TF kg.m^{-2}	FA ex.m^{-2}	FA kg.m^{-2}	*Mytilus*% de FA D%	*Mytilus*% de FA B%	Nema D%	Poly D%	Cope D%
3	176,7	167320	74,544	52	99,945	17	14	8
6	135,9	67768	105,963	80	99,994	0	10	6
9	131,0	525968	101,373	23	99,673	20	35	12
12	144,2	93520	96,735	58	99,980	5	23	8
15	126,9	70716	84,725	51	99,732	9	15	5
18	84,7	42665	66,086	60	98,692	0	19	7
21	63,8	35021	40,290	39	99,600	0	22	12
24	87,7	73848	76,215	70	99,866	9	4	9
27	79,3	40256	40,412	47	99,622	0	24	8
30	42,3	27561	28,648	67	99,829	0	11	10
Moyenne	107,3	114564	71,499	42	99,727	13	24	8

Les riches populations de moules sont formées, dans la plupart, d'exemplaires jeunes (82% au-dessous de 30 mm longueur). On peut estimer ainsi que les structures offshores représentent de vrais centres d'ensemencement avec des jeunes de moules, surtout des zones affectées temporairement par les phénomènes d'anoxie qui déterminent la disparition du benthos.

Le long temps de formation et de développement du système épibionte de GLORIA ont compliqué les structures spatiales dans lesquelles le byssus des moules, les thèques des hydrozoaires, les loges calcaires de *Balanus* et d'autres matériaux allochtones (sediments minéraux et organiques) ont formé un type de biotope "feutré" qui favorise le développement des formes vagiles. Les organismes vagiles représentent 53% du nombre des espèces (24% polychètes, 15% nématodes, 8% copépodes, 3% turbellariés), mais leur contribution à la biomasse est insignifiante (en moyenne, seulement 0,026%).

En conclusion, le sous-système pelagique de l'écosystème du large des côte roumaines a une grande associations épibiontes. Ces associations suspendues dans la masse d'eau, à l'encontre de celles du fond, sont très riches du point de vue quantitatif, grâce à une seule espèce - *Mytilus galloprovincialis*.

Références bibliographiques

GOMOIU M.-T., TIGANUS V., BONDAR C., 1978 - Com.st. - Al VIII-lea Simpozion BIOCLIMNAV '78, ICPE, 2: 375-380 (In Rom.; Engl. Summ.).

B-III21

Growth of *Mytilus galloprovincialis* in Offshore Waters of the Ligurian Sea

Marco RELINI

Istituto di Zoologia, Laboratori di Biologia Marina ed Ecologia Animale, Università degli Studi di Genova (Italia)

In January 1987 the ODAS 1 buoy (Oceanographic Data Acquisition System of the E.C.) was positioned about 30 miles off Genoa (43° 50' 19" N, 09° 06' 24" E) and moored to the bottom at 1100 m. The buoy comprises a cylinder which is 42 m long and 80 cm in diameter, with a stabilizing disk at its end and three reinforcing rings with alveolar surfaces. Oceanographic data on these offshore waters are available (t°, salinity, nutrients, chlorophyll (INNAMORATI *et al.* 1983), primary production (MAGAZZU' 1989)). An outstanding characteristic of the station are strong surface currents. (STOCCHINO and TESTONI 1977).

The study of the fouling has been in progress since summer 1987 . Here is reported the settlement and growth of Mytilus galloprovincialis, which has a leading role in covering the artificial substratum, being present from 3 to 42 m, (limit for scuba observation and sampling), a depth unusual in this species for natural substrata. However on artificial substrata this species has been recorded up to 130 m (Arnaud 1978).

At the first inspection, in July 1987, the covering of fouling was very poor: bivalves were represented by Pectinidae and a small number 5 mm Mytilus settled in the upper alveolar ring. In July 1988, after 18 months exposure, four samples of fouling organisms were collected by scraping 20 x 20 cm surfaces at depths of 6, 12, 25 m along the vertical wall. Similar samplings were repeated in December 88 and August 89 with the exclusion on this latter occasion of the 6 m level, which had been spoiled by unknown people. All samples proved to be rich in Mytilus galloprovincialis, which on vertical surfaces appeared fairly homogeneous in terms of their size distributions. For the study of the growth samples of each date were pooled. Modal lengths (shell length) of mussels were 6.5 cm in July 1988 (Fig. 1), 7 - 8 cm in December 1988 (Fig. 2). The samples collected in August 1989, (31 months exposure) (Fig. 3), show the presence of two cohorts: 6 -7 cm long mussels, more recently settled and the oldest ones with lengths of up to 10.5 cm. The 1987 cohort appears stronger than the following one. During 1989 no mussel settlement was recorded, neither on the buoy nor on series of experimental panels exposed for 3, 6 and 12 months.

On the basis of an algorhythm proposed for length-based fish stock assesment (SPARRE, 1984), the following Von Bertalanffy growth curve was established: $L_t = 12.5\ [1 - e^{-0.048\ (t+4.1)}]$ (Fig. 4).

Considering the fact that these are offshore waters, growth appears interesting. RELINI and RAVANO (1971) reported 6 cm growth in 10 months for mussels found in the eutrophic waters of the port of La Spezia (Ligurian Sea). Mussels from brackish environments, which are generally considered rich in food, had a lower growth (CECCHERELLI and ROSSI, 1984).

The favourable conditions of this offshore station are to be seen in its mild winter temperatures, the lack of extreme summer heat, and the strong currents (especially in summer), which support filtration.

Length/frequency distribution of Mytilus galloprovincialis
22.7.88

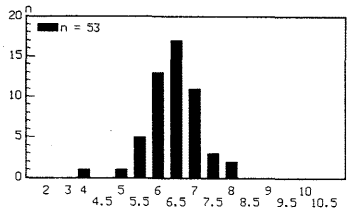


Fig. 1

9.12.88

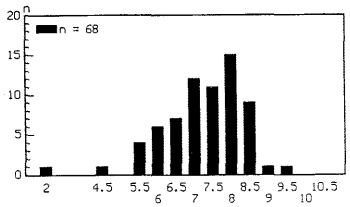


Fig. 2

6.8.89

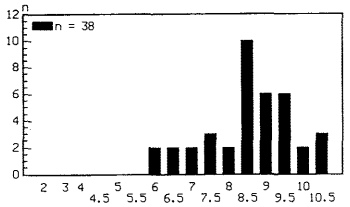


Fig. 3

Vonbertalanffy growth curve.

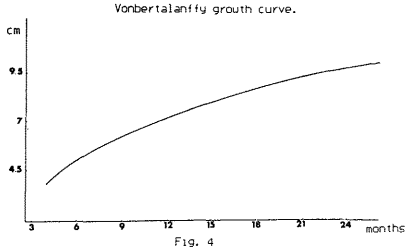


Fig. 4

References

ARNAUD P., 1978. Remarques sur le Pelecypodes du fouling de substrats artificiels profonds en Mediterranee nord-occidentale. Haliotis, 9 (1) : 41-44.

CECCHERELLI V. U., ROSSI R., 1984. Settlement, growth and production of the mussel Mytilus galloprovincialis. Mar. Ecol. Prog. Ser. 16: 173 - 184.

INNAMORATI M., BURACCHI G., MANNUCCI M., SENESI P., 1982. Chiazze termiche e fitoplanctoniche nel Mar Ligure. Campagna Ligure VI - Giugno 1981. Boll. Mus. Ist. Biol. Univ. Genova, 50 suppl., 228 - 235.

MAGAZZU' G., BRUNI V., DECEMBRINI F., PANNELLA S., 1989. La produzione primaria del picoplancton fotosintetico dei nostri mari. Oebalia, vol. XV-1, N.S.: 463 - 478.

RELINI G., RAVANO D., 1971. Alcuni aspetti dell'ecologia dei molluschi presenti nel fouling ligure. Atti Soc. Ital. Sc. Nat. e Mus. Civ. St. Nat. Milano, 112, 3 : 301 - 315.

SPARRE P., 1987. Computer programs for fish stock assesment. FAO Fish. tech. Paper, 101 Suppl. 2.

STOCCHINO C. and TESTONI A., 1977. Nuove osservazioni sulla circolazione delle correnti nel Mar Ligure. Istituto Idrografico della Marina, Genova, F.C.1076.

B

Offshore Buoy Fouling in the Ligurian Sea

G. RELINI* , M. RELINI* and M. MONTANARI**

*Istituto di Zoologia, Laboratori di Biologia Marina ed Ecologia Animale, Università degli Studi di Genova (Italia)
**Istituto per le Corrosioni Marine dei Metalli, C.N.R., Genova (Italia)

Due to the scarcity of available data on Mediterranean fouling far from the coast, we believe it would be useful to report on some observations carried out on ODAS 1 buoy (Oceanographic data acquisition system), which in January 1987 was positionated about 30 nautical miles off the coast at Genoa (43° 50' 19" N, 09° 06' 24" E) and moored on a bottom at 1100 m. The buoy is a 42 m long cylinder,80 cm in diameter, with three flanged rings along the axis and a stabilizing disk at its end. Another reason for studying this buoy was the reported presence of a large amount of mussels when the buoy was recovered at the end of 1986 because of maintenance. The study begun in the summer of 1987 using observations, samples and photographs made by scuba-divers. Despite very strong currents that made diving and sampling operations difficult to carry out, till February 1990, fifteen dives and three samplings (table 1) were effected. The fouling settled in particular at the end of 1989 is described; while another note in these reports deals with the mussels' population development. Settlement near the surface is poor on account of breaking action of waves. There are small green algae and amphipod Caprella andreae Mayer; in this area limpets (Patella caerulea L., Patella aspera var. tarentina) Lam. and cirripeds Lepas anatifera L., L. pectinata Spengler e L. hilli (Leach) have been found. At the following depths Amphipoda become dominant. At 3 m Caprellids and Jassa marmorata Holmes cover almost all the available surface. Below 3 m some sea-urchins Arbacia lixula (L.) and Paracentrotus lividus Lamarck, and some bivalves Hiatella rugosa (Pennant) were found.

At 6 m depth flanged ring was covered by mussel byssus residuals and brown algae Ectocarpus siliculosus (Dyllwyn) Lyngbye. M. galloprovincialis Lam., were unfortunately removed in large numbers by unknown people in the summer of 1989. In summer in these first meters of depth the green algae Enteromorpha compressa (L.) Greville, E. intestinalis (L.) Link, E. prolifera (Muller) J.Agardh ssp. prolifera were present.

Below 6 m depth the compound ascidian Diplosoma listerianum (Milne-Edwards H.) became dominant in most part of the fouling community, which was composed by Anomia ephippium L., brown algae and Caprellid amphipoda, the latter decreasing in number with depth. At -15 m the second flanged ring formed an area, which was higly settled by mussels. Hydroids (Bouncainvillia ramosa Van Beneden and Obelia dichotoma L.) occurred mainly in winter: they were more abundant and larger at deeper sites.

From 15 m downwards algal cover decreased considerably, leaving space to Didemnidae, which together with serpulids Pomatoceros triqueter (L.), Spirobranchus polytrema (Philippi), Semivermilia cribrata (O.G. Costa) become the dominant organisms. Few well-developed mussels and some small sea-anemones were also present. At 20-25m specimens of Echinus acutus Lam. and Lima lima (L.) were sampled. Other members of the fouling community were hydroids, bryozoans like Aetea sp., and sea-anemones of various species and sizes. The nudibranche of genus Eubranchus and the gastropod Lamellaria perspicua (L.) were also collected.

The ring at 30 m was still heavily settled by mussels, other members of the community were a great number of hydroids and sea-anemones of various species and sizes (which are still under study), bivalves, among which the most frequent were A. ephippium, H. rugosa and small specimens of Chlamys. Among the mussels sampled at this depth Decapoda Crustacean Pilumnus hirtellus (L.), P. villosissimus (Rafinesque) and Athanas nitescens (Leach) were found several times.

Below 30 m some particular colourful organisms were observed, inoluding large-sized pink sea-anemones, some specimens of Spirographis spallanzanii Viviani and a colony of Alcyonum palmatum.

The stabilizing disk on the upper surface was completely covered with bivalves. In July 1988, Aequipecten opercularis (L.), Clamys varia (L.), Chlamys multistriata (Poli), Pecten jacobaeus (L.), Palliollum incomparabile (Risso), Pseudamussium clavatum (Poli) were dominant over the mussels. A year later (August 1989) the mussels had exceeded them in terms of biomass. Other bivalves Pteria hirundo (L.),H. rugosa and Musculus subpictus (Contraine) occured.

In Table 1 some wet-weight values are recorded: the minimum amount of fouling occured at 3 m, the maximum at 36 m with about 25 Kg/m^2.

TABLE 1. Fouling taken from standard 20 x 20 cm areas

date	depth	wet-weight	g/dm^2	dominant organisms
22.7.88	6 m 12 m 25 m	210 g 430 g 360 g	52.5 107.5 90.0	M, GA, A M, As, A M, As, A, E.
9.12.88	3 m 6 m 12 m 30 m 36 m	65 g 565 g 440 g 845 g 1000 g	16.2 141.2 110.0 211.2 250.0	A, O, D M, A M, D M, O, As M, P, O
6.8.89	6 m 12 m 30 m 39 m	spoiled 720 g 440 g 680 g	--- 180.0 110.0 170.0	Byssus M,S,B,O M,S,D,B M,O,P,S

M = Mussels GA = Green Algae A = Amphipoda
O = Other Bivalves As = Ascidians
P = Polychaets S = Serpulids B = Bryozoans

Bellan Santini *et al.* (1970) described fouling settled on panels immersed up to 4 year from 47 m to 830 m depth off Nice.

Tsikhon-Lukaina *et al.* (1977) have described some Cirripeds on buoy and different floating materials immersed in the Sicily Channel only during 23 days. Because of so different experimental conditions of the above works it is impossible a comparison with our data.

References

TSIKHON-LUKAINA Ye.A., SOLDATOVA I.N., KUZNZTSOVA I.A., I.I II', 1977 - Macrofouling community in the strait of Tunisia (Sicily). Oceanology, 16 (5): 519-522.

BELLAN-SANTINI D., ARNAUD F., ARNAUD P., BELLAN G., HARMELIN J.G., LE CAMPION-ALSUMARD T., TAK KIT L., PICARD J., POULIQUEN L., ZIBROWIUS H., 1970 - Etude qualitative et quantitative des salissures biologiques des plaques expérimentales immergées en plein eau. Tethys, 1 (3): 709-714.

Molluscs in Offshore Fouling at Ravenna and Crotone

G. RELINI* , S. GERACI** and M. MONTANARI***

*Istituto di Zoologia, Laboratori di Biologia Marina e di Ecologia Animale, Università di Genova (Italia)
**Istituto Sperimentale Talassografico "A. Cerruti" (C.N.R.), Taranto (Italia)
***Istituto per le Corrosioni Marina dei Metalli, C.N.R., Genova (Italia)

Fouling of some offshore platforms situated in the North Adriatic (Ravenna 0-20 m) and Ionian Sea (Crotone 0-65 m) was investigated several years ago by direct observations, sampling, and panels immersed for periods of 1 to 12 months. The immersion technique and the characteristics of fouling at two localities have been reported previously (RELINI *et al.*, 1976).

The list of Bivalve Molluscs found on the AGO A and PCWA platforms at Ravenna and the LUNA A platform at Crotone is recorded in Table 1. Among ten species, seven were found at both the localities, two species indicated with * in Table 1 were not found on the panels but on platform structures. Among Gasteropods *Hinia reticulata* (L.) was common at Ravenna while some Nudibranch *Facelina* sp. and *Flabellina* sp. were recorded at both sites.

Table 1 - Presence of Molluscs on 19 panels examined at each site during one year

BIVALVE MOLLUSCS	RAVENNA						CROTONE			
	AGO A			PCW A			LUNA A			
	0	-9m	-20m	0	-5m	-11m	0	-14m	-20m	-65m
Mytilus galloprovincialis Lamarck	5	5	3	5	5	4	5	4	2	-
Ostrea edulis L.	+	2	1	+	+	1	+	+	+	+
Anomia ephippium L.	+	1	2	+	+	+	+	1	+	-
Hiatella arctica (L.)	2	3	4	+	2	+	2	4	3	-
Musculus subpictus (Cantraine)	+	2	+	+	+	+	1	1	1	-
Aequipecten opercularis L.	-	1	+	-	+	+	+	+	+	-
Modiolus barbatus L.	+	1	+	+	-	-	-	+	+	-
Neopycnodonte cochlear (Poli)	-	-	-	-	-	-	+	1	+	4
Lima inflata Link	-	-	-	-	-	-	-	*	-	-
Pteria hirundo (L.)	-	-	-	-	-	-	-	-	-	*

* species collected on platform structures

+	< 5 individuals/19 dm^2	3	50-100 individuals/19 dm^2
1	5- 10 " "	4	100-500 " "
2	10- 50 " "	5	> 500 " "

The data collected showed the undisputed role of mussels not only among molluscs but also in the formation of fouling on the offshore structures examined in the two Italian seas (RELINI and MONTANARI 1988), at least in the first 10 m of depth, where they represent 80 to 95% of total wet weight of fouling. Nevertheless, their importance assumed a different character in relation to the eutrophic state of the waters (Table 2). In the Adriatic, mussels form the largest biomass (up to 96.6 kg/m^2) and show a more rapid growth. The harvesting of this large amount of mussels has been suggested (RELINI 1977). Other species of Molluscs (Table 1), with the exception of *Hiatella arctica*, a species of small size and no economic value, are scarce.

At Ravenna, mussels show two periods of settlement over the year; the first and by far the more important is in the spring-summer period, reaching a maximum in June, and the second in autumn with a peak in November-December. The mussels prove to be dominant after three or four months on the panels immersed in May and after six months on those immersed in October. As the length of exposure increases, there is a corresponding increase in the accumulation of fouling and in particular of mussels and thus of the weight of the biomass. In general, one can say that the weight of mussels as a percentage of the total weight of fouling relates directly to the immersion time and inversely to the depth, with a maximum at about 1 meter.

At Crotone the period of settlement and of greatest growth is the spring and dominance is reached after 6-8 months, depending on the season in which the substrata are immersed.

An appreciable settlement of mussels was recorded only after one year at the surface with 379 individuals/dm^2, with a maximum length of 35 mm and a biomass of 4.1 Kg/m^2. At 14 m there were 93/dm^2 and at 20 m 25/dm^2. At 65 m the panel was completely covered with *Neopycnodonte cochlear*, some of which reached a size of 40 mm in diameter. On the whole, the largest development of Molluscs was found at the surface with seven species, providing a total of 596 individuals/dm^2, of which about 90% in number were *Mytilus galloprovincialis*. At 14 m there were nine species of Molluscs, giving 298/dm^2, of which 45% were *Mytilus* and 45% *H. arctica*. At 20 m the number of Molluscs was fewer (105 individuals/dm^2) with 55% *Hiatella* and 26% *Mytilus*. At 65 m *N. cochlear* dominated the settlement on all kind of substrata covered by a strong layer of calcareous shells and there were no mussels.

Table 2 - Hydrological data at 2 m depth for the three sites

	RAVENNA PCW - A	RAVENNA AGO - A	CROTONE LUNA - A
T°C	13.32 ± 7.02	13.88 ± 6.67	17.12 ± 3.66
S‰	32.84 ± 2.39	33.73 ± 2.28	38.18 ± 0.24
O_2 mg/l	9.47 ± 1.63	9.06 ± 1.79	7.41 ± 0.32
$N\text{-}NO_2$ ug/l	6.52 ± 5.22	4.72 ± 3.70	3.66 ± 2.89
$N\text{-}NO_3$ ug/l	103.40 ± 98.07	76.26 ± 68.76	22.26 ± 13.83
$P\text{-}PO_4$ ug/l	4.39 ± 2.02	4.44 ± 3.38	4.29 ± 2.20

References

RELINI G. - 1977 - Possibilità di sfruttamento del fouling di strutture off-shore nei mari italiani: i Mitili di Ravenna. Atti 7° Simposio sulla conservazione della natura, Bari 20-23 aprile 1977: 179-185.

RELINI G., GERACI S., MONTANARI M., ROMAIRONE V. - 1976 - Variazioni stagionali dei fouling sulle piattaforme off-shore di Ravenna e Crotone. Boll. Pesca Piscic. Idrobiol., 31 (1,2): 227-256.

RELINI G., MONTANARI M. - 1988 - Mussels in the offshore fouling of Italian seas. Proc. 7th International Congress on Marine Corrosion and Fouling. Valencia 7-11 Novembre 1988 (24 pages preprint) (in press).

Development of Sessile Macrobenthos Community in the Loano Artificial Reef

G. RELINI*, N. ZAMBONI* and F. SONMEZER**

*Istituto di Zoologia, Laboratori di Biologia Marina e di Ecologia Animale, Università di Genova (Italia)
**Institute of Marine Sciences and Technology, Dokuz Eylül University, Izmir (Turkey)

The construction of the Loano artificial reef began in 1986 with the immersion of perforated concrete blocks (2x2x2 m) arranged in pyramids and small modules (concrete blocks 1.2x1.2x1.2 m) distributed over an area of 3x1 km (Relini and Moretti, 1986) 150 big new blocks were added in spring 1989 to protect outer part of the artificial reef damaged by trawlers (Relini and Orsi, 1989).

Observations on the colonization patterns of macrobenthos of hard substrata have been made from 1986 onwards by scuba divers; studies on the settlement and development of the community were carried out from May 1987 to May 1988 using asbestos panels (20x30x0.4 cm) immersed for periods of 1, 3, 6, 9 and 12 months, exposed at four depths (St. 1: 5m; St. 2: 10m; St. 3: 18m; St. 4: 30m). Two more cycles of observations were concerned with periods of exposure of 3, 6, 9, 12 months. A preliminary list of species and some descriptions of colonization were reported at Ancona during WPARM - C.G.P.M. (Relini and Cormagi, 1989).

In this paper are referred data on the development of community on substrata exposed for 3, 6, 9, 12 months at four stations from May 1988 to May 1989.

After 3 months (fig.1) the panels immersed at station 1 were covered mainly by Algae and small colonies of incrusting Bryozoans (*Schizoporella errata* and *Cryptosula pallasiana*) followed in order of importance by Hydroids (*Laomedea* and *Clytia*), Serpulids (*Pomatoceros triqueter, Spirobranchus polytrema* and *Hydroides elegans*), Folliculinid Protozoans, Forams, Bivalves (*Ostrea edulis* and *Musculus subpictus*), Barnacles (*Balanus trigonus*) and Ascidians (*Didemnum maculosum*). At station 2 the 3 months settlement is characterized by few Algae and incrusting Bryozoans (they are not dominant as at the station 1). More important are Spirorbids (*Pileolaria militaris*), Serpulids, Barnacles, Bivalves (*Ostrea* and *Anomia*), Hydroids, compound Ascidians and some Sponges.

At station 3 Hydroids (*Clytia, Bougainvillia, Obelia*), Barnacles, Algae, Serpulids are the main organisms. At station 4 the biomass and surface cover are much more lower, the settlers are Spirorbids, Folliculinids and few of Hydroids, Bivalves, Serpulids and incrusting Bryozoans.

On 6 months exposure substrata at Station 1 incrusting Bryozoans are still dominant followed by Hydroids, Serpulids, Barnacles, Bivalves, Didemnidae; there are also some Algae and non incrusting Bryozoans (*Aetea*). At station 2 community is composed by the same organisms described after 3 months but there are also Corallinaceae, large individuals of *Ostrea* and *Anomia*, Didemnidae are disappeared. At station 3 the dominance of Hydroids is substituted by that of Bryozoans (*Nolella gigantea* and *Aetea truncata*) while Serpulids and Barnacles are still important followed by Bivalves, Ascidians and Protozoans (Forams and Folliculinids). At station 4 settlement on 6 months panels is formed by Corallinaceae, Spirorbids, Serpulids, Bivalves, Barnacles and many species of Ciclostomes and Cheilostomes Bryozoans.

The colonization of substrata of 9 and 12 months (fig.1) exposure is similar so is described together. At station 1 it is a clear dominance of the Bryozoans *Schizoporella errata* which cover most of the surface; besides the organisms already described there are also some Mussels and Amphipods. At station 2 Corallinaceae, Spirorbids, Serpulids, Barnacles with Sponges, incrusting and non incrusting Bryozoans are the main organisms on annual substrata.

At station 3 most of surface is covered by Bryozoans followed by other organisms described on 6 months substrata. A similar pattern is shown at station 4 though the amount of settlers is lower.

The biomass found at different stations in August, November, February and May is referred in Table 1.

Tab. 1 - Wet weights (g/dm^2) on panels immersed for 3, 6, 9, 12 months.

	3m A-88	N-88	F-89	M-89	6m N-88	M-89	9m F-89	12m M-89
ST. 1	4.76	7.55	7.5	7.99	7.49	14.49	15.44	23.63
ST. 2	4.08	3.33	2.75	4.75	4.25	6.91	8	13.66
ST. 3	4.56	2.70	2.68	5.01	5.20	10.76	10.95	18.22
ST. 4	2.33	1.75	1.91	2.75	2.41	3.08	3.08	3.41

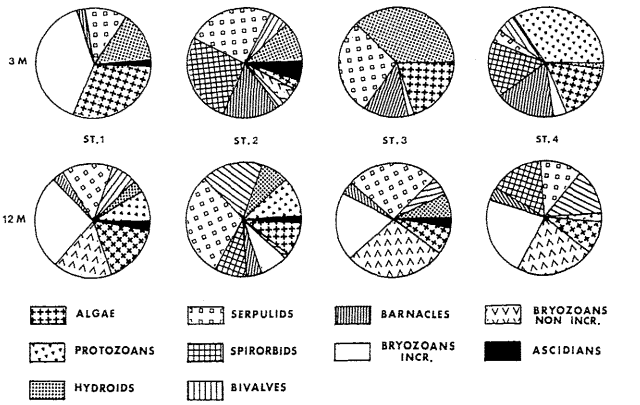


Fig. 1 - Percent cover of main settlers on substrates immersed for 3 and 12 months at four stations.

References

RELINI G., CORMAGI P. - 1989 - Colonization patterns of hard substrata in the Loano artificial reef (Western Ligurian Sea). Proc. first session of G.F.C.M. working party on artificial reefs and mariculture. FAO Fish Rep., 428: 6 pp.

RELINI G., MORETTI S. - 1986 - Artificial reef and Posidonia bed protection off Loano (Western Ligurian Riviera). FAO Fish. Rep., 357: 104-108.

RELINI G., ORSI RELINI L. - 1989 - Artificial reefs in the Ligurian Sea: a report on the present situation. Atti della prima riunione del gruppo GFCM sulle barriere artificiali. FAO Fish. Rep., 428: 6 pp.

Etude quantitative préliminaire de la composition chimique des communautés pionnières colonisant divers types de plastiques en Méditerranée

M.-F. VOSS-FOUCART, J.-C. BUSSERS, R. POIZAT et Ch. JEUNIAUX

Laboratoire de Morphologie, Systématique et Ecologie Animales, 22 quai Van Beneden, 4020 Liège (Belgique)

L'énorme consommation de matières plastiques ajoutée à la difficulté de les recycler font qu'on en retrouve en peu partout, notamment en mer, où ces objets constituent des supports vierges offerts aux organismes marins. Nous avons comparé l'attrait pour les communautés pionnières, de différents types de plastiques couramment utilisés, le PVC, le Plexiglas, le Polyéthylène, le Polystyrène, le Polycarbonate et le Nylon 6/6.

124 plaques (10 cm x 20 cm x 0,5 cm) ont été immergées entre le 11 et le 18 août 1988. La moitié de la surface de chacune des faces (10 x 10 cm) a été dépolie industriellement par soufflage de sable de corindon, afin d'envisager l'effet d'irrégularités de surface sur l'épibiose. Chaque plaque est suspendue par des cordelettes à un cadre ancré au fond.

Après 3 et 7 mois d'immersion, cinq plaques de chaque type de plastique ont été reprises. La récupération des plaques est effectuée en plongée.

Après 3 mois d'immersion, débutant au mois d'août, entre 32 et 35 m, dans la baie de Calvi (Corse, Méditerranée occidentale), le recouvrement des plaques est faible; des débris amenés par le courant, notamment des morceaux de feuilles de Posidonies, des Foraminifères, dont les Miliolinidae, des Amibes à thèques (*Gromia* sp.), des Annélides sédentaires (*Pomatoceros* spp.), des Bryozoaires (*Aetea sica* et *Metroporiella* spp.), des Hydrozoaires, des Mollusques (souvent des Nudibranches Dotoidae, mais parfois des Bivalves et des Gastéropodes). Les deux groupes qui dominent sont les Annélides Polychètes et les détachent très facilement du Nylon 6/6. Leur nombre est généralement plus élevé sur la partie dépolie des plaques.

Après 7 mois d'immersion, les organismes déjà présents après 3 mois se sont développés en nombre et en taille de sorte que la plaque n'est plus toujours visible. Bryozoaires et Hydrozoaires constituent une couche dense dans laquelle se sont installés Pycnogonides, Ophiures, Echiurens, etc... Les Tuniciers ne sont pas encore en compétition avec les Bryozoaires; par contre, les Eponges, quasi absentes après 3 mois, sont parfois très nombreuses et leur diamètre peut atteindre 2 cm. Les groupes dominant restent les Annélides Polychètes et les Bryozoaires. Cependant, Mollusques, Hydrozoaires, Spongiaires et Tuniciers deviennent importants. Les *Pomatoceros* spp. continuent à marquer une préférence pour les zones dépolies des plaques.

Selon les types de plastiques utilisés, les biomasses moyennes (poids sec) de la couverture biologique après 3 et 7 mois d'immersion étaient respectivement pour le Plexiglas 8,55 et 111,62 g/m^2, le Polyéthylène 4,47 et 97,37 g/m^2, le Polystyrène 15,82 et 203,6 g/m^2, le Nylon 6/6 15,29 et 173,97 g/m^2, le Polycarbonate 5,99 et 125,2 g/m^2, le PVC 10,57 et 214,76 g/m^2.

L'analyse de la variance appliquée aux valeurs moyennes des biomasses établies sur 5 plaques montre qu'elles varient significativement d'un plastique à l'autre: il semble donc y avoir une influence de la nature chimique du polymère sur la biocénose pionnière.

Le taux de matière organique de la couverture biologique (en % du poids total) varie après trois mois entre 33,7% sur le PVC et 50,2% sur le Nylon. Ce taux diminue sensiblement et devient pratiquement identique dans les différents cas après 7 mois d'immersion (entre 15,8 sur le polyéthylène et 18,7% sur le polycarbonate). La couverture biologique pionnière varie donc d'un substrat à l'autre. Elle se modifie également au cours du temps et tend à s'uniformiser sur les différents plastiques.

La quantité de chitine des communautés qui se sont développées sur les différents substrats varie d'une plastique à l'autre entre 13 et 51 mg/m^2 après 3 mois, 185 et 437 mg/m^2 après 7 mois d'immersion.

La quantité de protéines varie également d'un plastique à l'autre, entre 0,4 et 8,9 g/m^2 après 3 mois, 3,52 et 7,2 g/m^2 après 7 mois.

La biomasse de cellulose se monte de 0,02 à 0,20 g/m^2 après 3 mois et 0,16 à 0,57 g/m^2 après 7 mois d'immersion; la production et la biomasse de cellulose sont donc du même ordre de grandeur que celles de la chitine.

Une étude préliminaire au microscope électronique à balayage n'a pas révélé de dégradation de la surface des plastiques après 7 mois d'immersion. Ceci confirme le caractère hautement réfractaire de ces matériaux de synthèse et justifie l'inquiétude manifestée par les écologistes au sujet du sort de ce type de déchet dans la biosphère.

De multiples travaux ont déjà été consacrés à l'étude des peuplements pionniers colonisant des substrats vierges, notamment en plastique, en Méditerranée. Mais la plupart ont été réalisés en milieu portuaire (travaux des équipes de RELINI dans le port de Gène, de RIGGIO à Palerme, d'ARIAS en Espagne, entre autres), souvent à de très faibles profondeurs et en rapport avec la mise au point de système antifouling. Une comparaison des résultats de ces études avec ceux relatés dans le présent travail s'avère difficile.

Les travaux réalisés dans des conditions plus ou moins comparables à celles de nos propres recherches sont souvent essentiellement descriptifs et basés sur l'analyse des communautés, leurs variations saisonnières et leur succession chronologique (1,7,8,9). S'ils contiennent parfois des données concernant les biomasses, celles-ci sont exprimées sous forme de poids humides ou correspondent à des périodes d'immersion nettement plus longues (2,3) et sont donc difficilement comparables aux nôtres. Au contraire, notre approche, qui s'inscrit dans une étude de la production et de la dégradation de polymères organiques en milieu marin (4,5,6), concerne surtout l'analyse biochimique quantitative de la couverture biologique des plastiques immergés et son évolution au cours du temps.

REFERENCES

1.- BELLAN-SANTINI, D., 1970a - Salissures biologiques de substrats vierges artificiels immergés en eau pure durant 26 mois dans la région de Marseille (Méditerranée nord occidentale). I. Etude qualitative. Tethys, 2 (2): 335-356.

2.- BELLAN-SANTINI, D., 1970b - Salissures biologiques de substrats vierges artificiels immergés en eau pure durant 26 mois dans la région de Marseille (Méditerranée nord occidentale). II. Résultats quantitatifs. Tethys, 2 (2): 357-364.

3.- DE PALMA, J.R., 1969 - A study of deep ocean fouling, straits of Florida and Tongue of the Ocean, 1961 to 1968. In: Bellan-Santini D., 1970b.

4.- JEUNIAUX, CH., J.C. BUSSERS, M.F. VOSS-FOUCART et M. POULICEK, 1986 - Chitin production by animals and natural communities in marine environment. Chitin in Nature and Technology. Plenum Press edit.

5.- JEUNIAUX, CH., M.F. VOSS-FOUCART, E. GERVASI, J.C. BUSSERS et M. POULICEK, 1988 - Biomasse et production de chitine par des biocénoses benthiques et planctoniques dans la baie de Calvi. Bull. Soc. R. de Liège, 4-5: 287-299.

6.- POULICEK, M., G. GOFFINET, CH. JEUNIAUX, A. SIMON et M.F. VOSS-FOUCART, 1988 - Early diagenesis of skeletal remains in marine sediments: a 10 years study. Bull. Soc. R. de Liège, 4.5: 313-330.

7.- SENTZ-BRACONNOT, E., 1966 - Données écologiques sur la fixation d'Invertébrés sur des plaques immergées dans la rade de Villefranche-sur-mer. Int. Revue ges. Hydrobiol., 51 (3): 461-484.

8.- SIMON-PAPYN, L., 1965 - Installation expérimentale du benthos sessile des petits substrats dans de l'étage circalittoral en Méditerranée. Rev. Trav. St. Mar. Endoume, 39: 52-94.

9.- RELINI, G., RELINI-ORSI, L., VALSUANI, G., 1973 - Popolamenti di substrati artificiali posti su un fondo a coralligeno ed in una prateria di Posidonia. I: Caratteristiche generali. Atti V° Congresso Soc. It. Biol. Mar., Nardò, Ed. Salentina: 226-260.

B

Incidence and ecology of marine fouling organisms in the Eastern Harbor of Alexandria, Egypt

Mohamed M. EL-KOMI

National Institute of Oceanography and Fisheries, Alexandria, Kayet Bay Alexandria (Egypt)

The fouling communities developing on submerged test panels (sized 15x15cm) for short and long terms at the Eastern Harbor of Alexandria was investigated in relation to the prevailing environmental conditions. To give an idea of the respective period of immersion and it is possible to make interesting successional the growth and longivity of fouling groups inhabited on the submerged objects under the sea water.

The harbor is relatively small semicircular polluted bay. Its water temperatures ranged from 16°C to 28°C throughout the year and its salinities fluctuated within 38.1 to 39.4 ‰.

The larval stages of fouling organisms, namely; barnacles, polychaetes, ascidians, bivalves, bryozoans and hydroids leptomedusae appeared in the plankton samples throughout most of the year, with maximum persistance between May and September period. The number of larval stages in the plankton vertical hauls through May to September averaged 2824, 838, 300 and 236 org/m³ for polychaete trochophore larvae, naupliar stages of barnacles, veliger larvae and ascidian tadpole larvae, respectively. The attachment numbers and biomasses of fouling organisms increased as the period of immersion extended to 4 months or more (Table 1) depending on the season of immersion. Eight main groups of macro-organisms with 57 species were recorded on the submerged test panels. These groups comprised barnacles, calcareous tube worms, ascidians, bryozoans, amphipod building tubes, hydroids, algae and sponges. The calcareous forms were the most conspicuous fouling organisms. Four species of barnacles, namely; *Balanus amphitrite, B. eburneus, B. perforatus* and *B. trigonus* were recorded. Their survival extended for 8 successive months or more, showing maximum growth rate during the first two months. The calcareous tube worms were represented by 6 species; *Hydroides elegans, H. dianthus, H. diramphа, Serpula vermicularis, Pomatocerus triqueter* and *Spirorbis* sp. *H. elegans* appeared as the most dominant tube worms. The overcrowded tube worms could be persisted for about 3 successive months and can be easily displaced under external circumstances. The bryozoans, *Bugula neritina* and *B. turbinata* prevailed at the same time of the development of algae on the exposed panels except in summer. They appeared in large colonies reaching more than 20-bifurcations and could survive for about 4 successive months. The ascidians; *Ciona intestinalis, Styela partita, S. plicata* and *Ascidia mentula* developed well on the panels immersed for long durations. The first species thrived for short period extending for 2 or 3 months while the others persisted for 6 or 8 successive months.

Panels immersed for long durations during summer and early autumn were the most heavily populated by barnacles, ascidians, and bryozoans. The panels exposed for 2 to 6 successive months during spring and early summer, generally collected more individuals than did those exposed for same intervals during the rest of the year. Diameters of the largest specimens differed from month to month and the maximum sizes obtained for individuals recorded on panels exposed for 2 to 4 months during spring and summer months.

The seasonal occurrence of barnacle nauplius larvae in plankton indicates a high concentration during December in the vertical haul which yielded 2585 org/ m³, but it does not reflect the realist attachment number of barnacles grown on the monthly collectors during this period as well other fouling groups did. It may be due to low degree of temperature reached to 17 C°. During the last 23 years fouling populations at the Eastern Harbor were recorded by Banoub, 1960, Megally, 1970 and Ghobashy,1976 in which great changes have been take place in the frequency occurrence and settlement density of fouling. In the present study the fouling biomass is greatly reduced that reflects the changes in the environmental conditions resulting from the intensity of pollution. The settlement density of fouling population on exposed panels for long intervals reflects thateach community has an optimum intensity of attachment. Barnacles were able to survive for about 2.5 years under rearing conditions (El-Komi, 1988), whereas in natural population they persisted for only 3 or 9 successive months.

Table 1. The wet weight in grams of fouling organisms groups developed on submerged test panels (15x15 cm) for various immersion intervals during March 1983 to February 1984 in the Eastern Harbor of Alexandria.

Duration months	Period of immersion	Algae	Hydroids	Bryozoa	Serpulids	Barnacles	Ascidians	Other groups	Total wet weight
2	Mar-Apr	15	+	18	136	2	104	12	287
2	Jul-Aug	+	+	+	60	32	-	11	103
2	Sep-Oct	+	+	+	18	4	-	1	23
2	Oct-Nov	3	+	8	4	10	-	1	31
2	Nov-Dec	6	+	12	22	1	-	2	53
2	Dec-Jan	5	+	2	41	19	-	1	84
2	Jan-Feb	-	-	-	9	10	-	1	33
3	Mar-May	-	-	-	120	3	420	5	860
3	Jun-Aug	-	-	+	242	80	28	6	384
3	Sep-Nov	3	+	14	6	23	-	5	187
3	Oct-Dec	-	+	30	82	77	3	5	198
3	Nov-Jan	-	+	6	83	80	4	3	176
4	Mar-Jun	-	+	27	130	75	19	3	245
4	Jun-Sep	-	+	352	535	19	22	12	940
4	Sep-Dec	17	+	+	128	374	65	9	577
4	Oct-Jan	-	+	+	14	45	3	5	84
5	Mar-Jul	-	+	210	120	185	18	6	548
5	Apr-Aug	-	+	22	440	77	14	15	577
5	Oct-Feb	-	+	-	18	138	14	3	183
6	Mar-Aug	-	+	60	177	177	18	3	274
6	Apr-Sep	-	+	+	125	80	14	3	234
6	Oct-Mar	-	+	12	656	19	25	7	731
7	Mar-Oct	-	+	+	760	207	31	12	1030
8	Mar-Nov	18	+	+	33	563	84	5	721
9	Mar-Dec	-	+	42	33	455	142	7	783
10	Mar-Jan	-	+	+	32	335	290	6	774
11	Mar-Feb	-	+	+	98	45	220	6	1094
12					238	96		9	

+ Present in few numbers; - Not observed

REFERENCES

BANOUB,N.W., 1960. Notes on the fouling of glass plates submerged in the Eastern Harbour of Alexandria. Notes and Memoires, Alex. Institute Hydrobiol., 64, 1-11.

El-Komi, M.M., 1988. Studies on the reproductive biology of common barnacles. Ph.D. dissertation, University of Tokyo, Japan, pp. 119.

GHOBASHY, A.F.A., 1976. Seasonal variation and settlement behaviour of the principal fouling organisms in the Eastern Harbour of Alexandria. Proc. 4th Intern. Congr. Mar. Corr. Fouling: 213-220.

MEGALLY, A.H., 1970. Ecological study on marine fouling organisms in Eastern Harbour of Alexandria. M.Sc.Thesis,Univ. of Alexandria, pp. 250.

The Appearance of Pink Coloured Mussels (*Mytilus galloprovincialis* Lamarck) on the Western Coast of the Istrian Peninsula

Mirjana HRS-BRENKO, Davor MEDAKOVIC and Elvis ZAHTILA

Rudjer Boskovic Institute, Center for Marine Research, 52210 Rovinj (Yugoslavia)

The appearance of mussels with pink coloured inner part of the shell (nacreous layer) was registeres for the first time at several places on the Western coast of the Istrian peninsula during the phytoplankton bloom in the mid-summer of 1989. At present, the incidence of pink mussels, according to the information of several persons, has never been observed further south along the Yugoslav coast. In February and March 1990, a survey of mussel populations was made to elucidate the problem on the appearance of pink mussels.

Samples (53 to 75 specimens) were collected from natural and commercial mussel populations at various localities of the Istrian peninsula. Mussels were measured by the vernier caliper, and were divided into three length groups.

- smallest mussels with specimens shorter than 20 mm,
- mussels between 20 and 40 mm, and
- mussels longer than 40 mm.

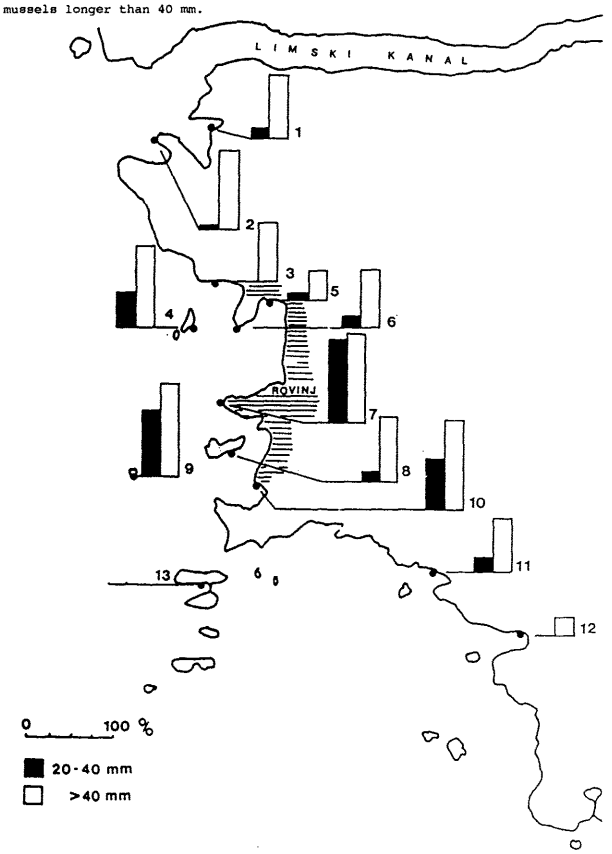


Fig. 1 - Incidence and percentages of pink mussels (*Mytilus galloprovincialis* Lamarck) in the Rovinj area. Sampling stations: Valalta (1), cap Faborsa and Saline (2), Leso (3), Figarola Island (4), Valdibora (5), Muccia (6), Rovinj (7), Katarina Island (8), Banjole Island (9), Lone (10), Polari (11), Vestar (12) and Red Island (13).

At some places investigated mussels larger than 40 mm were scarse, and this group sometimes comprehended less than 25 specimens per analysis.

Preliminary observations indicate the following results:

1. Pink mussels are present in natural populations along the coast of the Istrian peninsula, especially in the Rovinj, Porec and Vrsar areas.
2. In the Rovinj area, pink mussels were abundant in more polluted zones, on the coast close to the town and tourist zones (Fig. 1).
3. Not one pink mussel was observed among the mussels smaller than 20 mm in length.
4. The smallest pink coloured mussel was 22 mm in length.
5. The higheст incidence of pink mussels occurred in the group of specimens longer than 40 mm in length.
6. In one mussel a number of pink pearls was found.
7. The pink coloured nacreous shell layer was also observed in other bivalve species.
8. Investigations area in course, and will be continued till autumn months.

According to the results, we suppose that the pink mussel shell indicates some disturbance in the normal shell formation (Wilbur 1961), which appears to be in connection with the increased degradation of the northern Adriatic Sea environment (Degobbis 1989; Zavodnik *et al.* 1989), due to the intensive inflow of various pollutants, or it could be atributted to same pathogen agents.

REFERENCES

DEGOBBIS, D., 1989. Increased eutrophication of the northern Adriatic Sea. Second act. Mar. Pollut. Bull. 20 (9): 452-457.

WILBUR, K.M., 1964. Shell formation and regeneration. In: Physiology of Mollusca 1. K.M. Wilbur, C.M. Yonge, eds, Academic Press, New York: 243-282.

ZAVODNIK, D., ZAVODNIK, N., HRS-BRENKO, M., JAKLIN, A., ZAHTILA, E., 1989. Neuobicajeni oblik eutroficacije u sjevernom Jadranu u 1988. godini. 5. Posljedice na zivotne zajednice morskog dna zapadne obale Istre. Konferencija o aktuelnim problemima zastite voda "Zastita voda '89", 1, Rovinj 3-5 May 1989: 439-446.

B-IV2

Note on the incidence of the Hydroid *Eugymnanthea inquilina* Palombi, in Mussels *Mytilus galloprovincialis* Lamarck, along the Eastern Adriatic Coast

Zelika LABURA and Mirjana HRS-BRENKO

"Rudjer Boskovic" Institute, Center for Marine Research, 52210 Rovinj (Yugoslavia)

According to Cerruti (1941), the hydroid *Eugymnanthea inquilina* (synonim of *Mytilhydra polimantii*) is often found on the mantle epithelium of the mussel *Mytilus galloprovincialis*, causing the loss of cilia from the mantle epithelium and other pathological alterations in mussels. Through a heavy infestation of hydroids, disturbances in normal filtering (Lauckner 1983), and probably in feeding activity could happen, decreasing the index of condition of the host.

In 1985 and 1986 along the Yugoslav Adriatic coast investigations were conducted to establish the intensity of hydroid infestation of natural and commercial mussel populations, and to indicate possible effects of hydroids on the host index of condition. The samples (20 to 50 mussels) were analyzed to establish the number of invaded mussels by hydroids, mussel length data, and index of condition was calculated using the Hopkins methos (MANN 1978).

We have obtained the following results (see Fig. 1):

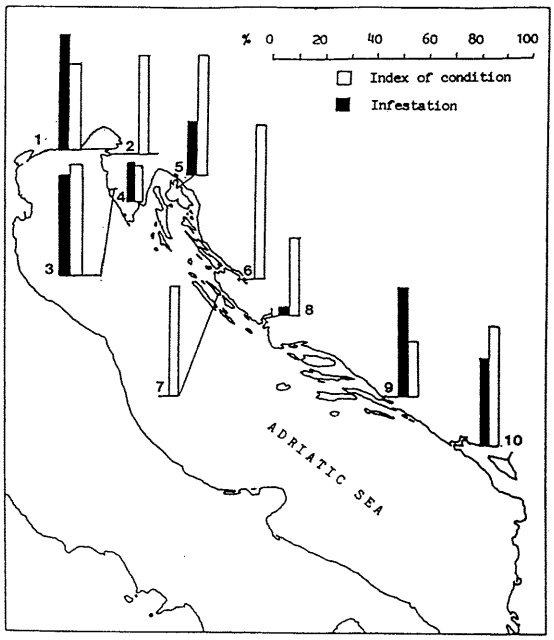


Fig. 1 - Incidence and intensity of *Eugymnanthea inquilina* infestation and index of condition of *Mytilus galloprovincialis* at sampling stations: Portoroz (1), Strunjan (Piran Bay, 2), Limski kanal (3), Rasa Bay (4), Soline (Krk Island, 5), Novigrad Sea (6), Mala Lamljana (Ugljan Island, 7), Martinska (Sibenik, 8), Mali Ston Bay (9), Kotor Bay (10).

1. The hydroid *Eugymnanthea* is a frequent species inhabiting the mantle cavity in mussels.
2. An abundance of hydroids occurred in the mantle cavity, especially near the mussel hinge zone. The hydroids were mostly individual, rare in colonies, which is in agreement with the findings of STJEPCEVIC (1974).
3. The infestation incidence ranged from 4% (Martinska, Sibenik, 8) to 46% (Strunjan, Piran Bay, 2). Hydroids were not observed in mussels from Strunjan (2), Novigrad Sea (6) and Mala Lamljana (Ugljan Island, 7). In Boka Kotorska about 30.0% of mussels (Kotor Bay, 10) were invaded, but, earlier, only 4-9% was registered by STJEPCEVIC (1974).
4. It seems that in Limski kanal (3) the intensity of infestation did not significantly change monthly. In January-March, July and November the infestation ranged as follows: 40.7, 20.0, 36.0, 40.0 and 49.7%, respectively. Hydroids were not observed in the June sample.
5. Mussels of various length frequency classes were invaded from 10.0 to 44.0% (Limski kanal, 3, Rasa Bay, 4).
6. It appears that the index of condition in mussels is not directly influenced by hydroid infestation. In Limsky kanal (3) and Mali Ston Bay (9) at almost the same level of infestation different index of condition were found.

In conclusion, our observations indicate that *Eugymnanthea* is frequent in the Adriatic Sea with a moderate infestation of mussels but it seems that the hydroid influence on the host is negligible.

REFERENCES

CERRUTI, A., 1941. *Mytilhydra polimantii* n. gen. n. sp. vivente sul mantello dei Mitili. Riv. Biol., 32: 1-18.

LAUCKNER, G., 1983. Introductions, Mollusca: Bivalvia to Scaphopoda. Vol. II. In: Diseases of Marine Animals. O. Kinne. ed., Boyens & Co., Heide, 467-983.

MANN, R., 1978. A comparison of morphometric, biochemical, and physiological index of condition in marine bivalve molluscs. In: Energy and Environmental Stress in Aquatic Systems. J.H. Thorp and I.W. Gibbons, eds, DOE Sym. Ser. No 48: 484-497.

STJEPCEVIC, J., 1974. Ekologija dagnje (*Mytilus galloprovincialis* Lam.) i kamenice (*Ostrea edulis* L.) u gajilistima Bokokotorskog zaljeva. Studia Marina, 7: 5-164.

B-IV3

Changes in size and abundance of *Donax trunculus* related to depth and bottom characteristics

A. VOLIANI, R. AUTERI, R. BAINO and G. GIANNARDI

Consorzio Regionale di Idrobiologia e Pesca, Livorno (Italia)

INTRODUCTION: Sandy bottoms resources in shallow waters off Tuscany have been for a long time exploited by artisanal shell-fishing. These resources have been recently studied by an appraisal fishing survey. A wide series of quantitative and biological information has been collected, aimed at defining both population structure and geographical distribution.

MATERIAL AND METHODS: 141 tows have been performed with a professional boat-operated dredge on the sandy bottoms between Livorno and Viareggio. The 25 km coastline has been sampled by means of 4 systematic campaigns within the 1-5 meters depth range. Furthermore, 7 monthly collections have been carried out with a close-mesh net dredger to survey the presence of smaller individuals which had not yet recruited to the professional fishery. The catches have been used to define local species abundance and size distribution. The structural composition of the sediment has been determined in 21 sites by standard Weber sieves.

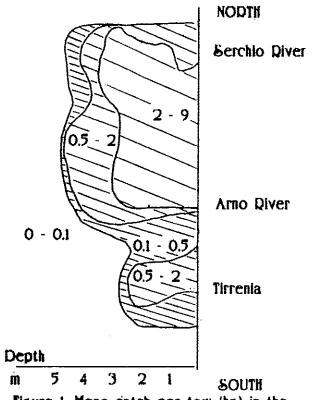


Figure 1. Mean catch per tow (kg) in the surveyed area.

RESULTS: The highest yields of Donax trunculus (more than 2 kg/tow) have been obtained to the north of the Arno River mouth within the 3.5 meters depth: Figure 1 illustrates the average annual catch per tow in the examined area in relation to geographical allocation and depth.

The analysis of the grain size reveals that sandy bottom is on the average quite uniform to the north of the Arno River mouth: 0.25-0.5 mm up to 3.5 meters depth and 0.12-0.25 mm from 3.5 to 5.5 meters; towards the south the sandy bottom is progressively finer from the Arno River mouth (>0.5 mm) to Calambrone (<0.25 mm).

These results are due to the solid outflow of Arno River and their differential dispersion by the coastal marine streams (Aiello et al., 1975).

The above mentioned highest yields have been found in the depth range of 1-3.5 meters and with a medium sandy ground (0.25-0.50 mm) in agreement with previous findings (Costa et al., 1987).

The mean weight of individuals is significantly related to the depth (Figure 2) and the resulting regression is linear and increases with the depth.

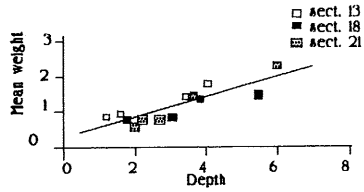


Figure 2. Relation between the individual mean weight (g) and the depth (m) in three sectors and the resulting regression line.

The increase in size with depth is also confirmed by the frequency distribution of age classes. In the histogram of Figure 3, the relative abundance of juveniles (between 15 and 22 mm length) and adults (over 23 mm length) is plotted on a depth axis.

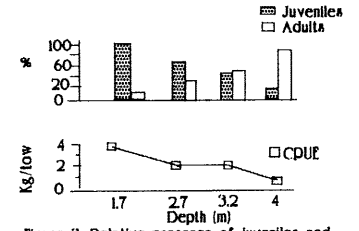


Figure 3. Relative presence of juveniles and adults, and CPUE at different depths.

CONCLUSION: Donax trunculus finds its optimum ground on medium sandy bottoms (grain size from 0.25 to 0.5 mm) and it represents a valid resource for the local fishing activity only in the northern area, from the Arno River mouth up to 3.5 m depth where this bottom sediment type is dominant.

The size distribution shows a positive trend with increasing depth. This is firstly due to the intense fishing effort which acts mainly on lower depths, where higher yields are common, secondly to the movement of the adult specimens also confirmed by the poor presence of young individuals at higher depths.

REFERENCES

Costa C., Bianchini M., Ceccarelli P., Orecchia P., Rambaldi E., Volterra L., 1987. Indagine sui molluschi bivalvi di interesse commerciale (telline, cannolicchi e vongole) delle coste della Toscana, del Lazio e della Campania. Quad. Ist. G.Brunelli, (7) 58 pp.

Aiello E., Bartolini C., Caputo C., D'Alessandro L., Fanucci F., Fierro G. et al., 1975. Il trasporto litoraneo lungo la costa toscana tra la foce del Fiume Magra e i Monti dell'Uccellina. Boll. Soc. Geol. It., 94, 1519-1571.

Quelques données sur la reproduction de la Pintadine *Pinctada radiata* (Leach) des Iles Kerkennah (Tunisie Méridionale)

Sabiha TLIG, Fredj KARTAS et Jeanne ZAOUALI

Laboratoire de Biologie et d'Ecologie littorale, Faculté des Sciences de Tunis (Tunisie)

B

La pintadine *Pinctada radiata* est un lamellibranche indopacifique à vaste répartition géographique. Elle s'est introduite en Méditerranée par la mer Rouge à la suite du percement du canal de Suez et n'a cessé, depuis, d'étendre son aire de distribution gagnant des zones de plus en plus septentrionales. En Tunisie, elle a été signalée pour la première fois par DAUTZENBERG en 1895 dans le golfe de Gabès où elle constitue à l'heure actuelle des gisements denses; mais ell se raréfie très rapidement à mesure que l'on va vers le nord et sa présence devient accidentelle dans le golfe d'Hammamet et de Tunis.

Les données sur la reproduction de l'espèce sont pour la plupart anciennes et peu nombreuses. Selon TRANTER (1958), les populations australiennes se reproduisent le long de l'année d'une façon presque continue. Le maximum de développement de la gonade a lieu durant les mois les plus chauds (d'octobre à janvier) et l'émission des produits sexuels se déclenche dès que la température de l'eau commence à diminuer et atteint son maximum d'intensité en avril-mai.

Dans le cadre de notre travail sur la pintadine des Iles Kerkennah, nous avons tenté d'élucider certains phénomènes liés à sa reproduction. Pour cela, nous avons déterminé les stades de développement des gonades établis par LUCAS (1965) (stade A: gonade vide, au repos sexuel; stade B: gonade en cours de maturation; stade C: gonade mature en préponte) et calculé l'indice de maturité R selon la formule de YASUDA *et al.* (1954) $R = \frac{n1A + n2B + n3C}{n1 + n2 + n3} \times 100$ avec A = 0; B = 0,5; C = 1 et n1, n2, n3 les nombres d'individus aux stades A, B et C. De plus nous avons essayé d'évaluer, d'une part l'influence de la température de l'eau (T) et, d'autre part, celle de la condition de la pintadine sur le déroulement de la reproduction, en analysant les variations de l'indice de condition (Ic) défini comme le rapport en pourcentage du poids de la chair humide égouttée sur celui de la coquille égouttée.

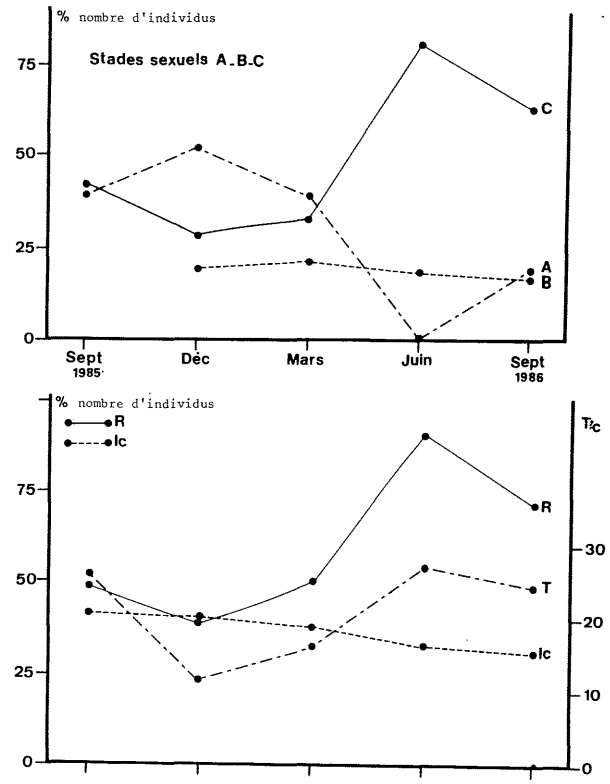
Les résultats obtenus sont illustrés par la figure ci-dessous.

L'évolution saisonnière des stades sexuels indique que le taux des spécimens en cours de maturation représentés par le stade B, gravite autour de 20% tout en manifestant de mars à septembre une légère et régulière diminution. Les individus en phase de repos sexuel (stade A) sont très nombreaux en décembre où ils constituent plus de 50% de la polulation; leur effectif chute ensuite considérablement pour devenir nul en juin. Il n'en est pasde même des individus matures en préponte (stade C), dont l'effectif, relativement faible en décembre (28% de la population), s'accroite fortement pour atteindre les proportions de 81% en juin et régresser les mois suivants, tout en demeurant assez élevé, puisqu'il forme en septembre entre 43 et 63% de l'ensemble.

Les valeurs saisonnières de l'indice de maturité (R), qui évoluent de la même manière que celles du stade C, montrent que la gonade est active durant toute l'année mais que cette activité est variable selon les saisons, elle est réduite en hiver, moyenne au printemps et en automne et élevée en été. L'émission des éléments sexuels est étalée dans le temps et se produit essentiellement pendant l'été et l'automne.

Les processus de maturation des gonades semblent étroitement liés à la température de l'eau (T), puisqu'aux faibles valeurs hivernales de la température correspond l'indice de maturité le plus faible, le maximum de l'indice de maturité coincidant par contre avec les plus fortes températures estivales.

Quant à l'indice de condition (Ic), il varie peu d'une saison à l'autre et les faibles valeurs enregistrées en septembre 1986 pourraient s'expliquer par une diminution du poids corporel consécutive à la ponte.



REFERENCES

DAUTZENBERG, A., 1985. Mollusques recueillis sur les côtes de Tunisie. Mem. Soc. Zool. France, 8: 363-375.

LUCAS, A., 1965. Recherche sur la sexualité des Mollusques Bivalves. Thèse de Doctorat es-Sciences.. Faculté de Rennes, 135 p.

TRANTER, D.J., 1958. III *Pinctada albina* (Lmk): Breeding season and sexuality. Australian J. Mar. Fresh. Res., 9: 135-143.

YASUDA, J., HAMAI, I. and HOTTA, H., 1954. A note on the spawning season in *Venerupis philippinarum*. Bull. Jap. Soc. Scient. Fish., 20: 277-279.

Aspects de la reproduction chez *Acanthocardia aculeata* (L.) (Mollusca, Bivalvia) du Golfe de Trieste

Giorgio VALLI, Alessandra CERINO et Paola NODARI

Dipartimento di Biologia dell'Università degli Studi di Trieste (Italia)

Abstract: The reproduction of Acanthocardia aculeata has been studied during 1988-89 by histological method. The reproductive activity occurs principally in the winter and smaller in the spring. The sex-ratio is 57.55% ± 2 * 3.39 (p=0.05) for males.

Acanthocardia aculeata est une espèce qui vit sur des substrats vaseux et sableux de la Mediterrannée et de l'Atlantique. Dans le Golfe de Trieste elle a été repérée (VIO, information personnelle) dès 9 mètres de profondeur et, plus fréquemment, dès 10 mètres dans le circalittoral. La littérature ne contient, à notre connaissance, aucune étude sur sa reproduction. A fin d'apporter une contribution à la connaissance de la biologie de cette espèce, on a recueilli, tous les mois, de juin 1988 à juin 1989, une cinquantaine d'exemplaires, provenant de pêches faites dans le Golfe de Trieste. On a mesuré, avec un compas à coulisse, la longueur, la hauteur et l'épaisseur de la coquille et determiné le poids total, celui des parties molles et de la coquille de tous les animaux. Les parties molles de 20 exemplaires, choisis au hasard, ont été fixées au Bouin, coupées (6 µm) et colorées à l'hematoxyline-eosine. Les gonades ont été classées selon une échelle de 6 Stades: Stade 0 (repos sexuel), Stade 1 (début de la gamétogénèse), Stade 2 (développement), Stade 3 (maturité), Stade 4 (émission), Stade 5 (fin du cycle). Sur les animaux restant 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. Enfin on a déterminé le volume intérieur de chaque valve. Toutes ces mesures, sauf la longueur de la coquille, seront analysées, par nécessité, ailleurs. La longueur moyenne était de 6.4 cm (l'intervalle de 2.6 à 8.8 cm) c'est à dire il s'agissait d'animaux adultes qui s'étaient déjà reproduit. L'étude histologique des gonades a permis d'établir que Acanthocardia aculeata est une espèce gonochorique, toutefois on a observé quelques individus hermaphrodites (5 sur 260 exemplaires examinés). Le sex-ratio est 57.55% ± 2 * 3.39 (p=0.05) pour les mâles. La gamétogénèse s'étend principalement d'août à novembre, mais on observe des exemplaires en gamétogénèse toute l'année, sauf en février-mars et en juin. L'émission des gamètes arrive, principalement, de novembre à janvier; elle est plus modérée en février-avril pour reprendre en mai et surtout en juin. En février-juillet on observe un petit nombre d'individus à la fin du cycle ou en repos sexuel. L'indice gonadique de 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), est (de juin 1988 à juin 1989):

J/88	J	A	S	O	N	D	J/89	F	M	A	M	J
1.35	0.75	1.80	1.95	1.95	2.25	2.45	2.10	0.85	0.70	0.75	1.25	1.70

Les valeurs de l'indice gonadique tendent à la baisse en juin-juillet, en relation avec la fin du cycle et l'entrée en repos sexuel, tandis qu'elles tendent à la hausse en août-décembre avec les progrès de la gamètogénèse et la réalisation de la maturité sexuelle. Par conséquent le cycle reproductif chez Acanthocardia aculeata du Golfe de Trieste est particulièrement intense. La raison de l'adoption d'une stratégie reproductive de type "r", selon la définition de Lucas et alii (1978), c'est à dire d'un remarquable effort reproductif, est à rechercher dans la mortalité élevée. Cette mortalité est la somme des mortalités naturelles, larvaire, juvenile, par predation, parasitisme et pêche qui pourront être mieux précisées par des recherches ultérieures. Les conditions ecologiques du Golfe de Trieste: température, salinité, oxygène, nourriture etc., étudiées par Fonda-Umani et alii (1985) e Milani et alii (1988), sont favorables. En particulier, selon ces Auteurs, les variations thermiques entre la surface et le fond sont limitées à 6-7 °C; les valeurs les plus faibles de la température, dans la colonne d'eau sont d'environ 7 °C à la fin de février et les valeurs maximales, autour de 24 °C, en août. La salinité descend, très rarement, au-dessous de 30 ‰. et l'oxygène descend au niveau de la sous-saturation au cours de très brèves périodes. En ce qui concerne la nourriture on peut remarquer que Acanthocardia aculeata vit dans le Circalittoral du Golfe de Trieste: par conséquent son alimentation peut être continuelle et elle demeure au dehors des chocs thermiques auxquels sont soumises les éspèces du mediolittoral, par exemple Mytilus galloprovincialis, obligées de survivre en conditions d'anaérobiose (Valli, 1971; Valli et Alii, 1975) pendant la marée basse. En conclusion le cycle reproductif chez Acanthocardia aculeata manifeste une tendance à la continuité (dûe au manque ou à la réduction de la période de repos sexuel) qu'on avait déjà observée pour une autre éspèce du Circalittoral du Golfe, Callista chione (Valli et Alii, 1983/84): mais la similitude s'arrêt là, les temps et la durée des diverses phases du cycle diffèrent. La gamètogénèse chez Acanthocardia aculeata du Golfe de Trieste est la phase prépondérante en août lorsque la température de la mer est la plus élévée et elle se poursuit tandis que la température diminue. La maturité sexuelle et l'émission des gamètes arrivent dans les mois froids de l'année. Des études ultérieures sont nécessaires car, au cours des dernières années, on assiste à une modification progressive des paramètres écologiques du Golfe de Trieste. En particulier on remarque une hausse de la température de la mer soit en été soit en hiver, dont les conséquences se sont déjà manifestées par une énorme production algale ("mare sporco").

Bibliographie sommaire

FONDA-UMANI S., FANZUTTI G.P., FINOCCHIARO F., OLIVOTTI R., STRAVISI, GENNARO M. e SICHENZE S. - 1985 - Un anno di ricerche sul particellato sospeso in una stazione idrologica del Golfo di Trieste: risultati preliminari. NOVA THALASSIA 7 Suppl. 3: 143-150.

LUCAS A., CALVO J. et TRANCART M. - 1978 - L'effort de reproduction dans la strategie demographique de six Bivalves de l'Atlantique. HALIOTIS 9(2): 107-116.

MILANI L., CABRINI M, FONDA-UMANI S. e HONSELL G. - 1988 - Parametri ambientali (temperatura, salinità, ossigeno disciolto, clorofilla a e feopigmenti) in una stazione del Golfo di Trieste da marzo 1986 a settembre 1988: dati. NOVA THALASSIA, In stampa.

SEED R. - 1980 - Reproduction and growth in Anomia ephippium (L.) (Bivalvia: Anomiidae) in Strangford Lough, Northern Ireland. J. CONCH. 30: 239-245.

VALLI G. - 1971 - Ciclo di maturità sessuale in Mytilus galloprovincialis Lmk. di Duino. BOLL. PESCA PISCIC. IDROBIOL. 26(1,2): 259-265.

VALLI G., CERNECA F. e FERRANTELLI N. - 1975 - Caratteristiche dell'accrescimento e del periodo riproduttivo in un allevamento sperimentale di Mytilus galloprovincialis. BOLL. PESCA PISCIC. IDROBIOL. 30(2): 299-313.

VALLI G., BIDOLI E. e MARUSSI C. - 1983/84 - Osservazioni preliminari sulla riproduzione e sulla biometria di Callista chione (L) (Mollusca, Bivalvia) del Golfo di Trieste. NOVA THALASSIA 6: 97-103.

B-IV6

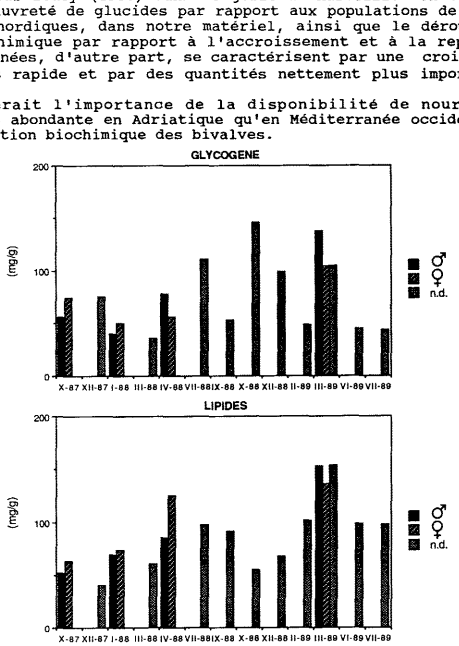
Cycle Biologique et Variations Biochimiques du Bivalve *Spisula subtruncata* en Haute Adriatique

P. ACCOSSATO, V. FESTA, A. OCCHIPINTI AMBROGI et P. VITA-FINZI

Dipartimento di Chimica Organica e Dipartimento di Genetica e Microbiologia dell'Università di Pavia (Italia)/ENEL - C.R.T.N., Milano (Italia)

Abstract - The growth and biochemical composition of a population of Spisula subtruncata living in the coastal sandy bottoms off the Po river delta are described. The lipid accumulation is related to reproduction, whereas carbohydrates are comparatively low and irregularly fluctuating, and proteins are rather steady.

Les variations de composition biochimique du bivalve Spisula subtruncata (da Costa) ont été suivies pendant un cycle annuel dans une station côtière devant le Delta du fleuve Pô, en relation avec l'accroissement des individus composants la population.
Les prélèvements ont été effectués à la drague, sur des fonds sableux de 5 à 6 mètres de profondeur, pendant 13 campagnes, à partir d'octobre 1987 jusqu'à juillet 1989. En même temps on a prélevé 10 échantillons avec une benne Van Veen (0,1 m^2) pour l'estimation de la densité et de la taille des animaux. Les méthodes utilisées pour l'extraction et la détermination des lipides (Ways et Hanahan, 1964; Zollner et Kirsch, 1962) et des glucides (Dubois et al.,1956) ont été appliquées en utilisant un spectrophotomètre Lambda 1 Perkin-Elmer; la teneur en protides a été évaluée en multipliant le contenu en azote élémentaire (mesuré par CHN Analyzer Leco) par le coefficient 6,25 (Giese, 1967).
Le cycle biologique de Spisula subtruncata s'est déroulé comme pour le passé (Ambrogi et Occhipinti Ambrogi, 1987), la nouvelle cohorte apparaissant aux prélèvements de juillet,la maturation des gonades pendant l'hiver et la libération des gamètes au printemps. La majorité des adultes ne survit pas à la reproduction.
La teneur en lipides totaux suit le cycle reproductif des bivalves, elle présente des valeurs maximalès en avril 1988 et mars 1989 (125 et 154 mg respectivement de lipides par g de poids sec). Les valeurs les plus basses ont été enregistrées en automne (40-70 mg/g).
Le D-glucose et le glycogène ont montré une variabilité également accusée mais un cycle moins défini, avec des pics soit en été (71 et 110 mg/g respectivement) soit en automne (72 et 146 mg/g).
La teneur en protides ne varie pas excessivement, passant de 446 mg/g en décembre 1987 à 565 mg/g en mars 1989.
La croissance pondérale des bivalves est strictement liée à l'accumulation des lipides. Le poids sec libre de cendre atteint son maximum de 50 mg (moyenne individuelle) en mars 1989. Dans nos prélèvements les individus les plus jeunes, sans gonades reconnaissables, avaient un poids moyen de 30 mg et étaient généralement plus riches en glucides.
Le cycle observé dans la région du Delta du Pô peut être comparé avec celui décrit par Bodoy (1980) dans le golfe de Marseille. On confirme la relative pauvreté de glucides par rapport aux populations de Bivalves des mers nordiques, dans notre matériel, ainsi que le déroulement du cycle biochimique par rapport à l'accroissement et à la reproduction. Nos données, d'autre part, se caractérisent par une croissance pondérale plus rapide et par des quantités nettement plus importantes de lipides.
Ceci confirmerait l'importance de la disponibilité de nourriture (beaucoup plus abondante en Adriatique qu'en Méditerranée occidentale) sur la composition biochimique des bivalves.



Bibliographie

Ambrogi, R. et A. Occhipinti Ambrogi, 1987. Temporal variations of secondary production of Spisula subtruncata (da Costa) in the area of the Po river delta. Estuarine Coast. Shelf Sci., 25: 369-379.
Bodoy, A., 1980. Croissance et variations de la composition biochimique du bivalve Spisula subtruncata (da Costa) dans le golfe de Marseille. Téthys, 9: 345-354.
Dubois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers et F. Smith, 1956. Colorimetric method for determination of sugar related substances. Analytical Chemistry, 28: 350-356.
Giese, A.C., 1967. A new approach to the biochemical composition of the mollusc body. Oceanography Marine Biology Annual Revue, 5: 159-186.
Ways, P. et D.J. Hanahan, 1964. Characterization and quantification of red cell lipids in normal man. J. Lipid Research , 5: 318-328.
Zollner, N. et K. Kirsch, 1962. Uber die quantitative Bestimmung von Lipoiden (Mikromethode) mittels der vielen naturlichen Lipoiden (allen bekannten Plasmalipoiden) gemeinsamen Sulphophosphovanillin-Reaktion. Z. ges. Exp. Med., 135: 545-561.

B-IV7

Etude Dynamique de *Venus gallina* (L.) et *Spisula subtruncata* (Da Costa) (Mollusques-Bivalves) de la Baie d'Alger

A. BAKALEM, A. MESSILI et J.-C. ROMANO

ISMAL, BP 90 Alger-1er Novembre (Algérie)

B

INTRODUCTION : Venus gallina et Spisula subtruncata, espèces caractéristiques constantes des sables fins de la baie d'Alger, sont des espèces "leader" du peuplement des sables fins au sein duquel elles sont les deux principaux producteurs secondaires de matière organique, et jouent un rôle prépondérant dans la chaine trophique en tant qu'espèce-proie (Bakalem, 1979). C'est dans cette optique que nous nous sommes intéressés à ces deux espèces et entrepris leur étude spatio-temporelle.
MATERIEL ET METHODES : Dans le cadre d'une étude des sables fins de la baie d'Alger des prélèvements quantitatifs à la benne Van Veen de novembre 1984 à septembre 1986 ont été réalisés à quatre stations : H, O, F et B. Ces stations (- 10 m) couvrent l'ensemble du peuplement des sables fins. Chaque prélèvement correspond à une surface de 1 m2, les effectifs dénombrés représentent la densité exprimée en nombre d'individus par m2 (ind./m2). Pour le calcul de la biomasse (g/m2) nous avons utilisé les relations taille-poids établies par Bakalem (1981) : $W = 2.10^{-6}L^{2.29}$ pour Venus gallina et $W = 2.10^{-6}L^{2.82}$ pour Spisula subtruncata où W est le poids sec (g) et L la plus grande taille (mm).
RESULTATS : A la station B les effectifs de Venus gallina diminuent au cours du temps, cette diminution est interrompue certains mois (mars, octobre et décembre 1985) par un recrutement éphémère. La densité maximale (301 ind./m2) est notée en mars 1986 ; la densité minimale (16 ind./m2) en septembre 1986. La station B devient défavorable à Venus au cours du temps car à partir de la fin de l'année 1985 et en 1986 ses densités sont faibles. L'évolution de la biomasse dans le temps est similaire à celle de la densité. Les fortes biomasses (29,56 à 44,35 g/m2) de novembre 1984 à avril 1985 s'opposent aux faibles valeurs de la biomasse notées à partir de mai 1985, en particulier la biomasse minimale (0,43 g/m2) en mars 1986. Venus gallina en automne et au printemps a des biomasses élevées grâce aux recrutements lors de ces saisons et à la croissance pondérale importante au cours de l'été. En novembre et décembre 1984 l'abondance de Venus de la station F augmente à la suite d'un recrutement automnal. Puis, nous observons une chute des effectifs en janvier 1985. De février à septembre 1985 la densité diminue, de 170 à 63 ind./m2 ; d'octobre à décembre 1985 (densité maximale : 190 ind./m2) elle augmente (recrutement automnal). En mars 1986 l'abondance est faible ; en juin 1986 grâce à un recrutement printanier, la densité est élevée (153 ind./m2) tandis qu'en septembre elle l'est moins. Les variations de la biomasse de Venus de la station F suivent celles de la densité, sauf de mars à juin 1986. De novembre 1984 à septembre 1986, en général, la biomasse diminue : d'une valeur maximale (30,65 g/m2) en décembre 1984 elle passe progressivement à une valeur minimale (1,73 g/m2) en septembre 1986. Les fluctuations de la biomasse de Venus des stations F et B sont similaires. La densité de Venus gallina de la station O fluctue considérablement et de façon irrégulière. Une forte augmentation de l'abondance est observée d'octobre à décembre 1985 (densité maximale : 345 ind./m2), suivie d'une chute (35 à 59 ind./m2). La fin de l'automne 1984 et le début de l'hiver 1985 sont caractérisés par une augmentation de la densité de Venus. Les faibles densités se rencontrent en été (densité minimale : 9 ind./m2 en juillet 1985). L'évolution de la biomasse de Venus dans le temps est identique à celle de la densité, excepté d'octobre à décembre 1985 où la densité augmente considérablement (arrivée de très jeunes individus) et la biomasse diminue. Les valeurs élevées (avant mai 1985) (9,38 à 31,80 g/m2) deviennent faibles après (1,06 à 8,33 g/m2) excepté en juin 1985 (16,9 g/m2). Le suivi de Venus à la station H met en évidence deux périodes :
- novembre 1984 à septembre 1985 : les densités sont faibles (11 à 64 ind./m2), et leurs fluctuations peu importantes, mis à part l'hiver et le début du printemps 1985 où a lieu un recrutement de jeunes, augmentant ainsi la densité (85 ind./m2 en février 1985). Les valeurs de la biomasse sont les plus élevées, particulièrement fin hiver-printemps 1985 (6,4 à 13,72g/m2) et août 1985 (12,24 g/m2).
- octobre 1985 à juin 1986 avec de fortes densités (203 à 420 ind./m2) résultant de recrutements automnal et printanier. En septembre 1986 la densité n'est que de 50 ind./m2. Les fluctuations des effectifs en cette période sont bien supérieures à celles de la période précédente. Cette augmentation n'entraîne pas une élévation des valeurs de la biomasse, excepté en mars 1986 où il y a une légère augmentation (7,41 g/m2). La biomasse diminue ensuite pour atteindre sa valeur minimale (2,44 g/m2) en septembre 1986. Durant cette seconde période les valeurs de la biomasse (2,44 à 7,41 g/m2) sont bien inférieures à celles de la première période.
Spisula subtruncata à la station B n'est pas constante, elle disparaît en hiver (décembre 1984 à mars 1985) ; sa densité fluctue généralement entre 1 et 4 ind./m2, sauf en juin et septembre 1986, respectivement 25 et 142 ind./m2. Les biomasses de Spisula de la station B sont extrêmement faibles (0,0029 à 0,025 g/m2) sauf en novembre 1984 (biomasse maximale : 3,21 g/m2) et septembre 1986 (2,01 g/m2), grâce au recrutement automnal ou aux individus ayant eu une croissance importante lors de l'été. Aux autres stations Spisula est très différemment représentée : très abondante dans le temps à la station H comparativement aux stations O et F où les densités sont proches. Pour ces trois stations les densités élevées existent du printemps jusqu'à l'automne, période correspondant à celle du recrutement. De très fortes densités sont notées en 1986, particulièrement en juin et septembre : 1201 et 230 ind./m2 pour la station H, 1892 et 1303 ind./m2 pour F et 1113 et 370 ind./m2 pour la station O, contrairement à 1985 où les conditions du milieu semblent être défavorables à Spisula. Nous remarquons des fluctuations importantes des effectifs aux stations H, O et F indiquant l'instabilité du milieu. L'abondance de Spisula en hiver est faible. Les fluctuations de la biomasse de Spisula suivent celles de la densité surtout aux stations O et F. La station O possède les biomasses les plus élevées (0,45 à 25,07 g/m2), suivie de H (0,02 à 16,4 g/m2) et F (0,0018 à 31,58 g/m2). Les biomasses en 1986 sont supérieures à celles des années précédentes, excepté pour la station O où de novembre 1984 à mars 1985 (sauf janvier) Spisula a des biomasses parmi les plus fortes notées pour cette espèce (16,6 à 25,07 g/m2). La biomasse maximale (31,58 g/m2) est observée en septembre 1986 à la station F. L'automne correspond à la saison où Spisula présente des biomasses élevées, c'est aussi le cas, mais à un degré moindre au printemps.
DISCUSSION - CONCLUSION : Venus gallina et Spisula subtruncata, sont distribuées différemment selon les fonds occupés par le peuplement des sables fins. Cette distinction évolue dans le temps. Les stations F et O ont des densités similaires au cours du temps pour Venus et Spisula. Venus gallina est une espèce constante, dans le temps, dans les stations étudiées, par contre Spisula subtruncata ne l'est que dans les stations H, O et F où elle est généralement dominante par rapport à Venus. Spisula est très peu abondante, ou absente du milieu, en hiver ; ses densités sont élevées au printemps et en automne. Venus gallina est bien représentée dans le milieu à la fin de l'hiver - début du printemps et en automne, par contre en été ses effectifs sont faibles. La distribution de Venus et Spisula semble étroitement liée aux conditions locales du milieu. Les stations retenues sont telles qu'elles reflètent chacune les conditions particulières existantes au niveau des fonds de sables fins de la baie d'Alger. Bakalem et al (1988) ont mis en évidence les particularités de chaque station tant sur le plan conditions écologiques que peuplement macrobenthique. Il ressort de leur étude que la stabilité écologique est différente selon les stations : - la station H où l'instabilité écologique est grande, se traduisant chez Venus et Spisula par des fluctuations quantitatives importantes et irrégulières dans le temps. Les conditions du milieu favorisent très nettement Spisula au détriment de Venus. - la station O où l'instabilité est moindre comparativement à la station H, les conséquences sont identiques pour les espèces étudiées mais Venus est mieux représentée
- la station B, la moins perturbée, possède une certaine stabilité écologique favorisant Venus, alors que Spisula ne semble guère y trouver de conditions favorables. Les variations des densité et biomasse sont faibles et régulières dans le temps
- la station F est une station intermédiaire entre les stations O et B ; les conditions existantes favorisent légèrement Venus aux dépens de Spisula.
BIBLIOGRAPHIE SOMMAIRE : Bakalem A., 1979. Thèse 3e cycle, U.B.O., 288 p. Bakalem A., 1981. Pelagos 6(1) : 165-220. Bakalem A., Hassam N., Mohammedi M., Oulmi Y.et Romano J.C., 1988. Rapp.Comm.int.Mer Medit., 31(2) : 167

B

Etude Spatio-Temporelle des Mollusques des sables fins de la Baie d'Alger

A. BAKALEM, F. BOUDJERRA, J.-C. ROMANO et A.-L. YAGOUBI

ISMAL, BP 90 Alger-1er Novembre (Algérie)

INTRODUCTION : Les sables fins de la baie d'Alger ont le peuplement macrobenthique le plus riche qualitativement et quantitativement (1). Ce peuplement, soumis de plus en plus à des perturbations ayant pour origine l'agglomération algéroise, est étudié depuis 1976 aussi bien sur le plan spatial que temporel, afin de connaître son évolution et de là préciser l'impact de la ville d'Alger sur la baie d'Alger (3). Au sein de ce peuplement les Polychètes et les Mollusques sont les groupes zoologiques principaux. Sur le plan quantitatif (densité, biomasse), les Mollusques dominent ; de ce fait nous avons étudié leur évolution spatio-temporelle et préciser leur importance dans le peuplement des sables fins de la baie d'Alger.

MATERIEL ET METHODES : De novembre 1984 à septembre 1986 quatre stations (-10 m) : H, O, F et B, des sables fins de la baie d'Alger, ont été prospectées. A chaque station 16 prélèvements, de 1 m2 chacun, ont été effectuée à la benne Van Veen. Les caractéristiques des stations ont été exposées dans des travaux antérieurs (2) (3). Pour le calcul de la biomasse nous avons eu recours à la relation taille-poids établie par Bakalem (1979) pour Venus gallina, Spisula subtruncata, Acanthocardia tuberculata, Pandora inaequivalvis et Nassa mutabilis et à la méthode de décalcification pour les autres espèces. La biomasse (en poids sec) est exprimée en g/m2 et la densité en nombre d'individus/m2 (ind./m2).

RESULTATS : Station H : 44 espèces, se répartissent ainsi : 32 Bivalves, 10 Gasteropodes et 2 Opisthobranches. Le nombre d'espèces à partir de décembre 1985 est très supérieur à celui antérieur à cette date. Le maximum d'espèces (26) est noté en mars 1986, le minimum (7) en février 1985. Les fluctuations quantitatives sont irrégulières et d'amplitude élevée. Les densités, à partir d'octobre 1985 sont plus grandes que celles des mois antérieurs. Les fortes densités se notent à la fin de l'hiver et au printemps (maximum en juin 1986 : 1799 ind./m2), période de recrutement, dont l'importance diffère selon les années. Les faibles densités se situent à la fin de l'automne et en hiver (minimum en février 1985 : 99 ind./m2). Les variations de la biomasse très irrégulières suivent celles de la densité. La biomasse élevée aux périodes de recrutement (maximum 28,28 g/m2 en mars 1986) et à la fin de l'été (maximum 31,54 g/m2 en septembre 1986), est faible en été (minimum 2,98 g/m2 en juillet 1985). Ces fluctuations sont dues à : Venus gallina, Spisula subtruncata et Dosinia lupinus. En effectifs, Spisula domine, sur le plan de la biomasse c'est Venus. A ces espèces s'ajoutent les espèces : Venerupis texturatus, Abra alba, Acanthocardia tuberculata, Corbula gibba, Donax semistriatus, Mactra corallina, Pharus legumen, Tellina distorta et T. pulchella, Nassa mutabilis et N. reticulata.

Station O : Il a été dénombré : 29 Bivalves, 10 Gasteropodes et 1 Scaphopode, soit 40 espèces, le maximum d'espèces (24) se situe en octobre 1985 et le minimum (10) en décembre 1984. Les fluctuations des effectifs sont fortes et irrégulières, à partir de septembre 1985 où des densités élevées sont notées (maximum en juin 1986: 2497 ind./m2). Les faibles densités s'observent en hiver et été (minimum 71 ind./m2 en juillet 1985). Au printemps et en automne, les effectifs sont grands. La biomasse, importante en novembre et décembre 1984, respectivement 50,29 et 50,99 g/m2, décroît de façon irrégulière jusqu'en juin 1986, avec une valeur minimale (3,55 g/m2) en juillet 1985, puis augmente en septembre 1986 (25,86 g/m2). La station O présente les plus fortes biomasses en automne et hiver. Les valeurs élevées, et les fluctuations, de la densité et biomasse sont dues à Venus et Spisula accompagnées de Dosinia lupinus, espèces constantes, les autres espèces principales sont : Venerupis texturatus, Abra alba, Donax semistriatus, Mactra corallina, Pandora inaequivalvis, Pharus legumen, Tellina pulchella, T. distorta et T. tenuis.

Station F : Le nombre d'espèces fluctue entre 9 (février 1985) et 22 (septembre 1986), soit 41 espèces inventoriées (32 Bivalves, 5 Gasteropodes et 2 Scaphopodes). Le maximun d'espèces est enregistré à partir d'octobre 1985 et le maximum de Gasteropodes (5) en septembre 1986. Les densités de juin à septembre 1986 sont supérieures à celles de novembre 1984 à mars 1986 période où les fluctuations faibles présentent un aspect "en dents de scie", avant d'augmenter considérablement en juin (densité maximale : 2318 ind./m2) et septembre 1986 (1624 ind./m2). Les faibles effectifs existent en hiver et été, les autres saisons ils sont à leurs valeurs maximales. La biomasse décroit de façon irrégulière de décembre 1984 (40,2 g/m2) à mars 1986 (7,11 g/m2, valeur minimale), à partir de ce mois elle augmente jusqu'à une valeur maximale (52,67 g/m2) en septembre 1986. Les fortes densités sont dues à Spisula, et la biomasse maximale à Spisula et Acanthocardia tuberculata ; à l'origine des fortes densités et biomasses les autres mois c'est Venus. Les autres espèces contribuant de façon notable aux valeurs de la densité et biomasse sont les mêmes que celles de la station O.

Station B : 30 Bivalves, 8 Gasteropodes et un Opisthobranche sont inventoriés. De novembre 1984 à février 1985 le nombre d'espèce minimal (9 à 10), augmente les mois suivants de façon irrégulière jusqu'à un maximum (20) en septembre 1986. Les variations quantitatives sont peu élevées. Les fortes densités de novembre 1984 à avril 1985, diminuent de manière irrégulière jusqu'en juin 1986 (160 ind./m2) ; en septembre 1986 la densité devient maximale (401 ind./m2), en septembre 1985 elle est minimale (69 ind./m2). La biomasse diminue et augmente alternativement de novembre 1984 à juillet 1985, passant par un maximum (52,09 g/m2) en avril, ensuite chute à 12,15 g/m2 en décembre 1985. L'augmentation de mars 1986 (27,04 g/m2) est suivie d'une forte diminution en juin et septembre 1986 période où la biomasse est minimale (8,78 g/m2). L'abondance des Mollusques dans le temps est due à Venus, Dosinia lupinus, Donax semistriatus, Tellina pulchella et Venerupis texturatus ; à ces espèces s'ajoute en juin et septembre 1986 Spisula. De novembre 1984 à décembre 1985, Venus contribue très largement à la biomasse ; Acanthocardia tuberculata y contribue aussi quand elle existe grâce à ses biomasses élevées en mars et septembre 1986 avec respectivement 25,57 et 9,32 g/m2 ; Dosinia lupinus, espèce constante s'ajoute à ces espèces mais ses biomasses sont faibles sauf en juin 1986 (la plus forte 5,32 g/m2).

DISCUSSION ET CONCLUSION : La station H a une plus grande richesse spécifique que les autres stations ayant un nombre d'espèces presque identique. En général à toutes les stations le nombre d'espèces et la densité à partir de septembre 1985 sont plus importants. L'abondance classe par ordre d'importance décroissant les stations ainsi: O, F, H et B. Si les écarts d'effectifs entre les trois premières sont relativement faibles, ils sont élevés entre ces 3 stations et la station B. Les fortes densités s'observent au printemps et en automne et les maxima en juin 1986 aux stations H, F et O, et en septembre 1986 à la B. La station B se classe en tête par ses fortes biomasses, suivie par O, F et H. A ces trois dernières stations la biomasse évolue sensiblement de la même façon, avec des variations notables dans le temps. De l'étude deux périodes se dégagent : - novembre 1984 à septembre 1985 : . stations O et F avec un nombre d'espèces et des densités faibles mais des biomasses élevées ; . station B avec un nombre d'espèces, des densités et biomasses élevées . station H a un nombre d'espèces, des densités et biomasses faibles.

- octobre 1985 à septembre 1986 : où la situation aux stations est totalement l'inverse de la précédente.

Les variations des densités ont pour origine Spisula associée à Venus gallina, Dosinia lupinus, Nassa mutabilis et Abra alba à la station H ; Venus accompagnée de Spisula, Dosinia, Mactra corallina et Abra alba aux stations F et O ; et associée à Donax semistriatus, Dosinia et Tellina pulchella à la station B. Les fortes biomasses et leurs fluctuations sont dues à Venus et Spisula aux stations H et O et à la station F où s'ajoutent Acanthocardia tuberculata, Dosinia et Mactra. Ces trois dernières espèces associées à Donax semistriatus contribuent avec Venus aux biomasses élevées, et leurs fluctuations, de la station B. Nous constatons que d'une année à une autre les fluctuations qualitatives et quantitatives des Mollusques sont irrégulières et importantes. Cela semble être dû aux conditions et à la stabilité écologiques du milieu. Il a été mis en évidence pour ce peuplement des perturbations notables dues aux rejets d'eaux usées urbains (3). Ainsi l'instabilité grande à la station H, décroit de la station O à la station B (la moins perturbée) en passant par la station F. Cette instabilité explique les variations qualitatives et quantitatives observées : importantes aux stations H et O, les plus perturbées, relativement faibles à la station B où la stabilité écologique est grande. la station F semble occuper une position intermédiaire.

BIBLIOGRAPHIE SOMMAIRE : (1) Bakalem A., 1979. 3e cycle U.B.O., 288 p. - (2) Bakalem A., 1981. Pelagos 6(2): 118-165 - (3) Bakalem A., Hassam N., Mohammedi M., Oulmi Y. et Romano J.C., 1988. Rapp.Comm.int.Mer Medit., 31(2) : 167

Size at sexual maturity for males of *Nephrops norvegicus* (L.) in the Northern Tyrrhenian Sea

Franco BIAGI* , Stefano DE RANIERI* and Mario MORI**

*Dipartimento Scienze Ambiente e Territorio, via A. Volta 6, 56100 Pisa (Italia)
**Istituto Anatomia Comparata, V. le Benedetto XV, 5, 16132 Genova (Italia)

Size at sexual maturity is basic information required for managing the harvest of a species of decapods (SOMERTON, 1980).

Most work on the size at sexual maturity of N. norvegicus has regarded the females, while there are fewer studies on males (FARMER, 1974; SARDA' et al., 1981). Male maturity can be determined either by histological examination of the gonads or by morphometric data since many authors have recognized that many decapod species may change shape at maturity (BROWN & POWELL, 1972; HARTNOLL, 1978). All specimens examined in this work were collected from March to June 1986.

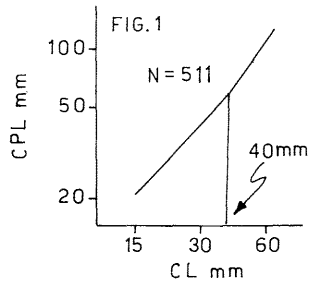
As for histological inspection we observed the presence of the spermatophore in each deferens duct, starting from 27 mm carapace length (CL). This result is in agreement with the observations of STORROW (1912) and FARMER (1974).

As it is known (HARTNOLL, 1978) the large chelipeds are primarily for sexual display and dominance. According to FARMER (1974) in most of Norway lobster juveniles the allometric growth of the chelae changes at sexual maturity . Therefore we have analyzed the relative growth of the crusher propodite length (CPL) vs. CL, using SOMERTON & MacINTOSH's (1983) computer program "Mature2".

FARMER (1974) found the change of allometry at 26 mm CL. SARDA' et al. (1981) also estimated the onset of sexual maturity of the males to be at 27 mm CL and found a further change in the relative growth rate at 40 mm CL.

On the contrary our analysis did not reveal any allometric change around 27 mm CL, while it was shown at 40 mm CL (Fig. 1). All the 511 points have not been drawn for the sake of clarity.

Thus the size at maturity onset obtained by our histological examination and the size at which there is a change in allometry do not agree but, as stated by AIKEN & WADDY (1980), two aspects of maturity must be considered in the Norway lobster male: physiological maturity, where the lobster is capable of producing mature spermatozoa, and functional maturity where, given a reasonable opportunity, the male is capable of mating with and inseminating a female. Whether the small males of lobster are capable of mating with females is a question that has not been properly investigated. This problem has been recognized in crabs as well (MORI, 1986). Observations in aquarium could probably clarify this aspect.



REFERENCES

AIKEN D.E. & S.L. WADDY, 1980. Reproductive biology: 215-276. In "The biology and management of lobsters" Eds. J.S.Cobb & B.F. Phillips. Academic Press, N.Y.

BROWN R. B.& G. C. POWELL, 1972. Size at maturity in the male Alaskan tanner crab Chionoecetes bairdi as determined by chela allometry, reproductive tract weight and size of precopulatory males. J. Fish. Res. Board Can., 29: 423-427.

FARMER A. S., 1974. Relative growth in Nephrops norvegicus (L.) (Decapoda: Nephropidae). Jour. nat. Hist., 8: 605-620.

HARTNOLL R. G., 1978. The determination of relative growth in crustacea. Crustaceana, 34: 281-293.

MORI M., 1986. Observations on the reproductive biology of Medorippe lanata (Crustacea:Decapoda:Dorippidae) in the Gulf of Genoa. Oebalia, 13 n.s.: 77-87.

SARDA' F., L. M. MIRALLES & I. PALOMERA, 1981. Morfometría de Nephrops norvegicus (L.) del mar catalán. Invest. Pesq., 45 (2): 279-290.

SOMERTON D. A., 1980. A computer technique for estimating the size of sexual maturity in crabs. Can. Jour. Fish. Aquat. Sci., 37: 1488-1494.

SOMERTON D. A. & R. A. MacINTOSH, 1983. The size at sexual maturity of blue king crab, Paralithodes platypus, in Alaska. Fish. Bull., 81: 621-628.

STORROW R., 1912. The prawn (Norway lobster, Nephrops norvegicus), and the prawn fishery of North Shields. Rep. Dove Mar. Lab., 2: 9-12. (Not Seen).

B-V2

Reproductive Biology of the Females of *Nephrops norvegicus* in the Northern Tyrrhenian Sea

Franco BIAGI*, Stefano DE RANIERI* and Mario MORI**

*Dipartimento Scienze Ambiente e Territorio, via A. Volta 6, 56100 Pisa (Italia)
**Istituto Anatomia Comparata, V. le Benedetto XV, 5, 16132 Genova (Italia)

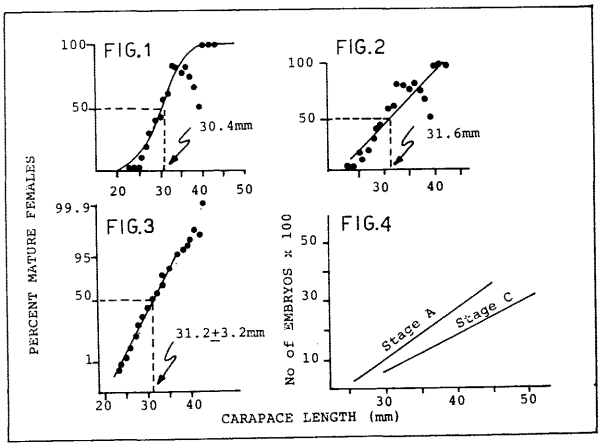
During research trawl surveys carried out in the Northern Tyrrhenian Sea, between the Isles of Elba and Giannutri, data on the reproductive biology of the females of N. norvegicus were collected. Here we report the results from the analysis of the data gathered in 1986/87.

Range size. The carapace length (CL) ranged between 10 and 55 mm. The CL seasonal frequency distributions were essentially unimodal with modal class between 27 and 33 mm CL. Size at sexual maturity. Size at 50% maturity was estimated, on samples caught at September 1986, using three methods: a) fitting the logistic equation, by using non-linear least squares, to percentage of the data classified as mature females by size (DRAPER & SMITH, 1981) (Fig. 1); b) by regressing CL on the percentage of mature females by size (WATSON, 1969) (Fig. 2); c) using a probability paper, on which cumulative percentage of mature females is shown for each size class (WENNER et al., 1974) (Fig. 3). Mature females were considered both those with dark green ovaries and ovigerous ones. All the three methods gave similar estimates of the size at 50% maturity. Our estimates of the size of sexual maturity are similar to those known for other areas of the Mediterranean Sea (FROGLIA & GRAMITTO, 1981; ORSI RELINI & RELINI, 1989). The slight differences among authors could arise either from having included, among mature females, specimens in different maturity stages or from having fitted the logistic curve by different methods. Spawning season. Most mature females spawn yearly. Females with mature ovaries (green and dark green) predominated in late spring catches and were found up to December. Most females with embryos, in agreement with the observations of FROGLIA & GRAMITTO (1981) for the Adriatic Sea, were present from August to February but single specimens were observed up to late Spring (May). Moulting frequency. Moulting of the females occurred throughout the year with monthly percentage floating between 9 - 18% reaching, however, peaks of 27-32% between April and July. Fecundity. The size-fecundity relationships have been calculated separately both for females carrying embryos at stage A and females with embryos at stage C, classified according to FIGUEIREDO & BARRACA (1963). The linear function was adopted to represent the size-fecundity relationships, since it fitted the data set better than the power function (Fig. 4). The ANOVA was used to determine whether the size-fecundity relationships differ between the two groups of females.

Stage A: N = 92; r = 0.902; Y = 181.65 X - 4426.2

Stage C: N = 29; r = 0.865; Y = 128.41 X - 3208.8

The slopes differ significantly (F=20.1; P<0.01) and there is a loss of embryos during the incubation that seems to be directly related to lobster size. Instead MORIZUR et al. (1981) observed a costant loss of 45% for the Norway lobster of the Bay of Biscay.



REFERENCES

DRAPER N.R. & H.SMITH, 1981. Applied regression analysis. Wiley & Sons, N.Y., 407 pp.

FARMER A.S.D., 1975. FAO Fishery Synopsis, 112: 97 pp.

FIGUEIREDO M. J. & I. F. BARRACA, 1963. Not. E. Inst. Biol. Mar. Lisb., 28: 1-44.

FROGLIA C. & GRAMITTO M. E., 1981. FAO Fish Rep., 253: 165-178.

MORIZUR Y., G. CONAN, GUENOLE & M. H. OMNES, 1981. Mar. Biol. 63: 319-324.

ORSI RELINI L. & G. RELINI, 1989. In : Reproduction, Genetics and Distributions of marine organisms: 153-160. Olsen & Olsen, Fredensborg.

WATSON J., 1969. Can. Fish Rep., 13: 24-47.

WENNER A. M., C. FUSARO & A. OATEN, 1974. Can. J. Zool. 52(9): 1095-1106.

B-V3

Relative Growth of the Crusher Propodite of *Nephrops norvegicus* (L.) in the Northern Tyrrhenian Sea

Franco BIAGI*, Stefano DE RANIERI* and Mario MORI**

*Dipartimento Scienze Ambiente e Territorio, via A. Volta 6, 56100 Pisa (Italia)
**Istituto Anatomia Comparata, V. le Benedetto XV, 5, 16132 Genova (Italia)

B

Though a lot of research has dealt with the relative growth of N. norvegicus only few papers (FARMER, 1974; SARDA' et al., 1981; OBRADOVIC, 1988) have treated the relative growth of the crusher propodite in detail. The aim of this work is to look at the relations of carapace length to various crusher proportions in both sexes of N. norvegicus.

The morphometric study was carried out on the Norway lobsters collected in Spring 1986 in the area comprised between the Isles of Elba and Giannutri. The following measurements were taken by a vernier calliper to the nearest 0.1 mm: Carapace length (CL), from eye socket to the mid-posterior margin of the carapace; Crusher propodite length (CPL), the distance from the tip of the propodus to the articulation with the carpus; Crusher propodite width (CPW), width across the palm; Crusher propodite depth (CPD), depth of the palm measured at CPW level; Anderson cheliped index (CPV), volume index based on the product of CPL, CPW, and CPD divided by carapace length (AIKEN & WADDY, 1980). The various measurements were plotted vs. CL and analyzed according to FINNEY & ABELE (1981) (Tab.1), while comparisons between sexes are shown in Tab.2.

Tab.1 - Estimated parameters between CPL, CPW, CPD, CPV (Y) and CL (X) for both sexes. N = Number of specimens; range = carapace length (mm) range; a = intercept; b = slope; SE = standard error of the slope; AS = allometric status by testing the slope vs a standard of 1, $\alpha = 0.05$; + = positive allometry; 0 = isometry; r = correlation coefficient.

Sex	N	range	a	b	SE	AS	r
Males (CPL)	264	15-68	-0.02415	1.126275	0.01	+	0.990
Females (CPL)	118	13-51	0.12530	1.017720	0.01	0	0.986
Males (CPW)	264	15-68	-0.81021	1.245487	0.01	+	0.987
Females (CPW)	118	13-51	-0.75243	1.200911	0.02	+	0.983
Males (CPD)	264	15-68	-0.97279	1.267291	0.01	+	0.982
Females (CPD)	118	13-51	-0.95454	1.246804	0.02	+	0.971
Males (CPV)	264	15-68	-0.80716	2.639054	0.03		0.982
Females (CPV)	118	13-51	-0.58166	2.465437	0.04		0.977

Tab. 2 - Equality test, at same size range, between the relationships of both sexes N.S. = not significant; * = significant

	Comparisons of the slopes (b)		Comparisons of the intercepts assuming a common slope (b*)		
Groups	t	Statistical differences $\alpha = 0.05$	b*	t	Statistical differences $\alpha = 0.05$
(a) M - F (CPL)	2.88	*	-----	-----	-----
(b) M - F (CPW)	0.54	N.S.	1.193	0.06	N.S.
(c) M - F (CPD)	0.84	N.S.	1.217	0.11	N.S.
(d) M - F (CPV)	0.20	N.S.	2.483	0.23	N.S.

The significative difference between CPL-CL relationships of both sexes is in agreement with FARMER (1974), SARDA' et al. (1981), and OBRADOVIC (1988), though this last author takes into account the total length instead of CL. Contrary to SARDA' et al. (1981) and OBRADOVIC (1988) no significative difference is observed in CPW-CL and CPD-CL between sexes within the same size range. The results obtained by these authors could be due both their having use groups of specimens of different size ranges for comparison and because, at the biggest sizes of CL, greater than 40 mm, the males, show a marked change in the chelae allometry (BIAGI et al., 1990).

REFERENCES

AIKEN D.E. & S.L. WADDY, 1980. Reproductive biology.1: 215-276. In "The biology and management of lobsters" Eds. J.S.Cobb & B.F. Phillips. Academic Press,N.Y.

BIAGI F., S. DE RANIERI & M. MORI, 1990. Size at sexual maturity for males of Nephrops norvegicus (L.) of the North Tyrrhenian Sea (submitted).

FARMER A. S., 1974. Relative growth in Nephrops norvegicus (L.) (Decapoda: Nephropidae). Jour. nat. Hist., 8: 605-620.

FINNEY W. C. & L. G. ABELE, 1981. Allometric variation and sexual maturity in the obligate coral commensal Trapezia ferruginea Latreille (Decapoda, Xanthidae). Crustaceana, 41: 113-130.

OBRADOVIC J., 1988. Morphometric characters in Nephrops norvegicus (L.) from Adriatic (Vinodol Channel): growth differences in male and female chelipeds. Rapp. Comm. int. Mer Médit., 31(2): 11.

SARDA' F., L. M. MIRALLES & I. PALOMERA, 1981. Morfometría de Nephrops norvegicus (L.) del mar catalán. Invest. Pesq., 45 (2): 279-290.

Some Aspects of the Biology of Norway Lobster, *Nephrops norvegicus*, in the N. Euvoikos Gulf (Greece)

Ch. MYTILINEOU, C. PAPACONSTANTINOU and A. FOURTOUNI

National Centre for Marine Research, Hellenikon, 16604 Athens (Greece)

B

INTRODUCTION

Norway lobster (Nephrops norvegicus) is one of the most important species of Crustacea, with a high commercial value. However, no informations is available about its biology in the Greek Seas. Various topics of the life history of the species have been studied, but only few references are cited for the Mediterranean Sea. This work deals with the length-frequency distribution, age determination, the growth, the mortality and the reproduction of Norway lobster in the N. Euvoikos Gulf.

MATERIAL AND METHODS

A total of 3649 individuals of Norway lobster (1912 females, 1745 males) was collected at three month intervals, between September 1987 and June 1988, by a 400HP fishing trawler with a cod-end mesh size of 14mm between streched knots, in the N. Euvoikos Gulf. Total and carapace length to the nearest mm, weight to the nearest g, sex and berried females, were recorded. All analyses have been made separately for each sex. Age was determined from length-frequency distribution, using the method of BHATTACHARYA (1967). Growth parameters from length distribution and mortality from catch curve, have been estimated using respectively the Elefan I and II computer programs (GAYANILO et al., 1988).

RESULTS

The length-frequency diagram of Norway lobster was based on the carapace length separately for each sex (Fig. 1). The female carapace length range was 17-63mm, and the male 16-72mm. Young-of-the-year, of both sexes appeared as recruits in February and remained present till September. The September length frequency distribution of females was used for age determination, according to the Bhattacharya method and applying the Compleat Elefan computer program. The above identified year classes could be considered as age groups. Table I shows the age groups of female and male Norway lobster, their mean length and the separation index, necessary to indicate that the groups are meaningfully different. Eight and nine age groups respectively for females and males were identified.

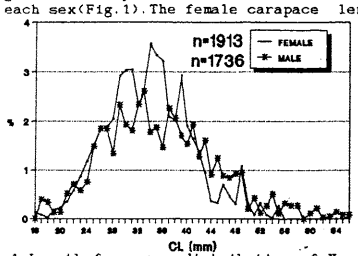


Fig. 1 Length-frequency distribution of Norway lobster in N. Euvoikos Gulf between September 1987 and June 1988.

The carapace (CL) and total length (TL) relationship was found for female: CL= 0.11+0.3XTL and male: CL=-1.88+0.32XTL. The length-weight relationship was calculated for female: $W=0.00083XCL^{2.962}$ and male: $W=0.00052XCL^{3.095}$, (where W in g). The growth parameters of the von BERTALANFFY equation, estimated by the Elefan I computer program were:
Female: $L_{\infty}=71/258*$ mm, k=0.13/0.11*, t_o=-1.39/-1.6*, Rn=0.27/0.36*
Male: $L_{\infty}=84/317*$ mm, k=0.06/0.1*, t_o=-2.98/-0.88*, Rn=0.26/0.42*
where Rn: is the goodness of fit index ranging between 0<Rn<1, (*): estimation has been done in TL. The GULLAND (1969) formula was used to calculated t_o. The estimtion of total (Z), natural (M) and fishing (F) mortality, based on TL, gave for female: Z=0.904, M=0.293, F=0.611 and for male: Z=0.928, M=0.263, F=0.665. The mortality estimations, based on CL, did not provide representative values of the fisheries status of the area.

TABLE I. Age groups of female and male Norway lobster determined by the BHATTACHARYA method.

	Female		Male	
Group	Separation index	Mean length(mm)	Separation index	Mean length(mm)
1	-	20.17	-	16.50
2	2.79	25.39	4.11	21.87
3	3.37	29.81	4.04	26.34
4	3.71	34.16	3.00	29.77
5	3.64	37.74	3.43	32.94
6	3.21	40.86	4.37	37.91
7	5.79	46.19	3.17	42.69
8	2.70	49.64	2.63	46.70
9			3.87	50.88

Norway lobster in the N. Euvoikos Gulf, appearing in waters deeper than 60m, showed its maximum presence in 100-200m depth range. The analyses of the sex ratio in the total sample of the Norway lobster, showed that female had almost the same proportions with male (o:o=1:1.01). However, the above sex ratio presented seasonal fluctuations. The distribution of sex ratio related with length showed that the proportion of both sexes remained about 1:1. After 42 mm (CL) the percentage increase in favor of the male, while after 56mm the female disappeared. The maximum percentage of berried females was observed in September and December, while the minimum in June. Berried females appeared from 29mm and the length at first maturity was 39mm (CL).

CONCLUSIONS

The Norway lobster sampled in the N. Euvoikos Gulf presented a slow growth pattern. Futhermore, differences between sexes were observed. Eight age groups for female and nine for male were determined. During the first year of life, females reached greater lengths than males. Males presented a higher longevity than females, as proved by the larger observed lengths, as well as the estimated asymptotic length.

REFERENCES.

BHATTACHARYA, C.G., 1967. Biometrics, 23: 115-135
GAYANILO, F.C., J.M. SORIANO & D. PAULY, 1988. ICLARM, Software 2, 66p.
GULLAND, J.A., 1969. Manuels FAO de Science Halieutique, 4, 160p.

Note on the Autecology of the Spider Crab *Macropodia rostrata*

Zdravko STEVCIC

Rudjer Boskovic Institute, Center for Marine Research, 52210 Rovinj (Yugoslavia)

The spider crab *Macropodia rostrata* (Linnaeus, 1761) is a quite common species in the northern Adriatic Sea. However, little has been published on its ecology. There exists only very little information concerning its vertical and horizontal distribution, substrate preference and reproductive period (GRAEFFE, 1902; PESTA, 1918; VATOVA, 1928). The main reason for the lack of information is due to its dispersion in the area. It was sampled constantly, but usually in a small number of specimens so that intensive autecological investigations were not possible. During my studies of decapod fauna in some bays in the Rovinj area (Saline, Leso, Ruja) I sampled a sufficient number of specimens to provide some inferences on species autecology. The crabs were collected monthly by a mušular (local type of dredge), preserved in 4% solution of formol and later studied in the laboratory.

Measurements. Maximum carapace length in the male was 24.5 mm and width 12.6 mm. The female maximum carapace length was 24.9 and width 13.2 mm. The minimum size of ovigerous females was 11.0 mm for carapace length, and 7.4 mm for carapace width.

Sex ratio. Among 196 sampled specimens 104 were males and 92 females. Thus, the sex ratio is 1.12.

Colour. The carapace and pereiopods of captured specimens were yellowish -brown, greyish-brown or greenish-brown. The specimens were usually not camouflaged with algae.

Occurrence. In the study area the crabs were variously abundant in season samples. They are frequent from November to April-May, with a maximum abundance during February and March. On the other hand, during summer months they were only rarely sampled, whereas in July and August were completely absent. However, the observations of VATOVA (1928) as well as our investigations show that the crab can be found, in particular during summer, throughout the entire area. From these data it can be concluded that *Macropodia rostrata* performs seasonal inshore-offshore migrations.

Substrate. In the studied localities the crab occurs in sea-grass (*Zostera, Cymodocea*) beds together with several algal species. In summer it can be found on various bottom types. VATOVA (1928) established that it preferes the stony bottom covered with algae and avoids soft mud. Being a migratory species it passes various types of substrate.

Depth. In the above-mentioned bays where it was collected the depth varied from about 1.5 to 4 metres, also in very shallow water. VATOVA (1928) reported the species from 10 to 36 metres. In the Adriatic Sea it was recorded from tidal flats down to 190 metres.

Reproduction period. PESTA (1918) reported that ovigerous females can be found from February to June. In the present research the ovigerous females were collected from the beginning of January to the mid of June. The number of larvae hatching has not been established.

Moulting period. The moulting period was estimated indirectly according to the hardness of the exoskeleton. Crabs with soft integument have been recorded from November to March, in particular in January, and only once in June.

Foregut fullness. From 142 specimens which foregut (stomach) was examined, 23 foreguts were empty. In the remaining 119 specimens the degree of fullness expressed in percentages is presented in the following table:

Percentage of fullness	No	Percentage of fullness	No
01-10	9	51- 60	8
11-20	20	61- 70	11
21-30	26	71- 80	13
31-40	13	81- 90	9
41-50	9	91-100	1

Thus, the majority of specimens at the time of capture were with a low percentage of foregut fullness.

Food composition. The analysis of food types eaten shows that crabs feed on various food items. It is noteworthy that the composition of the foregut contents is very difficult to identify because the content of the foregut is reduced to small fragments by the action of mouth parts and gastric mill. The most frequent component of the foregut content are sand particles (62 times), which in all probability are not used directly as a food. From the matter used for food by the crab for the great part (58 times) it was impossible to identify the origin. It refers to organic remnants including unrecognizable tissue or only amorphous particles of plant or animal origin. Algae (mostly filamentous green and others) were recorded 47 times. Thereafter follow the Crustaceans (mostly Natantia, and rarely also Anomura, Ostracoda, Mysidacea and Amphipoda) found 17 times. According to frequency next are higher plants (in particular marine Potamogetonaceae) 14 times, Polychaeta 12 times and Bivalvia 11 times. Unrecognizable, very finely destructed organic particles like detritus were recorded 11 times. Finally, the remnants of fishes were found only twice. From the mentioned components it is clear that *Macropodia rostrata* is an opportunistic omnivore, which feeds on benthic macroflora and macrofauna, predominantly on sessile or slow-moving organisms and only exceptionally on more active animals such as Crustaceans. This property is in accordance with its slow motion. According to RASMUSSEN (1973) the species feeds also on planktonic organisms. In the present research it was not possible to identify the remnants of holoplanktonic organisms in the stomach.
It is worthy to note that our results mostly agree with those obtained in other areas of distribution (MORI and MANCONI, 1987).

REFERENCES

GRAEFFE, E., 1902. Uebersicht der Fauna des Golfes von Triest. V. Crustacea. Arbeit. zool. Inst. Univ. Wien., 13 (1): 33-80.

MORI, M., MANCONI, R., 1987 (1989) Note sulla biologia di *Macropodia rostrata* (L.) del Golfo di Genova (Mar Ligure). Boll. Mus. Ist. Univ. Genova, 53: 57-68.

PESTA, O., 1918. Die Decapodenfauna der Adria. Versuch einer Monographie. Deuticke, Leipzig und Wien, 500 p.

RASMUSSEN, E., 1973. Systematics and ecology of the Isefjord marine fauna (Denmark). Ophelia. 11: 1-507.

VATOVA, A., 1928. Compendio della flora e fauna del Mare Adriatico presso Rovigno. Mem. R. Com. talassogr. ital., 143: 1-614.

B-V6

Comparative Size Distribution and Feeding Ecology of *Polycheles typhlops* and *Stereomastis sculpta* (Decapoda, Polychelidae) in the Mediterranean Bathyal Mud Assemblage

J.-E. CARTES and P. ABELLO

Institut de Ciències del Mar, Passeig Nacional, 08003 Barcelona (Spain)

Polycheles typhlops Heller, 1862 and Stereomastis sculpta (S.I. Smith, 1880), occur in the northwestern Mediterranean as characteristic species of the slope and bathyal basin (ABELLO & VALLADARES, 1988). Santucci (1932) stated that P. typhlops acted as a necrofagous species. However, Lagardère (1977) described it as a predator of bathypelagic crustaceans in the Bay of Biscay. The same author, from the foregut contents analysis of a few individuals, supposed that the diet of S. sculpta must be close to that of P. typhlops.

Three different kinds of bottom trawls were used: commercial demersal trawl nets equipped with a 6 mm mesh size codend, a modified Agassiz trawl, and a Marinovich deep-water bottom trawls. Codend mesh size was of 6 mm in all the different fishing gear used.

A total of 1869 individuals of S. sculpta and 736 of P. typhlops were studied. Sex, size (carapace length) and occurrence of ovigerous females were noted in every sample taken. Foregut contents of 168 P. typhlops (127 from the upper slope and 41 from the lower slope), and 153 S. sculpta from the bathyal basin were analysed. Prey item were identified to the lowest possible taxonomic level. Foregut contents were quantified: occurrence and relative abundance of preys were calculated.

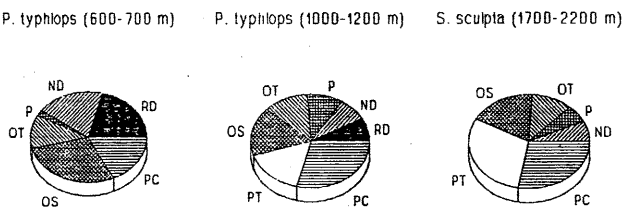
The size range of Polycheles typhlops and Stereomastis sculpta was very similar. Size ranges of males and females were very similar in S. sculpta, whereas in P. typhlops males are clearly smaller than females.

Sizes of P. typhlops showed a general tendency to decrease with increasing depth. Ovigerous females were more abundant in the upper distribution levels of the species. Recruitment apparently takes place at the deepest levels of the species distribution range, where almost exclusively only juvenile individuals are found. This tendency shows an inverse pattern to that of most littoral and shallow water decapods, in which recruitment usually takes place in shallower waters.

S. sculpta did not apparently show any clear tendency in its size distribution in relation to depth. The largest individuals and the ovigerous females occurred mainly between 1900-2200 m.

The diet of the two species of Polychelidae studied is mainly based on the capture of small epibenthic peracarid crustaceans and other preys such as polychaetes and small decapods (Plesionika acanthonotus, Pontophilus norvegicus): Scavenging is also important. Thus, we can find remains of large decapod crustaceans (Aristeus antennatus), cephalopods (Histioteuthis) or fish. Bathypelagic crustaceans (euphausiids, Pasiphaea, Sergestidae), basis of their diet according to Lagardère (1977) seem to have only a seasonal importance, and are restricted to the upper slope (500-700 m).

In the upper slope, burrowing crustaceans (Calocaris macandreae and Alpheus glaber) are also important in the diet and constitute about 20 % of the diet. They disappear in deeper areas. Detritus of pelagic origin, such as pteropod remains (Clio pyramidata, Cavolinia) and globular foraminiferans (Globorotalia, Orbulina, Globigerinoides) also constitute an important part of the diet in areas deeper than 1000 m in the two species studied. Foraminiferans, not quantified as relative abundance values in this study, occur more frequently in areas deeper than 1000 m (40 % in P. typhlops and 60% in S. sculpta), whereas in the upper slope their occurrence shows very small values (5 % in P. typhlops).



- Comparative diets of Polychelidae. RD: Reptantia decapods; ND: Natantia decapods; P: Polychaetes; OT: Others; O: Osteychthyes; PT: pteropods; PC: Peracarid crustaceans

REFERENCES

Abelló, P. & F.J. Valladares. 1988. Bathyal decapod crustaceans of the Catalan Sea (N.W. Mediterranean). Mésogée, 48: 97-102.

Lagardère, J.P. 1977. Recherches sur la distribution verticale et sur l'alimentation des crustacès dècapodès benthiques de la Pente Continetale du Golfe de Gascogne. Bull. Cent. Etud. Rech. sci. Biarritz, 11 (4): 367-440.

Santucci, R. 1933. Biologia del fondo a "Scampi" nel Mare Ligure. I. - Polycheles typhlops Heller. R. Comit. Talassograf. Ital. Mem. 199: 1-48

B-V7

Contribution to the knowledge of the accompaning fauna of *Aristeus antennatus* (Risso, 1816) on the bathyal bottoms in the S.E. of Spain

P. MARTINEZ BANO*, F. VIZUETE*, J. MAS** and F. FARACO*

*Consejeria de Agricultura, Ganaderia y Pesca de la Region de Murcia. Servicio de Pesca y Acuicultura, Plaza San Francisco, 1-1°. 30201-Cartegena. Murcia (Espana)

*Instituto Espanol de Oceanografia. Aptdo. Correos n°22. 30740- San Pedro del Pinatar. Murcia (Espana)

B

On the epibathyal and mesobathyal bottoms of the continental talus of the S.E. of Spain, there are some fishing areas relatively abounding in Aristeus antennatus (Risso, 1816). Some samplings of the captures of A. antennatus have been achieved from 1.987 in these areas subjected to fishing exploitation, noting down the accompaning species which came up during the different trawling.

Later some experimental fisheries have been carried out in the same areas, with the usual mesh used in this fishery, joining firmly at the cod-end another thicker net, separating and identifying the different species. This has allowed to work out some faunistic lists indicating the abundance of each species.

The relations between A. antennatus and its possible predators and preys have been studied in several areas of the western Mediterranean: in the Liguarian Sea, RELINI ORSI AND WURTZ (1.977), RELINI AND ORSI RELINI (1987) and in the Catalan Coast CARTES AND SARDA (1989).

The first results obtained in the Spanish South-east are shown in this work, pointing out that in all the sampling areas the main species which show up on the thicker net are the following: Symphurus ligulatus and Symphurus nigrescens which mean between 5,5-9,5 cm., with a maximum of 6,5 cm. (28%). Several species of Mictophidae show up also, although in a slight proportion. The main crustaceans dominating are: Pasiphaea sivado, depending on the area it varies between 1,6% and 12% of the whole capture, being the cephalothorax length (Lc) of 9 and 21 mm. classes and a maximum of 15% in individuals of Lc= 19 mm., there are also some egged-females (Lc= 18 mm.) and Plesionika heterocarpus.

On the cod-end the main predators are: Scyliorhinus canicula and Galeus melastomus, the former was very abundant in the sampling area of less depth (275-400 mts.) representing 24% of the whole capture, the latter has a stea dier presence, the size has a wide range 10,5-61,5 cm., the higher percentages are in 13 and 14 cm. (17%).

Among the species of fishing interest A. antennatus stands out, its abundance in all the cases was over 50% of the whole capture of commercial spe cies. Among the fish Micromesistius poutassou is very abundant in the epibathyal area, the captured individuals are of 7-37 cm., although more than 50% of the whole of the sampling ones are between 16,5-19,5 cm. classes. On the mesobathyal bottoms Phycis blennoides has a steady presence, its capture has varied being sometimes 12%, these individuals fluctuate between 11-41 cm., corresponding those with a higher size to the deep areas (650 mts.), 52% of the sampling individuals are between 14-16,5 cm.. Another characteristic species is Helicolenus dactylopterus, being 85% of the examined individuals between 9,5-16,5 cm., corresponding the higher percentages (9,3%) to a whole length equal to 10,5 cm.

In this Table we show some species captured in the fishing areas of Aristeus antennatus:

FISH

Fam. Macrouridae
- Coelorhynchus coelorhynchus (Risso, 1810)
- Nezumia sclerorhynchus (Valenciennes, 1838)
- Trachyrhynchus trachyrhynchus (Risso, 1810)

Fam. Squalidae
- Etmopterus spinax (Linnaeus, 1758)

Fam. Scyliorhinidae
- Galeus melastomus (Rafinesque, 1810)
- Scyliorhinus canicula (Linnaeus, 1758)

Fam. Congridae
- Conger conger (Linnaeus, 1758)

Fam. Gadidae
- Micromesistius poutassou (Risso, 1826)
- Phycis blennoides (Brünich, 1768)
- Antonogadus megalokynodon (Kolombatovic, 1894)

Fam. Stomiidae
- Stomias boa (Risso, 1810)

Fam. Alepocephalidae
- Alepocephalus rostratus (Risso, 1820)

Fam. Trachichthyidae
- Hoplostethus mediterraneus (Cuvier, 1829)

CRUSTACEANS

Fam. Pandalidae
- Plesionika martia (A. Milne Edwards, 1883)
- Plesionika edwardsii (Brant, 1851)
- Plesionika gigliolii (Senna, 1903)

Fam. Polychelidae
- Polycheles typhlops Heller, 1862

Fam. Xanthidae
- Geryon longipes A. Milne Edwards, 1881

Fam. Homolidae
- Paramola cuvieri (Risso, 1816)

REFERENCES.

CARTES, J.E. and F. SARDA.- 1989. Feeding ecology of the deep-water Aristeus antennatus. Mar. Ecol. Prog. Ser., 54: 229-238.

RELINI, G. and L. ORSI RELINI.- 1987. The decline of red shrimps stocks in the gulf of Genoa. Inv. Pesq., 51 (Suppl. 1): 245-260.

RELINI ORSI; L. e M. WURTZ.- 1977. Aspetti della rete trofica batiale reguardanti Aristeus antennatus (Risso, 1816) (Crrustacea, Penaeidae), Atti IX Congr. Soc. Ital. Biol. Mar. Ischia, 389-398.

B

Annual Luminosity Cycle as a forecast factor in the Deep Prawn Fishery *Aristeus antennatus* (Risso, 1816) from the Catalan Area

R. TOBAR and F. SARDA

Instituto Ciencias del Mar. P° Nacional s/n. 08003 Barcelona (Spain)

INTRODUCTION

In order to analyse the prawn school movements and the efficiency of their captures, the authors set up the possibility of considering light factor (directly or undirectly) as the responsible variable of species activity in relation to its catchability. These aspects have been scarcely studied in Crustaceans. Only few references on Norway lobster are available.

The present work tries to relate the CPUE with a specific brightness threshold in terms of wich a seasonal model of capture-depth is established.

MATERIAL AND METHODS

The fishery data came from the daily captures of trawler that supplied: haul situation, yield (K/h), depth, starting-time and duration of haul. The schedule of the captures were always considered with respect to the official sunrise time (GPM) during the whole year. The calculus of a light factor (Lf) was proceeded, estimating it proportional to the light which theoreticaly reaches the bottom, by the following equation: Lf = Lo exp.(-k.m)
where Lo, is the subsuperficial light factor obtained from the solar declination and the refraction index (1.33 for the Mediterranean). K, is the extinction coeffecient of the light in water (0.026 for the Mediterranean) and m, is the depth in meters.

The light factor was calculated for each day of the year and each depth of capture from an annual table which considers sunrise time prepared for the latitude and longitude of the studied area. From this table different relationships were analysed jointly: maximum yields with haul time, depth, brightness intensity and effect of official time shift during the spring.

RESULTS

The existence of an optimum schedule for maximum yields can be deduced from the relationship between the mean CPUE and the difference of the haul time with respect to the sunrise and zenith. This maximum was situated between zero and two hours after sunrise and decreases as we move towards midday.

As the year goes on the brightness intensity increases and the hauls take place with higher superficial light for the same schedule, noticing an increase in the earlier yields. This was confirmed when the spring time shift occurs (last Sunday in March) which brings fowards one hour for fishing activity. In consequence when brightness conditions change, a significant difference between the mean captures fished before and after time shift are noticed.

The relationship between the haul depth and the time of first capture presents a high correlation. As the difference between the haul time and the sunrise increase, the depth of the first haul also increases. Major captures correspond to very low brightness values and take place during the first trawls of the day (captures bigger than 15 Kg/h do not exceed a 1.E-6 light factor). Meanwhile for the second haul of the day this magnitude triplicates its value and the corresponding yield is much lower.

CONCLUSIONS

- In the prawn fishery from the Catalan Mediterranean a maximum CPUE schedule exists during the first two hours after sunrise.

- This can be corroborated when the official time shift occurs during spring, noticing a significant difference between the captures obtained before and after this shift

- We can deduce that an optimum brightness threshold exists which influences the prawn's catchability.

- To maintain this threshold as the solar intensity varies whith the seasonal inclination, a change of the haul depth is needed with an annual cycle.

- From the preceding concepts it can be concluded that a good regulation measure can derive from displacing the fishing schedule only one hour, avoiding the maximum catchability time.

LITERATURE

CHAPMAN, C.J., 1980.- Ecology of Juvenile and Adult Nephrops. In: "The Biology and Management of Lobsters". vol. II. (J.S. Cobb and B.F. Phillips, Edrs.): 143-180. Academic Press. London.

KIRK, J.T.O., 1983.- Light and photosynthesis in aquatic ecosystems. Cambridge University Press. Cambridge:400 pp.

SARDA, F., and M. DEMESTRE, 1987.- Estudio bioecológico de la gamba Aristeus antennatus (Risso, 1816) en el mar Catalán (N.E. de España). Investigación Pesquera, 5 (Supl. 1): 213-232.

TOBAR, R and F. SARDA, 1987.- Análisis de las capturas de gamba rosada, Aristeus antennatus (Risso, 1816), en los últimos decenios en Cataluña. Insformes Técnicos. Instituto de Ciencias del Mar de Barcelona, 142: 1-20.

Données sur l'activité trophique et gonadique de *Paracentrotus lividus* (Lamarck) dans le Golfe de Tunis

Feriel SELLEM , Fredj KARTAS et Jeanne ZAOUALI

Laboratoire de Biologie et d'Ecologie littorale, Faculté des Sciences de Tunis- 1060 (Tunisie)

La méthode quantitative la plus généralement utilisée pour apprécier l'intensité de l'alimentation et les modalités de la reproduction de l'oursin Paracentrotus lividus consiste à analyser les variations temporelles de l'indice de réplétion IR et celles de l'indice gonadique IG; le premier étant défini comme le rapport du poids du tube digestif sur le diamètre du test au cube, le deuxième étant égal au rapport du poids de la gonade sur le diamètre du test au cube.

Deux stations du secteur sud-est du golfe de Tunis ont été prospectées; celle de Port Prince occupe un substrat dur couvert d'algues encroûtantes et profond de 4m, celle de Sidi Raïs correspond à un herbier clairsemé de posidonie situé à 6m de profondeur et à 150m du bord de la plage.

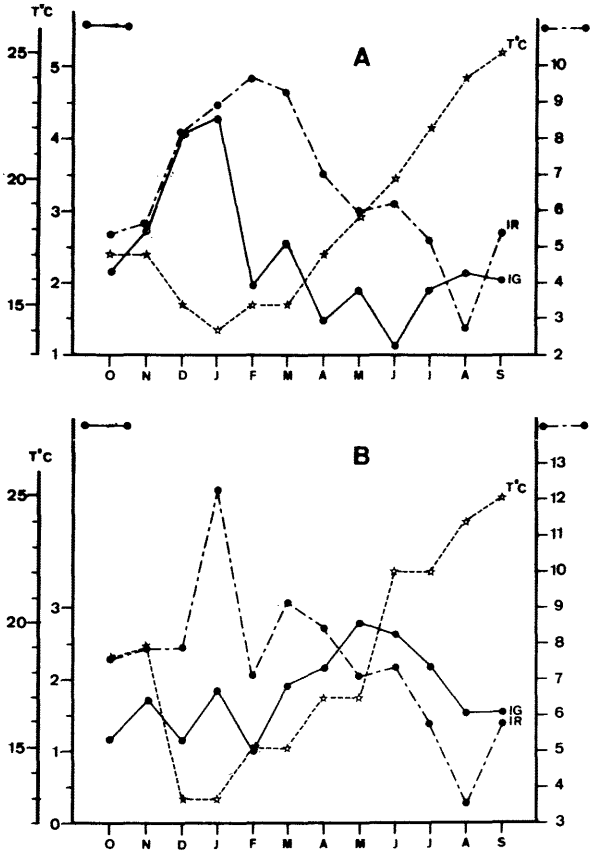
Des prélèvements mensuels, composés chacun de 40 à 90 individus de diamètre compris entre 30 et 60 mm, ont été effectués dans les deux stations durant une année (1988-1989), entre 11h et 13h. Le diamètre du test a été mesuré, sans les piquants, au 1/10mm, à l'aide d'un pied à coulisse. Le poids sec du tube digestif et de la gonade pris en compte est celui obtenu après un séjour de 24h de ces organes dans une étuve à 90°C. La température superficielle de l'eau a été notée à chaque prélèvement.

L'examen de la figure ci-dessous illustrant les résultats obtenus suggère les constatations suivantes:

S'agissant de l'indice de réplétion, il présente dans les deux stations de grandes similitudes que nous résumons comme suit:

- Une même grande amplitude de variation annuelle. Estimée à 7 à Port Prince, elle est comprise entre un minimum de 2,7 enregistré en août et un maximum de 9,7 en février. Elle est légèrement plus élevée à Sidi Rais (8,8) et oscille entre un minimum de 3,5 en août et un maximum de 12,3 en janvier.
- Une évolution synchrone en fonction du temps, avec une période de grand accroissement de IR allant d'août à février à Port Prince et d'août à janvier à Sidi Raïs et, une période de régression s'étalant de février à août à Port Prince et de janvier à août à Sidi Raïs.
- Une même relation inverse entre l'évolution annuelle de IR et celle de la température; au maximum de l'indice de réplétion correspond un minimum de température et vice versa.

Toutes ces observations mettent en évidence chez les deux populations d'oursins une phase d'activité trophique intense en hiver-printemps et une autre beaucoup plus réduite en été-automne.



Evolution des indices de réplétion (IR) et gonadique (IG) moyens mensuels de Paracentrotus lividus en fonction de la température (T°C) à Port Prince (A) et à Sidi Raïs (B).

Il en est autrement de l'indice gonadique dont les variations dans les deux stations diffèrent aussi bien par l'ampleur que par le déroulement du cycle. En effet, l'amplitude de variation annuelle de IG atteint à Port Prince la valeur de 3,2 et varie entre 1,1 en juin et 4,3 en janvier; elle est par contre, presque deux fois moins importante à Sidi Raïs (1,8) avec des valeurs extrêmes de 1,0 en février et 2,8 en mai. Ainsi, la population de Port Prince manifeste une activité gonadique nettement plus grande que celle de Sidi Raïs.

Quant aux variations annuelles de IG, elles sont complètement opposées dans les deux stations. A Port Prince, l'époque de grande maturation des gonades a lieu en novembre, décembre et janvier; l'émission principale des produits sexuels est rapide et s'effectue en février, elle est suivie d'autres émissions secondaires en avril et juin. A Sidi Raïs, le grand accroissement des gonades se produit de mars à juin. La ponte principale semble plus progressive et plus étalée dans le temps. Elle se déclenche en juin et se poursuit jusqu'en août; d'autres pontes de moindre importance s'effectuent en octobre, décembre et février.

Enfin, contrairement à ce qu'on observe chez la population de Sidi Raïs, celle de Port Prince se caractérise par une évolution annuelle presque parallèle des indices IG et IR.

B-V10

Données préliminaires sur la Population de *Paracentrotus lividus* de l'Etang d'Urbinu (Corse)

Catherine FERNANDEZ et Angela CALTAGIRONE

L.B.M.E.B., Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)

L'étang d'Urbinu se situe en Corse en bordure de la plaine orientale de l'île, entre Aleria et Ghisonaccia, à 7 km de l'embouchure du Tavignanu. Il a une superficie de 750 ha. Sa forme est presque circulaire, le diamètre varie entre 2,5 et 4 km. Il est séparé en deux par une presqu'île importante : "Isula Lunga". Les apports d'eau douce se font surtout sur le côté nord-ouest de l'étang par de très courts ruisseaux (DE CASABIANCA, 1966). La profondeur maximale est de 9 m au centre de l'étang. La température subit au cours de l'année de fortes fluctuations : elle peut varier de 6 à 33°C (COEURD'ACIER, 1987). Les fonds sont constitués de vase, de sable, de sédiments terrigènes ou coquilliers.

Neuf stations ont été étudiées, en Juin 1989. Dans chacune d'elles, nous avons étudié les populations de *Paracentrotus lividus* (Lamarck) en effectuant des mesures de densité le long de la côte. Celles-ci sont faites à l'aide d'un quadrat, de 1m de coté, jeté dix fois au hasard lors de nos trajets ; des diamètres d'oursins sont également mesurés, à l'ambitus, sans les radioles, grâce à un pied à coulisse (Tab I).

Tab I : Densité (nombre d'individus/m^2) et taille (diamètre du test à l'ambitus, sans les piquants) des *Paracentrotus lividus*, dans les différentes stations étudiées. La densité moyenne est la moyenne des dix densités observées dans chaque station ; la densité minimale est la plus petite densité observée dans chaque station ; la densité maximale est la plus grande densité observée dans chaque station.

Stations étudiées	Densité minimum (ind/m²)	Densité maximum (ind/m²)	Densité moyenne (ind/m²)	Tailles observées (cm)
A	5	10	7	3.0 à 4.0
B	5	20	10	2.5 à 4.0
C	10	35	20	1.5 à 3.5
D	0	5	3	1.5 à 2.5
E	20	30	28	1.5 à 2.5
F	25	30	28	1.5 à 4.0
G	0	2	0.2	4.0 à 4.2
H	60	100	80	1.0 à 4.6
I	0	0	0	—

Il existe bien une population de *P. lividus* inféodée à l'étang d'Urbinu ; celle-ci peut être très importante. La particularité de cette population est d'être de petite taille (taille maximale observée 4.6 cm). Le nanisme de *P. lividus* a également été signalé dans l'étang de Thau (SAN MARTIN, 1986) et dans l'étang de Berre (PICARD et LE ROCH, 1949) ; selon ces derniers auteurs, cela serait dû aux conditions de milieu plus changeantes qu'en mer ouverte. Nous remarquons que, dans les stations E et H, la majorité des individus sont de petite taille (1 à 2 cm de diamètre), ce qui nous permet de considérer ces stations comme des nurseries.

Dans l'étang d'Urbinu, on observe les oursins dans différents biotopes :

(i) Au bord des plages ; l'abondance *de P.lividus* pourrait être due au fait qu'ils y mangeraient les épaves de la phanérogame marine *Cymodocea nodosa* (Ucria) Ascherson provenant de l'herbier.

(ii) A la limite des herbiers à *Cymodocea nodosa* ou dans les herbiers peu denses ; deux explications sont possibles : soit les oursins restent à la limite de l'herbier car celui-ci consomme beaucoup d'oxygène durant la nuit, ce qui empêcherait les oursins de vivre à l'intérieur de l'herbier dense ; soit les oursins constitueraient un front qui avancerait et détruirait l'herbier au fur et à mesure.

(iii) Sur le fond sablo-vaseux ; les oursins sont posés sur le fond soit isolément, soit regroupés autour des épaves (bois, bouteilles, cailloux) et sont recouverts de coquilles de bivalves; ils se comportent alors comme des racleurs.

(iv) Sur les galets ; les oursins sont sur ou autour des galets et raclent la fine pellicule organique qui les recouvre.

(v) Sur les tables conchylicoles ; très peu d'oursins ont été observés dans ce biotope ; cela est dû au fait que les cordes conchylicoles de l'étang d'Urbinu sont très pauvres en macrophytes, contrairement à l'étang de Thau où celles-ci sont très riches en algues (GERBAL, 1985 ; SAN MARTIN, 1986).

Dans chaque type d'habitat, nous avons prélevé et disséqué 5 à 10 oursins. On constate en observant les gonades, que les oursins vivant au bord des herbiers ou sur les galets, possèdent des gonades très développées. Par contre, les oursins vivant sur les fonds sablo-vaseux ont des gonades très peu développées ou non apparentes. TRAER (1980) a montré que *Cymodocea nodosa* est une espèce très appréciée par *P.lividus*, et le bon développement des gonades des oursins qui s'en nourrissent en est sans doute la cause.

Cette étude montre que l'étang d'Urbinu héberge une importante population naturelle de *P. lividus*, ainsi que des nurseries et qu'il constitue donc un site favorable pour d'éventuelles expériences d'échinoculture. Cette étude préliminaire doit toutefois être approfondie ; notamment par une étude de la structure démographique, de la vitesse de croissance et par un suivi des populations tout au long d'un cycle annuel.

REMERCIEMENTS

Ce travail a été réalisé dans le cadre d'un stage de l'université de Corté (Corse) dirigé par Denise VIALE et le Professeur Charles F. BOUDOURESQUE. Nous tenons à remercier Luc BRONZINI, pour son aide sur le terrain et les informations qu'il nous a transmises.

BIBLIOGRAPHIE

DE CASABIANCA M.L., 1966. Etude des conditions écologiques dans les étangs de la plaine orientale de la Corse. Thèse de 3ème cycle d'écologie, Fac. Sci. Marseille, Fr. : 1-115.

COEURD'ACIER, 1987. Rapport. d'activité sur les étangs de Diana et d'Urbinu. IFREMER Santa Maria di Poggio, Fr. : 14-24.

GERBAL M, 1985. L'invasion de l'étang de Thau par les algues japonnaises, les peuplements à *Sargassum muticum* et la flore accompagnatrice. DEA d'écologie, Univ. Aix-Marseille III et Univ. Aix- Marseille II, Fr. : 1-63.

PICARD J. et LE ROCHS S., 1949. Les cnidaires épiphytes des Zostéra de la Méditerranée. Feuilles nat., N.S., Fr., 4 : 393-394.

SAN MARTIN G., 1986. Contribution à l'étude du comportement trophique de l'échinoïde *Paracentrotus lividus* dans l'étang de Thau (Hérault). Mem. DEA Océanologie, Univ. Aix Marseille II, Fac. Sci. Luminy, Fr. : 1-42.

TRAER K., 1980. The comsumption of *Posidonia oceanica* Delile by echinoides at the isle of Ischia. *In* Echinodermes : Present and past. Jangoux, M. Edit. Balkema publ., Rotterdam : 241-244.

B-V11

Croissance de l'Oursin *Paracentrotus lividus* en fonction de l'Algue consommée

Angela CALTAGIRONE*, Charles F. BOUDOURESQUE* et Michèle KNOEPFFLER-PEGUY**

*L.B.M.E.B., Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)
**Laboratoire Arago, 66650 Banyuls-sur-Mer (France)

Pour quantifier la croissance des échinoides, plusieurs méthodes ont été utilisées : analyse des stries d'accroissement des plaques coronales (AZZOLINA, 1988) ; quantification *in situ* en enclos (REGIS, 1978 ; AZZOLINA, 1988) ; élevage en aquarium (MILLIGAN, 1916 ; REGIS, 1978 ; CELLARIO et FENAUX, 1987 ; LE GALL, 1987). Les données sur la croissance *in situ* de *Paracentrotus lividus* (Lamarck) sont rares et peu concordantes. En Irlande, CRAPP et WILLIS (1975) donnent un âge de 4 ans environ pour des individus de taille commerciale (35-50 mm de diamètre). ALLAIN (1978) obtient des résultats comparables en Bretagne. REGIS (1978) observe une croissance beaucoup plus lente à Marseille ; un individu de 42 mm de diamètre aurait un âge minimum de 11 ans. Selon AZZOLINA (1988) les individus de 40 mm de diamètre sont âgés de 4 ans tandis que les individus de 50 mm ont près de 7 ans. En aquarium, LE GALL (1987) arrive en 2 ans seulement à la taille commerciale (40 mm). La croissance des oursins est conditionnée par différents facteurs biotiques (espèce consommée, quantité disponible) et abiotiques (température, salinité) (AZZOLINA,1988).

Dans la présente étude, on a voulu tester le taux de croissance du test (diamètre à l'ambitus sans les piquants), pendant une période de 18 mois (de Juin 1988 à Janvier 1990), de deux lots de *P. lividus* élevés en aquarium, en fonction de l'algue consommée. Les deux algues testées sont *Cystoseira mediterranea* Sauvageau et *Gelidium latifolium* Bornet et Thuret, la première étant une algue préférée (RICO, 1989) la deuxième une algue évitée (ODILE, 1988). L'étude s'est déroulée à Banyuls-sur-Mer (Pyrénées-Orientales, France). Deux lots d'oursins, ramassés entre 0.5 et 3 m de profondeur, sont placés dans des aquariums alimentés en eau de mer en circuit ouvert. Une grille en plastique est placée à 2-3 cm du fond, afin d'empêcher les individus de réingérer leurs *faeces*. Les algues sont fournies en quantité non limitante tout au long de l'expérience. La mesure du diamètre du test est faite à l'aide d'un pied à coulisse.

L'analyse des deux courbes de croissance (Fig.1) montre que :
(i) Dans les deux cas, on observe une croissance, mais elle est plus importante pour les oursins nourris avec *C. mediterranea*. Ce résultat confirme que l'absorption d'espèces préférées permet, chez les échinoides herbivores, un taux de croissance somatique plus élevé (FUJI, 1967 ; VADAS, 1977).
(ii) Dans les deux cas, la croissance est importante au cours des 6 à 8 premiers mois d'élevage : à partir d'une taille initiale de 19 mm, on arrive à une taille moyenne de 26 mm pour des oursins nourris avec *G. latifolium* et de 31 mm pour des oursins nourris avec *C. mediterranea*. A partir du 12ème mois, l'accroissement du diamètre du test n'augmente plus significativement ; des résultats identiques ont été obtenus par CRAPP et WILLIS (1975).
(iii) Contrairement à ce qu'observe AZZOLINA (1988) *in situ*, la croissance de *P. lividus* ne semble pas être soumise a d'importantes variations saisonnières dans les conditions d'élevage réalisées.
Une mortalité massive a eu lieu en août 1989 ; celle-ci est probablement due à des températures trop élevées (24°C). Le pourcentage de survie après les 18 mois d'expérimentation est de 53% pour les oursins nourris avec *G. latifolium* et de 89% avec *C. mediterranea*. Il semblerait donc que des oursins nourris avec *G. latifolium* (espèce évitée) soient moins résistants que ceux nourris avec *C. mediterranea*.

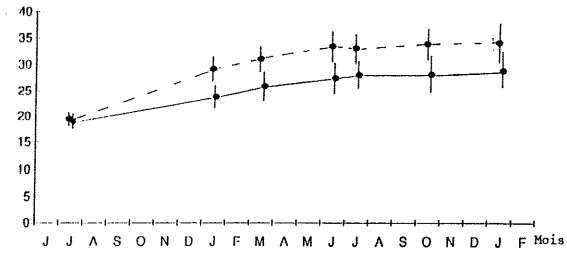


Fig.1. Courbes de croissance de *Paracentrotus lividus* nourris avec *Gelidium latifolium* ( ) et *Cystoseira mediterranea* ( ). Les points représentent les données expérimentales et les écarts-types ont été représentés par les traits verticaux. D = diamètre à l'ambitus (en mm).

Remerciements : Nous remercions le Prof. Alain Guille, Directeur du Laboratoire Arago, qui nous a permis de travailler dans les meilleures conditions.

BIBLIOGRAPHIE

ALLAIN J.Y., 1978. Age et croissance de *Paracentrotus lividus* (Lmk) et de *Psammechinus miliaris* (Gmelin) des côtes nord de Bretagne (Echinoidea). *Cah. Biol. mar.*, Fr. 19 (1) : 11-21.
AZZOLINA J.F., 1988. Contribution à l'étude de la dynamique des populations de l'oursin comestible *Paracentrotus lividus* (Lamarck). Croissance, recrutement, mortalité, migrations. Thèse Doct. Ecol., Univ. Aix-Marseille II, Fr. : 1-225.
CELLARIO C., FENAUX L., 1987. Croissance des juvéniles de *Paracentrotus lividus* (Lamarck) au cours de l'année qui suit la métamorphose. Etudes expérimentales. *In : Colloque international sur Paracentrotus lividus et les oursins comestibles*, C.F. BOUDOURESQUE ed., GIS Posidonie publ., Marseille, Fr. : 157.
CRAPP G.B., WILLIS M.E., 1975. Age determination in the sea-urchin *Paracentrotus lividus* (Lamarck), with notes on the reproductive cycle. *J. exp. mar. Biol. Ecol.*, Neth., 20 : 157-178.
FUJI A., 1967. Ecological studies on the growth and food consumption of the japanese common littoral sea-urchin *Strongylocentrotus intermedius* (Agassiz). *Mem. Fac. Fish.*, Hokkaido Univ., Jap., 15 : 83-160.
LE GALL P., 1987. Intérêt d'un élevage intensif de l'oursin violet *Paracentrotus lividus*. *In : Colloque international sur Paracentrotus lividus et les oursins comestibles*, C.F. BOUDOURESQUE ed., GIS Posidonie publ., Marseille, Fr. :399-405.
MILLIGAN H.N., 1916. Rate of growth of *Echinus miliaris*. *Zool.*, 20 : 399.
ODILE F., 1988. *Preferenda* alimentaires de l'oursin régulier *Paracentrotus lividus* . Mém. Maîtrise Biologie Organismes et des Populations, Fac. Sciences Nancy I, Fr. : 1-30.
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. d'Etat, Univ. Aix-Marseille III, Fr. : 1-221, I-VI, 12 pl. h.t.
RICO V., 1989. Contribution à l'étude des *preferenda* alimentaires et du comportement moteur de l'oursin regulier *Paracentrotus lividus*. Mém. DEA Océanogr. biol., Univ. Aix-Marseille II, Fr. : 1-56.
VADAS R.L., 1977. Preferential feeding : an optimization strategy in sea-urchins. *Ecol. Monogr.*, U.S.A., 47 : 337-371.

Comportement de *Paracentrotus lividus* : quelques exemples de budget temps

Valérie RICO*, Angela CALTAGIRONE* et Catherine FERNANDEZ**

*L.B.M.E.B., Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)

B

Paracentrotus lividus (Lamarck) joue un rôle fondamental dans la structure et le fonctionnement de deux écosystèmes infralittoraux : l'herbier à *Posidonia oceanica* (Linnaeus) Delile et les peuplements photophiles de substrat dur. Bien qu'il soit potentiellement omnivore, son régime est essentiellement végétarien (Muntz *et al.*, 1965; Gamble, 1966; Powis de Tenbossche, 1978; Traer, 1979; Kirkmann & Young, 1981; Nédélec, 1982; Verlaque, 1987).

Nous avons suivi en continu (observations directes : les 17 et 18 Mai, de 18:00 à 18:00 heure et le 29 Mai, de 7:00 à 18:00 heure), trois paramètres comportementaux (action d'alimentation ou sortie des dents, déplacement, mouvements des radioles) afin de vérifier la présence de cycles comportementaux (de période pluri-horaire ou pluri-journalière). En ce qui concerne l'alimentation, la prise en compte de tels cycles est essentielle lors du calcul des rations alimentaires journalières.

Cette étude s'est déroulée à Banyuls-sur-Mer (Pyrénées-Orientales, France). Les individus de *P. lividus*, ainsi que les végétaux (feuilles âgées de *Posidonia oceanica*, *Codium vermilara*, *Cystoseira mediterranea*) sont récoltés entre 0 et 3 mètres de profondeur. Les individus (50mm < diamètre < 54mm) sont placés dans des aquariums (2 individus marqués par aquarium) alimentés en eau de mer en circuit ouvert (16°C <t° eau mer < 19°C). Une grille en plastique est placée à 2-3 cm du fond, afin d'empêcher les individus de réingérer leurs *faeces*. Les aquariums sont éclairés par la lumière extérieure ainsi que par des néons, allumés de 8:00 à 22:00 heure (heure légale). Les individus jeûnent au préalable pendant six jours (afin de synchroniser les éventuels cycles d'alimentation et de jeûne).

Ces observations ont permis de préciser la fréquence et la durée des phases de déplacement durant 24 heures et au cours d'une journée (7:00 à 18:00 heure); 8 individus au total ont été suivis. Les phases de déplacement sont en général nombreuses et relativement courtes : en moyenne 13 phases en 24 heures, d'une durée moyenne de 21 minutes. Il n'y a pas de différence entre les individus confrontés à *Posidonia oceanica* (14 phases d'une durée moyenne de 23 minutes, sur 24 heures) et ceux confrontés à *Codium vermilara* (12 phases d'une durée moyenne de 25 minutes, sur 24 heures). Les déplacements ne semblent donc pas être en relation avec les préférences alimentaires.

D'une façon générale, lorsque les individus s'alimentent, ils ne se déplacent pas et ne bougent pas ou très peu leurs radioles. Les observations nous ont permis de voir que les phases d'alimentation, au cours d'un cycle de 24 heures, étaient très différentes d'un aquarium à l'autre. En effet, les individus alimentés avec *Codium vermilara* mangent très peu (en moyenne : 3 phases d'alimentation pendant 24 heures, d'une durée moyenne de 30 minutes) alors que les individus alimentés avec les feuilles de *Posidonia oceanica* présentent, en moyenne 12 phases en 24 heures, d'une durée moyenne de 47 minutes. Pour ces derniers, les phases d'alimentation peuvent durer jusqu'à 4 heures sans interruption. Les périodes d'alimentation sont également réparties entre la nuit et le jour.

Les individus ont souvent les dents protrudées même s'ils ne s'alimentent pas. Cela est peut-être dû au fait que, chez *P. lividus*, la croissance continue et rapide des dents (1 mm à 1.5 mm par semaine : Markel, 1969) le contraint à un broutage presque incessant pour les user (Verlaque, 1987). Nous remarquons également que les phases où *P. lividus* a les dents protrudées ne précèdent pas obligatoirement une phase d'alimentation.

Les individus ont souvent les radioles en mouvement; les périodes de repos sont rares. Ils sont capables de bouger leurs radioles à des vitesses variables, qu'ils soient immobiles ou en déplacement. Dans ce dernier cas, le mouvement des radioles est toujours rapide. Les phases durant lesquelles les individus bougent leurs radioles (lentement ou rapidement) sont, en moyenne peu nombreuses, mais de durée relativement longue : 10.5 phases, sur 24 heures, d'une durée moyenne de 90 minutes. Il y a peu de différence entre les individus confrontés à *Posidonia oceanica* (10.5 phases d'une durée moyenne de 106 minutes) et ceux confrontés à *Codium vermilara* (11.5 phases d'une durée moyenne de 70 minutes). Toutefois, pour les individus confrontés à *Posidonia oceanica*, les phases sont significativement plus longues. Régis (1978) émet l'hypothèse que le mouvement des radioles chez des individus immobiles pourrait être lié à la capture de particules en suspension dans l'eau. Dans ce cas, nous pourrions penser que les individus confrontés à une espèce "fortement évitée" (*Codium vermilara*) auraient davantage bougé leurs radioles que ceux confrontés à une espèce "fortement préférée" (*Cystoseira mediterranea*). Ce n'est pas le cas dans les expériences que nous avons réalisées.

Le suivi en continu de trois paramètres comportementaux met en évidence de très nombreux (58 en moyenne) changements d'activité au cours d'un cycle de 24 heures. A l'exception du mouvement des radioles, presque toujours rapide lors des phases de déplacement, il n'apparaît pas de relation entre les différents paramètres. En particulier, le mouvement des dents ne précède pas forcément des phases d'alimentation, et le mouvement des radioles (que nous pensions lié au filtrage, activité alternative à la consommation d'aliments figurés) n'est pas lié au degré de préférence pour l'algue proposée.

Remerciements : Nous remercions le Prof. Alain Guille, Directeur du Laboratoire Arago et Michèle Knoepffler-Peguy qui nous ont permis de travailler dans les meilleures conditions, ainsi que le Prof. Charles Boudouresque, qui nous a fait bénéficier de ses conseils.

BIBLIOGRAPHIE

GAMBLE J.C., 1966. Ecological studies on *Paracentrotus lividus* (Lmk.). *Underwater Ass. Rep.*, Malta : 85-88.

KIRKMANN H. & YOUNG P.C., 1981. Measurement of health, and Echinoderm grazing on *Posidonia oceanica* (L.) Delile. *Aquatic Botany*, Netherl., 10 (4) : 329-338.

MARKEL K., 1969. Morphologie der Seeigelzähne II. Die gebielten Zahne der Echinacea (Echinodermata, Echinoidea). *J. Morph. Tiere*, 66 : 1-50.

MUNTZ L., EBLING F.J. & KITCHING J.A., 1965. The Ecology of Lough Ine. XVI. Predatory of large crabs. *J. Animal Ecology*, U.K., 34 : 315-329.

NEDELEC H., 1982. *Ethologie alimentaire de Paracentrotus lividus dans la baie de Galeria (Corse) et son impact sur le peuplement phytobenthique.* Thèse Doct. 3 ème cycle, Océanogr. Biol., Univ. P. et M. Curie et Univ. Aix-Marseille II, Fr. : 1-175.

POWIS DE TENBOSSCHE T., 1978. Comportement alimentaire et struture digestive de *Paracentrotus lividus* (Lmk.) (Echinodermata, Echinoidea). Mém. Lic. Zool., Fac. Sci. Bruxelles, Belg. : 1-82.

REGIS M.B., 1978. *Croissance de deux échinoïdes 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. Techn. St. Jerôme, Marseille, Fr. : 1-221.

TRAER K., 1979. The consumption of *Posidonia oceanica* Delile by Echinoïds at the Isle of Ischia. *In.* Proceedings of the European Colloquium on Echinoderms, Belg. : 241-244.

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 Doct. Sci. nat., Univ. Aix-Marseille II, Fr. : 1-396.

Additions to Holothuroidea of the Adriatic Sea

Dusan ZAVODNIK

"Ruder Boskovic" Institute, Center for Marine Research, 52210 Rovinj (Yugoslavia)

In the Adriatic Sea, in the frame of a number of research programs, several holothurians were collected which previously were seldom recorded, or were even not found in the area. The material was sampled by SCUBA diving, by means of a Van Veen 0.1 m^2 grab, or by otter trawl.

Holothuria helleri Marenzeller, 1878, has not been noted in the Adriatic Sea in the past hundred years, except for a specimen noticed by Tortonese (1965) in the Venice lagoon. Only recently 5 specimens, 16-32 mm long, were collected among algae at a 1-2 m depth in the area of the Istrian Peninsula, Losinj Island, and at the Kornati Archipelago (Fig. 1).

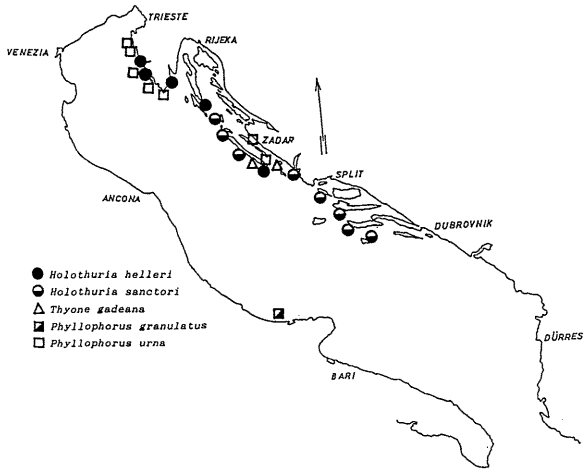


Fig. 1. Recent findings of some holothurians in the Adriatic Sea.

Holothuria sanctori Delle Chiaje, 1823, was noted in the area for the first time only a few years ago (Zavodnik, 1985). Recent information, mostly provided by Ms. J. Belamaric, widely expanded its distribution pattern (Fig. 1). Specimens were noted at 4-15 m depth, usually in hard bottom crevices and under rock projections.

Thyone gadeana Perrier, 1902, was not previously recorded in the Adriatic Sea. In 1987 I sampled 5 specimens, 16-54 mm long, at the Kornati Archipelago in the central Adriatic. Collections were made at four stations, on silty sediment, at 82-105 m depth. The ossicles and calcareous ring corresponded to the description of Reys (1959).

Phyllophorus granulatus (Grube, 1840) is also a new species for the area. One 50 mm long specimen was captured on grey mud by Mr. A. Simunovic on 8 December 1984 at a "Pipeta" station H1 (42°00'11" N, 15°05'20" E), at a 22 m depth. The ossicles were in accordance with those figured by Koehler (1927), Heding & Panning (1954), and Cherbonnier & Guille (1971). Most tables have beeb modified, carrying a low multi-columnal spire, dome- or cone-shaped, a finely and irregularly perforated disc.

Phyllophorus urna Grube, 1840. Recent findings (Fig. 1) of this well-known but rarely noted species (Mayer, 1937) reinforce the supposition that in the Adriatic Sea it is most frequent in the shallow north-eastern part of the basin.

Consequently, the present information increased the number of Adriatic holothurian species to 36, which is 73% of the Holothuroidea listed in the Mediterranean (Tortonese, 1980).

REFERENCES

CHERBONNIER, G. & A. GUILLE, 1971. Note sur l'Holothurie Dendrochirote *Phyllophorus granulatus* (Grube). Vie Milieu, 22 (2A): 281-288.

HEDING, S.G. & A. PANNING, 1954. Phyllophoridae. Spolia zool. Mus. haun., 13: 7-209.

KOEHLER, R., 1927. Les Echinodermes des mers d'Europe. II. O. Douin, Paris, 339 p.

MAYER, B., 1937. Die Holothurien der Adria. Thalassia, 2 (9): 55 p.

REYS, J.P., 1959. *Thyone cherbonnieri* nov. sp. et remarques sur le genre *Thyone* en Méditerranée. Rec. Tr. Stn. mar. Endoume, 17 (29): 173-180.

TORTONESE, E., 1965. Echinodermata. Fauna d'Italia 6. Calderini, Bologna, 422 p.

TORTONESE, E., 1980. Review of present state of knowledge of the Mediterranean Echinoderms. In: Echinoderms: Present and Past, M. Jangoux, ed. Balkema, Rotterdam, 141-149.

ZAVODNIK, D., 1985. Sur l'*Holothuria sanctori* D.Ch. (Echinodermata, Holothuroidea) identifiée recemment dans la mer Adriatique. Rapp. Comm. int. Mer Médit., 29 (5): 297-298.

C-I1

Carbon Fractionation and Balance in the Coastal Water of Alexandria Region

A.-R. ABDEL-MOATI, T.-A. ABOUL-KASSIM, N.-M. DOWIDAR and F. EL-NADY

Oceanography Department, Faculty of Science, Alexandria University, Moharam Bay, Alexandria (Egypt)

Carbon is the most important metabolic element in sea water. IT occurs in water as a result of precipitation containing increased amounts of CO_2 produced through fuel combustion, CO_2 fixation by aquatic plants, from agricultural drainage as organic matter or as major element of waste and sewage discharge. The knowledge of distribution of dissolved organic carbon (DOC) and coexisting particulate organic carbon (POC) is essential for understanding of carbon cycle in sea water. The present work is an attempt to assess the relative importance of land run-off on different carbon species and its contribution to the total carbon budget in a coastal bay off Alexandria falling under sewage stress.

The study area (2.5 Km^2) is a semi-circular shallow bay, surrounded by the city, connected to the Mediterranean through two openings. The basin is subjected annually to about $35X10^6 m^3$ of unprocessed sewage rendering its flushing rate to be 5 months.

Regular bimonthly sampling during 1985-1986 indicate elevated surface levels of POC reaching 6 mg C/l coinciding with maximum discharge periods as indicated by low salinities. Detrital POC constitutes about 28% of POC. Particulate inorganic carbon (PIC) constituted between 45-49% of total particulate carbon with an average of 4.62 mg/l. On the other hand, the DOC values recorded in the coastal water of Alexandria (average 13.95 mg/l) reflect the highly eutrophic characteristics of water. The organic forms of carbon thus could be used as index for organic pollution derived from sewage discharge.

Generally the dissolved organic fraction exceeds the inorganic by three. The average DOC/POC i.e. 2.4:1 is normal compared with other coastal waters.

The discharged sewage not only affect the carbon in water but raised carbon-sediment levels to 9.11% at areas directly affected by discharge.

The outstanding features of the carbon balance (Figure 1) are:

1. About 325 tons of organic carbon reaches the bay annually through land sources; 70% of which are in particulate form.

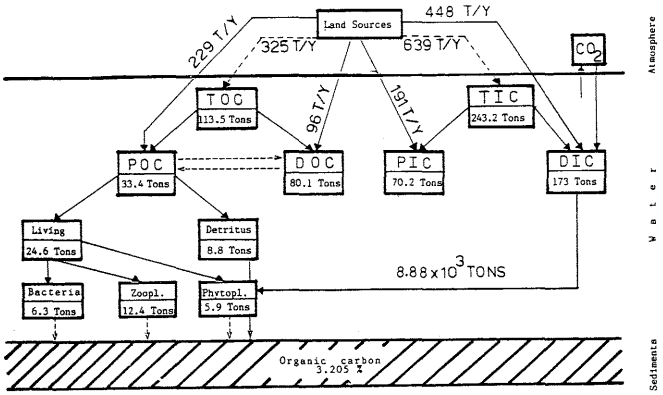


Figure 1. Schematic diagram of carbon input to the Eastern Harbour.

2. The bay receives 639 tons/y of inorganic carbon of which the particulate fraction forms only 30%.
3. About 15% of POC influx existed in the water column as living (74%) while about 37% of PIC influx is retained in suspension.
4. 85% of the inflowing DOC exists in the water column. The equilibrium shift of POC$\rightleftharpoons$DOC towards DOC may substitute the loss in DOC during oxidation processes.
5. About 8.88 X 10^3 tons carbon are fixed annually by phytoplankton. Atmospheric CO_2 input 4.4 X 10^3 tons/y could substitute a significant part of this uptake rate.
6. The short residence time of the bay water (5 months) leads to a mismatch between the inflowing carbon and that actually present in the bay as well as a considerable differences in the proportionality of different carbon species.

C-I2

Land Run-Off as a Source of Nitrogen in the Marine Coastal Environment of Alexandria

F.-E. EL-NADY, T.-A. ABOUL-KASSIM, N.-M. DOWIDAR and A.-R. ABDEL-MOATI

Oceanography Department, Faculty of Science, Alexandria University, Moharam Bay, Alexandria (Egypt)

INTRODUCTION: Nitrogen is one of the biologically important elements in the aquatic habitats. In addition to dissolved molecular nitrogen, sea water contains low, but extremely important, concentrations of inorganic and organic nitrogen. The present work deals with the concentrations of the different nitrogen species as well as their contribution to the total nitrogen budget in one of the most polluted basins off Alexandria, the Eastern Harbour (E.H).

MATERIAL AND METHODS: During the period 1985-1986, sampling was carried out at regular bimonthly intervals in a semi-closed bay, connected to the Mediterranean through two openings. The basin is subjected to about $35X10^6$ m^3 of unprocessed sewage, rendering its flushing rate to be 5 months. Nitrate, nitrite and ammonia were determined according to Strickland and Parsons (1972). Total dissolved nitrogen (TDN) and total nitrogen (TN) were determined on filtered and unfiltered samples using the technique described by Koroleff (1977) and modified by Valderrama (1981). Dissolved organic nitrogen (DON) and particulate nitrogen (PN) were estimated by calculations. The uptake rate of NO_3 & NH_3 by phytoplankton of the harbour water was determined using the procedure of Eppley et al (1969). The flux of nitrogen from the harbour sediments was measured following the method of Hargrave and Connolly (1978). Organic nitrogen in sediments was determined according to Niederl and Niederl (1942).

RESULTS AND DISCUSSION: Nitrate is the final oxidation product of nitrogen compounds in sea water. During the study period, its concentration in the E.H was comparatively high, the annual averages being 6.791±4.654 and 4.826±2.964 µg at/l for both surface and bottom waters, respectively. The nitrite concentrations were much lower than that of nitrate (The averages being 0.949 and 0.746 µg at/l for both surface & bottom waters, respectively). The importance of waste water discharged into the harbour as a source of ammonia was found from the inverse correlation between ammonia and salinity ($P<0.001$). In spite of shallowness of the E.H., ammonia concentration was relatively high, varying between 0.975-11.456 µg at/l (at the surface) and 0.480-12.334 µg at/l, near the bottom. The observed correlation ($P<0.001$) between NO_3 & NO_2 content and its insignificance with ammonia indicated that nitrate reduction rather than ammonia oxidation is a major source of nitrite.

Dissolved organic nitrogen (DON) was comparatively higher (annual average 11.866±6.129 µg at/l) than that of DIN (average 10.06±4.864 ug at/l). This is probably due to being assimilated by aquatic organisms at a much lower rate than inorganic forms or being resistant to bacterial attack, remaining in the water or sinking to the bottom (Riley and Chester, 1971). The correlations between DON with Chl a ($P<0.001$) and living biomass represented by ATP ($P<0.001$), confirmed the important role of living organisms as a source of DON.

High concentrations of PN occurred in summer, coinciding with the periods of maximum sewage discharge and chlorophyll a biomass (Aboul-Kassim, 1987). The highly significant correlations between PN with POM ($P<0.001$) and salinity ($P<0.001$) are evidences for the role of phytoplankton and sewage discharge as important sources of PN.

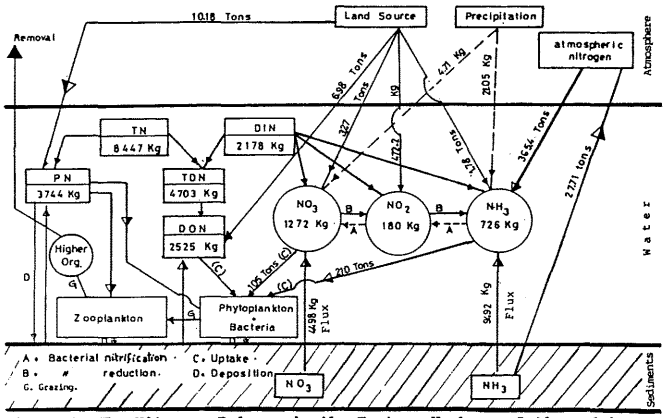


Figure 1: The Nitrogen Balance in the Eastern Harbour of Alexandria.

On the average, most of the nitrogen budget of the E.H (59%) was in the dissolved from. DON was more abundant, constituting about 54% of TDN. Nitrate was the most abundant form of DIN forming 55.7%, followed by ammonia 37.1% and nitrite 7.2%. The mean atomic ratios of the different nitrogen and phosphorus forms, i.e. NO_3/DIP, DIN/DIP, DON/DOP, TDN/TDP, PN/PP and TN/TP were as follows: 13.62:1, 23.97:1, 24.52:1, 22.67:1, 11.33:1 and 15.85:1, respectively.

Within the values given in figure 1, the total input of all nitrogen compounds from land sources, flux from sediments, precipitation and nitrogen fixation amounted to 402 Tons/year. This amount exceeds that due to uptake, denitrification from bottom sediments and the amount present in the harbour environment by 51 Tons/year.

REFERENCES:

Aboul-Kassim, T.A. (1987). M.Sc. Thesis, Fac. of Sci., Alex. Univ., Egypt.
Eppley, R.W., J.N. Rogers & J. McCarthy (1969). Limnol. Oceanogr., 14:912-20.
Hargrave, B.T. and C.F. Connolly (1987). Limnol. Oceanogr. 23:1005-1010.
Koroleff, F. (1977), In: Grasshoff, K. (ed.). Annex. Interim Commission of the Protection of the Baltic Sea.
Niederl, J.B. and V. Niederl (1942). Micromethods of quantitative organic analysis (2nd ed.), John Wiley & Sons, New York, 374 pp.
Riley, J.P. and R. Chester (1971). Marine chemistry. Academic Press, 465 pp.
Strickland, J.D.H and T.R. Parsons (1972). Fish. Res. Bd. Canada, Bull. 167, 2nd ed., 310 pp.
Valderrama, J.C. (1981). Marine Chemistry, 10:109-122.

C-I3

Living Biomass in the Highly Eutrophic Coastal Environment of Alexandria, Egypt

T.-A. ABOUL-KASSIM , F.-E. EL-NADY , A.-R. ABDEL-MOATI and N.-M. DOWIDAR

Oceanography Department, Faculty of Science, Alexandria University, Moharam Bay, Alexandria (Egypt)

ABSTRACT: During the period 1985-1986,the adenosine triphosphate (ATP) method was applied for the first time in EGYPT to assess the living biomass and its components (Bacteria, Phytoplankton and Zooplankton) in one of the heavily polluted basins off the Egyptian coasts, the Eastern Harbour of Alexandria. The ATP levels as well as its spatial and seasonal variations were presented to evaluate the impact of domestic sewage discharged into the harbour on its water quality.

C

AREA OF STUDY: The Eastern Harbour (E.H) of Alexandria is a relatively shallow semi-closed basin, sheltered from the sea by an artificial break-water , leaving two openings through which the exchange of the harbour water and the neritic Mediterranean water take place. About $35.2X10^6$ m^3 of domestic sewage are discharged into the Eastern Harbour of Alexandria through 11 outfalls, distributed along the coast. This quantity is about 2.3 times the water volume of this basin.Accordingly , the flushing rate would be about 5 months.

MATERIAL AND METHODS: Sampling was carried out at regular bimonthly intervals , throughout the period from May 1985 to May 1986. ATP measurements, for total living ATP and Zooplankton, were carried out according to the method described by Holm-Hansen (1973). Knowing the ATP corresponding to the total living organisms (TATP) and zooplankton (ZATP) as well as that equivalent to phytoplankton (PATP), calculated from phytoplankton biomass carbon (Holm-Hansen,1973), the bacteria (BATP) could be estimated by subtraction. The ATP equivalent of phytoplankton was computed from the chlorophyll a biomass (determined according to Strickland & Parsons, 1972) using the factor given by (Holm-Hansen, 1973).

RESULTS AND DISCUSSION: During the study period , the annual averages of total ATP (TATP), zooplankton ATP (ZATP), phytoplankton ATP (PATP) and bacteria ATP (BATP) amounted to 6.47 ± 2.06, 3.26 ± 1.28, 1.54 ± 1.41 and 1.83 ± 1.08 µg ATP/l , respectively. Karl (1980) mentioned that elevated ATP concentrations are characteristic to eutrophic zones with values >0.5 µg/l while in regions of moderate productivity,values range between 0.1 and 0.5 µg/l. Both the range and average values observed in the harbour are higher than those recorded in many other localities including the Mississippi bay.

Based on the assumptions of Holm-Hansen and Booth (1966), the estimated number of bacteria/l in the harbour ranged between $0.72X10^8$ and $45X10^8$ Cell/l at the surface and $0.33X10^8$-$58X10^8$ cell/l near the bottom. The annual averages were $12.9X10^8$ and $11.2X10^8$ cell/l,respectively. These values indicate that the bacterial number in the E.H water is exceedingly high compared with oceanic and even coastal waters reflecting the role of organic sewage dumped in this basin (Aboul-Kassim, 1987).

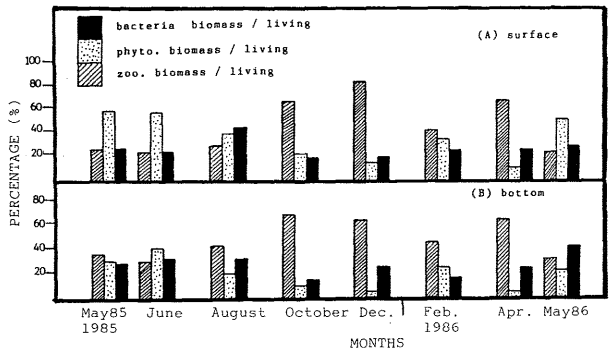


Figure 1: Monthly variations of the percentage composition of zooplankton, phytoplankton and bacteria biomass (mg C/l) in the Eastern Harbour during the period 1985-1986.

In the present study, an attempt was made to obtain the carbon biomass equivalent to that ATP values. The concentrations of living biomass in the harbour water were relatively high. The annual averages of total ATP carbon biomass and that of phytoplankton, zooplankton and bacteria were 1.620, 0.385, 0.820 and 0.450 mg C/l. The zooplankton biomass peak occurred in winter, while those of phytoplankton and bacteria were observed in warm months (Figure 1). An expected significant negative correlation was observed between secchi disk depth (Z_{SD}) , measured during sampling , and total living biomass (r=-0.4404, P<0.001). The regression equation relating both variables is:

$$\ln Z_{SD} = 1.2564 - 2.3316 \ln (\text{T.living biomass})$$

Statistically significant positive correlations were also observed between living biomass and that of phytoplankton, zooplankton and bacteria. The empirical regression equations relating these variables are:

T.living biomass = 0.3155 +0.6509 Phytoplankton Biomass
T.living biomass = 0.2388 +0.7946 Zooplankton Biomass
T.living biomass = 0.2704 +1.0053 Bacteria Biomass.

As revealed from the present study,the average relative abundance of the different components of living biomass in the harbour water could be expressed as follows:

Zooplankton: 50.02%, Bacteria:28.18%, Phytoplankton:21.8%.

REFERENCES:

Aboul-Kassim, T.A. (1987). M.Sc. Thesis,Faculty of Science, Alexandria University,Egypt.

Holm-Hansen, O. (1973). In:Estuarine Microbial Ecology. Stevenson,H.L. and R.R. Colwell (Ed.). Univ. of South Carolina press, Columbia, S.C., pp.73-89.

Holm-Hansen,O. and C.R. Booth (1966). Limnol. Oceanogr.,11 :510-519.

Karl, D.M. (1980). Microbiological Reviews, Vol.44 : 739-796.

Strickland,J.D.H and T.R.Parsons (1972). Fish.Res.Bd.Canada, Bull.167.

C-I4

Impact of Sewage Discharge on the Phosphorus Species and Dynamics in the Eastern Harbour of Alexandria, Egypt

N.-M. DOWIDAR , A.-R. ABDEL-MOATI , T.-A. ABOUL-KASSIM and F.-E. EL-NADY

Oceanography Department, Faculty of Science, Alexandria University, Moharam Bay, Alexandria (Egypt)

Phosphorus is one of the most important nutrient elements which control the growth and reproduction of phytoplankton. Mean while, when present in huge concentrations it may cause eutrophication and is considered as a potential pollutant.

This work assesses the importance of land based sources on the phosphorus species and budget in a heavily polluted basin off Alexandria coast.

The annual mean of dissolved inorganic phosphorus (DIP) in the Eastern Harbour (E.H) amounted to 0.44 ± 0.223 ug at/l. Generally, statistically significant correlations were found between DIP with particulate organic matter (POM) ($P< 0.001$) and dissolved oxygen ($P< 0.001$), indicating the importance of oxidation of organic matter as a source of DIP. The importance of the allochthonous source of DIP was demonstrated by the significant inverse correction found between DIP and salinity ($r=- 0.318$, $P< 0.001$).

Dissolved organic phosphorus (DOP) constitutes between 55-60% of total dissolved phosphorus (TDP) in the harbour water. The average value of DOP concentrations for surface and bottom water layers were 0.677 ± 0.491 and 0.436 ± 0.262 ug at/l , respectively . Significant corrections were observed between DOP and chlorophyll a ($P< 0.001$) as well as total living biomass ($P<0.001$), underscoring the important role of living organisms as a source of DOP in the harbour water.

Particulate phosphorus (PP) in the E.H was remarkably higher than that of TDP, constituting more than 58% of total phosphorus (TP). The overall average amounted to 1.394 ± 0.754 ug at/l. The high significant corrections between PP with POM ($P< 0.001$) and salinity ($r= - 0.5399$, $P< 0.001$) indicated that the concentration of PP is directly proportional to the amount of run-off. The regression equation being : $POM = 1.767 + 0.670\ PP$.

The overall average values of inorganic phosphorus, organic phosphorus and total phosphorus of the surficial sediments of the harbour basin amounted to 0.086%, 0.02% and 0.106%, respectively.

The annual inputs of DIP to the harbour basin during 1985-1986 from land sources, precipitation as well as flux from sediments were 567 kg, 6.5 kg and 520 kg, respectively. About 400 kg/yr of DIP reaches the harbour from the neritic Mediterranean waters through the eastern outlet. On the other hand, the total phosphorus input to the bay via precipitation amounted to 6.5 kg/yr. Laboratory experiments indicated that maximum phosphorus released from sediments was attained during the first five days. A total 520 kg DIP was estimated to be released to the overlying water from sediments. This amount is about 52% of the total DIP input to the harbour.

The annual rate of phytoplankton uptake of DIP was experimentally determined and amounted to 860 kg/yr. The present day standing stock of phosphorus in the harbour amounted to 209 kg. Following the circulation pattern in the bay, he outflowing water from the bay carries about 190 kg of DIP annually to the coastal water of Alexandria region. The rest of the inflowing phosphorus is either adsorbed on settling particles or sediments.

C-I5

The Determination of Oceanographic Characteristics, Primary Productivity and limiting Nutrient(s) of the Izmit Bay, Marmara Sea

S. TUGRUL*, O. BASTURK* and E. MORKOC**

*Institute of Marine Sciences, METU, P.K. 28, Erdemli, Icel (Turkey)
*Marmara Research Center, TUBITAK, P.K. 21, Gebze, Kocaeli (Turkey)

For the water quality management of the İzmit Bay, located on the northeastern part of the Marmara Sea, a long-term survey has been conducted in May 1984-July 1988 (Tuğrul et.al., 1989). The İzmit Bay, as being a part of the Marmara Sea, is influenced by the water exchanges taking place between the Black Sea and the Aegean Sea (Tuğrul et.al., 1986). The bay has a permanent two-layer stratification throughout the year as in the Marmara Sea. The degree of stratification and characteristics of the water masses show considerable interannual variations, particulary in the upper layer.

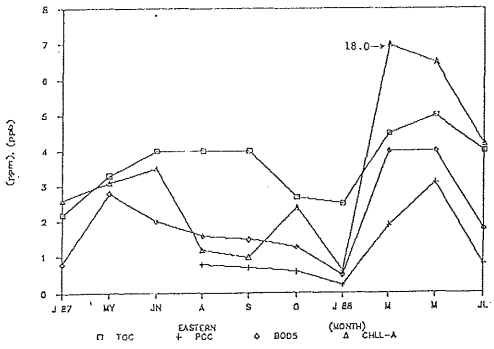
The dissolved oxygen, nutrient, total and particulate organic carbon, and chlorophyll-a concentrations within the bay are mainly governed by waste load inputs, primary production and physically by the water exchanges with the adjacent water masses of Marmara Sea. Because of the relatively long residence time of the bottom waters of the bay (below 30 m) and sinking of biodegradable particulate organic matter of algal and anthropogenic origins, the dissolved oxygen consumption rate exceeds its supply rate and thus the dissolved oxygen concentration decreases from 2 ppm in April to below 0.5 ppm in October.

The primary productivity and bio-assay studies have been carried out seasonally by C-14 technique for one year in 1987-1988 (Morkoç and Tuğrul, 1989). The results of POC, BOD_5, chlorophyll-a and primary productivity have demonstrated that there exist significant inputs of nutrient elements (N,P) associated with the biodegradable organic matter of industrial and domestic origins to the bay system. The annual algal production was found to be about 185 g-C/m² in the relatively less polluted waters of the western region whereas it reached 330 g-C/m²/year in the inner bay. The highest production value of 3810 mg-C/m²/day was measured in March, 1988, which corresponds to the spring-bloom time in the Marmara Sea.

The results of bio-assay predicted that the limiting nutrient elements on phytoplankton production were found to be ortho-phosphate and reactive silicate whereas the nutrient measurements in the surface waters of the bay indicated that the nitrate very likely limits the algal production within the bay, as expected in the Marmara Sea.

The nutrient results demonstrate that the $(NO_3+NO_2)/(o\text{-}PO_4)$ ratio (in mole) in the lower layers of the bay is less than 11, indicating denitrification reaction in the oxygen poor bottom waters of the bay. The concentrations of ortho-phosphate and (nitrate+nitrite) in the bottom waters range between 0.8-1.2 µM and 7-11 µM, respectively, depending upon the temporal and spatial variations of physical and biochemical processes within the bay.

As the consequence of large quantities of wastewater dischange to the eastern and central bay waters (Tuğrul et.al.,1986), BOD_5, TOC, POC and Chll-a measurements (see the figure below) clearly indicate a considerable amount of biodegradable organic



The variations of TOC, POC, BOD_5 (ppm) and Chll-a (ppb) with time in the surface water of the eastern region of the bay.

matter input to the inner bay. From the long-term TOC and POC measurements, the two important conclusions can be derived: first, a significant fraction of the land-based organic matter is degraded in the euphotic zone, the second is that 10-30% of TOC is in POC form. The highest POC concentration was always recorded in the surface layers (0-5 m) of the polluted waters of the eastern region whereas it associated with the chll-a maxima in the outer bay. The water quality modelling study has also verified these conclusions (Tuğrul et.al.,1989). The POC/Chll-a ratio in the bay waters showed seasonal changes, with the highest value in the summer months. The water quality model of the bay has predicted that the bay system is very sensitive to deep-sea discharges. Thus, at least, 90% of the present waste loads entering the bay should be removed by adequate wastewater treatment techniques prior to deep-sea dischange to the bay system.

REFERENCES

Tuğrul,S., Sunay,M., BaştÜrk,Ö. and Balkaş,T.(1986). The İzmit Bay case study. In: The role of the oceans as a Waste Disposal Option, ed.by G.Kullenberg, D.Reidel Publ.,pp.243-274.

Tuğrul,S., Morkoç,E. and Okay,O.(1989). The determination of Oceanographic characteristic and assimilation capacity of the İzmit Bay. In: Wastewater Treatment and Disposal studies, NATO TU-WATERS Project, Final report, TÜBİTAK-MRI Chem.Eng.Publ. pp.193-259.

Morkoç,E. and Tuğrul,S.(1989). Determination of primary production and limiting nutrients in the Bay of İzmit, NATO TU-WATERS Project, Final report, TÜBİTAK-MRI Chem.Eng.Dept. Publ. No. 232, 60 pp.

C-I6

Nitrogen and Phosphorus in Freshwaters Flowing into the Northern Adriatic Sea

V.-U. FOSSATO and G. CAMPESAN

Istituto di Biologia del Mare, CNR, Venezia (Italia)

The Italian coast of the northern Adriatic Sea is under direct influence of freshwaters conveyed by a number of rivers, which drain a land surface of about 120,000 km2.
The mineralogical-petrographic characteristics of the whole catchment basin are relatively well known: the rivers Po, Adige, Brenta and Bacchiglione belong to a subcarbonatic area, in which carbonate percentage in the sediment varies from 12% to 50% northwards(1), while the rivers Piave, Livenza, Tagliamento and Isonzo belong to a carbonatic area with CaCO3 plus MgCO3 percentages ranging from 61% to 86% and calcite/dolomite ratio increasing eastwards(2).

Table 1. Nitrogen and Phosphorus in the waters and carbonate content in the sediments of the rivers flowing into the northern Adriatic Sea. TIN = Total Inorganic Nitrogen µg-at/l; OP = Orthophosphate Phosphorus µg-at/l; N/P = Nitrogen to Phosphorus atomic ratio; % CO3 = % Total Carbonates in sediments; X = Mean; SD = Standard Deviation.

River	Years	Samples No.	TIN X	TIN SD	OP X	OP SD	N/P X	N/P SD	%CO3 Min - Max
Isonzo	1976-77	50	59.4	23.7	0.29	0.22	371	288	61.0-81.7
Tagliamento	1983-84	20	68.1	23.1	0.19	0.17	456	380	69.1-80.2
Livenza	1986-87	27	127.4	46.2	0.91	0.42	155	55	63.8-86.2
Adige	1968-78	196	68.1	21.0	1.51	0.71	46	43	11.3-15.3
Po	1968-84	270	121.5	64.9	2.81	1.87	69	97	6.9-14.9

The physical and chemical characteristics of freshwaters have been investigated and reliable concentration data series of nitrogen and phosphorus are available for some of these rivers(3,4,5,6,7,8,9). Table 1 summarizes published data on nutrient concentrations in freshwaters and carbonate content in sediments. The data available, although limited to inorganic dissolved forms of nitrogen and phosphorus, clearly indicate that: (i) significant differences in the concentration of nitrogen and phosphorus and in the N/P atomic ratio exist among different rivers; (ii) nitrogen and phosphorus of the Po and Adige rivers have increased significantly in the past two decades due to man-made inputs, but the N/P ratio remained almost unchanged; (iii) the lowest phosphorus values and the highest N/P ratio were generally measured in the carbonatic area, where phosphorus concentrations are an order of magnitude lower than in the rivers of the subcarbonatic area.
In principe, no river entering Adriatic coastal waters can be considered "unpolluted"; thus, the N/P atomic ratio reflects the balance between nitrogen and phosphorus concentrations originated from natural sources (by dissolution of rocks and soils) and from man-made sources (sewage and industrial effluents, runoff from fertilized agricoltural land). In moderately polluted waters of the carbonatic area, as it is the case of the rivers Isonzo, Tagliamento and Livenza, the high N/P ratio may be interpreted in terms of phosphate retention as a particulate or as an adsorbed phase on soils. Since the optimum N/P ratio for algae growth ranges from 10 to 20, freshwaters from karstic watersheds are generally limited by phosphorus.

REFERENCES

(1) Jobstraibizer P. and P. Malesani. Memorie della Società Geologica Italiana 12 (1973) 411-452.
(2) Stefanini S. Studi Trentini di Scienze Naturali, Sez. A 45 (1968) 101-124
(3) Bregant D. and G. Catalano. Istituto Talassografico di Trieste. Pubbl. n. 545 (1978) 1-12.
(4) Cioce F., Stocco G. and R. Toniolo. Istituto veneto Sci. 85 (1977) 119-132.
(5) Fossato V.U. Archo. Ocean. Limnol. 18 (1973) 59-70.
(6) Fossato V.U., Campesan G., Craboledda L., Dolci F. and G. Stocco. (in preparation)
(7) Fossato V.U., Perin G., Carniel A., Craboledda L. and F. Dolci. Atti 7° Congresso A.I.O.L. (1988) 279-282.
(8) Marchetti R., Pacchetti G. and A. Provini. Nova Thalassia 7 suppl. 2 (1985) 311-340.
(9) Provini A.and G. Pacchetti. Ingegneria Ambientale 11 (1982) 173-183.

C

Nutrients Concentrations in the Southern Adriatic Sea

A. SKRIVANIC and Z. GRZETIC

Center for Marine Research Zagreb, "Rudjer Boskovic" Institute, 41001 Zagreb (Yugoslavia)
Hydrographic Institute of Yugoslav Navy, 58000 Split (Yugoslavia)

C

In the Southern Adriatic Sea nutrients were measured during thirteen cruises from 1974 - 1990, at four profiles and twenty stations, from Vis Island to Otranto strait, about three expeditions per session were performed. Standard oceanographic parameters were also measured (transparency - Secchi disc, temperature, salinity, dissolved oxygen and pH).

All parameters were measured by standard oceanographic methods recommended by Strickland and Parsons (1975).

The region is under northern Adriatic cold water influences, mainly in the western part of the basin, and warm Mediterranean water influences in Central and Eastern part of the basin. Morphology of the basin enables existence of cyclonic current gyre with prevailing NE currents and Eastern coast, and SE currents at west Italian coast.

Orthophosphate and total phosphorus concentrations are smaller than in some other regions (less than 0.1 and 0.2 mol/m^3), and some exceptions at nearshore stations can be explained by local influences (Bojana run-off and smaller rivers at Italian coast).

Average nitrogen concentrations do not exceed 2 mol/m^3, mainly existed as nitrate, indicated highly oxidative region.

Orthosilicate concentrations are in similar range as nitrogen, with some exceptions, due to clastic region river run-off. In any case, the ratios (AOU : Si : N : P = -276 : 0.8 : 1.1 10.03) were significantly different from oceanic Redfields stoichiometric model (AOU : Si : N : P = -276 : 15 : 16 : 1, Redfield,1963), and those calculated for the Northern Adriatic (AOU : Si : N : P = -276 : 21 : 7 : 0.45, Degobbis, 1990). In this ratios extremelly low concentrations of phosphorus, nearly to the limits of the method, must not be neglected. Interestingly, differences in ratios due to seasons or depth variations are not noticeable.

It seems that phytoplankton assimilated more nitrogen than phosphorus, because of its relative enrichment in south Adriatic waters. Probably, phosphorus is the main limiting factor of bioproduction in the whole Adriatic Sea.

Nutrient budget in the South Adriatic is not quite clear, because of rare current measurements on main profiles, especially in advective outflowing North Adriatic waters and inflowing Mediterranean waters.

REFERENCES:

Degobbis, D., 1990. A stoichiometric model of nutrient cycling in the northern Adriatic Sea and its relation to regeneration processess, Mar. Chem. (submitted for publication).

Gržetić, Z., 1982, A contribution to the knowledge of thermohalinic structure of the South Adriatic, M.Sc. Thesis, University of Zagreb, (in Croatian).

Redfield, A.C., Ketchum, B.H., and Richards, F.A., 1963, The influence of organisms on the composition of seawater, In: M.N. Hill (editor), The Sea, Vol. 2 Interscience Publishers, New York, pp. 27-77.

Strickland, J.D.H., and Parsons, T.R., 1972, A practical handbook of seawater analysis, Fish. Res. Board Canada, Bull. No. 167, Ottawa, pp. 310.

Škrivanić, A., and Z. Vučak, 1983. A contribution to oceanology of offshore waters of the Montenegro coast, Marina biologija, 13, 223-231 (in Croatian).

Vučar, Z., Škrivanić, A. and J. Štirn, 1982, "A. Mohorovičić" expeditions: Reports and results of the oceanographic investigations in the Adriatic Sea. Basic physical, chemical and biological data, Hydrographic Institute of the Yugoslav Navy, Split, 1-239.

Very High Values of the Nitrate/Phosphate Ratio (>30) in the Subsurface Layers of the Western Mediterranean Sea

Patrick RAIMBAULT and Bernard COSTE

Centre d'Océanologie de Marseille, Faculté des Sciences de Luminy, 13288 Marseille (France)

For a long time the Mediterranean Sea has been known as an area with lower nutrient concentrations (Mc Gill 1961) and higher nitrate/phosphate ratio (N:P) than the adjacent Atlantic Ocean. While Atlantic waters show N/P close to the Redfield's ratio of 16:1 (Redfield *et al.*, 1963), mediterranean values are recognized higher than 20:1 (Mc Gill, 1965). This discrepancy is probably due to assimilation-regeneration processes inside the Mediterranean Basin. Previous works have shown that difference in N/P disappears if all the forms (inorganic and organic) of nitrogen and phophorus are taken into account (Coste *et al.*, 1988).

The present study gives greater insights on mediterranean N:P values obtained in Western Mediterranean Sea and Atlantic waters near the Strait of Gibraltar from several recent cruises during which intensive nutrient analyses have been performed (Mediprod IV, Mediprod V, Mediprod V2, Prolig II cruises): 1/ Modified Atlantic waters, noted by salinity lower than 38.0, keep N:P ratio close to 17:1 during their eastward transport along the Algerian coast, while nitrate and phosphate are consumed. 2/ In the same area, typical Mediterranean waters (salinity higher than 38.0) are characterized by a mean N:P of 21:1, in accordance with previous works (McGill, 1965). 3/ In the whole western basin and on several seasons (november 81, june 85, june 86, march 87) the vertical distribution of the N:P ratio can exhibit very high values (often higher than 30).

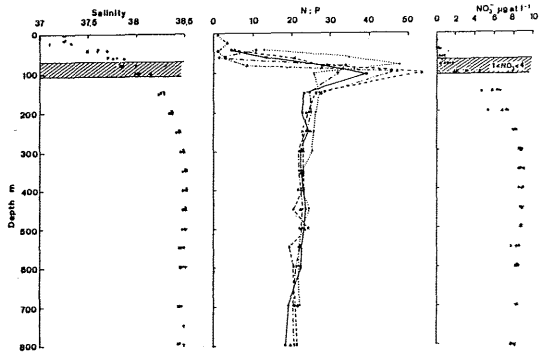


Figure 1: Vertical distributions of salinity, nitrate and N:P ratio observed along the Algerian coasts in March 1987 (Mediprod V2 cruise).

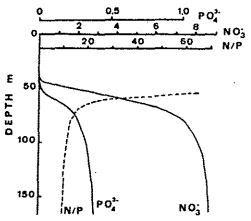


Figure 2: Exemple of continuous profiles of nitrate, phosphate and N:P ratio obtained in the Ligurian Sea during the Prolig 2 cruise.

Along the Algerian coast, a subsuperficial maximum with high N:P values is due to the presence of atlantic surface water with N/P even lower than 16:1 because of nutrient consumption by phytoplankton (Ketchum *et al.*, 1958; Fig. 1). In the northern basin, values do not present subsuperficial maximum but decrease regularly from the surface layer. The levels where N:P are higher than 30 are in the 50-150 m depth range with salinity around 38.10-38.20 and oxygen saturation about 80-85 %. Explanation of this feature has to be attributed to a phosphacline deeper than nitracline (Fig. 2) as opposed to observations in stratified oceans (Herbland and Voituriez, 1977). From T-S diagrams it can be deduced that the interested waters are originated by mixing of surface waters and Winter Water as represented by a temperature minimum. T-S diagram analysis shows that levels with high N/P values are characterized by nitrate and phosphate concentrations lower than those deduced from mixing alone. Involved waters have been interested by biological processes with a net gain for nutrient assimilation.

It must be mentionned that, in oceanic areas, uptake of nitrate is generally thought to be more rapid than uptake of phosphate, whereas phosphorus tends to be regenerated more rapidly than nitrogen (Mc Gill, 1965). Thus, mediterranean waters seem to be interested by biological processes in such a way that phosphate is more rapidly assimilated and/or nitrate is more rapidly regenerated, confirming a severe phosphorus limitation.

References

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.

Herbland A., Voituriez B., 1977. Production primaire, nitrate et nitrite dans l'Atlantique tropical. Cah. ORSTOM, sér. Océanogr., 15: 47-55.

Ketchum B.H., Ryther J.H., Yentsch C.S., Corwin N., 1958. Productivity in relation to nutrients. Rapp. P.V. Cons int. Explor. Mer,, 144: 132-140.

Mc Gill D.A., 1961. A preliminary study of the oxygen and phosphate distribution in the Mediterranean Sea. Deep-Sea Res., 8: 259-269.

Mc Gill D.A., 1965. The relative supplies of phosphate, nitrate and silicate in the Mediterranean Sea. Comm. int. Mer Medt., 18: 737-744.

Redfield A.C., Ketchum B.H., Richards F.A., 1963. The influence of organisms on the composition of sea water. In: The Sea, ideas and observations on progress in the study of the seas, Vol. 2 (Ed. M.M. Hill) pp. 26-77. J. Wiley and Sons, New York.

C-I9

Effect of a Coastal Current on the Pelagic System off Catalonia (NW Mediterranean)

A. CRUZADO* , R. VARELA* , A. CASTELLON** and M. ESTRADA**

*C.E.A.B., Blanes (Spain)
*I.C.M., Barcelona (Spain)

The Liguro-Provençalo-Catalan current that flows off the NW Mediterranean shelf between the Ligurian Sea and the Ibiza Channel (Font and Miralles, 1978; Font et al., 1988) was studied off Catalonia (Fig. 1) with a Doppler Acoustic Profiler installed on the hull of the B/O GARCIA DEL CID. In this area, the current is found on the slope, over depths of about 1000 m and shows a SW direction with a maximum intensity of about 35 cm s-1 at the surface, linearly decreasing with depth (Fig. 2), and a width of about 15 km.

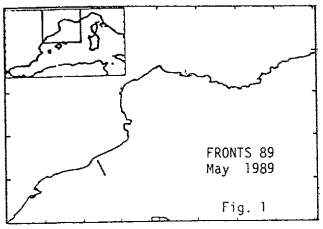


Fig. 1

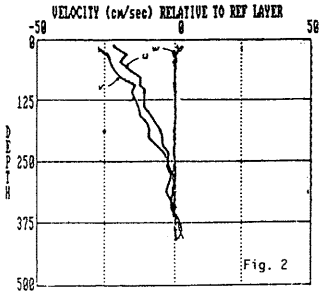


Fig. 2

The density distribution shows values over the shelf lower than those offshore. The former correspond to low salinity coastal water generated in the Gulf of Lions (Castellon et al., 1985) while the latter constitute the high salinity "Mediterranean Water Mass" (Salat and Cruzado. 1981) typical of the central parts of the Liguro-Catalan basin.

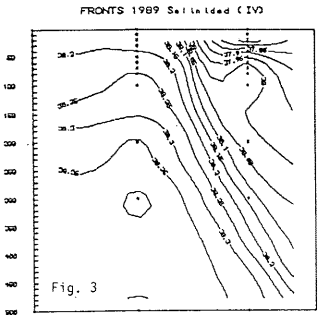


Fig. 3

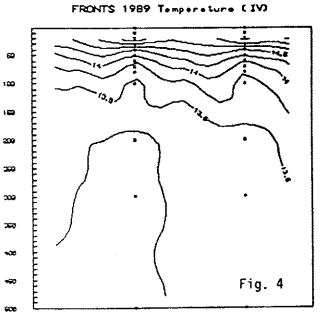


Fig. 4

The structure of the hydrodynamic front formed between the two water masses is best shown by the salinity distribution in various sections along the coast (Fig. 3). The lifting of the isohalines appearing in the central part of the sections is due to the vertical component of the water motion inducing an upward movement at the outer boundary of the current and a downwards movement at the inner boundary. The temperature distribution (Fig. 4) also shows a rising of the 13.5 °C isotherm in the middle of the sections and a sinking in the nearshore side. Some slight rising of the nutrient isopleths is also evident (Fig. 5) while the chlorophyll distribution shows maxima 40 to 50 m deep with greater values at the stations in which lifting occurs (Fig. 6).

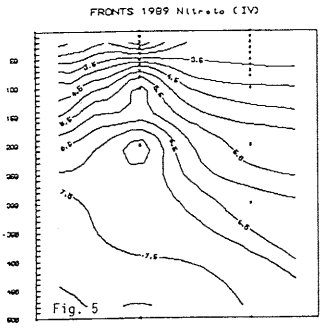


Fig. 5

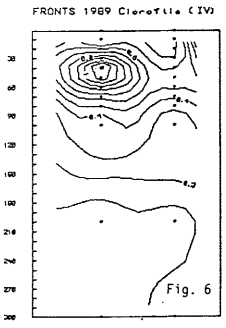


Fig. 6

These observations point out the existence of a hydrodynamic front in equilibrium with the longshore current that separates the less saline coastal water from that more saline offshore. Through the vertical component of the current, the flow of nutrients to the euphotic zone is enhanced at the offshore boundary allowing the phytoplankton community to develop at this boundary a larger biomass than that produced over the shelf.

Castellon, A., J. Salat, M. Maso (1985). Some observations on Rhone freshwater plume in the Catalan coast. Rapp. P.V. Reun. Comm. Int. Explor. Sci. Mer Mediterr., 29(3).

Font, J., Ll. Miralles (1978). Circulacion geostrofica en el Mar Catalan. Result. Exp. Cient. B/O Cornide de Saavedra, 7:155-162.

Font, J., J. Salat, J. Tintore (1988). Permanent features of the circulation in the Catalan Sea. Oceanol. Acta, S-9:51-57.

Salat, J., A. Cruzado (1981). Masses d'eau dans la Mediterranee Occidentale: Mer Catalane et eaux adjacentes. Rapp. P.V. Reun. Comm. Int. Explor. Sci. Mer Mediterr., 27(6):201-209.

C-I10

Facteurs de la Variabilité du Taux de Carbone Organique du sapropèle Holocène de Méditerranée Orientale

Anne MURAT* , Henri GOT** , Gustave CAUWET** et Roselyne BUSCAIL**

*INTECHMER, B.P.324, 50103 Cherbourg Cédex (France)
**LSGM, Université de Perpignan, Avenue de Villeneuve, 66025 Perpignan Cédex France)

Depuis OLAUSSON, (1961), l'existence en Méditerranée orientale de niveaux sédimentaires particuliers, riches en matières organiques : les sapropèles, est connue. La définition la plus complète du terme sapropèle a été donnée par KIDD et al., (1978) : niveau individualisé, d'épaisseur inférieure à un centimètre, dans des sédiments de mer ouverte et contenant plus de 2 % de carbone organique en poids. Il paraissait important pour comprendre le mécanisme de formation de ces niveaux de s'intéresser à la variabilité de leur teneur en carbone organique (C.O.). Pour mener à bien cette étude nous avons disposé de nombreuses carottes prélevées sur l'ensemble du bassin de Méditerranée orientale.

Les échantillons analysés représentent 1 à 2 cm de sédimentation pélagique ou hémipélagique (1 à 10 cm/1000 ans). Les analyses du taux de carbone organique ont été effectuées sur le sédiment total après destruction du carbone minéral par H_3PO_4 ou HCL.

La teneur en C.O. des sapropèles apparait très variable puisque les valeurs maximales obtenues atteignent 18 %.

Elle varie d'abord en fonction de l'épisode sapropélique (MURAT, 1984). Il est donc nécessaire de considérer séparément chacun des épisodes. Nous avons focalisé notre étude sur le sapropèle le plus récent (holocène - S_1) fréquemment recoupé dans les carottes et pour lequel les données disponibles sont donc les plus nombreuses.

Nous avons testé pour ce sapropèle cinq facteurs possibles de la variabilité du taux de C.O. : l'âge, les positions géographique et physiographique, la hauteur d'eau et l'épaisseur du niveau. Trois de ces facteurs ont une influence sur cette variabilité :

- l'âge, nous avons constaté une évolution du taux de C.O. du début à la fin de l'épisode, pour le sapropèle,S_1 les valeurs les plus fortes sont le plus souvent situées au sommet du niveau,
- l'épaisseur et/ou taux de sédimentation et/ou temps de résidence des particules à l'interface eau/sédiment jouent également un rôle. En effet, plus rapidement la matière organique est enfouie mieux elle se conservera. Tous les autres facteurs étant égaux, nous avons constaté que les épisodes les plus épais étaient plus riches en C.O.
- la hauteur d'eau est un facteur déterminant.

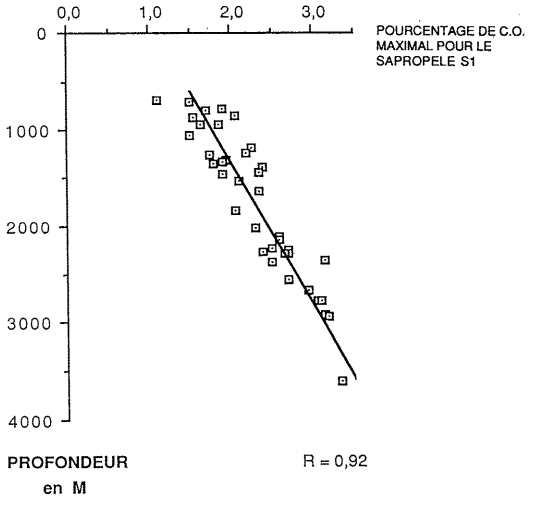
Pour mettre en évidence l'influence de ce dernier facteur, nous n'avons conservé que la valeur maximale de teneur en C.O. en considérant que cette valeur correspond à la phase culminante et que celle-ci est synchrone sur l'ensemble du bassin. Les résultats (cf. fig.) montrent une bonne corrélation linéaire (R = 0,92) entre le taux de C.O. et la hauteur d'eau. L'augmentation du C.O. est régulière avec la profondeur au moins jusqu'à 3600 m (limite des données) sans stabilisation.

Pourtant SUESS (1980) a montré qu'actuellement dans les océans, le flux de carbone organique diminue avec la profondeur car la matière organique est consommée dans la tranche d'eau. Nos résultats sont en apparente contradiction avec cette constatation, puisque les dépôts les plus riches en C.O. sont situés dans les zones les plus profondes correspondant au trajet le plus long et donc à une durée de transport plus importante.

Pour expliquer le gradient de C.O. constaté, il faut admettre les points suivants :

- il existait une stratification des eaux avec une tranche d'eau superficielle normalement oxygénée et productive et une couche profonde s'appauvrissant avec la profondeur en oxydants qui permettent la minéralisation de la matière organique,
- la matière organique produite n'est pas détruite en totalité dans la tranche d'eau superficielle oxygénée,
- une partie importante de la dégradation de la matière organique s'effectue à l'interface eau/sédiment et/ou dans la couche superficielle du sédiment, car étant donné le faible taux de sédimentation, le temps de résidence à l'interface est beaucoup plus élevé que la durée du transit dans la tranche d'eau stagnante,
- la stagnation n'a pas été totale, et même dans les zones les plus profondes, des oxydants devaient être encore disponibles pour minéraliser une partie de la matière organique arrivant à l'interface.

Si tel n'était pas le cas le taux de C.O. se stabiliserait avec la profondeur.



REFERENCES.

KIDD, R.B., CITA, M.B. et RYAN, W.B.F., 1978. Stratigraphy of Eastern Mediterranean sapropel sequences recovered during D.S.D.P. Leg 42 A and their paleoenvironmental signifiance. *In : Init. Rep. D.S.D.P. 42* (1) Washington, pp. 421-433.

MURAT, A., 1984. Séquences et paléoenvironnements marins quaternaires. Une marge active : l'arc hellénique oriental. *Thèse 3e cycle,* Université de Perpignan, 220 p.

OLAUSSON, E., 1961. Studies of deep-sea cores. *Rep. of Swed. deep-sea Exp.*, 1947, 1948, v. 8, fasc. 4, pp. 353-391.

SUESS E., 1980. Particulate organic carbon flux in the oceans - surface productivity and oxygen utilization. *Nature*, 288, pp. 260-263.

C

Bottom Layer Oxygen Depletion - An Increasing Problem in the Adriatic Sea ?

Alenka MALEJ

Marine Biological Station Piran, Institute of Biology, University of Ljubljana, Slovenija (Yugoslavia)

Low dissolved oxygen (DO) or hypoxia (levels below 3 ppm) and anoxia resulting in mass mortalities of benthic organisms is a problem that appears to be in rise in many coastal areas (*Officer et al., 1984; Westernhagen et al., 1986*). The magnitute of hypoxia/anoxia problem is spreading also in some Mediterranean coastal water bodies (*Friligos, 1982*), among others also the Northern Adriatic Sea. Severly hypoxic and even anoxic conditions have been documented in this area several times during last three decades and most recently in November 1989 (*Smodlaka, pers. comm.*).

Although the general processes which govern the bottom water DO levels have been identified and extensively studied there are still uncertainties about the relative importance of individual processes leading to oxygen depletion as well as the role of anthropogenic influences. The most important events in the development of the seasonal anoxia are considered to be the "bottom-sealed-by-pycnocline" phenomenon (*Tolmazin, 1985*), incresed organic loading either from *in situ* production or from allochtonous sources, reduced vertical mixing and lateral exchange. Increased eutrophication, which is blamed for more frequent and more intensive phytoplankton blooms, has also been related to hypoxia/anoxia problem.

The debate on oxygen defficiency and other eutrophication problems intensified during the last decade also in the countries around the Adriatic Sea, where environmental problems have substantial economic significance.

The Gulf of Trieste, the northernmost and the shallowest part of the Adriatic Sea, shows varying degrees of seasonal (late summer-autumn) oxygen depletion in its deeper waters (> 20 m). The annual cycle shows that DO in bottom waters normally declines during mentioned period to a minimum concentration in late August-September. Critically low DO levels and anoxic bottom waters leading to localized benthic mortalities have been observed in 1974, 1980, 1983 and 1987, the areal extent being the largest in September 1983 when about 1/6 of the Gulf's bottom waters were infected. In order to determine the causes and effects of oxygen depletion, a massive sampling programme has been carried out during 1986-89. We studied physical processes affecting bottom DO levels, especially seasonal development of water column stratification, oxygen sources and sinks in the bottom layer as well as sediment biogeochemical processes.

Our estimates indicate (*Malej et al., submitted*) that even during summers not characterized by critically low oxygen levels (like 1986 and 1988), the oxygen demands of the water column above the bottom and sediments in the Gulf of Trieste were large enough to exceed the supply available from *in situ* pelagic (the below pycnocline water column) and bottom (benthic micro algae) photosynthesis, therefore physical mechanisms affecting oxygen resupply must have contributed to slower deep water oxygen depletion.

According to our measurements done during 1986-89 severe hypoxic patches can be expected almost any summer-autumn with unfavourable meteorological conditions in the Gulf of Trieste. The general pattern of observations suggest the central part of the Gulf of Trieste to be most vulnerable and the spreading of hypoxic waters towards the coasts. However, *Faganeli et al. (in press)* who studied paleoenvironmental conditions from a deep 40-m core could not confirm an accelerated rate of organic matter deposition recently. They concluded that past biogeochemical processes in the Gulf of Trieste were not markedly different from those of the present day. Therefore, it seems that anoxic events in the Gulf of Trieste are not of recent origin.

While human activities may still be very important sources of oxygen-demanding loadings to the Gulf, the quantities of some natural sources have not yet been estimated, especially the role of lateral advection, plankton dynamics during the stratified conditions and sediment regeneration. Therefore it would be advisable to:

- monitor DO levels and rates of decline in bottom waters as well as relevant physical properties especially the degree of stratification
- assess quantitatively the man-made and natural oxygen-demanding loadings
- develop a predictive model and long-term trends using available data
- improve our understanding of the dynamic processes in the coastal waters and in meantime
- try to diminish oxygen-demanding loadings which will reduce the likehood of severe hypoxia and anoxia events.

REFERENCES

FAGANELI, J., PEZDIČ, J., OGORELEC, B., HERDNL, G. J., DOLENEC, T. The role of sedimentary biogeochemistry in the formation of hypoxia in shallow coastal waters (Gulf of Trieste, Northern Adriatic). Modern and Ancient Continental Shelf Anoxia, London, 17 - 19 May, 1989, (in press).

FRILIGOS, N. 1982. Some Consequences of the Decomposition of Organic Matter in the Elefsis Bay, an Anoxic Basin. Mar. Pollut. Bull.. 3: 103-106.

MALEJ, A., MALAČIČ, V., TUŠNIK, P. Factors affecting oxygen depletion in the Gulf of Trieste (Northern Adriatic). Chemistry and Ecology (submitted).

TOLMAZIN, D. 1985. Changing coastal oceanography of the Black Sea. Progress in Oceanography 15: 217-276.

WESTERNHAGEN, H.v., HICKEL, W., BAUERFEIND, E., NIERMANN, U., KRÖNCKE, I. 1986. Sources and effects of oxygen defficiencies in the South-Eastern North Sea. Ophelia 26: 457-473.

An Observation on the Occurence of Near-Anoxia Conditions in the Sea of Marmara

O. BASTURK, A. YILMAZ, S. TUGRUL and C. SAYDAM

Middle East Technical University, Institute of Marine Sciences, P.K. 28, Erdemli-Icel (Turkey)

The Sea of Marmara is a relatively small, inter-continental basin with a surface area of 11,500 km² and a volume of 3378 km³ (Özsoy, *et al.*,1986). It shows a transitory character between two semi-enclosed basins, the Black Sea and the Aegean Sea (Figure 1). The existence of less saline (22-24 ppt) Black Sea origin waters over the more saline (38.5 ppt) Mediterranean origin waters forms a strong salinity stratification at about 30m. Subhalocline waters of the Sea of Marmara recieve particulate organic matter, not only trough its own primary production, but also particulate organic matter originated from Black Sea and waste discharges around the İstanbul Metropolitan Area.

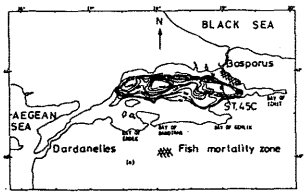


Figure 1. The Bathmetry of the Sea of Marmara (depths in meters) and location of Sta.45C

The stability of the halocline is further increased by thermal stratification developed during summer. The existence of a strong pycnocline prevents aeration of sub-halocline layer. The only possible route for the reaeration of subhalocline layer of the Sea of Marmara is the influx of oxygen rich waters through the Dardanalles lower layer flow. However, oxygen influx by this route is not sufficient to compensate the utilizations by sinking particulate organic matter from euphotic zone, thus the deep basins of the Sea of Marmara contain water with highly depleted oxygen content (1.0-1.5 mg O_2/l). Partial reaeration of the subhalocline waters by wind-induced vertical mixing was observed during late winter of

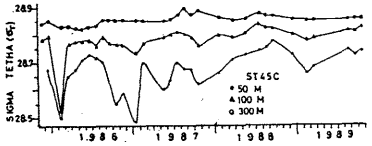


Figure 2. Time-variation of σ_T at Sta.45C for Nov.,1985-Oct., 1989 period

1986 and early spring of 1987 (Figure 2). However, a similar mixing was not seen during 1988-1989, probably due to a milder winter. Increased influx of relatively dense waters of Mediterranean origin (Fig.2) into deep basin of the Marmara during the summer of 1987 increased the stability. This, in turn, increased the AOU (Appearant Oxygen Utilization) levels of sub-halocline waters from about 5.0-5.5 mg O_2/l in 1986 to 6.0-6.5 mg O_2/l in mid-summer of 1987; the AOU, thereafter, increased gradually up to 7.0 mg

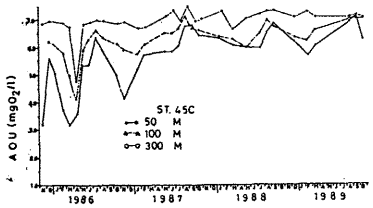


Figure 3. Time-variation of AOU at Sta.45C for Nov.,1985-Oct., 1989 period

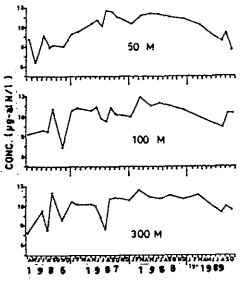


Figure 4. Time-variation of TON at Sta.45C for April,1986-Oct., 1989 period

O_2/l in 1989 (Figure 3). A parallel increase was observed in the level of total oxidized nitrogen ($TO_xN=NO_3+NO_2$) which increased gradually to 11 µM through mid 1988 (Figure 4) and then indicated a decrease towards the end of the year, during which the AOU levels continued to increase. Increased oxygen depletion within the sub-halocline waters and episodic strong northeasterly winds in August, 1989 moved the interface upwards. The oxygen below the halocline was 0.3 mg/l. Mass mortalities of benthic and demersal fish in the region adjacent to the Anatolian coast of the BMU region (Fig.1) were recorded following the observation.

REFERENCES

Özsoy, E., T.Oğuz, M.A.Latif and Ü.Ünlüata, 1986: Oceanography of the Turkish Straits, V.I: Phyiscal Oceanography of the Turkish Straits, First Annual Report, pp:133, METU-Institute of Marine Sciences, Erdemli, İçel

C-I13

Expert System for Phytoplankton Classification (ESPHYNKS)

N. MARBA*, E. MERINO**, A. CRUZADO*, Z. VELASQUEZ* and J. PLUSS**

*Centre d'Estudis Avançats de Blanes, C.S.I.C., Cami de Santa Barbara s/n, Blanes (Spain)
**Facultat de Ciencias Exactas, Ingenieria y Agrimensura, U.N.R., Av. Pellegrini 250, Rosario (Argentina)

The goal of the work reported here was to build a Prototype Expert System for the identification of marine phytoplankton.

The system runs PC -AT compatible computer, an auxiliary video monitoring, a TV camera and a digital video processing card. A comercially available inference tool has been used to facilitate the development task.

At the present stage of prototype development, ESPHYNKS allows identification of 8 phytoplankton genus and 16 species belonging to the genus *Coscinodiscus*. The knowledge base of the system is developed from a matrix (Fig.1) organized with a data base program. The *Coscinodiscus* matrix is composed of seven variables visible under optical inverted microscope, sufficient for unambiguous identification of each species. The data base program is used to explore the combinations of morphological characters for all *Coscinodiscus* species. After testing the matrix, combinations of characters are translated into expert system rules.

SPECIE	AREOLAE ARRAY	CENTRAL AREA	VALVES FORM (AV)	CONCAVE CENTRE	CHROMATOPHORES	TRIM AREOLATION
C. CENTRALIS	RADIAL ROWS	WITH ROSETTE	CONVEX			NO
C. CONCINNUS	RADIAL ROWS	WITH ROSETTE	CONVEX		IN ALL CYTOPLASM	YES
C. CONCINNUS	RADIAL ROWS	FREE AREA	CONVEX			
C. CURVATULUS	GROUPED IN STRIAS					
C. EXCENTRICUS	CURVED TANGENCIAL					
C. GRANII	RADIAL ROWS	WITH ROSETTE	FLAT	YES		YES
C. GIGAS	RADIAL ROWS	FREE AREA	FLAT	YES		NO
C. LINEATUS	STRAIGHT TANGENCIAL					
C. MARGINATUS	IRREGULAR MESH					
C. MODULIFER	RADIAL ROWS	PAPILLAE				
C. NITIDUS	FREE AREOLAE					
C. OCULUS IRIDIS	RADIAL ROWS	WITH ROSETTE	FLAT	YES		NO
C. PERFORATUS	RADIAL ROWS	WITH ROSETTE	FLAT	NO		
C. PERFORATUS	RADIAL ROWS	FREE AREA	FLAT	NO		
C. RADIATUS	RADIAL ROWS	NO SP. FORM				
C. STELLARIS	RADIAL ROWS	STAR LIKE FORM				
C. THORII	RADIAL ROWS	WITH ROSETTE	CONVEX		IN CENTRAL & MARGINAL REGIONS	YES
C. WAILESII	RADIAL ROWS	FREE AREA	FLAT	YES		YES

Fig.1 - Matrix organized with a data base program useful to build the ESPHYNKS knowledge base.

An image bank build from observations of field and laboratory phytoplankton samples under optical and scanning electron microscopes is associated to the knowledge base. During consulting, the system combines image display with questions to facilitate the identification. At the present time the image bank includes more than 450 different views of about 150 species.

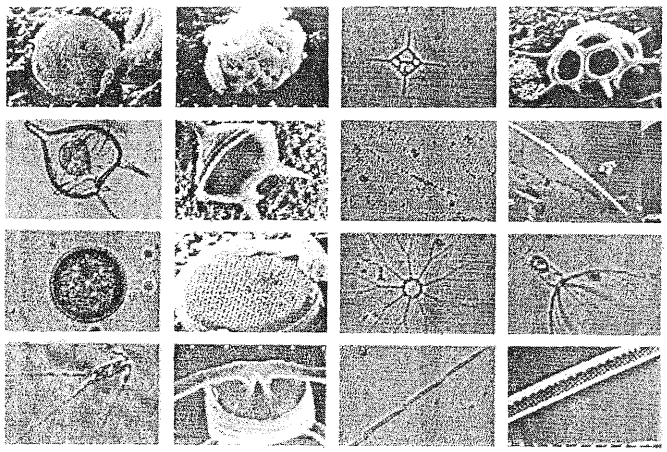


Fig.2 - Reproduction of one of the screens on the auxiliary video monitor. This one presents eight phytoploankton genus included in the system.

ESPHYNKS structure provides different ways for species identification in field samples being observed under the microscope or described by the user. Each session begins presenting a screen (Fig.2) on the auxiliary video monitor with images of the eight phytoplankton genus included in the system. Two possibilities are considered depending on wether the sample is identical or not to one of the images. In the first case, the answer is trivial and the system concludes about the genus directly. In the second, an interactive process isestablished with the user by means of questions, help menus and images displayed on the video monitor leading to the complete determination of the genus. After this first phase is completed satisfactorily, the same procedure is repeated for that particular genus until the species is identified or not, depending on the answers given by the user. Further development of ESPHYNKS would consist on the repetition of the method applied in the construction of the prototype.

This novel computerized system proposes a new way for species classification and greatly facilitates the task to non specialists in the field of phytoplankton (e.g., technicians working in environmental assessment projects, students, etc.). The system is also an excellent tool for educational purposes. The use of relatively inexpensive hardware also allows for remote use of the system once it is fully developed. Experts and technicians around the world may send their own optical or SEM images on diskette or through electronic mail to a central identification centre where full identificationcould be accomplished.

C-II1

Mobility of some Benzene Derivatives on Progressively Dried Fe (III)-Impregnated Silica Gel

Sonja ISKRIC*, Zeljka TOPOLCIC*, Nevenka ZAMBELI** and Olga HADZIJA*

*Ruder Boskovic Institute, Zagreb, Croatia (Yugoslavia)
**Faculty of Pharmacy and Biochemistry, Zagreb, Croatia (Yugoslavia)

It is known that the surface of rocks, sediments and soils have active functional groups, in particular OH, derived from hydrous oxides or organic materials. The hydroxy groups of metal hydroxy/oxides are active factors for processes of interaction with organic ligands i.e. formation of inner sphere surface complexes (1).
In the transformation of iron in soils and sediments, and also in biochemical systems, great importance has been attributed to the dissolution of iron hydrous oxides (2). In natural systems this process is affected by biogenic ligands such as organic acids - dicarboxylic or hydroxy carboxylic. Iron hydrous oxides may differ widely with regard to chemical composition and structure and consequently may have different chemical reactivity (3,4,5,6).
In our work we examined the dependence of the level of hydration of iron hydrous oxides on the behaviour (binding) of some benzene derivatives, as a model system for natural conditions. As the technique thin-layer chromatography on silica gel impregnated with Fe(III)-ions was applied. The plates were prepared by spraying with iron nitrate solution and dried at 140°C for different time intervals. Developers were distilled and tap waters. Organic model compounds were pyrogallol and salicylic acid.
It was found that prolonged drying of the support increased mobility of the compounds. This phenomenon can be explained by formation of different species of silica gel Fe(III) complexes containing decreasing amounts at hydroxy groups and water. The results are given in Table 1. representing the dependence of R_fx100 of the compounds on drying time.

Table 1.

Compound	Time of drying at 140°C		
	5 min	3 h	22 h
Pyrogallol	R_f = 20	R_f = 24	R_f = 54
Salicylic acid	R_f = 30	R_f = 37	R_f = 49

References:

1. W. Stumm, B. Wehrli and E. Wieland, Croat. Chem Acta 60 (1987) 429.
2. W. Stumm, B. Sulzberger, .Siffert, D. Suber and S. Banwart, Mar. Chem., in press
3. W. Schneider and B.B. Schwyn in Aquatic Surface Chemistry, W. Stumm Ed., Wiley and Sons, 1987, p. 167.
4. S. Musić, A. Vertes, G.W. Simmons, I. Nagy-Czako and H.J. Leidheiser, J. Colloid Interface Sci. 85 (1982) 256.
5. O. Hadžija, S. Iskrić and M. Tonković, J. Chromatogr. 402 (1987) 358.
6. O. Hadžija, S. Iskrić and M. Tonković, J. Chromatogr. 464 (1988) 220.

C-II2

Model Investigation of Interaction of some Benzene Derivatives with Metals Related to Soils and Sediments

Zeljka TOPOLCIC*, Suzana CRNADAK*, Sonja ISKRIC**, Nevenka ZAMBELI* and Olga HADZIJA**

*Faculty of Pharmacy and Biochemistry, Zagreb, Croatia (Yugoslavia)
**Ruder Boskovic Institute, Zagreb, Croatia (Yugoslavia)

C

It is considered (1) that processes of alteration and dissolution of minerals of soils and sediments are a consequence of surface reactions occuring, beside the others (such as H+ action), between OH--groups on the surface of hydrous oxides and dissolved organic ligands through coordination and surface complexes formation. Investigation with natural occuring materials (2-4) revealed that in dissolution of metals through complexation the most important role have the compounds with carboxy and hydroxy functional groups. These compounds, being mostly benzene derivatives, are either degradation products of humic material or are found as free molecule in soils and sediments (5-7). These facts initiated us to investigate the chromatographic behaviour of some benzene derivatives on various supports, such as: silica gel (8), alumina and silica gel impregnated with Fe(III) (9), Ca and Mg ions to simulate natural conditions. Organic model compounds were benzene derivatives with carboxy, hydroxy and methoxy groups. Thin layer chromatography was performed using tap and distilled waters as developers.

The following results were found:

- benzene carboxylic and phenolic acids exhibit small mobility on plain plates of silica gel and alumina and also on plates impregnated with Ca and Mg ions. This can be attributed to low solubility of the compounds in water. On the same supports the mobility of the compounds having two hydroxy or an aldehyde group is greater.
- on Fe(III) impregnated plates the mobility of the compounds examined is greater or lesser than on plain plates depending on the properties of the complexes formed with iron oxy/hydroxide. In addition, it is dependent on the way of how the plates are prepared; by prolongation of drying the plates, the mobility of the compounds is increased. This can be explained by decreasing the amount of hydroxy groups and water on the support and thus by different complexes formed.

The chromatographic data obtained can give us some information about the behaviour of the complexes formed as well as about the possible activity of the compounds tested against metal oxides in soils.

References:

1. W. Stumm, B. Wehrli and E. Wieland, Croat. Chem. Acta 60 (1987) 429.
2. M. Schnitzer and S.I.M. Skiner, Soil Sci. 94 (1965) 278.
3. M. Schnizer and P.A. Poabst, Nature (London) 213 (1967) 598.
4. T. Takamatsu, R. Kusakabe and T. Yoshida, Soil Sci. 136 (1983) 371.
5. J.I. Hedges and P.L. Parker, Geochim Cosmochim. Acta 40 (1976) 1019.
6. I. Kogel and R. Bochter, Soil. Biol. Biochem. 17 (1985) 637.
7. G. Eglinton and M.T.J. Murphy, Organic Geochemistry, Springer Verlag, Berlin, 1969, p. 566.
8. O. Hadžija, S. Iskrić and M. Tonković, J. Chromatogr. 402 (1987) 358.
9. O. Hadžija, S. Iskrić and M. Tonković, J. Chromatogr. 464 (1988) 220.

C-II3

Relationship between Specific Surface Area and Bulk Properties of Particulates - Investigation in the Nothern Adriatic

Mladen JURACIC and Neda VDOVIC

Center for Marine Research, "Ruder Boskovic" Institute, Zagreb, Croatia (Yugoslavia)

Geochemical and sedimentological investigations of particulates (suspended matter and sediments) in the northern Adriatic Sea revealed direct relationship between surface properties of particulates (specific surface area, SSA) and granulometric and mineralogic composition. Suspended matter samples, collected by sediment traps, have a mean size between 3 and 10 /um, large quantities of alumosilicates, and SSA between 7 and 23 m^2/g. Investigated sediment samples (surface samples and core samples up to 2 m deep) vary in size between 5 and 180 /um, have carbonate share between 2 and 50 %, and SSA between 1 and 15 m^2/g.

Mineralogic composition and grain size distribution are interrelated indicating that samples having more clay minerals (either sediments or suspended matter) are always fine-grained. On the other hand coarse sediments have more quartz and carbonates.

It was found that the SSA is apparently most dependent to grain size[1]. However, laboratory investigations show that mineralogic composition is the most important factor that governs the SSA of the inorganic core of particulates.

Organic matter found in large concentrations in investigated samples (up to 16.5 %) considerably changes the SSA of investigated samples[2]. In the investigated samples organic matter present in sediment samples usually increases the SSA, whereas the surface of suspended matter is usually blocked by the organics.

References

1. Rabitti, S., Boldrin, A. & Menegazzo Vitturi, L. (1983): Relationship between surface area and grain size in bottom sediments. *J. Sediment.Petrol.*, 53, 665-667.
2. Jednačak-Bišćan, J. & Juračić, M. (1987): Organic matter and surface properties of solid partiles in the estuarine mixing zone. *Mar. Chem.*, 22, 257-261.

C-II4

Determination of Alkylphenol Polyethoxylates and their Metabolites in Estuarine Waters by High-Performance Liquid Chromatography

M. AHEL and S. TERZIC

Center for Marine Research, Rudjer Boskovic Institute, Zagreb (Yugoslavia)

Alcohol polyethoxylates and alkylphenol polyethoxylates (APnEO) represent about 80% of the total manufacture of nonionic surfactants. Their annual consumption figures for Western Europe were in 1987 230 000 and 150 000 tons, respectively. In spite of somewhat lower consumption alkylphenol polyethoxylates are considered ecotoxycologically much more critical compounds than the alcohol polyethoxylates. The reason for that is their higher persistence towards biodegradation as well as the high toxicity of the formed lipophilic metabolites to the aquatic life.

Biogeochemical behaviour of alkylphenol polyethoxylates in the wastewater treatment as well as in various types of freshwaters was recently intensively investigated (1,2) but the reports on APnEO and their metabolites in the marine environment are very scarce.

The results presented in this paper represent the first data on the determination of alkylphenol polyethoxylates and their lipophilic metabolites in the polluted part of the Krka River estuary. The area of investigation is a highly stratified estuary located in the Yugoslav Middle Adriatic region (3).

Grab samples of the surface waters were taken in glass bottles at different distances from the wastewater outlets in the Šibenik Harbour. In addition, samples on the vertical profile of the water column were collected by scuba diving (4).

Table 1. *Concentrations (µg/L) Alkylphenol Plyethoxylates and Their Lipophilic metabolites in the surface Waters (0.5 m) of the Šibenik Harbour*

Location	Distance[a] (m)	NPnEO	NP	NP1EO	NP2EO
SH1	1	72	2.1	26	27
SH2	1	28	2.7	3.4	3.2
SH4	1	19	1.0	2.5	2.7
SH4-A	10	-	0.36	0.64	0.35
SH4-B	100	-	0.064	0.042	0.01
SH4-C	200	-	0.048	0.053	0.020
SH4-D	300	-	0.068	0.057	0.015
SH4-E	400	-	0.058	0.036	<0.01

[a] distance from the sewage outlet

Unfiltered water samples were analysed for APnEO and lipophilic metabolites using highly specific chromatographic methods which were originally developed for the analysis of the freshwater samples (5,6). Briefly, the parent compounds were determined by the reversed-phase HPLC using spectrofluorimetric detection (277/300 nm). Prior HPLC anačysis APnEO were extracted using the standard Wickbold procedure and the extracts were purified on the column of partially deactivated aluminium oxide (5). The lipophilic metabolites (nonylphenol: NP, nonylphenol monoethoxylate: NP1EO, and nonylphenol diethoxylate: NP2EO) were enriched in cyclohexane employing continuous steam-distillation/extraction in a specially designed apparatus and the extracts were directly analysed by the normal-phase HPLC (6).

Table 2 *Vertical Distribution of Lipohphilic Metabolies of Alkylphenol Polyethoxylates in the Water Column of the Šibenik Harbour (µg/L)*

Location/Depth	Salinity (‰)	NP	NP1EO	NP2EO
E4a/0.5 m	13.0	0.054	0.043	0.015
E4a/1.25 m	15.0	0.300	0.036	0.030
E4a/1.5 m	22.0	0.067	0.050	0.013
E4a/6 m	36.5	0.100	0.051	0.017
E4a/20 m	37.5	0.084	0.165	0.031
E4a/40 m	37.5	0.230	<0.010	<0.010

The concentrations of APnEO in the samples taken immediatelly at sewage outlets (Table 1) were very low (7-72 µg/L). The strongly predominant homologues were nonylphenol polyethoxylates while octylphenol polyethoxylates were not detected. The concentrations of the lipophilic metabolites in the same type of samples were, as expected, even lower than the concentrations of parent compounds (1.9-55.1 µg/L) but indicated that they could significantly contribute to the total concentration of the nonylphenol compounds. According to the results presented in the Table 1 it seems that their dispersion and/or elimination in the Šobenik Harbour is very fast. Namely, after 100 m distance from the sewage outlet further decrease of the concentration is not any more significant.

References

1. Ahel, M., *Biogeochemical Behaviour of Alkylphenol Polyethoxylates in the Aquatic Environment*, Ph.D. Thesis, University of Zagreb, **1987**, 200 p.
2. Giger, W.1 Ahel, M.1 Koch, M., *Vom Wasser* **1986**, 67, 69-81.
3. Žutić, V.; Legović, T., *Nature*, **1987**, 328, 612-613.
4. Kniewald, G.; Kwokal, Ž., Branica, M., *Mar. Chem.*, **1987**, 22, 343-352.
5. Ahel, M.; Giger W., *Anal. Chem.*, **1985**, 57, 2584-2590.
6. Ahel, M.; Giger, W., *Anal. Chem.*, **1985**, 57, 1577-1583.

C-II5

Study of Cadmium Interaction with Humic Substances at the Mercury/Water Interface

M. PLAVSIC and B. COSOVIC

Center for the Marine Research, Rudjer Boskovic Institute, P.O. Box 1016, 41001 Zagreb (Yugoslavia)

The fate of many trace substances especially trace metals in natural waters depends on the interaction with present organic matter and different surfaces . A large amount of organic substances beside complexing properties towards metal ions exibit also surface active properties . Because of their characteristic molecular structure consisting of structural groups that have very little affinity for the water phase (hydrophobic groups) together with the groups that have a strong attraction for water (hydrophilic groups). Such organic substances accumulate at different phase boundaries . On that way they mediate the behaviour of trace metals on the phase boundaries . Adsorbed organic compounds on the mineral/water interface can influence dissolution processes and crystal growth as well as adsorption and scavenging processes of microconstituents and contaminants.

Electrochemical investigations of adsorption processes and interactions in the adsorbed layer at the mercury/ water interface were found very useful for the study of interfacial phenomena which are interesting for natural aquatic systems (1,2,3) .

Very useful information on the adsorption behaviour of different organic substances and their mixtures can be obtained by investigation of the influence of the adsorbed layer on the electrode processes of metal ions. So far the reduction process of metal ions at the electrode surface in the presence of the adsorbed organic layer has been studied . This can serve as a simplified model for adsorption and precipitation of metal ions at natural mineral/water phase boundary in the presence of organic coatings.

Additional information on mineral dissolution one can obtain by electrochemical investigation of anodic dissolution of metal at the mercury/ water interface covered by the film of adsorbed organic molecules.

By using differential pulse voltammetry at the HMDE in this work we compare anodic dissolution and cathodic deposition of cadmium in the presence of humic acid in chloride solutions and seawater . The complexing properties of the used humic substance towards cadmium ions were examined as well . The influence of Ca and Mg ions and pH value of solution upon adsorption and interactions of cadmium ions with humic acid were studied.

References:

1. B. Ćosović in W. Stumm (ed.), Chemical Processes in Lakes, Wiley, New York, 1985, 55-80.
2. Z. Kozarac, B. Ćosović and V. Vojvodić, Water Res. 20 (1986) 295-300.
3. M. Plavšić, V. Vojvodić and B. Ćosović, Analyt. Chim. Acta (1990) in press.

C-II6

Electrophoretic Studies of Model Colloidal Systems

Jasenka BISCAN

Center for Marine Research, "Ruder Boskovic" Institute, Zagreb, Croatia (Yugoslavia)

The coexistence of particles having different surface chemical properties, in aqueous solutions, is an essential problem in natural processes. The adsorption of organic molecules(ligands) on the surface of solid particles in such systems depends on the nature of the solid phase and on the conditions of the liquid medium: ionic strength, pH, adsorbate functionality, steric configuration, molecular weight and concentration(1). The adsorption of various ligands influences the stability of the system which is directly reflected on the transport of particles suspended in natural aquatic systems. Especially sensitive and critical zone in natural aquatic systems, is the salinity transition zone within an estuary, where abrupt changes at the solid/liquid interface strongly influence the geochemical fate of suspended particles(2). Electrokinetic study of mixtures of colloidal particles of different composition and surface properties contribute to the understanding of the properties of such systems (3,4).

In this work, the selected mixtures of inorganic oxides (SiO_2, Al_2O_3), clay minerals and carbonates, and organic particles (PS latices, fatty acids and amino acids), suspended in aqueous solutions, represent the models for the studies of the interactions in natural aquatic systems (5,6). Their ***electrophoretic mobilities*** were measured and related to the changes in the composition of both the solid phase and the aqueous solution. The pH range of the solutions were defined taking into account the isoelectric points of the members of the mixed system. The concentration of the electrolyte and other constituents (ligands) were determined according to their significance in natural waters, however, within the limitations determined by the technique used (PenKem S3000 microelectrophoresis).

References

1. R.J. Hunter: Foundation of Colloid Science, Vol.1., Oxford Science Pub., Oxford, 1987.
2. J. Bišćan, I. Rhebergen, M. Juračić, J-M. Mouchel and J-M. Martin: Surface Properties of Suspended Solids and Model Solids in Stratified Estuaries, Marine Chemistry, (1990) in press.
3. R.O. James and G.A. Parks: Characterization of Aqueous Colloids by their Electrical Double Layer and Intrinsic Surface Chemical Properties, in Surface and Colloid Science (E. Matijević Ed.) Vol.12. Plenum Press., New York, 1982.
4. J. Lyklema: Colloid Stability as a Dynamic Phenomena, Pure. Appl. Chem., 52 (1980) 1221-1227.
5. A. S. Rao: Stability of Alumina Dispersions in Presence of Surface Active Agents, Ceramic International, 14 (1988) 49-57.
6. J.Jednačak-Bišćan and D. Čukman: Interactive Forces at Silica/Organic Solution Interfaces, Colloids and Surfaces, 41 (1989) 87-95.

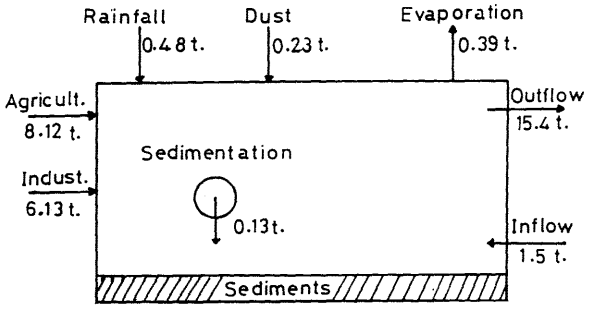
C-II7

An Input/Output Flux for Lead in a Coastal Bay off Alexandria Region

A.-R. ABDEL-MOATI

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

As a consequence of the rapid increase in human population represented as growing industrialization and activities in the adjacent coast of the eastern region of Alexandria coastal belt task of lead pollution has become a serious problem. For a better understanding for the behaviour and impact of lead on the living and non-living resources of the coastal region an overview on the levels and the input and output fluxes of the metal are presented in this paper. The relative importance of the different sources of the metal as well as the environmental capacity of the system are evaluated.



Input/Output flux of Pb in Abu-Kir bay.

Abu-Kir bay is a semicircular bay located 36 Km east of Alexandria city. The area is about 360 Km^2 with an average depth of 12 m. The bay receives 1400 x $10^6 m^3$ of brackish agricultural water/year, in addition to 2 x $10^6 m^3$/day of industrial wastes including textile, paper, dye and weaving, food processing and paper industries. Integrated over the bay area the annual rainfall and evaporation were 82 x $10^6 m^3$/y and 540 x $10^6 m^3$/y, respectively. Assuming the mixing of the bay (of constant volume) the whole year round as well as constancy of the residence time of water, the annual bottom input of the Mediterranean neritic waters to the bay is 19.43 x $10^9 m^3$/y opposed by an outflowing surface water from the bay amounting to 21.1 x $10^9 m^3$/y. The mean water residence time is 2.5 months.

Samples from 10 stations were collected to cover the bay area for determination of dissolved (dithizone/chloroform extraction) and particulate (Tessier et al., 1979) lead, followed by measurements using GFAAS. Mean blanks were 10 ± 1 ng/Kg, triplicates yield a precision of ± 12% while extraction efficiency exceeded 92%. Analysis of NBS (standard River Material) shows 8% deviation while replicates were within 10%. Rain water and airborne dust were collected on 2 gas platforms (near and offshore) away from sea spray as possible.

The mean concentration of Pb in the bay was 658 ng/l of which 73% are in the particulate form. Both the concentrations of dissolved (range 47-630 ng/l) and particulate (range 208-916 ng/l) showed elevations at the nearshore area. The standing stock of lead in the bay water was 2.84 tons. The in/output fluxes of Pb to and from Abu-Kir bay are represented in the box diagram.

The main features of the lead balance are 1) Despite the increase in the concentration of industrial derived Pb (8.4 µg/l), its magnitude is less significant than agricultural derived lead. 2) 40% of industrial lead is derived from raw textile wastes resulting from dyes used in finishing processes, 13% via electric power plant, 8% from paper industry, 5% through fertilizers industry, the rest distributed among waste water and organic chemicals. 3) Normalized to Pb/Al in crustal material lead is enriched (EF=19.2x10^{-5}) in rain water. 4) The average airborne lead concentrations (1.8 µg/m^2/day) is 6 times higher than those reported over central Alexandria city. 5) Atmospheric input accounts for 5% of the total lead input to the bay, the magnitude of which is masked by huge land-runoff derived lead. 6) The bulk sedimentation rate of Pb (using sedimentation traps) was 95 Kg/y yielding high sediment concentrations (>64 µg/g) in the nearshore zone. 7) About 0.6 tons of Pb are accumulated in the water system 30% of which were observed in phyto-and zooplankton. 8) The residence time for Pb was 0.17 years. 9) Quantification of Pb derived from scrap metal during ships dismantling, expore to $(CH_3)_4Pb$ and $(C_2H_5)_4Pb$ used as petrol ingradients and the use of Pb as an anticorrosive primer paint for ships, are hardly difficult.

Assuming linear relation between loading and Pb concentration in the bay, the assimilative capacity of the bay amounted to 25 ton y^{-1}/µg l^{-1}. 10% annual reduction in the present day load of Pb to the bay for about 11.2 years, leading to a reduction of 2.5 tons, will pass by Pb to a safe concentration limit of 100 ng/l.

References

Tessier, A.; P. Campbell & M. Bisson (1979). Analytical Chemistry, 5: 844-851.

C-II8

Adsorption of Cadmium and Lead Ions on Calcite in Estuarine Waters and Seawater

Sonja KOZAR*, Halka BILINSKI** and Marko BRANICA*

*Centre for Marine Research, Zagreb (Yugoslavia)
**Department of Physical Chemistry, "Rudjer Boskovic" Institute, 41001 Zagreb (Yugoslavia)

According to classification of **Whitfield** and **Turner** (1987), toxic cadmium shows deep-sea profiles characteristic of the recycled elements. It is held in the organic matrix via sulfur bonds. **Price** and **Morel** (1990) reported cadmium substitution for zinc in the marine diatom Thalassiosira weissflogii and have attempted to explain cadmium surface depletion relative to deep waters.

Regarding inorganic particles, we have shown that cadmium had very poor affinity for SiO_2, Al_2O_3 (Bilinski et al., 1976), for MnO_2 (**Bilinski et al.**, 1977), for bentonite and kaolinite (**Bilinski et al.**, 1990a). Cadmium could be adsorbed on synthesized northupite (**Vančina et al.**, 1986) and on calcite (**Bilinski et al.**, 1990b).

In the present work the primary interest is on the simultaneous interaction of cadmium and lead ions with calcite, which mineral is present in surface sediments in the Krka River Estuary.

Cadmium and lead ions were added to natural water samples in low concentrations (8×10^{-8} M) to have solutions undersaturated with respect to $CdCO_3(s)$ and $PbCO_3(s)$. Adsorption isotherms of simultaneously and individually adsorbed cadmium and lead ions show that the two ions do not compete for the same surface sites. This fact can be explained comparing ionic radii and chrystallographic space groups of corresponding metal carbonates. So, Ca^{2+} and Cd^{2+} have similar and Pb^{2+} has greater ionic radius ($r(Ca^{2+}) = 0.99$ A; $r(Cd^{2+}) = 0.97$ A; $r(Pb^{2+}) = 1.20$ A). Calcium and cadmium carbonates crystallize in R3C space group and show similar parameters of the unit cell (ASTM, 8-456 and 5-586) while lead carbonate crystallizes in Pmcn group (ASTM, 5-417). Behaviour of cadmium can be directly compared with one observed for zinc by **Zachara et al.** (1988). Zinc carbonate also shows R3C space group (ASTM, 8-449). Analogously to zinc ion, cadmium can exchange with calcium ion, present at the surface layer of calcite. As Ca^{2+} and CO_3^{2-} species have been identified as the only major surface ions on calcite (**Thompson et al.**, 1989), it can be concluded that lead ion adsorbs via surface CO_3^{2-} group.

LITERATURE:

Whitfield, M., and Turner, D.R. (1987) Ch.17. The role of particles in regulating the composition of seawater. In: Aquatic Surface Chemistry (ed. W. Stumm), John Wiley & Sons, New York, 457-493.

Price, N.M., and Morel, M.M. (1990), Cadmium and cobalt substitution for zinc in a marine diatom, Nature, **344**, 658-660.

Bilinski, H., Kozar, S., and Branica, M. (1976), Adsorption of trace heavy metals on particulate matter in seawater, In: Colloid and Interface Sci. V. (Ed. M. Kerker), Academic Press, New York, 211-231.

Bilinski, H., Kozar, S., Kwokal, Z., and Branica, M. (1977), Model adsorption studies of Pb(II), Cu(II), Zn(II) and Cd(II) on MnO_2, added to Adriatic seawater samples, Thalassia Jugosl., **13**, 101-108.

Bilinski, H., Kozar, S., Plavšić, M., Kwokal, Z., and Branica, M. (1990a), Trace metal adsorption on inorganic solid phases under estuarine conditions, Mar. Chem., in press.

Vančina, V., Plavšić, M., Bilinski, H., Branica, M., and Millero, F.J. (1986), Preparation and solublity of northupite from brine and its adsorption properties for Cu(II) and Cd(II) in seawater, Geochim. Cosmochim. Acta 50, 1329-1336.

Bilinski, H., Kwokal, Z., Kozar, S., and Branica, M., (1990b), Scavenging of mercury and cadmium ions in the Krka River Estuary, Book of Abstr., 11th Int. Symp. "Chemistry of the Mediterranean", "Reactivity of Chemical Species in Aquatic Environments", Primošten, May 9-16, 1990, p. 124.

Zachara, J.M., Kittrick, J.A., and Harsh, J.B. (1988), The mechanism of Zn^{2+} adsorption on calcite, Geochim. Cosmochim. Acta, 52, 2281-2291.

Thompson, D.W., and Pownall, P.M. (1989), Surface electrical properties of calcite, J. Colloid. Int. Sci., 131, 74-81.

C-II9

Fate of Trace Elements (Co, Sb, Zn) Entering Saronikos Gulf, Greece

N. KALOGEROPOULOS*, M. VASSILAKI-GRIMANI** and A.-P. GRIMANIS**

*National Centre for Marine Research, Athens (Greece)
**Radioanalytical Laboratory, NCRPS "Demokritos", Athens (Greece)

INTRODUCTION

Saronikos Gulf receiving the industrial and domestic wastes of the greater Athens area is among the most polluted gulfs of Greece. In order to study the fates and pathways of trace elements in Saronikos Gulf, several sampling cruises were organised and a big number of seawater and sediment core samples were collected from several stations (See Fig. 1). The trace element content of the samples was determined by Instrumental Neutron Activation Analysis. The results obtained for three selected trace metals namely cobalt, antimony and zinc, are presented and discussed.

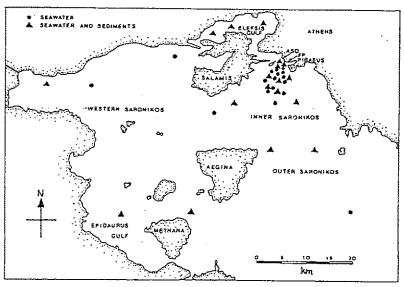


Figure 1. Sampling Stations

DISCUSSION

-The main pollution sources of the trace elements studied are the Athens Sewage Outfall (ASO) and a big Fertiliser Plant (FP) at the entrance of Piraeus Harbour where the highest concentrations of Co, Sb and Zn in seawater and sediments were observed (See Tab. 1 and 2).

-The settling of particles and flocs in the area of the outfall is very effective in removing the bulk of these trace elements from the water column, since their concentrations decrease with distance from the sources to reach those of unpolluted coastal regions at a distance of 5-7 Km. The rapid sedimentation was confirmed by the analysis of particulate matter which revealed that with the exception of the area close to the point sources where 15-25% of total Co, Sb and Zn were found to be associated with particulate matter, the bulk of the elements in seawater were in dissolved forms which constituted 95-99% of their total concentrations in the rest of the stations.

-The concentrations of Co and Sb in seawater and sediments of Inner Saronikos were almost equal to those of the Open Saronikos, while the respective Zn levels were higher in the Inner Gulf. In the water column the higher concentrations were observed in summer samples. The following can be considered as typical concentrations for the waters of open Saronikos: Co: 0.090±0.014 µg/l, Sb: 0.23±0.11 µg/l and Zn: 4.8±3.0 µg/l. For the open Saronikos sediments the respective values are: Co: 9.2±0.41 µg/g, Sb: 0.43±0.13 µg/g and Zn: 83±5.8 µg/g.

-A distinction among the point sources was possible by means of sediment treatment with 0.5N HCl, which extracts the "anthropogenic" fraction of trace elements (Agemian and Chau, 1976). It was found that 40-60% of total Zn and Co were in extractable form in the sewage outfall cores, while in sediments affected by the fertiliser plant solid wastes (gypsum, pyrites, phosphorites etc) this fraction was much lower, ranging from 6-18%.

-A correlation study among several trace elements and organic carbon in the "anthropogenic" fraction of the sediments revealed that the easily dissolved iron forms and the organic matter on recent particle coatings affect the distribution of Co, Sb and Zn in the Saronikos sediments. Furthermore, concerning the distribution patterns of trace elements in polluted and not polluted samples, it was documented that Zn and Co in Saronikos Gulf behave in a similar manner with other trace elements of anthropogenic origin like Ag, Cr, V (Kalogeropoulos et al., 1989), while Sb together with As consist a distinct group mainly as a result of their distribution in the polluted samples (Grimanis et al., 1984; 1988).

TABLE 1. Cobalt, antimony and zinc seawater (µg/l). Average values are given parentheses

AREA	COBALT	ANTIMONY	ZINC
ASO, FP	0.12-0.60 (0.22)	0.60-1.40 (1.0)	9.0-41 (19)
Inner Saronikos	0.03-0.18 (0.10)	0.16-0.55 (0.29)	0.5-19 (10)
Outer Saronikos	0.03-0.16 (0.09)	0.11-0.31 (0.23)	0.5-14 (4.8)

TABLE 2. Cobalt antimony and zinc in silt-clay fraction of sediments (ug/g). Average values are given in parentheses.

AREA	COBALT	ANTIMONY	ZINC
Fertiliser Plant	35-87 (54)	14-100 (60)	840-2100 (1520)
Sewage Outfall	13-24 (18)	6.6-32 (16)	220-620 (430)
Inner Saronikos	8.6-9.6 (8.0)	0.48-0.72 (0.57)	81-110 (91)
Outer Saronikos	7.8-10 (9.2)	0.31-0.60 (0.43)	68-100 (83)

ACKNOWLEDGMENTS The partial financial support of this work by the IAEA (R. Contract E/4544) is gratefully acknowledged.

REFERENCES

AGEMIAN, F. and A.S.Y. CHAU, 1976. Analyst, **101**, 761-767.

GRIMANIS A.P., D. ZAFIROPOULOS, N. KALOGEROPOULOS and M. VASSILAKI GRIMANI, 1984. VIIes Journ. Etud. Pollution, Lucerne, CIESM, 391-397.

GRIMANIS A.P., N. KALOGEROPOULOS and M. VASSILAKI-GRIMANI, 1988. Rapp. Comm. Int. Mer Medit., **31**, 2, p. 160.

KALOGEROPOULOS N., M. SCOULLOS, M. VASSILAKI-GRIMANI and A.P. GRIMANIS, 1989. Sci. Total Environ., **79**, 241-252.

Dissolved and Particulate Mercury Concentration in Seawater collected during the *Discovery* and *Bannock* Cruises (EROS 2000 Project)

R. FERRARA, B.-E. MASERTI and M. MORELLI

C.N.R., Istituto di Biofisica, Via San Lorenzo 26, 56100 Pisa (Italia)

This paper reports data on dissolved and particulate mercury in seawater samples collected during two field studies in the sea region of the Gulf of Lions, performed in the frame of EROS 2000 project (1988-1989).
As regards the study area, sampling station positions and notations, refer to the cruise and scientific reports prepared by Dr. Fauzi-Mantoura (Plymouth Marine Laboratory, UK) and by Dr. R. Ferrara / A. Seritti (CNR-Istituto di Biofisica, Pisa, I) respectively.

C

EXPERIMENTAL

Seawater was filtered on 0.45 μm pretreated membrane filter (Sartorius SM11306) in a closed device, under nitrogen pressure.
400 ml of filtered seawater were photooxidized for 15 min by means of a U.V. immersion lamp (90 W), after an addition of 400 μl of an acid solution of $KMNO_4$. The ionic mercury was reduced by tin chloride and transferred on gold trap, as described elsewhere (1). Determination of mercury, electrothermally desorbed, was achieved by an atomic fluorescence spectrometer.
Filters containing particulate suspended matter, were mineralized with 3 ml of HNO_3 (Merck selectipur) in a pressure digestion system for 2 hours at 160°C. Mercury was determined as described for the dissolved form.

RESULTS

Table 1 and table 2 show the mercury concentration measured in the studied area during the two cruises.
From the tables it appears that the mercury levels are quite low and comparable with those measured for other areas of the Mediterranean basin (2,3,4), with the exception of the sampling station 8, where values are very high with respect to the mean value of the other stations. No variation of the metal concentration was noted as a function of the depth and in function of the season of collection.
Rather low values for the mercury associated to the particulate matter have been observed in the station 25 at about 40 miles from the coast.

DISCOVERY CRUISE Leg 1 (13-26 December 1988).

St	Depth	LatN	LongE	Hg D	St	Depth	LatN	LongE	Hg D
MA5	5	43 03.6	04 50.2	3.2	MC2	25	42 22.6	04 01.9	3.0
MA5	20			5.3	MC3	21	42 45.0	04 19.9	4.2
MA5	40			6.1	MD1	31	42 51.9	03 41.9	3.0
MA5	71			4.7	MD2	20	43 01.3	04 04.9	3.6
MA5	89			3.9	ME1	5	43 24.3	04 01.1	4.7
MA5	105			5.3	ME2	4	43 18.8	04 25.4	4.1
MA6	3	43.17.3	04 50.6	4.9	MF1	-	42 44.4	06 00.6	4.9
MA7	-	43 12.8	04 49.6	4.2	MF2	40	42 55.2	05 37.8	2.8
MA8	4	43 07.5	04 48.6	17.4	MF3	50	43 03.0	05 19.6	5.7
MC1	25	41 59.9	03 36.7	7.9	MF4	5	43 10.6	05 07.3	4.8

Table 1 - Dissolved mercury concentration in seawater (ng/l); Depth (m).

BANNOCK CRUISE (1-15 JULY 1989)

St	Depth	LatN	LongE	HgD	HgP	St	Depth	LatN	LongE	HgD	HgP
04	0	43 24.3	04 00.7	4.4	0.4	18	0	43 02.6	05 02.9	3.8	0.7
04	5			2.7	---	18	5			5.1	---
04	16			7.5	0.1	18	15			5.1	---
04	25			4.5	0.1	18	55			5.5	---
						18	145			5.7	0.9
05	0	43 20.3	04 17.9	4.8	8.4	18	295			5.4	0.5
08	0	43 15.9	04 57.4	13.6	13.3	20	0	41 45.4	05 37.1	19.1	0.3
08	5			13.5	2.4						
08	10			10.3	1.9	25	0	42 27.1	05 18.3	5.2	---
08	20			7.1	1.3	25	5			4.1	0.2
08	45			21.5	4.4	25	10			3.7	0.2
08	70			19.4	4.5	25	25			5.7	0.8
						25	35			5.7	0.1
09	0	43 13.5	04 51.1	8.5	3.9	25	50			4.2	0.8
						25	75			5.1	0.2
10	0	43 08.7	04 29.9	4.3	1.7	25	100			5.2	0.3
						25	150			4.2	0.2
11	0	43 02.4	04 09.2	4.7	1.3	25	300			4.3	0.2
						25	480			3.3	0.2
12	0	42 53.0	03 40.6	7.5	1.5						
12	8			8.7	3.5	**Samples in front of Rhone estuary**					
12	20			8.2	1.5	A	0			4.9	0.6
12	50			6.1	2.6	B	0			6.6	0.5
12	70			4.8	0.6	C	0			4.5	1.2

Table 2 - Concentration (ng/l) of dissolved mercury (HgD), mercury associated with particulate suspended matter (HgP) in seawater. Depth (m).

These data confirm the difficulty of finding an explanation for the problem of the high mercury concentrations in pelagic fish in the Mediterranean basin, as the concentration measured in the Mediterranean are quite comparable to those in the oceans (5).

REFERENCES

1 - Ferrara, R., Seritti, A., Barghigiani, C. and Petrosino, A. (1980). Anal. Chem. 117: 391-395.
2 - Copin-Montegut, G., Courau, P. and Nicolas, E. (1986). Mar. Chem. 18: 189-195.
3 - Ferrara, R. and Maserti, B.E. (1988). Mar. Pollut. Bull. 19: 387-388.
4 - Ferrara, R., Maserti, B.E. and Zanaboni, C. (1989). Sci. Total Environ. 84: 129-134.
5 - Gill, G.A. and Fitzgerald, W. (1985). Deep Sea Res. 32: 287-297.

This research has been undertaken in the framework of the "EROS 2000" (European River Ocean System) project. We kindly acknowledge the support from the Commission of the European Communities 4th Environment R&D Programme under contract EV4V-0111-F.

Mercury Speciation in Water of the Krka River Estuary

N. MIKAC, Z. KWOKAL and M. BRANICA

Center for Marine Research, Ruder Boskovic Institute, P.O.B. 1016, 41001 Zagreb, Croatia (Yugoslavia)

Research studies concerning the mercury cycle in the Krka River Estuary have been carried out since 1983. Preliminary results showed relatively low mercury levels in sediments and mussels *Mytilus galloprovincialis* from this area (1). The mercury levels in estuarine water and seawater are comparable with the values found recently in unpolluted coastal areas and open ocean waters (1). The vertical distribution of mercury concentraction in this highly stratified estuary indicates the mercury accumulation at the fresh/saline water interface (1,2). A proportion of organic mercury in various samples has also been measured. The methylmercury was found in sediments, mussels and fish, but not in water (1). Further investigations will be focused on the study of mercury speciation in water, especially at the fresh/saline water interface.

During 1988 and 1989 distributions of reactive and total as well as dissolved and particulate mercury in estuarine waters were investigated. Reactive mercury-$(Hg)_R$ concentration measurements represent those Hg species that are readily reducible by $SnCl_2$ in acidified water. It is composed of dissolved inorganic Hg species; certain mercury associations with organic ligands and in unfiltered water sample the mercury which is easily leached from particulate matter. Total mercury-$(Hg)_T$ refers to the amount of Hg measured after UV-photochemical destruction of samples and will also include stable organomercury associations. It was found that the reactive mercury in unfiltered water generally corresponds to the values of the dissolved mercury fraction. This is in accordance with the fact that the dissolved mercury was mostly inorganic, both in fresh and saline water. A positive correlation between the difference of total and reactive mercury concentrations and quantity of suspended matter, as well as with the concentration of particulate mercury has been found in unfiltered estuarine water. From this it can be concluded that particulate mercury is predominatly bound in organic complexes.

In the deeper saline water layer, over 80 % of the total mercury is reactive Hg. However, this percentage changed in the upper layer, depending on hydrological and/or biological conditions. For example, the portion of reactive mercury in unfiltered samples from the upper layer at the low river discharge

Table 1. Concentrations of reactive and total mercury (ng dm^{-3}) in unfiltered samples from the upper water layer (0.5 m) of the Krka River Estuary

	January 1989 (Q = 16 $m^3 s^{-1}$)				July 1989 (Q = 51 $m^3 s^{-1}$)			
L(km)[a]	S(‰)	$(Hg)_R$	$(Hg)_T$	$\%(Hg)_R$	S(‰)	$(Hg)_R$	$(Hg)_T$	$\%(Hg)_R$
0	0	0.3	0.8	38	0	0.3	1.0	30
1	-	-	-	-	1	0.1	0.5	20
4	3	0.7	0.7	100	2	0.1	0.9	11
10	10	0.4	0.7	57	5	0.2	1.0	20
17	16	1.3	1.9	68	7	0.1	1.2	8
22	25	1.1	1.4	79	14	0.3	1.5	20
32	38	0.8	0.9	90	38	1.2	1.2	100

[a] Distance from the begining of the estuary in seaward direction

(January 1989) was significantly greater than at the high river flow in July 1989 (Table 1), reflecting the influence of hydrological conditions.

Speciation of mercury along the vertical water profile showed a minimum of the particulate mercury at the interface of fresh and saline layers. This finding is in accordance with the presumption that particles accumulated at the interface (3) release mercury owing to dissolution as a result of increased salinity (aglomeration of organic matter, competition of macrocations and complexation by chloride).

Further investigations on the mercury speciation in water will contribute to a better understanding of the biogeochemical cycle of mercury in stratified estuaries as well as of mechanisms regulating mercury behaviour at the boundary conditions which are prevailing at the fresh/saline water interface.

1. Mikac,N., Kwokal,Ž., May,K. and Branica,M., Mar.Chem. 28 (1989) 109.
2. Kniewald,G., Kwokal,Ž. and Branica,M., Mar.Chem. 22 (1987) 343.
3. Žutić,V. and Legović,T. Nature 328 (1987) 612.

C-II12

Speciation of Fe, Mn, Zn, Cu and Pb in the Inner-Shelf Sediments off Alexandria

S.-N. NASR*, I.-H. ELSOKKARY**, A.-A. FAKHRY*** and I.-A. EL-SHIBINY*

*Department of Environmental Studies, Institute of Graduate Studies and Research, Alexandria University (Egypt)
**Soil and Water Science Department, Alexandria University (Egypt)
***National Research Centre, Cairo (Egypt)

A chemical speciation study for the bottom sediments of the coastal belt off Alexandria has been conducted for iron, manganese, zinc, copper and lead. The purpose of the search is to demonstrate in which forms these metals are chemically associated, as well as, to differentiate between the residual metals (natural background) and non-residual ones (man-made sources of pollution). To acheive these objectives, twelve bottom samples were collected along the coastal water off

Table(1): Ranges and averages for different metal extracts(ppm)

Fraction	Exchangable (EXCH)		Carbonate (CARB)		Easly reducible (EASR)		Organic matter (ORGS)		Residual (RESD)	
Metal	range	aver.	range	aver.	range	average	range	average	range	average
Fe	8.87-22.2	12.97	8.89-37.72	24.65	16.29-33.85	25.24	15.28-36.95	25.24	997.59-1881.95	1482
Mn	N.D-2.2	1.48	6.5-14.3	9.79	3.8-18.8	4.77	N.D.-4.85	1.85	85-166.3	125.58
Zn	1.8-2.2	1.79	4.98-21.1	9.85	N.D.-4.35	2.77	N.D.-4.35	2.87	25.83-93.73	48.83
Cu	N.D.-3.56	1.31	3.8-5.88	4.84	N.D.-2.2	8.43	N.D.-5.75	1.46	5.73-39.85	14.11
Pb	N.D.-7.52	2.69	6.25-22.5	11.82	N.D.-12.5	4.89	N.D.-7.58	1.34	27.29-65.8	48.5

* Not Detected.

Alexandria city. Following the procedures described by Tessier et al.(1979) and Rapiń and Forstner(1983), the suspensions of fine fraction sediments (0.250-0.125 mm) were sequentially fractionated to determine the levels of different metals in the following geochemical fractions: exchangeable (EXCH), carbonate (CARB), easily reducible (EASR), organic matter including sulphides (ORGS) and residual (RESD). The total metal contents in sediments (TOT) was determined after digesting the sediments with concentrated HNO3. pH, organic carbon, total carbonate and Fe-Mn oxides were estimated for correlation with the different forms of

Table(2): Ranges and averages for the total concentrations(TOT) of investigated metals(ppm).

Metal	Range	Average
Fe	1457.8-3813.4	2296.4
Mn	125 - 288	182.29
Zn	48.93-148.23	74.56
Cu	16.88-62.88	29.42
Pb	43.23-127.2	71.52

metal associations. This study revealed that the recorded high levels of metals obsrved in the investigated area are due to natural phenomena, as well as anthropogenic inputs. The levels of different metal extracts, and the total metal concentrations are shown in tables 1 and 2. Results showed that the recorded levels of the examined metal fractions are represented in the following sequence: RESD>EASR=ORGS>CARB>EXCH for iron,
RESD>CARB>EASR>ORGS>EXCH for manganese,
RESD>CARB>EASR>ORGS>EXCH for zinc,
RESD>CARB>ORGS>EXCH>EASR for copper
and finally RESD>CARB>EASR>EXCH>ORGS for lead.
The characteristic high content in the residual fractions for the different metals emphasises the strong influence of water discharge and sediment influx from the river Nile into the Mediterranean Sea (UNEP,1984). This mean that, considerable amounts of heavy metals are transported naturally into the Mediterranean as background contribtions. Among the non-residual metal fractions, the carbonate associated metals showed noticeably high concentrations of Fe, Mn, Zn, Cu and Pb in comparsion with the other extractions. This could be attributed to the prevalence of carbonate materials in the investigated area(El-Wakeel and El-Sayed,1978; Nasr et al.1988 and 1989) which offer favourable conditions for the heavy metals to be associated with them. The non-residual metal forms (man-made sources) represent 5.88% of the total extractable fractions for iron, 12.85% for manganese, 25.44% for zinc, 38.98% for copper and 31.06% for lead. These figures reflect a quite evident pollution with zinc, copper and lead in the investigated area. Correlation matrix has been carried out to highlight the interrelationship among different studied parameters.

REFERENCES

El-Wakeel,S.K. and El-Sayed,M.Kh.(1978).The Texture, mineralogy and chemistry of bottom sediments and beach sands from Alexandria region, Egypt. Mar.Geol.,27 :137-160.
Nasr,S.M., Elsokkary,I.H., Fakhry,A.A.and El-Shibiny,I.A.(1988) Pollution Effect on coastal sediments of Alexandria. Proc. Symp. Environ. Sci.(UNARC),Alexandria,Ed. M.El_Raey :181-197.
Nasr,S.M., Elsokkary,I.H., Fakhry,A.A. and El-Shibiny,I.A.(1989) Industrial and domestic sewage pollution in sediments of coastal area of Alexandria. Proc. Conference on Marine Environment Protection.United Arab Emirates University.Al Ain,23-24 May 1989.
Rapin,F. and Forstner,U.(1983). Proc. Int. Conf. on heavy metals in the environment. Heidelberg, Ed. G.Muller.
Tessier,A. Campbell,P.G. and Bisson,M. (1979). Anal.Chem. V.51,N.1 :844-851.
UNEP Report(1984). Pollutants from land-based sources in the Mediterranean. UNEP Regional Seas Reports and Studies. N.32.

C-II13

Redox Distribution of Uranium Species in Suboxic Marine Environments

Goran KNIEWALD and Marko BRANICA

Center for Marine Research, "Ruder Boskovic" Institute, P.O.Box 1016, 41001 Zagreb (Yugoslavia)

Uranium is a member of the 5f (actinide) series of elements, all of which have a pronounced inherent sensitivity to the redox state of the environment. There are six well defined oxidation states of uranium which occur in nature. In the marine environment, including the complete vertical water column from the surface layer of the ocean down to the bottom sediments, three oxidation states of uranium - U(IV), U(V) and U(VI) - can coexist. In oxygenated seawater uranium is associated with the carbonate ion forming the very stable $UO_2(CO_3)_3^{4-}$ complex. This results in the rather high dissolved uranium concentration in the ocean, the average values being 3.3 ug L^{-1} (Chen et al., 1986). In the euphotic zone of the ocean, mixed complexes between uranium, carbonate and peroxide may be significant (Djogić and Branica, 1990).

In sedimentary processes the uranyl species are reduced to lower oxidation states and are incorporated into insoluble uranium minerals or bound to particulate organic matter. The problem of the solid(s) limiting the solubility of uranium in seawater, and thus also its concentration, remains unsolved and minerals such as uraninite, schoepite, haiweeite and others have been deemed responsible as the solubility controling solids. Under all circumstances, the oxidation state of uranium depends on the stability of reduced uranium species, which involves complex redox equilibria and processes sensitive to system parameters such as Eh-pe, pH, concentration of dissolved and particulate organic matter, free radical activity and degree of anoxia.

In the transitional suboxic/anoxic layers of the water column, particularly if the oxygen/hydrogen sulfide interface is involved, uranium(V), i.e. UO_2^+ species are thermodynamically stable (Langmuir, 1978; Kniewald and Branica, 1988). However, at the pH of seawater, the disproportionation reaction of U(V) into the (IV) and (VI) oxidation states is a feedback process resulting in a "dynamic disequilibrium" between dissolved U(VI) and U(V) species and U(V) precipitation.

The geochemical equilibrium computer code MINTEQ (Felmy et al., 1984) was used to evaluate the thermodynamic likelyhood of various uranium redox reactions under conditions of low Eh prevailing in reducing marine environments. The two probable mechanisms of reduction are:

a) reduction of dissolved UO_2^{2+} to dissolved UO_2^+ involving a kinetic equilibrium between the disproportionation reaction and the precipitation of insoluble U(V) and U(IV).

   Preliminary investigations of UO_2^+ formation in seawater, using visible and ultraviolet spectrophotometry yielded encouraging results and provide evidence that even dissolved U(V) species (the UO_2^+ cationic complex) is a probable redox species to be encountered in suboxic marine milieus, because the reduction from UO_2^{2+} to UO_2^+ involves no structural changes of the UO_2^{n+} (n = 1 or 2) ion.

b) binding of U(VI) to particulate/suspended organic matter (such as humic material) and its subsequent reduction to the less soluble redox species of U(V) and U(IV) during early diagenetic stages. This reduction process may take place at the solid/liquid interface, either in suspension or in the sediment proper.

Nonetheless, a combination of these mechanisms is also possible and will obviously depend on the prevailing redox potential of the environment, supply of DOM and POM, structure and texture of the sediment, dynamics of water exchange as well as the activity of anaerobic microorganisms.

Literature:

Chen, J.H., Edwards, R.L. and Wasserburg, G.J. (1986): Uranium-238, uranium-234 and thorium-234 in seawater. Earth Planet. Sci., Letters, 80, 241-251.

Djogić, R. and Branica, M. (1990): Characterization of dissolved uranyl species in seawater. Presented at the 11th International Symposium "Chemistry of the Mediterranean", May 1990, Primošten, Yugoslavia.

Felmy, A.R., Girvin, D.C. and Jenne, E.A. (1984): MINTEQ - a computer program for calculating aqueous geochemical equilibria. US-EPA, EPA-600/3-84-032.

Kniewald, G. and Branica, M. (1988): Role of uranium(V) in marine sedimentary environments: a geochemical possiblity, Marine Chemistry, 24, 1-12.

Langmuir, D. (1978): Uranium solution-mineral equlibria at low temperatures with application to sedimentary ore deposits. Geochim. Cosmochim. Acta, 42, 547-569.

C

An Account of the Levels of the Dissolved and Particulate Trace Metals in the Amvrakikos Gulf

M.-J. SCOULLOS, M. DASSENAKIS, C. ZERI, K. PAPAGEORGIOU and P. DAGRE

University of Athens, Department of Chemistry, Navarinou 13A, Athens (Greece)

The Amvrakikos Gulf, from ecological and fisheries point of view, is one of the most important coastal areas of Greece. It is a basin of 455Km² with max depth of 60m, surounded by lagoons receiving the outflow of two rivers. It is connected to the Ionian Sea through a narrow (500m width) and shallow (10m depth) natural channel. Virtually nothing is known about the metal levels in its waters apart from a preliminary report of our group. (Scoullos et al, 1986)

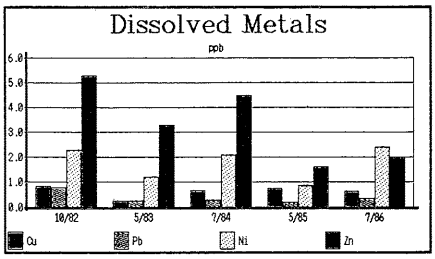


figure 1

The purpose of the present paper is to establish average seasonal levels of Cu,Zn,Pb and Ni as they were obtained from a grid of 15 stations sampled during a five year period (1982-1986). (fig. 1, 2)

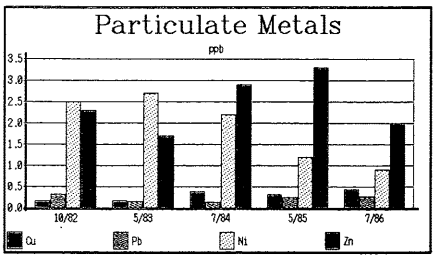


figure 2

Seawater samples were collected using polypropylene IOS bottles and plastic coated steel wires. The samples were filtered through 0.45μ Millipore filters which were treated in PTFE covered beakers with conc. HNO_3 whereas dissolved metals were preconcentrated on Chelex-100 resins using a slight modification (Scoullos and Dassenakis, 1984) of the Riley and Taylor (1968) method. The metals were determined by flameless AAS.
From the five samplings presented here one represents autumn (October 1982), two represent spring (May 1983 and 1985) and two summer (July 1984 and 1986).
The most prominent characteristic followed by all metals is the autumn maximum of their concentrations, particularly of the dissolved species of Cu, Pb and Zn and the particulate phase of Pb and Ni. This phenomenon is attributed to the breakdown of the very stable thermocline which enriches the entire water column with metals accumulated in the near bottom layers throughout spring and summer and also to the contribution of washout of the land and the atmosphere after the first rains.
The two spring samplings offer in general comparable levels of dissolved Pb and Ni, particulate Pb and total Zn although the percentage contributions of the two phases differ. The spring 1985 Cu concentrations, however, were significantly higher than those of the same period of 1983, influenced mainly by much higher levels observed in the deeper waters, (fig.3).

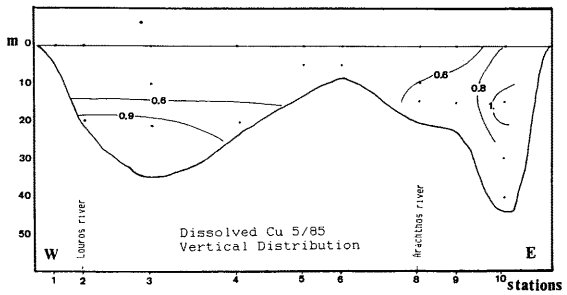


figure 3

The summer samplings of 1984 and 1986 also provide comparable levels for most metals (e.g. in ppb, for total Cu =1.05 and 1.06; Pb=0.43 and 0.58; Ni=4.3 and 3.3 respectively) whereas for Zn the 1984 value 7.4 ppb is nearly double of the 1986 one (4.0 ppb).
It is noteworthy that due to the morphological characteristics of the gulf a prominent stratification prevails already in May. The density gradients allow the surface waters to flush out rapidly, whereas the deep water mass is trapped in the gulf for long periods. The accumulation of all metals below the thermocline is clearly demonstrated during the summer.
The percentage contribution of the dissolved phases to the total is significant (50-70%) for all metals mentioned above.
In the 1984 sampling some extremely high values were observed at stations of the western part of the gulf influenced directly by the town of Preveza and the Ionian sea.

References

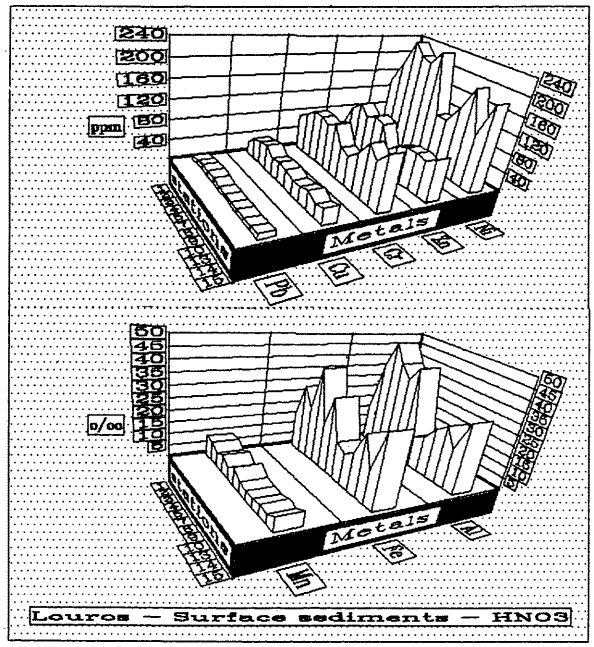
Scoullos, M.and Dassenakis, M. 1984. Determination of dissolved metals in sea water. Problems and modifications of the use of Chelex-100 resin. Proc.1st Greek Symp.on Ocean.& Fish.,pp.302-309
Scoullos, M. et al. 1987. Chemical studies of main estuaries and coastal areas of Greece. second version, Project CEC-ENV-560-GR.

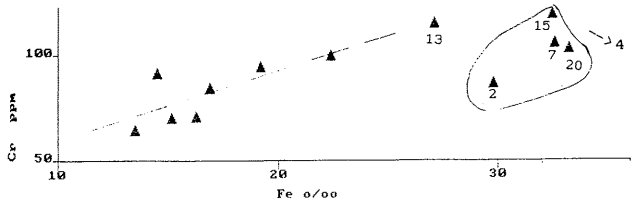
General Trends in Trace Metal Distributions of Louros Estuary Sediments

M.-J. SCOULLOS, M. DASSENAKIS, C. ZERI and M. RAPTI

University of Athens, Department of Chemistry, Navarinou 13A, Athens (Greece)

The estuary of the river Louros is located within the semienclosed Amvrakikos Gulf which is connected to the Ionian sea, in the north-western coast of Greece. Previous works on metals in the estuary are scarce. (Scoullos et al, 1986, 1988) The present paper summarises our results on trace metal studies in the Louros river estuary from a trench of 15 stations extended from a site within the river located approximately 30 Km upstream from the river mouth to a station placed 4 Km offshore. Station 1 is clearly a riverine one and no traces of saline water were determined during the sampling. Station 16 could be considered as a marine one, whereas at station 2 in a distance of 5.5 Km a very thin layer of saline water S‰=25.6‰ was observed near the river bed.





Iron - Chromium Correlation in Surface Sediments

Sediment samples were collected by using a Mackereth (1969) minicorer. All chemical treatments were performed on the <61 μm sediment fraction. The samples were treated with conc.HNO_3 in PTFE beakers and for the extraction of the labile metal the samples were leached for 12 hours with 0.5 N HCl (Agemian and Chau, 1976). The carbonate content was determined as a weight difference before and after the HCl leaching. Organic carbon was determined by using the Gaudette et al (1974), method.
The carbonate content of the sediment is relatively stable and high fluctuating around 30%, whereas the carbon content in the upper part of the river (st 1) is around 0.6 % and in the intermixing zone around 2.3%
The relative invariability in the concentrations of several metals (Fe, Cr, Ni) extracted by diluted HCl could be attributed to a significant contribution of the Fe, Cr and Ni connected with carbonates in their HCl extracted fraction throughout the estuary. This is not the case for a series of other metals such as Pb, Cu, Mn, Cd and Zn which show an important variability and in general higher values in the riverine stations and the upper limits of the intermixing zone and a relative decrease in the area around the sill and the mouth of the river. The concentrations tend to increase again offshore, a tendency also followed by Cd. This indicates that considerable percentage of extractable forms in the river mouth area, is not related with carbonates but are coprecipitated and trapped with organics etc.
The HNO_3 extractable Mn,Cu and Pb follows the same distribution as their HCl extractable fractions. The even distribution of the difference $Me_{HNO_3}-Me_{HCl}$ might reflect a relative homogeneity of the mineralogy of the sediment, for the above mentioned metals, within certain limits.
It is noteworthy that the HNO_3 extractable fraction of Fe, Cr and Ni varies considerably from station to station. Considering the interelemental ratios one could identify good linear corelations between Cr, Ni and Fe a feature rather common in many estuaries.
This correlation is not followed, in a group of stations where Fe has particularly high concentrations (Fe>25‰). In the same envelope, station 20, (Tsopeli lagoon) is included indicating that the given sediments (st. 2,4,7,13,15) are most likely influenced by sediments rich in FeS, formed in the adjacent lagoons and finding their way to the river. The good correlation with Fe is also followed by Zn and Cu.

References: Mackereth, F.J.H., 1969. A short core sampler for sub-aqueous deposits. Limnol.Oceanogr., 14:145.
Agemian, F. and A.S.Y. Chau, 1976. Evaluation of extraction techniques for the determination of metals in aquatic sediments. Analyst, 101:761-767. Gaudette, H.E., Flight, W., Tones, L. and Folger, D. 1974. An inexpensive titration method for the determinations of organic carbon in recent sediments. J.Sedim.Petrol., 44:249-253. Scoullos, M. and Oldfield, F. 1986. Trace metal and magnetic studies of sediments in Greek estuaries and enclosed gulfs. Marine Chemistry, 18:249-268. Scoullos, M. et al 1988. Project report on the sediments of Acheloos estuary - Patraikos Gulf, Louros estuary-Amvrakikos Gulf,Spernios estuary-Maliakos Gulf,Gulf of Elefsis. Min.of Ind.Res.&Techn.Programme YVET/ERE 1632

C-III3

Zooplankton Grazing in the Inner Part of Izmir Bay

Baha BUYUKISIK

Ege Universitesi, Fen Fakültesi, Biyoloji Bölümü, Hidrobiyoloji Ana Bilim Dali, Bornova, Izmir (Turkey)

ABSTRACT: Chlorophyll-a and phaeo-pigment concentrations were measured at one station through the year in the inner part of Izmir Bay which has been polluted. It was tried to obtain the information about the zooplankton grazing. The phaeo-pigment concentrations had shown that the grazing only was unimportant during March diatom bloom and was important during the other phytoplankton blooms in April,June and September.

INTRODUCTION: Chlorophyll-a concentrations in the seawater have been used as a measurement of phytoplankton biomass (YENTSCH,1966).Phaeo-pigment concentrations have determined the zooplankton grazing (YENTSCH,1965).At the pH of digestive track ,the phaeo-pigment have been formed releasing Mg atom from the chlorophyll-a of phytoplankton which is taken by filtration of herbivor zooplankton (LORENZEN,1967). LORENZEN(1967) had reported that bacterial effect on the chlorophyll-a was unimportant and phaeo-pigments have been formed as a residue of zooplankton grazing.The aim of this investigation was to state the fluctuations of phytoplankton biomass and zooplankton grazing activity through the year.

RESULTS & DISCUSSION: The trends of the nutrients and pigments were given in the figure 1.Total inorganic nitrogen decreased to minimum levels from January to March,April and phytoplankton biomass also followed the same trend.As a result of the bloom of phytoplankton in fall ,phytoplankton biomass decreased with the effect of decreasing the level of nutrients .This situation fits well the reports before(BÜYÜKIŞIK,1988).

In March,low phaeo-pigment concentrations comparing chlorophyll-a indicated that the grazing on the diatom bloom were relatively unimportant .It is probably due to the low water temperature which may caused decreasing activity of zooplankton.

Increased phaeo-pigment concentrations in April,June and September reflected the effect of zooplankton grazing on the phytoplankton community ,although it was not coincident to this condition regularly.The growth of phytoplankton had been also affected positively by increased turnover rate due to the direct regeneration.

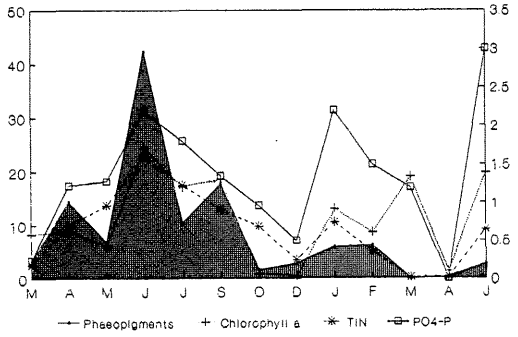


Figure 1. Monthly fluctuations of chlorophyll-a(µg/l.),phaeo-pigments(µg/l.),Total Inorganic Nitrogen (µg-atN/l.) and reactive phosphate(µg-atP/l.).TIN and pigments were explained on the left scale and phosphate on the right scale.

LITERATURE CITED:

BÜYÜKIŞIK,B.1988.Distribution of chlorophyll and nutrients in Izmir Bay(Aegean Sea).Rapp.Comm.Int.MerMedit.,31,2.

LORENZEN,C.J.1967.Vertical distribution of chlorophyll and phaeo-pigments:Baja California.Deep-Sea Research,14:735-745.

YENTSCH,C.S.1965.Distribution of chlorophyll and phaeophytin in the open ocean.Deep-Sea Research,12:653-666.

YENTSCH,C.S.1966.The measurement of chloroplastic pigments-thirty years of progress?.Proceedings of an I.B.P.Symposium,255-270.

C-III4

Fluorescence Characteristics Due to Phytoplankton Chlorophyll and Optical Transparency of Northeastern Mediterranean Waters

A. YILMAZ , D. EDIGER , A.-C. SAYDAM and O. BASTURK

Middle East Technical University, Institute of Marine Sciences, Erdemli-Icel (Turkey)

In situ fluorescence and light data together with the hydrological data collected during the two expeditions (July 1988, March 1989) to Northeastern Mediterranean are presented and discussed. Continuous *in situ* profiles of fluorescence could be particularly valuable for estimating biomass and productivity in coastal waters where particulate matter and Gelbstoff limit the use of satellite imagery (Mackey, *et al.*,1989).

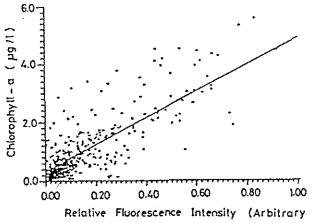


Figure 1. Calibration curve of *in situ* fluorescence and extracted chlorophyll-a (The data from The Sea of Marmara and The Black Sea were influnced for extra support)

Calibration of fluorescence against chlorophyll-a determined on discrete samples collected from depths was performed and extracted chlorophyll concentrations were well-correlated to chlorophyll fluorescence (Figure 1) by a linear equation of:

$$Chll\text{-}a = 4.85\ (Fluo) + 0.32\ (n=390).$$

Subsurface chlorophyll-a maxima observed in the NE Mediterranean (Yılmaz *et al.*, 1988; Salihoğlu *et al.*, 1989) was clearly and statistically confirmed by *in situ* fluorescence data. As summarized in Table 1, max fluorescence due to chlorophyll-a was measured as

Table 1. Relative Surface Fluorescence(SF), Maximum Fluorescence Intensity (MFI), Depth of Maximum Fluorescence (DMF) and Depth of Zero Flourescence (DZF) in the Northeastern Mediterranean

	July, 1988			March, 1989		
	Min.	Max.	Ave.	Min.	Max.	Ave
F(X10^{-2},arbitrary unit)	0	5	2 (n=63)	0	14	5 (n=40)
MFI(")	3	10	5 (n=61)	7	34	14 (n=40)
DMF (m)	57	120	88 (n=59)	10	88	52 (n=40)
DZF (m)	57	135	113 (n=57)	70	130	104 (n=41)

deep as 120 m and the max depth of zero fluorescence determined as 135 m. The depth of max fluorescence is more deeper in summer than the depth measured in early spring because of light inhibition. On the other hand the quantitative fluorescence values are relatively higher in spring since the bloom time is determined as February-March in the NE Mediterranean. The deepest 1 % light transmission was measured as 120 m (average being 105 m) in the region so the euphotic zone is thick and the photosynthetic activity is observed in the deeper parts of euphotic layer.

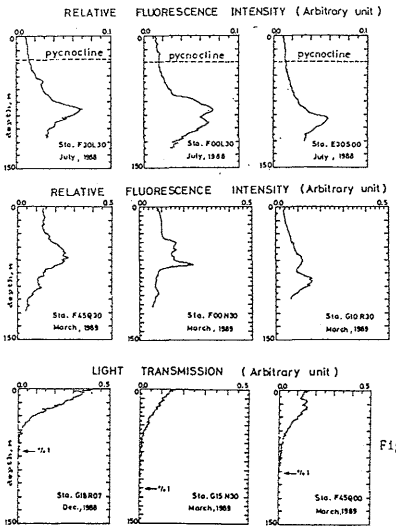


Figure 2. Continuous *in situ* profiles of relative fluorescence and light penetration at selected stations in the Northeastern Mediterranean

Some specific examples of deep chlorophyll-a maxima which were obtained by continuous fluorescence measurements in the water column and the vertical profiles of light penetration are illustrated in Figure 2. As is seen from the figure there is no match with pycnocline and the max fluorescence (summer examples). Euphotic layer is hydrologically homogeneous due to the presence of convective mixed layer caused winter cooling in March examples but still the deep fluorescence peaks were clearly observed.

REFERENCES:

SALİHOĞLU,İ., C.SAYDAM, Ö.BAŞTÜRK, K.YILMAZ, D.EDİGER, E.HATİPOĞLU,A.YILMAZ,1989, "Transport and distribution of nutrients and chlorophyll-a by meso-scale eddies in the Northeastern Mediterranean", Marine Chemistry *(in press)*

YILMAZ,A., D.GÖÇMEN, Ö.BAŞTÜRK, A.C.SAYDAM and İ.SALİHOĞLU, 1988, " Deep chlorophyll-a maximum in the Norheastern Mediterranean", *Presented at XXXI^ème Congrès- Assemlée de la C.I.E.S.M., Athens, 17-22 October 1988. In: Rapp.Comm.int.Mer Médit.,32(2),1988: pp.44, (Abstract only).*

MACKEY,D.J., E.C.V.BUTLER, P.D.NICHOLS and H.W. HIGGINS, 1989,"Continuous Shipboard and in situ Measurements of pH and Fluorescence in Seawater", *Marine Chemistry, 28,pp.41-60.*

Trace Elements in *Mytilus galloprovincialis* LMK from Sozopol and Nessebar Areas, Bulgaria

S. STAMOV*, I. SLAVCHEVA* and S. ZLATANOVA**

*Higher Institute of Chemical Technology, 8000 Bourgas (Bulgaria)
**Fisheries Institute, 8000 Bourgas (Bulgaria)

INTRODUCTION

During the period 1988-1989 the study [1] was continued to determine some trace elements in Mytilus galloprovincialis Lmk from Sozopol and Nessebar (Bulgarian Black Sea coast). Samples cultivated (suspended culture) and rock mussels were taken seasonally and analysed for Cu, Zn, Pb and Cd concentrations. In October 1988 quantitative determinations of four samples were made for other 9 metals.

MATERIALS AND METHODS

The preliminary preparation of the samples was carried out in accordance with the methodology recommended by FAO [2]. Approximately 2g of mussel meat, homogenized and dried at 105°C was weighed with an analytical balance, placed into a quartz glass and 15 ml concentrated solution of HNO_3 was added attentively. In 24 h the mixture was vaporized on a sand bath up to the volume of 5-6 ml and then 5 ml of $HClO_4$ was added to the solution and again vaporized up to the same volume. The solution obtained was placed into a 50 ml beaker and bidistillated water was added up to the mark. The samples were analysed by a AAS "Perkin Elmer 2380" in graphite furnace HGA - 400 applying the method of a standard addition and 0.5% $(NH_4)_2HPO_4$ as a matrix modifier in Pb determination.

The same technique following an extraction of the analysed elements with APDC and MIBK was used to determine other 9 metal components in 4 mussel samples (October 1988).

RESULTS AND DISCUSSION

In Table 1 means of trace metal concentrations in 13 samples cultivated and rock mussels, are given.

The concentration variations of those elements in cultivated and rock mussels from Sozopol and Nessebar areas were comparable with the reproducibility of the analytical method. The relative standard deviation, Sr (n=5) for the concentrations presented does not exceed 10%.

Table I. Means of trace elements concentrations in Mytilus galloprovincialis Lmk from Sozopol and Nessebar mussel farms, 1988 -1989 *)

Period	Average concentrations (mg/kg dry weight) Cu	Zn	Pb	Cd
1988 / X	18.0	93.6	12.3	1.9
1989 / II	9.7	102.1	11.0	1.7
IV	9.9 (12.8)	91.7 (138.3)	6.3 (7.9)	1.3 (2.0)
X	16.3 (18.1)	99.0 (125.4)	8.6 (8.7)	1.4 (1.4)
XI	8.1	83.2	-	-

*) In parentheses concentrations of trace elements in rock mussels

The following concentrations (mg/kg dry weigh) were found for the trace elements in October samples (1988); 27.2 ± 5.3 for Bi, 7.0 ± 0.7 for Ni, 13.7 ± 2.2 for Mn, 2.8 ± 0.4 for Co, 338.4 ± 32.9 for Fe, 18.2 ± 3.5 for Ba, 15.0 ± 2.8 for Cr, 30.2 ± 5.8 for Mo and 48.3 ± 9.4 for V.

In comparison with the concentrations previously determined, the new analyses showed increased values for Cu, Zn, Pb and Cd in mussels attributed likely to increased total pollution of the Black Sea area during the period of study. The comparative results for cultivated and rock mussels (regarding a definite mussel farm & season) indicate higher concentrations for rock mussels. The increased values for trace elements in cultivated mussels (spring generations 1988)in October 1988 and February 1989 is attributed mostly to higher concentrations of those components in the sea water along the coast in 1988. It should be noted that the concntrations of the analysed elements are higher in the samples, collected in October 1988 and 1989.

REFERENCES

1. Stamov, S.,S.Zlatanova, Rapp. Comm. int. Mer. Medit., 31 (1988), 2, p 160.
2. Bernard, M., (1976) Manual of methods in aquatic environment research, FAO, Part 3; p. 48-70.

Spectral Characterization of the Romanian Bottom Black Sea Sediments Contaminated by 137 Cs

Iulia I. GEORGESCU and Aurealia MEGHEA

Polytechnical Institute, Faculty of Chemical Technology, Bucharest (Romania)

ABSTRACT. Bottom sediments sampled on the Romanian Black Sea coast, by X-R diffraction, EPR (Electronic Paramagnetic Resonance) and IR (Infra-Red) spectra were investigated in view to explain the higher accumulation of ^{137}Cs in front of Portitza site Razelm lagoon.

INTRODUCTION. The aim of this research is to carry out the investigation on the mineralogical nature of the silty clay sediments sampled on the bottom of the Black Sea Romanian coast, aerobe oxydo-reduction zone.This in view to explain the higher accumulation of ^{137}Cs 30 y important by its accumulation in the biota, especially at Portitza Razelm lagoon,very rich in fishing activities.The chemical composition with the grain size as well as with the retention and exchange of man made radionuclides between crystalline lattice and the soluble form of the radionuclide in water,in previous paper has been discussed (1-2).

MATERIAL AND METHODS. Marine sediment samples were collected at 45°08'N 29°57'E to 44°08'N, 28°57'E coordinates, offshore 13.2 to 17.3 marine Miles at Portitza. Other characteristics at Portitza: liquid discharge of Danube river, Q=6830 m^3/s, on the bottom sea water temperature t = 6.5°C, water salinity S=18.23‰, flow current V=8 cm/s, direction α = 100°. The grain size of the silty clay was 70 +80 µm. The dried sediments at 105°C were submitted to the following investigations: X-ray diffraction carried out by a TUR M-72 installation with the CuKα radiation, EPR (Electronic Paramagnetic Resonance) by means of a EPR Spectrometer ART-5 IFIN-Bucharest type with X-band frequency and IR (Infra-Red) spectra registered in the band of 200-4000 cm^{-1}, making use of a PERKIN-ELMER apparatus type, the samples being packed in KBr.

RESULTS AND DISCUSSION.

- In TABLE 1 are included the results concerning the mineralogical composition of the bottom sediments sampled during June 1989, established by X-ray diffraction. It is to be outlined only at Portitza site in the silty clay are to be found the highest content of *illite*, but lower content in calcite, favorable to accomodate in the crystalline lattice the Cesium ions. On the other hand, by INAA analysys only in this region 8 ppm of stable Cs was found (3). It is known the radionuclide follows the pathway of its stable counterpart.

TABLE 1. Identified minerals by X-Ray diffraction in bottom sediments of the Romanian Black Sea coast, 1989

Sample	ß-Quartz	Calcite	Illite	Kaolinite	Feldspath
Sulina	+ + +	+ +	+	-	-
St.Gheorghe	+ +	+ +	+	+	+ +
Portitza	+ + +	+	+ +	+	-
Constantza	+ + +	+ +	+	+	-

- From IR spectra the following conclusions can be drawn: the calcite ($\tilde{\nu}_3$ = 1460 cm^{-1} and $\tilde{\nu}_2$ = 710 cm^{-1}) in the sample is decreasing as follows: Constantza > Sf.Gheorghe > Sulina > Portitza. Lower content in calcite at Portitza explains higher concentration of Cs and ^{137}Cs. The illite was identified ($\tilde{\nu}_{Si-O-Si}$, Si-O-Al at $\tilde{\nu}$ = 1020-1100 cm^{-1} and δ = 420-520 cm^{-1}, while Kaolinite at $\tilde{\nu}$ = 3600 cm^{-1}. The illite is present at every sampling station also more concentrated at Portitza.By IR spectra it was not be observed the characteristic vibrations of any organic pollutants in the samples.

- EPR spectra shown the Fe^{3+} and Mn^{2+} ions. The highest content of Fe^{3+} about 4% (3) is related to illite presence. The presence of Cr^{3+} is also discussed. In all sediment samples except those of Constantza, the EPR characteristic signal was put in evidence the organic matter named *Kerogen* disseminated in sedimentary facies rocs, generator of petroleum (4). The highest signal of Kerogen was at Portitza sampling site.

REFERENCES

1. GEORGESCU ,I.I. and STROILA,I. 1980. Contributions to the chemical study of bed-load sediments collected on Romanian cross-sections of Danube river. Thalassia Jugosl. 17 (2) pp. 95-101.
2. GUEGUENIAT,P. et CARBONNIE,M. 1976. Contamination de sédiments marins par le ^{137}Ce en fonction de leur composition en Argiles et en Carbonates. Rapp. Comm. int. Mer Médit.,23, 7, pp. 133-135.
3. PANTELICA,A. SALAGEAN,M. and GEORGESCU,I.I., Variation of trace elements in bottom sediments and in some Macrophytes in the last ten years, sampled on the Romanian Black Sea coasts (in press).
4. DURAND,B., 1980. Kerogen. B.DURAND Ed. Edition Technip. Paris:250-340.

C-III7

Vertical Distribution of Heavy Metals in Sediments from Rivers in Northern Greece

V. SAMANIDOU, G. VASILIKIOTIS and I. PAPADOYANNIS

Laboratory of Analytical Chemistry, Chemistry Department, University of Thessaloniki, Thessaloniki (Greece)

Data obtained by vertical distribution studies may,generally,cover the last two hundred years or greater time span of industrial development.

The vertical distribution of Cu,Cd,Cr,Mn,Zn,Fe, and Pb was studied in sediment cores from two rivers in Northern Greece,Axios and Aliakmon ,which had been previously(SAMANIDOU et al 1987) examined for the metal partitioning into selective fractions in surface(0-10 cm)sediments.Both rivers flow into the Thermaikos Gulf.

Axios is affected by domestic effluents and industrial wastes mainly from the Yugoslavian region,since in the Greek area only domestic and agricultural effluents are discharged into its waters. Aliakmon is affected by domestic effluents and wastes of textile and food industries(FYTIANOS et al, 1986).

Four samplings were performed in three month intervals during a period of one year. A plexiglass corer of 1 m length and 8.0 cm diameter with a latex stopper for the upper side,was manually driven into the sediment. Samples were subsequently subdivided in 10 cm fractions. Due to technical difficulties the subdivision of the core in shorter sections,in order to obtain more detailed information ,was not possible. Only at one sampling was it possible to take a core of a length greater than 30 cm, due to the sandy texture of the sediments beneath this depth. All sediment samples were wet sieved using nylon sieve,and the fraction <0.063 mm,was selected for study. The sieved material was then dried at 105°C. Metal analysis was performed by wet acid digestion under pressure using a mixture of HNO_3-$HClO_4$ 4:1 v/v , at 150°C (AGEMIAN et al, 1976). The acid extracts were analysed for the above mentioned metal ions,by flame AAS (Pye-Unicam SP 192) or flameless AAS (Perkin-Elmer HGA 400) when needed. The standard addition method was followed for each metal separately. The precision of sediment metal analysis was checked by five replicate samples of SD-N-1/2 IAEA reference river sediment material and coefficients of variation ranged between 1 and 8 %.

Table 1 presents the metal core correlation coefficients for the examined metals at the four sampling stations (AX1 ,AX2 ,AL1 ,AL2),obtained from one sampling, for core depth >30 cm. As shown , a negative correlation (significant though only for Pb,Zn and Cu in AX1 station) ,is observed ,between metal concentration in sediments and depth in the core. Except for Cd ,all other metals exhibit a peak concentration at 10-20 cm depth in core, probably due to resuspension of surface sediments. The fact that most of the metals show the peak concentration at the same depth implies, that these metals have a common origin. Cadmium which has its maximum concentration at the surface layer has probably a different origin. The enrichment of Cd at the top

Table 1. Correlation coefficients between metal concentrations and depth in core.

	AX1	AX2	AL1	AL2
Pb	-0.786*	-0.823	-0.576	-0.772
Zn	-0.883	-0.636	-0.401	-0.439
Cu	-0.855	-0.368	-0.517	-0.764
Mn	-0.735	-0.620	-0.754	-0.876
Fe	-0.410	-0.727	-0.162	0.493
Cr	-0.641	-0.525	-0.941	-0.642
Cd	-0.641	-0.705	-0.771	-0.659
d.f. (n-2)	5	3	2	4

***The underlined values are significant at the 5% level.**

of the core is due to the high anthropogenic flux during the last decades (ETCHEBER et al ,1977).

Surface layers (0-10 cm) are directly affected by human activities. Suspended materials after a certain period of transportation are deposited on the river bottom, enriching consequently the upper layers of sediments with heavy metals. On the other hand, surface layers are mostly exposed to the pH-Eh changes in aquatic environment, which lead to a heavy metal release(HILTON et al,1985). As acid mine effluents are discharged into Axios river, a decrease of pH value can lead to a release of heavy metals bound to carbonates and hydroxides. A change of redox conditions can cause the reduction of hydrous Fe-Mn oxides yielding the scavenged or sorbed heavy metals (SALOMONS et al ,1984).

REFERENCES

AGEMIAN,H.,et al,1976.The Analyst,101, 761-767.

ETCHEBER,H., et al, 1977.Rev. Int. Oceanogr. Med.,48, 91-95.

FYTIANOS,K., et al, 1986. Ambio, 15(1), 42-44.

HILTON,J., et al ,1985. Chem. Geol. 48, 281-291.

SALOMONS, U., et al, 1984."Metals in Hydrocycle", Springer-Verlag, Berlin-Heidelberg-N.York-Tokyo.

SAMANIDOU, V., et al, 1987.The Sci. of the Total Environ. 67, 229-285.

C-III8

Etude des Métaux Lourds (Zn, Cu, Pb, Cd, Cr) dans les Sédiments de la Pêcherie d'Homa - Izmir

O. YARAMAZ*, H. MORDOGAN** et A. ALPBAZ*

*Ecole Supérieure des Produits de l'Eau, Université d'Egée, Urla (Iskele) Izmir (Turquie)
**Université du Neuf Septembre, Faculté d'Ingénierie et d'Architecture Bornova, Izmir (Turquie)

La Pêcherie d'Homa située entre la rivière Gediz et la Saline de Camaltu, dans la baie extérieure d'Izmir, a une superficie de 1800 ha. et une profondeur moyenne d'1m. (Fig. 1) qui est régulièrement diminuée par les apports d'alluvions de cette rivière et par l'étranglement de la passe qui assure la circulation entre la mer et la Pêcherie (YARAMAZ & ALPBAZ, 1988).

Les prélèvements ont été réalisés, mensuellement, à l'aide d'un benne "Orange-Peel" en novembre, décembre 1989 et en janvier 1990 à partir de 5 stations (Fig.1)

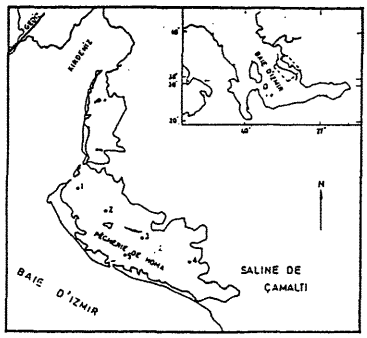


Fig. 1 : Localisation des Stations

Les échantillons de sédiments ont été transportés au laboratoire dans un sac en plastique puis séchés à 60°C pendant 24 heures. On pèse 1g. de sédiment préalablement broyé afin d'obtenir une poudre (<160 µm) que l'on met dans un ballon. On ajoute 10 ml d'eau régale [HC1:HNO_3 (3:1 v/v Merck)] qui est chauffée durant deux heures à 120°C. On filtre la solution additionnée d'environ 25 ml d'eau permutée à l'aide d'un filtre Whatman, puis on ajoute encore jusqu'à 50 ml. dans une fiole jaugée. La solution est prête pour l'absorption atomique modèle 2280 Perkin-Elmer (ARNOUX *et coll.*, 1981).

Le tableau 1 révèle les concentrations en métaux lourds dans la Pêcherie d'Homa à travers des prélèvements réalisés aux mois de novembre, décembre 1989 et janvier 1990.

St.		1	2	3	4	5
Zn	Nov.	40.5	47.5	57.0	41.5	68.0
	Dec.	49.0	50.5	59.0	36.0	61.0
	Jan.	47.5	60.0	65.0	32.0	59.0
Cu	Nov.	21.0	20.0	24.0	21.5	26.5
	Dec.	21.0	19.5	27.0	22.2	22.0
	Jan.	19.0	25.5	24.5	19.0	19.5
Pb	Nov.	10.0	40.0	95.0	25.0	25.0
	Dec.	10.0	25.0	20.0	24.0	20.0
	Jan.	33.5	38.5	34.3	18.5	28.0
Cd	Nov.	3.0	5.5	3.5	3.0	3.0
	Dec.	4.0	2.5	3.0	3.0	2.0
	Jan.	5.5	4.0	3.6	2.5	4.0
Cr	Nov.	60.0	44.5	72.0	57.0	69.0
	Dec.	66.0	59.0	73.0	60.6	68.5
	Jan.	44.0	43.0	78.0	50.0	43.0
Mat.col. %	Nov.	9.09	9.17	11.89	11.91	15.44
	Dec.	8.38	8.63	13.67	14.27	13.07
	Jan.	7.65	14.08	8.52	2.64	6.30
% C	Nov.	1.65	1.86	2.21	2.14	3.00
	Dec.	1.53	1.43	2.53	2.45	2.29
	Jan.	1.45	2.35	1.70	1.39	1.27

Tab. 1 : Concentrations des métaux lourds dans les sédiments de Pêcherie d'Homa (µg/g poids sec)

Comme le montre le Tableau 2, les concentrations relevées dans la Pêcherie d'Homa sont inférieures à celles de la Baie d'Izmir et il n'existe pas actuellement de risques de pollution par les métaux lourds.

	Zn	Cu	Pb	Cd	Cr	Ref.
Baie d'Izmir	53 - 8660	33 - 866	40 - 280	0.2 - 40	-	(UYSAL,TUNCER 1984)
Baie d'Izmir	61 - 899	16 - 213	13 - 305	1.3 - 6.6	21 - 237	(GEY, MORDOĞAN 1988)
Baie de Gülbahçe	16 - 135	12 - 56	35 - 183	1.4 - 14	-	(UYSAL, TUNCER 1984)
Pêcherie de Homa	32 - 68	19 - 27	10 - 95	2 - 5.5	43 - 78	(Ce travail)

Tab. 2 : Comparaison des teneurs en métaux lourds entre la Pêche d'Homa, la Baie d'Izmir et celle de Gülbahçe (µg/g poids sec)

Références

ARNOUX (A.), NIENCHEWSKI (L.-P.) & TATOSSIAN (J.), 1981.- Comparaison de quelques méthodes d'attaque des sédiments marins pour l'analyse des métaux lourds. *Journal Français d'Hydrologie*, 12, fasc 1 n°34, pp. 29-48.

GEY (H.) & MORDOGAN (H.), 1988.- Concentrations of various heavy metals in near shore sediments of Inner Bay and in some marine organisms in the Bay of Izmir. *Doga, TU Zoologie D.C.*, 12, s.3, pp. 216-224.

UYSAL (H.) & TUNCER (S.), 1984.- A comparative study on the heavy metal concentrations in some fish species and in sediments from Izmir Bay. *Vlles Journées Etud. Pollutions*, Lucerne, C.I.E.S.M., pp. 275-284.

YARAMAZ (O.) & ALPBAZ (A.), 1988.- Recherches des paramètres physico-chimiques, des sels nutritifs et des détergents anioniques dans la Pêcherie d'Homa d'Izmir. *Rapp. Comm. Int. Mer. Médit.*, 31,2, p. 45.

Rapp. Comm. int. Mer Médit., **32,** 1 (1990).

C

Distribution of Mercury in Aegean Coastal Sediments

A. BALCI, H.-A. BENLI and F. KUCUKSEZGIN

Institute of Marine Sciences and Technology, Dokuz Eylül University, Izmir (Turkey)

In this study, the distribution of mercury in suspended matter and sediment of the Aegean Sea were investigated. The total mercury content in deposited sediments ranges between 0.09 ug /g and 3.61 ug/g with mean of 0.91 ug/g.

MATERIAL AND METHOD

Mercury was detected flameless atomic absorbtion spectrophotometry (AAS) using cold vapour technique stripping by an argon flow the metallic mercury reduced by an $SnCl_2$ acid solution.

Water samples for suspended material were filtered through 0.45 um pore size preweighted Nucleopore filter. Study area and sampling stations are shown in Figure 1.

RESULTS AND DISCUSSION

Concentrations of total mercury in surface sediments from Aegean Sea are given in Table I. Highest cocentration of mercury in the Aegean have been obtained at Karaburun Peninsula. Karaburun mining region, for the Aegean, the must important source of mercury. But even if it not being mined, it might be responsible for appreciable amounts of mercury being carried by surface erosion and rivers in to Aegean Basin. Küçük Menderes and Büyük Menderes rivers flow through the mercury-bearing ores and cary mercury rich material in to the Aegean Sea. It has been reported that the amount of mercury trasported to the Aegean Sea by rivers is about 14 ton/years (UNEP 1984). Continental weathering and subsequent erosion play an important role in determining the mercury content of rivers and thus amount of mercury entering the Aegean.

The mercury load on suspended particles in rivers ranged between 4 and 231 ug/g. In estuaries, the suspended matter is more contaminated than the deposited sediments. This is due to its greater amount of fine grained particles and organic matter to which trace metals used to be associated Cranston and Buckley, (1972). The mercury content of suspended matter in rivers are given in Table II. High level of mercury on suspended particles in Küçük Menderes river.

STATION	n	R	X
1	7	0.09-1.32	0.60
2	3	0.70-0.91	0.82
4	6	0.43-3.61	1.39
5	4	0.96-1.68	1.03
12	2	0.39-1.19	0.79
13	6	0.09-1.91	0.87
14	7	0.17-1.28	0.81
16	3	1.43-3.47	2.32
17	4	0.47-2.06	1.05
18	6	0.36-1.15	0.74
22	-	0.39-1.33	0.83
40	2	0.24-0.73	0.49
41	2	0.64-0.88	0.76

Table : I Mercury concentrations in Aegean Sediments (ug/g)
n: number of sample, R: Range X: mean

Rivers	TSM (mg/l)	Particulate Hg Range	(ug/g) mean
Meriç	32	4-231	32
Havran	34	10-26	35
Gediz	77	8-83	46
K.Mend.	7	24-231	152
B.Mend.	46	38-149	84

Table : II Particulate Mercury and total suspended material (TSM) in some rivers.

CONCLUSIONS

Industrial sources and the frequent natural geochemical anomalies in Aegean sea influence the mercury distribution in the marine sediments, adjacent to these sources. Near the river mouths due either to anthropogenic or natural sources, sediments show higher levels. The pattern of distribution of mercury in coastal sediments indicates that suspended particulate matter is the main vehicle for mercury from land based sources to marine environment. Another aspect which is worth further investigation is whether the inflow of waters through the straits of dardanels might represent an appreciable input or output of mercury in Aegean sea.

REFERENCES

BERNHARD and RANZONÍ (1977): Mercury concentration in Mediterranen marine organisms and their environment natural or anthropogenic origin. Thlassia, Jugo., 13:265.300

CRANSTON, R.E. and D.E.BUCKLY (1972): Mercury pathways in a river and estuary. Environ. Sci. Techn., 6:274-8

FLEİSCHER, M. (1973): Natural Sources of some trace metals in the environment in cycling and control of metals, Cicinnati, National Env. Resch. Cent. pp.3-10

UNEP (1984): "Pollutants from the Land Based Sources in the Mediterranean" Unep Regional Seas Reports and Studies NO:32

Manganese, Iron, Cobalt, Nickel and Zinc in the Eastern Harbour and El-Mex Bay waters of Alexandria

Hosny I. EMARA and M.-A. SHRIADAH

National Institute of Oceanography, Alexandria (Egypt)

The concentrations of manganese, iron, cobalt, nickel and zinc have been determined by atomic absorption spectrophotometry on 970 sea-water samples from 8 stations in the Eastern Harbour and 7 stations from El-Mex Bay (Fig. 1) of Alexandria during the period from November 1987 to January 1989. Trace metals concentrations are scattered in the ranges (0.14-30.7), (1.39-148.0), (nd-0.32), (0.09-1.43) and (2.02-320.7) $\mu g.l^{-1}$ respectively.

The concentrations of trace metals in both areas are in the order Zn > Fe > Mn > Ni > Co at the surface and near the bottom water. El-Mex Bay, the most industrialized area in Alexandria, showed higher levels of Mn, Co, Ni and Zn in the bottom water than in the surface water. On the other hand, with the exception of Zn, the surface water of the Eastern Harbour reflects higher values in comparison with the bottom water.

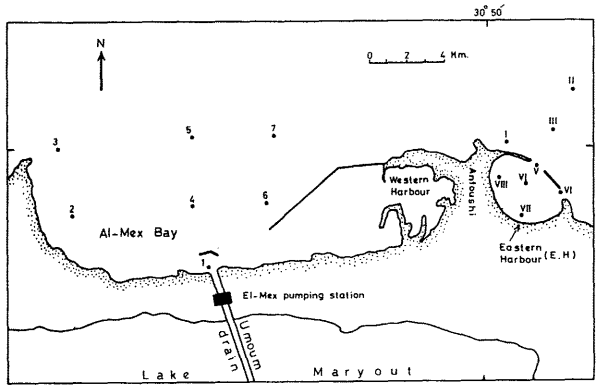


Fig. 1 - Area of investigation

Generally, the Eastern Harbour reveals slightly higher levels of Fe, Co, Ni and Zn than El-Mex Bay water.

Trace metals Mn, Fe and Zn distribution suggests a clockwise circulation pattern of fresh water discharging from Umoum drain to El-Mex Bay. The Eastern Harbour which is polluted by sewage, showed a tendency to concentrate Fe and Zn inside the harbour by 14 and 39% more than outside the barour, while Mn, Co and Ni showed nearly the same level.

The distribution of Zn showed a rate of decrease of 15.9 $\mu g.l^{-1}.km^{-1}$ in the Eastern Harbour and can be used as a good tracer for fresh water or sewage discharge.

The appearance of local high concentration for one metal by possible contamination does not necessarily correlate with high values for other metals, however the relationships Fe-Mn (r=0.80) Fe-Zn (r= 0.80), Mn-Zn (r= 0.85) showed good correlation for the bottom water as well as for the surface water (Mn-Ni, r= 0.80) of El-Mex Bay. The Wastern harbour also showed good correlation between Fe and Co (r= 0.83), Mn and Co (r= 0.60) for the surface and bottom water respectively.

The present data show that the concentrations of trace metals compared to other regions in the world are higher, probably due to the increasing pollution from industrial waste and domestic sewage.

C-III11

Relationships between Oxygen and Alkalinity Benthic Fluxes at Cadiz Bay (S.W. Spain)

J.-M. FORJA and A. GOMEZ-PARRA

Instituto de Ciencias Marinas de Andalucia (C.S.I.C.), 11510 Puerto Real, Cadiz (Spain)

Nutrients benthic regeneration through biogenic decomposition of organic matter in coastal ecosystem is mainly produced by aerobic oxidation and sulphate-reduction pathways (Jorgensen, 1982; Crill and Martens, 1987). The relative contribution of both processes is very variable, depending on many environmental factors, and can be assessed determining the fluxes across the sediment-water interface of both oxygen and alkalinity. This has been frequently realized by means of the chemical concentration profiles in pore water (eg, Aller and Yingst, 1980; Jorgensen and Sorensen, 1985; Crill and Martens, 1987). In this paper, the stoichiometric values of oxygen and carbonate alkalinity "in situ" fluxes are measured in order to evaluate the participation of the two main alternative mechanisms for nutrient regeneration in coastal sediments. The study are carried out over a year period in a site located in the bay of Cadiz.

EXPERIMENTAL

The Bay of Cadiz is a productive shallow coastal ecosystem, receiving a large input of organic matter. The bay has a mixed bathymetry and it is subject to a semidiurnal tidal regime with about 2,70 m average amplitude. These facts generate a complex hydrodynamic and sedimentary behaviour. Sampling station is located in a argillaceous subtidal area (8 m in depth) and it is affected by a moderate flood current system. Its botton contains a large assemblage of infaunal benthos, mostly pollychaeta.

Matter fluxes across the sediment-water interface were determined by means of benthic stirred opaque chambers. They were made of plexiglass and semiellipsoid revolution shape of circular section. These chambers cover 0.385 m^2 of bottom and contain between 65 and 90 L. Chamber incubation of botton lasted 3-5 h. A previously calibrated YSI 5739 polarographic sensor was used for measuring oxygen concentration every 5 min. Alkalinity was determined by Gran titration method in samples withdrawn from the chambers each 15-20 min. Complementary pore water chemical profiles were obtained from 40 mm i.d. cores by centrifugation at 24,000 g.

RESULTS

In relation to the temporal evolution of the oxygen benthic demand and carbonate alkalinity flux (fig. 1a), two facts can be noted: i) both oxygen and alkalinity fluxes show a clear seasonal trend;

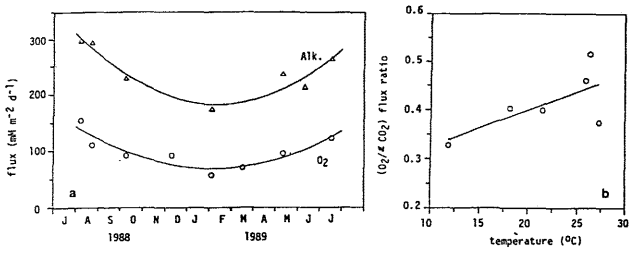


Figure 1

ii) measured fluxes are high, specially in summer. Their values are generally greather than those obtained in other zones at a similar latitude.

Fluxes of ΣCO_2 are always greather than oxygen fluxes. According to Redfield's ratios and assuming that organic matter decomposition would occur exclusively via aerobic pathway, the $O_2/\Sigma CO_2$ fluxes ratio would have a value of 1.3. Values obtained for this ratio in Cadiz bay are always smaller than 0.5. This denotes the importance of anaerobic degradation processes. On the other hand, an increase of $(O_2/\Sigma CO_2)$ fluxes ratio with temperature has been found (fig. 1b). This suggests that the aerobic pathways contribution in degradation processes is greater in summer, in spite of the oxygen concentration in the water column being apprecibly lesser than in winter. Two explanation can be suggested: i) benthic macrofauna density is greather in summer (about 250 specimens m^{-2}), and also their activity. In this way, Revsbech *et al.* (1983) have reported the existence of oxic microenvironment at depths below the oxic layer, due to the macrofaunal irrigation in the sediments; ii) The increase of the temperature in summer, acelerating the benthic metabolism, is specially important in the sediment surface. In this layer the aerobic degradative processes take place; therefore these can be enhanced.

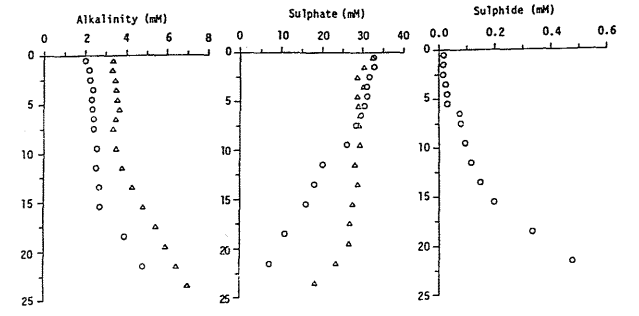


Figure 2

In fig. 2, pore water profiles of carbonate alkalinity, sulphate and sulphide are showed for winter (○) and summer (●). Low gradient concentration upper 10 cm of sediment can be observed. Similar variations are encountered by other authors (Goldhaber et al., 1977) and they are related with the influence of benthic macrofauna irrigation. For this reason, diffusive fluxes calculated by means of vertical profiles in interstitial water are very low in relation to "in situ" fluxes.

Acknowledgments. We thank M.F. Osta for her help with field work and nutrient analyses.

REFERENCES:

Aller, R.C. and Yingst, J.Y.-1980. *Mar. Biol.*, 56: 29-42.

Crill, P.M. and Martens, C.S.-1987. *Geochim. Cosmochim. Acta*, 51: 1175-1186.

Goldhaber, M.B., Aller, R.C., Cochran, J.K., Rosenfeld, J.K., Martens, C.S. and Berner, R.A. -1977. *Am. J. Sci.*, 277: 193-237.

Jorgensen, B.B. and Sorensen, J. -1985. *Mar. Ecol. Prog. Ser.*, 24: 65-74.

Revsbech, N.P., Sorensen, J., Blackburn, T.H. y Cohen, Y.-1983. *Limnol. Oceanogr.*, 28(6): 1062-1074.

C-III12

Influence of Meteorological Conditions and the Rhone River Discharge on the Distribution of Iron, Manganese and Copper in the Gulf of Lion

Mohamed A. EL-SAYED

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

The Gulf of Lion, extending from the Gulf of Marselia to the Spanish fronteers, receives fresh water principally from the Rhone River. The spreading of the river water in the gulf dpends on the meteorological and climatological conditions in the area. One of the most important characteristics of the meteorology of the area is the presence of a strong NW wind "Mistral"which drives away the surface water in the coastal area giving rise to the advection of the bottom or subsurface water (Minas, 1986). This upwelling brings to the surface deep water of differing chemical composition and may result in the limitation of the surface spreading of the panache of the Rhone (Aminot, 1986).

In the period from 14 to 26 September, 1984, 28 surface water samples were taken from the Gulf and the Rhone Delta. Besides two samples were taken at the river-sea connection and a vertical profile was performed in the open Mediterranean water (Fig. 1). The unfilterd water samples were analyzed, under clean laboratory conditions, for their Fe, Mn and Cu content. Filtered samples of particularly turbid water were also analyzed.

Salinity measurements (Aminot et al. 1986) showed that the dispersion of the Rhone river water extends in a SSW direction represented by the stations 11, 35, 46, 47, 49 and 50. The relation between salinity and Fe, Mn and Cu along the axis of dispersion shows a massive elimination of the three elements during the first stages of mixing (84, 44 and 83.0 per cent for Fe, Mn and Cu respectively). The perfect agreement between the metals and turbidity indicates that suspended matter is the main vector in the transport of these elements in the Rhone water. Data of the filtered samples show that at station R1 (salinity less than 1) dissolved (0.45 um) Fe represents less than 1% of the total while dissolved Mn and Cu represented 37 and 38% of the total metal.

In the Gulf, according to hydrological characteristics and trace metals distribution, illustrated here by iron, three sectors are identified (Fig. 2):

1- the southern near coastal zone (st. 1, 2, 3): not affected by upwelling and characterized by intermediat salinity (38. 07-38.10), high water temperature (18 c) and relatively low Fe concentration (4. 66 ug/l) but showed marked S-N increase;

2- the eastern and northern zone (st. 4-9): highly influenced by water advection which lead to a marked temperature decrease (14), a significant salinity and turbidity increase and the highest Fe concentrations (31. 75 ug/l).

3- the central part of the Gulf and the open Mediterranean water: characterized by moderate salinity (38.1) excepting st. 52, very low turbidity and the lowest Fe concentration (0. 92 ug/l).

Data of the vertical profile indicate a marked enrichement of the surface water in Fe, Mn and Cu as has been previously observed by Kremling (1981).

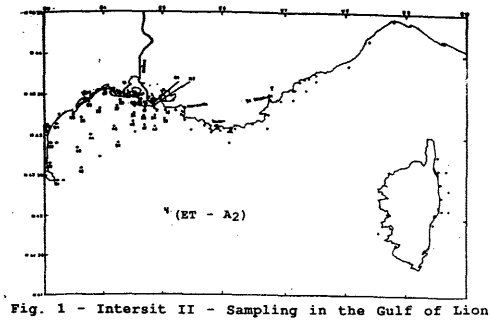


Fig. 1 - Intersit II - Sampling in the Gulf of Lion

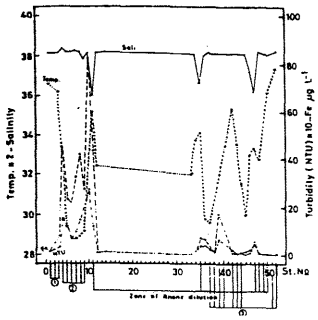


Fig. 2 - Geographic Distribution of Salinity, Temperature, Turbidity and Iron in the Gulf of Lion

REFERENCES

Aminot, A.; Kerouel, R.; Joanny, M. and LE Guellec, A. M. 1986. Hydrologie, éléments nutritifs et matière organique dissoute en Mediterranee Nord-Occidentale (campagne RNO-Intersite II, 14-26 Septembre 1984). Rapport DERO-86. 26-EL 83p.

Minas, H.J., 1968. A propos d'une remontéed'eaux "profondes" dans les parages du Golfe de Marseille (oct. 1964). Consequences biologiques. Cha. Oceanogr. , XX (B), 647-674.

Kremling, K. ans Petersen,-H., 1981. The distribution of zinc, cadmium, copper, manganese and iron in waters of the oper Mediterranean Sea. "Meteor" Forschungsergeb. , Reihe A/E, 23: 5-14.

Dissolved Oxygen and Nutrients in the Northeastern Ionian Sea

E. SOUVERMEZOGLOU, I. PAMPIDIS, E. HATZIGEORGIOU and K. SIAPSALI

National Centre for Marine Research, Hellinikon (Greece)

Nutrient and dissolved oxygen data collected at several stations in the northeastern Ionian Sea (Figure 1) during the September - October 1987 cruise of R/V AEGAIO, were used to demonstrate the distribution of the chemical characteristics along a section parallel to the coastline. The oxygen and nutrient pattern was affected by the presence of mesoscale cyclonic and anticyclonic gyres in the area.

In the vicinity of the Otranto Strait (northermost part of the oxygen and nitrate sections), the interface of interaction between well oxygenated and relatively poor in nutrient Adriatic Water (Ad) made a front with the richer in nutrient and poorer in oxygen water of Levantine origin (Figure 2 and 3). This front appeared also on the salinity and temperature profiles. Similar patterns have been found recently in winter (Georgopoulos et al. 1986, Theodorou et al. 1988).

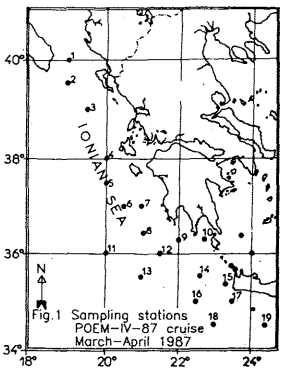


Fig.1 Sampling stations POEM-IV-87 cruise March-April 1987

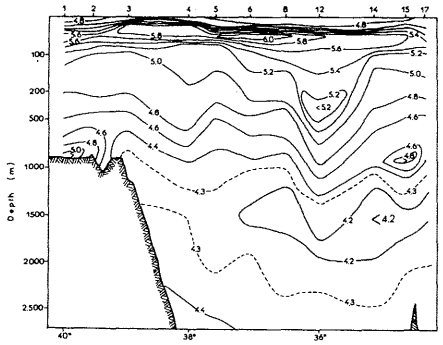


Fig.2 Distribution of oxygen (ml/l) along a transect in the Ionian Sea

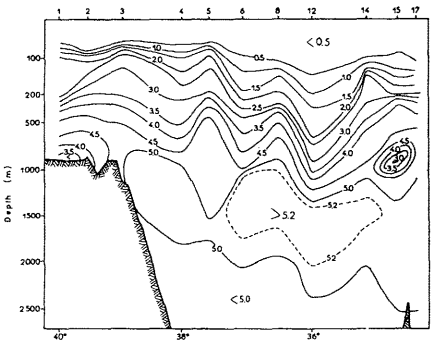


Fig.3 Distribution of nitrates (µgat/l) along a transect in the Ionian Sea

The nutrient poor surface layer extended down to 60 m in the north, while, in the south, it was brought down to 150 meters by a meandering anticyclone near 36°00 N latitude. This layer presents high concentrations of oxygen and very strong gradients between 50 and 100m. Note that, between these depths there was less saline and warmer water of Atlantic origin (NAW).

In the intermediate layer, the depth of isoconcentrations of 4.8 ml/l O_2 and 3.5 µgat/l NO_3 followed that of 38.80 psu isohaline, deemed to represent the boundary delineating the spatial extent of the Levantine Intermediate Water (LIW), (Artegiani et al. 1988, Theodorou et al. 1988).

The thermocline, isohaline, oxygen (Figure 2) and nutrient (Figure 3) isoconcentration lines at station 12 (36°00 N, 21° 30'E) were about 400 m below those in the adjacent areas.

The Deep Water (DW) had an oxygen content lower than 4,4 ml/l and nitrate greater than 5,0 µgat/l. The concentration of oxygen diminuted and that of nitrate augmented at the south of the section, where a core with oxygen less than 4,2 ml/l and nitrate greater than 5,2 µgat/l was found.

At station 15, to the west of Crete, there was a water mass with low nutrient also and high oxygen content at a depth of 900 m. This water mass also presented high salinity and temperature ; it probably originated from the Cretan Sea.

REFERENCES

Artegiani A., R. Azzolini, M. Morbidoni and E. Paschini, 1988. Observations on the Atlantic water present in the Ionian Sea during POEM - V- 87 cruise (August 31 - September 19, 1987). Rapp. Comm. Int. Mer Medit., 31, 2, 194.

Georgopoulos D., A. Theocharis, G. Zodiatis, 1986. Water masses in the Ionian Sea. Proc. UNESCO/IOC, POEM Scientific Report, No. 1, Pt. 2, Cambridge Mass. USA.

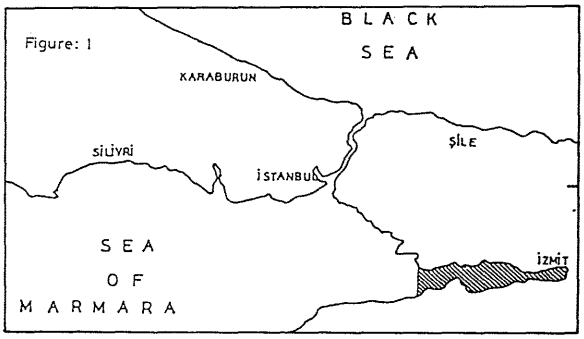
Theodorou A., D. Georgopoulos and A. Theocharis, 1988. Aspects of hydrology and circulation of the Northeast Ionian Sea. Rapp. Comm. Int. Mer. Medit., 31, 2, 208.

Heavy Metal Distribution in Surface Sediments from Izmit Bay, Eastern Marmara Sea (Turkey)

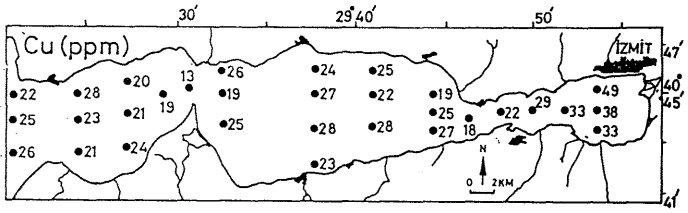
Mustafa ERGIN and Riza YORUK

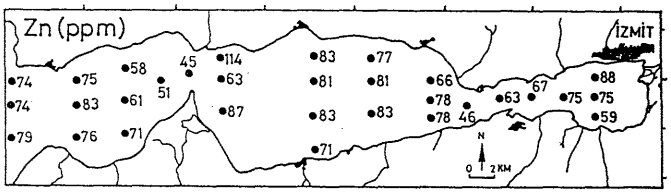
Institute of Marine Sciences, Middle East Technical University, P.K. 28 Erdemli, Icel (Turkey)

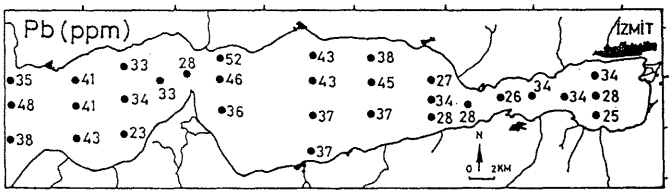
A total of thirty-one surficial sediment samples were collected from the floor of İzmit Bay (Fig. 1) with a grab onboard the R/V Bilim in 1987 and analyzed for their heavy metal (Fe, Mn, Cr, Co, Cu, Zn, Pb and Ni) concentrations and associations.



Low-calcareous-terrigenous mud (2-45 % $CaCO_3$; 0.35-1.62 % Org.C; ERGİN and YÖRÜK, 1990) with relatively high silt percentages are principal sediment types found on the floor of İzmit Bay. After removal of the pore waters, the HNO_3-extractable heavy metal concentrations of bulk sediments ranged from 1.40 to 3.97 % for Fe; 112-678 ppm for Mn; 13-49 ppm for Cu; 43-105 ppm for Co; 45-114 ppm for Zn; 23-52 ppm for Pb; 6-81 ppm for Cr; and 34-98 ppm for Ni (Fig. 2; YÖRÜK, 1988).







A comparison of the heavy metal data of this study with those from relatively unpolluted sediments and sedimentary rocks elsewhere suggests that Fe, Mn, Zn, Cr and Ni in the İzmit Bay sediments occur largely at natural background levels. And, also, use of a geoaccumulation index reveals relatively unpolluted sediments on the floor of İzmit Bay, although this region is densely urbanized and industrialized.

However, the presence of coal and slag particles in some sediment samples and the high, positive correlation coefficients between Pb-Zn and Zn-Cu concentrations suggest metal influxes from anthropogenic sources. Part of the Cu probably originates from the waste discharges of electrolytic industries located around the eastern section of the bay.

As inferred from the correlation coefficient matrix data, the studied heavy metals in the sediments were predominantly associated with organic and iron phases.

REFERENCES.

ERGİN, M. and YÖRÜK, R. 1990. Distribution and texture of the bottom sediments in a semi-enclosed coastal inlet, the İzmit Bay from the eastern Sea of Marmara (Turkey). Submitted to Est. Coast. Shelf Sci. 18 p.

YÖRÜK, R. 1988. A partial geochemical study of bottom sediments from the İzmit Bay. Thesis, Institute of Marine Sciences, METU, İçel, Turkey, 90 p.

C-III15

Variations Saisonnières du Plomb, du Cadmium et des Hydrocarbures Aromatiques Polycycliques dans l'Atmosphère d'une Agglomération Côtière Méditerranéenne - Etude Préliminaire

C. MARMENTEAU et A. VEGLIA

Centre Scientifique de Monaco, 16, Bd de Suisse (Monaco)

Dans le cadre d'une étude de la pollution des eaux côtières méditerranéennes par la voie atmosphérique, les variations saisonnières des métaux lourds Cd et Pb et des hydrocarbures aromatiques totaux ont été déterminées dans les aérosols prélévés en 1988-1989 à Monaco (1).

Les particules atmosphériques ont été prélevées par filtration (0,2 µm) au moyen d'un collecteur d'air à débit constant placé sur la terrasse du Musée Océanographique de Monaco, en un lieu situé à proximité de la mer et soumis aux influences urbaines. La durée de chaque prélèvement était de 15 jours environ.

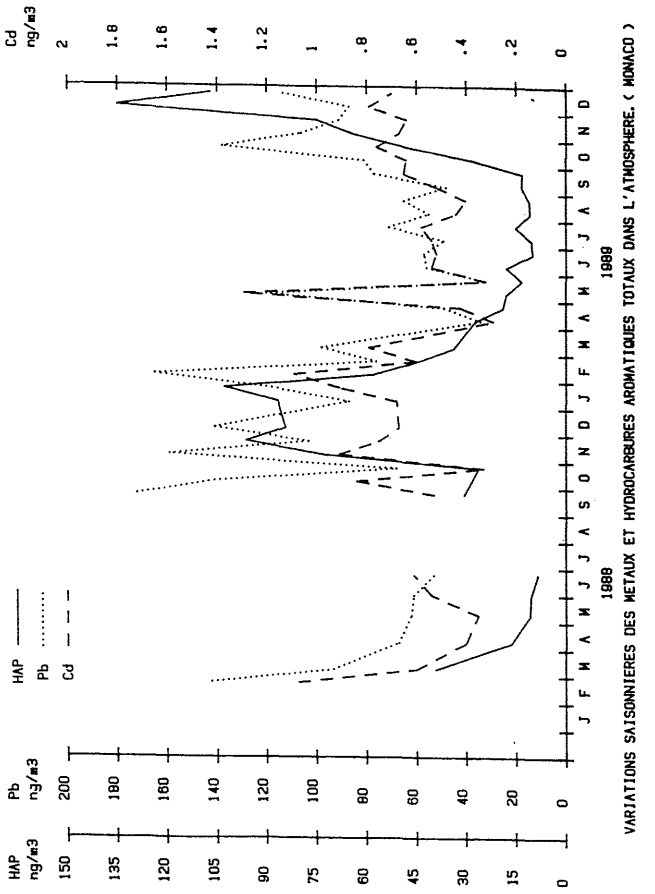
Les métaux présents sur les filtres ont été extraits par HNO_3/H_2O_2 et les solutions d'attaque ont été analysées par spectroscopie d'absorption atomique à effet Zeeman. Les hydrocarbures aromatiques totaux ont été dosés par spectrofluorimétrie après extraction avec le n-hexane, l'étalonnage étant réalisé par une solution de chrysène dans le n-hexane.

Les variations saisonnières du plomb, du cadmium et des hydrocarbures aromatiques polycycliques sont représentées sur la figure ci-jointe. On constate que les concentrations mesurées pour les trois paramètres sont, dans l'ensemble, plus élevées en hiver qu'en été. Des corrélations significatives ont été aussi observées entre les différents paramètres mesurés, à savoir :

r = 0,780 ($p<0,001$) pour la corrélation plomb-cadmium
r = 0,669 ($p<0,001$) pour la corrélation plomb-HAP
r = 0,533 ($p<0,001$) pour la corrélation cadmium-HAP

la meilleure corrélation correspondant, dans chaque cas, à une fonction puissance du type : $y = a.x^b$.

Ces corrélations suggèrent que, dans le cas présent, les métaux dans l'atmosphère proviennent essentiellement de la combustion des essences et des fiouls. L'absence de corrélation avec l'intensité du trafic automobile qui est plus intense en été qu'en hiver dans cette région indique l'existence d'un autre facteur prédominant dans l'explication des variations saisonnières observées. Les conditions météorologiques semblent jouer un rôle essentiel et les fortes concentrations hivernales observées sont probablement liées aux conditions anticycloniques particulières qui ont prédominé sur le Sud de la France pendant l'hiver 1988/89 (2).



REFERENCES

1) P.N.U.E., 1989. Rapport de la réunion des chercheurs responsables des programmes de surveillance continue, document UNEP(OCA) MED WG.5/3 (24 mars 1989)

2) A.M.P.A.D.I., 1989. Surveillance de la qualité de l'air en Languedoc-Roussillon, Rapport d'activité 1988 (juin 1989).

C-III16

Données sur l'Azote et le Phosphore Inorganique dans la Zone Centrale du Littoral Roumain de la Mer Noire

Adriana COCIASU

Institut Roumain de Recherches Marines, Constanta (Roumanie)

Pendant les deux dernières décennies, la mer Noire en général, et particulièrement les eaux côtières roumaines, se confrontent avec des phénomènes de pollution chimique et biologique de grande ampleur, ayant des effets négatifs qui génèrèrent de graves deséquilibres dans les écosystèmes côtiers. On a mis en évidence toute une série de modifications écologiques à nombreuses chaînes, dont les chaînons peuvent avoir des valeurs doubles de cause et effet. Dans ce sens, un exemple est constitué par les nutrients, et spécialement les sels de l'azote et du phosphore minéral, dont la croissance considérable (effet de l'utilisation intensifiée de fertilisateurs en agriculture) (1) représente le chaînon cause-clé qui a déterminé l'augmentation de la production primaire, surtout de manière explosive, par la chaîne colatérale des floraisons (2). Les grandes quantités de substance organique, résultat de l'eutrophisation, sont responsables, à leur tour, de la remise en circulation de certaines grandes quantités de nutrients, par les processus de minéralisation, qui déterminent le maintien du fonds nutritif à de grands taux, même dans la saison chaude de l'année. A côté de l'intensité de la production primaire, les processus régénératifs commencent à jouer un rôle extrêmement important dans le contrôle de la concentration de nutrients dans la zone euphotique.

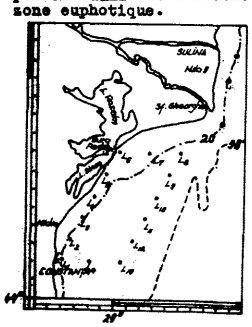


Fig.1 - Stations d'échantillonnage

Le présent travail est basé sur les observations mensuelles, pendant l'intervalle mai-septembre 1984-1988, dans la zone centrale du littoral roumain, couvrant un réseau de 14 stations, aux horizons standard jusqu'à 40 m profondeur (Fig.1).

On a déterminé la concentration des formes de l'azote (NO_3, NO_2, NH_4) et du phosphore inorganique; on a calculé les rapports atomiques $\Sigma N:P$ et les coefficients de corrélation $r_{\Sigma N,S}$; $r_{P,S}$.

Quelques-uns des résultats obtenus sont inscrits dans le tableau 1.

Les données inscrites dans le tableau indiquent, malgré l'activité biologique très intense de la zone, un maintien du fonds élevé de nutrients pendant toute la saison chaude, avec des oscillations entre très larges limites dans toute la masse de l'eau. Les grandes valeurs de concentration de l'azote et du phosphore inorganique, ainsi que celles de leur rapport atomique, sont dues à la forte eutrophisation de la zone. Dans aucune situation on n'a atteint l'épuisement total, les deux éléments ne constituant plus des facteurs limitatifs de la production primaire.

Tableau 1

Valeurs limite et moyennes de l'azote et du phosphore minéral de l'aire étudiée

	Mai	Juin	Juillet	Août	Septembre
			0 m		
N	1,24-18,74 $\bar{x}$ = 9,29	1,95-49,16 $\bar{x}$ = 7,21	1,41-18,38 $\bar{x}$ = 5,92	1,48-21,87 $\bar{x}$ = 7,63	0,82-36,79 $\bar{x}$ = 7,10
P	0,02-2,92 $\bar{x}$ = 0,46	0,02-4,56 $\bar{x}$ = 0,30	0,04-0,77 $\bar{x}$ = 0,24	0,06-5,16 $\bar{x}$ = 0,33	0,02-4,07 $\bar{x}$ = 0,40
$\Sigma N:P$	1 - 281 $\bar{x}$ = 20	1 - 354 $\bar{x}$ = 24	1 - 250 $\bar{x}$ = 24	1 - 155 $\bar{x}$ = 22	2 - 139 $\bar{x}$ = 18
			0 - 40 m		
N	1,81-23,38 $\bar{x}$ = 8,57	2,21-34,32 $\bar{x}$ = 7,08	1,33-31,20 $\bar{x}$ = 7,82	2,24-22,60 $\bar{x}$ = 8,32	1,94-20,4 $\bar{x}$ = 8,24
P	0,03-2,06 $\bar{x}$ = 0,50	0,06-6,37 $\bar{x}$ = 0,51	0,08-3,48 $\bar{x}$ = 0,38	0,07-1,85 $\bar{x}$ = 0,35	0,11-5,50 $\bar{x}$ = 0,67
$\Sigma N:P$	4 - 329 $\bar{x}$ = 17	4 - 186 $\bar{x}$ = 14	2 - 250 $\bar{x}$ = 21	2 - 77 $\bar{x}$ = 24	2 - 137 $\bar{x}$ = 12

En ce qui concerne la dynamique saisonnière, les modifications sont améliorées de beaucoup, le consume du plancton végétal dans le processus de nutrition étant vite récupéré, en principal par les quantités remises en circulation par les processus régénératifs et non pas par l'apport fluvial, réduit pendant cette période. Dans ce sens, une confirmation fournissent les moyennes de la couche 0-40 m, généralement supérieures à celles de surface, ainsi que la domination de la forme ammoniacale (70-80 %) et aussi le manque de corrélation des taux de l'azote et du phosphore minéral avec la salinité ($r_{\Sigma N,S} = 0$, $r_{P,S} = 0$).

En conclusion, les processus de régénération dans les sédiments jouent un rôle important dans le contrôle de la concentration et de la distribution des nutrients dans la zone de faible profondeur, ayant un apport considérable à l'eutrophisation des eaux côtières. Dans ce sens, nos études devront désormais viser l'échange de nutrients à l'interface eau-sédiment.

BIBLIOGRAPHIE

(1). COCIASU (A.), POPA (L.), 1980 - Observations sur l'évolution des principaux paramètres physico-chimiques de l'eau marine de la zone de Constanţa. Cercetări marine, IRCM Constanţa, 13, pp. 51 - 61.

(2). BODEANU (N.), 1983 - Modifications concernant le développement quantitatif et la structure du phytoplancton du littoral roumain de la mer Noire. Rapp.Comm.int.Mer Médit., 28.

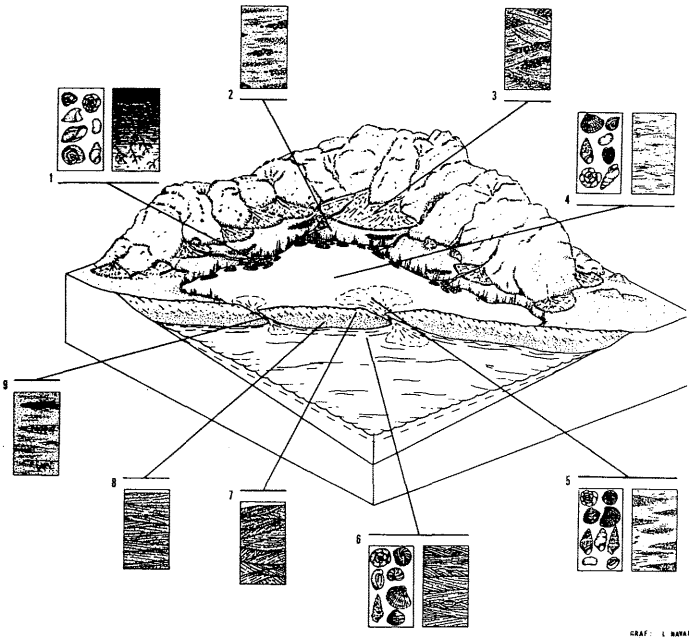
E-I1

Quaternary Evolution of some coastal Lagoons of the Spanish Mediterranean Littoral (Valencia, Alicante and Mallorca)

M.-P. FUMANAL* , G. MATEU** and M.-J. VINALS*

*Departamento de Geografia, Universitat de Valencia, 46080 Valencia (Espana)
**Instituto Espanol de Oceanografia, Muelle de Pelaires, Palma de Mallorca (Espana)

This is a study of the quaternary evolution of four barrier-island systems in the Mediterranean coast.
We have worked in four areas, three of them in the peninsular littoral: The Oliva-Pego marsh (Valencia), Xàbia and Moraira (Alicante). The fourth, S'Albufera de Alcudia, is in the easthern coast of the island of Mallorca. These environments have very active sedimentary dynamics, dependant on the quaternary eustatic oscillations, finally responsable for the migration of the ancient coastalines.
The reconstruction of the successive depositional environments in these littoral zones is approached from the sedimentological and micropaleontological analysis and from absolute datings of the materials extracted from several cores.
The Oliva-Pego marsh is currently a barrier-island system placed in the southern part of the Valencia Gulf. DUPRE et al (1988) and VIÑALS et al.(1989) have recognized several subenvironments from marginolittoral areas that allow us to place different positions of the coastline during Upper Quaternary.



Ideal reconstruction of the Oliva-Pego marsh in the Upper Pleistocene. Facies of the margino-littoral environemnt: (1) Biotope of the freshwater swamp; (2) facies of aluvial plain; (3) facies of aluvial fan; (4) Biotope of brackish lagoon; (5) Biotope of marine influenced brackish lagoon; (6) Biotope marine, infralittoral; (7) Dune facies; (8) Dry beach facies; (9) Inlet facies. Sedimentary structures are from REINECK and SINGH (1975).

The Xàbia and Moraira bays have a more structural morphology since they are inserted in the sea-cliffs of La Nao. Now they are relic systems (FUMANAL and VIÑALS, 1989 a; 1989 b), whose pleistocene barrier formations are recognizable in the present landscape (FUMANAL et al., 1990).
S'Albufera de Alcudia is the biggest lagoon of the Baleares. The cores taken inside this area have a depth of 350 m. From micropaleontological studies COLOM (1985) and MATEU (1982) have established different levels, the majority of them from the Terciary age. The upper 62 m are due to quaternary sedimentation.
The sedimentological features of the records allow the reconstruction of the different sedimentary environments and the diverse positions of the coastline along the considered period.
The species found permit the paleoenvironmental reconstruction. The fact that many of the species are euryhalines, imply that the study must be base on the consideration of faunistic associations and the dinamycs of populations.

References

COLOM, G. (1985): estratigrafía y paleontología del Andaluciense y del Plioceno de Mallorca (Baleares). Bol. Soc. Hª Nat. Baleares, 23. pp.25-33.
DUPRE,M.; FUMANAL,M.P.; SANJAUME,E.; SANTISTEBAN,C.; USERA,J. y VIÑALS, M.J. (1988): Quaternary evolution of the Pego coastal lagoon (Southern Valencia, Spain). Palaeogeography, Palaeoclimatology, Palaeoecology, 68. pp.291-299.
FUMANAL,M.P. y VIÑALS, M.J. (1989 a): La albufera residual de Moraira (Alicante): Evolución geomorfológica. Actas del XI Congreso Nac. de Geografía, Madrid, 25-30 septiembre. pp. 391-400.
FUMANAL, M.P. y VIÑALS, M.J. (1989 b): El litoral de Xàbia: Contrastes morfológicos y genéticos. Xàbiga, 5. pp.7-16.
FUMANAL,M.P.; SANTISTEBAN,C. y VIÑALS, M.J. (1990): Implicaciones geomorfológicas de las formaciones de restinga en el sector Prebético externo (Alicante). Actas 1ª Reunión Nac. Geomorfología. Teruel.
MATEU, G. (1982 a): El Neógeno-Pleistoceno de Mallorca. Bol. Soc. Hª Nat. Baleares, 26. pp.75-133.
VIÑALS,M.J.; MATEU,G.; FUMANAL,M.P. y USERA,J. (1989): Aportación al conocimiento de las facies lagunares y litorales de la marjal de Oliva-Pego (Valencia). Cuaternario y Geomorfología, 3.

E-I2

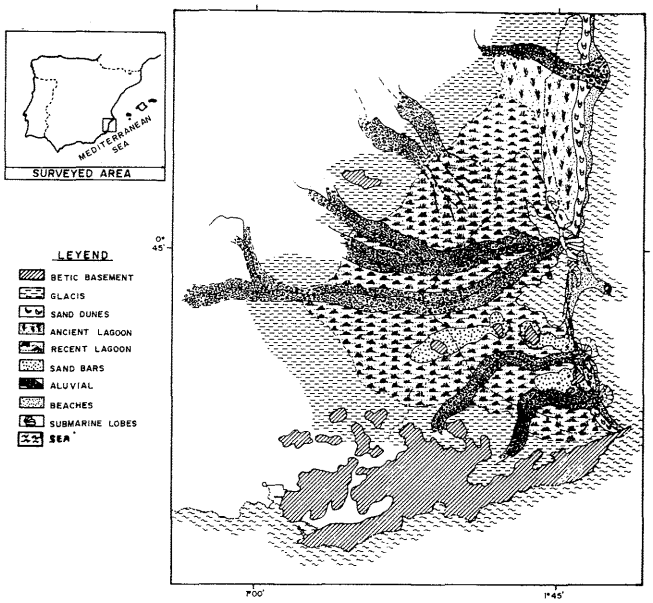
The Role of the Relative Sea Level Changes on the Quaternary Evolution of the "Mar Menor" (Murcia, Spain)

Victor DIAZ DEL RIO* , Luis SOMOZA* , Caridad ZAZO** and José L. GOY***

*Centro Oceanografico de Fuengirola, Apartado 285, Fuengirola (Spain)
**Museo de Ciencias, C.S.I.C., C/ J. Gutierrez Abascal nº2, Madrid (Spain)
***Facultad de Geologia Universidad Complutense, Madrid (Spain)

Mar Menor is a simple coastal-lagoon in the southeastern end of the Iberian Peninsula (Western Mediterranean). Its origin is related to Flandrian transgression, and can be interpreted as a residual coastal-lagoon (DIAZ DEL RIO, 1989). It's underlain by Plio-Quaternary sedimentary sequences prograding seaward, developing the continental margin in the area. High-resolution seismic profiling, aerial reconnaissance studies, vibrocores and sediment samples have been used to interpret the Quaternary history and evolution of the system.

The sediments in the bottom are dominated by mud-size clastics and biodetritic materials, mainly from mining wastes. Only the borders are dominated by sandy sediments, forming the barrier and the land edge.



The thickness of the recent sedimentary units shows high variability, between 1 and 12 meters. The seismic reflectors are generally characterized by strong signals separated by an acoustic reflection (at the base of the series) having a large lateral extent, interpreted as a Tyrrhenian basal level.

Variations in sea level, in this case glacio-eustatic, display a high morphology variability on the coastal-lagoon, as well as in the barrier (SOMOZA, 1989; NICHOLS, 1989). The effect of relative sea level changes, as far as it relates to the construction of the youngest barrier, is the landward migration of the beach simultaneous to an expantionary lagoon.

Based on seismic-reflection data, and assuming a Tyrrhenian-III age (based on regional stratigraphic studies in the area) for the basal level, it is possible to estimate a sedimentation rate close to 1.2 mm/y - 2 mm/y, for the last 80.000 years.

As a result of a relative drop in sea level, 18.000 years B.P. (minimun regressive), a fluvial-torrential system was placed in the lagoon, developing a marsh system in the back-barrier. In the mouth of the channels fluvial sediments could be deposited constructing submarine lobes, composed by coarse sand and gravels. These sedimentary bodies, can be seismically recognised in the inner continental shelf.

REFERENCES.

DIAZ-DEL-RIO, V., 1989. Morfología, formaciones superficiales y evolución reciente del margen continental en la región del Cabo de Palos (entre el Cabo Tiñoso y el Cabo Cervera), SE de la Península Ibérica. Tesis Doctoral. Universidad Complutense. 358 pp.

NICHOLS, M.M., 1989. Sediment accumulation rates, and relative sea-level rise in lagoons. In: L.G. Ward and G. M. Ashley (Editors). Physical Processes and Sedimentology of Siliciclastic Dominated lagoonal Systems. Mar. Geol., Vol. 88: 201-219.

SOMOZA, L., 1989. Estudio del Cuaternario litoral entre el Cabo de Palos y Guardamar del Segura (Murcia-Alicante): Las variaciones del nivel del mar en relación con el contexto geodinámico. Tésis Doctoral. Universidad Complutense.

Geochemical and Chemical-Physical Characterization of a Polluted Mud Flat in the Venice Lagoon

E. ARGESE*, F. COSTA**, G. GHERMANDI***, G. PERIN*, R. PINI****, P. TRAVERSO*, S. VAZZOLER** and R. ZONTA**

*Dipartimento di Scienze Ambientali, Universita' di Venezia, Venezia (Italia)
**Istituto per lo Studio della Dinamica delle Grandi Masse, Consiglio Nazionale delle Ricerche (CNR), Venezia (Italia)
***Osservatorio Geofisico, Universita' di Modena, Modena (Italia)
****Istituto per la Chimica del Terreno, Consiglio Nazionale delle Ricerche (CNR), Pisa (Italia)

The continual discharge of pollutants in a semi-enclosed body of water as the Venice Lagoon, induces the formation of dystrophic states and causes accumulation of toxic species in water and sediment, particularly in the areas with little tide exchange.

To evaluate in detail the causes of degradation in these areas and to advance solutions to restore it, the study of the environmental conditions can not leave out a multi-parameters analysis of "tracer" variables that permit to establish the availability of nutrients and heavy metals in the sediment to surface water and the biosphere.

On this basis, a study was made on the chemical and physical characteristics of a mud flat inside the Venice Lagoon, that is subject to intense growths of macroalgae, predominantly Ulva Rigida. In the last year, in fact, the Venice Lagoon has been particularly afflicted by eutrophication manifestations, at the point of making it necessary to mechanically remove macroalgae during the summer period, to limit the degradation of water and air quality.

The mud flat studied covers a surface area of about 1.5 Km^2; its mean tide is 50 cm, with mean excursion of about ± 30 cm. Analyses were made on the first 50 cm of sediment. During the period between May 1988 and November 1989, four samplings of sediment cores were taken, using a "syringe-type" corer, hand-made in plexiglass; it allows to extract undisturbed samples with 5 cm diameter. On the collected samples, redox potential E_H, grain-size distributions and heavy metal (Cr, Cu, Fe, Mn, Ni, Pb, Zn) concentration measurements were performed; the latter for both in the total content and through the application of a selective extraction technique. Further - during two field measurements - the current evolution through the channels delimiting the mud flat was observed in response to tides of quadrature and syzygies, utilizing data acquired by self-recording current meters immersed simultaneously in four places.

For the E_H measurement a methodology was set-up that permits to obtain representative values of the oxidation-reduction condition in situ from samples practically undisturbed [1].

Instead, the cores to analyse grain-size distribution and heavy metals content were immediatly subdivided into ten 5 cm-long cylinders. Grain-size determination was made with a laser-beam particle analyzer [2] (Microtrac mod.7995), obtaining the particles percentage distribution in fifteen dimensional classes of diameter, from 0.7 to 125 μm. Heavy metals were determined in the total content (cold 1N HCl) and for their presence in five geochemical phases [3], [4] corresponding to these metal fractions: extractable, associated with carbonates, bound to Fe and Mn oxides, associated with the organic matter and sulphides, and finally the non-lattice-held residual (obtained for difference).

In the surface layer (the top 5 cm) all measurements made on the samples coming from the nine measurement-sites chosen in the mud flat indicate the existence ot three sectors with different characteristics. One is, in fact, able to distinguish a very reduced zone with greater presence of fine grains and heavy metals, where there is the greatest growth of algae in the mud flat. Next, a oxidated zone with a greater presence of larger diameters, poor or no accumulation of heavy metals and scarce algae presence. Finally, a third zone with intermediate characteristics.

As a general rule, the E_H values decrease along the cores till about 15 cm depth, indicating more reduced conditions in the deeper layers with respect to the surface layers. The upper 15 cm thick-layer has varying redox characteristics, which are sensitive to the hydrodinamycal and hydrological conditions of the overlaying water, since it is involved in the water interaction processes and bacterial activity. On the contrary, sediment deeper than 15 cm definitely gives negative E_H values, which are about equal and constant in all the nine sampling-points in the mud flat (≈-170 mV). With the depth, either a general but slight increase of particles with smaller diameters and a remarkable decrease of heavy metal contents (total and fractionated), in the deeper layers with respect to the surface layers. Only Mn does not follow this trend.

Utilizing statistical correlation techniques [5],[6], the existing relations between the three measured variables at the same depth in the mud flat and along the sediment column were finally emphasized. In particular a strong, positive correlation among total heavy metal, the redox condition intensity and particles percentage in the diameter range $10<\phi<40$ μm is evidenced for the sediment surface layer. Further, the correlation coefficient r values together with heavy metal present in the five extracted geochemical phases permit the formulation of an interpretative picture of the dependence of heavy metal speciation on the intrinsic sediment characteristics.

The authors thank G.Arcari, G.Cogoni, T.Corso, L.Gobbo, G.Magris, M.Meneghin, R.Ruggeri, F.Salviati, F.Simionato, G.Zamperoni and R.V. Zonta for their collaboration given during the field measurements, in collecting the samples and in the analyses by atomic absorption. The research activity was partially financed by the City's Environmental Council.

[1] E.Argese, G.Cogoni, R.Pini and R.Zonta: "Study on the Redox State and Grain-Size of Sediments in a Mud Flat of the Venice Lagoon" The Science of the Total Environment, in press.

[2] P.E.Plantz, in H.G.Barth (Ed.), "Modern Methods of Particle Size Analysis", J.Wiley and Sons, New York, 1984 p.173

[3] (see for example) U.Forstner, in I.Thornton (Ed.), "Applied Environmental Geochemistry", Academic Press, London, 1983 p.395.

[4] (see for example) A.Tessier, P.G.C.Campbell and M.Bisson: "Sequential Extraction Procedure for the Speciation of Particulate Trace Metals", Anal. Chem., 51, N.7, (1979), 844.

[5] (see for example) M.Ezekiel and K.A. Fox, in Methods of Correlation and Regression Analysis, J.Wiley & Sons, Inc., New York, 1959, Ch.8 and 25.

[6] (see for example) D.F.Morrison: "Multivariate Statistcial Methods", McGraw-Hill, N.Y, 1967, p.338.

Studies on the Bottom Deposits of the Egyptian Lakes

Massoud A.-H. SAAD

Oceanography Department, Faculty of Science, Alexandria University, Moharem Bey, Alexandria (Egypt)

SUMMARY:- Sediment samples were collected from six Egyptian lakes and subjected to some physico-chemical investigations. Variable amounts of organic matter, calcareous substances, allochthonous materials and diatom-silica were deposited on the bottom of the Egyptian lakes. The distribution of these components in the Egyptian lake sediments was found to depend upon certain factors which were discussed.

Lake Manzalah, Lake Brollus, Lake Edku, Lake Mariut and the Nozha Hydrodrome are situated at the north of the Nile Delta, whereas Lake Qarun is found in Upper Egypt southwest of Cairo. The first three lakes are connected to the Mediterranean Sea and hence their chlorosity varies according to locality and season. All these lakes receive huge amounts of drainage waters, except the Hydrodrome which feeds from the Nile water. The present work was undertaken to study the nature and composition of sediments collected from these lakes and to compare the results from each lake with those of the others, since each lake has its own limnological characteristics. Sediment samples were collected from three different localities in each lake. The samples of each lake were mixed to form a composite, which was subjected to some physical and chemical investigations.

The external events have a remarkable effects on the nature, composition and distribution of the Egyptian lake sediments (Saad and Arlt, 1977, Saad, 1978). The allochthonous mineral materials entering into the Egyptian lakes mainly with drainage and sea waters, as well as by the influence of the prevailing wind are distributed by water currents throughout most of the lakes. The recent allochthonous sediments cover the autochthonous organic sediments or mix with them. Consequently the exchange of elements between the sediments and the upper free water is greatly reduced (Saad, 1984).

The maximum density of wet mud found in Lake Edku sediments coincided with the maximum value of dry matter and the minimum value of water content. This reflects the large quantities of allochthonous minerogenic materials entering into this lake via drainage and sea waters, giving the maximum value. However, the sediments of Lake Mariut showed the opposite trend; being soft due to the influence of heavy pollution (Saad, 1972).

Variable amounts of organic matter were deposited on the bottom of the Egyptian lakes. The great amounts of organic matter found in the sediments of Lake Brollus and Lake Qarun are due mainly to the increase in the amounts of allochthonous supply and autochthonous production of organic matter. In spite of the influence of organic pollution on Lake Mariut, the organic content in its sediments was relatively low , due to the high intensity of decomposition of organic matter (Saad,1972).

The bottoms of the Egyptian lakes are characterized by accumulation of shells and shell fragments of calcareous organisms (Saad, 1978). The increase in the amounts of calcareous substances in the sediments of Lake Brollus, Lake Edku and Lake Qarun is due to the abundance of these shells (Saad and Arlt, 1977, Saad,1984).

Diatomaceous silica were deposited in variable amounts on the bottom of the Egyptian lakes. The maximum value of diatom-silica found in Lake Qarun sediments reflects the richness of these sediments with diatom shells (Saad, 1976, 1984). However, the minimum amount found in Lake Mariut coincided with the scarcity of diatom frustules in the sediments of this lake.

REFERENCES

SAAD, M.A.H. 1972. Effect of pollution on the sediments of Lake Mariut, Egypt. Rapp. Comm. int. Mer Medit., 21 (3): 125-127.

SAAD, M.A.H. 1976. Core sediments from Lake Brollus (Bahra el-Burullus), Egypt. Acta Hydrochim. Hydrobiol., 4: 469-478.

SAAD, M.A.H. 1978. Core sediments from four Egyptian delta lakes. Bull. Off. Natn. Pech. Tunisie, 21 (1-2): 337-345.

SAAD, M.A.H. 1984. A preliminary study on the bottom sediments of Lake Nasser. Notes, 56: 1-7.

SAAD, M.A.H. & G. ARLT. 1977. Studies on the bottom deposits and the meiofauna of Shatt al-Arab and the Arabian Gulf. Cah. Biol. Mar., 18: 71-84.

E-I5

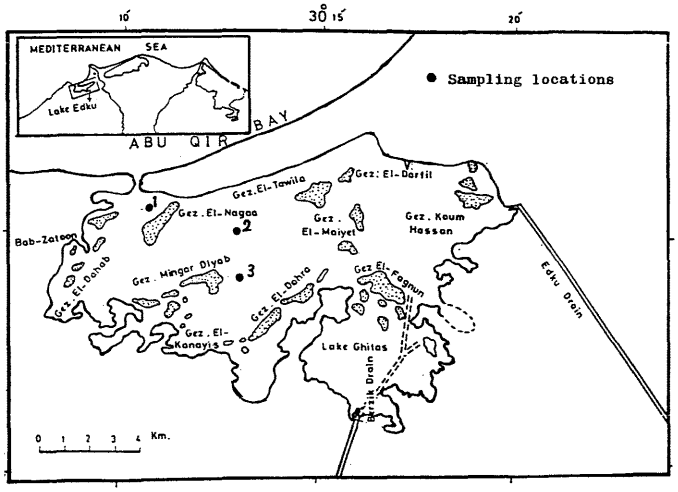
Geochemistry of Fe, Mn, Zn, Cu, Pb and Cd in Sediment Cores from Lake Edku

Atef A. MOUSSA and Mohamed A. EL-SAYED

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

Lake Edku is one of the shallow, brackish-water coastal lagoons of the Nile Delta. The lake is separated from the Mediterranean Sea by a sandy coastal barrier, yet, lake-sea water exchange is kept through a narrow outlet.

The lake sediments are mostly derived from soil erosion in addition to contribution from indegenous plants and animals. On the average, the sediments compose of a mixture of 45% sand; 23% silt; and 32% clay. Mollusc shell fragments constitute in most cases the major part of sand. The clays and fine silt on the other hand compose of mixed layer smectite-illite, illite and subordinate kaolinite (Moussa and Saad, in preparation). X-ray amorphous Fe hydrous oxides seem to contribute to these fractions a lot.



For the present work we collected three sediment cores in a way to represent the three main subenvironments of the lake: 1- the lake-sea communication vicinage; 2- the central basin; 3- the area affected directly by drains.

In the laboratory, the sediment interstitial water were extracted by centrifugation. The sediments were then dried at 70 c. A carefully homogenized portion of each sediment was powdered for the determination of organic carbon, carbonate and total heavy metal concentrations. A 1.0 g cut of each nonpowdered sediment was taken for the extraction of labile elements by 1M HCl. Another suitable cut was taken for the determination of sand, silt and clay contents.

The element analysis were done by flame ASS. All the precautions of sample handling and analysis were taken in order to assure high quality of data.

The results showed that the lake average concentrations of the total Fe, Mn, Zn, Cu, Pb and Cd are: 57787, 943, 81, 55, 42, 3.4 ug/g respectively. The per cent leachable fractions of these elements in the given order are: 18, 64, 30, 53, 612, 30. The leachability of the elements decreases generally from top to bottom in the cores.

The correlation analysis of the total element concentrations with the other sediment parameters indicate two groups of element associations: a) Fe-Zn-Cu and b) Mn-Pb-Cd. The clay and to some degree the silt are the major sites for the first association, while, the calcareous shells (sand) are the sites for the second group.

The resolution of the total element concentrations into labile (HCl leachable) and residual (total - labile) gives a more clear picture.

In the labile phase, Zn of group (a) went out of the combination to become specifically correlated with organic carbon (r=0. 75) leaving Fe and Cu with clays. In group (b) assciation improved correlations are observed between Pb and Cd (r=0. 96) and between Mn, Pb and Cd (r=0. 77). Also their link to calcareous sand becomes more evident (r=0. 82-0.87).

In the residual phase all the elements are interrelated. About 70% of Fe and 50% of Pb are shown to be incorporated in the silt and clay minerals. The weak correlation between Zn, Cd, Cu and the silt and clay minerals suggests that these elements are most probably incorporated in heavy minerals.

References

Moussa, A. A. and Saad, N. A., Mineral composition of Lake Edku sediments (in preparation)

E-I6

Copper Speciation in the Sediments of the Nile River Delta Lakes in Egypt

A.-R. ABDEL-MOATI

Oceanography Department, Faculty of Science, Alexandria University, Alexandria (Egypt)

A five step sequential extraction scheme (Tessier et al., 1979) was applied to surfacial sediments collected during the period 1982-1989 from four northern Nile River delta lakes in Egypt namely Lake Mariut, L. Edku, L. Burullus and L. Manzalah to illustrate the different species of Cu associated with their sedimentary phases. Cu concentration in each phase was determined using a Perkin Elmer AAS. Almost, the summation of sequential extracts showed a good agreement (within 6%) with the total metal concentration. The accuracy was tested against NBS standard River Material 1645 and concentrations were within 3-5% of certified values. Triplicates showed high reproduceability not exceeding 10%.

Information for the sampled lakes as well as the average concentrations of the different Cu species are shown in Table 1.

Table 1. Area, depth range, trophic status, flushing time and mean Cu species concentrations (µg/g) as well as organic matter (%) and Cu/Al ratio in the Nile delta lakes.

LAKE	MARIUT 1986	EDKU 1989	BURULLUS 1988	MANZALAH (1982/83)
AREA (Km^2)	70	115	370	700
DEPTH (cm)	90-150	50-150	50-200	100
TROPHIC STATUS	Hypereutrophic	Mesotrophic	Mesotrophic	Eutrophic
FLUSHING TIME (d)	ND	21	42	38
Exchangeable *	1.03±0.54	0.16±0.04	0.34±0.1	0.67±0.3
Carbonate*	1.20±0.25	0.80±0.13	3.10±0.4	1.90±0.4
Fe/Mn oxide *	6.80±0.90	9.30±1.10	5.26±0.9	12.40±3.6
Organic/sulphide*	36.40±18.3	11.80±1.50	7.50±0.8	28.10±12.6
Residual*	28.80±5.10	16.90±2.10	12.80±1.6	32.20±6.1
ORGANIC MATTER (%)	10.1	2.4	1.8	6.9
Cu/Al * 10^{-5}	325	139	95	267

ND = Not determined *= µg/g

The exchangeable fraction of Cu showed no statistically significant magnitude between the different lakes. The carbonate fraction as well was only enriched in samples collected at the lake-sea connection sites where the carbonate content of sediments reached >55%. Despite the presence of Fe and Mn in considerably high concentrations in the studied lakes, the easily reducible fraction was the third in abundance. The organic and sulphide associated Cu were enriched in the sediments of Lake Mariut and Manzalah forming on the average 49% and 43% of the total Cu, respectively. Both lakes receive huge amounts of sewage discharge and are suffering from anoxia in most of there productive areas with H_2S values reaching >15 ml H_2S/l. Station to station variations were reflected on elevated standard deviations from the mean in both lakes. Lake Edku receives sea-derived industrial wastes which may elevate the Cu concentration at the lake-sea connection while L. Burullus is comparatively clean receiving only agricultural discharge and local sewage.

The use of $CuSO_4$ as an algicide in controlling aquatic plants' blooms, specially during warm season, is the main route of Cu to the northern delta lakes. The accumulation of dissolved Cu by phyto-, zooplankton as well as floating and submerged macrophytes may transfer Cu to the lake sediments after their death and decay. The Cu/Al ratio calculated for the different delta lakes showed Cu enrichment in all lakes when compared with the Cu/Al ratio of standard shale. Table 1 showed that Cu is enriched in the sediments of the delta lakes in the order : Mariut > Manzalah > Edku > Burullus.

References

Tessier, A. et al. (1979). Anal. Chem. (51) 7: 844-850.

E

Salinity and Major Ions in Lake Manzalah, Egypt

A.-R. ABDEL-MOATI and N.-M. DOWIDAR

Oceanography Department, Faculty of Science, Alexandria University, Alexandria (Egypt)

The northern delta lakes in Egypt receive various types of water ranging from Nile fresh water (salinity < 1‰) to coastal Mediterranean sea water (salinity > 39‰). Mixing inside the lake systems leads to the appearance of various in-lake environments. Variations in salinity and subsequent variations in the major ions have been evaluated.

Lake Manzalah is the largest (900 km2) and most productive Nile delta lake, boardered by the Mediterranean Sea to the north, the Suez Canal (east) and the Nile branch (west). The average depth is 1 m. About 6,600 million m3 of fresh and brackish water reaches the lake annually.

During 1982/83, 50 stations were sampled monthly. Salinity was measured using inductive salinometer; chloride argentometrically ; calcium, magnesium, sodium and potassium by an ICP spectrometer; sulphate by turbidimetry; bicarbonate and carbonate by titration.

The lake is divided into 2 regions, the N.W. region (average salinity 41.9 + 9‰) and the main lake region (average salinity 2.49 + 1.1‰). Since 1933 (average lake salinity 24‰), the progressive increase in drainage water reaching the lake and the Nile flood cessation since 1965 as well as the restriction of marine water flowing through the lake-sea connection during late 1960's (average salinity 9‰) are the main reasons for salinity declination in the lake. In 1982, the amount of water discharging into the lake was 7.7 times the lake water volume. Salinities at the lake-sea connection reached 19.9‰ during summer. The mixing of fresh and sea water appears at the coastal Mediterranean waters opposite to the lake-sea connection and the resulting brackish water enters the lake as a side way current.

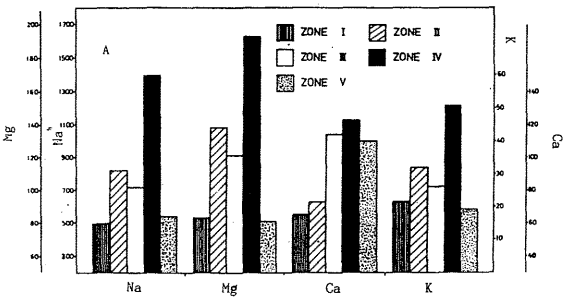


Figure 1. Zonal averages (mg/l) of major ions in lake Manzalah.

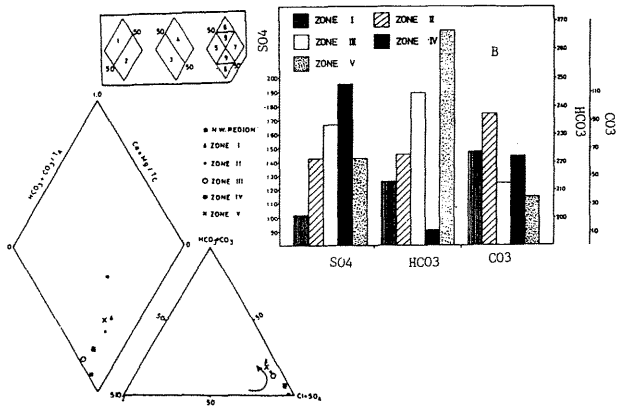


Figure 2. Multivariate graph for major ions in lake Manzalah.

According to salinity, stations were grouped into 4 water types:Type A (0-5‰), Type B (5-20‰), Type C (20-40‰) and Type D (>40‰) with the following salinity/chlorinity relations S‰=1.888 Cl‰+ 0.126; S‰=1.794 Cl‰+ 0.121; S‰=1.783 Cl‰+1.349 and S‰=1.754 Cl‰+ 2.042; indicating deviations in the relative proportions than those of oceanic waters.

The average concentrations of different cations and anions are represented in Figure 1. Zonal fluctuations are related to the quality of water reaching each zone. The relative abundance for cations was Na > Mg > Ca > K while for anions was Cl > HCO3 + CO3 > SO4. Anoxic conditions prevailing in certain lake areas lead to reduction in sulphate concentrations.

Table 1. Ion/Chlorinity ratios for lake Manzalah water.

Water type ION	A S‰(0-5‰)	B S‰(5-20‰)	C S‰(20-40‰)	D S‰(>40‰)
Na	0.5594	0.5518	0.5477	0.5353
Mg	0.0684	0.0665	0.0630	0.0628
Ca	0.0223	0.0206	0.0188	0.0185
K	0.0277	0.0208	0.0202	0.0196
SO4	0.1433	0.0994	0.0988	0.0843
HCO3	0.1963	0.0553	0.0100	0.0050

Table 1 shows the different ion/chloride ratios for different water types. The chlorinity ratios for all ions showed a progressive decrease by increasing salinity, despite the progressive increase in the mean ion concentration with increasing salinity.

Relations among cations and anions (Figure 2) classified the lake water as soft in relation to its content of dissolved salts. The N.W. region and areas affected by sea water invasion represent a halite dominated system while others are shifted towards carbonate enriched systems.

Etude Comparative des Caractéristiques Physico-Chimiques de la Lagune de Nador (sur la Méditerranée) et de la Lagune de Moulay Bousselham (sur l'Atlantique)

Abdeljaouad LAMRINI

Section Halieutique, Institut Agronomique et Vétérinaire Hassan II, B.P. 6202, Rabat - Instituts (Maroc)

La lagune de Nador est située sur la cote méditerraneenne Nord-Est du Maroc, elle s'étend sur un arc de cercle de 115Km^2 et s'ouvre par une étroite passe assurant une communication précaire avec la Méditerranée.
Alors que la lagune de Moulay Bousselham est située sur la partie nord du littoral marocain ; de forme elliptique, elle occupe une cuvette de 35Km^2 à l'interieur de laquelle le niveau de l'eau est variable suivant les marées et les saisons.Elle s'ouvre sur l'océan par une passe ayant tendance à s'ensabler.

Ces deux lagunes reçoivent des rejets domestiques, agricoles et industriels entrainant des variations des paramètres physico-chimiques, ce qui provoque des perturbations de la faune et de la flore aquatiques redoutables pour l'équilibre biologique.

Pour apprécier la qualité des eaux lagunaires des deux écosystèmes, une étude analytique des principaux paramètres (T° , S/$_{oo}$, pH, O_2 , Sels nutritifs) a été faite en 1988 pour la lagune de Nador et 1989 pour la lagune de Moulay Bousselham.

Les techniques d'analyse utilisées ont été celles présentées par AMINOT et CHAUSSEPIED (1983).

L'examen des résultats obtenus permet de répartir les paramètres physico-chimiques étudiés en deux catégories : d'une part le pH et l'oxygène dissous qui présentent des niveaux comparables dans les deux lagunes, d'autre part la température, la salinité et les sels nutritifs qui enregistrent des résultats bien différents d'une lagune à une autre.

Dans la première categorie, le pH est alcalin dans les deux lagunes et oscille autour de 8, les valeurs les plus élevées sont enregistrées à l'amont.
Pour les concentrations d'oxygène, bien qu'elles soient dans la même fourchette au niveau des deux lagunes (3 à 8 ml/l), la lagune méditerraneenne semble être moins oxygenée.

Dans la seconde categorie, bien qu'il soit difficile de faire une comparaison entre les deux lagunes en raison des périodes d'étude différentes, on peut faire les constatations suivantes:
- Dans chaque écosystème, la température est plus élevée en amont qu'en aval, de plus les amplitudes thermiques sont plus élevées dans la lagune atlantique que dans la lagune méditerraneenne. Il y a lieu de considerer un risque de dystrophisme engendré par les hautes températures estivales (27°C et plus pour les deux lagunes).
- Le milieu lagunaire méditerraneen est globalement plus salé que le milieu atlantique (abstraction faites des stations situées sur les fleuves), ce qui serait dû en partie à la période d'étude estivale dans la lagune de Nador.Les fortes dessalures (jusqu'a 3‰) de la lagune atlantique auraient une incidence sur la reproduction de certaines espèces.
- Pour les sels nutritifs (NO_2^- , NO_3^- , PO_4^{3-} , NH_4^+), la lagune méditerraneenne est plus riche que la lagune atlantique bien que celle-ci ait été étudiée en grande partie durant la période des précipitations.
Une étude anterieure de la lagune de Nador (GOUDAN, 1986) a révelé des concentrations en nitrites inférieures et des concentrations en oxygène superieures aux concentrations actuelles.
La pauvreté dans la lagune atlantique du moins temporaire en nitrates qui entrent en grande partie dans la constitution de la matière organique serait prejudiciable, ces éléments pourraient jouer un rôle de facteur limitant.

Les deux lagunes pourraient présenter à l'avenir des limites dans leurs possibilités biologiques ; pour pouvoir mettre en place des aménagements de revalorisation, une surveillance continue des niveaux des paramètres physico-chimiques ainsi que des déversements des affluents urbains et agricoles sont nécessaires.

BIBLIOGRAPHIE

AMINOT, A et CHAUSSEPIED, M 1983 - Manuel des analyses chimiques en milieu marin
CNEXO, 395p.

BEAUBRUN, P.C 1976 - la lagune de Moulay Bousselham, étude hydrologique et sédimentologique.
Bull.Inst.Sci.n°1, pp : 5 - 37.

GOUDAN, A 1986 - Pollution physico-chimique de la lagune de Nador (Sebkha Bou Areg) - Maroc.
Mémoire de fin d'études en halieutique I.A.V Hassan II Rabat, 62p.

KAPETKY, J.M 1982 - Quelques considerations sur l'aménagement des pêches des lagunes cotières et d'estuaires.
FAO.Doc.Tech.Pêche (218), 54p.

E-II3

Global Model for Nutrient Flux and Biomass Production in the Albufera of Valencia, Spain

E. VICENTE, M.-R. MIRACLE and J.-M. SORIA

Ecologia, Facultad Ciencias Biologicas, Universitat de Valencia, Burjassot (Spain)

The Albufera of Valencia is an hypertrophic lagoon of 26 km² surface and mean depth 1.1 m. It constitutes the center of a Natural Park composed by this lagoon and the surrounding marsh land, dedicated almost completely to rice fields. Miracle et al (1986, 1988) emphasize the heavy eutrophication impact suffered by this lagoon in recent years. The present paper gives the global model of functioning of the Albufera in respect to the total nutrient input and the consequent biomass production which will be discharged in part to the sea, but in another and more important part to its own sediments. This study compiles results of seasonal measurements made in the 36 most important inflowing channels, the three outflowing channels and inside the Albufera during the year 1988. Parameters measured were the rate of inflow or outflow in the channels, and nutrient and chlorophyll contents in all sampling points (phytoplankton cells were also counted and identified). Primary production was also evaluated by ^{14}C experiments.

Results and discussion

The annual inputs of nutrients in Albufera of Valencia are extremely high (table 1). The inflow of sewage water registered in table 1 was calculated measuring the P concentration in the sewage discharge at their exit from the surrounding villages and estimating the proportion of sewage in the mouth of the channels from their P content. The concentration of nutrients in Albufera water is very low, as well as the inorganic nutrient output. Inorganic N and P outputs are respectively 10 and 50 times less than their corresponding inputs. The entrance of particulate P is mainly due to organic matter, while the outflow is mainly constituted by phytoplankton biomass.

Table 1. Albufera of Valencia. Global nutrient flux and pollution.

	N-ammonia	N-nitrate+nitrite	N-org	O - P	P - P	Sewage
INFLOW CHANNELS						
T/y	1907.9	2076.9	4335.1	371.8	619.3	Hm^3 /y 78.6
$g/m^2.y$	74.3	80.8	168.7	14.5	24.1	$m^3/m^2.y$ 3.1
					28 % total water inflow	
OUTFLOW CHANNELS						
T/y	178.8	191.8	1470.0	8.7	210.0	
$g/m^2.y$	7.0	7.5	57.2	0.3	8.2	

Figure 1 shows the functioning of Albufera of Valencia based on a phosphorous balance. Phosphorous enters in the Albufera in soluble inorganic form or as particles of organic matter with a low proportion of algal cells, and it goes out of the Albufera mainly in the form of phytoplankton biomass. Experiments in aquaria using Albufera water and mud, demonstrated that added dissolved phosphorus remains in the water and the rate of deposition in the sediments is extremely low. Nevertheless particulate phosphorus may be deposited in the sediment as not recycled organic matter.

On the other hand, 100 times more biomass goes out of the system than enters in it. This is because the lagoon acts as a continuous culture; primary production in the lagoon was evaluated to be 40,000 Tons of C/year. In the lake it is produced five times more biomass than it is outflowed. It is assumed that phosphorous used in primary production comes in equal parts from the external input and from the recycling of the decomposition of previous phytoplanktonic production. From this assumption and considering the relationship P/biomass = 1/500, it is estimated that the phytoplankton uses about half of the total P input (which was around 1,000 Tons/year). If soluble inorganic P is maintained in the water, then about 500 Tons of the alloctonous particulate P must have gone that year to the sediment altogether with 300 Tons of the particulate P of the 150,000 Tons of autochthonous not recycled primary production. Summarizing, half of the primary production is recycled and reincorporated again to enhance new production, while the other half is exported: 20 % to the sea and 30 % to the sediment. Primary production is low when compared with P input and the standing stock of algal biomass in the lake. The system is limited by light and production is around 2 g C/m³.h (corresponding to 4 mg C/mg chlorophyll) restricted to a thin surface layer, being negligible in the rest of the water profile. Thus, daily primary production is around 4 g C/m².

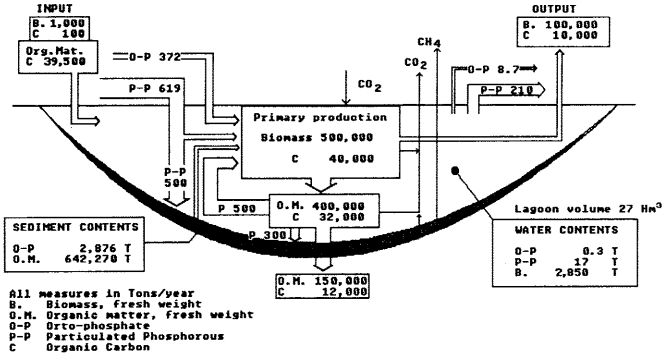


Figure 1. Functioning model of the Albufera. Double lined arrows and numbers correspond to the estimated values of P circulation; single lines to C not quantified circulations.

BIBLIOGRAPHY

Miracle, M.R., J.M. Soria, E. Vicente y S. Romo. 1987. Relaciones entre la luz, pigmentos y fitoplancton en la Albufera de Valencia, laguna litoral hipertrófica. Limnetica, 3: 25-34.

Miracle, M.R., E. Vicente and J.M. Soria. 1988. The Albufera of Valencia, an hypertrophic stressed ecosystem. Rapp. Comm. Int. Médit. 31. 2:64.

E-II4

Nutrient Balance and Biomass/Productivity Interrelations in the Coastal Lagoon Lake Burullus, Egypt

A.-R. ABDEL-MOATI*, A. BELTAGY** and M. MAMONEY**

*Oceanography Department, Faculty of Science, Alexandria University (Egypt)
**National Institute of Oceanography and Fisheries, Alexandria (Egypt)

The Nile delta lakes are proximate reservoirs for the Nile water flowing to the Mediterranean. Taking Lake Burullus as a model, in this study we tried to estimate the amount of nutrient input to the water system and analyze their probable impact on lake productivity.

Lake Burullus is located between the Nile River branches, connected to the Mediterranean through Bz. El-Burullus. The lake area is 420 Km^2 of which 370 Km^2 are open water; the average depth is 1.25 m. The lake receives $3.6x10^9 m^3$ of fresh and brackish water/y of which $2.2x10^9 m^3$/y is discharged to the Mediterranean. The islands divide the lake into four zones of different ecological conditions.

Water samples were collected during February 1987 - March 1988 from different zones and drains for determination of nitrogen, phosphorus and chlorophyll a (Strickland&Parsons, 1972) as well as primary productivity (Steeman-Nielsen, 1952).

Lake Burullus is considered a mesotrophic lake (average chlorophyll a 6.6 mg/m^3) specially when compared with Lake Manzalah (average 21 mg/m^3) (Hamza, 1985). The area receiving >80% of drain water reaching the lake recorded the maximum chlorophyll a average (10.8 ± 14.1 mg/m^3). The same zone attained the maximum average productivity (0.23 g C/m^2. d) and contributes to about 1/3 the annual phytoplankton production of the lake i.e. 102,024 tons C/y.

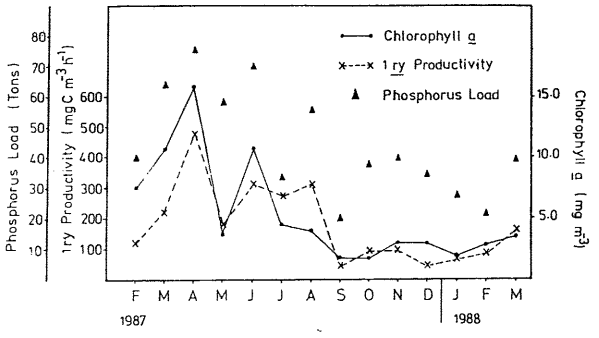


Figure 1 Biomass and productivity response to phosphorus load in Lake Burullus.

The question "what limits the lake productivity" is interesting to speculate. The fact that the lake don't receive any sewage disposal from heavily urban areas limits the phosphorus input to agricultural activities through the use of fertilizers. Mean-while, the dominant phytoplankton group inhabiting the lake are capable for nitrogen atmospheric fixation.

Table 1. Balance sheet for phosphorus and nitrogen in Lake Burullus.

ELEMENT	TOTAL* INFLOW (Tons/y)	OUTFLOW (Tons/y)	TOTAL GAIN (Tons/y)	DISSOLVED IN LAKE WATER (Tons/y)	SEDIMENTED OR UPTAKE (Tons/y)	PHYTO-** PLANKTON UPTAKE (Tons/y)	SEDIMENTED (Tons/y)
P	558	94	464	23.6	228	30	198
N	2318	291	2027	1416	611	238	373

* Rain water contributes 10 Kg P/y and 36 Kg N/y.

** Abdel-Moati (unpublished data).

Table 1 shows the dynamical balance of nitrogen and phosphorus in Lake Burullus. The wind driven circulation in the lake is set in a condition that the bulk nutrient derived to the lake flows northeast to the outlet. About 60% of inflowing water carrying 94 and 291 tons of N and P/y are conveyed to the Mediterranean i.e. 17% and 12% of N & P discharged, respectively. Only 42 and 61% of the total inflowing load of N and P are distributed throughout the water column. The annual phytoplankton consumption of N and P (in situ experiments) was 30 and 238 tons, hence sedimented P and N account for 35 and 16% of inflow. The increase of the lake water level over pumped drain water leads to sedimentation of nutrient bearing particles at discharge sites a process which controls the amount of phosphorus reaching the lake and prevent the lake from reaching its optimum production capacity. The short residence time of lake water (about 38 days) prevents the in-lake accumulation of organic derived material and continuously disturbs the lake equilibrium.

Direct relations not only occur between nutrient loading and lake-nutrient concentrations but also with the biomass and production levels. Figure 1 showed that biomass and production correspond to variations in phosphorus load in Lake Burullus.

REFERENCES

Steeman-Nielsen, E. (1952). J. Cons. Perm. Int. Explor. Mer., 18: 117-140.

Strickland, J.D.H. and Parsons, T.R. (1972). Fish. Res. Bd. Canada Bull. 167, Second ed. 310 pp.

ACKNOWLEDGEMENT

Thanks are due to Prof. Dr. Ali I. Beltagy, Principal investigator of Lake Burullus management Project who offered all the facilities encouragement and guide to support this work through a financial agreement between the USAID and the Acadamy of Scientific Research and Technology (MIMSC-NIOF program).

Increasing the Productivity of a Small Lake by Chemical Fertilizers

Saad D. WAHBY , M.-A. SHRIADACH , M.-H. EBEID and W.-M. ABDEL NAGA

Institute of Oceanography and Fisheries, Alexandria (Egypt)

Nozha hydrodrome is an artificial lake with an area of about 504 hectar (1200 acres). Formerly it was a part of the brackish water lake Maryut, new used as a fish farm.

In 1982 till 1987 a long term fertilization experiment was carried out to increase fish production using chemical fertilizers. At the beginning 5 kg of super-phosphate+5 kg of ammonium nitrate were added weekly per acre. The fertilizer was well mixed with water and spread as evenly as possibly using a motor boat. Fertilizers were not added during December and January also during July and August, as these months proved to be of minimum plankton production.

The amount of fertilizer was lowered according to the results of water analysis. Water was analysed for temperature, pH, oxygen content, ammonia, phosphate, nitrate, nitrite, carbonate alkalinity and chlorophylla.

Water temperature varied between a minimum of 12.9°C in February 1983, and a maximum of 29.5°C in July 1986. Generally water temperature is favourable for plankton production. The pH was nearly always above 8.0.

Alkalinity is relevant to the suitability of water to fish culture, water with low alkalinity values are generally biologically less productive. The alkalinity of the hydrodrome water was between 21-43 mg $CaCO_3$/L.

No sign of oxygen deficiency was observed in the hydrodrome water during the experiment. With the progress of fertilization the oxygen content increased.

In 1982 the average oxygen value was 4.95 ml/l, in 1983 it was 5.98 ml/l in 1984 it was 6.77 ml/l and in 1985, it reached 7.01 ml/l.

Nitrogen compounds were not detected in high concentrations even after fertilization, this is due to the role played by denitrification and retention of ammonia by bottom deposits and its subsequent utilization by algae. This leads us to ask whether adding inorganic nitrogen fertilizers is economic.

Unlike nitrogen compounds, inorganic phosphorus was high in the hydrodrome water due to successive superphosphate addition. From October 1982 to March 1987, the phosphate content of the water never fell below 15 µg at/l.

Chlorophylla is regarded as the essential component responsible for the amplitude of photosynthetic potential. Chlorophylla content of the hydrodrome water was measured before fertilization and found to be 2.0 mg/m^3. After adding fertilizers it rose remarkably reaching up to 13.7 mg/m^3 in the period May-December 1982, in 1983 it rose up to 20.11 mg/m^3, in 1984 it reached a maximum of 29.11 mg/m^3 in 1985 it reached 18.7 mg/m^3. In May 1986, due to a sudden plankton bloom it rose up to 175.37 mg/m^3, then dropped sharply after one week to reach 63 mg/m^3.

The ultimate goal in any fertilization experiment is to increase fish production. The yield of fish from the hydrodrome before fertilization was 54 ton/year. As a result of fertilization the yearly increase in fish production is :

1982	1983	1984	1985	1986	1987	
13.4	48.7	150.6	148.8	65.0	151.0	ton

To sum up, the fertilization experiment of the Nozha hydrodrome gave a total gain in the fish yield of 577.5 ton, equivalent to a maximum increase reaching in some years up to 300%.

The Primary Production of the Larnaca Salt Lake - A Bioenergetic Approach

Nicos A. HADJISTEPHANOU

Fisheries Department, Ministry of Agriculture and Natural Resources, Nicosia (Cyprus)

INTRODUCTION

The purpose of this study was to measure the primary production of the Salt Lake of Larnaca. The productivity of the ecosystem and its overall function was determined.

Site Description: The Salt Lake of Larnaca is the biggest and lowest in a series of lakes situated to the southwest of Larnaca town. It covers an area of 5.01km^2 and its lowest part lies 2.16m below the sea level. Natural catchment area is about 5.7km^2.

The basin of the Lake is dry and covered by a salt crust during the summer months. Water in the Lake usually appears after the first rainfall and builts up at rates depending on the precipitation. The rainfall occurs mainly during the winter months and is considered as contributing most of the Lake's water.

The water collected in the Lake has no other way to escape except through evaporation.

The conditions which will prevail in the habitat of the Salt Lake in given a year are not predictable because they depend on - and they are imposed by - the meteorological conditions of the year; the environment of the Larnaca Salt Lake, in which biological activity will develop, is unpredictable. (Hadjistephanou, 1989).

MATERIALS AND METHODS

The primary production of the Salt Lake was determined by measuring the photosynthesis by the oxygen method.
Estimates were made on three selected dates, the beginning, the middle and the end of the period during which water is present in the Lake's basin.

The experimental procedure as it is described by Strickland and Parsons (1972) was strictly followed. The LB and DB samples were tight on poles which marked two stations, one on the central and deepest part of the Lake and another on the periphery.

The energy absorbed by the water was calculated from the meteorological data for the solar radiation of the area.

RESULTS AND DISCUSSION

The titration results were plugged into the equations given by Strickland and Parsons (1972) and the gross and net photosynthesis, as well as respiration were calculated in mgC/m^{3}h. These figures were converted in MJ per m^2 per day. The estimations are given on Table below.

Table : The Primary Production of the Salt Lake of Larnaca in MJ/m^2.d

Date	Station	Gross Photosynthesis	Respiration	Net Photosynthesis
29/12/1988	A (surf.)	0.0019	0.0045	0.000
	A (bott.)	0.0019	0.0045	0.000
	B	0.0047	0.0057	0.000
24/ 2/1987	A (surf.)	0.00088	0.00210	0.00000
	A (bott.)	0.00088	0.00160	0.00000
	B	0.00220	0.00106	0.00114
18/ 5/1987	A (surf.)	0.0384	0.0254	0.01297
	A (bott.)	0.0401	0.0275	0.01262
	B	0.0396	0.0227	0.01343

The results of the Table show that gross photosynthesis is detected during the whole wet period of the Lake and that photosynthetic activity is uniform in the water column.

At the beginning of the period of water accumulation gross photosynthesis was detected in the Lake, but the energy lost in respiration exceeds photosynthesis. On the contrary, net primary production is detected in the ecosystem towards the end of the wet period, in May. On February, around the middle of the wet period, the ecosystem is found to be in a transitional phase.

On the basis on Odum's (1963) classification, the ecosystem of the Larnaca Salt Lake is a heterotrophic ecosystem for a period from November till February i.e. from the beginning to the middle of the wet period of this seasonal lake. Nonetheless, the tendency is for ecosystems to proceed towards stability and thus to maintain themselves over both the short and long term. This tendency for the Larnaca Lake ecosystem is initiated from about the middle of the wet period onwards and the system appears with net primary production.

The function of the Larnaca Lake ecosystem as described above appears on an annual basis in temperate systems, where the spring-summer autotrophism is offset to varying degrees by fall-winter heterotrophism (Kormondy, 1976).

Although net primary production is detected during the second half of the wet period, the ecosystem of the Larnaca Lake is not very productive.

REFERENCES

HADJISTEPHANOU N. 1989. Ph.D. Thesis. University of Athens. 386pp.
KORMONDY E.J.1976. Concepts of Ecology. Prentice - Hall Biological Sciences Series. William D. McElroy and Cart P. Swanson, Eds., New Jersey, 238pp.
ODUM E.P. 1963. Ecology. Holt, Rinehart and Winslon. New York.
STRICKLAND J.D.H. AND T.R. PARSONS 1972. A Practical Handbook of Seawater Analysis. Fish. Res. Board of Canada. Bull. 167. Ottawa. 310pp.

E-III1

Cycle annuel du Phytoplancton en deux sources du Parc Naturel de "l'Albufera de Valencia" (Espagne)

William COLOM et Maria Rosa MIRACLE

Departament d'Ecologia, Facultat de Ciències Biologiques, Universitat de Valencia, Burjassot (Espagne)

Introduction

Le "Parc Naturel de l'Albufera de Valencia" (Espagne) comportait de nombreuses sources disséminées sur toute sa surface. A cause de la forte pression anthropique qui conditionne cette zone, la majorité de ces sources ont été comblées afin de favoriser les cultures de riz principalement. Seules quelques-unes de celles qui demeurent, conservent leur morphologie et leurs caractéristiques originales. Cependant, l'eau de ces sources est de bien meilleure qualité que celle du reste de l'écosystème qui est fortement eutrophisée et polluée. De plus, elles jouent un rôle très important, au titre de refuge d'espèces disparues ou en régression sur le reste de la surface du Parc.

Dans ce travail, nous présentons les résultats relatifs au Phytoplancton des sources de "Romani" et de "Baldovi". Il s'agit de deux sources très éloignées l'une de l'autre et qui supportent des impacts agricoles différents, puisque la première est complètement entourée de plantations d'orangers tandis que la seconde est enfermée parmi les rizières.

Matériel et méthodes

Les prélèvements ont été réalisés, tous les mois, pendant une période allant du début du mois d'avril 1986 à la fin de février 1987. Les échantillons de Phytoplancton ont été recueillis à la surface, à l'aide de bouteilles de verre et fixés "in situ" avec de l'iode à 5%. Pour la classification et la numération, nous avons utilisé la méthode d'UTERMOHL (1958), recueillie par HASLE (1978) et celle de LUND *et al.* (1958).

Résultats et discussion

Nous avons ainsi observé que, pour les deux sources, la conductivité, la température et le pH demeuraient stables pendant toute l'année, comme c'est le cas pour ce type d'eaux qui sont nourries par des eaux souterraines. La stabilité est plus accentuée pour la source de Romani (Fig. 1). Cette variation

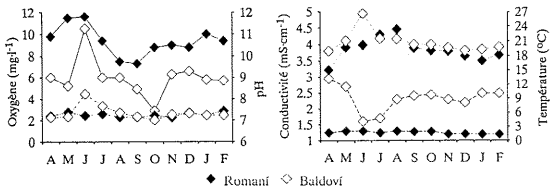


Fig. 1.- Oscillations de la température, de la conductivité, de l'oxygène et du pH dans les deux sources.

est due à ce que cette source est fortement associée aux rizières qui l'entourent et que des déversements des eaux dans la même source se produisent quand elles sont inondées, ce qui entraîne, dans ce cas, une augmentation de l'oxygène dans l'eau ainsi qu'une élévation du pH et de la température et, par contre, une diminution de la conductivité.

Les différences que l'on constate sont plus sensibles encore pour le Phytoplancton (Fig. 2) :

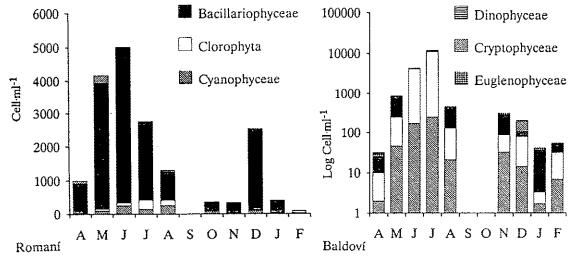


Fig. 2.- Oscillations de la densité du Phytoplancton dans les deux sources.

1 - La composition spécifique est très différente. Pour la source de Romani nous avons trouvé 108 espèces diverses, tandis que pour celle de Baldovi, on en a découvert 84 dont 30 seulement sont communes aux deux sources. Elles se distribuent, respectivement dans la Romani et la Baldovi, selon les groupes suivants : Cyanophycées, 25 et 14 espèces ; Chlorophytes, 18 et 23 espèces ; Diatomées, 56 et 39 ; Euglenales, 5 et 2 ; 4 et 5 espèces de Cryptophycées et enfin 1 espèce de Dinophycées pour Baldovi.

2 - Les deux présentent des baisses de densité, surtout Baldovi qui (sauf en des occasions précises) a toujours une densité phytoplanctonique inférieure à celle de Romani, qui atteint jusqu'à 5.000 cell.ml^{-1} durant le mois de juin.

3 - On a pu relever pour la source de Baldovi des fluctuations très marquées qui coïncident avec les perturbations des paramètres physico-chimiques indiquées et qui engendrent une croissance explosive d'une Chlorophyte, (*Pyramimonas* cf. *inconstans*) qui fait augmenter la population jusqu'à presque 12.000 cell.ml^{-1} en juillet. Ensuite, ce petit "bloom" diminue brusquement et la population d'Algues finit par atteindre seulement 29 cell.ml^{-1}.

4 - Il faut noter la prédominance des Diatomées dans la source de Romani qui sont en outre responsables des maxima de cette source et des oscillations de la population phytoplanctonique. Dans le cas présent, c'est une seule espèce qui produit fondamentalement le maximum, il s'agit d'une petite Diatomée : *Achnanthes minutissima*.

5 - Dans la source de Baldovi, on ne note pas la nette prédominance d'un seul groupe taxonomique, puisque la dominance en juin et juillet des Chlorophytes ne se reproduit plus jusqu'à février.

Références bibliographies

HASLE (G.-R.), 1978.- The inverted microscope method, in *Phytoplankton manual* (éd. A. Sournia) 1ère reimp. UNESCO. pp. 88-96.

HASLE (G.-R.), 1978.- Using the inverted microscope, in *Phytoplankton manual* (éd. A. Sournia) 1ère reimp. UNESCO. pp. 191-196.

LUND (J.-W. G.), KIPLING (C.) & LE CREN (E.-D.), 1958.- The inverted microscope method of estimating algal numbers and the statistical basis of estimations by counting. *Hidrobiologia.* Vol XI (2), pp. 143-170.

E-III2

Structure des Peuplements Phytoplanctoniques du Lac Ichkeul (Tunisie)

Amel BEN REJEB-JENHANI et Fredj KARTAS

Laboratoire de Biologie et d'Ecologie littorale, Faculté des Sciences de Tunis (Tunisie)

Le lac Ichkeul, étendue d'eau saumâtre de 9000 ha de superficie et de profondeur faible (1.20 m en moyenne), fait partie du complexe lagunaire du nord de la Tunisie. Il est caractérisé par des variations spatio-temporelles considérables dues principalement aux apports d'eau douce en hiver en provenance du bassin versant et à l'entrée de l'eau de mer en été par l'intermédiaire de l'oued Tinja , (fig.1). Pour définir l'état trophique du lac, nous avons entrepris une étude qualitative et quantitative du phytoplancton en relation avec les conditions du milieu. Nous exposons ci-dessous les résultats concernant la structure de la taxocénose phytoplanctonique à travers les variations de l'indice de diversité spécifique de Shannon et Weaver (1949), noté : H_S et des diagrammes rang-fréquences, préconisés par Margalef (1967). L'évolution du phytoplancton a été suivie tous les mois de janvier à décembre 1985 et de septembre à décembre 1986 au niveau d'une station centrale du lac et analysée par numération cellulaire au microscope inversé selon la méthode d'Utermöhl.

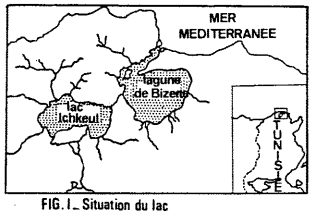


FIG. 1_ Situation du lac

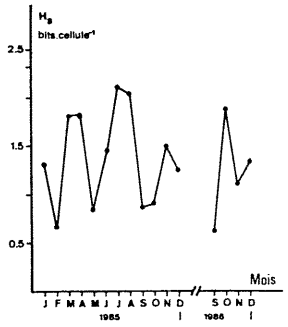


FIG. 2 _ Evolution temporelle de la diversité spécifique H_S

L'étude du phytoplancton du lac Ichkeul a permis de recenser 51 espèces dont 32 Diatomophycées et 12 Chlorophycées. La plupart d'entre elles sont cosmopolites. La densité des populations phytoplanctoniques varie entre 0.14 et 23.5 millions de cellules par litre ; elle est élevée en hiver, moyenne au printemps, faible et fluctuante en été et en automne. Grâce à l'analyse conjointe des fluctuations de la diversité spécifique (fig.2) et des différents aspects des diagrammes rang-fréquences (fig.3) nous avons pu délimiter les 3 stades définis par Margalef (1967) comme étant caractéristiques de la succession saisonnière des communautés du phytoplancton. Les successions phytoplanctoniques du lac Ichkeul généralement incomplètes et

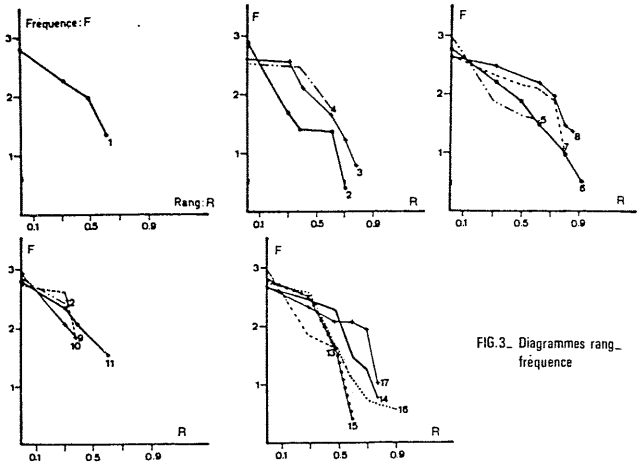


FIG.3_ Diagrammes rang_ fréquence

difficiles à déterminer parce qu'elles sont fréquemment brisées par des perturbations de l'environnement physico-chimique, sont caractérisées par la multiplicité des stades 1. Ceci explique d'ailleurs, la prédominance dans ce milieu de peuplements à tendance monospécifique. C'est le cas par exemple, de la succession qui a eu lieu au printemps 1985. En effet, le stade 1 de cette succession débute en février (courbe 2); la faible diversité (0.65 bit/cell.) et l'allure sigmoïde du diagramme traduisent la forte dominance de l'espèce pionnière *Skeletonema costatum* . A partir de mars (courbe 3), le peuplement se diversifie (H_S = 1.80 bits/cell.) avec régression de l'espèce de rang 1 (*Skeletonema*) et poussée de celles des rangs 2 (*Chlorella*), 3 (*Cyclotella*), 4(*Ankistrodesmus*), 5 (*Hyaloraphidium*), 6 (*Crucigenia*). Il s'agit d'un stade intermédiaire entre les stades 1 et 2. Le stade 2 est atteint en avril (H_S : 1.85 bits/cell.) avec une codominance des espèces présentes dans le milieu (courbe 4). Au mois suivant (courbe 5), un nouveau cycle se manifeste avec une chute de la diversité (H_S = 0.83 bit/cell.) consécutive à la pullulation d'*Ankistrodesmus*.

Les conditions de milieu, variables dans le lac Ichkeul imposent aux peuplements une réadaptation quasi permanente qui se caractérise par la multiplicité de ces stades 1 et 2. Le stade 3 de la succession n'a été observé qu'en décembre 1986 (courbe 16). Le lac Ichkeul apparaît en cela comme un lac à caractère eutrophe. En effet, d'après Amblard (1987), en milieu eutrophe, la délimitation des différents stades semble beaucoup plus aléatoire et la taxocénose ne paraît jamais atteindre un niveau de structuration élevé et durable.

REFERENCES:

AMBLARD C.,1987 _ Les successions phytoplanctoniques en milieu lacustre. Ann. Biol., 26 (1):1-34.

MARGALEF R.,1967 _ Some concepts relative to the organization of plankton. Oceanogr. Mar. Biol. Ann. Rev.,5 : 257-289.

SHANNON C.E. et WEAVER W.,1949 _ The mathematical theory of communication. Urbana Univ. Press Illinois : 117 p.

UTERMOHL H.,1958 _ Zur vervolkommung der quantitative Phytoplankton. Methodik. Mitt. Inter. Ver. Linnol., 9 : 1-38.

Hydrology and Phytoplankton in Greek Shoals

O. GOTSIS-SKRETAS, N. FRILIGOS and S. BARBETSEAS

National Centre for Marine Research, 166 04 Hellenikon (Greece)

The Messolonghi Lagoon (Fig. 1) borders the north-west side of the Patraikos Gulf, in the Ionian Sea. In the north, the Aitolikou Lagoon (st. 1 and 2) has a maximal depth of 28 m. It receives drain water pumped from the neighboring fields. Its salinity remains close to 14‰. A dam separates it from location 3 which has a depth of just 0.6 m and nearly double salinity. Farther south lies the central portion of the Messolonghi shallows (st. 4 to 11). It has depths between 0.2 and 1.2 m only. In the south, a barrier of elongated islets does not prevent some mixing with the open sea water. Its salinity exceeds slightly that of the Patraikos Gulf in summer, as a result of evaporation and falls well below it in winter owing to the inflow of fresh water or rain. The pier protected Palaiopotamos Lagoon (st. 12) has a depth of merely 0.3 m. The also well enclosed Kleissova Lagoon (st. 13 and 14) presents similar depths and salinity. The shallow (0.3 m) canal of station 15 receives the waste water from the Port of Messolonghi. As a result, it has a steady salinity of 24‰.

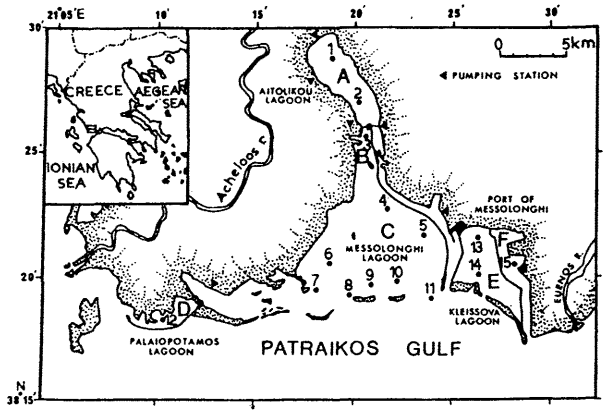


Fig. 1 Sampling locations in the Messolonghi Lagoon.

In June and December 1983, surface water samples were taken at 15 stations in the Messolonghi Lagoon. The examination concerned the phytoplankton, temperature, salinity, phosphate, silicate, ammonium, nitrite and nitrate. Phytoplankton samples were fixed with lugol solution and analysed by the Utermohl (1931) method. Nutrient analyses were made by the methods of Strickland and Parsons (1972). Also, the sediment was analysed for organic carbon. In June, the temperature varied from 21 to 28.0 C and the salinity from 13 to 51‰. In December, both temperature and salinity were reduced. The dissolved oxygen content was rather low (4.7 ml/l) and variable in June. It was higher (5.6 ml/l) and almost uniform in December. The concentration of nutrients were higher than those usually observed in the Mediterranean Sea and generally went up from June to December.

The variety of environmental conditions prevailing in the above six areas of the Messolonghi lagoon caused drastic changes in their phytoplankton compositions (Table 1). In June, the concentrations of diatoms reached enormous heights in A and E. The dinoflagellates also abounded there. The microflagellates were extremely dense in F. In December, the levels of the diatoms fell sharply to about one seventh, those of the dinoflagellates to a quarter, while the microflagellates decreased only marginally. The diatoms still proliferated in A, the dinoflagellates in B and F and the microflagellates in E. As a rule, the number of species did not rise with the number of individuals.

Table 1. Mean surface phytoplankton values (cell X 10^3/l)in the stations of the areas A-F

Time	June						December					
Area	A	B	C	D	E	F	A	B	C	D	E	F
Taxa St.	1-2	3	4-11	12	13-14	15	1-2	3	4-11	12	13-14	15
Diatoms	1122	35	25	71	2850	105	528	36	12	83	24	35
Dinoflagellates	256	3.2	5.3	5	86	26	8.7	41	7	5.5	18	48
Coccolithophores	-	-	0.1	-	-	-	1.2	-	0.2	-	0.5	-
Silicoflagellates	1	-	0.1	-	-	-	-	-	0.1	-	-	-
Total phytopl.	1379	38	30	76	2939	131	538	77	19.4	88	43	83
µ-flagellates	513	2570	404	4750	832	44200	2660	195	2329	1080	3480	1160
Dia/Tot.phyt.(%)	81	92	83	93	97	80	98	46	62	94	56	42
µ-fl./Tot.phyt.	0.4	67	13	62	0.7	340	5	2	131	12	79	140

The Aitolikou Lagoon, displayed a phytoplankton composition entirely unlike that of the other very shallow expanses. The semi-enclosed ponds (B, D, E, F) rich in organic matter, with sea water hardly getting into them, tended to hold more phytoplankton than the open shoals. The enormous microflagellate growth there in summer appears to denote a greater tolerance pollution, extreme salinity changes and turbidity. B, though much less brackish, resembled D whereas E and F had many species in common. The greater pollution in F explains the extreme multiplication of microflagellates of the expense of the larger cells. Great differences were also noticed in species composition: In June, Chaetoceros tortissimus, Rhizosolenia calcar avis, Gymnodinium sp. attained high concentrations in A, whereas in shallows certain genera belonging to pennates, such as Navicula, Nitzschia, Amphora, Synedra, predominated.

References

Strickland, J.D.H. and T.R. Parsons, (1972). Bull. Fish. Bd Can. 167(2nd Ed.), 311 pp.

Utermohl, H., (1931). Ach. Hydrobiol. Planktonk., 22: 643 - 645.

La Dynamique du Phytoplancton du Lac Sursalé Tekirghiol pendant les années 1988-1989

V.-H. SKOLKA, Mariana NAZIRU et Maria RUSU

Institut Roumain de Recherches Marines, Contantza (Roumanie)

Abstract : This work presents the development cycle of phytoplankton of the Lake Tekirghiol in 1988-1989 period.

Dans nos travaux antérieurs (1979, 1981, 1983, 1984, 1988) nous avons présenté l'évolution hydrologique de ce lac et son influence sur la dynamique qualitative et quantitative du Phytoplancton. La présente note est la dernière d'un cycle qui s'est déroulé en conditions de haute pression anthropique et de protection de son écosystème. A partir de 1990, des mesures plus efficaces conduiront à des changements plus radicaux.

Durant l'hiver 1986-1987, extrêmement rigoureux, les températures négatives enregistrées, jusqu'au 20 mars 1987, et les grandes quantités de neige non fondue ont favorisé, à la surface du lac, la formation d'une couche de glace de 4 à 7 cm d'épaisseur, qui a subsisté longtemps.

Les hivers suivants de plus en plus chauds et secs, ont été bénéfiques pour l'écosystème. Si, en 1987, la température de 10°C a été relevée, à la fin du mois d'avril, en 1989 elle était déjà atteinte en mars. L'apport diminué d'eau douce météorique et provenant d'irrigations a baissé le niveau du lac de 102 cm, en octobre 1987, à 94,7 cm, en octobre 1988, et à 80 cm en 1989. Ceci eut pour conséquence d'augmenter la salinité maximale de 57 g % en septembre 1987 à 58,44 g %, en septembre 1989.

En 1988, un hiver chaud et sans précipitations a favorisé le développement de l'association de l'automne précédent. L'absence du Zooplancton a engendré l'accumulation du Phytoplancton de 1.093.800 cell/l et 3.311 mg/m^3 en octobre à 4.570.000 cell/l et 30.095 mg/m^3 en mars, où prédominaient *Glenodinium gymnodinium* et *Chroomonas caudata*. L'association a diminué, jusqu'en mai en fonction du développment du Zooplancton. Pendant les mois de juin-juillet, lorsque l'on constate la disparition presque totale du Phytoplancton, se développe *Characiopsis aristulata*. Après la chute brusque de la population d'*Artemia* du mois de juillet, les valeurs du Phytoplancton s'élèvent à nouveau, par le développement de la même association *Glenodinium cryptomonas* (Tableau 1).

Tab. 1 : Densité et biomasse du Phytoplancton du lac Tekirghiol en 1988-1989

Mois/Année	1988		1989	
	No. cell/l	mg/m^3	No. cell/l	mg/m^3
II	-	-	63.700.000	85.913,0
III	4.570.000	30.095,0	25.850.000	53.870,0
IV	3.375.000	25.339,5	5.489.000	16.852,0
V	497.600	3.432,2	116.000	269,6
VI	1.900	5,2	230.000	457,2
VII	194.000	37,7	181.000	198,2
VIII	1.086.700	2.497,2	20.731.800	144.564,6
IX	-	-	4.886.300	154,7
X	5.721.300	14.771,3	95.085.700	12.751,5
Moyenne	2.206.700	10.881,3	21.574.700	24.328,7

La fragilité de l'écosystème se révèle à nouveau, en 1989, avec l'apparition, dans le plancton, d'espèces nouvelles pour le lac : *Trachelomonas eurystoma* Stein, *Cryptochrysis commutata* Pasch. et notamment *Gymnodinium excavatum* Nyg. qui, dès le début, devient une espèce de masse. Il est quand même à souligner que, jusqu'à présent, dans ce lac, n'a pas été signalée l'apparition d'espèces toxiques.

L'hiver, plus chaud que le précédent, favorisa une accumulation plus riche encore, jusqu'en février. Les espèces dominantes furent *Chroomonas caudata*, *Glenodinium gymnodinium* et *Gymnodinium excavatum*. Pendant les mois de mai à juillet, lors de la diminution estivale, les espèces planctoniques typiques ont presque disparu. Les densités et les biomasses sont dues à l'espèce *Synedra tabulata* dispersée dans la masse d'eau par les plaques de *Cladophora vagabunda* en épave ce qui permet à la population d'*Artemia* de ne pas diminuer par absence de nourriture, comme ce fut le cas les années précédentes.

D'août jusqu'en octobre, les quantités de Phytoplancton s'accroissent à nouveau, après l'apparition, en grand nombre, de *Dendromonas cryptostylis*, *Chlorobotrys polycloris* (de petite taille), *Woloszynskia leopoliensis*, *Chroomonas caudata et Glenodinium gymnodinium*.

Cette évolution du Phytoplancton due à la clémence des températures hivernales, favorise le développement du Zooplancton consommateur.

Références bibliographiques

1.- SKOLKA (V.-H.), 1979.- *Rapp. Comm. int. Mer Médit.*, 25/26, 3 : pp.177-178.
2.- SKOLKA (V.-H.), 1983.-*Rapp. Comm. int. Mer Médit.*, 28, 6 : pp. 253-254.
3.- SKOLKA (V.-H. *et coll.*), 1984.-*Rapp. Comm. int. Mer Médit.*, 30, 2 : p. 57.
4.- SKOLKA (V.-H. *et coll.*), 1988.-*Rapp. Comm. int. Mer Médit.*, 31, 2 : p.75.

E-III5

Distribution and Ecology of Phytoplankton in El-Mex Bay (Egypt)

Zeinab M. EL-SHERIF

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

El-Mex Bay represents a shallow sheltered estuary, lying west of Alexandria at longitude 29° 50' E and latitude 31° 10' N. It extends parallel to the coast line for about 7 Km between El-Agamy headland and the western Harbour and has an average width of 3 Km (Fig. 1). Its total area amounts to about 20 Km^2. The depth of water in the bay fluctuates between 1.5 and 15 meters, being more shallow near to the shore and the depth increases gradually seawards.

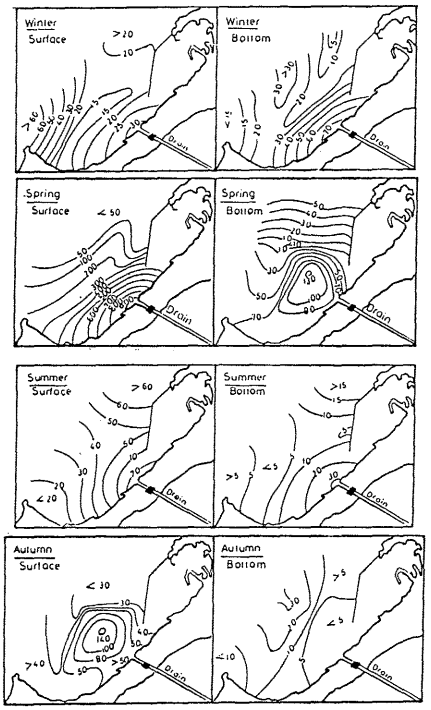


Fig.1

Horizontal distribution of phytoplankton (thousand u/l) in the surface water and near bottom layer at El-Mex bay

The bay receives large amounts of drainage water contaminated with sewage and industrial wastes from the Umum Drain. The salinity of the surface water is highly reduced particularly infront of the outlet of the drain and it fluctuated between 6.7 ‰. and 32.7 ‰. The near bottom layer was less affected and the salinity was always over 37.6 ‰. Quantitative and qualitative estimations of phytoplankton at both the surface and near bottom layer have been carried out in the bay for four seasons. According to the high load of nutrients discharged with the drain water, the bay is highly eutrophic. The highest density of phytoplankton was recorded at the surface around the opening of the Umum Drain (Fig. 1), while it decreased gradually towards the offshores. The near bottom layer was less productive throughout most of the year except in winter. The average annual standing crop for the whole bay amounted respectively 96,560 and 26,980 units/l in the surface water and near bottom layer. The phytoplankton community included both allogenetic fresh and brackish water species introduced with thethe Umum Drain water and autogentic forms of marine origin. The former comprised green algae, euglenophytes, cyanophytes as well as many diatom species, while the latter included marine diatoms and dinoflagellates.

Chlorophytes constituted about 54.7 % of the total phytoplankton in the bay (average 33,805 cells/l). They were dominated by members of the genera Scenedesmus, Closterium and Chlorella. Diatoms ranked as the second important class with about 24.3 % of the total phytoplankton counts (average 15,015 cells/l). They were dominated by Cyclotella, Nitzschia, Melosira and Chaetocerous. Euglenophytes (Euglena spp.) appeared less frequent and they averaged 7,250 cells/l, forming about 12.2 % of the total phytoplankton counts. They are indicators of water pollution. Dinoflagellates and cyanophytes were infrequently recorded.

The phytoplankton community showed an outstanding peak of 257,630 units/l in the surface water during the spring, mainly due to green algae, while it remained at lower values in the other seasons, which amounted 26,040; 44,330 and 58,220 units/l in winter, summer and autumn respectively.

The bay is considered among the eutrophic marine habitats. Nevertheless, the polluted water of the Umum Drain should be treated to improve its quality before being discarded into the bay.

E-III6

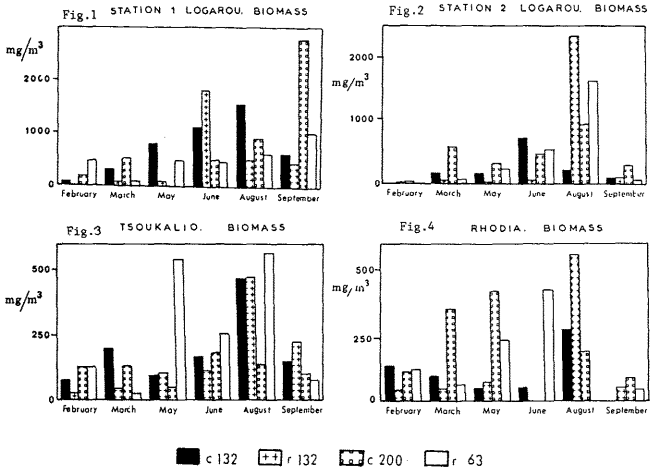
Biological Investigations on Zooplankton Composition in three Lagoons from Western Greece

E. PAPATHANASSIOU and M.-A. PANCUCCI-PAPADOPOULOU

National Centre for Marine Research, Agios Kosmas, Hellinikon, Athens (Greece)

Several publications exist on the composition and spatial distribution of the zooplankton in the lagoons and closed bays in the Mediterranean Sea (Comaschi Scaramuzza & Martino, 1981; Specchi & Fonda Umani, 1981; Ferrari et al, 1982; 1985; Siokou Frangou, 1986). However most of these studies have been conducted using a particular sampling method and a special design net without previously performing test to assess the efficiency of the sampling gear. On the other hand, the differences on the sampling equipments that have been used contribute to the lack of information and confusion since the obtained results are rarely comparable.

Zooplankton was collected from three lagoons (Logarou, Tsoukalio and Rhodia) in the area of Amvrakikos Gulf (Western Greece). Four different nets were used (two conical with 132 and 200µm mesh size gauze and two rectangular with 63 and 132µm gauze) for a period of 6 months during 1987 at 4 stations in these lagoons. On the total 94 samples were collected. The abovementioned gear was chosen in order to give a global picture of the zooplankton composition and biomass values in these different sites using the described nets. In addition, an approach was made to clarify problems related to zooplankton sampling in very shallow waters and provide the tool to facilitate any decision to choose the appropriate sampling gear in these habitats.



BIOMASS VALUES USING THE FOUR MESH-SIZE NETS.

c132 : 132µm conical net; r132 : 132µm rectangular net;

c200 : 200µm conical net; r63 : 63µm rectangular net.

Biomass values were relatively higher in Logarou than in the other lagoons for the whole sampling period with values sometimes exceeding an order of magnitude (Figs 1, 2, 3, 4). Densities of organisms in the samples expressed as number per m^3 were fluctuating between months, having generally, a good relation with the biomass values. Some major differences in the total density between samples and between stations during the sampling period were observed, showing that the most productive lagoon was the largest lagoon (Logarou). The number of zooplankton groups and their abundance varied in relation to the net type. Important differences exist between samples collected with different mesh-size nets. High abundance of copepods was generally observed in samples collected with the 200 µm net, while copepod nauplii and bivalve larvae were abundant in samples collected with the 63 µm net. Not statistical differences were observed when different type nets with the same mesh-size were applied for sampling (conical and rectangular 132µm). The use of only one net type is not the appropriate method for sampling in the lagoons and in order to give a representative estimation of zooplankton abundance, several mesh size nets should be used.

References

Comaschi Scaramuzza, A. & E. Martino. 1978. Archo Oceanogr. Limnol. 19 :99-120.
Ferrari, I., V.U. Ceccherelli, M.G. Mazzocchi & M.T. Canterelli. 1982. Neth. J. Sea Res. 16: 333-344.
Ferrari, I., M.T. Canterelli, M.G. Mazzocchi & L. Tosi. 1985. J. Plank. Res. 7 : 849-865.
Siokou Frangou, I., 1986. Thalassographica. 9 : 29-38.
Specchi, M. & S. Fonda Umani. 1981. Rapp. Comm. int. mer Medit. 27 : 101-103.

Zooplankton of Lake Gebekirse (Izmir-Turkey)

M. Rusen USTAOGLU and Süleyman BALIK

Ege University, Faculty of Science, Department of Biology, Section of Hydrobiology, Bornova, Izmir (Turkey)

Lake Gebekirse is an alluvial dam lake with an area of almost 75 hectares , a maximum depth of less than 5 meters and slightly salty waters (Fig. 1). The lake is fed mostly by rain and some freshwater sources on the northern side. It has a connection to the Aegean Sea via a man-made southern channel to Küçük Menderes River. The lake is surrounded completely with reeds (Phragmites australis). Veronica anagillis-aquatica and Juncus hybridus were observed in the water. Juncus acutus, Halimione portulacoides and Salicornis europea were reported from saline marsh area near the lake (SEÇMEN and LEBLEBİCİ, 1982). During our investigation, we found Moerisia pallasi (Moerisiidae-Hydrozoa), which is a new species for Turkish inland waters (BALIK and USTAOĞLU, 1987). There are 11 fish species living in the lake , 3 of them are freshwater species (Cyprinus carpio, Barbus capito, Gambusia affinis) and the rest of them originated from salt water (Mugil cephalus, Liza ramada, Liza saliens, Liza aurata, Anguilla anguilla, Dicentrarchus labrax, Sparus aurata, Solea vulgaris). The yearly physico-chemical ratios in the surface water of the lake are as follows: Transparency, 35-165 cm; Temperature, 10.8-27.7°C; pH, 7.1-8.0; Dissolved Oxygen (DO), 8.99-12.15 mgl^{-1}; Salinity, 1.976-4.281‰; Ca^{2+}, 90.84-175.40 mgl^{-1}; Mg^{2+}, 84.30-196.99 mgl^{-1}; Total Hardness, 573.33-1153.00 mgl^{-1}; Temporary Hardness, 10.82-36.40°d; NO_2^--N, 1.503-14.830 μgl^{-1}; NO_3^--N, 0.000-288.980 μgl^{-1}; NH_4^+-N, 9.260-495.320 μgl^{-1}; PO_4^{3-}-P, 2.860-417.530 μgl^{-1}(BALIK and USTAOĞLU, 1988).

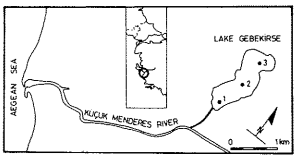


Fig. 1. Location and sampling stations in Lake Gebekirse.

Lake Gebekirse is an eutrophic and brackish lake with a salinity above 3‰ (except in February and March where heavy rainfall occurs).

Zooplankton samples were collected from 3 stations at monthly intervals for a one year period (October 1984-September 1985) with a zooplankton net of 60 μ mesh size. The samples were fixed in 4% formaldehyde.

The zooplanktonic organisms of Lake Gebekirse belong mainly to the Rotifera, Cladocera, Copepoda, Hydrozoa (Limnomedusae), Decapoda (Zoea larvae) and Mysidacea groups.

A total of 20 species have been identified in the lake, complied of 11 species of rotifers, 4 species of copepods, 2 species of cladocerans, 1 species of Limnomedusae, 1 species of Mysidacea and 1 species of decapod zoea larvae.

The monthly distribution of the zooplanktonic organisms found in Lake Gebekirse are given Table 1.

Table 1. Monthly distribution of zooplanktonic organisms in Lake Gebekirse.

SPECIES	MONTHS	O N D J F M A M J J A S
HYDROZOA		
Moerisia pallasi		+ - - - - - - - - - - +
ROTIFERA		
Brachionus quadridentatus		+ - + + + + - + + + + -
Brachionus urceolaris		+ + + + + + - + + + + -
Brachionus calyciflorus		- - - + - + - - - - - -
Brachionus angularis		- + + - - + - - - - - -
Keratella quadrata		- - + + + + + + + + - -
Keratella valga		- - + - - - - - - - - -
Notholca acuminata		- - - + + - - - - - - -
Notholca squamula		- - + + - - - - - - - -
Lecane luna		- + - - - - - - - - - -
Hexarthra fennica		+ - - + - + - + - - - -
Hexarthra oxyuris		- - - - + - - - - - - -
CLADOCERA		
Alona rectangula		- - - - + - - - - - - -
Chydorus sphaericus		- + + - + - - - - - - +
COPEPODA		
Calanipeda aquaedulcis		+ + + + + + + + + + + +
Diacyclops bicuspidatus		- - - - + + - - - - - -
Mesochra aestuarii		- + - - + + - + + + + -
Ergasilus cf. sieboldi		- + - - + + - + + + + +
DECAPODA		
Palaemonetes antennarius		- - - - - - - + - - + -
MYSIDACEA		
Mesopodopsis slabberi		+ + - - - - - - - - - +

REFERENCES

SEÇMEN, Ü. and LEBLEBİCİ, E., 1982. Ege Bölgesi, İç Anadolu batısı ve Akdeniz Bölgesi'nin batısında bulunan göl ve bataklıkların Flora ve Vegetasyonu. TÜBİTAK, Proje No.TBAG-407, 130 p.

BALIK, S. and USTAOĞLU, M.R., 1987. Gebekirse gölünde (Selçuk-İzmir) tespit edilen yeni bir Limnomedusae: Moerisia pallasi (Derzhavin, 1912)(Moerisiidae,Hydrozoa).VIII. Ulusal Biyoloji Kongresi, 2:635-643.

BALIK, S. and USTAOĞLU, M.R., 1988. Akgöl ve Gebekirse Gölü'nün (Selçuk-İzmir) Fiziko-kimyasal özellikleri, Balıkları ve Balıkçılığı. IX. Biyoloji Kongresi (in press).

Changements produits en 1989 dans la structure qualitative du Zooplancton de la Lagune Sinoie comme suite à la salure

Teodora ONCIU

Institut Roumain de Recherches Marines, Contantza (Roumanie)

La communauté zooplanctonique de la lagune Sinoie a fait l'objet de recherches systématiques depuis 1971. On a pu constater les dernières années une tendance de stabilisation de sa structure qualitative, avec la dominance des espèces euryhalines et limnicoles, leur répartition dans la lagune permettant la délimitation de 4 zones distinctes (2).

L'éboulement, à la fin de mars 1989, du cordon littoral a déterminé la salure des eaux de la lagune et comme suite, surtout des changements d'ordre qualitatif dans la communauté zooplanctonique. On les a surpris en étudiant 50 échantillons quantitatifs prélevés chaque mois (excepté le mois d'août), des eaux de surface (0 - 0,25 m) dans les stations habituelles (2).

On a déterminé 39 espèces (36 holo- et 3 méroplanctoniques), dont la dominance ne dépasse que rarement 50 % (Pilinia limnaetica, Acartia clausi et Calanipeda aquae-dulcis).Par rapport à la situation de 1984, la zooplanctonofaune s'est enrichie par 6 espèces pénétrées avec les masses d'eaux marines et autres typiquement limnicoles à l'occasion des crues des eaux des canaux de liaison avec le lac Razim (tableau 1).On n'a plus retrouvé 23 espèces, surtout les Cladocères Daphnia magna Straus, Leptodora kindti (Focke), Cercopagis pengoi (Ostroumov) et des Copépodes comme Heterocope caspia Sars, Acanthocyclops spp., espèces caractéristiques pour la lagune, responsables des hautes valeurs de densité et biomasse constatées en 1984 (1, 2). En 1989 la densité moyenne du zooplancton a été de 135838 $ex.m^{-3}$, lui revenant une biomasse de 370 $mg.m^{-3}$, 7 fois plus basse qu'en 1984 (1).

Pour la période à salinité accrue, on a fait des comparaisons entre les stations en ce qui concerne la salinité, la densité des zooplanctontes, ainsi que le nombre d'espèces et l'indice de diversité, comme suit:

STATIONS 1 MOIS	2	3	4	5	6	7	1	2	3	4	5	6	7
	Salinité (g $NaCl.l^{-1}$)						Densité ($ex.m^{-3}$.1000)						
IV	6,05	-	5,33	6,59	5,60	6,09	-	189	-	172	277	214	36	-
V	3,59	3,51	4,85	5,04	4,72	4,52	4,83	48	6	55	33	29	3	2
VI	-	4,52	4,41	4,47	4,38	4,27	4,34	-	1389	1084	527	448	234	38
VII	2,36	2,23	2,25	2,20	2,72	2,47	3,10	224	201	385	323	218	172	207
IX	1,90	1,74	1,63	1,97	2,04	1,99	2,97	146	249	235	301	236	278	340
	Nombre des espèces						Indice de diversité (d'après SHANNON-WIENER)						
IV	14	-	11	7	8	9	-	2,24	-	2,43	2,29	2,14	2,77	-
V	9	12	12	8	9	8	5	2,76	2,47	2,32	1,97	1,59	1,39	1,85
VI	-	8	8	9	8	8	7	-	0,43	0,40	0,73	0,36	0,28	0,65
VII	8	9	11	11	8	8	10	2,33	2,50	0,89	0,99	1,19	0,98	0,71
IX	8	12	11	12	13	12	12	0,99	2,11	1,88	2,46	3,15	2,19	2,11

On peut constater que le dynamisme des masses d'eau de diverses origines/salinités a produit des changements dans la répartition des zooplanctontes dans la lagune de sorte que la délimitation des 4 zones distinctes (2) ne soit plus possible. C'est dans la moitié du nord où, en avril et en mai abondent les espèces marines, bien que la zone sud a un aspect appauvri. L'uniformité caractérise la communauté zooplanctonique en été, avec la mention qu'en juin il y a une explosion des stades nauplials des copépodes, tandis qu'en juillet Brachionus rubens, Cornigerius maeoticus et Acartia clausi sont les espèces dominantes. En septembre, seulement la zone sud garde son caractère marin, la présence des espèces limnicoles dans celle du nord prouvant une massive pénétration des masses d'eaux danubiennes.

Tableau 1

Fréquence d'apparition dans les échantillons(%)des espèces (lagune Sinoie,1989)

Espèces \ Mois	I	II	III	IV	V	VI	VII	IX	X	XI	XII
Tintinnopsis meunieri Kofoid&Campbell*	-	-	-	-	6	-		14	6	-	-
Noctiluca miliaris Suriray*	-	-	-	4	-	-	-	-	-	-	-
Brachionus quadridentatus Hermann	4	4	-	2	14	8	4	-	-	-	6
B. calciflorus v. amphiceros Ehr.	-	-	-	-	-	-	6	6	-	-	-
B. plicatilis Müller	-	-	-	-	-	-	-	12	6	6	-
B. rubens Ehrenberg	-	-	-	-	-	-	14	2	-	-	-
B. forficula Wierzejki**	-	-	-	-	2	-	4	-	-	-	-
B.diversicornis v.homoceros Wierzejki	-	-	-	-	-	-	2	2	-	-	-
B. angularis Gosse	2	6	2	-	-	12	-	-	6	2	-
Keratella cochlearis Gosse	-	-	-	-	-	-	10	10	6	6	-
K. valga Ehrenberg**	-	-	-	-	-	-	6	8	-	-	-
K. quadrata Müller	-	-	6	6	12	-	8	2	2	2	-
Notholca acuminata Ehr.	-	-	-	-	-	-	-	14	6	4	-
Argonotholca foliacea Ehr.	6	6	2	-	-	-	2	-	-	-	2
Lecane sp.	2	-	-	8	-	-	14	14	-	-	4
Polyarthra remata Skorikow**	-	-	-	-	6	-	-	-	-	-	-
Synchaeta littoralis Rouss.	-	-	-	6	12	-	-	-	-	-	-
Hexarthra fennica Lov.	-	-	-	-	-	-	-	6	-	-	-
Filinia limnaetica Zacharias	-	-	-	-	14	12	14	14	-	-	-
Polychaeta - larvae*	-	-	-	4	-	-	2	-	-	-	-
Bivalvia - larvae	-	-	-	10	-	-	-	-	-	-	-
Balanus improvisus Darwin - larvae	-	-	-	10	4	6	8	6	-	-	-
Ceriodaphnia quadrangula(O.F.Müller) **	-	-	-	-	4	-	-	-	-	-	-
Bosmina longirostris (O.F.Müller) **	-	-	-	2	8	-	4	-	-	-	-
Eurycercus lamelatus (O.F.Müller) **	2	-	-	-	-	-	-	-	-	2	2
Alonella exigua (Lilljeborg)**	-	-	-	-	2	8	-	-	-	-	-
Chydorus sphaericus (O.F.Müller)	4	6	6	-	4	6	-	-	-	-	-
Pleopis polyphemoides (Leuckart)*	-	-	-	8	-	-	2	-	-	-	-
Cornigerius maeoticus (Pengo)	-	-	-	-	4	12	14	10	-	-	-
Acartia clausi Giesbrecht* *	-	-	-	10	14	12	14	10	-	-	-
Calanus helgolandicus Claus *	-	-	-	4	-	-	-	-	-	-	-
Calanipeda aquae-dulcis (Kritsch.)	4	4	-	10	12	10	-	14	4	6	4
Eurytemora velox (Lilljeborg)	-	-	-	-	8	10	2	-	-	6	6
E. lacustris Poppe	-	2	-	10	-	-	-	12	6	-	-
E. hirundoides Nordquist	4	2	6	10	-	-	-	-	-	-	-
Eucyclops serrulatus (Fisch.)**	4	4	-	-	-	-	-	-	-	-	-
Cyclops rubens (Jurine)**	-	-	6	-	-	-	-	-	-	-	6
C. vicinus (Uljanin)	-	4	-	-	-	-	-	-	-	-	-
C. sautifer (Sars)	4	4	-	-	-	-	-	-	-	-	-
Cyclops sp.	-	2	-	-	-	-	-	-	4	4	-
Salinité moyenne (g $NaCl.l^{-1}$)	1,8	1,4	5,2	5,9	4,4	4,4	2,5	2,0	1,4	1,3	1,8
Densité moyenne ($ex.m^{-3}$.1000)	82	79	49	178	25	621	247	298	35	10	7
Nombre des espèces	9	10	6	15	16	10	18	17	9	9	7

Espèces qui enrichissent la zooplanctonofaune en 1989: *)marines; **)limnicoles.

BIBLIOGRAPHIE

1. ONCIU T., RUSU M., 1986 - Rapp.Comm.int.Mer Médit., 30, 2: 55.
2. ONCIU T., RUSU M., 1988 - Rapp.Comm.int.Mer Médit., 31, 2: 74.

E-III9

Dynamique de l'Algue *Cladophora vagabunda* L. et du Phyllopode *Artemia salina* Leach. du Lac Sursalé Tekirghiol en 1988-1989

V.-H. SKOLKA, Maria RUSU et Mariana NAZIRU

Institut Roumain de Recherches Marines, Constantza (Roumanie)

Abstract : Dynamics of the species *Cladophora vagabunda* L. and *Artemia salina* Leach. Production is presented in the mentioned period.

Les propriétés thérapeutiques des eaux et de la vase du lac Tekirghiol sont connues depuis les temps de la domination turque. A partir de 1890, des initiatives privées, puis gouvernementales établirent des exploitations balnéaires sur ses rives.

Les premières recherches commencèrent à partir de 1900 (TUCULESCO, 1965). La surveillance de l'écosystème se poursuit maintenant, soigneusement, (SKOLKA, 1983, 1984, 1988), afin de prévoir et d'éviter les actions anthropiques défavorables.

A partir de 1970, le lac a subi l'effet d'eaux douces provenant de systèmes d'irrigations agricoles, qui endommagèrent l'évolution normale de l'écosystème et de son pouvoir de péloïdogenèse. Après les mesures prises en 1978, la situation hydrologique s'améliore lentement, mais les productions annuelles des deux espèces citées présentent des variations inattendues.

La distribution en profondeur de l'Algue *Cladophora* est conditionnée par la présence du fond rocheux non colmaté et d'un bon éclairage. La présence des pellicules gélatineuses de Diatomées empêchent parfois sa fixation sur les rochers. C'est ainsi que sa distribution quantitative n'est pas la même d'une année à l'autre, entraînant des variations de ses stocks. Après avoir atteint 2. 054 tonnes de poids frais en 1986, ses productions diminuèrent à 1. 312 tonnes en 1987 et 1. 268 tonnes en 1988.

Grâce aux conditions climatiques favorables, en 1989 l'Algue se développe sur tout le littoral du lac de telle manière que ses frondes atteignent la surface de l'eau en de grandes étendues, à une hauteur de 2-2,5 m. La production réalisée fut de 3. 189 tonnes de poids frais.

Le développement du Phyllopode *Artemia salina* est déterminé par la date où est atteinte la températures d'éclosion de ses kystes et, ensuite, par l'abondance de la nourriture .

Les deux hivers chauds accélèrent l'apparition des premiers nauplii de la façon suivante : 68 ex/m^3 en mars 1988 et 2. 379 ex/m^3 en mars 1989 pour 222 ex/m^3 en avril 1987 (Tableau 1). Les six générations qui suivirent se développèrent d'une façon différente d'une année à l'autre.

En 1988, la nourriture phytoplanctonique, riche après l'hiver favorable, disparaît presque totalement pendant l'été, ce qui produit une chute brusque de la population d'Artemia avec une légère augmentation jusqu'à l'automne.

Tab. 1 : Evolution du Phyllopode *Artemia salina* au cours des années 1988-1989; de I à VI sont indiquées les générations successives en ex/m^3.

Mois	Nauplii		Metanauplii		Adultes	Biomasse mg m^{-3}
		Pmax				
III	I	68	0		0	0,57
IV	I	5.682	2		0	30,09
V	I	3.128	2.182	I	1.700	2.312,07
VI 10	II	1.212	25	I	900	2.070,18
VI 20	III	54.648	0	II	2.214	2.955,67
VII	IV	10.275	205	III	205	405,75
VIII	V	2.564	2.225	IV	750	1.221,61
IX	VI	909	250	V	10	77,45
		Pmax				
III	I	2.470	0		0	90,81
IV 10	I	2.211	427	I	113	251,40
IV 20	I	1.709	150	I	50	186,21
V	II	52.650	2.150	I	0	2.531,95
VI	III	186.950	1.102	II	1.400	6.366,95
VII	IV	3.092	1.715	III	927	1.189,54
IX	V	95.200	2.486	IV	2.924	4.520,96
X	VI	1.122	250	V	105	215,52

En 1989, la population d'*Artemia* commença avec un taux accru de nauplii, soutenu par une base trophique plus abondante. Après avoir atteint une grande densité de nauplii de la IIe génération, en mai, les espèces phytoplanctoniques disparurent presque totalement; ce fut *Synedra tabulata* diospersée par les plaques flottantes d'Algues, qui assurera la nourriture pour une population d'*Artemia* de plus en plus nombreuse.

Le stock total d'*Artemia* augmenta d'un an à l'autre de la manière suivante : 56 tonnes poids frais en 1987, puis 74 tonnes en 1988 et 119 tonnes en 1989.

En conclusion, pour la péloïdogenèse les quantités totales, en poids frais sont les suivantes : 1. 368 tonnes en 1987, 1. 341 tonnes en 1988 et 3. 308 tonnes en 1989.

Références bibliographiques :

1. - SKOLKA (V.-H.), 1983.- *Rapp. Comm. int. Mer Médit.*, 28, 6 : pp. 253-254
2. - SKOLKA (V.-H.), 1984.- *Rapp. Comm. int. Mer Médit.*, 30, 2 : p. 57
3. - SKOLKA (V.-H. *et al.*), 1988.- *Rapp. Comm. int. Mer Médit.*, 31, 2 : p. 75
4.- TUCULESCO (I.), 1965.- *Biodinamica lacului Techirghiol*, Ed. Acad. Rom. Bucarest.

E-III10

Report of Preliminary Results on Inoculation of *Artemia franciscana* in nondeepened ponds of Saltern Ston (Central Adriatic)

Andelka PETROVIC

Institute of Oceanography and Fisheries, Set. Mose Pijade 63, Split (Yugoslavia)

Parthenogenetic brine shrimp Artemia is presented in Yugoslavia in saltworks in Strunjan, Sečovlje and Ulcinj (MAJIĆ and VUKADIN, 1987). Considering cyst diameters of hydrated untreated cysts, Yugoslavian Artemia from Sečovlje are bigger when compared with more than 70 Artemia sources of the world (Sveučilište u Splitu, 1985, LEGER and all., 1986, PETROVIĆ, 1987). The lack of the cysts, suitable for the Yugoslav mariculture results in a total dependence on the imported cysts. For that reason, in August 1987 inoculation with Artemia franciscana was carried out in the nonmodified ponds the saltwork at Ston (42°50'N; 17°41'E). The inoculation was realized in an evaporation pond (1020 sq.m.. depth 15 cm) and the Rotonda canal (200 sq.m., average depth 30 cm). The aim of present experiment was to collect preliminary data on environmental conditions and to verify if introduction of Artemia could result in the establishment of a temporal Artemia population in the nonmodified evaporation ponds of saltern, where had never been recorded Artemia before.

Before stocking the nauplii, the ponds were drained to eradicate predatory fishes Cyprinodon calaritanus S.V. After drying the evaporation pond and Rotonda were felt with brine of 84 ppt and 75.4 ppt. After fertilization according to WALNE (1966) the inoculation was carried out with nauplii of Artemia franciscana, a bisexual strain from San Francisco Bay (batch n° 503-16). The Artemia cysts were decapsulated according to SORGELOOS and all. (1977). The 48 hours old nauplii of an approximate size of 350-710 um were put in the ponds at the concentrations of cca 50 ind/l.

In the evaporation pond the individuals started riding ten days after inoculation. The cysts were produced 54 days later at a salinity of 232 ppt and at he dissolved oxygen concentration of 1.42--2.03 ml/l of 0_2. There were 4.36 gr cysts collected two times in October. As it rained hard two times during the end of experiment, nauplii were produced from the cysts. Maximum density of individuals in evaporation was noted 54 th day from inoculation, in cca 540 ind/l and all developing forms of Artemia with domination of nauplii were presented.

In the Rotonda canal Artemia started riding on the eight day following inoculation. They reproduced in ovoviviparous way up to day 24 after which they produced 2.68 gr of cysts and they all died. The salinity was 87.32 ppt and the dissolved oxygen concentration in the morning was 6.56 ml/l of 0_2. The concentration of dissolved oxygen during the night were not measured.

At the moment of mass mortality of Artemia in Rotonda chanal, the red-tide of dinoflagelate Peridinium subsalsum Ostenfeld (40x37,5 um) were observed in the concentration of 310 cells μl^{-1}. The seawater was mucous, of an intensive yellow-brown colour. Alimentary canal of Artemia were full with the cysts of dinoflagellates, even on their thoracopods.

Preliminary test inoculation carried out with Artemia franciscana in nondeepened ponds showed that in the conditions of our climate, Artemia can survive. Temperature varied during the day between 17.0 and 34.2°C, and salinity ranged during experiment between 75.4 to 232.0 ppt. In evaporation pond, at a higer salinity, higer temperature and lower water intake, the individuals achieved a smaller lenght and in Rotonda where the salinity and temperature were lower and the higer water intake, the individuals were longer.

The maximum size of Artemia in the evaporation pond was 8781 um for males and 8906 µm for females. In Rotonda, the maximum size of a male was approximately 12430 µm, and that of a female 13063 µm.

REFERENCES.

MAJIĆ, A. and VUKADIN, I., 1987. Preliminary report on the brine shrimp (Artemia) from Yugoslav saltworks. In Artemia Research and its Applications Vol.3. Ecology, Culturing, Use in aquaculture P. SORGELOOS D.A. BENGTSON, W.DECLEIR and E. JASPERS eds., Universa Press, Wetteren, Belgium: 145-149.

LEGER, P., BENGTSON, D.A., SIMPSON, K.L. and SORGELOOS, P., 1986. The use and nutritional value of Artemia as a food source. Oceanogr.Mar. Biol.Ann. Rev., 24 : 521-623.

PETROVIĆ, A., 1987. Artemia - povijesni pregled, problemi i mogućnost uzgoja u Jugoslaviji. 4: 111-118.

SORGELOOS, P., BOSSUYT, E., LAVINA, E., BAEZA-MESA, M., and PERSOONE,C. 1977. Decapsulation of Artemia cysts in aquaculture. Aquaculture, 12: 311-315.

SVEUČILIŠTE U SPLITU, 1985. Projekt: Novi energetski izvori, proširenje sirovinske osnove i proizvodnja hrane kao osnov privrednog razvoja područja Dalmacije. Znanstvena tema: Ribarstvo i marikultura Dalmacije: 61-66.

WALNE, P.R., 1966. Experiments in the large-scale culture of the larvae of Ostrea edulis L., Fish.Invest.Min.Agric.Fish, London, 2: 25-53.

Temporal Heterogeneity, Zooplankton Composition and Fish Food supply in the Albufera of Minorca, a highly fluctuant environment

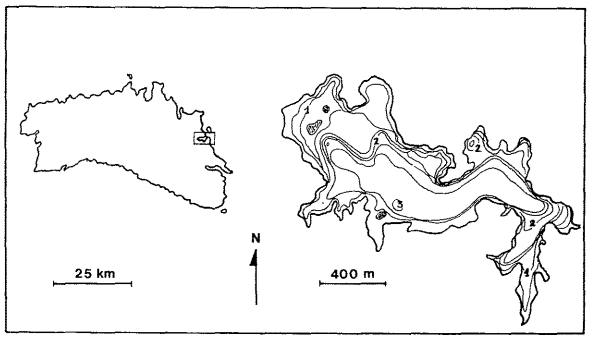
Joan Ll. PRETUS*, Jordi DE MANUEL* and Lluis CARDONA**

*Departament d'Ecologia, Facultad de Biologia, Universitat de Barcelona, Avg. Diagonal 645, 08028 Barcelona (Spain)

**Departament de Biologia Animal, Facultad de Biologia, Universitat de Barcelona, Avg. Diagonal 645, 08028 Barcelona (Spain)

The Albufera of Minorca coastal lagoon is located in the NE cost of the island (fig.1), and its hydrological cycle depends upon a small basin ca. 25 Km^2. Some morphometrical parameters relevant to the following discussion are summarized in table 1. A tentative scheme of the long term changes in salinity of surface waters is presented in table 2.

Fig.1 Situation of the Albufera of Minorca and bathimetric map



For the 1983-84 period and to the descriptive purposes of this paper, a summary of its biophysical variation is derived following the results of a PCA of the main conservative (depth of the tube, temperature, evaporation, rainfall, mean monthly wind, alkalinity, SO_4, Cl, Ca, Mg, Na, K) and biologically dependent parameters (Secchi depth, surface and bottom oxygen content, pH, NO^3, NO_2, Fe, PO_4). Indeed, additional ecological information is achieved in the PCA because the Secchi depth (D) and PO_4 (P) contents of surface water showed strong correlation with Chlorophyll of water column ($D = 6.44\ Chl^{-0.325}$ $r = -0.998$ $p < 0.01$; $Chl = 17.71\ P^{1.135}$ $r = 0.983$ $p < 0.01$). As a result, two main factors contribute largely to the overall ecological variability: trophic level and salinity. The evolution of the lagoon, based in the position of the loading scores on the plane of these two factors, allows a typification of at least three situations. Always mesopolyhaline salinities are concerned: the high relative depth of the lagoon minimizes the interference and mixing between fall-winter freshwater inputs with "old" summer-fall polyhaline waters, making the occurrence of oligohaline states rather improbable (Pretus, 1989).

The three states are commented in the following lines:

Case 1. A winter-spring water, with salinities covering a range of 10 - 25 g/l. Microphytoplankton density increases until 10^6 cells/ml (*Nannochloris* sp.), this high density prevents, because of high turbidity, the development of macrophytes.

Case 2. A winter-spring water of similar salinity than in case 1, but with clean oligotrophic water column, controlled by a dense covering of *Chaetomorpha*, or a combination of this species with *Gracillaria*, adding *Rupia cirrhosa* in spring.

Case 3. Polyhaline summer-fall water, easily reaching 30°C in August. Seawater intrusions are frequent in this period, but usually mixed by the wind. Then the mean salinity of the lagoon remains between 22 - 30 g/l. This situation develops a mature covering of Rupia with peaks of phytoplankton (*Chaetoceros* sspp.), and clean waters with *Prorocentrum scutellum*.

Tab. 1. Morphometric parameters.

Surface	72.4 Ha
Maximum length	1700 m
Maximum depth	3 m
Mean depth	1.37 m
Relative depth	0.312 %

Tab. 2. Salinity (g/l) ranges and month measured

	Minimum	Maximum
1983	12.9 (III)	29.1 (XI)
1984	14.6 (IV)	>28.5 (VIII)
1987	3.7 (II)	29.4 (XI)
1988	11.6 (III)	27 (XI)
1989	23.0 (II)	33.2 (XII)

15 rotifera species were found, 5 of them were new records for the Balearic archipelago: *Notholca bipalium* (Müll.), *Proales reinhardti* (Ehrb.), *Synchaeta kitina* Rousselet, *Encentrum marinum* Dujardin and *Hexarthra oxyuris* (Sernov). *Brachionus plicatilis* Müll. was the most abundant species, and the only rotifer found in hipereutrophic states, with densities up to 2500 ind/l. Rotifer populations decreased and were controlled because of salinity, which affects fecundity rates more than other factors (Miracle & Serra, 1989). Relatively diverse rotifer communities occurred in winter-spring waters.

Crustacea species found were: *Acartia latisetosa* Kritsch., *Halicyclops neglectus* Kief., *Ectinosoma* sp., *Euterpina* sp. *Ergasillus sieboldii* Nordm., *Nitocra lacustris* (Schmank.), *Mesochra heldtii* Monard, *Tisbe longicornis* T. & A. Scott, *Cyprideis torosa* (Brady), *Cypridopsis* sp., *Mesopodopsis slabberi* (van Beneden), *Corophium insidiosum* Crawford, *Gammarus aequicauda* Martynov, *Lekanesphaera hookeri* (Leach), *Palaemon serratus* (Pennant), and *Carcinus aestuarii* Czerniavsky. *Acartia latisetosa* behaves as a true planktonic species, and its densities increased in the hipereutrophic state of the lagoon. The harpacticoidea were found mainly close to the bottom algal and macrophytic communities, and occurred from June onward in the summer. Several species disappeared during the hipereutrophic period and reappeared later:*Masopodopsis slabberi, Cyprideis torosa* and *Corophium insidiosum*.

Five grey mullets were found in the lagoon: *Mugil cephalus* (L.), *Chelon labrosus* (Risso), *Liza (Liza) ramada* (Risso), *Liza (Liza) aurata* (Risso), and *Liza (Protomugil) saliens* (Risso). Gut contents analysis revealed an occasional intake of small organisms as *Brachionus* and some harpacticoidea, whilst ostracoda, *Gammarus*, and *Corophium* are more common preys. That pattern shows a high selectivity of food supply by grey mullets.

REFERENCES:

PRETUS, J. Ll., 1989. Limnologia de la albufera de Menorca. *Limnética*, 5: 69-81

MIRACLE, M.R. & M. SERRA. 1989. Salinity and temperature influence in rotifer life history characteristics. *Hydrobiologia* 186/187: 81-102.

Rehabilitation of Open Waters within the Albufera of Majorca (selective criteria)

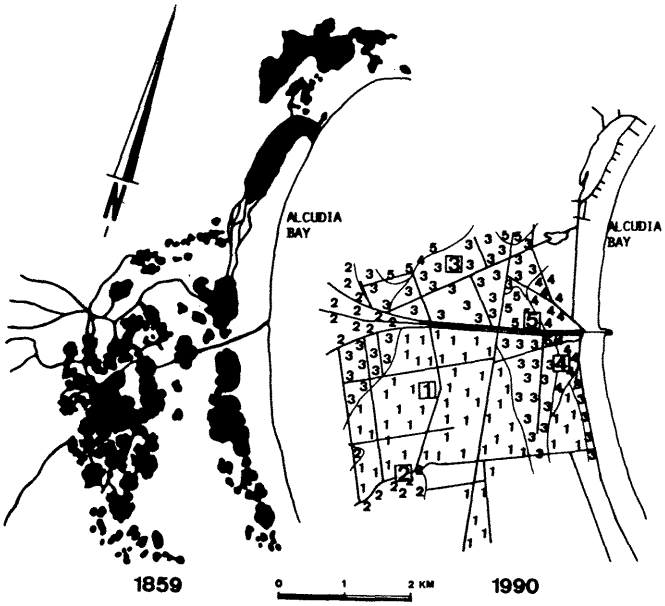
A. MARTINEZ-TABERNER*, M. RUIZ-PEREZ**, V. FORTEZA*, I. MESTRE* and C. PONSELL*

*Departament de Biologia i Ciències de la Salut, Universitat, Illes Balears (Espana)

**Departament Ciències de la Terra, Universitat, Illes Balears (Espana)

In 1988 a Natural Park was declared in part of the Albufera region. At present only 3% of the surface area is open water whereas last century water covered 30-40%. In consequence the food resources and habitat of aquatic species have been greatly reduced and the landscape is very homogeneous with emergent macrophytes.

In order to rehabilitate the area we propose an increase in the volume of water which will thus have a longer residence time within the Park.



A plan for use and management (MAYOL 1989) and limnological criteria for the rehabilitation of the Park (MARTINEZ-TABERNER et al. 1990) have been published. The present work discusses one of the criteria in the latter.

By predicting the distribution of submerged macrophytes we can determine the aquatic zones suitable for rehabilitation. We hope to guarantee the continuing existence of aquatic communities that are present but poorly represented and to rehabilitate areas for the reintroduction of those species which have disappeared (BARCELO-COMBIS, 1879-81; MARTINEZ-TABERNER, 1986; MARTINEZ-TABERNER & PERICAS, 1988).

From the existing information on the physico-chemical dynamics of the water and from the environmental tolerances of species we can predict the most likely species in the zones of the Albufera which were previously open waters (see map of 1859). Having established this prediction we can determine the criteria for the selection of new environments within the Natural Park in the following way:

a.- On the vegetation map of the Albufera (FORTEZA & MARTINEZ-TABERNER, 1987), ponds for each community of emergent macrophytes will be included (see map 1990) i.e. a ponds within *Soncho-Cladietum marisci* (1), *Typho Schoenoplectetum glauci* (2), *Scirpietum maritimi-litoralis* (3), *Juncion maritimi* (4) and *Artrocnemetum fruticosi* (5).

b.- The potential vegetation map is superimposed on the map with the planned ponds (see map of 1990 with squares) and we will eliminate those that offer the same potential vegetation and those that already exist.

Thus we will obtain not only food resources and new habitats but these resources will also be sufficiently diverse to ensure the existence of many different species. It could be thought that it would be better to invest in a single lagoon but this would only provide a homogeneous change within the Albufera and would only serve to maintain many individuals of very few species. Furthermore this would homogenize the present physico-chemical gradient of the waters which is the most important characteristic of the Park, since it allows a wide diversity of environments and species within a small area.

References:

BARCELO-COMBIS, F. (1879-81). *Flora de las Islas Baleares*. Ed. Gelabert. Palma de Mallorca.

FORTEZA, V., MARTINEZ-TABERNER, A. (1987). *Proceedings I Jornades del Medi Ambient de les Balears*. Palma de Mallorca.

MARTINEZ-TABERNER, A. (1986). *Boll. Soc. Hist. Nat. Balears* 30, 155-164.

MARTINEZ-TABERNER, A, PERICAS, J. (1988). *Boll. Soc. Hist. Nat. Balears* 32.

MARTINEZ-TABERNER, A., MOYA, G., RAMON, G., FORTEZA, V. (1990). *Ambio* 19.

MAYOL, J. (1989). *Plà d'ús i gestió de S'Albufera de Mallorca*. Tech. Rapp. Conselleria d'Agricultura. Govern Balear.

E-III13

Model for the Distribution of Submerged Vegetation in a Gradient of Coastal Marsh. Albufera of Majorca (Balearic Islands)

A. MARTINEZ-TABERNER* , I. MESTRE* and M. RUIZ-PEREZ**

*Departament de Biologia i Ciències de la Salut, Universitat de les Illes Balears, Palma de Mallorca (Espana)
**Departament Ciències de la Terra, Universitat de les Illes Balears, Palma de Mallorca (Espana)

On the basis of the dynamics of physico-chemical variables of water outcropping in the Albufera and the environmental tolerances of submersed macrophytes, the most probable composition of submersed vegetation of rehabilitated lagoons in the silted coastal marsh is predicted.

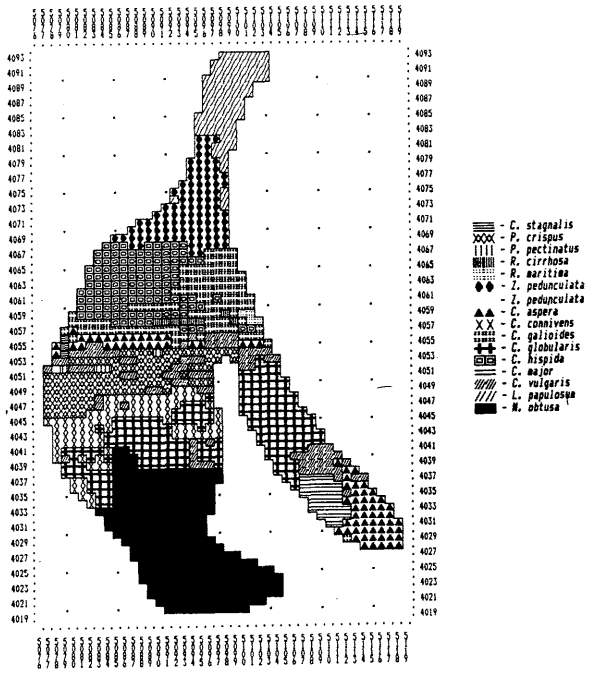
After dividing the Albufera into 10000 m^2 squares we plotted the seasonal distribution of values for variables of the environment over the digital cartography. These values include all the squares of the margins of the Albufera and the values of the isolines among sample stations. The values Z of empty slots among squares with values are a function of the variable Z in the closeset 4 slots, as an extension of the UTM axes, and their distance in relation to the problem slot are extrapolated. The Z values in the problem slot p would be as follows:

$$Zp=\frac{(Za/Ya-Yp)+(Zb/(Xb-Xp)+(Zc/Yp-Yc)+(Zd/Xp-Xd)}{(1/Ya-Yp)+(1/Xb-Xp)+(1/Yp-Yc)+(1/Xp-Xd)}$$

Zi: value of the parameter Z for each slot.
Xi,Yi: values of co-odinates for each slot.

These extrapolations have been applied to NO_2+NO_3, PO_4 and conductivity, which correspond to the most important loading factors derived from the principal components analysis of the system, and for each season during two years. As a consequence we obtain the margins and range of variation for each variable within each square.

The second step consists of the introduction of the data referring to the margins and range of environmental tolerance of submerged macrophytes for the parameters previously used.



From the information of slots and tolerances we calculated the overlap between the degree of variation of each square and the tolerance of each species by means of a procedure of iterative integration which applies the Jaccard index modified for quantitative data (MARTINEZ-TABERNER, 1983). This index has a range of variation between 0 and 1 which allows its treatment as a value of the probability of occurrence of each species in each of the geographical squares.

The probability of occurrence of specie x within square y is a function of all parameters used. For this purpose the following open expression is calculated:

$$Px,y=\sqrt[n]{S_1}xS_2x...xS_n$$

S is the probability of species x within square y for the paremeter i. P is a total probability and Si represents partial probabilities of each variable used.

Finally, species are arranged from highest to lowest probability, and an inventory of potential vegetation for each square is produced.

References:
MARTINEZ-TABERNER, A. (1983). *Boll. Soc. Hist. Nat. Bal.* 27,23-32.

E-III14

An Ecological View of a Littoral Zone in a Gulf in West Greece

Aristidis DIAPOULIS , Theodoros KOUSSOURIS , Emmanouel PAPAGEORGIOU and Ilias BERTAHAS

National Centre for Marine Research, Hellenikon, Athens (Greece)

The studied area from ecological point of view can be divided into: the coastal lagoons, the marsh regions with salt plains and the mouths of the rivers (Louros and Arachthos). Most of the lagoons are being located at the delta area and their boundaries fluctuate depending on climate and hydrological conditions. Their functions are like a natural fishery and can be classified from nutrition point of view as oligomesotrophic. Their fauna and flora are typical for brackish water. This lagoon system is one of the largest in the Mediterranean region.

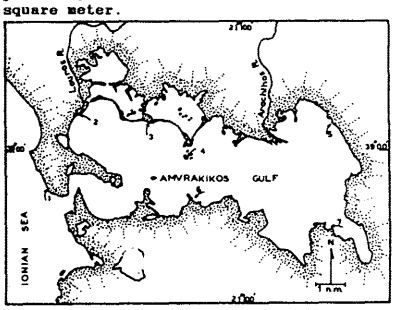
The delta area under investigation is located at the Amvrakikos Gulf (20°44 -21°07 E and 38°59 -39°11 B). This Gulf represents the major Gulf along the West Greek coast (Fig. 1). It is an almost enclosed embayment with a surface of 385 Km^2 and a maximum depth of 60m. The whole delta coastal region covers an area of about 450 Km^2. The delta forming rivers of Louros and Arachthos differ with respect to their hydrology and kind of drifts

According to recent information dealing with the studied area Louros and Arachthos rivers are the main contributors of water from a great run-off basin of 4.400 Km^2. The delta area which is bounded by the two rivers, the extended wetlands between them , as well as the lagoon system with their coastal ridges, cover an area of 450 Km^2.

Most of the lagoons are located at the delta zone and their boundaries fluctuate, depending mainly on climatic and hydrological conditions. The total surface area and mean depth of all lagoons is about 64 Km^2 and 1 meter respectively. The bottom of the lagoons is composed of decomposing mud where anaerobic processes occur, typical of natural conditions. The main aquatic vegetation, which covers part of the bottom, consists with Zostera noltii Horneman and Ruppia maritima Linne.Salinity fluctuates from mesohaline to polyhaline level and pH is weak alkaline (pH=8.8). Their typical functions are like a natural fishing grocent, while with respect to water quality and from nutrition point of view,they can be classified as mesotrophic.

The coastal lagoon system are protected from the sea by coastal bars ridges that consist mostly of coastal sands (shells, detritus, sluge and other organic materials). In the early summertime some areas dry out and are covered with the green alga Valonia utricularis (Roth) Agarch, forming balls. Late in summer Salicornia europea Linne and other halophytes colonize the area.

Along the littoral zone of the sea coast, sea grass meadows cover in patches the area. Here predominate Cymodocea nodosa (Ucria) Aschers. and Zostera noltii. Most of them are degradated by the grazing activities of sea urchins, mainly Paracentrotus lividus Lam. and Psamechinus sp. The abundance of these species are rather high in most areas (except in areas close to the proximity of the river estuaries), as high as 20 individuals per square meter.



Marsh regions have an extensive reed belt with an area of 31 Km^2 and with a rich diversified fauna (fish, insects, birds). The major reed belt area on the Louros can be characterized as one of the largest coherent belt of Phragmites australis (Cav.)Trin.in Greece. The extended zone of Phragmites australis is located in certain locations of Louros and the lagoons, with stands mainly consisted of Schoenoplectus tabernaemontani Palla, while in locations with strong wave activity Typha angustifolia Ch.and B., Bolboschoenus maritimus Palla and Iris pseudacorus Linne, occur.

The two rivers discharging to the delta area differ both in morphology flora and fauna. This is primarily due to their different water hydrological characteristics.

The slower continiously flowing Louros river, with an average annual flow rate of 19.4 m^3/sec, spillover the banks fine sediments that have led to highly oxygenized and nutritive riverside soils. Vegetation communities predominantly reed belts (Phragmites australis, Iris pseudacorus etc.), have been developed in clearly zoned regions of great extension and the aquatic fauna is characterized by a high diversity. Green algae (Cladophora spp and Enteromorpha spp) and the red alga Thorea ramosissima Bory are encountered in the area of the river mouth. The water moss Salvinia natans is found in higher region of the river. The benthic or epiphitic fauna of the Louros river composed of gastropods , crustacea and larval stages of odonata , diptera and trichoptera.

Arachthos river has a peculiar hydrological regime. It depends on the water that the dam of Public Power Corporation releases regulating thus the flow of the river.

The diversity of the flora and fauna is very low. Around the mouth area the sea gras Cymodocea nodosa, the red alga Lemanea sp and blue green alga (Phormidium sp, etc) are found. Along its banks in rare stands the Phragmites australis grows up, while in salt plains stands of Juncus spp are found.

Further upstream odonata Ischnura elegans, hemiptera (Corixa sp) and the gastropoda Theodoxus fluviatilis, Valvata piscinalis, Limnaea peregra, etc dominate.

Finally the potential resources of the delta areas are severaly altered by various anthropogenic and or natural disturbances.

Recherches sur la Flore Marine de la Lagune d'Homa (Baie d'Izmir, Turquie)

S. CIRIK*, S. CIRIK**, A. ALPBAZ*, S. GOKPINAR* et C. METIN*

*Ecole Supérieure des Produits Aquatiques de l'Université d'Egée, Bornova Izmir (Turquie)
**Institut des Sciences et de Technologie Marine de l'Université de Dokuz Eylül, P.K. 478, 35213 Izmir (Turquie)

La lagune d'Homa se trouve dans la partie extérieure de la baie d'Izmir en Turquie. Elle se situe à 38°33'10" N et 26°49'50" E de l'Anatolie Occidentale. Sa profondeur moyenne est d'un mètre et elle a une superficie de 1800 ha.

En ce qui concerne les paramètres physico-chimiques et les sels nutritifs, notamment, cette lagune est assez riche (YARAMAZ et ALPBAZ, 1988).

Les ressources vivantes de cet endroit sont importantes. La production annuelle de poisson varie entre 30 et 60 tonnes. Les espèces économiques sont Sparus aurata, Anguilla anguilla, Mugil ssp, Dicentrarchus labrax.

La richesse floristique algale joue un rôle essentiel dans les chaînes alimentaires des lagunes. En particulier les Diatomées constituent les nourritures des Mugilidés dans les milieux saumâtres (KIENER, 1978). De ce point de vue, les recherches algologiques sont importantes. Nous avons commencé à étudier, d'une manière mensuelle, la flore marine de le lagune d'Homa en mars 1989. Selon nos résultats préliminaires, les espèces du phytoplancton récoltées appartiennent aux groupes des Diatomophycées (27 sp), des Cyanophycées (12 sp) et des Dinophycées (5 sp). La végétation marine macroscopique est constituée d'espèces des groupes des Rhodophycées (7 sp) des Chlorophycées (5 sp), des Phaeophycées (3 sp) et des phanerogames marines (1 sp).

Des espèces de Diatomophycées typiquement saumâtres comme Achnanthes longipes, Nitzchia longissima, Nitzchia closterium, Synedra ulna, Synedra fulgens var mediterranea, Surirella elongata, Navicula salinarum, Coscinodiscus sp, Rhabdonema adriaticum, Diploneis sp, Melosira borreri, Cocconeis sublittoralis sont très fréquentes. Parmi les espèces déterminées, les diatomées pennées sont plus abondantes.

Les Cyanophycées prennent une place importante dans la microflore à cause de l'eutrophisation et de la température élevée des eaux peu profondes de la lagune pendant les périodes chaudes. En particulier Lyngbya majuscula est l'espèce la plus abontante et on la trouve toute l'annee. Nous avons observé également Oscillatoria erythreum, Lyngbya martensiana.

Parmis les Dinophycées, Prorocentrum micans est abondant pendant toute l'année. Gonyaulax sp, Gymnodinium cf. variabile se voient en été, tandis que Peridinium conicum, au printemps.

Au cours des prélèvements nous avons observé également la presence abondante de certaines espèces de végétation macroscopique comme Enteromorpha spp, Cladophora spp, Chaetomorpha linum, Ceramium rubrum, Ceramium diaphanum et Zostera noltii.

REFERENCES

KIENER (A.), 1978-Ecologie, physiologie et économie des eaux saumâtres. Ed. Masson, 220p. 77 fig. Paris.

YARAMAZ (Ö.) et ALPBAZ (A.), 1988-Recherches des paramètres physico-chimiques, des sels nutritifs et des detergents anioniques dans la pecherie d'Homa, İzmir (Turquie) Rapp. Comm.int.Mer Medit. 31,2:45.

Changes on Benthic Community Promoted by an Artificial Sea-Connection in a Brackish Coastal Lagoon (St. André, SW Portugal)

L. CANCELA DA FONSECA*, A.-M. COSTA** and J.-M. BERNARDO**

*Department of Zoology Anthropology, Faculty of Sciences, Lisbon (Portugal) and Marine Laboratory, Guia, Cascais (Portugal)
**Department of Ecology, Evora University, Evora (Portugal)

St. Andre (150 ha, ca. 1.5m average depth) is a land-locked lagoon isolated from the sea except during a short period in early Spring (*ca.* 1 month), when an artificial channel is opened through the sand barrier. Seasonal variation of this lagoon has the following main phases: i) Connection with the sea, which leads to a sudden decrease in the water level, salinity increase, decrease of accumulated materials exported to the sea and colonization by marine species; ii) Summer period, with increasing temperatures, the occurence of anoxia near bottom (and possibly dystrophic phenomena), increased water concentrations of nutrients released from the sediment and reduction of the species number; iii) Rainfall period, with loading of nutrients, strong reduction of salinity and colonization by limnetic species.

During the 1978-1985 period, an effective wash-out and sea water renewal only occurred in 1978, 1979 and 1985. Otherwise the connection either did not exist (1981, 1982) or was inadequate (only a few days - 1984, or too late in the year - 1980, 1983). As a consequence increasing amounts of organic matter accumulate in the sediment leading to dystrophic processes (BERNARDO *et al.*, 1988) and input of marine species was non existent or low, promoting an impoverishment of the marine component of the fauna and a decrease of the benthic diversity (CANCELA DA FONSECA, 1989; CANCELA DA FONSECA *et al., in litt.*).

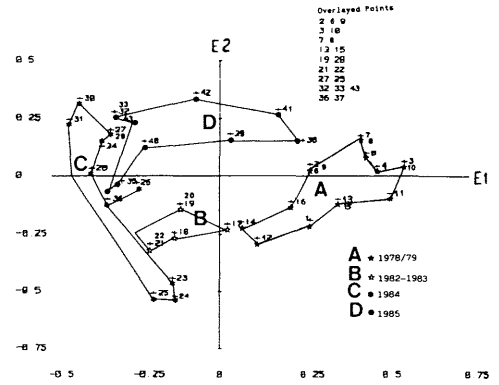


Fig. 1 - Q ordination (PCO, PHI corr. coeff.) of the macrobenthos global binary matrix (sediment types per season).

Ordination of the macrofaunal disponible data concerning the period refered above (Principal Coordinate Analysis - PCO - carried on the similarity matrix obtainned with the PHI correlation coefficient upon the presence-absence species data) suggests, during 1978-1985, the existence of a benthic community cycle with the following main phases (Fig. 1): i) A major influence of the sea component in the fauna (1978-1979), before the start of the irregularities concerning the traditional artificial opening (benthic community dominated by a marine pool of species); ii) A more limnetic situation after the non-opening period (1982,1983,1984), leading to benthic communities restricted to a few lagoonal species or dominated by a continental pool of species; iii) Probable transitional situation (1985), with the start of a recovering process after the re-establishment of the traditional opening procedure, with the increase of the marine component of the benthic fauna. Similar results have been repported from the mediterranean lagoons.

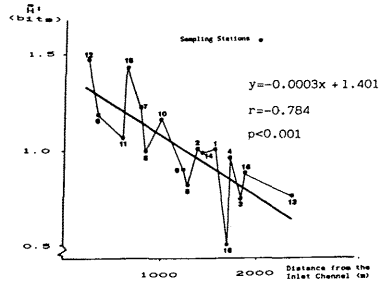


Fig. 2 - Average specific diversity related to the distance from the inlet channel (St. André Lagoon).

This interpretation is also suggested by the evolution of the benthic community structure average with the distance to the local of the inlet channel (Fig. 2). The negative correlation between the community structure and that distance ($r=-0.784$, $p<0.001$) emphasizes the importance of the marine component of the fauna in the benthic community of this system. This is also supported by the study of the post 1985 period (CRUZ, 1989).

REFERENCES

BERNARDO, J.M.; COSTA, A.M.; CANCELA DA FONSECA, L., 1988. *Rapp. Comm. int. Mer Médit.*, 31(2):61.

CANCELA DA FONSECA, L. 1989. *Estudo da influência da "abertura ao mar" sobre um sistema lagunar costeiro: A Lagoa de Santo André.* Tese de Doutoramento, Fac. Ciências Lisboa, X+355p.

CANCELA DA FONSECA,L., COSTA,A.M. & BERNARDO,J.M. (*in litt.*). Seasonal variation of benthic and fish communities in a shallow land-locked coastal lagoon (St.André, SW Portugal). *in* ROS, J.D. (Ed.), *Topics in Marine Biology.*

CRUZ, T. 1989. *Estrutura e dinâmica de uma comunidade de macrofauna bentónica na Lagoa de Stº André.* Estágio de Licenciatura Rec. Faunísticos e Ambiente, FCL. 165p.

E-III17

Analyse Trophique du Peuplement à Polychètes d'une Lagune Côtière Italienne (Lago Fusaro)

Paolo SORDINO

Laboratorio di Ecologia del Benthos, Stazione Zoologica di Napoli, Ischia (Italia)

Ce travail a pour but d'évaluer dans quelle mesure l'organisation fonctionnelle des Annélides Polychètes reflète le milieu. Pour les Polychètes lagunaires des Côtes italiennes, ce type d'analyse a seulement été réalisé par GRAVINA et SOMASCHINI (1986), pour les lagunes côtières du Lazio. Ce travail représente donc une contribution ultérieure au complément d'une recherche précédente sur la structure et la distribution spatio-temporelle des communautés à Polychètes du Fusaro (SORDINO & GAMBI, 1989; SORDINO *et al.*, 1989). La description détaillée du milieu a été donnée par CARRADA (1973).

On a échantillonné quatre stations (deux sur fonds meubles, B1 et B2 et deux sur fonds durs, G1 et G2) en deux zones de la lagune, situées, la première près du débouché intérieur d'un des graux, la deuxième dans la partie intérieure et plus confinée de la lagune (Fig. 1). Les échantillons ont été réalisés avec une cyclicité saisonnière.

Les catégories trophiques des Polychètes ont été identifiées suivant les indications de FAUCHALD & JUMARS (1979), excepté pour les Omnivores. On a identifié 9 catégories trophiques pour un total de 35 espèces et 136962 individus. Les groupes trophiques ont été traités en 6 catégories principales et, pour chacune d'elles, on a calculé la dominance quantitative percentuelle (Tab.1).

	JUIN		JUILLET		NOVEMBRE		JANVIER		MARS	
	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2
CARNIVORES	0.02	1.6	0.15	0.6	0.5	5.38	1.4	1.0	6.9	2.95
DEPOSIVORES	0.02	22.7	1.55	5.4	0.5	1.4	0.7	4.2	3.2	4.95
FILTRATEURS	99.8	66.0	89.0	81.6	74.6	89.0	84.3	8.15	78.0	22.8
HERBIVORES	--	1.7	0.9	2.4	2.7	2.7	5.1	6.85	7.8	8.9
LIMIVORES	0.06	2.2	0.25	0.5	0.1	0.02	--	20.2	0.1	3.2
OMNIVORES	0.1	5.8	8.15	9.5	21.6	1.5	8.5	59.6	4.0	57.2

	JUIN		JUILLET		NOVEMBRE		JANVIER		MARS	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
CARNIVORES	8.8	5.24	18.0	14.2	4.45	5.38	9.95	8.09	13.5	22.5
DEPOSIVORES	13.5	6.0	21.0	20.5	1.0	1.4	1.75	1.8	3.9	4.2
FILTRATEURS	48.7	84.5	--	39.7	88.8	89.0	80.8	86.8	77.5	65.5
HERBIVORES	--	1.05	61.0	9.6	1.5	2.7	2.1	0.9	0.5	2.6
LIMIVORES	--	0.01	--	--	--	0.02	--	0.01	0.1	--
OMNIVORES	29.0	3.2	--	16.0	4.25	1.5	5.4	2.4	4.5	5.2

Tab. 1 - Dominance quantitative percentuelle des catégories trophiques

Du point de vue qualitatif, la catégorie trophique la plus riche est celle des Carnivores avec 9 espèces, suivie par les Déposivores (8 espèces), Filtrateurs (7 espèces), Herbivores et Limivores (4 espèces respectives) et Omnivores (3 espèces).

. **Carnivores** : Cette catégorie est représentée soit par des formes ayant des mâchoires, soit par des formes inermes. On a relevé les plus grandes valeurs d'abondance surtout dans les échantillons de fond dur (stations G1 et G2). Les espèces les plus abondantes sont *Syllis gracilis* et *Ophiodromus pallidus*. Les valeurs les plus élevées pour les Carnivores ont été observées au printemps et en été.

. **Déposivores** : Ce groupe comprend soit des formes meubles soit des formes sessiles. Il ne présente pas une préférence marquée pour le type de substrat primaire et pour les différents milieux que l'on retrouve dans la lagune. Les espèces les plus représentatives sont *Polydora ciliata, Prionospio multibranchiata, Cirriformia tentaculata* et *Terebella lapidaria*. On relève les valeurs de dominance les plus élevées durant les mois d'été.

. **Filtrateurs** : Cette catégorie représente, dans son ensemble, le groupe numériquement dominant, mais sans différences particulières liées au substrat ou à divers milieux. L'espèce qui contribue davantage à la dominance de cette catégorie est *Hydroides elegans*. Pour les Filtrateurs, on observe les valeurs d'abondance les plus réduites en été dans la station inférieure à fond dur, et dans la période hiver-printemps dans la station extérieure à fond meuble.

. **Herbivores et Limivores** : Ces deux groupes sont les moins re-présentés et il n'a donc pas été possible de déceler aucun type de différence soit pour le substrat soit pour d'autres facteurs écologiques.

. **Omnivores** : Ils ont une distribution spatio-temporelle uniforme, à l'exception du matériel de la station B2, où ils présentent toujours les valeurs les plus élevées.

La dominance du groupe des Filtrateurs reflète aussi bien les conditions hydrodynamiques de la lagune que l'apport élevé de matière organique en suspension provenant des égouts urbains distribués autour du périmètre lagunaire.

D'autre part, la richesse spécifique des autres catégories trophiques peut être interprétée comme la conséquence du recouvrement des équilibres lagunaires après la crise distrophique estivale, particulièrement dans la zone lagunaire la plus vivifiée.

La distribution spatio-temporelle des catégories trophiques du peuplement à Polychètes du Fusaro reflète donc celle obtenue par l'analyse structurelle des communautés, ce qui avait déjà été observé par GRAVINA & SOMASCHINI (1986) pour d'autres lagunes tyrrhéniennes.

Bibliographie

CARRADA (G.-C.), 1973.- *Archo Oceanogr. Limnol.*, 18 suppl., pp. 145-164.

FAUCHALD (K.) & JUMARS (P.-A.), 1979.- *Oceanogr. Mar. Biol. Ann. Rev.*, 17, pp. 193-284.

GRAVINA (M.-F.) & SOMASCHINI (A.), 1986.- *Rapp. Comm. int. Mer Médit.*, 30 (2), p. 252.

SORDINO (P.) & GAMBI (M.-C.), 1989.- *Oebalia*, 15 (1), pp. 337-340.

SORDINO (P.), GAMBI (M.-C.) & CARRADA (G.-C.), 1989.- *Cah. Biol. Mar.*, 30, pp. 375-391

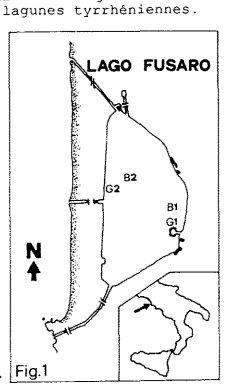


Fig.1

Fig. 1 - La lagune avec l'indication des stations.

E-III18

Le Benthos de substrat dur de la Sacca di Goro (Delta du Pô)

A. OCCHIPINTI AMBROGI* et R. AMBROGI**

*Dipartimento di Genetica e Microbiologia, Università di Pavia (Italia)
**ENEL, Centro di Ricerca Termica e Nucleare di Milano (Italia)

ABSTRACT : Hard-bottom macrobenthos was sampled in three occasions on various substrata in the Sacca di Goro, a shallow water embayment of the Po river delta. No clear-cut zonation of assemblages was apparent in the different areas of the lagoon, but a severe summer dystrophic crisis affected the species composition of the community.

La Sacca di Goro est un bassin d'eau à salinité variable dans la partie meridionale du Delta du Pô, à faible profondeur et ayant une surface d'environ 32 km^2. Elle communique avec la Mer Adriatique par une ouverture de 2,5 km de large et reçoit de nombreux apports d'eau douce, surtout dans sa partie occidentale.

Dans le cadre d'un programme de recherches écologiques comme support scientifique à l'aménagement de la lagune, qui est menacée par les conséquences de l'eutrophisation, on a étudié le macrobenthos des fonds durs, au cours de trois campagnes de prélèvement.

Les prélèvements ont été effectués en juin, juillet, et octobre 1988, en grattant à l'aide d'un filet à bord coupant, la surface des poteaux en bois qui marquent les parcours des canaux navigables, selon la téchnique déjà utilisée en lagune de Venise (Occhipinti Ambrogi et al., 1988). D'autres substrats ont été aussi observés (pierres, installations de mytiliculture, roseaux etc.)

En particulier, on a échantillonné suivant les gradients écologiques marqués:

1) par le parcours allant de la mer jusqu'au port de Goro,
2) par le déversement des eaux du Po di Volano, et
3) par le confinement de la partie orientale, qui a un échange assez pauvre avec la mer.

Le contingent faunistique de ce peuplement (59 taxa) est assez riche, si on le compare à d'autres lagunes du Delta (Relini et al., 1985), mais nettement moins important de celui de la Lagune de Venise (Occhipinti Ambrogi et al., 1988).

Les groupes les plus représentés sont les Cnidaires (6 espéces), les Crustacés Peracarides (20 espèces), les Mollusques (7 espèces), les Entoproctes (5 espèces) et les Bryozoaires (6 espèces).

Du point de vue quantitatif, les biocénoses sont dominées par Mytilus galloprovincialis, dont les amas offrent le substrat secondaire pour l'implantation des balanes (Balanus improvisus, B. eburneus, B. amphitrite) des Bryozoaires (Conopeum seurati, Bowerbankia gracilis) et des Hydrozoaires (Gonothyrea loveni, Obelia dichotoma).

Parmi la faune vagile, qui occupe les interstices entre les coquilles des moules, on signale les Polychètes Nereis succinea, les Amphipodes (Corophium insidiosum, Melita palmata), les Isopodes (Sphaeroma serratum) et les Décapodes (Brachinotus sexdentatus).

La distribution des espèces principales est assez homogène et leurs rapports quantitatifs sont assez constants dans toutes les stations prospectées, en dehors de quelques exceptions.

Notamment, dans la partie la plus proche du canal du Po di Volano, avec une salinité mesurée lors du prélèvement inférieure à 10 ‰, Cordylophora caspia et trois espèces de Victorellidae marquent le caractère nettement estuarin de ce secteur. Dans la partie orientale, au contraire, on a noté un affaiblissement de la dominance des moules, la disparition des Hydrozoaires, et une plus grande abondance d'espèces typiques des zones plus proprement lagunaires, comme Conopeum seurati, Balanus eburneus et Ficopomatus enigmaticus.

L'aspect le plus frappant de la dynamique des biocénoses de substrat dur de la lagune est toutefois représenté par les variations temporelles qui se sont produites entre les trois prélèvements.

En effet, pendant le mois de juin, on a observé le maximum de recouvrement et de richesse spécifique, tandis qu' en juillet et en octobre, à la suite des crises dystrophiques estivales, on assiste à une rèduction assez nette, surtout à cause d'une mortalité massive des moules.

Corazza et al. (1989), pour le benthos des substrats meubles de trois stations de la Sacca di Goro, avaient remarqué, pendant l'année 1984, une grande différence entre les biocénoses des trois zones de la lagune et une assez bonne stabilité temporelle du peuplement de chaque zone. Si les données en cours d'élaboration que le même groupe de recherche a obtenu en 1988 confirment ces résultats, on devrait reconnaître une spécialisation moins marquée des communautés de substrat dur par rapport à celles du sédiment.

BIBLIOGRAPHIE

Corazza, C., M. Mistri et V.U. Ceccherelli, 1989 : Osservazioni preliminari sulla dinamica spazio-temporale delle comunità macrobentoniche della Sacca di Goro (Delta del Po). Oebalia, 15 N.S. : 119-128.

Occhipinti Ambrogi, A., R. Sconfietti, C. Morri et C.N. Bianchi, 1988: Ricerche sulla zonazione spazio-temporale dell'epifauna sessile nel settore centrale della laguna veneta. Boll. Mus. civ. St. nat. Venezia, 38: 155-173.

Relini, G., G. Matricardi, C.N. Bianchi, G. Diviacco, C. Morri et E.Pisano, 1985: Il macrobenthos di substrato duro dell'area deltizia padana. Nova Thalassia, 7 (suppl. 2): 253-280.

Elements for an Ecological Characterization of a Lagoon in the Deltaic System of the Po and Adige Rivers : Porto Caleri

Renato SCONFIETTI* and Valerio VENDEGNA**

*Dipartimento di Genetica, Sezione di Ecologia, Centro interuniversitario di Ecologia delle Acque Interne, Piazza Botta, Pavia (Italia)

**Centro di Ricerca sulle Acque dell'Università di Pavia, Via Montefiascone, Pavia (Italia)

The lagoon of Porto Caleri lies to the south of the Venetian lagoon, between the mouths of the Adige and Po rivers. Its origin is mostly due to the alluvial sediments from Adige, which is the third Italian river as length and the second one as catchment- basin after Po. Most of the original lagoon basin is now left out from the free exchange with the Adriatic Sea, to delimit fishing ponds ("valli"). Therefore the internal boundary is wholly artificial, in the form of low banks. The lagoon has two communications with the sea; the northern mouth supplies the main portion of the sea water exchange, while the southern one has even more narrowed its opening after the building of an embankment with a short bridge, which links up the mainland with the touristic port of Albarella on the homonymous island. Through the Varco Pozzatini dissalate waters flow into the lagoon from a lateral branch of the river Po (Po di Levante), whose inflow is retained by a littoral bar (Scanno Cavallari). Irregular inflows of low salinity waters may also come from the surrounding "valli", which produce high organic loads. From the northern Palude di Boccavecchia a few years ago freshwater flowed directly from Adige through a narrow canal ("Ghebo" della Testa), now silted up. Only traces of schorres persist after the marked subsidence of the last years.

Two mussel-breeding areas and a clam one are placed along the two canals directly influenced by the sea during the tidal cycles, that show an amplitude of about 60-80 cm.

A biological survey has been carried out in autumn 1989 in order to identify different ecological communities in macrobenthos. The complex hydrological pattern does not allow to define well diversifiable benthic communities in terms of salinity gradients, as observed in other estuarine systems (SCONFIETTI, 1988, Crustaceana, 52: 193-201). On the contrary different communities are explainable in terms of different rate of marine "vivification" (sensu D'ANCONA et al., 1954, Archo Ocean. Limnol., 9: 9-295) or of confinement gradients (sensu GUELORGET & PERTHUISOT, 1983, Trav. Labor. Geol. Ecole sup. Paris, 16: 1-136) (for a discussion, see SACCHI, 1985, Mem. Biol. mar. Oceanogr., 15: 71-89). Five ecological communities can be mainly pointed out (fig. 1): A) a community remarkably influenced by the marine vivification and characterized by essentially marine or open lagoon species of hard substrata (wooden piles or banks): Mytilus galloprovincialis Lam., Ostrea sp. and Crassostrea sp., Actinia equina (L.), Cryptosula pallasiana (Moll), Hyale perieri (Lucas), Littorina neritoides (L.), Fucus virsoides J.Ag.; B) a banal lagoon community typical of confined sectors, poor as species distributed all over the lagoon, in which the most "marine" elements of the community A are absent: C) a community influenced by scarce freshwater inflows and, at the same time, subject to a still efficient water exchange, characterized by Bowerbankia gracilis (Leidy), Conopeum seurati (Canu), Balanus eburneus Gould, Hyale perieri (Lucas); D) a community made by elements of different origin, but dominated and characterized by large "masses" of Ficopomatus (=Mercierella) enigmaticus (Fauvel), to show the frequent freshwater influence; E) a very poor community, including large amounts of Ulva sp. and Enteromorpha sp.pl., Haminea navicula (Da Costa) and Gammarus insensibilis Stock, which are distributed all over the lagoon, but here present without other species, more sensitive to the drastic reduction of the vivification.

In a small internal bay, isolated by the main circulation of the water (community E), the presence of a very little spot of Zostera marina L. must be pointed out. In the lagoon of Porto Caleri we confirm the persistence of Fucus virsoides, which has here the southern limit of its characteristic north-Adriatic distribution (SACCHI et al., 1983, Rapp. Comm. int. Mer Medit., 28: 225-228), probably due to the strong ecological disjunction imposed by the large freshwater plume of the river Po into the sea (SACCHI, 1978, Boll. Mus. civ. Stor. nat. Venezia, 29 suppl.: 43-73).

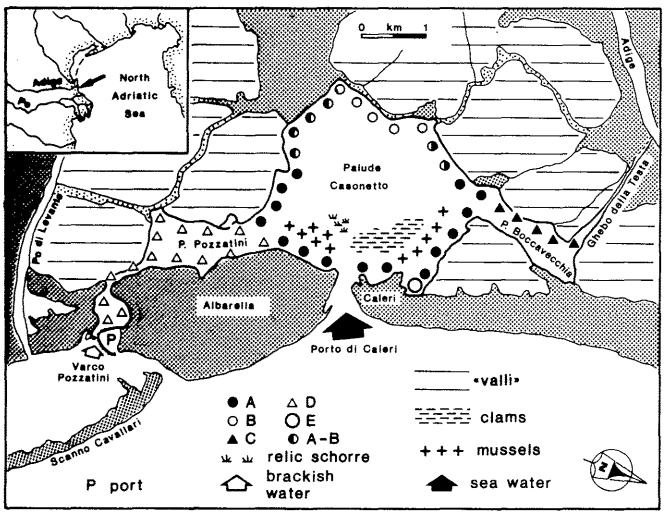


Fig. 1 - Ecological characterization of the lagoon of Porto Caleri.

In conclusion, we can distinguish two main hydrological sub-basin, characterized by almost separated circulations of the water: 1) a main basin, Palude Casonetto, influenced by the marine waters flowing through the Porto di Caleri and expanded towards Palude di Boccavecchia; 2) a secondary basin, Palude Pozzatini, where the strong dominance of Mercierella delimites the area influenced by the brackish waters of the Po river, flowing from its Levante branch through Varco Pozzatini. The difficult circulation in the inner sector of the lagoon causes a long-time stagnation of water masses with their high organic contents, coming from "valli", that actually cause important dystrophic crysis during the hottest months. The rational exploitation of the natural resources for the production of mussels and clams will be preserved in the next years only by a wise management of the active circulation of the water.

Periodicity and Distribution of Bottom Fauna in Hyper-Saline Bardawil Lagoon (Egypt)

Sawsan M. ABOUL-EZZ

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

Bardawil Lagoon is a shallow hyper-saline water basin, located at the northern extrimity of Sinai Peninsula (Egypt). Its depth ranges between 0.5 and 2 meters with a total area of about 65000 hectar. It is in the direct connection with the Mediterranean Sea through two narrow openings (Figure 1).

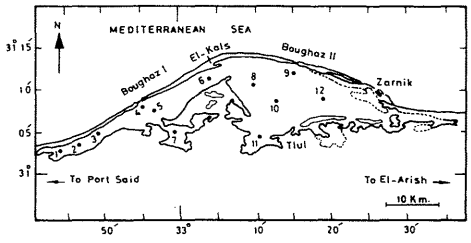


Fig. (1): Morphometry of Bardawil Lagoon and location of stations.

Quantitative sampling of bottom fauna was performed seasonally during the years 1986 and 1987. The samples were collected from tweleve stations representing the different habitats in the lagoon, using a modified Ekmann bottom sampler. Two dredges were taken from each station representing an area equivalent to 0.06 m^2.

The different groups were counted and their biomasses were determined. Results were given as their total numbers per square meter as well as their biomasses in gram fresh-weight per square meter.

The living benthic macrofauna in Bardawil Lagoon comprised about 46 species belonging to the phyla; Annelida, Arthropoda, Mollusca, Echinodermata, Coelentrata and Nematoda Most of the recorded species are typical hyper-saline or euryhaline water forms. The benthic community in the lagoon was dominated by members of Polychaeta (Hydroides, Sabella and Nereis), Crustacea (Corophium and Gammarus), Insecta (Chironomid larvae), Lamellibranchiata (Brachiodontes) and Gastropoda (Cerithium) which constituted respectively about 60.7 %, 12.3 %, 11.5 %, 9.8 % and 2.7 % by number of the total benthos. The other groups were less frequent or rare (table 1).

Table (1)

Annual distribution of the total bottom fauna (Organisms/m^2) and their total Biomass (gram fresh wt/m^2) in Bardawil Lagoon during 1986 & 1987.

groups	1986				1987			
	No/m^2	%	gm/m^2	%	No/m^2	%	gm/m^2	%
Polychaetes	2510	64.5	23.3	38.6	2010	57.0	8.5	14.1
Crustacea	298	7.6	9.2	15.2	571	16.2	8.3	13.8
Insecta	361	9.3			462	13.1		
Lamellibranchs	528	13.6	24.4	40.4	203	5.8	25.7	42.6
Gastropods	63	1.6	3.5	5.8	123	3.5	17.8	29.5
Other groups	134	3.4	--	--	159	4.5	--	--
	3894		60.4		3528		60.3	

The total biomass of benthos in the lagoon averaged 60.4 gram fresh weight/m^2. Lamellibranchs were the heaviest bottom dwellers during the two successive years, followed by Polychaetes in 1989 and Gastropods in 1987.

The highest counts of bottom fauna were recorded at the semiclosed station 7 due to polychaetes and insects larvae. While the highest biomasses appeared at stations 8 and 10 during 1986and 1987 respectively due to the presence of big molluscs.

The benthic community was more diversified during the spring of the two successive years and harboured the highest biomasses. The middle part of the lagoon was more productive in bottom fauna. The dominant species of the benthic community slightly differed within the two successive years.

Results indicate that the distribution of benthos in Bardawil Lagoon were controlled by the prevailing ecological conditions. The dominant species are marine forms which usually inhabits muddy bottoms and are more resristant to low oxygen concentration.

G-I1

Gravity and Tectonics of the Western Mediterranean Sea

J. LIU , J. MAKRIS and K. SPOHR

Institut für Geophysik, Universität Hamburg (F.R.G.)

All gravity data available for the western Mediterranean Sea and adjacent countries have been reevaluated and reprocessed into Bouguer gravity maps. Previously, onshore gravity data from the western Mediterranean Sea were not terrain corrected. With a raster of digital onshore and offshore topographic data terrain correction was carried out up to Hayford zone O_2. The largest effect of the terrain correction was found in the area of the sea-land boundary and the Balearics. The new Bouguer maps show clearly the main geological and tectonic features. Values of over 180 mGal for example are found in the Algero-Provencal Basin where the crust is probably oceanic. In the Valencia Trough on the other hand, where the crust is considered to be stretched continental, values reach only 140 mGal. The Bouguer values decrease towards the Iberian peninsula and Africa where the crust is continental.

Preliminary results of a refraction seismic experiment carried out in Autumn 1989 in the Valencia Trough and adjacent flanks confirm the Bouguer gravity interpretation. In the central part of the Valencia Trough the crust is about 15 km thick. The depth to Moho increases to approx. 25 km close to the Balearic Promontory, and 20 km towards the Iberian Peninsula. The gravity and seismic results are presented and the tectonic evolution of the area discussed.

G-I2

Sur l'Age et l'Origine des Bassins de la Méditerranée Occidentale

Alain COUTELLE

UBO, Département des Sciences de la Terre, URA du CNRS n°1278, Brest (France)

Observées à petite échelle, les relations entre la Méditerranée et la chaîne alpine paraissent présenter tous les cas possibles :

- à l'extérieur de la chaîne : cas de la Méditerranée orientale, de l'Adriatique, du Golfe de Valence, du Bassin provençal ;
- à l'intérieur de la chaîne : cas de la Mer Tyrrhénienne, de la Mer d'Alboran et du Bassin nord-algérien ;
- selon une transversale, cas de la Mer Egée, de la Mer Ligurienne.

Il ne faut donc pas s'étonner qu'il n'existe pas d'accord entre les auteurs concernant les rapports entre l'orogène alpin et la formation des bassins méditerranéens. Ceci est particulièrement net dans le cas de la Méditerranée occidentale qui nous retiendra maintenant.

Pour L. GLANGEAUD (1957), la filiation entre les bassins actuels et les mers anciennes était directe. Par exemple, la Mer d'Alboran faisait partie d'une "néo Téthys" qui avait pris la suite de la Téthys mésozoïque après un épisode de bouleversement temporaire créateur d'un "tectorogène biliminaire" à l'origine des chaînes maghrebines et rifaines. C'est au cours de cet épisode que le sillon téthysien s'est "vidé", par écoulement latéral, de son contenu sédimentaire de flyschs.

Une autre conception, plus moderne, consiste à assimiler le sillon "téthysien" à la fosse externe d'un arc insulaire implanté sur les domaines à socle de type rifo-kabylo-péloritain. Dans ce schéma, l'édifice alpin maghrébo-sicilien - et même apenninique, si l'on rattache le bloc corso-sarde à ces massifs - serait l'analogue d'un prisme d'accrétion et les bassins tyrrhéniens et nord-africain correspondraient à un bassin arrière-arc. La création de ces bassins serait, dans cette hypothèse, génétiquement liée et synchrone de la tectogenèse alpine régionale. Proposé une première fois par F.C. WEZEL (1970), ce modèle a ensuite été étendu par J.M. AUZENDE, J. BONNIN et J.L. OLIVET (1973), suivis par de nombreux auteurs, en particulier par J.P. REHAULT, G. BOILLOT et M. MAUFFRET (1984).

Ces vues, toutefois, ne font pas l'unanimité et dès 1973, J. AUBOUIN a formulé des réserves sur ce type d'interprétation, en particulier à propos du synchronisme qu'elles impliquent entre la tectogenèse alpine et l'ouverture des bassins. Les faits de terrain montrent, en effet, que la formation des bassins est postérieure à la tectonique qui affecte les unités alpines. Comme l'essentiel de la structuration est acquise au cours du Miocène, entre le Burdigalien et le Tortonien, le creusement des bassins intra ou trans- chaîne alpine ne peut être que plus tardive. Il semble ainsi exclu de faire descendre l'âge du remplissage subhorizontal du bassin algérien jusqu'à l'Oligocène (LE PICHON, PAUTOT, AUZENDE, OLIVET, 1971) alors que son soubassement est cisaillé par des contacts tortoniens.

Bien entendu, des retouches tardives sont tout à fait possibles, comme le montrent les glissements gravitaires, dirigés par le plaine du Fer à Cheval où vers la Mer Ionienne. Il est clair aussi que des bassins situés à l'extérieur de la chaîne alpine peuvent être plus anciens que le Miocène. Ce serait le cas, par exemple, d'une partie du Bassin provençal, dont l'âge peut remonter aux temps secondaires (COUTELLE, OLIVET, LE CANN, PAUTOT, 1986).

D'autres objections peuvent être formulées. Elles concernent - l'assimilation du volcanisme littoral d'Afrique du Nord à un volcanisme d'arc typique des zones internes, ce qu'il n'est pas, - l'assimilation du sillon des flyschs maghrébins à la fosse externe de l'arc supposé, ce qui n'est - au moins-pas démontré (COUTELLE, DELTEIL, 1989) et-l'incompatibilité de fond entre la dynamique alpine et celle des dérives continentales. La première voit l'alternance des phases de tectogenèses brèves et intenses avec de longues périodes distensives. La seconde est, au contraire, lente, régulière et continue.

AUBOUIN, J., 1973 .- Obs. et Com. à la note de OLIVET, J.L., AUZENDE, J.M. et BONNIN, J. *Bull. Soc. géol. France*, 7e sér., t. XV, p. 112.

COUTELLE, A., DELTEIL, J., 1989 .- La suture alpine en Méditerranée occidentale. Remarques sur une synthèse récente et rappel d'une autre conception. *Bull. Soc. géol. France*, 8e sér., t. V, p. 859-863 et 866-867.

COUTELLE, A., OLIVET, J.L., LE CANN, C., PAUTOT, G., 1986 .- Le bassin liguro-provençal. Précisions sur la structure du bassin profond, essai de synthèse morpho-géologique, conséquences sur les modalités de la dérive du bloc corso-sarde. *III Congr. Ass. plén. CIESM*, Palma de Majorque, 20-25 Octobre 1986, Rapp. P.V. Réun., vol. 30, fasc. 2, p. 74.

GLANGEAUD, L., 1957 .- Essai de classification géodynamique des chaînes et des phénomènes orogéniques. *Rev. Géogr. Phys. Géol. dyn.*, 2e sér., vol. I, fasc. 4, p. 200-220.

LE PICHON, X., PAUTOT, G., AUZENDE, J.M., OLIVET, J.L., 1971 .- La Méditerranée occidentale depuis l'Oligocène. Schéma d'évolution. *Earth Planet. Sc. Letters*, vol. 13, p. 145-152.

REHAULT, J.P., BOILLOT, G., MAUFFRET, A., 1984 .- The western mediterranean basin geological evolution. *Marine Geology*, vol. 55, n° 314, p. 447-477.

WEZEL, F., 1970 .- Interpretazion dinamica della "eugeosinclinale" mesomediterraneo. *Riv. Min. Sicil.*, anno 21, n° 124-126, p. 124-126.

Holocene Evolution on the Septentrional Catalan Shelf

Gemma ERCILLA and José I. DIAZ

Instituto de Ciencias del Mar, C.S.I.C., Paseo Nacional s/n 08003 Barcelona (Spain)

The septentrional sector of the catalan continental shelf is characterized by an irregular width, and narrow and deeply incised submarine canyons (Cape Creus and La Fonera) (Stanley et al.,1976). The shelf is narrow (6-19 km) in front of onland structural highs (Pyrenaic Axial Zone and Bagur Massif), showing a rocky and abrupt coast line; while is wide (17-30 km) in front of the onland Neogene depressions (Bajo and Alto Ampurdán), where Fluvia, Muga, and Ter rivers develop deltas, and longitudinal beaches are predominant. The shelf break is gentle and is located around 150 m waterdepth. Dominant oceanographic processes are waves from storms generated in the nearby Gulf of Lyon, a N-S general current regime, and a clockwise geostrophic flow in the Gulf of Rosas.

The sedimentological analysis of surficial samples reveals three types of sediments: a) terrigenous gravels and coarse-to-medium sands (-2.80 Ø - 1.25 Ø mean) on the abrupt coasts, and medium-to-fine terrigenous sands (1.21 - 2.57 Ø mean) on the longitudinal beaches; b) finnig-offshore muds with a terrigenous sand fraction, on inner and middle shelf prodelta areas (4 Ø - 9 Ø mean), and on the north sector (5 Ø-7 Ø mean); and c) coarsening northwards palimsest sediments (7 Ø - 3 Ø mean) on the outer shelf, having a mainly terrigenous sand fraction, with bioclastic components (35-45%).

The core (up to 1.5 m long) stratigraphy suggests two main types of transgressive sequences (Fig. 1). 1) coarsening-, and fining-upward sequences in the prodelta areas, well correllated with the high-resolution seismic facies (Díaz and Ercilla, 1989). These sequences represent muddy deposits with thin intercalations of sandier horizons whose number and thickness decreases toward the distal prodelta, where only mud is found. 2) fining-upward transgressive sequences, offshore the prodelta areas. These transgressive sequences show an erosional basal contact and are composed (from bottom to top) of: shell fragments and other bioclastic (bryozoans, serpulids crusts) on a muddy matrix and fining upwards sands, sometimes grading to shelf muds.

Sedimentary processes, that have dominated on the septentrional catalan shelf during the Holocene, record the interaction of terrigenous input from several river sources and the local oceanographic conditions. The sedimentary processes are responsible for the present surficial sediment distribution: Holocene sediments on the inner and middle shelf, and palimsest sediments (Pleistocene deposits mixed with the modern sediments) on the outer shelf. The main active sedimentary processes are: 1) longshore drift and offshore downwelling bottom flows, that distribute the coarse sediments in a narrow sand belt parallel to the coastline; 2) advection of fine-grained river-carried sediment, that is distributed by the general current regime, forming the prodeltas across the inner and middle shelf; 3) resuspension of fines by storm waves and gravity-induced processes and their deposition offshore the prodeltas areas; and 4) escape of fine-grained sediment from the Gulf of Lyon, that mainly contributes to the muddy covering on the northern shelf sector.

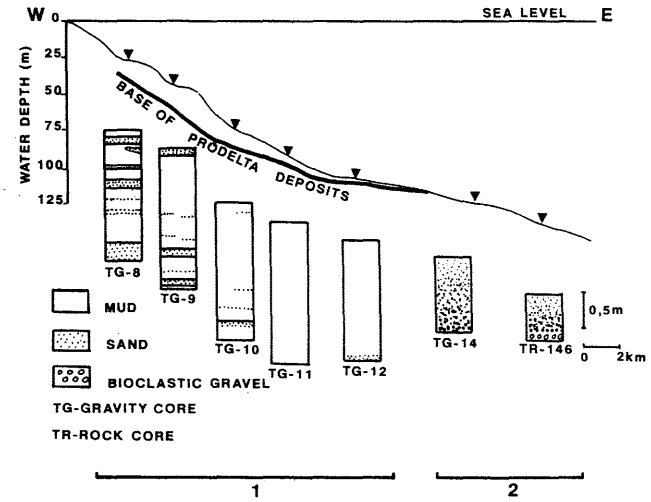


Figure 1.- Types of transgressive sequences on the septentrional catalan shelf: 1) coarsening-, and fining-upward sequences in prodelta areas, and 2) fining-upward transgressive sequences, offshore the prodelta areas.

REFERENCES

DIAZ, J.I. AND ERCILLA G.,1989. Holocene prodeltaic depositional history in the gulf of Rosas, Northwestern Mediterranean Sea. AAPG Annual Convention, 1990, (in press).

STANLEY D.J., GOT H., KENYON N.H., MONACO A. AND WEILER Y., 1976. Catalonian, eastern Betic, and Balearic margins: structural types and geological recent foundering of the western Mediterranean basin. Smithson Contributions to the Earth Sciences. Number 20, pp 1-29

Relative Sea-Level Oscillations and Depositional Patterns on the Ebro Distal Continental Margin : Plio-Quaternary Evolution

Belen ALONSO and Andrés MALDONADO

Instituto de Ciencias del Mar, C.S.I.C., Paseo Nacional s/n 08013 Barcelona (Spain)

The Plio-Quaternary deposits of the Ebro distal margin are developed over a major boundary, Reflector M of Messinian age. This reflector was eroded when most of the margin was subaerealy exposed due to the sea level drops of the Messinian salinity crisis. The sedimentary sequences, above Reflector M, define four major environments (shelf, slope, base-of-slope, basin floor) corresponding to several systems tracts related to major sea level oscillations. Lowstand and highstand systems tracts are differentiated on the basis of reflectors characteristics, unit geometry and interpreted depositional environment. Information from piston cores samples and boreholes from the oil industry and DSDP Site 122 complement the identification of depositional units, and allow for a time framework to correlate with global eustatic sea level oscillations (Ryan, Hsü et al., 1973; Garcia-Siñeriz et al., 1979; Alonso and Maldonado, 1990; Dañobeitia et al., 1990).

Lowstand systems tracts are characterized basinward by shelf margin deltas near the shelf edge, thick slope muds on the slope, and channel-levee complexes, base-of-slope aprons and interchannel deposits at the base-of-slope region. These deposits, accounting for most of the stratigraphic thickness of the Quaternary sequence show a stratigraphic continuity of seismic reflectors between these two provinces that may represent a contemporary deposition (Fig. 1). The most active growth periods of the distal margin occurred during intervals characterized by relative sea-level falls, similarly to siliciclastic turbidite deposits throughout the geological record. Slope deposits are largely related with shelf-edge spillover and distal prodelta high density flows on the upper slope, with gravity-driven nepheloid flows on the middle slope, and with turbidite and mass-flows on the lower slope (Baraza, 1989). The base-of-slope deposits were also developed during these periods of low-sea stands and they are associated with two styles of deposition: (1) flushing of sediments from river discharge, outer shelf and upper slope environments trough slope canyons, to base of slope channel-levee complexes, and (2) with unchannelized mass flow processes, from slope mass-failure in areas of unstable slope terrain resulting in the base-of-slope aprons (Alonso and Maldonado, 1990). The highstand systems tracts are characterized at the slope and base of slope by volumetrically less important stratified facies developed by hemipelagic processes over most the distal margin, although some transparent, high energy facies of the base-of-slope aprons may also occurs. These deposits were developed during the latest rising segment of the eustatic curve, high sea level stand and initial sea lowering (Fig. 1).

We can identify four epochs in the growth patterns of the distal Ebro margin during the Plio-Quaternary (Fig. 1): (A) during the "salinity crisis" the emergence of the Ebro margin allows the carving of extensive erosional surfaces and the by-passing of sediments to the distal basin plain; (B) the Pliocene flooding of the Mediterranean Sea after the Messinian time, and generalized global eustatic high sea level favoured the development of depositional units characterized by shallow marine facies in the fluvial valleys and a drape of fine-grained deposits (Ebro Clays) over most of the continental margin, corresponding to a highstand systems tract (C) the generalized lowering of sea-level of the Late-Pliocene displaced the sediment supply from Ebro River to the distal margin, developing a new drainage system with canyons and channels above the lower sequence, and initiates a lowstand systems tract; and (D) the subsequent eustatic-climatic oscillations of the Late Pliocene-Quaternary time have controlled the deposition of sequences represented by slope wedges, channel-levee complexes and base of slope aprons, alternating with low energy, sediment drape units that represent respectively low and highstand systems tracts.

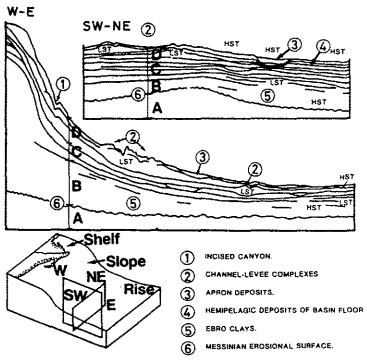


Figure 1. Lowstand (LST) and highstand (HST) systems tracts and four epochs (A,B,C,D) in the growth patterns of Ebro distal continental margin.

REFERENCES

ALONSO, B. AND MALDONADO, A., 1990. Late Quaternary sedimentation patterns of the Ebro turbidite systems (Northwestern Mediterranean): two styles of deep-sea deposition. In: C.H. Nelson and A. Maldonado (Eds), Northwestern Mediterranean Sea. Mar. Geol., (in press).

BARAZA, J., 1989. Procesos de edificación y caracteristicas geotecnias del talud continental del Ebro. Doctural Thesis, U.P.C., 471 pp.

DAÑOBEITIA, J.J., ALONSO, B. AND MALDONADO, A., 1990. Geological framework of the Ebro continental margin and surrounding area. In: C.H. Nelson and A. Maldonado (Eds), Northwestern Mediterranean Sea. Mar. Geol., (in press).

GARCIA-SIÑERIZ, B., QUEROL, R., CASTILLO, F. AND FERNADEZ, J.R., 1979. A new hydrocarbon province in the western Mediterranean. 10th World Petr. Congr., Bucarest, p. 191-197.

RYAN, W.B.F., Hsu, K.J. et al., 1973. Initial reprts of the Deep Sea Drilling Project, XIII. U.S. Print. Office, Washington. 1447 pp.

G-I5

Evidence for Slope Instability on the Iberian Mediterranean Margin (Mazarron Scarpment)

Victor DIAZ-del-RIO* and Ramon VEGAS**

*Centro Oceanografico de Fuengirola, Fuengirola (Spain)
**Facultad de Geologia, Universidad Complutense, 28033 Madrid (Spain)

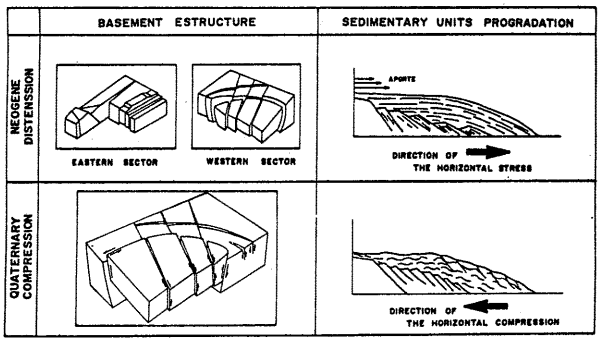
The structural configuration of the acoustic basement infered from seismic-reflection profiles (Sparker 1.500 and 8.000 joules), show the evidence in the existence of a faulted network displaying a special geometry, where the grabens and horsts are alternated in the margin, as a result of the geological evolution that tooke place in the area during Upper Miocene, Pliocene and Quaternary periode (Díaz-del-Río, 1989).

The detailed morphology and structure of the surveyed area, seems to indicate the development of two combined faulted system, oriented into two main directions: W-E to SW-NE and NW-SE. Tectonic activity during pre-Neogene has exerted an important influence on the relief of the acoustic basement surface. These topographic features have been mantained during later tectonic processes on Neogene-Quaternary times, imposing the depositional axis on the basins, in the places where the grabens was formed (Somoza, 1989).

In the western sector, by the other hand, the main faults are running parallel to the coast line, and this particular phenomena determine a steplike basal geometry. For this reason, the thicknes of the sedimentary bodies are increasing seaward, showing its maximum out of the shelfbreak on the continental slope. As a result of the basement structure, this zone of the margin turn out highly comportmentalised (Vegas, 1986), in a E-W direction, as well as in NNW-SSE direction. The geological processes envolved in the Neogene-Quaternary history, includes two main factors: (1) Tectonic activity (ancient and recent) and, (2) sedimentological imput. There is a third factor inherent in the recent evolution of the Western Mediterranean that is "glacioeustatic factor" being the one that determines the succession of different depositional units in the upper sedimentary bodies composing the margin.

Recent tectonic activity and relative movements of basal blocks (vertical, horizontal and others), have been the origin of certain gravitational slumping observed in the litoseismic serie composing the continental slope and shelfbreak. These morphological irregularities should have been generated under a tectonic distenssion regime, which turns to a compression one.

In this general structural framework, the depositional units could break away along a discontinue surface caused by the heterogeneity of the beds. This is the reason why there is a high variety of submarine relief shapes (uneven bottom, scars, submarine valleys, ...etc), the evolution of which are in relation with the following factors: (1) water depth; (2) hydrodinamic conditions and, (3) sedimentary texture.



REFERENCES

DIAZ-DEL-RIO, V. 1989. Morfología, formaciones superficiales y evolución reciente del margen continental en la región del Cabo de Palos (entre el Cabo Tiñoso y el Cabo Cervera), SE de la Península Ibérica. Tesis Doctoral. Universidad Complutense. 358 pp.

SOMOZA, L. 1989. Estudio del Cuaternario litoral entre el Cabo de Palos y Guardamar del Segura (Murcia-Alicante): Las variaciones del nivel del mar en relación con el contexto geodinámico. Tesis Doctoral. Universidad Complutense.

VEGAS, R. 1986. Tectónica del área Ibero-Mogrebí. En: Mecanismo de los Terremotos y Tectónica. Editores: A. Udías, O. Muñoz y E. Buforn. Publicaciones Editorial de la Universidad Complutense.

G-I6

Microtidal Influence in the Ebro River Salt Wedge (Northwestern Mediterranean)

J. GUILLEN, A. PALANQUES, J. CAMP and J.-I. DIAZ

Instituto de Ciencias del Mar, C.S.I.C., Pso Nacional s/n 08003 Barcelona (Spain)

Introduction

In many of the Mediterranean rivers a salt wedge intrudes up to several kilometers upstream from their mouths, at least during periods of low water discharge. Presence of the salt wedge is controlled basically by the freshwater discharge of the river. The landward limit of the salt wedge changes with the flow variations. In this work we study the tidal influence and the dynamic behavior of the salt wedge in the lower part of the Ebro River.

Tidal range

Tidal data in the Ebro Delta show a microtidal range, with diurnal and semi-diurnal components. Resulting daily tidal oscillations have two very asymmetrical cycles (Fig. 1). The mean tidal range between the higher-high and lower-low tide is 20 cm while the tidal range between the lower-high and the higher-low tide is 7 cm.

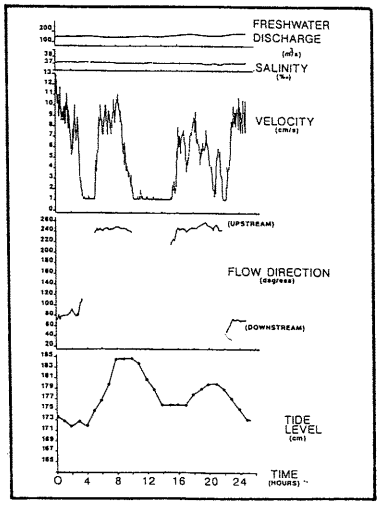


Fig. 1.- Relationships between freshwater discharge, salinity, current velocity of the salt wedge, flow orientation and tide level during the field experiment.

Field Experiment

Five hydrographic cruises were carried out along 30 km upstream from the river mouth in May 88, September 88, January 89, July 89 and October 89. Salinity, temperature and current profiles were recorded systematically in three sections of the river and at the upper limit of the salt wedge. An AANDERAA RCM8 currentmeter was installed 1 meter above the river bed and 3 km upstream from the river mouth on October 4th and 5th of 1989. During these days there were under estuarine conditions and a very steady freshwater discharge controlled by the river dams. Data of current velocity, flow orientation, salinity and temperature were recorded with a sample interval of 2 minutes.

Results

Estuarine conditions in the Ebro River are reached when freshwater discharge is lower than 500 m^3/s. Landward limit of the wedge intrudes more than 30 Km upstream from the river mouth when freshwater flow is lower than 100 m^3/s. The upper limit of the salt wedge in the Ebro River is also controlled by the bed morphology, especially by the topographic high located near Gracia Island, 17 Km upstream from the river mouth. This high stops the upstream salt wedge intrusion until the freshwater discharge is lower than about 150 m^3/s. Velocities in the freshwater layer during estuarine conditions increase downstream from 20 cm/s near the upper limit of the wedge to 80 cm/s in the river mouth, because of the thickness decrease of this layer downstream.

Daily distribution of currents in the salt wedge show two intervals with an upstream orientation (250°N) and one interval with a downstream orientation (70°N) separated by still flow periods. Current velocity ranges from less than 1.1 cm/s (lowest detectable speed by the used currentmeter) to 13 cm/s.

These results are correlated with the daily tidal cycle (Fig. 1): High tide periods correspond to the upstream salt wedge motion. The higher-high tide produces upstream mean flow velocities of 9 cm/s and the lower-high tide generates upstream mean velocities of 5 cm/s in the salt wedge. Downstream salt wedge motion is correlated with the lowest tidal level. Downstream mean velocities are of 9 cm/s, which is similar to the velocities recorded during the high tide level period. Still flow periods correspond to the higher-low tide level and to the intermediate phases between low and high tidal levels.

Conclusions

In microtidal areas, the circulation pattern of salt wedge intrusions in rivers is controlled mainly by tides when freshwater discharge conditions are steady. In the Ebro River, salt wedge motions reflect the diurnal and semi-diurnal components of the mixed tide that affects the Ebro Delta area. Mean upstream-downstream flow velocities in the salt wedge are also related to the tide level.

The Effects of Damming and Recent Climatic Changes on the Sediment and Water Discharge of the Ebro River (Northwestern Mediterranean)

Albert PALANQUES, Jorge GUILLEN and Jordi CAMP

Instituto de Ciencias del Mar, C.S.I.C., Paseo Nacional s/n 08003 Barcelona (Spain)

The Ebro River is one of the most important fluvial systems that discharge into the Northwestern Mediterranean Sea. During the last few centuries this fluvial system has been greatly affected by human activities. Deforestation of its drainage basin became very intense from the 15th century onwards, making the deltaic system prograde very rapidly. Construction of irrigation systems became important at the end of the 19th century and the beginning of the 20th century and in addition, many dams have also been built during this century. These facts have dramatically changed the sediment dynamics and the hydrodynamics of this fluvial system. The area most affected by this changes is the lower part of the river and especially the delta and the river mouth, where the marine-fluvial interaction controls the evolution of the delta.

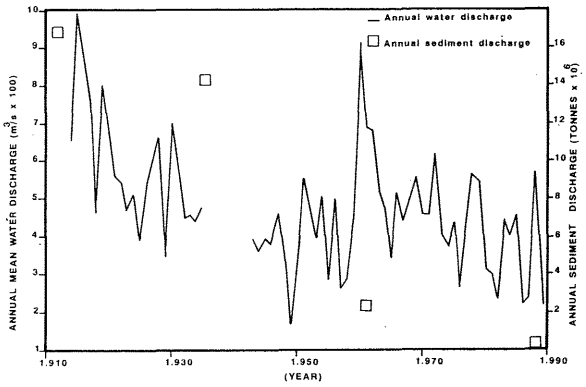


Fig.1. Annual Water and sediment discharge of the Ebro River during the 20th century

The water discharge of the Ebro river is quite irregular during the year. The annual distribution of water discharge in the lower part of the river shows that the higher values occur between November and March and the lower values in summer. During this century the annual mean water discharge of the Ebro River has been very irregular. Maximum mean water discharge was 992 m³/s in 1915 and the minimum was 165 m³/s in 1949. The mean distribution shows a decreasing trend from 1914 to the present with some stages of high water discharge. These stages correspond to 1915 and 1960. Another stage may have taken place in 1937 when a strong flood led to a change in the location of the river mouth. Unfortunately there are no data for the end of the thirties. The decreasing trend in the annual water discharge has been quite continuous from 1960 to the present. The eighties have been especially dry years. In 1982, 1986, 1987 and 1989 the mean was lower than 250 m3/s. The decreasing trend in annual mean water discharge can be attributed to the human management of the river water and to climatic changes. Dams have also contributed to mitigate the river floods. Floods of more than 3000 m3/s took place before the construction of the dams, but after the regulation of water discharge induced by the dams, these big floods have ceased to occur.

Historical data allow the estimation of sediment discharge in the late 19th century. In 1891, before the construction of the dams, suspended load transported by the river was about 25x10^6 tons per year. Like the water discharge, the transport of suspended sediment without river damming was quite irregular during the year. During the higher water discharge floods, the river could transport more than 10^6 Tm/day. Between 1906 and 1930, some significant dams (200 Hm³) were built in the upper part of the Segre River and several small capacity reservoirs (0.3-28 Hm³) were built in some of the Ebro River tributaries. The average amount of suspended sediment transported by the river decreased to 17x10^6 tons per year in 1911 and to 14x10^6 tons per year in 1935. A really significant reservoir was not constructed until the forties, when the Ebro dam (540 Hm³) was built in the upper part of the river. During the forties and the fifties several reservoirs with a capacity ranging from 50 to 200 Hm3 were constructed. In 1959 another important dam, the Yesa dam (470 Hm³) was located in the upper part of the Aragon River (one of the most important tributaries of the Ebro River). At the beginning of the sixties, the amount of suspended sediment discharged by the river was 2.2x10^6 tons/year. The largest dam in the Ebro system (the Mequinenza dam) was built in the lower part of the river in 1966. The Mequinenza dam has a capacity of more than 1000 Hm³. In 1969 the Ribarroja dam (136 Hm³) was built a few kilometers downstream of the Mequinenza dam. In 1968 another important dam was constructed in the Cinca River, the Mediano dam, whose capacity is 436 Hm³. During the eighties the Ebro river discharged only between 120.000 and 150.000 tons per year (Fig.1). This means that at the present time the Ebro River is discharging into the Mediterranean less than 1% of the suspended sediment that this river discharged into the sea before the construction of the dams (Palanques, 1987; Palanques et al., 1990).

This huge reduction of the sediment input is mainly the result of the accumulative sediment retention in each of the dams built along the Ebro river and its tributaries and it is also the result of the location of the Mequinenza and Ribarroja dams. These dams are located only a few kilometers upstream of the delta and they retain more than the 75% of the suspended sediment input and the totality of the bed load input that they receive (Palanques, 1987, Palanques et al., 1990). The decrease of the river water discharge also contribute to the reduction of the river sediment discharge. Moreover, dams prevent the big floods that could transport huge amount of sediment to the sea. At present, the Ebro river discharges mainly very fine sediment to the marine environment, the bed load transported along the lower part of the river is insignificant and the Ebro delta coast receives practically no sand sediment supplies from the river so the action of the marine processes on the delta coast dominates the present evolution of the delta. It is not possible to interpret the geological record of the recent Ebro sedimentary deposits from present day river conditions.

REFERENCES

PALANQUES A., 1987. Dinámica Sedimentaria, Mineralogía y Micro-contaminantes Inorgánicos de las Suspensiones y de los Sedimentos Superficies en el Margen Continental del Ebro. Unpublished Ph.D. Thesis. Ciencias del Mar. U.P.C., 475 pp.

PALANQUES, A., PLANA, F., MALDONADO, A. Recent influence of man on Ebro margin sedimentation system (Northwestern Mediterranean sea). In: C.H. Nelson and A. Maldonado, (editors), Marine Geology of the Ebro Continental Margin, Northwestern Mediterranean Sea. Marine Geology.(in press).

Biofaciès Margino-Littoraux de la Méditerranée Occidentale (Baléares et Valence-Alicante-Murcie) Espagne

G. MATEU* et M.-J. VINALS**

*Instituto Espanol de Oceanografia, Palma de Mallorca (Espana)
**Departamento de Geografia, Universidad de Valencia (Espana)

En Méditerranée Occidentale, tant sur l'Ile de Majorque que sur le littoral péninsulaire (Murcie, Alicante et Valence), d'importantes formations lacustres du Néogène-Quaternaire offrent d'intéressants biofaciès margino-littoraux incluant des organismes dont les biotopes oscillent entre les eaux douces et les eaux supersaturées.

Pour l'Ile de Majorque préorogénique (Burdigalien inférieur) l'existence de lagunes paraliques est confirmée par la présence de biocénoses chaudes et euryhalines, alors que le lacustrisme post-orogénique des Baléares doit être rapporté aux processus régressifs finimiocènes et surtout à ceux dépendant de la grande crise messinienne de salinité dans toute la Méditerranée (COLOM, 1985).

Le sondage, de 350 m de longueur, à l'intérieur de l'Albufera de Alcudia (Majorque) nous offre une paléo-biologie tortono-messinienne, dont le caractère nettement marin (*Marginulina costata, Cibicides pseudoungerianus*, etc. et dans les formes planctoniques *Globorotalia mediterranea, Turborotalia acostaensis, Globigerinoides obliquus*, etc.) cède la place à des niveaux riches en espèces littorales (*Ammonia beccarii, Florilus boueanus*, etc.). Sur ces faciès, repose un niveau de Charophytes, Ostracodes euryhalins et cristallisations de gypse syngénétique, typique d'un milieu polyhalin et tendant à une haute salinité.

Cet épisode paralique finimessinien, régressif et interinsulaire, atteint 30 m de puissance sédimentaire et paraît contemporain de l'intervalle entre la fermeture des "canaux" bétique et morafricain et l'ouverture origopliocène du Détroit de Gibraltar.

C'est entre -183 et -110 m du sondage qu'apparaît une faune planctonique riche en Foraminifères, avec plus de 60 espèces parmi 6000 individus (MATEU, 1982) qui indique l'incursion d'une microfaune atlanto-ibéro-africaine (*Sphoeroidinellopsis seminulus, Globorotalia margaritae, Globorotalia puncticulata*, etc.) à travers le nouveau Gibraltar.

Dans le Pliocène médio-supérieur, et précisément pendant le Plaisancien, se consolide l'écosystème lacustre, marginolittoral de Majorque, avec *Ammonia tepida, Chara* sp. et *Hydrobia* sp. etc. qui, tant dans le marais d'Alcudia que dans les autres zones humides de la moitié sud de l'île est lié à la fluctuation quaternaire de la ligne de côte au colmatage progressif alluvial du "canal central de Majorque" et à la régulation de ces aquifères.

Les zones lacustres de Majorque (Baléares) aussi bien que celle de Valence-Alicante-Murcie se trouvent dans les rades d'âge Postmiocène, sur un substrat Méso-cénozoïque, plissé pendant l'orogénie alpine, avec des plissements et des failles d'orientation bétique (NE-SO).

Ces biofaciès margino-littoraux des îles de la Péninsule, évoquent non seulement les anciens écosystèmes "Lago Mare", comparables aux actuels de la Mer Noire (TUFESCU, 1974), mais aussi les unités Pleisto-holocènes du littoral de Valence (Pego), Murcie (Mar Menor) et Majorque (Albufera de Alcudia, Salobrar de Campos) ; malgré le tectonoglacioeustatisme quaternaire, (RIO *et al.*, 1987 etc.), tous ont des associations de biocénoses margino-littorales méditerranéennes (LEVY, DUPRE *et al.*, 1988, MATEU, 1989, etc.)

Références bibliographiques

COLOM (G.), 1985.- Estratigrafia y Paleobiologia del Andaluciense y del Plioceno de Mallorca (Baleares). *Bol. Geol. Min.* T., XCVI.III, pp. 235-302.

DIAZ DEL RIO (V.), MATEU (G.) and REY (J.), 1987.- Intercontinental shelf of Murcia (Mar Menor), Alicante Bay, Gulf of Valencia and Palma (Balearic Island). In Late *Quaternary Sea-level Changes* : Edit C. Zazo, p. 176.

DUPRE (M.), FUMANAL (M.-P.), SANJAUME (E.), SANTISTEBAN (C.), USERA (J.) and VINALS (M.-J.), 1988.- Quaternary evolution of the Pego coastal Lagoon (SE, Valencia, Spain). *Palaeogeogr. Palaeoclimar. Palaeogeology*, 68, pp. 291-299.

LEVY (A.), 1984.- Les associations margino-littorales de Foraminifères et d'organismes associés de quelques gisements quaternaires du site de l'Oued El Akarit (Sud Tunisien). *Benthos*, 83, pp. 361-367.

MATEU (G.), 1989.- Sondeo de l'Albufera de Pego (Valencia) : Micropaleontologia y Biofacies, (Valencia).*Cuad. geogr.* 45, pp. 1-9.

MATEU (G.), 1982.- El Neogeno-pleistoceno de Mallorca. *Bol. Soc. Hist. Nat. Baleares*. 26, pp. 75-133.

TUFESCU (M.), 1974.- Populatile de foraminifere dins litorale romanesti pp. 176. Bucuresti.

G-I9

Caractère de la Sédimentation sur le Plateau Continental de Mostaganem (Golfe d'Arzew, Algérie)

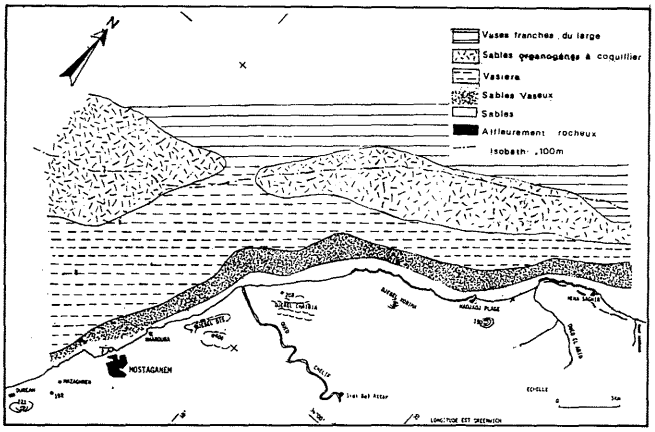
Farid ATROUNE

Laboratoire de Géologie Marine, I.S.T./U.S.T.H.B., B.P. 32, El-Alia, Alger (Algérie)

Du point de vue strictement sédimentologique, la plate-forme devant Mostaganem est caractérisée par une couverture essentiellement vaseuse. L'étude s'appuie sur l'analyse d'une centaine de prélèvements de benne (type Van Veen) répartis au travers de la plate-forme, dans un domaine situé de part et d'autre d'une importante alimentation en éléments fins issus de l'Oued Chelif.

Les prélèvements ont fait l'objet d'analyses sédimentologiques classiques et micropaléontologiques (Ostracofaune).

Nous distinguons sur la Figure I, les différents faciès qui ont fait l'objet d'une étude détaillée.



Le secteur littoral est exclusivement occupé de sable (courbe unimocale); ces sables s'enrichissent progressivement vers le large en éléments fins qui atteignent à -40 mètres plus de 90% de pelites. Pour rendre compte de la présence d'une fraction fine, ALOISI *et al.* (1975) font intervenir un dépôt rapide provoqué par les réactions physico-chimiques à l'interface. Seule la floculation permet d'expliquer l'hétérogénéité du matériel qui participe au dépôt ; des exemples sont également fournis (MONACO, 1971 ; PAUC, 1970) dans le golfe du Lion et à l'embouchure du Grand Rhône.

Dans le secteur externe du plateau, les travaux de CAULET (1970) décrivent le faciès bioclastique comme un sable organogène à coquillier (courbe plurimodale), l'analyse de ces sédiments (sup. à 50% de carbonates) nous a conduit à observer les fractions principales suivantes : débris bioclastiques, Algues calcaires, Bryozoaires Echinodermes, spicules d'Eponges.

Au large, les vases franches sont caractérisées particulièrement par la présence de glauconie, minéral typiquement marin qui se rencontre le plus souvent à la base des formations transgressives (MONACO, 1973).

Les Foraminifères (fort pourcentage) et les Ostracodes nous permettent de bien différencier la vasière des vases franches du large (BAKIR, Thèse en cours)

Références bibliographiques

ALOISI (J.-C.), MONACO (A.) & PAUC (H.), 1975.- Mécanisme de la formation des prodeltas dans le Golfe du Lion. Exemple de l'embouchure de l'Aude (Languedoc). *Bull. Inst. Géol. Bassin Aquitaine,* 18, pp. 3-12.

BAKIR (M.).- Etude des Ostracodes dans le Golfe d'Arzew. *Thèse en cours.*

CAULET (J.), 1972.- Les sédiments organogènes du Précontinent Algérien. Thèse d'Etat, Université de Paris, *Mémoires Muséum, Paris*, 25, pp. 1-289.

MONACO (A.), 1971.- Etude minéralogique des Argiles fluviatiles du Rousillon. *Bull. BRGM*, IV, 1, pp. 33-45.

MONACO (A.), 1973.- Présentation de la carte lithologique des dépôts superficiels du plateau continental du Rousillon et des Albères (Golfe du Lion), *Rapp. Comm. int. Mer Médit.*, 21, 11, pp. 827-829.

PAUC (H.), 1970.- Contribution à l'étude dynamique et sédimentologique des suspensions solides à l'Embouchure du Grand Rhône (Gram de Roustan). *Thèse 3e Cycle*, Montpellier-Perpignan, 126 p.

G-I10

Apports détritiques de l'Oued Isser et le rôle du Canyon de Zemmouri El Bahri dans la dynamique des sédiments du Plateau Ouest-Algérois

Hanifa BENSLAMA

IST/USTHB, B.P. 32, El-Alia, Alger (Algérie)

La baie de Zemmouri El-Bahri se situe à l'Est immédiat de la baie d'Alger. Très largement ouverte vers le Nord, elle s'étale sur une cinquantaine de kilomètres . Elle est limitée à l'Ouest par le cap Matifou, massif cristallophyllien, et à l'Est par le cap Djinet, massif éruptif basaltique.

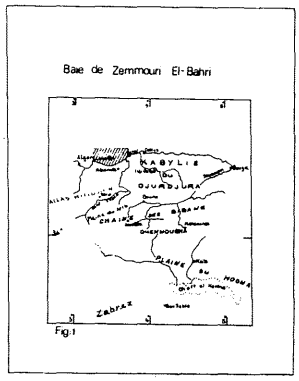


Fig.1

L'oued Isser constitue son principal tributaire (fig.1). Le plateau continental, très étroit, occupe entre 2 et 6 km de largeur. Il est entaillé par des canyons sous-marins fortement encaissés, comme les canyons de Zemmouri et du cap Blanc. La carte bathymétrique (LECLAIRE, 1972) montre que les têtes des canyons entaillent très haut le plateau : le canyon de Zemmouri El-Bahri influence largement la topographie jusqu'à 50 mètres (fig.2).

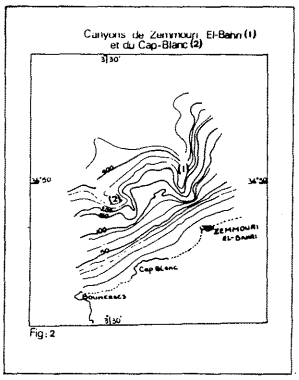


Fig.2

On étudie la répartition des paramètres sédimentologiques autour des têtes de canyons et sur le plateau adjacent.

Le gradient d'envasement s'avère partout extrêmement rapide, surtout autour et dans l'axe des canyons. En particulier, l'envasement dépasse 90 % dès l'isobathe de -20 mètres autour de la tête du canyon de Zemmouri alors que l'environnement sur le plateau adjacent est beaucoup plus silteux (fig.3).

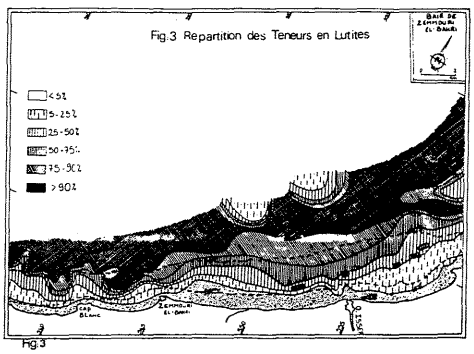


Fig.3

On peut donc penser que le matériel fin, issu en grande partie de l'oued Isser, se concentre dans l'axe du canyon de Zemmouri El-Bahri tandis que le grossier se répartit latéralement. Ces résutats démontrent donc que ce canyon ne joue pas un rôle de transit mais sert de piège aux sédiments par effet d'abri. Il s'agit donc d'une structure tectonique et non d'une morphologie induite par un transit sédimentaire.

REFERENCE

LECLAIRE, L., 1972 . La sédimentation holocène sur le versant méridional du bassin Algéro-baléare. Thèse Univ. Mémoires du Muséum d'Histoire Naturelle, Paris.

Mécanismes hydrosédimentaires en Baie d'Alger (Algérie)

S. BERKANE

Laboratoire de Géologie Marine, I.S.T./U.S.T.H.B., B.P. 32, El-Alia, Alger (Algérie)

L'étude sédimentologique d'une centaine de prélèvements (bennes et carottes) ainsi que des données de matière en suspension ont permis de définir les mécanismes hydrosédimentaires responsables de la mise en place des dépots marins récents à actuels du plateau continental et du talus supérieur de la baie d'Alger (Algérie).

- La synthèse des données sur la distribution des faciès fait apparaitre les traits majeurs suivants :

. Un large envasement , occupant le partie centrale et septentrionale face à la côte basse à partir de -30 m de profondeur de part et d'autre des embouchures des oueds El-Harrach et Hamiz .

. Des formations détritriques plus grossières sableuses à sablo-pélitiques constituent les fonds littoraux à infralittoraux

. Face aux bordures rocheuses qui limitent la baie à l'Est et à l'Ouest , le plateau est réduit . Les dépots côtiers sont représentés par des formations grossières carbonatées , qui se prolongent en digitation vers le centre de la baie jusqu'à 65-70m de profondeur .

Dans ces secteurs l'envasement occupe à l'Ouest , la partie médiane et septentrionale de la plate-forme , à l'Est , la partie médiane du plateau , encadrée par des formations détritiques trés grossières et carbonatées , les sables côtiers et les sables du large du haut fond rocheux de Matifou .

Le caractère dominant de la sédimentation actuelle s'exprime donc par l'existence d'un large envasement dés 30m de profondeur (les dépots comportent plus de 50% de pélites et le plus souvent plus de 95% de part et d'autre des embouchures) . Les minéraux argileux constituent l'essentiel de ces dépots excepté les secteurs où la turbulence est active ; le secteur des embouchures notamment celui de l'oued Hamiz , au niveau des caps et bordures rocheuses .

Ces envasements précoces face aux sources d'apports paraissent homologues aux prodeltas décrits par Aloïsi et Al (1975) dans le golfe du Lion et liés en grande partie à la floculation électrochimique et organo-minérale , qui se produit à l'interface eau douce eau salée .

- Les carottes prélevées en baie d'Alger recoupent presqu'exclusivement la vase grise argileuse holocène à actuelle à taches de monosulfures , indice d'un caractère réducteur dû au contexte local , notamment la morphologie de la baie . Dans le domaine infralittoral , le recouvrement vaseux actuel , dans lequel s'individualisent des niveaux ou nids silteux qui traduisent des changements dans le régime hydrologique et hydrodynamique , possède une épaisseur d'au moins 1m . On peut supposer que les taux de sédimentation au niveau du dépot des prodeltas sont au moins de l'ordre de 0.1 mm/an .

A partir de nos observations , l'épaisseur de cette unité ne semble pas varier suivant un fort gradient des dépots prodeltaiques vers les parties distales .

En effet , dans le domaine circalittoral on peut supposer des vitesses minimales de sédimentation du même ordre (0.1 mm/an). Vers le large (secteur externe du plateau , au large du cap Ouest) l'épaisseur du recouvrement vaseux diminue et les taux de sédimentation ne dépassent pas 0.05 mm/an puisque dans ce secteur on atteint le faciès sables coquilliers préholocène .

Globalement ces estimations qui représentent des taux minimes s'accordent avec les interprétations d'Aït-Kaci et Pauc (1982) en baie de Bou-Ismaïl à l'Ouest d'Alger . En effet dans cette région , où les apports fluviatiles (Oued Mazafran) sont largement plus importants qu'en baie d'Alger , le recouvrement vaseux holocène à actuel présente une épaisseur variable mais généralement faible (moins de 10m).

On peut donc envisager des phénomènes de reprise sédimentaire et d'exportation du matériel vers le bassin , sous l'effet de l'hydrodynamisme local et de la circulation générale .

En conclusion cette étude nous a permis de préciser le fonctionnement physiographique des différents domaines océanographiques de cette région :

- Le secteur physiographique infralittoral central soumis à la dynamique littorale résultante orientée vers l'Ouest est principalement alimenté par les alluvions fines de l'oued El-Harrach.
- Le secteur oriental représente une zone à production carbonatée. On distingue la partie interne et la partie externe . Le secteur interne subit l'influence locale des apports de l'oued Hamiz et une dynamique littorale intense .Le secteur externe est le siège d'une remise en suspension du matériel terrigène et d'une production thalassogène accrue en relation avec les structures turbulentes décrites par Millot (1985).
- Les prodeltas et l'envasement circalittoral correspondent à une zone de stockage alimentée principalement et notamment pour les prodeltas par l'oued El-Harrach .
- Enfin le secteur externe et le talus supérieur Algérois sont alimentés en partie par les particules fines terrigénes qui échappent au secteur interne de la baie . Ces zones sont le siège d'une faible sédimentation terrigène , voir d'une reprise sédimentaire sous l'effet du courant turbulent algérien.

REFERENCES

AIT-KACI,D. et PAUC,H.,1982.La couverture sédimentaire récente en baie de Bou-Ismail.Nature et structure .XXVIIè congrés C.I.E.S.M. Cannes

ALOISI,J.C.,MONACO,A.,PAUC,H.,1975 . Mécanismes de formations des prodeltas dans le golfe du Lion exemple de l'embouchure de l'Aude (Languedoc).Bull.Inst.Geol.Bassin d'Aquitaine , 18 : 3-12.

MILLOT,C.,1985.Some features of the Algerian current. J.Geophys.Res.,90,C4 : 7169-7176.

Rôle de l'Oued de la Soummam dans la Sédimentation argileuse du Golfe de Béjaïa (Algérie Orientale)

Lazreg BENSLAMA

I.S.T/U.S.T.H.B., B.P. 32, El-Alia, Alger (Algérie)

Le Golfe de Béjaïa constitue une large échancrure du littoral entre le Cap Carbon et le massif d'El-Aouana.

Le Plateau continental est réduit, presque inexistant devant les promontoires rocheux du Cap Carbon et de la pointe d'El-Aouana. Il s'exprime entre l'Oued Soummam et l'Oued Djemaa par une étendue de l'ordre d'une dizaine de kilomètres. Il est entaillé par un Canyon très étroit qui remonte jusqu'à 30 m de profondeur au droit de l'Oued Soummam auquel il se rattache. Ce canyon s'estompe et disparaît vers l'isobathe 400.

Sources d'apports et origine du matériel

Au Sud immédiat du Golfe, se dresse brutalement la chaîne des Babors essentiellement constituée de calcaires jurassiques et de formations crétacées. Ces contreforts sont draînés par des cours d'eau très encaissés, à régime torrentiel. Les plus importants sont les Oueds Djemaa et Agrioun. La Soummam est le principal tributaire par la dimension de son bassin versant (8460 Km^2 à Sidi Aïch) et par ses apports liquides et solides. Il draine, par le biais de ses confluents, les Oueds Sahel et Bou-Sellam, les formations bibaniques et les hautes plaines sétifiennes. Il s'achemine vers le golfe par la dépression néogène de la vallée de la Soummam. Le matériel détritique livré à la mer par cet Oued est estimé 4 millions t/an.

Le débit liquide de la Soummam est de 577 Hm^3 (moyenne inter-annuelle sur 20 ans). Il est marqué, comme tous les Oueds Algériens, par le facteur saisonnier ; le cycle annuel comprend 5 mois de crues (décembre à avril), 6 mois d'étiage (juin à novembre) et seulement un mois de débit moyen (mai). Ce facteur saisonnier conditionne les apports fluviatiles. Les charges solides en suspension relevées pour cet Oued à l'embouchure, se répartissent ainsi:

étiage	crue moyenne	crue maximale
7 à 10 mg/l	1,8 g/l	12,7 g/l

Il a été établi un apport solide en suspension en transit à l'embouchure de l'ordre de 0,3 million de t/an. Ce tonnage a été déterminé par extrapolation des résultats obtenus sur l'Oued Mazafran. Il a été tenu compte de la similitude des régimes et du rapport des débits liquides. Le matériel est composé pour moitié de minéraux argileux.

Préparation des échantillons et analyse minéralogique

Après attaque à l'eau oxygénée (30 volumes) durant 2 h. à 60°C, la fraction inférieure à 40 microns est purifiée des matières humiques qu'elle peut contenir ; l'élimination des carbonates est obtenue par attaque à l'HC1 (à 10%). L'échantillon est lavé par centrifugation à l'eau distillée. Il est soumis après ajout de défloculant (Hexamétaphosphate à 0,1%) aux ultra-sons, jusqu'à complète désagrégation. La suspension est alors versée dans une éprouvette au repos pendant une heure ; la prise est effectuée dans le centimètre supérieur et déposée sur une lame. Cette dernière, mise dans une étuve maintenue à 40°C, fournit une lame mince de minéraux argileux orientés qui servira à l'analyse diffractométrique(°).

Les enregistrements des échantillons naturels montrent d'une manière générale, des grands angles de diffraction aux petits angles, un doublet à 3,54 A-3, 58 A, le pic à 3,58 A étant le plus exprimé ; un pic fin et bien développé s'individualise à 7,20-7,12 A. Entre 9,98 A et 14,30 A l'enregistrement est diffus mais il présente un pic à 10 A bien individualisé par sa forte intensité ; quelques pointements soulignent le passage entre ce pic et celui à 14 A légèrement exprimé.Le traitement à l'éthyl-glycol n'amène des changements que dans l'intervalle des petits angles de diffraction ; le pic à 10 A se précise davantage vers 9,95 A, où il devient plus étalé. L'épaulement entre 10 et 14,26 A se resserre autour du pic à 14,18 A et est mieux marqué que sur l'essai naturel.

Il ressort donc une association de minéraux argileux simples : illite, kaolinite, chlorite et un mélange interstratifié-smectite. Nous avons pris en considération pour la présente étude la répartition des teneurs relatives des minéraux argileux majeurs : illite, chlorite et kaolinite.

Répartition des différents minéraux argileux

L'illite est le minéral dominant. Sa concentration est particulièrement élevée devant les Oueds Agrioun, Djemaa et Soummam. Au droit de ce dernier, une zonation se fait dans l'axe du canyon et on note une diminution des teneurs d'amont en aval : de plus de 60% à moins de 40%.

Les teneurs moyennes en chlorite sont comprises entre 25 et 30% et se répartissent sur l'ensemble du plateau entre -20 et -100 mètres de fond. Au-delà de la bordure du précontinent, les concentrations sont voisines de 20% sauf au droit de la Soummam où l'on note une distribution inverse de celle de l'illite. Les plus fortes concentrations en chlorite sont confinées en aval du Canyon (40%).

La kaolinite occupe sensiblement les mêmes aires que la chlorite, mais elle est mieux exprimée dans les profondeurs intermédiaires du plateau continental. Il est à noter que les plus faibles valeurs sont situées à l'embouchure des Oueds Djemaa, Agrioun et Soummam.

La dispersion des particules détritiques en mer s'accompagne d'une sédimentation différentielle. Le canyon de Bejaïa joue le rôle d'émissaire dans l'acheminement des sédiments fins vers les grands fonds. Le flux d'eau douce issu de l'Oued Soummam se fait en direction du Canyon. Ceci est souligné par la distribution de l'illite. Chlorite et kaolinite occupent un domaine bathymétrique où l'effet de l'hydrodynamisme côtier permet leur dépôt. On note des concentrations élevées de ces minéraux devant le Port de Béjaïa qui est une zone abritée des houles et des vents d'Ouest à Nord-Ouest les plus fréquents.

(°) La détermination des minéraux argileux a été faite sur des échantillons naturels et glycolés par traitement informatique mis au point et utilisé au laboratoire de Perpignan

G-I13

De l'existence d'un Faciès Coquillier Relique en bordure externe de la Plate-forme Continentale du Golfe d'Arzew (Algérie Occidentale)

Djamal AMOKIES

I.S.T./U.S.T.H.B., B.P. 32, El-Alia, Alger (Algérie)

La répartition des faciès superficiels sur le plateau continental du Golfe d'Arzew fait ressortir les aspects essentiels suivant :

* une sédimentation détritique et organogène constituant les dépôts de la zone littorale à infralittorale (-10 à - 40 mètres);

* un envasement circalittoral de grande extension occupant la partie médiane du golfe (-40 à - 80 mètres;

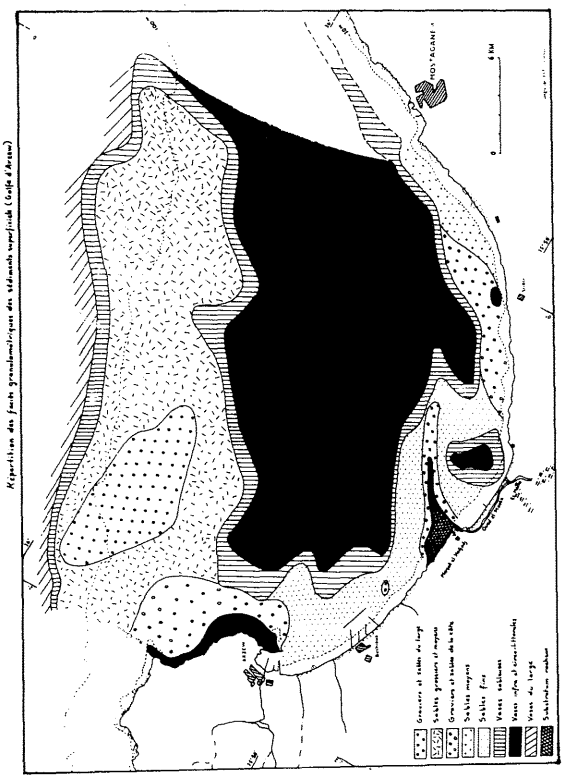
* un faciès coquillier relique en bordure du plateau (-80 à -130 mètres).

Les deux faciès grossiers sont relativement peu étendus de part et d'autre de l'importante vasière centrale.

Le long du rebord continental, le faciès coquillier du large forme une bande continue. Il est représenté par des débris grossiers à moyens, plurimodaux, dont la taille varie de 60 à 4500 µm. Les médianes sont comprises entre 90 et 1050 µm. Il semble que le classement décroisse vers la périphérie de la zone coquillière relique: l'indice de classement (So de Trask) passe de 1,72 à 3,02 vers l'extrémité orientale du dépôt.

La fraction carbonatée y est toujours très importante (>50%) et d'origine organogène. On y reconnait des débris de Lamellibranches, Gastéropodes, Lithothamniées (maërl), des Foraminifères et des Ostracodes.

L'existence de ce faciès en bordure du plateau, l'usure et la fragmentation des débris et la présence de glauconie conduisent à interpréter ce faciès organogène comme un sédiment relique.



REFERENCES

CAILLERE, S. et MONACO, A., 1971 . Nature et origine des glauconites dans les dépôts du Quaternaire terminal du plateau continental roussilonais (Pyrénées oriezntales). C.R.Acad.Sc. Paris, t.273, D.

CAULET, J., 1972 . Les sédiments organogènes du précontinent algérien. Thèse, Univ. Paris, Mémoires Muséum Paris, 25 : 1-289.

LECLAIRE, L., 1972 . La sédimentation holocène sur le versant méridional du bassin Algéro-baléare. Thèse. Univ. Paris , 382p.

FROGET, C. et CHAMLEY, H., 1977 . Présence de sépiolite détritique dans les sédiments récents du golfe d'Arzew (Algérie). C.R.Acad.Sc. Paris, t.285, D.

GOT. H., ALOISI, J.C.,and MONACO, A., 1985 . Sedimentary processes on deltas and shelves of the Mediterranean Basin . D.J. STANLEY and F.C. WEZEL eds., Plenum Press, New-York : 355-376.

G-I14

Relation entre les Associations Faunistiques d'Ostracodes et la Bathymétrie - Marge Continentale du Golfe d'Arzew (Algérie Occidentale)

Mimia BAKIR

I.S.T./U.S.T.H.B., B.P. 32, El-Alia, Alger (Algérie)

Le Golfe d'ARZEW se situe dans la partie méridionale du bassin algéro-baléare.

L'étude porte essentiellement sur le plateau continental de cette zone et concerne la fraction supérieure à 40µm du sédiment superficiel.

Les faunes d'Ostracodes se regroupent en quatre types d'associations selon un étagement bathymétrique bien déterminé.

PREMIERE ASSOCIATION : de 25 à 50 mètres :

- *Loxoconcha rhomboïdea*
- *Loxoconcha granulata*
- *Carinocythereis carinata*
- *Semicytherura incongruens*
- *Limnocythere sp.*

DEUXIEME ASSOCIATION : de 50 à 80 mètres :

- *Loxoconcha rhomboïdea*
- *Loxoconcha granulata*
- *Cytheropteron rotundatum*
- *Costa Edwarsii*

TROISIEME ASSOCIATION : de 80 à 150 mètres :

- *Loxoconcha rhomboïdea*
- *Cytheropteron rotundatum*
- *Cytheropteron alatum*
- *Costa Edwarsii*
- *Bosquetina dentata*
- *Krithe*

QUATRIEME ASSOCIATION : de 150 à 280 mètres :

- *Cytheropteron rotundatum*
- *Cytheropteron alatum*
- *Paracypris polita*
- *Krithe.*

La présence de représentants du genre *Krithe* à des profondeurs de l'ordre de 80 à 100 mètres est remarquable. Cette espèce se trouve normalement à des profondeurs plus élevées.

Deux récentes études d'Océanographie physique (C. MILLOT, 1985 et I. TAUPIER-LETAGE, 1988) ont mis en évidence la présence de formations tourbillonnaires -gyres- le long de la marge algérienne. Ces structures, engendrées par l'entrée atlantique, la morphologie de la marge et la déviation de Coriolis, induisent des remontées fréquentes d'eaux profondes , systèmes d'up-welling soulignés par les études planctoniques.

Les *Krithes* peuvent être considérées comme des espèces-témoin de ces phénomènes.

Cette étude permet de mettre en évidence deux résultats :
-1- la relation profondeur-association faunique spécifique;
-2- la confirmation de la présence d'un système tourbillonnaire à l'origine de remontées d'eaux profondes sur la bordure du plateau continental ouest-algérien.

REFERENCES

CAULET, J.P., 1972 . Les sédiments organogènes du précontinent algérien. Thèse, Mémoire du Muséum National d'Histoire Naturelle, série C, Tome XXV.

MILLOT, C., 1985 . Some features of the Algerian current. J. Geophys. Res., 90, C4 : 7169-7176 .

PEYPOUQUET, J.P., 1980 . Les relations Ostracodes-profondeur; principes applicables pendant le Cenozoïque. Bull. Inst. Géol. Bassin d'Aquitaine, Bordeaux, n°28 : 13-28.

TAUPIER-LETAGE, I., 1988 . Biodynamique du bassin algérien. Estimation de la réponse biologique à certaines structures hydrodynamiques de moyenne échelle par télédétection (AVHRR et CZCS) et mesures in situ. Thèse, Univ. Aix-Marseille II.

WAGNER, C.W., 1957 . Sur les Ostracodes du Quaternaire récent des Pays-Bas et leur utilisation dans l'étude géologique de dépôts holocènes. Monton and co ed. 259 p., 50 pl., 26 fig.

G

Rôle de l'Oued Soummam et du Canyon de Béjaïa dans la sédimentation argileuse du Golfe

Lazreg BENSLAMA

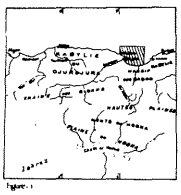
I.S.T./U.S.T.H.B., B.P. 32, El-Alia, Alger (Algérie)

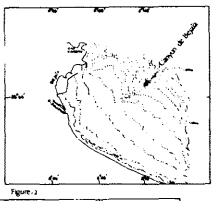
Le golfe de Bejaia constitue une large échancrure du littoral entre le cap Carbon et le massif d'El Aouana. Le plateau continental est peu étendu. Il est entaillé par un canyon très étroit qui remonte jusqu'aux fonds de 30 mètres au droit de l'oued SOUMMAM. Le matériel détritique livré à la mer par ce tributaire est estimé à 4.10^6 t/an (LECLAIRE, 1972). Il a été établi un apport solide en suspension en transit à l'embouchure de l'ordre de $0,3.10^6$ t/an (PAUC et BENSLAMA, 1988). Ce matériel est composé pour moitié de minéraux argileux (PAUC et al., 1988). Notre étude a porté sur la détermination et la répartition des teneurs relatives des minéraux argileux majeurs : illite, chlorite et kaolinite, dans les sédiments superficiels du golfe.

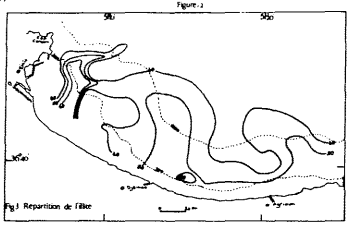
L'illite est le minéral dominant. Sa répartition décrit des concentrations élevées devant les oueds Djemaa, Agrioun et Soummam. Devant ce dernier, une zonation se fait dans l'axe du canyon et on note une diminution des teneurs d'amont en aval : de plus de 60% à moins de 40%.

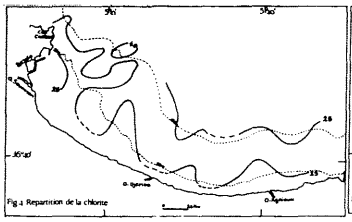
Les teneurs moyennes en chlorite sont comprises entre 25 et 30 % et se répartissent sur l'ensemble du plateau entier -20 et -100 mètres de fond. Au-delà de la bordure du précontinent, les concentrations sont voisines de 20 % sauf au droit de la Soummam où l'on note une distribution inverse de celle de l'illite.Les plus fortes concentrations en chlorite sont confinées en aval du canyon (40 %).

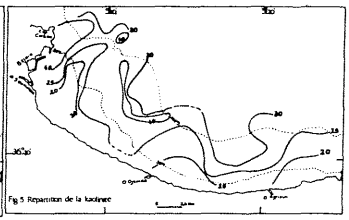
La kaolinite occupe sensiblement les mêmes aires que la chlorite, mais elle est mieux exprimée dans les profondeurs intermédiaires du plateau continental. Il est à noter que les plus faibles valeurs sont situées à l'embouchure des oueds Djemaa, Agrioun et Soummam.











Conclusion

La dispersion des particules détritiques en mer s'accompagne d'une sédimentation différentielle. Le canyon de Bejaia joue le rôle d'émissaire dans l'acheminement des sédiments fins vers les grands fonds. Le flux d'eau douce issu de l'oued Soummam se fait en direction du canyon. Ceci est souligné par la distribution de l'illite (CHAMLEY, 1971). Chlorite et kaolinite occupent un domaine bathymétrique où l'effet de l'hydrodynamisme côtier permet leur dépôt. On note des concentrations élevées de ces minéraux devant le port de Bejaia qui est une zone abritée des houles et des vents d'ouest à nord-ouest les plus fréquents.

REFERENCES

BENSLAMA, L. et PAUC, H., 1988 . Les flux d'apports en suspension par les oueds Chéliff, Mazafram et Soummam sur la marge continentale algérienne . Application au programme Medpol 87 . Séminaire des Sciences de la Terre, Alger .

PAUC, H., AIT KACI, D., ATROUNE, F. et BENSLAMA, L., 1988 . L'interface fluvio-marine et la dynamique des suspensions . Conséquences sur la pollution : Cheliff, Mazafran et Soummam . Séminaire sur l'Environnement, Constantine .

LECLAIRE, L., 1972 . La sédimentation Holocène sur le versant méridional du bassin algéro-baléare . Mémoires du Museum d'Histoire Naturelle . Paris, série C , XXIV .

CHAMLEY, H., 1971 . Recherches sur la sédimentation argileuse en Méditerranée . Thèse, Univ. Aix-Marseille .

HOLTZAPFFEL, L., 1985 . Les Minéraux Argileux . Soc. Géol. du Nord, Publication n°12 .

The Miocene salt formations of the Central Paratethys Basin are not evaporites

Jerzy LISZKOWSKI

Department of Geology, Adam Mickiewicz's University, Poznan (Poland)

Salt bearing formations of Lower and Middle Miocene age are widely distributed deposits within the molasses of late - to post - tectonic structural basins of the Carpathian region of the eastern Central Paratethys : The Carpathian Foredeep, the Transylvanian-, Transcarpathian and South-Slovakian Basins. In compliance with the generally accepted paradigm of sedimentology, oceanology, physical geology e.t.c. salinar formations are of evaporitic origin, i.e. formed under hot (warm), semiarid climatic conditions, where evaporation (E) exceeds precipitation (P) and inflow (I) : /E > P + I/.

However, palaeobotanic, both macro- and microfloral, as well as results of paleozoological, especially of terrestrial great mammals studies point to a warm or even hot but humid, periodically even wet climate durint the whole Lower to Middle Miocene time of the Central Paratethys. These data are inconsistent with the evaporative halogenetic model which require a substantial deficyt in the water budget due to evaporation.

Also, the geological setting, the lithology and mineralogical-geochemical composition of the Miocene salt formations of the Carpathian region are in many respect quite unusual : (i) they occupy the basal parts of individual macrocycles of molasse deposits; (ii) they occur transgressively in respect to the marginal zones of particular molasse basins; (iii) they pass laterally into late syndiastrophic flyschoidal or flysch deposits of the final miogeoclinal troughs; (iv) they pass laterally into or are immediately covered by brown coal deposits; (v) they commonly exhibit features of redeposited sediments, i.e. of olistostromic, olistolithic and turbiditic deposits; (vi) they show exact temporal coincidence with pulses and phases of strong tectomechanic activity within the adjoining Neo-Alpine Carpathian fold - and thrust belt; (vii) they are lithologically mostly composed of zubers with clay to halite ratio between 9 to 6 (halite saturation index : 0,1 to 0,4); (viii) halitites possess abnormal high Ba and Sr concentrations and a strongly variable Br-index; (tx) potash-salts occur accidental, not infrequently in basal parts within the vertical sections of individual salt formations, e.t.c.

Based on these and other inconsistences it is stated that the salt formations discussed are not of evaporitic origin. Paleoclimatic reconstructions based on the presence of salts in the geological section alone are in the case cited a classical circulus in demonstrando.

To explain the origin of Miocene salt formations of the eastern Central Paratethys region, a new halogenetic model was formulated. The model proposed stress the first order, active role of the orogenic factor for the origin of the salt formations discussed. They were the result of precipitation and deposition of salt minerals from highly concentrated residual connate brines (formation fluids) expulsed from the compacting and consolidating underthrust sediments and folded and thrusted flysch masses of the acretionary prism due to the increase of the overburden pressure and lateral compression (Liszkowski, 1989).

There is only one point which is difficult to explain within the framework of the proposed model : the presence of potash salts and their accidental and even in the basal parts within the vertical succession of salts deposited. To explain this it is assumed that a part of the fluids expelled where of descendic origin, i.e. formed as the result of dissolution of an older salt formation of true evaporitic origin. Then the concentration of the expulsed brines could attained more than 600 g/dcm^3, resulting in rapid, extensive subaqueous precipitation of potash salts. Looking for the source-rocks of this old evaporite formation, the author (Liszkowski, 1989) has drawn attention that the Late Eocene to Early Ologocene Menilite Formation of the eastern part of the West-Carpathian and of the East-Carpathian Flysch belt exhibit many characteristics of a basal anoxic member of a complete evaporite sequence. The occurence of gypsum intercalations and layers, globigerina oozes, pelocarbonates, silicites and quartz crystals, diatomites and quartz grains with eolian surface textures may been interpreted as additional particulars in support of the last hypothesis.

Thus the acceptance of the evaporative halogenetic model as universal theory or paradigm may be praemeture.

REFERENCES

LISZKOWSKI (J.), 1989 - A new halogenetic model for the origin of Lower and Middle Miocene salt formations of the Carpathian region, eastern Central Paratethys (in Polish, Engl. and Russ. res.). Prace Naukowe, Uniw. Slaskiego w Katowicach nr 1019, Katowice, 102 p.

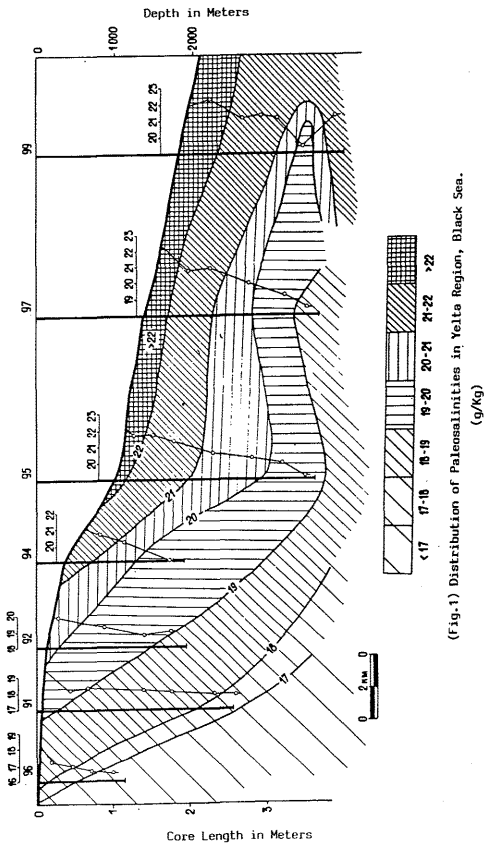
Paleosalinity of the Black Sea (Yelta Region)

S.-M. NASR* , Y.-N. GURSKY** and M.-G. VALYSHKO**

*Department of Environmental Studies, Institute of Graduate Studies and Research, Alexandria University (Egypt)

**Department of Geochemistry, Faculty of Geology, Moscow University (U.S.S.R.)

The aim of this study was to construct a distribution map for paleosalinities in Yelta region to highlight the environmental conditions and geological evolution of the Black Sea during the Late Quaternary time. Seven successive core samples were collected along a profile extending for about 40 Km offshore. According to a previous stratigraphic study (Nasr,1983), the age of core sediments No.96, 91 and 92 is Holocene (New Black Sea + Old Black Sea), while cores No. 94, 95, 97 and 99 is Holocene + Upper Pleistocene (New Euxinian). Values of paleosalinities of interstitial water varied from 16.38 to 22.69 %. in the investigated sediments. In nearshore area, the values of paleosalinities of interstitial water were less than salinities of the overlying sea water, while in deep sea , it was the contrary. Contouring for vertical distribution of interstitial paleosalinities in Yelta region (Fig.1) reflected two important facts:(1)Gradual increase in the offshore direction,and(2)Gradual decrease in the downward direction . The gradual increase of paleosalinities in offshore direction reached a maximum value (22.69 %.) at the top of core No.99 in the deepest part of the



(Fig.1) Distribution of Paleosalinities in Yelta Region, Black Sea.

investigated area (1820m)., while a minimum value (16.38 %.) was recorded at the lower part of core No. 96 in nearshore area (36m depth). The values of paleosalinities observed in nearshore area could be attributed to inland fresh water dicharege into the Black Sea. This is in agreement with Manheim and Chan (1974), who suggested the presence of subsea discharge of relatively fresh water in the Black Sea basin, espcially from west of Crimea. Gradual decrease of paleosalinities in downward direction in sediment succession i.e. from Holocene to Upper Pleistocene (New Euxinian) is due to environmental conditions and geological evolution prevailed during this time. In glacial stage of New Euxinian time, the sea level was lower than present, and the Black Sea had less salinity. It virtually became brakish water- or even fresh water lake when the sea level stayed low long enough (Emery and Hunt,1974). Irregular disribution of paloesalinity is evident in the tongue shaped pattern in the lower part of core No. 99 . This could be attributed to the reaccumulation of deposits from the continental margin to the deep sea sites.

REFERENCES

Emery, K.O. and Hunt, J.M. (1974). Summary of Black Sea Investigations. In " The Black Sea - Geology, Chemistry and Biology" . Eds. E.T. Degens and D.A. Ross. Mem. Asocc. Petrol. Geol., Tulsa, Okl. V. 20.

Manheim, F.T. and Chan, K.M. (1974). Interstitial waters of Black Sea sediments. New data and review. In " The Black Sea - Geology, Chemistry and Biology". Eds. E.T. Degens and D.A. Ross. Mem. Asocc. Petrol. Geol., Tulsa, Okl. V. 20.

Nasr, S.M. (1983). Geochemistry of the interstitial water and authigenic mineral formations in the sediments of Yelta region, Black Sea. Ph.D. thesis, Moscow University, 217P (In Russian).

Danube Delta, Genesis, Evolution and Sedimentology

N. PANIN

Institute of Geology and Geophysics, Marine Geology and Sedimentology Laboratory, Bucharest (Romania)

The Danube Delta can be divided into three major depositional systems (fig.1,2): the delta plain with a total area of about 5,800 sqKm, from which the marine delta plain area is of 1,800 sqKm; the delta front with an area of ca.1,300 sqKm, divided into delta-front platform (800 sq Km) and delta-front slope (ca.500 sqKm) extending off-shore to a water depth of 30-40 m; the prodelta lies off-shore, at the base of the delta-front slope till 50-60 m depth, covering an area of more than 5,500 sqKm. The delta front and especially the prodelta display a pattern of sub-marine channels, 4-10 m deep, bordered by lateral levees; these channels seem to constitute discharge ways of turbid flow yield by the river distributaries at high flood. Beyond the prodelta seaward there is the continental shelf with a thin, non-consolidated, actual sediment cover (fig.2). Here we can identify the pattern of the channels followed by the Danube during the low sea level periods towards the shelf edge, more precisely to the canyon Viteaz (fig.1). It is also to notice the existence of some deformational processes of nonconsolidated sediments, such as: rotational slides, affecting the superficial layer of 10-30 m thick, mass- or mud-flows, collapse depressions etc.

The delta development is controled by: the river sediment input (the Danube average sediment discharge is ca.50.10⁶ t/y out of which 5-8.10⁶ t/y sandy material); the prevailance of winds from the northern sector (40-50 % of instances); the predominance of southward trending of marine currents; the long-shore sediment drift directed also towards the South; the relatively important values of wave power etc. The interaction of these factors is controlling the delta morphological type, the geometry of the volumes of deltaic deposits, the assimetry of the deltas of Danube's distributaries and their development and evolution. In the end to characterize the delta sediment distribution and the magnitude of fluvial and marine processes controlling the delta shape and development there were used the indices of protrusion (Ipr),of crenulation (Icr) and of sediment distribution or skewness (Sk) proposed by Coleman and Wright (1971).

The Danube Delta overlaps the predobrogean Depression which, in its turn, lies mainly on the Scythian Platform. The sequence of the Scythian Platform cover deposits which constitute the filling material of the Predobrogen Depression display six sdimentation cycles (Paleozoic, Lower Triassic, Middle-Upper Triassic, Jurassic, Lower Cretaceous and Sarmatian-Pliocene)(Patrut et al., 1983). The Danube Delta is situated in a area of high mobility of the Earth crust, repeatedly affected by strong subsidences and important sediment accumulations. The deltaic conditions were settled here during the Quaternary, when the Danube started flowing into the Black Sea basin.

The Danube Delta edifice is build up of a sequence of detrital deposits of tens to 300-400 meters thick formed mainly during the Upper Pleistocene (Karangatian, Surojskian, Neoeuxinian) and the Holocene. The Holocene evolution of the Danube Delta include the following main phases: (1) the formation of the Letea-Caraorman initial spit, 11,700-7,500 years BP; (2) the Sf. Gheorghe I Delta, 9,000-7,200 years BP; (3) the Sulina Delta, 7,200-2,000 years BP; (4) the Sf.Gheorghe II and Chilia Deltas, 2,000 years BP- present; (5) the Cosna-Sinoie Delta, 3,500-1,500 years BP.

The Danube delta plain displays a few main facies types of sediments, as follows (fig.4):(I) marine littoral deposits of two types: type"a", formed by the longshore drift from the North (from the mouths of rivers Southern Bug, Dniester and Dnieper) and type"b", of Danubian origin; (II) lacustrian littoral deposits, forming the Stipoc and Rosca-Suez lacustrian spits; (III) fluvial deposits, genetically related to the Danube distributaries system, include several types: bed-load and mouth-bar deposits, subaqueous and subaerial natural levees deposits, crevasse and crevasse-splay deposits, point bar and meander belts deposits, decantation deposits into intradeltaic depressions and interdistributary area etc.; (IV) marsh deposits;(V) loess-like deposits.

REFERENCES

ALMAZOV,A.A., BONDAR,C. et al., 1963. Zona de varsare a Dunarii. Monografie hidrologica. Ed.Tehn., Bucuresti, 396 p.

COLEMAN,J.M., 1982. Deltas. Processes of deposition and models for exploration. Second Ed., Boston, 124 p.

PANIN, N.,1983. Black Sea coast line changes in the last 10,000 years. A new attempt at identifying the Danube mouths as described by the ancients. Dacia, N.S.,XXVII (1-2): 175-184.

PANIN,N., PANIN,STEFANA, HERZ,N. and NOAKES J.E.,1983. Radiocarbon dating of Danube Delta deposits. Quaternary Research,19: 249-255.

PATRUT,I.,PARASCHIV,C.,DAMET,T.,HOTAS,L.,DAMET,M. and BALTES,N., 1983. The geological constitution of the Danube Delta. An.Inst.Geol.Geofiz., 59, Bucuresti.

WRIGHT,L.D. and COLEMAN,J.M., 1971. The discharge/wave-power climate and the morphology of delta coasts. Assoc.Amer.Geogr., 3: 186-189.

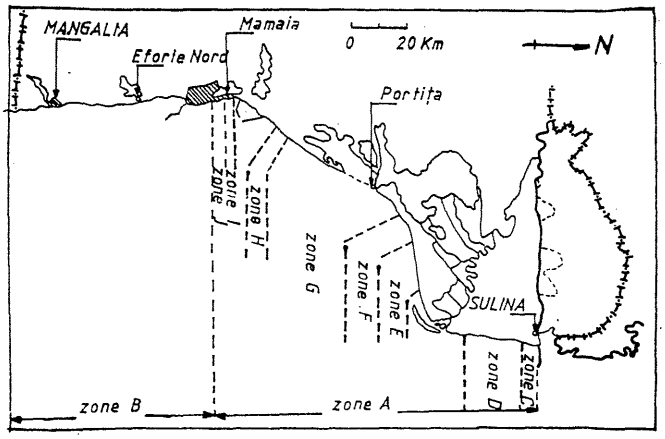
WRIGHT,L.D. and COLEMAN,J.M., 1973. Variations in morphology of major river deltas as functions of oceans waves and river discharge regimes. Bull.AAPG,57 (2): 370-398.

Man's Impact on the Romanian Coastal Zone

Iulian POSTOLACHE

Romanian Institute for Marine Research, Constanta (Romania)

Generally, until man's impact on coastal processes, the discharge of sediment has exceeded the erosion potential, the delta extended seaward and the other beaches of the zone A were enriched with sand.



Two major and distinct sediment types are found in the Romanian Shore Zone. The first sediment type consist of sand, silt and clay which are brough to the sea by the Danube. In the past, fine sediments from Danube have provided a major portion of the sediment that fill the beach of the zone A up to 87% on the beach and up to 95% in the nearshore zone.

The second type consists of calcareous suite sediments (shell fragments and other organic material that predominantly fill the beaches of the zone B up to 98% on the beach and up to 80% on the nearshore zone.

Man's intervention beginning with hydrotechnical constructions on rivers, with construction of the harbors and with the extention seaward for 9km of the Sulins Channel. The utilization of the sand from beaches for constructions and industry, pollution of the sea are the other interventions too.

Man's impact has resulted in a partial loos of Danube as an important sediment source for the delta and for the beaches of zone A. As a consequence, the action of waves and currents, which have remained undiminished, are in the process of eroding and changing the configuration of the coastline of the zone A.

The beginning in 1975 of a series of beach profiles, from Sulina to South to Mangalia, was an essential part of erosion study. Repeated surveys along these profiles have proved to be the most effective means of monitoring the erosion. Comparison of the beach profiles shows the rate of the shoreline change from year to year.

The modifying distances of the coastline are presented in the following table :

The Zone	from 1962 to 1978 *	from 1978 to 1987 *
C	310; 22	110; 59
D		- 12; - 22; - 47
E	- 102; 16; - 33	- 53; - 21; 0
F	27; 147; 162; 99; 65; 35	17; 7; 24; 20; 1; 13
G	1;- 34;- 131;- 87;- 72;- 21;- 10	- 1; - 40; - 54; - 60; - 56; - 32
H	100; 82; 190	48; 39; 7
I		- 3; 14; 1
J		- 26;- 4;- 17;- 7;- 20;- 26;- 36;- 10

*The profiles are distributed uniform by plotted zones in the figures
-erosion; accretion

The yearly rates show the accelerating of erosion and that the coastline has retreated about 70% as the lenght of the coast.

In the zone B there are predominantly the cliffs that separates the cells seaward with a typical transport of the sediments. The coast has a relative stability in case of this particular beach. The waves periodical erode the cliff. Numerous structures have been built along the coast of the zone B to widen beaches for recreational use and to prevent cliff erosion, and others to provide harbors.

Geophysical Studies and Crustal Structure of the European Geotraverse - Southern Segment

F. EGLOFF* , J. MAKRIS* and R. NICOLICH**

*Institut für Geophysik, Universität Hamburg (F.R.G.)
**Istituto di Miniere e Geofisica Applicata, Università Trieste (Italia)

The structure of the crust in the Ligurian Sea and the Sardinia Channel was investigated by the EGT-S (European Geotraverse-South) seismic experiments in 1985 and 1987. The resulting refraction and wide-angle reflection seismic data indicate a stretched continental crust in the eastern part of the Ligurian Sea. The ocean-continent boundary can be seen at water depths of nearly 2,000 m. The Pg and PmP arrivals can be clearly identified. The P-wave velocity of the sedimentary layers is about 2.5 km/s and 4.1 to 4.5 km/s. The continental-oceanic crust boundary is characterized by a marked change in the amplitude and velocity behaviour in the seismic sections. The most heavily stretched segment of the continental crust is 17 km thick, and the crust thickens towards the Italian coast to about 30 km. The oceanic crust is approximately 10 km thick. The upper mantle velocity under the continental crust is 7.5 km/s, as established by previous investigations. The oceanic crust has an upper mantle velocity of 8.0 km/s (Fig. 1).

The profile shot in the Sardinia Channel shows an 18 km thick stretched continental crust in the central part. The sedimentary cover reaches a depth of 6 km below sea-level and is 4 to 5 km thick. It consists of two main layers, one of recent sediments with 2.2 km/s, while the lower sediment velocity varies between 3.8 and 4.2 km/s. Strike-slip movements and shearing along the southward dipping faults are responsible for the present day geometry of the crust in this area. Our results show that the shear zone previously identified across the Kabylia structure and the Sardinia Channel is located south of an observed crystalline high in the central part of the profile. This shear zone divides the profile into two parts, the southern one being the most heavily stretched. These two profile segments are presented and the geological evidence discussed.

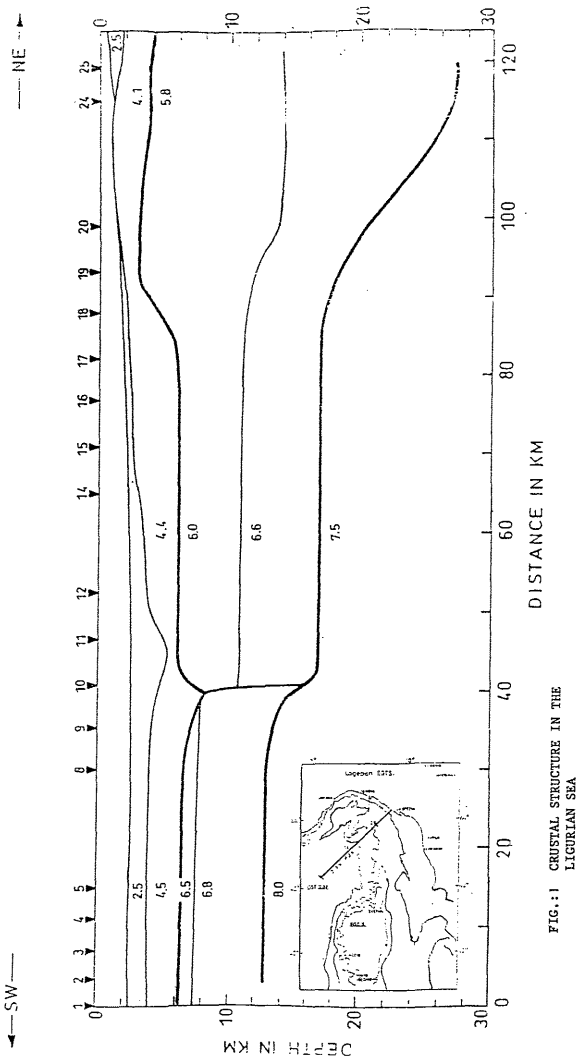


FIG.:1 CRUSTAL STRUCTURE IN THE LIGURIAN SEA

G-III2

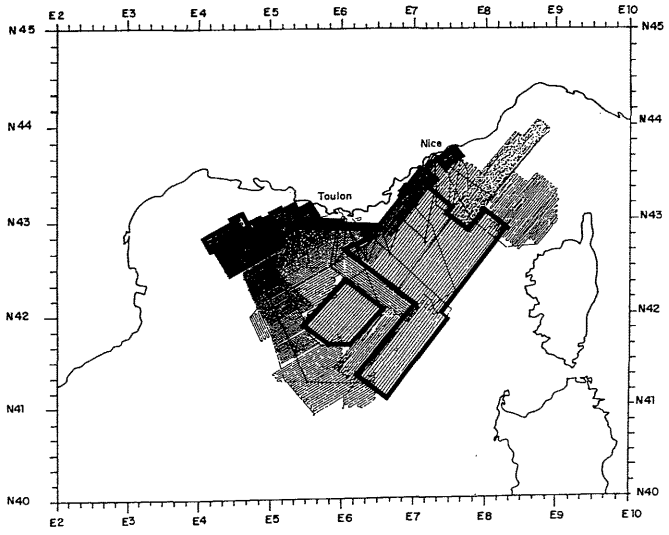
La campagne "Me-Sea 1" du "Jean-Charcot"

Gilbert BELLAICHE*, Laurence DROZ*, Virginie GAULLIER*, Alain COUTELLE**, Jean-Claude ALOISI*** et Claude DEGIOVANNI****

*Laboratoire de Géodynamique Sous-Marine, Villefranche-sur-Mer (France)
**Université de Bretagne Occidentale, Brest (France)
***Laboratoire de Sédimentologie et Géochimie Marines, Université, Perpignan (France)
****Centre Océanologique de Marseille, Faculté des Sciences de Luminy

La campagne "Me-Sea 1" s'est déroulée du 18 Janvier au 22 Février 1990 au large des côtes françaises de la Méditerranée à bord du navire océanographique "Jean Charcot". Elle avait pour but de compléter la couverture Seabeam et géophysique (sismique continue, magnétométrie et sondages 3,5 kHz)) de ces secteurs entreprise dès 1981 et 1982 ("Deltarho" 1 et 2, "Seadome"). Cette campagne, qui s'inscrit dans le cadre d'un vaste programme d'exploration systématique des zones d'exploitation économique sous juridiction française (ZEE), a abouti au levé de 186 profils parallèles représentant une longueur de près de 13 000 kilomètres (figure ci-dessous, cadre épais). Leur exploitation scientifique permettra de préciser les connaissances que nous avons de ce bassin et les documents cartographiques qui en résulteront serviront de base aux travaux océanographiques à venir.

Ce programme sera poursuivi à la fin de l'année 1990 par l'exploration de la marge corse à bord du nouveau navire océanographique français, "l'Atalante" (" Me-Sea 2").



Plan de position des différents profils Seabeam, sismiques 3,5kHz et magnétométriques réalisés pendant les campagnes Deltarho 1 et 2 (1981, 1982), Seadome (1982) et Mesea 1 (1990) à bord du N.O. "Jean Charcot".

G-III3

Le Banc des Blauquières (Sud-Est Marseille, France) : Juxtaposition de deux types de Marges Continentales Méditerranéennes? Apport de la Stratigraphie Sismique

Claude DEGIOVANNI et Frédéric POYDENOT

Centre d'Océanographie de Marseille, 13288 Marseille (France)

Le banc des Blauquières, situé au Sud de la baie de La Ciotat est limité à l'Ouest par le canyon de Cassidaigne et à l'Est par le canyon des Blauquières.

Du Nord au Sud, trois secteurs divisent le banc morphologiquement.

-Un secteur septentrional qui est caractérisé par une topographie en cuvette dissymétriquement et dont le grand axe est orienté W-E. Cette cuvette s'ouvre largement à l'Ouest vers le canyon de Cassidaigne. Les profils topo-bathymétriques révèlent du littoral jusqu'à -70m de profondeur une pente relativement forte (environ 9%). De -70m à -120m la pente a une valeur voisine de 0.5%, un décrochement intervenant à la cote -90m.

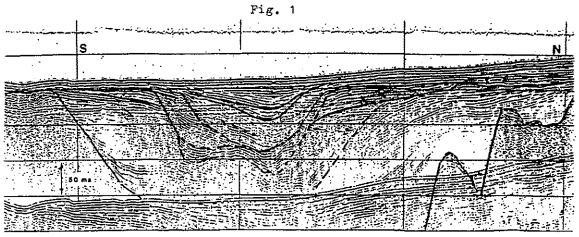
-Une zone de haut-fonds, orientée également W-E (Esquine - Îles des Embiez - Sicié), culmine vers -90m. Une passe, approximativement située en son milieu permet d'éventuels échanges (hydrologiques et/ou sédimentaires) entre les deux secteurs Nord et Sud.

-Enfin, la partie méridionale à un relief tabulaire et de faible pente forme un plateau présentant une brusque rupture de pente vers -120m.

Au delà, vers le Sud, le banc des Blauquières est limité par le talus continental que nous n'aborderons pas particulièrement dans ce travail.

Des campagnes sismiques récentes, haute et moyenne résolutions ainsi que des carottages, ont permis d'individualiser deux types de structures sédimentaires génétiquement différentes, qui caractérisent les zones localisées au Nord et au Sud de l'arête Esquine - Îles des Embiez - Sicié. Sur cette dernière les sédiments récents ou quaternaires sont soit absents, soit d'épaisseurs réduites. Les carottages ont précisé la nature cristallophyllienne (phyllades) de ces affleurements.

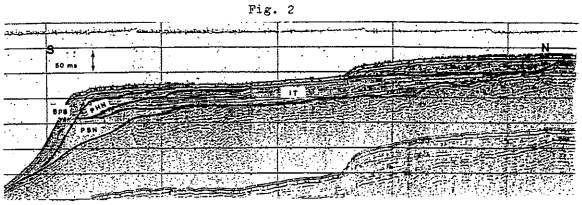
Fig. 1



-Les coupes sismiques du secteur septentrional (fig. 1) montrent une structure synclinale d'effondrement et subsidente qui peut être interprétée comme le prolongement sous-marin du synclinal à coeur Oligocène identifié à terre au Sud de Bandol. Cette structure relativement étroite à l'Est, s'élargit vers le centre du bassin (au droit de la baie de La Ciotat), puis se rétrécit de nouveau en approchant de la tête Est du canyon de Cassidaigne. Les divers profils perpendiculaires au grand axe du bassin montre que depuis l'Oligocène, ce bassin est le siège d'une sédimentation de type chenalisante reliant la tête Est du canyon de Cassidaigne. On peut voir là dans ces paléomorphologies la trace d'un paléocanyon qui débouchait alors dans le canyon de Cassidaigne.

L'examen des coupes sismiques montrent plusieurs corps sédimentaires sur la bordure N de l'Esquine. Selon les schémas de Vail *et al.* (1987), il s'agit de prismes de bas niveaux.

Fig. 2



Au Sud de l'arête (fig. 2), les analyses de stratigraphie sismique séquentielle du secteur méridional révèlent l'imbrication de plusieurs corps sédimentaires correspondant à des niveaux bas (PBN, PBP), des niveaux intermédiaires (IT) de transition et des niveaux hauts (PHN) selon les interprétations de Vail *et al.* (1987). Ces corps sédimentaires caractérisent une plateforme continentale sur laquelle on met en évidence une séquence de type 1 avec un prisme de bas niveau, un niveau intermédiaire et un niveau de haut niveau. Latéralement ces structures varient en puissance, en étendue, et peuvent même disparaître localement. Les épandages de canyon sous-marin n'apparaissent qu'au bas du talus et qui n'ont pas été considérés ici. Vers l'Est, un ensemble d'origine incertaine recouvre la surface du banc.

En conclusion, le banc des Blauquières est constitué par trois entités qui traduisent la zone charnière entre le plateau continental large, progradant, subsident du golfe du Lion: et le plateau continental étroit longeant les côtes des Maures et de l'Estérel. L'arête cristallophyllienne (Esquine - Sicié) forme un haut-fond depuis le Quaternaire et des corps sédimentaires bien définis y sont venus s'adosser. Au Sud, le plateau continental est une structure façonnée depuis le Messinien par les transgressions et régressions successives. Il s'agit de la poursuite vers l'Ouest des types séquentiels observés plus à l'Est sur la marge continentale de type intermédiaire du littoral varois. Enfin, au Nord de l'arête, le banc est caractérisé par un bassin subsident comblé récemment par un paléofleuve qui transitait vers le canyon de Cassidaigne.

REFERENCES

Vail, P.R., Colin, J.P., Jan du Chene, R., Kuchly, J., Mediavilla, F., Trifilieff, V., 1987. *Bull. Soc. géol. France,* (8),t. III, n°7, p. 1301-1321.

Le Contrôle Eustatique (successivement endoréique puis universel) de la création et du fonctionnement des Bassins Pliocènes du Midi Méditerranéen Français

Georges CLAUZON* et Jean-Loup RUBINO**

*URA 903 du CNRS, Université d'Aix-Marseille II, 13621 Aix-en-Provence (France)
**TOTAL-C.F.P., 218, avenue du Haut-Lévêque, 33605 Pessac (France)

Les bassins pliocènes du Midi méditerranéen français possèdent une double originalité : leur élaboration a précédé leur submersion et leur remblaiement sédimentaire est structuré en Gilbert deltas (Gilbert, 1885). Ces deux caractéristiques procèdent d'un contrôle eustatique.

1/ Les bassins pliocènes du Midi méditerranéen français sont des rias

La configuration linéaire de chacun de ces bassin moule fidèlement la morphologie d'une vallée fluviatile ; il s'agit, d'Est en Ouest, de celles du Var, de la Durance, du Rhône, de l'Orb et de l'Hérault, de la Têt et du Tech. Le plus étendu d'entre eux, celui du Rhône, pénètre le continent sur 3OO km pour une largeur qui, dans certains secteurs, n'excède pas 5 km.

Cette configuration linéaire va de paire avec un approfondissement systématique vers l'aval conformément au profil longitudinal de ces fleuves façonné par l' érosion régressive : à l'aplomb des côtes actuelles, la bathymétrie atteint des valeurs restituées égales (cas du Var) ou supérieures (cas du Rhône) au millier de mètres. En pied de marge, enfin, ces bassins débouchent sur de vastes cônes alluviaux et des fans deltas qui progradent sur les évaporites des plaines abyssales.

Du point de vue physiographique donc, l'origine fluviatile de ces bassins relève de l'évidence morphologique tandis que, du point de vue chronologique, leur synchronisme avec la crise de salinité (Clauzon et al., 1989) conduit à les imputer à l'eustatisme endoréique messinien. A l'extrême base du Pliocène, leur submersion - consécutive à la remise en eau brutale du bassin méditerranéen - les a alors transformés en rias.

2/ Structuration en Gilbert deltas du remblaiement de ces rias

Le comblement de ces rias est structuré en Gilbert deltas. On y retrouve en effet l'organisation caratéristique des Gilbert deltas : bottom set silteux (marnes bleues rhodaniennes), fore set graveleux (poudingues du Var), top set en cônes alluviaux (série continentale du Roussillon). Compte tenu des conditions d'affleurements et des vicissitudes tectoniques régionales, cette structuration s'observe plus ou moins bien selon les rias. A titre d'exemples, la ria du Var - fortement exhaussée dans sa partie proximale - offre d'excellents affleurements de faciès sous-aquatiques profonds tandis qu'à l'inverse, le Roussillon - qui enregistre une subsidence distale prononcée - a pu, grâce à celà, préserver ses niveaux sommitaux continentaux qui ont livré le célèbre gisement de mammifères du Serrat d'en Vacquer.

Dans ces deux rias ainsi que dans celle du Rhône, la transition marin/continental séparant les niveaux sous-aquatiques clinoformes des niveaux émergés sub-horizontaux constitue un niveau repère (fréquemment ligniteux) cartographiable. Restitution étant faite des déformations qui peuvent l'affecter, ce niveau présente une disposition planaire.

3/ Le contrôle eustatique de la genèse et du comblement des rias pliocènes

Pour l'essentiel, ce contrôle incombe au cycle eustatique TB 3.4 prolongé par l'épicycle TB 3,5 (Haq et al., 1987). En effet, le cycle précédent TB 3.3 s'achève (vers 5, 6/5,7 Ma) par une baisse eustatique à - 5O NGF (vers 5,5 Ma). Le synchronisme de cette chute avec le déclenchement de la crise de salinité révèle une relation de cause à conséquence entre les deux événements

En effet, dans ce bassin, séparé de l'océan universel par un double seuil (nord-bétique et sud-rifain), cette chute eustatique provoque le découplage du niveau de base méditerranéen par rapport à celui de l'Atlantique. Isolée, la Méditerranée devient désormais le siège d'un eustatisme endoréique contrôlé par les seules données climatiques régionales auxquelles s'ajoutaient d'épisodiques apports atlantiques. Dans un tel contexte, le niveau de base du bassin occidental se stabilise durablement (O,5 Ma) à des profondeurs estimées entre 15OO et 2OOO m en contre-bas de l'Atlantique (Ryan, 1976; Clauzon, 1982).

Cet effondrement eustatique d'ampleur inusitée est à l'origine du démantèlement généralisé des marges méditerranéennes (élaboration de la "surface d'érosion messinienne" des profils sismiques). Au droit des organismes hydrographiques majeurs, ce démantèlement se prolonge dans la masse continentale par de profonds canyons (Rhône etc...).

A la faveur de la phase positive du cycle TB 3.4/3.5, le remblaiement pliocène succède au creusement messinien. La précision chronologique requise pour ce nouvel épisode est fournie: en domaine marin, par les données paléontologiques du sondage Canet révisé (Clauzon et Cravatte, 1985) et, en domaine continental, par les nombreuses microfaunes de rongeurs récoltées dans les premiers niveaux exondés de ce remblaiement. On sait grâce à elles que la submersion des rias s'opère vers - 5 Ma (Clauzon et al., 1987) ce qui place la remise en eau du bassin méditerranéen en synchronisme avec le maximum flooding du cycle TB 3.4 . Il apparaît ainsi que la fin du découplage Atlantique/Méditerranée - tout comme, antérieurement, son initiation - furent de nature essentiellement eustatique et non purement tectonique comme on l'admettait généralement jusqu'ici.

Entre ce maximum flooding et l'effondrement eustatique qui marque la fin de l'épicycle TB 3.5, se place un "stillstand sea level" (Vail and Hardenbol, 1977) de longue durée (1,2 Ma) et de haut niveau (+ 8O NGF). De la sorte, à la régression endoréique messinienne d'ampleur kilométrique succède immédiatement le plus haut niveau eustatique des 1O derniers Ma. Une telle conjonction eut pour effet de créer un potentiel d'accomodation exceptionnel sur une marge compartimentée en rias. C'est ce potentiel qui est à l'origine du développement systématique des Gilbert deltas au sein des rias pliocènes.

CLAUZON G. (1982)._ *Bull. Soc. géol. Fr.*,(7), XXIV, 3, p. 597-61O.

CLAUZON G. et CRAVATTE J. (1985)._ *C. R. Acad. Sc. Paris*, II, 3O1, 19, p. 1351-1354.

CLAUZON G., AGUILAR J-P et MICHAUX J. (1987)._ *C. R. Acad. Sc. Paris*, II, 3O4, 11, p. 585-590.

CLAUZON G., AGUILAR J-P et MICHAUX J. (1989)._ *Bull. Soc. géol. Fr.* (8), V, 2, p. 361-372.

GILBERT G.K. (1885)._ *U.S. Geol. Survey*, V, p. 75-18O.

HAQ B.U., HARDENBOL J. and VAIL P.R. (1987)._ *Science*, 235, p. 1156-1167.

RYAN W.B.F. (1976)._ *Sedimentology*, 23, p. 791-813.

VAIL P.R. and HARDENBOL J. (1979)._ *Oceanus*, 22, 3, p. 71-79.

Observations sur la validité des Signaux Paléoclimatiques basés sur les Foraminifères pélagiques, en Mers Tyrrhénienne et Adriatique, pour une Séquence de 130 000 ans, de la fin du Riss à l'Actuel

Jean-Joseph BLANC*, Laure BLANC-VERNET* et Franca SGARRELLA**

*Centre d'Océanologie de Marseille, O.S.U., Luminy, Marseille (France)
**Dipartimento di Paleontologia, Largo S. Marcellino, 80100 Napoli (Italia)

Une analyse séquentielle a été réalisée sur quatre carottages effectués en Mer Tyrrhénienne et en Mer Adriatique (missions ETNA 1980-1982, CNRS-CEA) correspondant aux derniers 130 000 ans (mesures isotopiques et datations : PATERNE, GUICHARD, LABEYRIE, GILOT, DUPLESSY, 1986; PATERNE, GUICHARD, LABEYRIE, 1988; micropaléontologie : BLANC-VERNET, SGARELLA, 1989).

On observe une série climatique précisée avec les assemblages de Foraminifères pélagiques chauds et froids, se traduisant par une succession d'oscillations formant des cycles apparents, - de la fin du Riss à l'actuel (analyses isotopiques $\delta^{18}O$ et ^{14}C). La validité de ces "rythmes" constitue un problème lié à l'interprétation de la séquence climato-sédimentaire.

Signaux utilisés

Les données analysées, pour les séries chronologiques, sont établies à partir des pourcentages codifiés des Foraminifères pélagiques. Une analyse factorielle des correspondances (tri croisé) fait ressortir deux axes significatifs correspondant respectivement à un facteur thermique et aux propriétés des masses d'eaux (salinité).

Trois types de signaux sont utilisés :

1 : coordonnées factorielles sur le premier axe (températures),
2 : coordonnées factorielles sur le deuxième axe (salinités,...),
3 : indice C - F ou différence entre les pourcentages des Foraminifères chauds et froids.

La séquence des signaux, pour les carottes examinées, prélevées au large (40°35' N, 11°42'E, - 2430 m; 41°44'N, 17°35'E, - 1077 m; 38°49'N, 14°29'E, - 1900 m; 40°32'N, 13°21'E, - 1920 m), montre un "bruit de fond" à partir duquel se détachent des oscillations "courtes" de l'ordre de quelques millénaires. Le tout est superposé à un effet de tendance "long" exprimant les changement climatiques : conditions "chaudes" au Tyrrhénien, période froide et interstadiaires würmiens, réchauffement holocène avec optima à l'Atlantique et au Sub-Atlantique.

Le message est altéré par la variabilité des taux moyens de sédimentation, différents au Würm (7,6 à 14,7 cm/1000 A) et à l'Holocène (7,3 à 11,4 cm/1000 A), ainsi que par l'insertion de tephras et de turbidites.

Interprétation des signaux

*La tendance climatique générale des cycles "longs" est confirmée, avec des alternances de stades froids et chauds/tempérés-chauds, quel que soit le procédé de filtrage employé.

*Les signaux basés sur les coordonnées factorielles des axes 1 et 2, ainsi que l'indice C - F, sont le plus souvent superposables avec une meilleure résolution pour ce dernier.

*Les périodogrammes pour les données centrées sur le signal C - F soulignent des rythmes à basses et moyennes fréquences. Le traitement des périodogrammes intégrés montre des cycles le plus souvent aléatoires à l'exception de quelques basses fréquences pour la fenêtre 0,1 - 0,22 Hz. Un résultat voisin est obtenu pour le "facteur" thermique.

*L'analyse spectrale opérée sur les résidus entre les séries chronologiques brutes et les séries lissées, pour le signal C - F, permet d'écraser l'effet de tendance et confirme l'existence de cycles aléatoires courts de nature "événementielle".

*Les corrélations croisées entre les séquences adriatique et tyrrhénienne portant sur le signal C - F, suggérent un effet de tendance résiduel, plus froid dans l'Adriatique, alors que le réchauffement apparaît mieux marqué en mer Tyrrhénienne. Le traitement simultané des quatre séquences (matrice des corrélations croisées) traduit des dissemblances liées à la discrimination des eaux adriatiques, notamment à la fin de l'Holocène.

Conclusion

Les fréquences observées sur les séries chronologiques, du Riss à l'Actuel, impliquent la superposition de plusieurs types d'oscillations se détachant du "bruit de fond" :

1 : rythmes irréguliers, à courte période (quelques millénaires), liés à des évènements aléatoires.

2 : oscillations à moyennes fréquences (aléatoires) ou basses fréquences (déterministes), au niveau des interstades climatiques, pour des variances élevées.

3 : tendance cyclique très longue assujettie aux fluctuations climatiques classiques des temps quaternaires.

G-III6

A Simple Mathematical Model for Sediment Transport

Franz EBERSOLDT and Michael EHMKE

Fachbereich Mathematik (FB 11), Universität Duisburg, Lotharstr. 61, 4100 Duisburg (F.R.G.)

Sediment transport in water is mostly studied by using purely empirical methods. But in order to predict sedimentary deposit or erosional effects, one would like to have some theoretical tools for the description of sediment motion.

We consider a two-dimensional (x,z) stationary model, where the main sediment flow is horizontally (x-axis) and where the ground has a distance $z = h(x)$ from the surface.
Using diffusion theory one derives - with some physically justified simplifications - from the continuity equation (sedimentary mass conservation) the following parabolic partial differential equation for the mean sediment concentration in suspension $c(x,z)$

$$u\frac{\partial c}{\partial x} + (w - w_s)\frac{\partial c}{\partial z} - \frac{\partial}{\partial z}(\epsilon_s \frac{\partial c}{\partial z}) = 0 \qquad (1)$$

with some appropriate initial and boundary conditions.
u and w are the x- resp. z-components of the velocity field of the current. The coefficient ϵ_s takes into account the sedimentary exchange due to *turbulent* flux. Using a lot of experimental data KERSSENS [2] gave a suitable formula for $\epsilon_s(z)$.
The constant w_s characterizes the mean sedimentation speed, which is a function of the diameter, form and mass of the sediment particles and of the Reynolds number.

The mean velocity field (u,w) could of course be determined by solution of the associated time-independent Navier-Stokes equations for a viscous incompressible fluid. Since they are valid only for a laminary current, one could superpose a turbulent motion in adding a term taking into consideration the Reynolds tensions and the laminary layer phenomena.
Instead of choosing this complicated approach necessitating the resolution of a nonlinear system of partial differential equations, we follow an idea of PRANDTL [3] for the description of the shear-stresses. Introducing a roughness function for the description of the ground structure, as it has been done by J. NIKURADSE (see [4]), one can find by elementary integrations that

$$u = \frac{K \ln(z/z_0)}{\ln(h/z_0) - 1} \qquad (2)$$

and

$$w = \frac{K \ln(h/z_0)\frac{dh}{dx}}{h \ln(h/z_0) - 1)}(z \ln(z/z_0) - z + z_0), \qquad (3)$$

where the constants K and z_0 depend on $h(x)$ and the roughness of the ground.

If one uses (2) and (3), the diffusion equation (1) can be solved numerically by standard discretisation techniques.

Knowing the local sedimentary density $c(x,z)$ and the current field (u,w), one easily calculates the total transport of the suspended particles.

Beyond that the motion of drift materials can be treated by the Engelund-Hansen method [1], which is also applied for finding the necessary boundary conditions at the ground level.

REFERENCES.

[1] ENGELUND, F.; HANSEN, E., "A Monograph on Sediment Transport in Alluvial Streams", Kopenhagen 1967

[2] KERSSENS, P.J.M., "New Developments in Suspended Sediment Research", Delft Hydraulic Laboratory 237/1980

[3] PRANDTL, L., "Über die ausgebildete Turbulenz", Z. Ang. Math. Mech. 5/1925, 136-139

[4] SCHLICHTING, H., "Grenzschicht-Theorie", Karlsruhe 1965

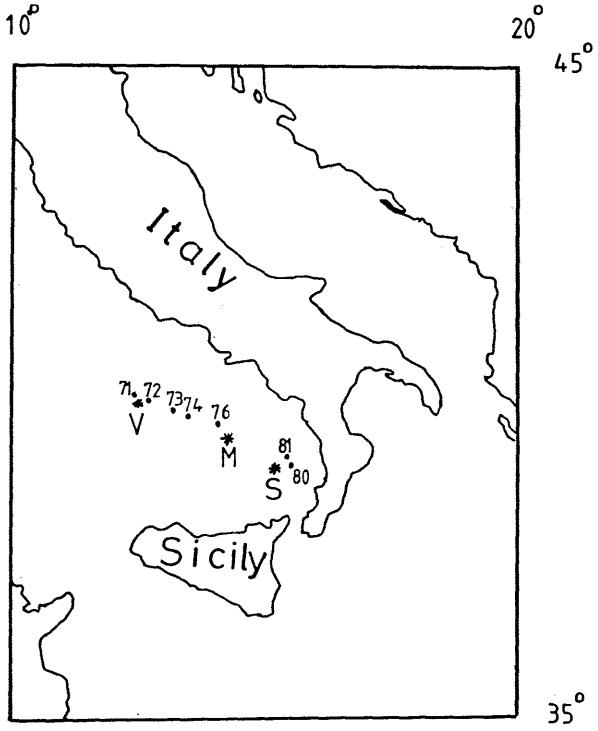
G-III7

Interstitial Water of Tyrrhenian Sea, Western Mediterranean

S.-M. NASR* and Y.-N. GURSKY

*Department of Environmental Studies, Institute of Graduate Studies and Resaerch, Alexandria University (Egypt)
Department of Geochemistry, Faculty of Geology, Moscow Univresity (U.S.S.R.)

This study aimed to demonstrate the characteristics and type of interstitial water,as well as the paleoenvironment and digenetic processes governing the western Mediterranean region during the Holocene time. Seven core samples have been collected from Tyrrhenian Sea (Fig.1) using a stainless steel gravity core sampler of 4 meter length and 65mm diameter. Titanium hydraulic squeezers with pressure up to 200Kg/Cm2 have been used to extract the interstitial water from the sediments(Kriukov and Manheim,1982).The interstitial water was analysed for salinity, alkalinity, SO4,Ca,Mg,Na and K. Measurements of Redox potential



(Fig.1) Location Map for core samples in Tyrrhenian Sea (V.Vavilov volcano, M.Marsili volcano, S.Stromboli volcano).

for some samples revealed that the sediments under investigation have been exposed to diagenesis due to aerobic conditions. Such diagenesis generally leads to very limited changes- or almost none at all-in the interstitial water, where it retains the original composition as sea water. According to Valyashko(1955), the interstitial water of Tyrrhenian Sea could be classified as océanic type (MgSO4). Similar conclusion has been reached by the authors in 1988 concerning Nile Cone sediments, Southern Mediterranean. Normal values of salinity were found in the investigated basin, except in the southern part where higher values were recorded (i.e. up to 44.33 %.). In addition, higher values of SO4, Na and K were observed in this part of Tyrrhenian. Stromboli volcano, which is active uptill now may play a dominant role in this respect. Infiltration of brines from the underlying Messinian evaporites have to be in considration too. Alkalinity showed a slight decrease with depth in sediment successions in the northern part of the basin (cores No. 71,72,73 and 74), on the other hand, increased in the southern part. Generally, the low values of alkalinity observed in the interstitial water of the Tyrrhenian Sea could be attributed to the following reasons: 1-The precipitation of HCO_3^- and CO_3^- from the interstital water as CaCC3 minerals,i.e. aragonite and calcite. 2- Absence of sulphate reduction which prevents the accumulation of HCO_3^- in interstitial water (S04+2C+2H2O ----> 2HCO3+H2S). This phenomenon is due to the low content of organic matter which is the case in the investigated sediments. 3- Leaching of gypsum (CaSO4) from biogenic carbonate sediments. This gypsum decreases the solubility of CaCO3 and consequently, ceases the accumulation of HCO_3^- in the interstitial water (Shishkina,1972).

REFERENCES

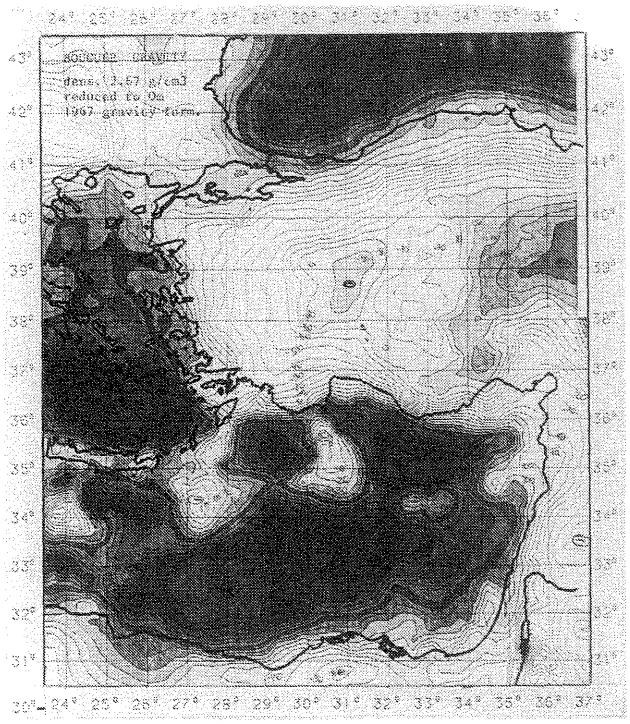
Kriukov, P.A. and Manheim, F.T. (1982). Extraction and investigate technique for study of interstitial water of unconsolidated sediments : A review in " The Dynamic Environment of Ocean Floor". Eds. K.A. Fanning and F.T. Manheim, Lexington books :3-26.
Nasr, S.M. and Gorsky, Y.N. (1988). The study of interstitial water of a core sample from the Nile Cone Southern Mediterranean. Rapp. Comm. Int. Mer Medit., 31, 2.
Shishkina, O.V. (1972). Geochemistry of marine and oceanic interstitial waters. Moscow, Nauka, 228P (In Russian).
Valyshko, M.G. (1955). Main chemical types of natural waters and conditions of their formation. Dokl. Akad. Nauk, SSSR, V.102.N.2 :315-318. (In Russian).

Geophysical Studies and Tectonics of the Eastern Mediterranean Sea

J. WANG , J. MAKRIS and C. HENKE

Institut für Geophysik, Universität Hamburg (F.R.G.)

By reevaluating all available geophysical information for the Eastern Mediterranean Sea new Bouguer gravity and total magnetic maps were compiled. Previously the gravity and magnetic fields of the region had never been resolved with sufficient accuracy to permit reliable quantitative evaluation.



The thickness of the Eastern Mediterranean Rise ranges from 28 to 34 Km. Its sedimentary cover is about 10 Km thick. The borders of the Eastern Mediterranean Sea are built up of thick continental crust. Tectonically the northern borders of the Eastern Mediterranean Sea are built up of active continental margins defined by the Calabrian, Hellenic and Cyprus- Antalya Arcs, whereas the southern border represents a passive continental margin formed by stretching and subsequent subsidence.

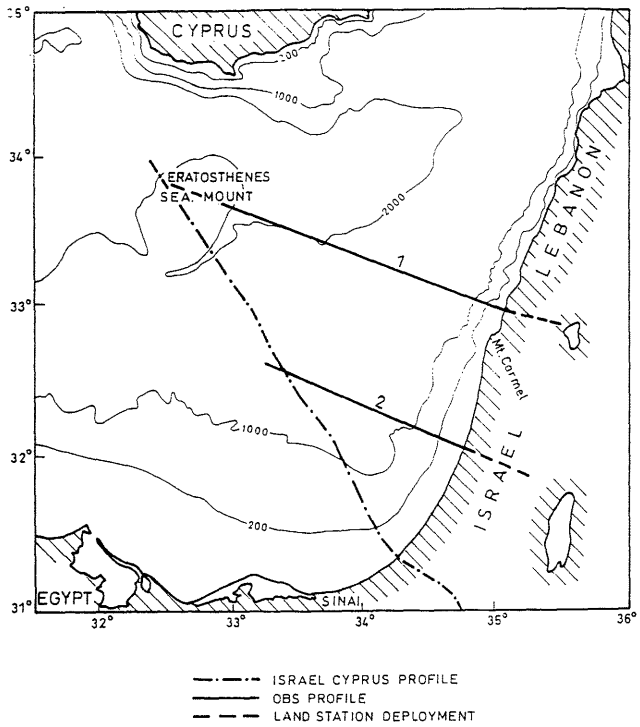
Using the newly compiled maps, new crustal models were calculated; the results and implications are presented and discussed.

A Seismic Study of the Levantine Margin and Basin

A. GINZBURG* , Z. BEN-AVRAHAM* and J. MAKRIS**

*Department of Geophysics and Planetary Sciences, tel Aviv University (Israel)
**Institut für Geophysik, Universität Hamburg (F.R.G.)

Previous geophysical studies indicate the presence of a fossil oceanic crust overlain by a thick sequence of sediments in part of the Levantine basin. Further, an examination of geophysical data shows that there are differences in the nature and structure of the crust norht and south of the Carmel block in northern Israel.



ISRAEL CYPRUS PROFILE
OBS PROFILE
LAND STATION DEPLOYMENT

In order to confirm these indications a combined onshore-offshore seismic study was undertaken by the Department of Geophysics, Tel Aviv University and the Institute of Geophysics, Hamburg University which was funded by the German-Israeli Foundation for Scientific Reseach and Development.

The study comprised two profiles, one across Lower Galilee, extending to Mt. Eratosthenes offshore and the other extending from west of Jerusalem extending west to some 180 km offshore. Data acquisition was based on OBSs offshore and mobile land stations onshore. Energy sources were airgun shots offshore, augmented by two large explosive shots per profile and by quarry blasts onshore.

The data which were recorded on analog tapes were digitized and plotted on to record sections. While the evaluation of the data is still underway, preliminary evaluation confirms the presence of a continental crust under Mt. Eratosthenes. It also confirms the position of the continental to oceanic crust and brings new information regarding the thickness, structure and nature of the sedimentary cover.

G-IV3

The New Results of Correlated Onshore and Offshore Geological and Geophysical Studies in the Cyprus Area

A.-L. KNIPPER*, A.-Ya. SHARASKIN* and K. XENOPHONDOS**

*Geological Institute of the USSR Academy of Sciences (U.S.S.R.)
**Geological Survey of Cyprus

Two expeditions carried out with RV "Akademik B. Petrov" (1989) and RV "Akademik N. Strakhov" (1990) in the Cyprus area yielded new data on the onshore geology and marine geophysics of the region.

Many of the gravity and seismic refraction data obtained are still undergoing processing, but some preliminary results merit a brief outline and discussion. They support previous conclusions that Cyprus is underlain by continental type crust, and that south of the island the crust is of oceanic nature (Makris et al., 1983). The base of the Mamonia rock complex seems to be a rootless nap of the Trodos ophiolites of about 4.5 km thickness, as indicated by the interpretation of the seismic refraction data. The upper and lower boundaries of the Trodos aliochtoneons were traced and correlated for the continuous onshore-offshore seismic profiles. They are truncated by graben-like structures and disappear north of the Eratosthenes Seamount. The results of the onshore geological studies include a new biostratigraphic subdivision of the Diarisos group. It was established that the uppermost lava are lower Cretaceous and thus younger than previously suggested. Evidence for MORIS affinities of the basalts from the lower part of this sequence was found. Furthermore it was discovered that the serpentinite melanges related to the Diarisos group do not include any exotic blocks of Trodos affinity. These last two observations indicate that the upper Triassic basalts were generated under true oceanic conditions (as oceanic crust).

Sediments associated with these lavas are of pelagic type and do not include any terrigenous components. We intend to outline briefly the scope of our institute's "Tethys" project.

Reference

Makris, J., Ben-Avraham, Z., Behle, A., Ginzburg, A., Giese, P., Steinmetz, L., Whitmarsh, R.B. and Eleftheriou, S, 1983: Seismic refraction profiles between Cyprus and Israel and their interpretation. Geophys.J.R.astr.Soc. 75, 575-591.

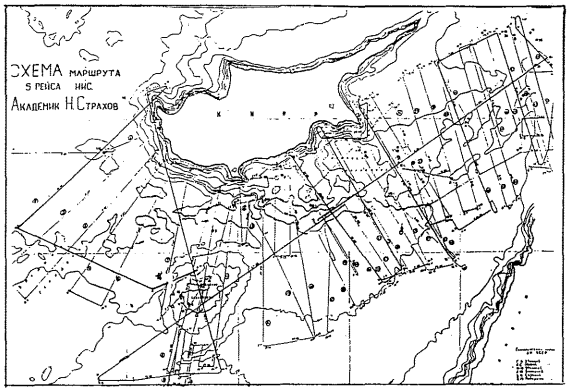
G-IV4

New Geological and Geophysical Data from the Cyprus Island Arc and Eratosthenes Seamount and their Interpretation

V.-A. KRASHENINNIKOV and G.-B. UDINTSEV

Geological Institute, USSR Academy of Sciences (U.S.S.R.)

During the 5th cruise of RV *Akademik Nikolaj Strakhov* (1987) in the Cyprus Arc and Eratosthenes Seamount region we collected 6.000 n.m. of multibeam echosounding and continuous seismic profiles. In addition, several localities were dredged and sampled. The results show that the submarine ridge does not connect the Cyprus Arc with the Bassit Massif of Syria. This is particularly evident for the structures at basement level which are clearly discontinuous. A series of normal faults at the southern flank of this ridge controls the sharp diapiric crest and numerous diapiric structures, all associated with the Messinian evaporites. The diapiric ridge between the Heccata ridge off Cyprus and the Bassit Massif of Syria is a structural continuation between the two which is confined only in the deformation of the sediments.



The detailed survey and dredging of the Eratosthenes Seamount provided reliable proof of its continental origin since samples are typical for platform limestones and also metamorphic rocks of acidic affiliation. The top of the seamount submerged to depths of about 800 to 900 m. This subsidence is in good agreement with that observed for downfaulted seamount flanks that limit the Eratosthenes Seamount towards the adjacent floor of the Eastern Mediterranean.

G

Sedimentary History of the Northeastern Mediterranean Continental Shelf

A.-E. AKSU*, A. ULUG** and K.-E. IZDAR**

*Department of Earth Sciences, St. John's, Newfoundland (Canada)
**Institute of Marine Sciences and Technology, Izmir (Turkey)

Approximately 1500 line-kilometers of continuous seismic reflection profiles were obtained with O.R.E. 3.5 KHz transducer system and 40 cu-in PAR airgun system in the Cilicia and İskenderun Basins. The data were collected from the research vessel "K. Piri Reis" of the Institute of Marine Sciences and Technology (İzmir, Turkey) on cruise NE-AK 88. Fig. 1 and 2 show the present day neotectonic framework of the Northeastern Mediterranean and "Study Area", seismic profiles and selected offshore exploration wells, respectively.

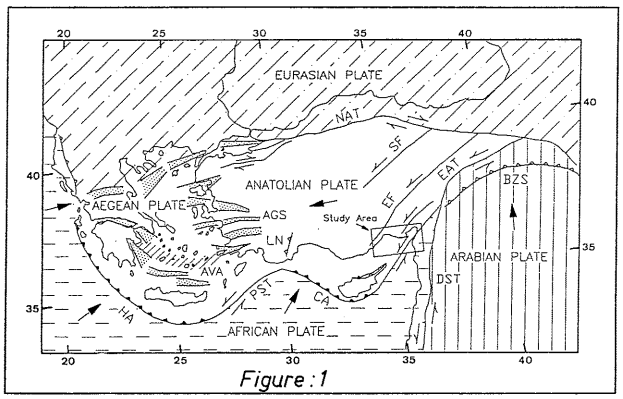


Figure :1

Detailed interpretation of the single channel airgun and 3.5 KHz data from the Northeastern Mediterranean Sea revealed that there are 7 correlatable depositional sequences within the upper ca 750 m (Fig. 3a) and show that the continental shelf is formed by superimposed deltaic successions (depositional sequences), separated by major erosional unconformities. Each depositional sequence is composed of a sigmoid prograding package overlain by an oblique prograding package and represents the delta progradation phases during an interglacial and subsequent glacial isotopic stages, respectively (Fig. 3b). During the glacio-eustatic low stands of sea-level deltas prograded seaward. The present-day shelf break denotes the topset to foreset transition at maximum progradation during the last glacial period. During the post-glacial transgressions deltas initially lost

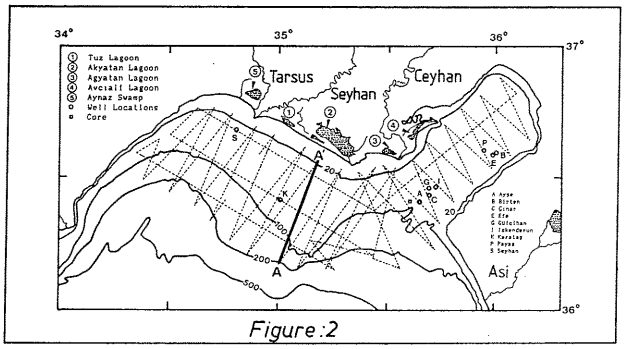


Figure :2

their dynamic equilibrium with the environment and rapidly retrograded landward, leading to the deposition of a thin veneer of sediments originating from reworking of formerly coastal sediments. With the maximum transgression the deltas were re-established in the ancestral Adana Bay and foreset progradation started.

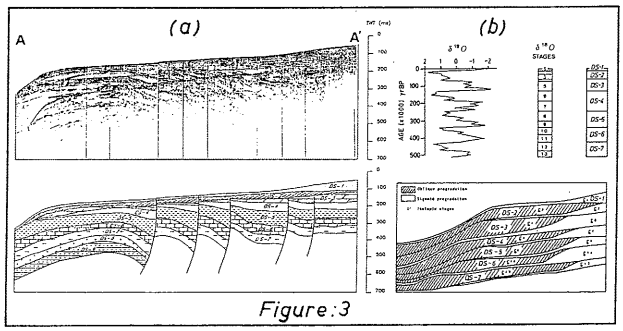


Figure :3

The data suggest that the Cilicia and İskenderun Basins are subsiding at rates of 0.39 m 1000 yr^{-1} and 0.34 m 1000 yr^{-1}, respectively. Seismic reflection profiling have shown that the delta architecture in the Adana, Cilicia and İskenderun Basins in mainly controlled by the glacio-eustatic sea-level fluctuations and continuous basin subsidence. The evolution of the Pliocene-Pleistocene depocentres in the study area is largely controlled by the major tectonic elements of the collison of the African and Eurasian plates.

Distribution of Macrobenthic Plants and Recent sediments on the Sea-Floor of the Anamur Bay (Turkey), NE-Mediterranean, mapped with Side-Scan Sonar

Vedat EDIGER and Mustafa ERGIN

METU-Institute of Marine Science, Erdemli-Icel (Turkey)

A side-scan sonar system was used to obtain continuous acoustic pictures in the sea-floor along 14 lines in the Anamur Bay, in 1984-1986 (Figure 1). Additionally, a total of 94 surface sediment samples including benthic organisms were collected in the study area.

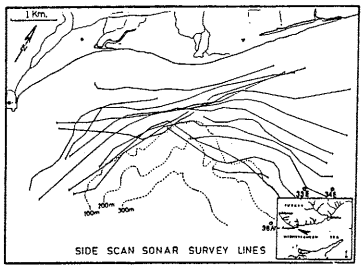


Figure 1. Side-Scan sonar survey lines.

Sediments overlying the sea-floor consisted of mixtures varying in gravel-, sand-, and mud-sized components. These sediments were partly infilling the Anamur submarine canyon, which is believed to have onshore-offshore extend. Three major zones can be distinquished on the basis of the grain-size distribution of the surficial sediments. These are the coastal zone, which is covered mainly with gravel; a large part of the shelf covered with sand, and the slopes and valleys/channels of the canyon covered with mud (Figure.2).

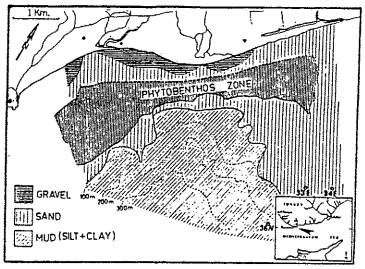


Figure 2. Map showing distribution of surface sediments and other features on the sea-floor based on sonographs.

Of course, the most prominent features on the sonographs were the presence of marine plants (Figure 3).

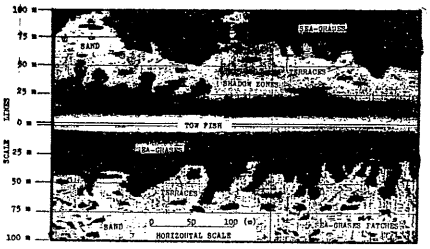


Figure 3. Side-scan sonar image showing the distribution patterns of the sea-grases, some small terraces, and sand areas.

These were the Hydrocharitaceae and Potomogetonaceae. These include the species, Zostera nana, Zostera marina, Cymodocea nodosa, Udotea petiolata, and Posidonia oceanica, which were restricted between 10 and 40 m countour lines.

G-IV7

Cretaceous Unconformities in the Southeastern Mediterranean Basin

Yossi MART

National Institute of Oceanography, IOLR, Tel Shikmona, Haifa 31080 (Israel)

The Cretaceous period in the SE Mediterranean region was characterized by intensive sedimentation along the continental margin and the adjacent continental rise, and by significant tectonic phases during the Neocomian and the Senonian. There is ground to presume that the tectonic phase, that affected the continental slope and rise area in the Senonian, did not lead to subaerial exposure of the sedimentary sequence. Therefore stratigraphic unconformities in the late Cretaceous marine depositional sequence are attributed to changes in seafloor geomorphology and the sedimentary regime, with submarine erosion in places. The Cretaceous seismostratigraphic unconformities thus delineate the contemporaneous structural features with marginal masking of subsequent subaerial erosion.

The continental margin of the SE Mediterranean is located on top of the ancient margin of the southwestern Neo-Tethys. This superposition apparently suggested a tectonic effect of pre-existing Jurassic and early Cretaceous structures on the preceding late Cretaceous and Neogene phases. However, recent findings suggest that although superimposed, structures of the late Cretaceous tectonic phase that affected the SW margin of the Neo-Tethys show only marginal similarity to early Cretaceous structures in that region. The correlation between the structures of the two phases seems erratic, conformable in some places, contrasting in others, and a few structures show no correlation between the early and the late phases. It is suggested that the conspicuous tectonophysical constraints in the southeastern Mediterranean margin region that caused the general geographic recurrence of the folded belts in the region, as well as the stability of the land-sea transition zone during more than 200 Ma, are associated with variations in crustal composition. Therefore the significance of the superpositional structural constraints are secondary to the deformational stress tensor in setting the outlines of regional tectonic development.

G-IV8

Late Pleistocene Paleoclimates and Anoxic Events in the Eastern Mediterranean : The Deep-Sea Record

Yvonne HERMAN

Department of Geology, Washington State University, Pullman, WA 99164 (U.S.A.)

Faunal composition and oxygen isotopic analyses of foraminiferal and pteropodal shells were utilized to reconstruct the paleoclimatic and paleohydrologic history of the Eastern Mediterranean. The reconstruction was done by mapping the recent fauna in core "tops" deposited during the Holocene and their calibration against observed present-day temperatures and salinities in the water column. The broad data base, using published faunal distributions from the world ocean, covers a wider range of temperatures and salinities and a combination of these factors, than those which are thought to have existed during glacial periods in the Mediterranean. In the longest core with a nearly continuous record, spanning ~ 500 K years is contained in the ≈ 1000 cm long Lamont-Doherty Geological Observatory (LDGO) core RC9-181. Within this time interval represented by RC9-181 six major cold-warm cycles, correlatable to Emiliani's isotopic stages 1-12 occur. Calcareous

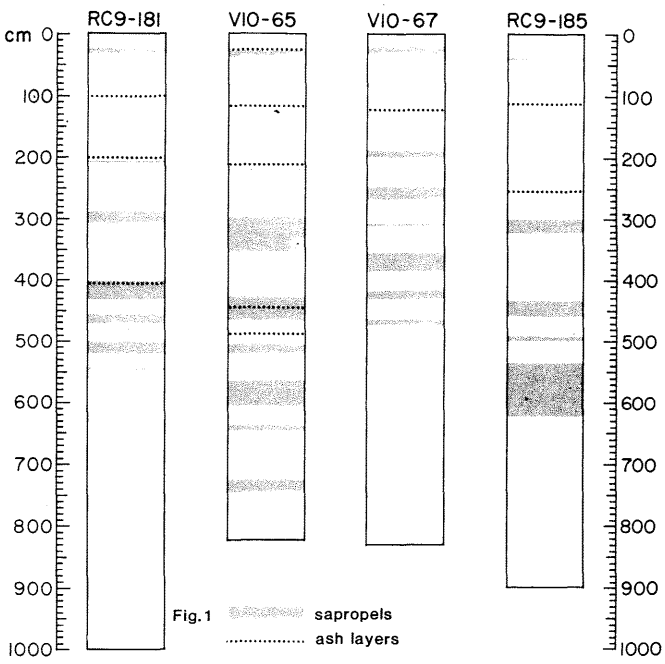


Fig. 1

nannoplankton biostratigraphic and biochronologic framework was utilized for determining the times various events occurred and for estimating rates of sedimentation. Two important datum levels were recorded: the extinction of *Pseudoemiliania lacunosa* between 899 and 938 cms (0.44-0.46 Ma ago), and the first appearance of *Emiliania huxleyi* 0.26-0.27 Ma ago, between 455 and 479 cm depth in core. During glacial temperature minima, surface water temperatures were ≈ 3°C lower in summer and 3-4°C lower in winter. Stadial and interstadial salinities were variable, reaching highest values during the last glacial temperature minimum when climates were more arid than today, sea level stood very low, the Nile discharge was greatly reduced and the connection between the Mediterranean and the Black Sea, which is a major supplier of low salinity water was severed. Following global warming and subsequent massive deglaciation, sea level rose. When the sea stand reached the Bosporus sill (≈36 m) the connection between the Mediterranean and the Black Sea was reestablished and the low salinity Black Sea water spilled over into the Mediterranean. A significant increase in precipitation and river runoff is also recorded during transitional climatic periods. These compounded effects produced a low density surface water layer which restricted thermohaline convection. The result was stagnation of the subsurface water and subsequent deposition of sapropels, some of which were laid down during intervals of pronounced density stratification. Surface water salinities dropped to low values during the deposition of sapropels as evidenced by oxygen isotope data. Twelve sapropels, characterized by distinct faunal associations, documenting different degrees of stagnation, occur in sediments representing the last 0.5 Ma.

TABLE 1 Location, deptn and length of cores

Core	Latitude (N)	Longitude (E)	Depth of water (m)	Length of core (cm)
V10-65	34°37.00'	23°25.00'	2586	960
V10-67	35°42.00'	20°43.00'	2890	830
RC9-181	33°25.00'	25°01.00'	2286	930
RC9-185	34°27.10'	20°07.00'	2858	902

ACKNOWLEDGEMENTS.

I thank Lamont-Doherty Geological Observatory (LDGO) for making the R. Conrad and Vema cores available, and the Core Curators, most recently Rusty Lotti, for sampling and shipping the core samples to WSU. Support for the curating facilities of the LDGO Deep-Sea Sample Repository was provided by the NSF through Grant OCE85-00232 and the ONR through Grant N00014-84-C-0132. This investigation was supported by the donors of the Petroleum Research Fund administered by the American Chemical Society Grant 10939-AC2.

G-V1

A Geophysical Study of the Aegean Sea

R. EGLOFF*, J. MAKRIS* and P. PAVLAKIS**

*Institut für Geophysik, Universität Hamburg (F.R.G.)
**National Centre for Marine Research, Athens (Greece)

The Aegean Sea was resurveyed with gravity, magnetic and seismic methods. The gravity and magnetic profiles, spaced at between 1.5 to 6 n.m., covered the entire area and yielded extremely precise data. These confirm to a large extent the existing models and provide new information which can be used to refine the geological concepts for the development of the Aegean Sea.

In the past the evolution of this area has been explained using the back-arc spreading model. Our interpretation however suggests that the deformation is a consequence of the large-scale shearing associated with the East Anatolian Fault System, and of the way that continental crust and lithosphere react under shearing forces. The Aegean microplate responds to the kinematic pattern in the east with extension and partial strike-slip, and in the west with compression and the building-up of a thrust belt and nap systems. The factor controlling the tectonic development of this area is the shear movement and not the subduction. Seen under this aspect, the Aegean Sea can be understood as a "pull-apart" basin.

The crustal profiling across the Aegean Sea revealed a stretched thinned continental crust, resting on a "soft" upper mantle characterized by low Pn velocity, high heat-flow and low density distribution. Mapping of the sedimentary record of recent and subrecent subsidence events and the major tectonic lineaments confirmed the continuing stretching and subsidence of the Cretan Trough. The newly compiled gravity and magnetic anomaly maps of the Aegean Sea show a strong correlation with the tectonic elements of delineation and weakness.

G

G-V2

Neotectonic and Recent Deformation of Crete

M. DERMITZAKIS, V. KARAKITSIOS and E. LAGIOS

Subfaculty of Earth Sciences, University of Athens, Panepistimiopolis, 15784 Athens (Greece)

In Crete, the Quaternary shorelines constitute good vertical deformation indicators. The stratigraphical age of the shorelines and their todays elevation, show that they 've been under strong deformation associated with the block-faulting that affected Crete.

Radiometric dating of the shorelines, made from various researchers, show that the average speed of some uplifts from Tyrrhenian up to the last thousand years ranges between 5 to 6 cm/100 years.

The speed of differential deformation for the entire Neotectonic period (approximately 13 M.years) is estimated to be similar with the speed of the fossilized Pleistocenic shorelines.

The analysis of the Neotectonic period faults shows that they are associated with a strong extentional status, in a perpedicular direction to the longer dimention of Crete (and in general to the Aegean arc). In the internal of this status, small events of ephemeral compression have been observed, that are different in width and in direction.

This extention that has been expressed with normal faults, has caused a gravitationnally spreading of Aegean towards the Ionian sea on an extremely large scale in Crete. This phenomenon is associated with the subduction of the African plate under the Aegean plate.

Shorelines of the last 1500 years "record" revolving upward movements in West Crete with maximum rising approximately 10m.

Gravimetric measurements of the last 7 years in Crete show that the upward and downward movements in the horsts and grabens respectively, are still continuing in an increasing speed. This phenomenon is probably related to the particular stage of continental collision between Africa and Europe.

G-V3

Geologic Controls of the Santorini Caldera and the Columbus Volcano

C. PERISSORATIS and I. ANGELOPOULOS

Institute of Geology and Mineral Exploration, IGME, Athens (Greece)

The marine sectors of the Santorini volcanic island complex and the surroundings was extensively studied during the years 1987 and 1989 by the Marine Geology department of IGME.Preliminary results of the 1987 research were presented during the 3rd Santorini Congress (Perissoratis and Angelopoulos,1989).

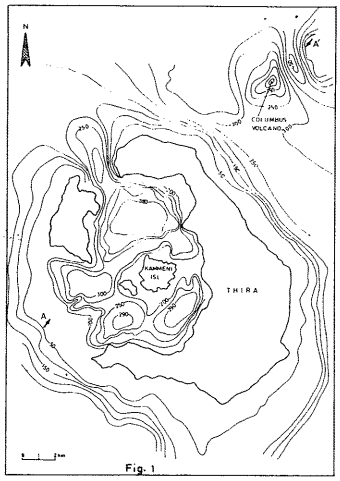


Fig. 1

Within the Santorini Caldera four basins can be distinguished (fig.1) one north of Kammenni (northern basin) and three south of it (western,southern and eastern basins).All basins have flat bottoms , with maximum depth ranging from 280 to 390m ,and are filled by fine grained loosed sediments having thickness from 90m at the northern basin to about 20 m at the western. The stratification in the basins (fig.2) is subhorizontal and in the seismic profiles two sectors , an upper opaque and a lower more transperrent, were discerned.The deeper structure of the basins and its relation with the land geology indicate that the northern one is younger than the other three.

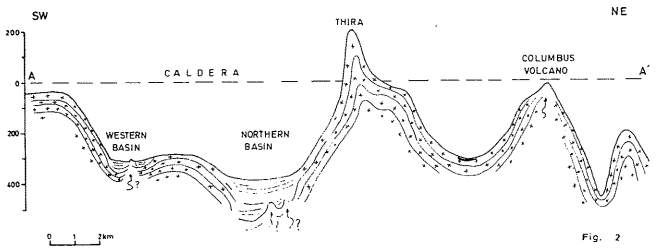


Fig. 2

The subhorizontal structure of the basin floor sediments is locally disrupted by piercing domes that are from 5 to 12m high and from 200 to 700 m wide, giving the impression of intrusions that were effected after the formation of the basins.Five such domes were mapped , three of which are located at the northern ,one at the western and one at the southern basin . Apparently these ''intrusions'' postdate the sediments which were deposited during the Minoan eruption (fig.2).

Petrographic study carried out at the coarse fraction of the surface sediments revealed abundance of authigenic iron oxides at the northeastern sector of the northern basin, attributed probably to local hydrothermal action (Bostrom et al 1989).

All these indicate that there are other locations of recent hydrothermal activity ,within the caldera ,except the well known ones at the Kammeni island.

Another area which was extensively examined was the Columbus Volcano.This is a cone-shaped feature lying at about 7 km northeast of Thira. It erupted last time in 1950 , and during that eruption its cone rose a few meters above sea level (Fyticas et al 1989). Subsequent erosion lowered the cone top below sea level.The research conducted now indicated that the cone feet lies at a depth from 300m to the southwest to 490 m at the northeast . The cone top is at 18 m belowm sea level.It is about 150 m wide and barren of loose sediments which are present only at the lower parts of the cone attaining thickness up to more than 20m.A few boulders were retrieved from the cone top wich consist of andesitic tuff while the surface is covered by manganese, iron and other oxides,with abundant organisms (sponges, shells etc.).

The hydrothermal activity which is present at the Columbus Volcano and the NE part of the northern basin is apparently correlated with the known "Kammeni line", a northeast -southwest trending fault zone in the Santorini complex.

REFERENCES

-BOSTROM,K., PERISSORATIS,C., GALANOPOULOS,V., PAPAVASSILIOU,C., BOSTROM,B., INGRI,J., and KALOGEROPOULOS,S., 1989 : Geochemistry and structural control of hydrothermal sediment in the Caldera of Santorini, Greece. Thera and the Aegean World, III., Abstr.p.24.

-FYTICAS,M., KOLIOS,N., and VOUGIOUKALAKIS,G., 1989 : Post Minoan Volcanic Activity of the Santorini Volcano. Volcanic monitoring and forecasting possibilities. Thera and the Aegean World, III., Abstr.p.25.

-PERISSORATIS,C., and ANGELOPOULOS,I., 1989 : Marine Geological Research on Santorini.Bottom sediment texture and composition-subbottom stratigrarhy and structure. Thera and the Aegean World III,Abstr.p29.

G-V4

Evolution Géologique Récente de la Partie Nord de l'Ile d'Eubée

Th. RONDOYANNI , A. METTOS , Ch. GEORGIOU , I. PAPADAKIS et P. PASCHOS

Institute of Geology and Mineral Exploration, 70 Messoghion str., 115 27 Athens (Greece)

L'île d'Eubée en Grèce centrale, s' étend entre le canal d'Atalanti,le golfe d'Eubée du sud et la mer Egée. La partie nord de l'île présente une activité tectonique intense, responsable du volcanisme quaternaire (f),de l'existence des sources thermales (g) et de la forte seismicité, contrairement de la partie sud où la tec - tonique ne semble être très intense.

Dans cette note nous présentons les premiers résultats de notre étude,concernant la partie nord de l'île, qui est bordée par des failles importantes,reliées à l'évolution du canal d'Atalanti, du canal d'Orei et du golfe Maliaque,prolongement probable de la fosse nord-égéen.

La plus grande partie de la région etudiée est constituée par les séries la - custres et fluviolacustres du Néogène et du Quaternaire, où on a pu distinguer:

- La série du Miocène inférieur (b) d'une épaisseur 250m environ, signalée pour la première fois dans cette région. Il s'agit des conglomérats,surtout ophiolitiques et des pelites gris-verts alternés avec des argiles,des grès et des conglomérats polygéniques. Ces dépôts correspondent aux dépôts du,bien connu en Grèce, bassin lignitifère de Kimi-Aliveri (dans l'Eubée Centrale) etudiée en detail par differents auteurs (Katsikatsos et al. 1981, Velitzelos et Gregor 1982,e.t.c.).

- L'épaisse série fluviolacustre (1200m environ)du Miocène supérieur-Pliocène supérieur (c).Elle est representée par des conglomérats fins,des grès,des travertins et des argiles brunes contenant une faune de vertebrés d'âge turolien,des marnes blanchâtres et des argiles lacustres contenant des gasteropodes pliocènes et des conglomérats et des marnes qui renferment une microflore indicative d'âge Pliocène supérieur.

- La série détritique du Quaternaire ancien (d)au coin NW de l'île,composée des conglomérats et des marnes contenant des mammifères quaternaires comme Elephas meridionalis (Psarianos et Thenius 1953).A son sommet cette série est couronée par des dépôts saumâtres renfermant une malacofaune à affinités euxinocaspiques d'âge Pléistocène inférieur.

En fin le Pléistocène moyen-supérieur et l'Holocène est representé par des dépôts surtout continentaux (e).

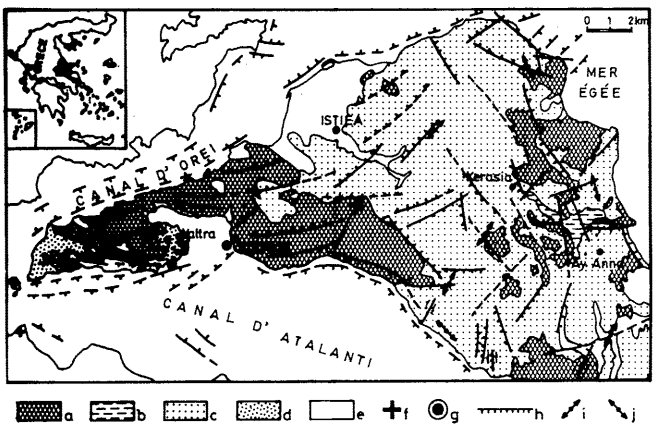
Les formations géologiques précedentes ainsi que le substratum prenéogène (gneiss,grès,phyllites,ophiolites et calcaires du palaeozoique-jurassique)(a)sont affectées par des failles de direction NW-SE et ENE-WSW (h).Il s'agit des failles normales ou decrochantes,formées ou rejouées au cours du Néogène-Quaternaire,qui sont responsables pour l'aspect morphotectonique actuel de l'île ainsi que des régions voisines sous-marines comme les recherches géologiques et géophysiques marines ont montré (Mitropoulos et Michailidis, 1988).Le traitement des mesures microtectoniques par la méthode numerique de Carey (1979) nous a aidé determiner la direction des contraintes principales des phases successives de la deformation.

Nous avons distingué trois phases tectoniques :

- Une phase distensive Mio-pliocène a direction d'extension NE-SW (i).Les failles de cette période qui montrent des composantes verticales dominantes, ont provoqué la formation des bassins néogènes et la déformation des dépôts qui les ont rempli.

- Une phase probablement d'âge pliocène terminal qui est manifestée par des failles surtout decrochantes senestres,de direction N 100°-120°reconnues dans la partie sud de la région étudiée.

- Une phase extensive Quaternaire à direction d'allongement NNW-SSE,(j) reconnue en principe dans la partie la plus nord de l'île, qui caracterise l'evolution actuelle de cette région.Cette activité tectonique c'est poursuit jusqu'à nos jours est se traduit soit par une activité seismique importante, soit par des mouvements lents qui semblent avoir lieu le long des côtes de l'Eubée du nord.



REFERENCES

CAREY, E., 1979. Recherche des directions principales de contraintes associées au jeu d'un population de failles.Rev.Geogr.Phys.Géol.Dyn.,21 p.57-66.

KATSIKATSOS,G.,BRUIJN de H. et Van der MEULEN, A.J.,1981.The neogene of the island of Euboea, a review Geol.Mijnbouw 60: p.509-516.

MITROPOULOS,D., MICAHILIDIS, S.,1988.Seismic stratigraphy and structure of Pagasitikos and Maliakos gulf and the surrounding areas,Aegean Sea,Greece.CIESM,vol.31, fasc. 2, p.96.

PSARIANOS, P., THENIUS, T. (1953). Uber Elephas (Archidiskodon)meridionalis (Eleph. Mammal)von Euböa Griechenland.Prkat.Akad.Athènes,vol.28, p.413-424.

VELITZELOS, E., GREGOR, H.J., 1982. Der erste nachweis von mastixiaceen im tertiär von Euboea (Griechenland). A.G.P.H.,vol.31, p.107-112.

Les Mouvements Tectoniques autour du Golfe Pagassitikos du Pliocène au Récent

Anastasie KOUTSOUVELI et Dimitris GALANAKIS

I.G.M.E., 70 Messoghion Av., 115 27 Athènes (Grèce)

Le golfe Pagassitikos est une région très active du point de vue des séismes.

Les sédiments du Pliocène et Pléistocène de la région sont dispersés en bas - sins. Au Nord sont étendus les sédiments du bord oriental du bassin de Thessalie, tandis qu' au Sud les sédiments, plio-pléistocènes sont limités dans le bassin d' Almyros-Sourpi.

Le substratum prénéogène se constitue des marbles, schistes, calcaires, flysch et ophiolites.

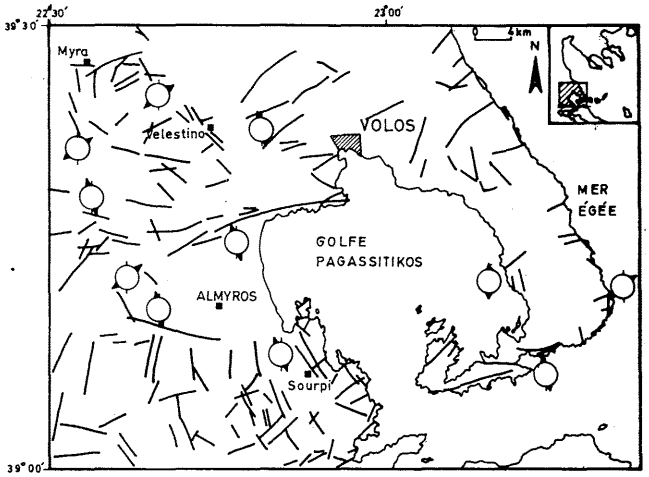
Les formations pliocènes et pléistocènes sont de faciès lacustre et fluvio - lacustre à plusieurs transitions laterales. Les plus anciens dépôts de la série néogène-quaternaire sont des marnes blanches lignitifères qui affleurent dans le bassin d' Almyros et datent du Pliocène inférieur, tandis que le dépôt des marnes jaunâtres dans la partie septentrionale (Velestino-Myra) a eu lieu pendant le Pliocène supérieur. Par endroits les marnes sont masquées par des brèches ou conglomérats intercalés à des bancs gréseux et marneux. Les conglomérats pléistocènes couvrent une grande étendue des bassins. L' épaisseur de la série néogène-quaternaire dépasse les 400 mètres.

Tous les dépôts du domaine étudié sont affectés par des mouvements tectoniques très intenses qui font parti de la néotectonique de l' arc égéen du Nord. Le golfe de Pagassitikos ainsi que le bassin de Thessalie sont des éffondrements tectoniques qui ont eu lieu à la fin du Tertiaire et continuent à être actifs jusqu' à présent. Le regime tectonique de la région est en extension.

L'étude tectonique nous a amené de distinguer trois groupes de failles normales, au domaine méridional à directions: a) NNW-SSE, b) NE-SW et c) ENE-WSW, tandis qu'aux domaines septentrional et central les directions des failles sont a)NW-SE, b) NE-SW et c)E-W. On doit souligner ici, que des études séismiques soumarines (Perissoratis et al. 1988, Mitropoulos et al. 1988) au golfe Pagassitikos ont donné des directions de failles NNW-SSE et E-W qui sont relatives aux précédentes. Ces failles normales sont responsables pour des grands effondrements tectoniques comme le golfe Pagassitikos, les bassins de Thessalie, d' Almyros-Sourpi, de Sesklo etc qui ont eu lieu au cours du Pliocène et elles sont réactivées pendant le Quaternaire, mais avec un rejet horizontal assez important.

L' analyse des données microtectoniques a défini deux phases d'extension.

- la première phase à direction d' extension NE-SW (~N50°) qui a un âge Pliocène-Pléistocène inférieur.
- la deuxième phase à direction d' extension NNW-SSE (~N 345°) qui date du Pléistocène inférieur au récent.



Carte tectonique et directions d' extension du Pliocene à l' Actuel

REFERENCES

1. MITROPOULOS D., MICHAILIDIS S.: Seismic stratigraphy and structure of Pagassitikos and Maliakos Gulf and the surrounding areas Aegean Sea, Greece. Rapp. Comm. int. Mer. Medit, 31, 2 (1988).

2. PERISSORATIS C., ZACHARAKI P., ANDRINOPOULOS A.: Texture and composition of the bottom sediments of Pagassitikos Gulf and Trikeri Strait, Thessaly (Greece) Rapp. Comm.Int. Mer. Medit, 31, 2 (1988).

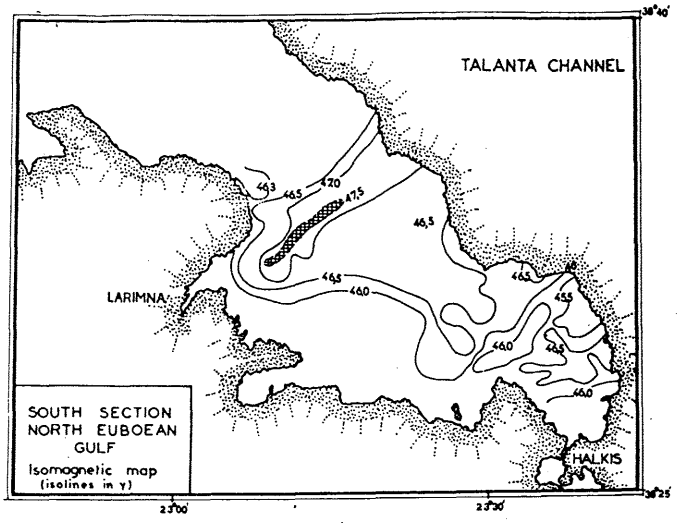
An Interpretation on the Magnetic Measurements of the Southern Part in the North Euboea Gulf

Helen BARBETSEA

National Centre of Marine Research, Athens 166 04, Hellinikon (Greece)

The interpretation of the magnetic data collected during 1983 are based on the local anomalies due to the magnetic differences of the rocks and the stratigraphy of the North Euboea Gulf.

From the isomagnetic map, is inferred, that the Gulf is divided in two parts through the isomagnetic line of 46.000γ directed to the North. The above area have been characterized by high intensity values (46.500γ-47.500γ) of the magnetic field (Fig. 1). It seems that an



(Fig. 1)

elevation to the North Gulf is extended to Larimma area. A difference of 800γ was found and could be supported also by the uplift of the hard basement, which appeared in the seismic profiles, of 3,5 KHZ (Chronis et al 1984). This can be observed on the map of the spreading of the isomagnetic lines in order of 46.500γ and 47.000γ along the coasts. Therefore, a difference of 800γ can also be justified from the above. The two other explanations are due to the nature of the rocks in Larimna area, as also to serpentines and ophiolithes, and the second, are the chemical analysis of the surface sediments (Fe, Ni, Cr) (Voutsinou - Varnavas, 1987). In this case the concetrations of Fe - Ni - Cr were found to be high and are in a good agreement with the high values of the magnetic Intensity in this area. On the other hand in the southern part the values of isomagnetic lines are relatively lower. It seems therefore, that the value of 45.500γ is in conformity to the Neogene deposits in this area. The difference of 500γ may be attributed to the existing peridodites of the studied area. It is known that the magnetic susceptibility of order $7.600\text{-}15.600.10^{6}$ C G S shows that the above mentioned rocks belong to the igneous rocks. Accordingly this is one of the most possible reasons of the relatively high values of magnetic intensity observed in the southern part of N. Euboea gulf.

References

1) G. Chronis, S. Stavrakakis, Ch. Tziavos, Ch. Anagnostou, H. Barbetsea, A. Caragiorgis, 1984. The recent sedimentation on the southern part of the Euboea Gulf (1st Symposium of Oceanography, Athens 1984, 468-484) (in Greek).

2) F. Voutsinou - S. Varnavas, 1987. Marine Mineral Resources in the Eastern Mediterranean Sea II. An Iron, Chromium and Nichel Deposit in the Northern Euboikos Bay Greece.

G-V7

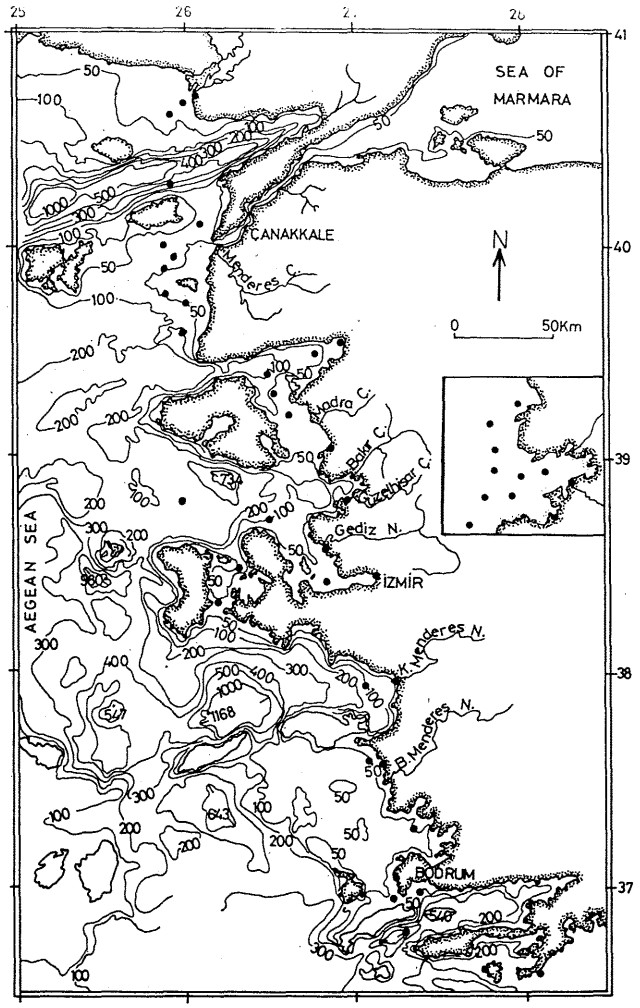
A Preliminary Study of the Principal Recent Sediment Types along the Eastern Margin of the Aegean Sea

Mustafa ERGIN, Vedat EDIGER, Mehmet N. BODUR and Mahmut OKYAR

Institute of Marine Sciences, Middle East Technical University, P.K. 28 Erdemli, Icel 33731 (Turkey)

Fourty-six surficial sediment samples collected during the oceanographical cruise of the R/V Bilim in Eastern Aegean Sea in 1987, from depths ranging between 12 and 640 m (Fig. 1), were subjected to granulometric, carbonate, organic carbon, and optical investigations. The main goal is to provide data that contribute to increase the knowledge on sedimentary processes in this poorly known part of the Aegean Sea.

Preliminary results suggest that - on the basis of biogenic $CaCO_3$ content - four main types of Recent sediments overlay the floor of the Eastern Aegean Sea, namely very low-calcareous (< 5 % $CaCO_3$), low-calcareous (5-25 % $CaCO_3$), calcareous (25-50 % $CaCO_3$), and high-calcareous (50-75 % $CaCO_3$) sediments. Carbonate components of sediments are largely made up of benthonic-shelly materials mostly occurring in the surroundings of Gökçeada Island-Strait of Dardanelles, south of Bozcaada Island, Chios Island-Çeşme Peninsula, and Bodrum Peninsula-Kos Island.



Most of the organic carbon values of sediments (0.30-0.70 %) are comparable with those found elsewhere in the Eastern Mediterranean (ERGİN et al., 1988), but somewhat lower than those from the Sea of Marmara (ERGİN and EVANS, 1988). The organic carbon contents of the Aegean Sea sediments of this study, in general, reflect low biogenic production here, compared to sediments from highly productive Marmara waters. Exceptionally high organic carbon concentrations (up to 3.50 %) occurred at or near river mouths, and also at sites with high sea-grass communities.

Among the biogenic components, the occurrence of calcareous algae "Lithothamnium" is characteristic, especially off the coasts of Bozcaada Island and in areas of between Kos Island and Bodrum Peninsula.

Sediments are composed of materials ranging in grain size: from silty clay to gravelly-muddy sand. Mud is widely distributed off the river mouths (areas of high terrigenous input) and in the embayments (areas of low energy conditions), particularly in Edremit and İzmir Bays, as well as, the Karaburun Peninsula-Lesbos Island-Chios Island triangle.

REFERENCES.

ERGİN, M., ALAVİ, S.N., BODUR, M.N., EDİGER, V. and OKYAR, M., 1988. A review of the geology and geochemistry of the Northeastern Mediterranean Basins. Institute of Marine Sciences, METU, Erdemli, İçel, Turkey, 154 p.

ERGİN, M. and EVANS, G. 1988. Recent Sediments from the Sea of Marmara. Institute of Marine Sciences, METU, Erdemli, İçel, Turkey, 134 p.

G-V8

Geophysical Framework of the Sea of Marmara

Mustafa ERGUN

Institute of Marine Sciences and Technology, P.O. Box 478, 35213 Izmir (Turkey)

Western Turkey has undergone dominantly N-S extension causing the formation of E-W trending grabens and similarly oriented normal faults (Eyidoğan, 1988). Marmara Sea is the extension of the Trakya basin in the north. Neogene lateritic depositions are present at the borders of this basins. The islands which are also called Marmara, are made up of crystalline Paleozoic rocks of marbles and granites. The Caspian-Black Sea region up to Italy in the west is at present tectonically very labile. Rapid subsidence characterizes a series of more-or-less elongated basins run subparallel to and are interrupted by areas undergoing uplift. Thus, during the Quaternary, the Sea of Marmara has subsided an amount well in excess 1000 m, accompanied by extension and transform motion. On the other hand, Quaternary uplift in western Anatolia is widespread. The early Quaternary erosional plateau has raised to up to 300 m in Trakya, 950 m on Tekirdağ and almost 2000 m on Uludağ in the south. These uplifts and subsidences are tha extensive phenomena traceable to regional tectonics. During the final phase of the destruction of the Tethys, readjustments of the microcontinents and collision lead to the development and reactiviation of transforms, as well as non-rigid deformation of continental crust along the collision front. As a result, north-south crustal shortening and secondary east-west stretching occurred. The primary vertical tectonics is uplift, but where transform faults cut across the direction of transform motion, crustal attenuation and subsidence prevail, leading to the formation of pull-apart basins.

Marmara region has different seismic characteristics from the rest of western Anatolia and appears to act as a separate tectomic unit (Crampin and Erans, 1986). This region shows higher seismic activity than the western Turkey in general indicating that this region is partly under the influence of the western end of the North Anatolian Fault which splays into a number of branches in and around the Sea of Marmara (Dewey and Şengör, 1979). The norhernmost branch becomes a graben and follow the Gulf of İzmit, connecting the Çınarcık pull-apart basin in the Sea of Marmara (Şengör et al., 1985). Based on fault mechanism solutions, Crampin and Evans (1986) suggested that the Marmara block is beging rotated and sheared in order to accommodate the right-lateral motion of the North Anatolian Faault and extensional tectonics of the southwestern Anatolian province.

The structures of the Sea of Marmara show the characteristics of rapid subsisdence acconpanied by extension and transform motion. In this area, pure strike-slip motion changes into extensional strike-slip movement responsible for the creation of the basins of the Sea of Marmara and the North Agean where the Ganos Dağ area active faults joins these two basins. It migth be well possible that the Saros trough and the Sea of Marmara basin (Adatepe, 1988; Ergün et al., 1988) were activated after the extension ceased in the north where the Trakya basin is situated having 3 to 4 km of Neogene sediments.

The seismological, seismic reflection , gravity and magnetic geopysical data will be reviewed for the Sea of Marmara and the surrounding area. Earthquake data indicate seismolgically very active region. The estimated crustal thickness is around 30-35 km determined from the earthquake data. The northern side of the Sea of Marmara shows smoother gravity and magnetic anomalies than the southern side. Magnetic anomalies are very much affected by the magmatic end volcanic intrusions on the southern side of the Sea of Marmara. The basement (most probably made up of the crystalline rocks df the Biga Peninsula on the south and the Istranca in the north) has been obtained to be around 2 to 5 km determined by the gravity modelling and power spectrum analysis. Neotectonic movements show their effects even within the very recent sediments indicated by shallow seismics in the area. Also, there exists a crushed zone in the middle of the basin marking the effects of strike-slip motion coupled with tensional movement. İzmit Bay area in the east of the Sea of Marmara was found to be a half graben from the gravity interpretation with the vertical movements taking place on the south side.

REFERENCES

Adatepe, F.M, 1988. Interpretation of the Geophysical data of the Sea of Marmara. Ph. Thesis, İstanbul University (in Turkish).

Crampin, S. and Evans, R., 1986. Neotectonics of the Marmara Sea region of Turkey. J. Geol. Soc. London, 243: 343-348.

Dewey, J.F. and Şengör, A.M.C, 1979. Aegean and surrounding regions: Complex multi-plate and continuum tectonics in a convergent zone. Bull. Geol. Soc. Am., 90: 84-92.

Ergün, M., İzdar, E., Uluğ, A. and Özel, E., 1989. Structure and Evolution of the Sea of Marmara. Terra Cognita 8.

Eyidoğan, H., 1988, Rates of crustal deformation in western Turkey as deduced from major earthquakes. Tectonophysics, 148: 83-92.

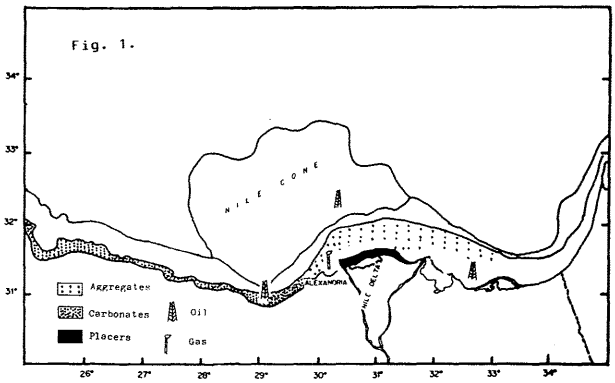
Şengör, A.M.C., Görür, N. and Şaroğlu, F., 1985. Strike slip faulting and related basin formation in zones of tectonic escape: Turkey as a case study. In: Strike-slip Deformation, Basin Formation and Sedimentation. Soc. Econ. Paleoutol. Mineral., Spec. Publ., 37: 227-264.

Non-living Marine Resources in the Egyptian Mediterranean Offshore

Mahmoud Kh. EL-SAYED

Department of Oceanography, Faculty of Science, Alexandria University, Alexandria (Egypt)

Ocean mining is considered to be a new frontier for mineral development; yet it is a long established industry in many countries. The IOC-UN(OALOS)/OSNLR have stressed on the importance to develop the techniques for the exploration and exploitation of the non-living marine resources. There are serious efforts to develop an ocean science in relation to the non-living marine resources in the Mediterranean.



The Egyptian Mediterranean offshore is considerably large (Fig.1); however, its non-living resources are not yet seriously evaluated. This area could be a source for several non-fuel and fuel marine resources.

Most of the non-fuel potentially valuable resources in this region are not presently exploited for several technical and marketing demand reasons. Aggregates and carbonates are widely distributed in the offshore region, surface exposed placers, on the other hand, have been intensively mined and hence exhausted. Large estimated amounts (reserves) of subsurface (Pleistocene?) placers in the coastal zone along the Nile delta contain zircon, tourmaline, ilmenite and rutile in appreciable quantities.

Marine oil and gas fields are explored in the Nile cone and to the west of Alexandria; gas is intensively exploited from marine gas field east of Alexandria.

The offshore oil discoveries in the eastern Nile cone in Oligocene and early Miocene indicate the need for deeper explorations.

Special attention was paid to the coastal zone as a resource (CZAR), as this area is highly attractive for socio-economic development. It comprises major cities, industrialization, harbours and several summer resorts and recreational centres. However, this area experiences continuous erosion and is vulnerable to the expected rise of sea level.

This paper is a contribution in assessing the non-living marine resources along the Egyptian Mediterranean offshore, with respect to their origin and factors that influenced their development and to review past and present mining activities. However, a more detailed resource inventory is required to provide a more certain assessment.

Facies Analysis of the Nile Delta Continental Shelf Sediments, Egypt

Omran E. FRIHY

Coastal Research Institute, 15 El Pharaana St., El Shallalat, Alexandria (Egypt)

This study serves to define more precisely the major sedimentary facies groups of the Nile delta shelf, and to relate their distribution patterns to environment of deposition. This was achieved by evaluating quantitatively the grain size distribution and mineralogical components of the coarse fraction in 108 bottom samples (Fig.1). Q-mode factor analysis of Klovan and Imbrie (1971) was employed on 19 variables, 7 textural (>-1, 0-1, 1-2, 2-3, 3-4, 4-8 and 8-10), plus 12 compositional (light minerals, heavy minerals, mica, "glauconite", plant matter, foraminifera, shell fragments, ostracods, echinoids, corals, bryozoans and carbonate oolites). Factor analysis of these variables related to sediment size and composition, reveals four dominant associations of lithofacies groups or factors. These facies statistically "explain" (or encompass) 83.6% of the total textural and compositional variation (variance).

1) The most significant contribution is facies I, formed of fine and very fine sands and contains light and heavy minerals and "glauconite". It covers most of the inner shelf area and progressively decrease seaward across the shelf and interpreted as delta front environment. The delta front facies appears to have been formed when there were several former Nile branches and the delta probably had an arcuate shape.

2) The next most important sediment group is facies II. It consists of silty sand enriched in biogenic components (foraminifera, shell fragments, echinoids, corals, bryozoans and ostracods). It occupies the entire outer shelf and its contiguous lower terraces. They are mostly relict (iron stained), probably resulted from sediment dynamics during lowering sea level of the Pleistocene.

3) Facies III is formed of fine-grained sediments of prodelta mud associated with mica, "glauconite", covering the middle shelf zone and the upper terraces. The gradient of concentration of this facies on the central delta off the Burullus headland may reflect an added sources related to the former branches of the Nile.

4) Facies IV is mainly represented by fine to coarse-grained sands and light minerals. Biogenic components are mainly absent. They are locally scattered on the inner shelf area along the coast of Idku, Burullus, Damietta promontory and El Gamil. These facies is equivalent to the upper Holocene prograding sands reported by El Askary and Frihy (1986) and Coutellier and Stanley (1987) from sediment cores at the Nile delta coastal zone. They interpreted these sands as coastal accretionary sand ridges of nearshore bars, accumulated during progradational phases of the delta when the Nile delta margin migrated northward. The geographic distribution of facies IV shows a correspondance with the position of the former Canopic, Sebennitic and Mendesian branches.

The configuration patterns of facies assemblages of grain size distribution, faunal and floral components on the shelf are related to former major distributary branches of the Nile as well as the pre-modern Rosetta and Damietta branches. The facies patterns are also a response to Holocene sediment transport processes, combined with sediment dynamics during lowering of sea level in Pleistocene.

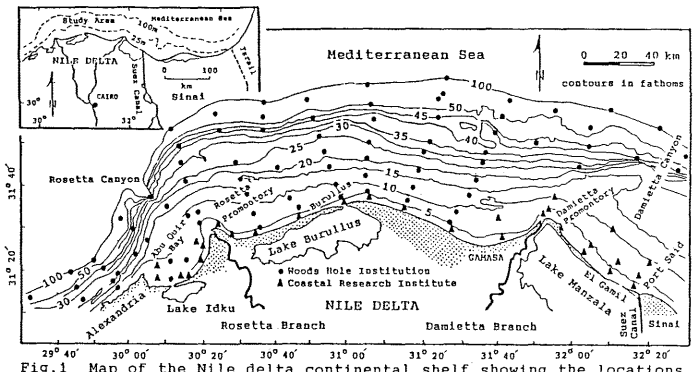


Fig.1 Map of the Nile delta continental shelf showing the locations of bottom samples examined.

REFERENCES

Coutellier, V. and Stanley, D.J., 1987. Late Quaternary stratigraphy and paleogeography of the eastern Nile delta, Egypt. Mar. Geol., 77:257-275.

El Askary, M.A. and Frihy, O.E., 1986. Depositional phases of Rosetta and Damietta promontories on the Nile delta coast. J. Afr. Earth Sci., 5:627-633.

Klovan, J.E., Imbrie, J., 1971. An algorithm and FORTRAN -IV program for large scale. Q-mode factor analysis and calculation of factor scores. J. Int. Assoc. Math. Geol., 3: 61-77

G-VI3

Study of Carbonate Contents in the Shelf Sediments off the Nile Delta

N.-M. DOWIDAR, M.-A. EL-SABROUT and A.-A. EL-SAMMAK

Department of Oceanography, Faculty of Science, Alexandria University, Alexandria (Egypt)

The carbonate content of the Nile sediments between El-Agami and El-Arish were studied (Figure 1.). The method described by Presley (1975) was used for determination of total carbonate content. Mineralogical analysis were performed using XRD.

Obviously, the carbonate content of the sediments between Rosetta and El-Arish are comparable to the previous results in the same area ,and to the other data in similar areas. East of Rosetta, the carbonate content varies between 0.823 % and 8.85 % with an average of 2.48 % . On the other hand, the carbonate content of the sediments in the area west of Rosetta increases gradually west-ward with an average of 55.32 %.

Carbonate minerals occurred in the area west of Rosetta (off El-Agami and Abu-Qir). The Most dominant mineral was aragonite, followed by calcite, Mg-calcite and quartz . On the other hand quartz , feldspar and mica are, in order, the most dominant minerals in the area between Rosetta and El-Arish . Carbonate minerals in the area west of Rosetta are possibly derived by erosion from coastal formations. The formation of aragonite may be engendered by strontium, in addition to the possibility of inorganic precipitation through biological processes. This is in accordance with the results and conclusions obtained by Emelyanov (1972) ; El-Sayed (1974,1981,1985) ; El-Wakeel and El-Sayed (1978) ; Stoffers et al. (1980);.

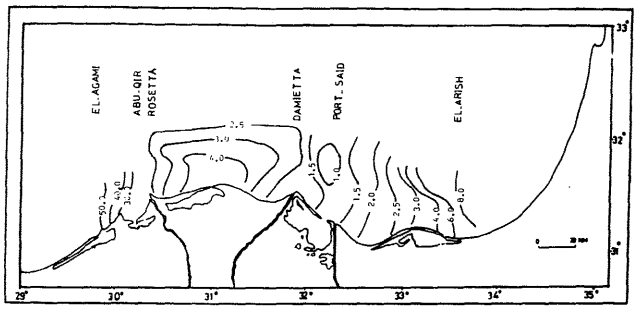


Figure 1. Areal distribution of total carbonate in the surficial sediments of the study area (%).

Conspicuously , on the basis of carbonate content and mineralogical data, the study area can be divided into two zones ; El-Agami/Abu Qir zone and Rosetta/El-Arish zone. The former zone is characterized by high content of carbonate reaching about 84 % in the inner shelf area off El-Agami. The area between Rosetta and El-Arish is mainly covered with Nile sediments and is characterized by low carbonate content. The increasing of carbonates east of Port Said is due to the gradually increase by deposition from the water ; in addition the area off Sinai is subjected to some supplementary contribution from sea cliffs and the seasonal streams of Sinai.

References :
El-Sayed, M. Kh. (1974). M.Sc. Thes. , Alex. Univ. (unpub. Man.).
El-Sayed, M. Kh. (1981). Rapp. P.-V. Reun. CIESM, 27:87-89.
El-Sayed, M. Kh. (1985). Rapp. P.-V. Reen. CIESM, 29:147-151.
El-Wakeel, S. K. and M. Kh. El-Sayed (1978). Mar.Geol., 27:137-160.
Emelyanove, E. M. (1972). In: Med. Sea. ; Stanley,D.J.(Ed.):355-386.
Presley, B. J. (1975). J.Sed. Petrol., 45:745-748.
Stoffers, P; C.D.Summerhayes and J. Dominik (1980). Mar. Geol.,34:M1-M8.

G-VI4

Geological and Physical Aspects of the Nile Delta with reference to the natural and man-made hazards

Mahmoud Kh. EL-SAYED

Department of Oceanography, Faculty of Science, Alexandria University, Alexandria (Egypt)

The Nile delta belongs to a group of deltaic coastlines that are largely shaped by waves. It represents one of the world's largest deltas with most conspicuous physiographic features (Fig.1).

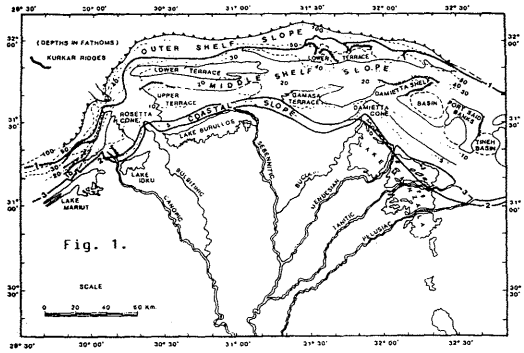


Fig. 1.

The geological history of the delta started in the Late Miocene; the contemporary delta is however much modern (Late Pliocene). Tectonics and sediment input influenced the formation and development of this area. The Nile cone was resulted from the accumulation of turbidites offshore.

The lower Nile delta host several axes of socio-economic development. However, this area has long experienced continuous erosional problems, and presently is regarded as most vulnerable to the expected rise of sea level. The erosion problem of the fragile coastal deltaic stretch is partly due to the cut off of about 100 million tons of sediments used to brought in the area prior to the construction of the Aswan High Dam, and largely due to continuous nature induced subsidence (Fig.2).

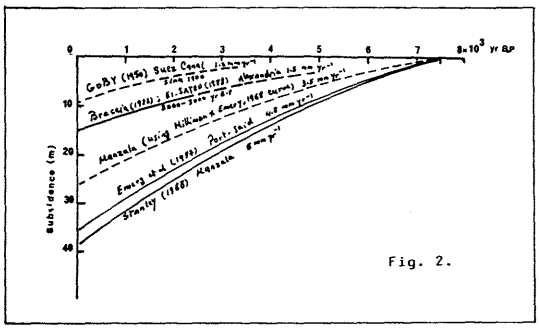


Fig. 2.

A conceptual model is provided to illustrate the variables forces and their different interaction on the coastal deltaic Nile area (Fig. 3).

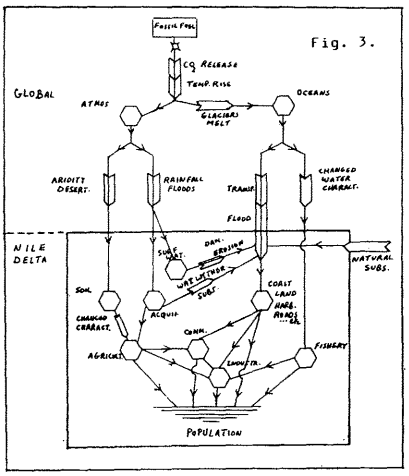


Fig. 3.

This paper presents a synthesis of geological, geomorphological, geophysical and hydrodynamic aspects of the Nile delta and aimed to discuss the natural and man-made hazards regarding the erosion and subsidence of this area.

Relationship between clay mineralogy and thermal maturity of Neogene-Quaternary shales in Ras El-Barr well No. 1, off shore Nile Delta, Egypt

Ramadan Abu EL-ALLA

Sciences and Mathematical Department, Faculty of Petroleum, Suez Canal University, Suez (Egypt)

The Nile Delta basin contains a thick section of Neogene-Quaternary strata that have a different values of thermal maturity as determined by vitrinite reflectance. The studied area in the Esatern part of the off shore Nile Delta basin is represented by the Ras El-Barr well No. 1. Clay mineralogy, the half-width of 10 A° illite and chlorite peaks, and the A/H (Area under peak/peak height) are systematically related to thermal maturity. Fig. 1, see GUTHRIE *et al.*, 1986 and HEROUX *et al.*, 1979.

The most important changes in clay minerals with increased depth of burial are: (a) the regular reduction of expandable layers; (b) the gradual increase in the crystallinity of illite and chlorite (decrease of the half width value) with depth. Table 1.

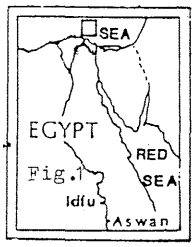


Fig. 1

The results of this study suggest that, in the absence of vitrinite, the values of half width of 10 A° peak and A/H parameters of illite (especially glycolated) may be used quantitatively to estimate the levels of thermal maturity; and consequently as indicators for the differentiation between the above and below oil window zones and to approximate hydrocarbon generation-preservation stages of potential source rocks.

Table 1. Summary of clay mineral data and the mean values of the level of organic metamorphism (LOM) (Hood *et al.*, 1975), the vitrinite reflectance R_o, and T_{max}, the maximun bottom hole temperature of each Formation.

Age	Formation	Label	Depth cm	Nonglycolated A/H I	Nonglycolated Half-width I	Nonglycolated Half-width C	Glycolated A/H I	Glycolated Half-width I	Glycolated Half-width C	Clay minerals Identified	T_{max} °C	R_o	LOM
Pleisto-cene	Mit Ghamr	B_1	599	2.64			0.89			Smectite dominates			
			903	2.17			1.43			"			
			990	1.68			1.45	0.72	0.71	(I),mixed layer clay,(C)	49 -		4.6
Upper Pliocene	El-Wastani	B_2	1060	1.28	1.32	0.40	0.80	0.40	0.48	(I),mixed layer clay,(C)	57	0.21	5.0
			1212	1.05	0.62	0.35	1.06	0.60	0.51	(I),(C),minor mixed layer clay			
Middle & lower Pliocene	Kafr El-Sheikh	B_3	1351	0.91	0.56	0.36	0.88	0.52	0.40	(I),(C),minor mixed layer clay	95.1	0.31	6.7
			1569	0.56	0.42	0.26	0.60	0.43	0.28	" " " "			
			1686	0.75	0.52	0.33	0.84	0.62	0.36	" " " "			
			1854	0.80	0.65	0.26	0.88	0.60	0.28	" " " "			
			1989	0.72	0.47	0.23	0.64	0.42	0.38	" " " "			
			2550	0.57	0.39	0.44	0.55	0.38	0.40	" " " "			
			2670	0.54	0.38	0.28	0.53	0.38	0.26	" " " "			
Lower Pliocene	Abu Madi	B_4	2799	0.49	0.38	0.35	0.46	0.32	0.35	" " " "	102	0.46	7.0
Miocene	Sidi Salem	B_6	2920	0.57	0.36	0.35	0.39	0.28		(I),(C)	140	0.57	9.6
			2998	0.56	0.35	0.37	0.38	0.26		(I),(C)			

References

GUTHRIE (J.), HOUSEKNECHT (D.) & JOHNS (W.), 1986.- Relationships among vitrinite reflectance, illite crystallinity and organic geochem. In Carb. strata, Quachita mountains, Oklahoma and Arkansas. *AAPG Bull.* v. 70, pp. 26-33

HEROUX (Y.), CHAGNON (A.) & BERTRAND (R.), 1979.- Compilation and correlation of major thermal maturation indicators. *AAPG Bull.* v. 63, pp. 2128-2144.

Mineralogical and Chemical Diagenesis of the coastal sediment in the area from Sidi Abd El-Rahman to Mersa Matruh (Egypt)

Mohamed A. SHATA

National Institute of Oceanography and Fisheries, Kayet Bay, Elanfoshy, Alexandria (Egypt)

The area of study extends from sidi Abd El-Rahma to Mersa Martruh for about 150 Km. It can be divided according its morphology into two parts ; namely Gulf of Kanayis and Abu Hashaifa Bay (Fig.1).

Two types of sediments were collected those of bottom samples and the other collected from three succive ridge extending parallel to the North Western coast of Egypt. The aim of study is to follow up the mineralogical and chemical change during the course of the carbonate diagenesis.

A.- Emphasizes arised from the mineralogical investigations

1.- The first stage of diagenesis proceeds through the transformation of aragonit into low Mg-calcite in the Gulf of Kanayis.

2.-In Abu Hashaifa Bay the transformation of Mg-calcite into the more stable of carbonate minerals is not clear.

3.- The samples of the first ridge reveal that the transformation of aragonit into calcite become more obvious than that into Mg-calcite. Actually these comprises the middle stage of the diagenetic process.

4.- The last stage is accounted for the second ridge, where aragonit and Mg-calcite are converted into calcite, the transformation of aragonite into Mg-calcite is ceased.

The correlation between the different forms of the carbonate minerals indicates that :

a.- The transformation of aragonit into Mg-calcite decreases landward.

b.- The transformation of aragonit into calcite increases in the same previous direction.

c.-The last stage of diagenesis proceeds particularly in the second ridge.

Comparable study between the present work and that of (LYNN *et al.*, 1979) leads to conclusion that the diagenic changes occur in a different from rather than that in both of the Mediterranean Coast of Israel (GAVISH & FRIEDMAN, 1969) and in Bermuda Island (RISTVIT, 1971), in which the early loss of Mg-calcite through the course of long term regional diagenesis had been achieved. For the short term local diagenesist the transformation of Aragonit into Mg-calcite is observed in the study area. These diagenetic processes have not signs in the sediments off Alexandria (EL-SAYED, 1974, STOFFER *et al.*, 1980) and the adjacent sediments of Arabs Bay (ANWAR *et al.*, 1981).

B.- Emphasizes arised from the chemical investigations

1.- The substitution of Ca for Mg is strong in the Gulf of Kanayis where the aragonit dominates. In the other studied area the substitution becomes lower. The reason for such chemical behaviour thought to be the increase of the other forms i.e. Mg-calcite and calcite on the expense of aragonit.

2.- Generally Mg-content reflects two important processes.

a.- Mg-calcite secretion from organisms, where there is positive correlation between Mg-content and Mg-calcite i.e. Mg increases in the area wich covers with Mg-calcite secreting organisms.

b.-The diagenetic process by which Aragonit transformed into Mg-calcite.

3.- The Sr content of the study area shows that the higher content of Sr are linked with the higher values of the aragonit. It becomes lower under the influence of the transformation of the aragonite into the other forms of the carbonate minerals. Generally Mn increases in the Existence of calcite owing to its incorporation in the crystal lattice of the calcite (ICHIKUNI, 1983).

References

ANWAR (Y.-M.), EL-ASKRY (M.-A.) & NASR (S.-M.), 1981.- Petrography and origin of the oolitic carbonate sediments of Arabs Bay, Western part of the Continental shelf of Egypt. *Neues Jb. Geol. Palaontol. Monatsh.* (Stuttgart), 2, 12 Abb, pp. 65-75

EL-SAYED (M.-K.), 1974.- Littoral and shallow water deposits of the continental shelf area of Egypt, off Alexandria. *Thesis. Univ. Alexandria*, 150 p.

GAVISH (E.) & FRIEDMAN (G.-M.), 1969.- Progressive diagenesis in Quaternary to late Tertiary carbonate sediments, Sequence and time scale. *J. Sed. Petrol.*, 39, pp. 980-1006.

ICHIKUNI (M.), 1983.- Anionic Substitution in Calcium Carbonate ; in *Augustithis*, N. (Ed.) ; The significance of trace elements in solving petrogenetic problems and controversies ; (Athens), pp. 83-94.

LYNN (M.), WALTER (N.) & HANOR (S.-J.), 1979.- Orthophosphate effect on the relatively stability of aragonite and magnesium calcitee during early diagenesis. *J. Sed. Petrol.*, 49/3, pp. 937-944.

RISTVET (B.-L.), 1971.- The progressive history of Bermuda. *Bio. Stud. Res. Publ.*, 9, pp. 118-157.

STOFFER (P.), SUMMERHAYES (C.-P.) & DOMINIK (J.), 1980.- Recent pelletoidal carbonate sediments off Alexandria, Egypt. *Marine Geology*, 34.

G-VI7

Distribution of Recent Marine Sediments of the Continental Shelf off Sinai, Egypt

A.-A. EL-SAMMAK and M.-A. EL-SABROUTI

Department of Oceanography, Faculty of Science, Alexandria University, Alexandria (Egypt)

Abstract: Shelf sediments off Sinai Egypt were studied. A patchy distribution of sediments can be observed.Mud covers most of the area. It is assured that the distribution of the sediments is governed by the current in the area as well as the sources of the sediments.

Previous reconnaissance studies of the shelf sediments off the Nile delta have involved by several authors (El-Wakeel et al.(1974); Misdrop and Sestini (1976); Summerhays and Marks(1976); El-Wakeel and El-Sayed(1978); Summerhays et al.(1978); Coleman et al.1981;Yanaki and Kronfeld(1982); El-Sammak(1987); El-Sabrouti and El-Sammak(1988);· El-Askary and Frihy (1986) reviewed most of these studies; they mentioned that the near-shore facies is restricted to depths shallower than 30 m. in depth , which is a delta front platform covered with fine to very fine sand and admixture of sand and silt further seaward (offshore), prodelta mud which is composed of silt and clay extends almost as far as the shelf edge (20 -70 m. in depth). Scattered patches of relict medium to coarse sand occur near the middle of the shelf; seaward of this, there is a broad muddy sand zone of high organic silty clay and clays (mud).
The present study is in accordance with the previous studies; however the eastern part, East of Port Said (i.e. off Sinai) is hardly ever studied. Actually the present study fills this gap. Accordingly a complete general picture for the type of sediments as well as their distribution can be given for the area of the south eastern Mediterranean Sea off Sinai peninsula east of Damietta.

The area surveyed (Figure 1.) covers the continental shelf and part of the upper continental slope of the south easter Mediterranean Sea between 2 m. and 445 m. 30 sediment samples were collected using a peterson grab sampler with a movable upper lied that covers surface area of 65 cm by 35 cm. Detailed granulometric analysis were made by standard sieve and pipette methods. The sediment types were given according to the method of Shepard (1954).

The study area shows a patchy distribution of the sediments. In general most of the outer shelf and the upper slope are covered with mud, this is due to the failure of coarse materials to reach the outer shelf, mud also covers most of the innershelf off the study area between Damietta and El-Tena . This area is characterized by receiving great amount of the fine materials,loaded by the Nile waters and lake waters through Rosetta branch and El-Manzalah lake opening (Boughaz El-Gamil). Sand presents in the innershelf area off Dameietta derived mainly through Burullus lake opening. Silty sand , sandy silt and sand patches occur off El-Tena. El-Bardawil and El-Arish could be attributed to the secondary wind-borne deposits coming from northern Sinai. Middle shelf sand patch occur off Damietta may be related to the older mouths of the Nile (Misdrp and Sestini;1976). Generally, the distribution of the sediments is governed by the current in the area as well as by the source of the sediments. In the south eastern Mediterranean, the general current is directed eastward, as a results most of the Nile sediments are deposited in a NNE direction. However, east of Damietta the eastern current slows down and follows two directions,ESE with a velocity of 6 cm/sec and anther opposite current with a velocity of 4.6 cm/sec.(Mohamed and Anwar;1978), making a sort of wide vortex. As a result , most of the fine sediments carried by the current are deposited in the area between Damietta and El-Tena.

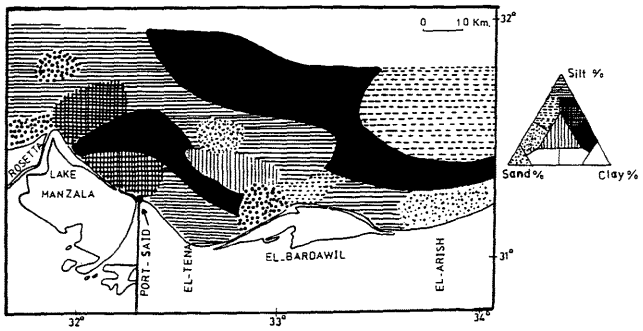


Figure 1. Areal distribution of sediments in the study area.

References:
Anwar,Y.M.;M.A.El-Askary and O.E.Frihy (1984).J.Afr.Earth Sci.,2:17-29.
Coleman,J.H.;H.H.Roberts;S.P.Murray and M.Salama (1981).Mar.Geol., 42:301-326.
El-Askary,M.A. and O.E.Frihy(1986).J.Afr.Earth Sci.,5:627-633.
El-Sabrouti,M.A.and A.A.El-Sammak(1988).1st Sym.Env.Sci.Alex.:32.
El-Sammak,A.A.(1987).M.Sc.Thes.Alex.Univ.(unpub.Mans.).
El-Wakeel,S.k. and M.Kh.El-Sayed(1978).Mar.Geol.,27:137-160.
El-Wakeel,S.K.;H.F.Abdou and M.A.Mohamed(1974).Geol.Soc.Iraq.,7:15-37.
Misdrop,R and G.Sestini(1976).Seminar om Nile delta Sed.Alex.:145-161.
Mohamed,M.A,and Y.M.Anwar(1978).J.Univ.Kuwait(sci.),5:152-161.
Shepard,F.P.(1954).J.Sed.Petrol.,24:151-158.
Summerhays,C.P.and N.Marks(1976).Seminar on the Nile delta Sed.Alex.:162-190.
Summerhays,C.P.;G.Sestini and R.Misdrop(1978).Mar.Geol.,27:43-65.
Yanaki,N.E.and J.Kronfeld(1982).Mar.Geol.,49:301-310.

G-VII1

Un exemple d'Impact de l'Interaction Tectonique - Eustatisme - Aménagements Anthropiques sur l'Equilibre d'un Domaine Littoral en Environnement Deltaïque Méditerranéen - L'Evolution Quaternaire du Littoral du Golfe de Tunis et ses Conséquences sur la Détermination d'une Stratégie d'Aménagement

Claude BOBIER*, Moncef SLITI** et Claude VIGUIER***

*Département de Géologie et Océanographie, Université de Bordeaux I, Avenue des Facultés, Talence (France)
**Direction des Ports Maritimes, Ministère de l'Equipement, Tunis (Tunisie)
***LERGA, Université de Bordeaux I, 355 Cours Gambetta, Talence (France)

Les auteurs présentent une synthèse des résultats d'une série de travaux d'océanographie géologique conduits sur le littoral du Golfe de TUNIS depuis 1980.

Dans un premier temps ils montrent que l'évolution quaternaire et particulièrement l'évolution récente du trait de côte sont le résultat de l'interaction dans un environnement deltaïque entre :
- l'évolution néotectonique active en raison du contexte géodynamique,
- et la courantologie au niveau du littoral et sur le proche plateau qui évolue en fonction des pulsations climato-eustatiques.

Il apparaît aussi que l'évolution naturelle des cortèges sédimentaires de haut niveau moyen des mers est fortement perturbée par l'impact des aménagements anthropiques réalisés dans les Bassins versants de l'Oued Medjerda et de l'Oued Miliane.

Dans une deuxième partie sont présentés les résultats d'observations et d'études expérimentales faites sur le comportement de brises lames dont l'implantation a été rendue nécessaire en raison du recul du littoral induit par ces interactions entre tectonique-eustatisme et aménagements anthropiques.

En conclusion, des règles touchant les caractéristiques des brises lames sont dégagées et une réflexion sur la stratégie d'aménagement du Nord de la TUNISIE est conduite.

G

Holocene Sedimentation on the Western Egyptian Shelf

Torbjörn ALEXANDERSSON

Geology Department, Uppsala University, Box 555, S-751 22 Uppsala (Sweden)

The Egyptian shelf in the Mediterranean Sea exhibits two sedimentary regimes: (1) The Western desert-fronting shelf; (2) The Nile delta-front with its down-current (easterly) field of influence. The transition zone lies at Alexandria near longitude 30E.

Much work has been focused on the Nile-influenced shelf, while data from the Western shelf are just beginning to appear. Specifically, studies in the Arabs Bay have discovered a regime of abiotic carbonate sedimentation producing modern aragonite oolites and aragonite mud.

ARABS BAY

The Arabs Bay shelf lies W of Alexandria. For 120 km, from Point Abukir to El Alamein, shelf width is 18-20 km; a distinct shelf edge runs at 80 m depth (44 fm). The area is 2,500 km^2, with no less than 700 km^2 (28%) in the littoral zone inside the 15 m (8 fm) depth contour. The Bay is closed to bed-load sediment input from W by morphological constraints at El Hekma and El Daba. Net transport is setting E, leaving the Arabs Bay shelf unaffected by Nile delta material. The result is a sea-floor starved for allochtonous sediments.

Bedrock belongs to the Marmarica Formation, a Middle Miocene sequence of calcarenites capped by Pliocene limestone (El Shazly, 1977). It has been tectonically stable at least since the close of the Lower Pleistocene (Fairbridge, 1972).

Sea levels during the last 300,000 years generally have been lower than today, giving the Western shelf a long history of subaerial exposure. The last regression dropped below -80 m about 18,000 BP (Milliman & Emery, 1968; Thunell, 1979), remaining low for 7,000 years.

Around 11,000 BP the sea rose again over the shelf edge in the last Holocene transgression. It passed the -15 m depth contour as recently as 8,000-6,000 years ago. The wedge of biogenic carbonates produced during this last transgression is on the order of 0.5 m in the off-littoral; even less in the littoral.

SHAMMAMA BANKS OOLITE

The Shammama Banks off El Alamein are a littoral oolite field 5x24 km in size. Main morphological elements are seven submarine ridges, 10-15 km in length and several hundred meters in width, pointing SE. These are hydrodynamic bed-forms rising from barren rock floor at water depths of 12-15 m, running through the breaker zone and terminating in the shoreface.

The bank material is pure oolite sand, both in the ridges and on inter-ridge seafloor. Median grain size is 600 µm. The tail of material smaller than 250 µm (possible desert sand) is <1%.

The oolite is virtually 100% carbonate. A sample of 10 g left a residue of 20 mg after dissolution in dilute HCl (=carbonate content 99.8%). The residue consists mainly of clear quartz <63 µm from intragranular hollows in the ooids.

The ooid cortex phase consists of concentrically laminated aragonite enclosing a nucleus phase entirely of Mg-calcite and aragonite (no low-Mg calcite, no quartz). This indicates a direct marine supply of nuclei from off-littoral shell sands. It is noteworthy that terrigenous sand from the Sahara has no real part in the littoral sedimentation here, neither as grains as such, nor as nuclei for ooid growth.

The bulk C-14 age of the cortex phase is 800 yr BP. Petrographic analysis shows oolitization in progress: Skeletal components (echinoderm needles, small gastropods) occur in a series of transformation steps, from intact to thickly overgrown and rounded. For each skeletal category, the amount of transformed grains far outweighs the number of intact specimens. The picture is that of a low supply of biogenic products continuously exposed to cortical growth, thus forming ooid grains.

Landward and longshore sediment transport builds an oolite beach and coastal oolite dune reaching eastward to Alexandria. A radiocarbon age of weakly cemented dune material was 2,100 BP; the age of off-littoral shell sand from 20 m water depth 1,500 BP. This whole coastal sequence is, in fact, much younger than the Egyptian pyramids.

Off Point Agami, 80 km down-current (east) of the oolite banks, a pure aragonite mud of zero radiocarbon age accumulates at depths of 25-50 m (El-Sayed, in preparation). The coast-parallel current here fans out in a plume with very little momentum. Isotopic data indicate an abiotic origin of the mud.

THE NORTH AFRICAN OOLITE BELT

Arabs Bay emerges as the eastern end of a great North African Oolite Belt, extending 2,200 km from the Gulf of Gabès to the Nile delta. The NAO Belt is one of the world's major oolite fields. It borders the south coast of two basins - the Ionian and the Levantine - occupying half the length of the Mediterranean Sea, between longitudes 10E and 30E.

The coast is marked by a sequence of oolite dunes, running virtually uninterrupted the whole distance (Fabricius & Klingele, 1970; Emelyanov, 1972).

Off Djerba island in the Gulf of Gabès, relict oolites occur down to 13 m water depth, mixed with biogenic carbonates. Their radiocarbon ages are 6,000-30,000 yr BP (Fabricius et al., 1970; Blanpied & Bellaiche, 1981). Fabricius and co-workers state specifically that Tunisian ooids are not forming at the present time. They infer that the last period of oolitization terminated at the onset of a mid-Holocene cooler climate.

Emelyanov (1972) has one observation from the shelf in the innermost Gulf of Sidra, Libya. His sample No. 742 from 36 m water depth is described as oolitic sand with median grain size 550 µm and carbonate content 90%. In contrast to what is found in Arabs Bay, "heavy minerals (ore minerals, hornblende) often form the nuclei of ooliths, which then have a specific gravity above 2.9" (ibid., p. 371).

So far, Arabs Bay is the only area in the Mediterranean Sea where oolitization in progress has been observed. Conditions conducive to the process are: total absence of a terrigenous influx; high summer water temperatures (26 °C) and salinities (40 per mil); and a wide, shallow littoral zone exposed to strong water turbulence facilitating transport and degassing.

REFERENCES

BLANPIED, C., & BELLAICHE, G., 1981, Signification sédimentologique des oolithes calcaires et bioclastes noircis remaniés au sud-est de l'île de Djerba: *Géol. Méditerranéenne*, v. 8, p. 167-172.

EL SHAZLY, E. M., 1977, The geology of the Egyptian region, in, Nairn, A. E. M., Kanes, W. H., & Stehli, F. G., eds., *The Ocean Basins and Margins, Vol. 4A, The Eastern Mediterranean:* New York, London, Plenum Press, p. 379-481.

EMELYANOV, E. M., 1972, Principal types of recent bottom sediments in the Mediterranean Sea: their mineralogy and geochemistry, in, Stanley, D. J., ed., *The Mediterranean Sea: A Natural Sedimentation Laboratory*: Stroudsburg, Pa, Dowden, Hutchinson & Ross, p. 355-386.

FABRICIUS, F. H, BERDAU, D., & MUNNICH, K. O., 1970, Early Holocene oöids in modern littoral sands: reworked from a coastal terrace, S. Tunisia: *Science*, v. 169, p. 757-760.

FABRICIUS, F. H, & KLINGELE, H., 1970, Ultrastrukturen von Ooiden und Oolithen: Zur Genese und Diagenese quartärer Flachwasserkarbonate des Mittelmeeres: *Verh. Geol. Bundes-Anst. (Wien)*, Jahrg. 1970, p. 594-617.

FAIRBRIDGE, R. W., 1972, Quaternary sedimentation in the Mediterranean region controlled by tectonics, paleoclimates and sea level: in, Stanley, D. J., ed., *The Mediterranean Sea: A Natural Sedimentation Laboratory*: Stroudsburg, Pa, Dowden, Hutchinson & Ross, p. 99-113.

MILLIMAN, J. D., & EMERY, K. O., 1968, Sea levels during the past 35,000 years: *Science*, v. 162, p. 1121-1123.

THUNELL, R. C., 1979, Eastern Mediterranean Sea during the last glacial maximum; an 18,000-years BP reconstruction: *Quat. Res.*, v. 11, p. 353-372.

Cortèges Sédimentaires sur le Plateforme Rhodanienne - Caractéristiques Faciologiques - Calage Chronologique

Bernard GENSOUS*, David WILLIAMSON**, Michel TESSON* et Abdellah EL HMAIDI*

*Laboratoire de Sédimentologie et Géochimie Marines, Université, Avenue de Villeneuve, Perpignan (France)
**Laboratoire de Géologie du Quaternaire, CNRS, Faculté des Sciences de Luminy, Marseille (France)

L'analyse séquentielle de profils sismiques haute résolution récemment effectués sur la plateforme rhodanienne a permis de distinguer et de détailler l'agencement spatial des cortèges sédimentaires mis en place lors des variations glacio-eustatiques du Quaternaire terminal (Tesson et al., 1990).

Parallèlement, l'échantillonnage des cortèges sédimentaires les plus récents a été réalisé par carottages Kullenberg positionnés et corrélés aux données sismiques au moyen de profils de sondeur 3,5 KHz.

Le calage chronologique des prélèvements a été établi d'une part par datations ^{14}C sur les niveaux coquilliers, d'autre part par l'application, sur les dépôts terrigènes, de la méthode paléomagnétique des "variations séculaires", jusqu'alors utilisée en domaine continental (Williamson et al.,1990) .

La caractérisation des dépôts a été réalisée sur la base des paramètres lithologiques, texturaux, minéralogiques et géotechniques (El Hmaidi, 1989 ; Gensous et al., 1990).

Les dépôts progradants de cortèges de bas-niveaux sont subaffleurant sur la plateforme externe ("shelf perched lowstand wedges"). les données sédimentologiques et microfauniques montrent qu'ils se sont mis en place en domaine prodeltaïques (vases à monosulfures) à infralittoral cotier (alternances sables argiles) lors de la dernière baisse du niveau marin relatif. Ils sont recouverts par une mince couverture discontinue de vases hémipélagiques et de sables coquilliers glauconieux ("sables reliques du large") formant une section condensée associée à la remontée post-glaciaire du niveau marin.

Le cortège transgressif, peu développé sur le plateau externe où il constitue des terrasses rétrogradationnelles, s'épaissit en direction du continent. Sur le plateau médian, les dépôts se présentent sous forme d'une séquence globalement granodécroissante à alternances de niveaux silto-sableux évoluant verticalement vers des vases à monosulfures. Les accumulations les plus importantes se situent, à l'arrière d'un corps sableux, dans la partie occidentale du secteur étudié (entre l'embouchure du petit Rhône et Palavas); elle correspondent à une période de ralentissement de la remontée relative du niveau marin entre 10 et 8 Ka BP. Les dépôts transgressifs sont surmontés par un niveau coquillier puis des vases hémipélagiques représentant un intervalle condensée correspondant au dernier stade de la remontée du niveau marin relatif à l'Holocène terminal.

Les études antèrieures ont conduit à la mise en évidence, sur la plateforme interne, d'un "prisme sédimentaire épicontinental" (Aloisi, 1986). Les carottages, effectués dans ce prisme au droit du delta du Rhône, ont recoupé des vases prodeltaïques silteuses riches en matière organique contenant une abondante phase carbonatée détritique issue du bassin versant rhodanien ; elles passent, en domaine proximal, aux dépôts sablo-vaseux du front deltaïque puis aux sables des cordons litorraux. Les données chronostratigraphiques établies à partir des mesures paléomagnétiques et l'évolution verticale des paramètres sédimentologiques et géotechniques permettent de differencier les dépôts du cortège transgressif de ceux de la partie distale du prisme de haut niveau. Ce dernier atteint son plein développement au niveau de l'édifice deltaïque rhodanien dont l'édification, par progradation et migration latérale des distributeurs au-dessus du cortège transgressif a débuté lors de la période de ralentissement de la transgression Holocène (6 Ka BP).

Ces études sont réalisées dans le cadre du programme D.B.T. "Message Sédimentaire et Paléobiologique".

REFERENCES

ALOISI J.C., 1986. Sur un modèle de sédimentation deltaïque. Contribution à l'étude des marges passives. Thèse Doct., Univ. Perpignan, 162 pp.

El HMAIDI A., 1989. Géochronologie des dépôts holocènes de la plateforme rhodanienne. D.E.A. Univ. de Perpignan, 30p.

GENSOUS B., EL HMAIDI A., WILLIAMSON D. et TAIEB M., 1989. Caractérisation chronologique et sédimentologique des dépôts récents de la marge rhodanienne. 2ème Congrés Français de Sédimentologie, Nov 89. Paris. pp 133-134.

TESSON M., GENSOUS B., ALLEN G.P. and RAVENNE C., 1990. Late quaternary deltaic lowstand wedges on the Rhône continental shelf, France. In Press. Marine Geology.

TESSON M., RAVENNE C. et ALLEN G.P., 1990. Application des concepts de stratigraphie séquentielle à un profil de sismique haute résolution transverse à la plateforme rhodanienne. C. R. Acad. Sci. Paris, t. 310, Série II, p. 565-570.

WILLIAMSON D., GENSOUS B., EL HMAIDI A., TAIEB M. and HOUVENY M., 1990. Deltaic platform deposits as recorders of geomagnetic oscillations. In Press. Marine Geology.

G-VII4

The Rhône Deltaic Margin : a Preferential Natural Laboratory for Testing Sequential Stratigraphy Concepts in High Resolution Analysis

Michel TESSON*, Bernard GENSOUS*, André MONACO*, Henri GOT*, Maurice TAIEB**, David WILLIAMSON**, Lorenzo MIRABILE*** and Jordi SERRA****

*Laboratoire de Sédimentologie et Géochimie Marines, URA 715 du CNRS, Université, Avenue de Villeneuve, Perpignan (France)
**Laboratoire de Géologie Quaternaire, CNRS, Faculté des Sciences de Luminy, Marseille (France)
***Istituto Universitario Navale, Via Acton 38, Napoli (Italia)
****Departament de Geologia Dinamica, Geofisica i Paleontologia, Zona Universitaria de Pedralbes, Barcelona (Espagne)

Detailed stratigraphic models of modern deltaic systems have not been proposed yet in terms of the sequential analysis developed since 1977 by EXXON scientists and others, except for a few studies of the Louisiana shelf (SUTER and BERYHILL, 1985). Deltaic environments which are characterized by high sedimentation rates have recorded and preserved worldwide fluctuations of the natural environment (climatic) and effects of regional stresses (tectonic, hydrodynamical). These events can be identified from the distribution of sedimentation patterns, variations of sedimentological parameters and facies and changes in biological communities. Chronostratigraphic models would certainly be helpful for the exploration and management of natural resources and the assessment of the impact of changes introduced by human activities .

A programme was developed since 1987 in the Rhône continental margin with national and international participants. It is included in "DBT" ("Dynamique et Bilan de la Terre) national programme supported by INSU-CNRS and oil companies (TOTAL and IFP) and based on the previous studies carried out by various laboratories which are now involved in the new program .

The time scale sequence is of order 5 (VAIL et al., 1977) and studies are focussed on the latest cycles of the Quaternary. A coherent data base should contain a continuous and homogeneous grid of high resolution seismic profiles coupled with outcrop and well sampling performed with the same level of precision. Boring would be one of the task for the future European Research Vessel but seismic data acquisition started in 1987. Outcrop core sampling which began one year later has been based on efficient location systems and preliminary mud penetrator profiling. These studies should rely on precise time scales (secular) which require paleomagnetic measurements to be adapted to shallow marine environments, besides data provided by more classic methods .

A first homogeneous grid of seismic lines has been achieved which provides a high resolution continuous recording of acoustic reflectors from the shoreface to the upper slope which will be complemented. The late Quaternary deltaic shelf deposits mainly consist of stacked prograding wedges built up during relative sea-level variations which are classical features of the shelf. The construction of such wedges was attributed to a period of sea-level highstand according to the initial model by VAIL et al. (1977). But our recent studies (TESSON et al., 1990a et b, WILLIAMSON et al., 1990) have shown that they should be considered as "Shelf-Perched Lowstand Wedges", at least the uppermost ones. This interpretation is based on the rates of shifts and the regional bathymetry of their coastal onlap. This implies new developments which are supported by recent studies already taken into account in the new global high frequency models (POSAMENTIER and VAIL, 1988) .

Subsurface data which were obtained by a coring network adapted to the sismostratigraphic scheme are consistent with the new interpretation. Only the uppermost Shelf Perched Lowstand Wedge is well documented from a stratigraphic point of view. Lateral correlations lead to assume an age 25-30 000 yrs BP. At 120m water depth, the sedimentary facies varies from prodeltaic silty muds rich in organic matter to coarsening up interbedded sand/mud of basal shoreface and near intertidal environments. These facies are described for the first time. They contain microfaunal associations which are consistent with the proximity of sediment distributaries moving seaward during small-scale eustatic falls in sea-level. This time and paleaobathymetric record well agrees with the "Shelf-Perched Lowstand Wedge" model.

The detailed two-dimensional chronostratigraphy is well documented for the Transgressive and Highstand System Tracts and the condensed section of the postglacial time. Fine sequential analysis agrees well the typical patterns of such system tracts, the carbonate/terrigenous ratio excepted. They can be assumed to be related to sea-level oscillations of higher frequency (parasequences). The last set of cores should lead to identify allocyclic to autocyclic events .

The very high resolution programme carried out in the Rhône continental margin participates in the development of new concepts in high frequency sequential stratigraphy, such as Shelf-Perched Lowstand Wedges. This area which had been amply studied represents a preferential environment due to its limited extension and broad diversity of interactions, biological activity included, which can be quantified. The programme has been extended to the slope and the deep sea fan and should be developed furthermore .

REFERENCES

POSAMENTIER, H.W. and VAIL, P.R., 1988. Eustatic controls on clastic deposition . II Sequences and system tract models. In Sea-level changes - an integrated Approach. Soc. Econ. Paleontol. Mineral. Spec. Publ. 42: 125-154.

SUTER, J.R. and BERYHILL Jr., H.L., 1985. Late Quaternary shelf-margin deltas, Northwest Gulf of Mexico. Am. Pet. Geol. Bull., 69: 77-91.

TESSON, M., RAVENNE, Ch. et ALLEN, G.P., 1990a. Application des concepts de stratigraphie séquentielle à un profil sismique haute résolution transverse à la plate-forme rhodanienne. C.R. Acad. Sc. Paris, 310, ser. II: 565-570.

TESSON, M., GENSOUS, B., ALLEN, G.P. and RAVENNE, Ch., 1990b. Late Quaternary deltaic lowstand wedges on the Rhône continental shelf, France. Marine Geology, in press .

VAIL, P.R., MITCHUM Jr., R.M., TODD, R.G., WIDMIER, J.M., THOMPSON III, S., SANGREE, J.B., BUBB, J.N. and HATLELID, W.G., 1977. Seismic stratigraphy and global changes of sea-level. In Seismic Stratigraphy - Applications to hydrocarbon exploration, C.E. Payton ed., Am. Ass. Petrol. Geol., Mem. 26: 49-205.

WILLIAMSON, D., GENSOUS, B., EL HMAIDI, A., TAIEB, M. and THOUVENY, N., 1990. Deltaic platform deposits as recorders of geomagnetic oscillations. Marine Geology, in press .

G-VII5

Stratigraphie Séquentielle des Unités Sédimentaires Quaternaires de la Plateforme Rhodanienne - Mise en évidence de Prismes de Bas Niveau Marin Relatif

Michel TESSON* , Bernard GENSOUS* , Georges Paul ALLEN** , Christian RAVENNE*** et Lorenzo MIRABILE****

*Laboratoire de Sédimentologie et Géochimie Marines, Université, Avenue de Villeneuve, Perpignan (France)
**Total Exploration Laboratory, Pessac (France)
***Institut Français du Pétrole, Rueil Malmaison (France)
****Istituto Universitario Navale, Via Action 38, Napoli (Italia)

La plateforme continentale rhodanienne constitue un secteur propice (marge passive, mer sans marée, apport terrigène ponctuel important) à l'étude de l'enregistrement sédimentaire des effets des variations cycliques (glacio-eustatiques) du niveau relatif marin.

L'analyse séquentielle, selon les concepts développés par Posamentier et Vail (1988), de profils récents de sismique haute résolution a permis de détailler l'agencement et les conditions de mise en place des unités sédimentaires du Quaternaire terminal (Tesson et al., 1990).

La plateforme continentale apparait constituée d'unités progradantes superposées, en forme de prismes, s'épaississant (50-60m) vers le bassin et se biseautant en onlap sur la plateforme interne-moyenne. Chaque prisme est constitué de réflecteurs obliques à sigmoïdes, pentés vers le large et subhorizontaux à leur base (downlap). La partie supérieure des prismes est parfois incisée par des chenaux de quelques km de large et 10-15 m de profondeur.

Des unités sédimentaires, à configuration rétrogradationnelle en onlap, séparent les prismes. Elles sont généralement peu développées, à l'exception de la plus récente, dont le sommet constitue le fond marin, qui s'épaissit vers le continent et se raccorde à l'appareil deltaïque rhodanien.

Les prismes progradants quaternaires qui ont construit la plateforme rhodanienne peuvent être interprétés de deux façons contradictoires : prismes de haut niveau marin relatif ou prismes de bas niveau marin relatif. La haute résolution et la bonne couverture régionale des données sismiques permettent de trancher entre ces deux hypothèses :

- L'analyse détaillée de la configuration interne des prismes progradants montre que les clinoformes sont, de façon répétée, tronquées par des surfaces obliques sur lesquelles viennent se biseauter, avec un décalage vers le bas, les cliniformes suivants. Ce type de disposition, en "downward shift", déja décrit (Plint, 1988) résulte d'une baisse saccadée du niveau marin relatif.

- A l'échelle régionale, le prisme le plus récent vient se biseauter vers le continent à une profondeur constante comprise entre 80 et 90 m sous le niveau marin actuel. Du fait de sa mise en place relativement récente, probablement juste avant le dernier maximum glaciaire, une intreprétation en prisme de haut niveau marin relatif oblige à envisager une subsidence de 50 à 60 m ce qui est incompatible avec les données connues pour cette marge passive (Lefevbre, 1980).

Au vu de ces données, il apparait donc que les prismes progradants ont été mis en place durant les phases terminales de baisse du niveau marin et représentent des "Shelf Perched Lowstand Wedges" dont l'existence avait été récemment envisagée (Posamentier et Vail, 1988)

Les périodes de remontée du niveau marin relatif correspondent à la mise en place, au-dessus des surfaces de ravinement, du remplissage des vallées incisées puis des cortèges transgressifs rétrogradationnels ici peu développés du fait sans doute du taux important de remontée ; lorsque leur épaisseur est infèrieure à la limite de la résolution sismique, la surface de ravinement apparait comme marquant une limite de séquence.

L'unité tout à fait supèrieure, située au-dessus du prisme de bas niveau le plus récent, peut être subdivisée en un cortége transgressif, marquée sur le plateau externe par des terrasses rétrogradationnelles, et surmonté prés du continent par les clinoformes de la partie distale du cortége de haut niveau. Celui-ci atteint son plein développement au niveau de l'appareil deltaïque du Rhône qui s'est édifié par progradation depuis la période de ralentissement de la transgression Holocène.

Ces études sont menées dans le cadre du programme D.B.T. "Message Sédimentaire et Paléobiologique".

REFERENCES

LEFEBVRE D. 1980. Evolution morphologique et structurale du Golfe du Lion. Essai de traitement statistique des données. Thèse 3e cycle, Univ. Pierre-et-Marie-Curie, Paris, 163p.

PLINT J.M., 1988. Sharp-based shoreface sequences and "offshore bars" in the Cardium formation of Alberta : their relationship to relative changes in sea level. In : Sea-level Changes-an integrated approach. Soc. Econ. Paleontol. Mineral. Spec. Publ., 42 : 357-370.

POSAMENTIER H. W. and Vail P.R., 1988. Eustatic control on clastic deposition II. Sequence and system tract models. In : Sea-level Changes-an integrated approach. Soc. Econ. Paleontol. Mineral. Spec. Publ., 42 : 125-154.

TESSON M., GENSOUS B., ALLEN G.P. and RAVENNE C., 1990. Late quaternary deltaic lowstand wedges on the Rhône continental shelf, France. In Press. Marine Geology.

TESSON M., RAVENNE C. et ALLEN G.P., 1990. Application des concepts de stratigraphie séquentielle à un profil de sismique haute résolution transverse à la plateforme rhodanienne. C. R. Acad. Sci. Paris, t. 310, Série II, p. 565-570.

First Results of the "SARECO" Cruise on the Rhone Fan : Further Evidences of Destabilization Processes

Equipe SARECO
Michel TESSON*, Bernard GENSOUS*, Laurence DROZ**, Valérie GAULLIER**, Michel VOISSET*** and Yann MEAR****

*Laboratoire de Sédimentologie et Géochimie Marines, Université, 66000 Perpignan (France)
**Laboratoire de Géodynamique Sous-Marine, B.P. 48, 06230 Villefranche-sur-Mer (France)
***DERO/GM, IFREMER, B.P. 70, 29263 Plouzané (France)
****INTECHMER, B.P. 324, 50103 Cherbourg (France)

Most fan constructions were set up as sequential units which reflect the cyclic variations in relative sea-level . The main depositional features can be related either to constructional processes (overbank deposits) or to destructive ones such as gravitational failures . High quality acoustical data are needed to recognize internal characteristics, patterns and unconformities and to identify the relationship between deposits in order to correlate high frequency sea-level changes with the resulting stratigraphic sequences.

The poster presented illustrates the main depositional features which are well developed at the top of the upper constructional series of the Rhone fan (northwestern Mediterranean Sea, France). It is the first contribution of a research programme which began in November 1989 (SARECO cruise) using a deep-towed sonar and 3.5 kHz profiler ("SAR", Système Acoustique Remorqué) .

The construction of the Rhone fan began at the end of the Messinian crisis which was followed by the flooding of the Mediterranean Basin during the Plio-Quaternary period . The fan was fed with terrigenous material discharged by the Rhone River and transported through the Petit Rhone Canyon . Its structure results from the stacking-up of sedimentary bodies superposed during four main successive phases ("basal", "lower", "upper" and "surficial" series (DROZ and BELLAICHE, 1985). The surficial series is well displayed only to the west. Therefore the "upper" one can be observed elsewhere . It shows at its top, on both sides of the fan, two large sedimentary bodies which contain chaotic or transparent seismic facies interpreted as debris-flow deposits. The eastward transparent unit has been mapped over 5100 km² . It reaches 160 m in thickness and represents about 170 km³ (BELLAICHE, COUTELLIER, DROZ et LE CANN, 1990). It originated from the remobilization of previously stratified deposits . The 3.5 kHz lines and sonograms have shown scarps with truncated strata at the location where the movement was initiated . Sliding of sediments deposited on both the continental slope and deep-sea channel levees are documented .

Geotechnical properties of sediments (water content, plasticity and cohesion) were determined at the eastern limit of the western transparent unit (BOUYE, 1983; MEAR, 1984). A poorly cohesive grey silty mud body (CU < 40-50) was found to lay unconformably on cohesive silty mud (CU ranging from 40 to 80) . It thickens away from the limit of the unit and is overlain with thin Holocene recent grey mud, separated by an oxidized layer dated of 11.000 yrs B.P.. These variations of the geotechnical properties of the grey silty mud can be assumed to illustrate the abnormal superposition of the destabilized unit over the levee overbank stratified autochtonous deposits .

The uppermost construction ot the deep-sea fan is due to a large extent to gravity induced mass transport which affected poorly compacted water-rich sediments on steep slopes and channel levees . These processes are assumed to have occurred mainly during the interglacial period and especially sea-level initial lowering (COLEMAN and ROBERTS, 1988) . Efficient new tools are still needed to study and correlate the major processes operative in deep-sea environments during the high frequency cycles of sea-level of the Quaternary . The SAR survey has provided such detailed information .

This programme will be developed and complemented by coring and in situ geotechnical measurements both in stratified and remobilized sedimentary units in the Rhone fan.

REFERENCES

DROZ, L. and BELLAICHE, G., 1985. Rhone deep-sea fan : morphostructure and growth pattern . Am. Ass. Petrol. Geol. Bull., 69 : 460-499.

BELLAICHE, G., COUTELLIER, V., DROZ, L. et LE CANN, C., 1990. Les glissements en masse du glacis provençal. Oceanologica Acta, sous presses.

BOUYER, C., 1983. Etude des corrélations entre la réponse sismique haute-résolution de quelques types de dépôts meubles . Thèse, Univ. Perpignan, 163p.

MEAR, Y., 1984. Séquences et unités sédimentaires du glacis rhodanien (Méditerranée occidentale) . Thèse, Univ. Perpignan, 214p.

C.I.E.S.M. Mediterranean Ocean Drilling Program Workshop

J. MASCLE

Laboratoire de Geodynamique Sous-Marine, B.P.48, 06230 Villefranche-sur-Mer (France)

So far, three scientific deep sea drilling cruises have been conducted in the Mediterranean : DSDP Leg 13 in 1970, DSDP Leg 42 in 1975, and more recently ODP Leg 107, in 1986.

DSDP Leg 13 was chiefly devoted to the first global exploration of the recent sedimentary cover of the domain. the results focused on one of the specific catastrophic event that occured in the Mediterranean : the Messinian dessication-salinity crisis. These results have allowed discussions and speculations on the significance, reasons and consequences of this paleo-environmental catastrophe, that occured some 5 MA ago.

DSDP Leg 42A, also facing the Messinian salinity model, allowed to illustrate the complex and puzzling evolution of the present Mediterranean, made of recent back-arc type basins developing in the middle of Mesozoïc oceans remnants as a consequence of the Africa-Europe convergence.

ODP Leg 107 recently focused on a transect study of the most recent the Mediterranean sub-basins : the Tyrrhenian Sea where opening processes also interact with the Messinian dessication event. Both the drilled sedimentary and basement sections have allowed to better understand and tentatively model rifting and magmatic processes that occur in response to a collision controlled opening and subduction.

Since 1986 and the COSOD II conference, many reports from various ODP structures have strongly recommended to look both towards global perspectives and new frontier experiments. After nearly twenty years of successful results in the Mediterranean, we believe that it is also time to propose drilling operations that should adress global prospects. In this challenge we believe that the Mediterranean Sea can play its part. As stressed during a previous Mediterranean ODP worshop held in Athens (1988), the Mediterranean represents the only area in the world where two large continents are progressively entering collision, therefore the Mediterranean is the only area where processes at colliding continental plate boundaries can really be studied.

In organizing this second workshop, we are concerned by a triple goals :

1.- to propose global scientific targets that can be addressed using new development in drilling technology (deep hole);
2.- to combine if possible deep drilling with *in situ* (logging) and possibly nearby geophysical experiments;
3.- to preserve further use of holes for future potential *in situ* experiments that may be organized using other platforms (drilling, submersible).

We believe that potential ODP programs for the Mediterranean sea will be successfull only if these goals are reached under internationaly managed team.

I-I1

L'Origine de la Flore des Iles Baleares : Endemisme, Paleogéographie, Paeozoologie, Anthropologie

Angels CARDONA

Laboratori de Botanica, Facultat de Ciències, Universitat Autonoma de Barcelona, Bellaterra, Barcelona (Espagne)

Il faut distinguer, aux Baléares, deux groupes d'îles par leur âge, leur végétation et leur climat: les Baléares orientales et les Baléares occidentales.

- Les Baléares orientales comprenant Majorque et Minorque (400 millions d'années) possèdent le Quercion ilicis , l'Oleo-Ceratonion qui constituent souvent un refuge pour quelques endémiques, et un Rosmarino-Ericion appauvri dans lequel manquent des taxons ibériques et, enfin, plusieurs communautés endémiques formant la végétation caractéristique.

Le climat de type méditerranéen est relativement humide.

- Les Baléares occidentales ou îles Pithyuses avec Ivice et Formentera (200 millions d'années) montrent l'absence du Quercion ilicis alors que l'Oleo-Ceratonion est bien représenté et un Rosmarino-Ericion à caractère ibérique.

Aux Pithyuses, une soixantaine d'espèces sont communes avec le Sud-Est de la Péninsule ibérique et ne se trouvent pas aux Baléares orientales.

Le climat, méditerranéen, est plutôt sec.

L'endémisme végétal, aux Baléares, se présente comme un phénomène très complexe qui dépend de nombreux facteurs essentiellement historiques attachés à la paléographie de la Méditerranée occidentale et liés à l'isolement insulaire, génétiques, écologiques et anthropogènes.

Une partie importante de la flore endémique des Baléares orientales constitue,avec une part de celle de la Corse et de la Sardaigne, un élément paléogène commun, méditerranéen et développé " in situ " sur un ancien massif hercynien qui, pendant l'Oligocène, se fragmenta (dérive du bloc corso-sarde). Les taxons tyrrhéniens(16), communs aux îles citées, l'existence de paléo-endémiques (21), de patro-endémiques (9) et de schizo-endémiques à aire de distribution de type fossile (30) montrent l'ancienneté de cette flore endémique. Il en est de même pour la faune. En effet, les aires de distribution de plusieurs endémiques renforcent cette hypothèse: Planariae, Tenebrionidae, Formicidae, des rongeurs ainsi que d'autres mammifères...

La formation de l'archipel des Baléares remonte à l'orogènèse alpine. L'érection des Chaines Pré-Bétiques qui se termineront par un éperon jouxera la partie dégagée du massif hercynien.

Les affinités floristiques entre les endémiques des îles Pithyuses, de rang souvent subspécifique, avec des taxons du Sud-Est de l'Espagne et, parfois du Nord de l'Afrique montrent des phénomènes de spéciation dont l'origine est moins ancienne que celle des endémiques des Baléares Orientales. Les schizo-endémiques récentes (21) et les apo-endémiques (12) indiquent une activité évolutive relativement récente au sein de la flore baléarique.

Cette activité est en relation avec la paléogéographie: le Messinien et les glaciations. Pendant la première période, le fort desséchement de la Méditerranée a provoqué des émersions considérables de terres permettant des échanges floristiques et faunistiques (Afrique du Nord, Sud-Est de l'Espagne, îles Pithyuses , Baléares orientales). Le passage du rupicaprain Myotragus de la Péninsule ibérique aux Baléares date de cette époque.

L'ouverture du détroit de Gilbratar, ultérieurement, rétablira l'isolement insulaire. La différenciation et l'évolution ees taxons se poursuivra sur place comme le prouve la présence de nombreuses endémiques inchoactives (17).

L'action anthropogène fut et est encore très forte. L'arrivée de l'homme aux Baléares causa la disparition des Myotragus qui avaient subi une évolution très remarquable et, selon toute probabilité de celle de tous les animaux endémiques et de nombreuses plantes. Une des causes principales fut l'introduction par l'homme d'animaux , de plantes et de graines pour leur utilité. Il est cependant difficile de préciser quelles ont été les plantes introduites et leur action sur les endémiques.

La flore des Baléares dont l'origine méditerranéenne est surtout paléogène apparait actuellement comme une flore très active en pleine évolution.

CARDONA, A. & J. RITA. 1983. Aportació al coneixement de la flora balear. Folia Bot. Miscellanea 3 : 35–42.

CARDONA, A. & J. CONTANDRIOPOULOS. 1983. Chromosomic numbers reports (Pres. A. Löve). Taxon, 32 : 323–324.

CONTANDRIOPOULOS, J. & A. CARDONA. 1984. Caractère originale de la flore endémique des Baléares. Bot. Helvetica, 94 : 101–132.

CARDONA, A. 1984. Caryosystématique et différenciation évolutive de quelques Rubia méditerranéennes. Webbia, 36 : 513–529.

CARDONA, A.; J. CONTANDRIOPOULOS & E. SIERRA. 1986. Étude biosystématique comparée d'Anthyllis hystrix (Willk. ex Barc.) comb. nova et d'A. hermanniae L. Orsis, 2 : 5–25.

CARDONA, A. 1986. Ganoderma lucidum nova per a Menorca. Folia Bot. Miscellanea, 5 : 147.

GOMEZ–CAMPO, C., A. CARDONA et al. 1987. Libro Rojo de especies amenazadas de la España peninsular e Islas Baleares. ICONA. Madrid.

CARDONA, A. 1988. El món vegetal. Enciclopèdia de Menorca, tomo 2. Ed. J.M. Vidal. Maó.

I-I2

Biotopes de l'Ile de Tinos (Cyclades, Mer Egée Centrale) et leur destruction : milieux humides sous l'influence de l'eau douce et saumâtre

Nikolaos KYRTATOS

Centre de Recherches Marines et Côtières, Tinos (Grèce) et Institut für Meereskunde, Kiel 1 (R.F.A.)

Communautés végétales des milieux humides

* = espèce étrangère,introduite à Tinos; (*) = espèce probablement étrangère,introduite à Tinos. P = présence; I = 1-20% des échantillons;..... V = 81-100 % des échantillons; 1=présence aux échantillons,si leur nombre est inférieur de cinq;...; 4=présence aux échantillons,si leur nombre est inférieur de cinq;(x) = hors des échantillons. R = recouvrement:+ = sporadique et recouvrement <5 %; 1 = recouvrement <5 %; 2a = recouvrement 5-15 %; 2b = recouvrement = 16-25 %; 3 = recouvrement 26-50 %; 4 = recouvrement 51-75 %; 5 = recouvrement 76-100 %.Localités des inventeires à Tinos: E = est de Tinos; PSE = Porto au sudest de Tinos; SE = autres localités au sudest de Tinos; S = sud de Tinos; NO = nordouest de Tinos; N = nord de Tinos; NE = nordest de Tinos; T = total. Les espèces caractéristiques ou différentielles des communautés (associations,faciès ou catégories superieures) sont soulignées.

Catégories des biotopes	ruisseaux à Platanus orientalis	ruisseaux à Platanus et Nerium	ruisseaux à Nerium	milieux humides à Arundo donax	marais à Phragmites austra lis	marais à Phragmites et Juncus acutus	marais à Juncus acutus	marais à Ammophila arenaria
N°des catégories	1	2	3	4	5	6	7	8
Recouvrement végétal (%)	60- 90	55- 80	50-100	60-100	70- 90	±100	25-100	±100
Inclinaison (°)	5- 45	20- 30	2- 40	±1 - 2	± 1	± 1	± 1	± 1
Altitude (m)	30-280	50-200	1- 60	0 - 1	0 - 1	0,2-1	0,2-1,5	0,3
Distance de la mer (km)	1 - 4	0.5-1.5	0.01-1	0.02-0.1	0.02-0.1	0.02-0.2	0.02-1	0.02
Période	hiver 1988-1989 / hiver 1989-1990	nov-jan / janvier	dec-jan / dec-jan	dec-jan / 21.2.89	7.1.89 / nov-jan	19.1.89	dec-jan / nov-dec	30.12.88
Nombre des inventeires et leur localités à Tinos	1 SE + 3 S = 4 T	3 E + 1 SE = 4 T	10 PSE+2 SE+1 NO+1 N+3 NE=16T	1 PSE+1 NO +3 N=5 T	1 PSE + 1 S + 3 N = 5 T	2 PSE = 2 T	16 PSE+2 S + 1 NO = 19 T	1 PSE = 1 T

	1 P	1 R	2 P	2 R	3 P	3 R	4 P	4 R	5 P	5 R	6 P	6 R	7 P	7 R	8 P	8 R
Platanus orientalis	2	0-3	4	1-2b	I	0-1										
Arum italicum byzantinum	2	0-1			I	0-+			I	0-+			I	0-+	1	+
Rubus fruticosus ulmifolius	4	2a-3	3	0-2a	III	0-4					(x)		II	0-2a		
Vitis vinifera	3	0-1														
Populus alba	2	0-2b	1	0-1	I	0-1										
Salix alba	2	1-4	4	2a-3												
Salix species	3	0-2a														
Hedera helix	2	0-2a	2	0-1												
Cyclamen hederifolium	1	0-1	2	0-1												
Cyclamen species			2	0-+												
(+)Populus nigra	1	0-1														
Bellis perennis			2	0-+							1	0-+	II	0-+		
Myrtus communis	1	0-2a														
Rhamnus alaternus	1	0-2a														
Parietaria lusitanica	1	0-1														
Parietaria officinalis	1	0-2a											I	0-+		

N°des catégories	1 P	1 R	2 P	2 R	3 P	3 R	4 P	4 R	5 P	5 R	6 P	6 R	7 P	7 R	8 P	8 R
Smyrnium olusatrum	2	0-1	1	0-1	I	0-1							II	0-1		
Adiantum capillus-veneris			2	0-+	I	0-1										
Ranunculus species			1	0-+	I	0-+							I	0-1		
Vitex agnus - castus	1	0-1	2	0-2a	III	0-4							III	0-1	1	1
Nerium oleander	2	0-1	4	2a-4	V	2a-5			I	0-+	1	0-2a	II	0-1		
Inula viscosa	1	0-+	2	0-1	II	0-2a			I	0-+	1	0-1	IV	0-3	1	2a
Hyperrhenia hirta			4	+	II	0-2a							I	0-1	1	1
Methiola sinuata			1	0-1	(x)											
Narcissus tazetta					I	0-+										
Rosmerinus officinalis					I	0-1										
Sarcopoterium spinosum			1	0-+	III	0-1							I	0-1		
Bolboschoenus maritimus							I	0-+	I	0-+						
*Arundo donax	2	0-2b	4	1-2b	II	0-2a	III	0-5	I	0-1			I	0-1		
(*)Arundo species					I	0-1	II	0-4								
Chlorophyceae (1 species)					(x)		III	0-4	II	0-3			I	0-+		
Typha latifolia							II	0-2b	II	0-4						
Phragmites australis					I	0-+	I	0-+	IV	0-5	2	3	IV	0-2b		
Juncus acutus	1	0-1	2	0-+	III	0-2b	IV	0-1	II	0-2a	2	2a	II	2a-5	1	2a
Carex extensa													I	0-1	1	+
Samolus valerandi									I	0-+			II	0-+		
Sonchus arvensis													I	0-+		
Scorzonera parviflora	1	0-+			I	0-+							II	0-2a		
Agropyron pycnanthum					I	0-+							I	0-2a		
Plantago maritima											1	0-+	I	0-2a		
Schoenus nigricens			2	0-+	II	0-2a							III	0-3	1	1
Plantago major	1	0-1			I	0-+							I	0-+		
Foeniculum vulgare			3	0-+	I	0-1					1	0-1	III	0-2a		
Cichorium intybus					I	0-+							II	0-2a		
Viola palustris													I	0-+		
Daucus species					I	0-+					1	0-2b	II	0-2a	1	+
Scirpus holoschoenus			2	0-+	III	0-1	II	0-1	III	0-+			III	0-2b	1	1
Plantago lanceolata											2	1	II	0-1		
Centaurium species									I	0-+	1	0-+	I	0-+		
Cynodon dactylon											1	0-+	I	0-+		
Ononis spinosa					I	0-+							I	0-1		
Lotus corniculatus													II	0-+		
Geranium species					I	0-+							II	0-+		
Cynosurus echinatus											2	+-3	II	0-2a		
*Oxalis pes - caprae	1	0-+	4	+-1	III	0-2a	I	0-2b	I	0-+	1	0-1	IV	0-2b		
*Tamarix species					I	0-+							II	0-1	1	2a
Cynanchum acutum											1	0-1	II	0-1		
Limonium species									I	0-+	1	0-1	II	0-3	1	1
Chaetomorpha species									I	0-2a			I	0-1		
Arthrocnemum glaucum													I	0-+		
Atriplex hastata													I	0-+		
Sporobolus pungens									I	0-+			II	0-2b	1	1
Agropyron junceum					I	0-1					1	0-1	IV	0-2a	1	1
Ammophila arenaria					II	0-2a			I	0-+			III	0-2a	1	4
....et d'autres espèces																

On peut distinguer 4 communautés principales: a) L'association de Platanus orientalis et Salix alba (qui appartient au Populion albae) le long des ruisseaux vers l' intérieur de l' île; b) celle de Nerium oleander et Vitex agnus-castus (qui appartient aux Tamaricetalia) le long des ruisseaux cotiers; c) un Scirpo-Phragmitetum aux marais en eau douce et d) l'association de Juncus acutus (Juncion maritimi, probablement un faciès du Juncetum maritimo-acuti) aux marais en eau saumâtre. Toutes ces formations, de valeur fondamentale pour la survie des organismes rares, l'équilibre écologique et le climat, ainsi que Porto, qui est leur lieu le plus remarquable, sont en danger immédiat par l' urbanisation, le tourisme, la pollution. Les formations des milieux humides de Tinos à Ammophila arenaria et celles a Arundo donax proviennent de la destruction des formations autochtones originales.

Annual Evolution - Activity and influence of the Goat in two Insular Biotopes Island of Naxos, Cyclades, Aegean Sea, Greece

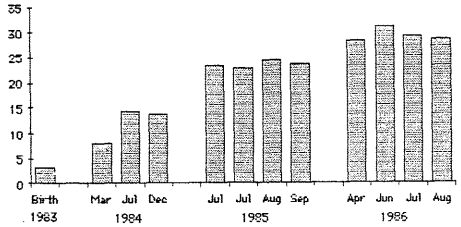
St.-N. MAGIORIS and G.-M. TSIOURLIS

Section of Ecology and Taxonomy, Department of Biology, University of Athens (Greece)

In the SE part of the island of Naxos,at the locations Sideroboukí and Troulada,we studied the annual evolution and the activity of the goat,and its influence upon the vegetation of the region. We also compared the results of an experiment of controlled pasturing against that of the traditional free pasturing which is done on these islands.

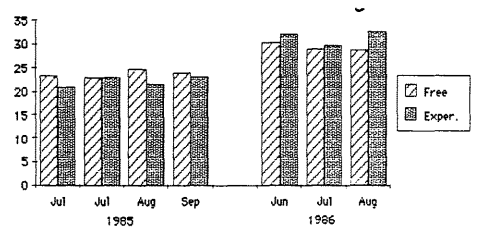
The biotopes which were under investigation consisted of phryganic and macchia vegetation.The main plants were: *Thymus capitatus,Genista acanthoclados, Quercus coccifera, Pistacia lentiscus*. The soil is characterised by the red mediterranean soil with intense erosion and the absence of leaf litter except under some shrubs. The island is characterized by a semi-arid mediterranean climate.In this area, during the summer period of drought, we usually have temperatures higher than 40°C, while the mean rainfall does not exceed 380 mm per annum,with some intense fluctuations.

FIGURE A. Free Pasturing - Coarse of the mean weight.



RESULTS AND DISCUSSION: During March of 1984 we selected an experimental group of 22 animals (20 females,2 males).These animals remained with the other goats of the flock until the beginning of July 1985 when the rotation grazing experiment was started.In March of 1985 we had fenced in this region an area of 2.4 Ha.In July we divided the experimental group in to two equal new groups of 11 individuals.One of these was transferred in to the fenced area,(which had not been pastured during the previous 4 months),while the other remained with the whole flock to be used as a control group. The experimental-animals remained there for 3 months,while from the beginning of August they were given supplemental food of oats and vetch,(0.3-0.4 Kgr/goat/day).The water required by the animals was brought in from a neighbouring well, by means of a pump. The next year,the experiment was repeated with another neighbouring flock with animals of the same age as the previous one.

FIGURE B. Coarse of the mean weight of the goats during Free and Experimental Pasturing.



The main aim was to avoid grazing upon vegetation during the period of the spring growth.The time required is 40-60 days,because the kerm oak, *(Quercus coccifera)* the main food in the diet of the goats will have completed its annual growth in this time.This aim could be achieved by rotation grazing. In this way the vegetation can be protected especially during the spring, a period,during which the danger of intense goat activity and influence interrupting even future plant growth, is very high.

The results of the annual evolution and experiment are given in Figures A,B.

CONCLUSIONS: 1. The traditional management of the flocks of goats which is employed on the islands of the Cyclades is based on the special abilities of resistance and adaptation of the native goat to the climatic conditions. It permits the animals to make use of the sclerophylus vegetation during the year.

2. The general condition of the flocks is not satisfactory. There is a high fluctuation in the percentage of mortality, 0-32%, especially in the immature animals. There is also a remarkable decrease in the goats weight during the summer months.This happens because the continuous and extreme grazing does not allow a normal growth of the vegetation which in turn depletes the vegetation's own nutrative reserves.And as direct result we have a decrease in the vegetation's nutrative value as a food. Finaly, it observed a low reproduction among the goats of ages less than two years,while animal productivity is medium to low.

3. The course of the mean weight of the goats was: At birth 3.3 Kgr, during the first spring of its life 8.0 Kgr and 14.6 Kgr at the beginning of the summer. Later,in the summer a reduction in the weight was observed and during the autumn it stabilized at 13.8 Kgr.

4. The experimentation proved the positive role of unpastured spring on the animals as well as of the provision of supplementary food during the critical dry period. By the end of the experiment we had a percentage of 8% in favour of the experimental group,and this means a fresh biomass increasee of 2.1 Kgr/goat and a simultaneus decrease of 0.5 Kgr/control-goat.For the immature animals the results were more visible.We had 23.5% in favour of the control immature goats. During the second year of the experiment we have the same type of evolution with different quantitative results because of an unusual wintering drought.

5. Finally we should note that in this study,even if the positive affect of the unpastured spring vegetation is not very clear,while the result of the supplementary food is more visible,it is certain that: with a rotation system of grazing we assist the vegatation to be more tolerant to future goat activity.

Sur le Peuplement Microfaunistique de deux Ilots Volcaniques de la Côte Méditerranéenne Espagnole

Enrique GADEA

Département de Biologie Animale (Zoologie), Université de Barcelone (Espagne)

Summary

In this paper is studied the lichen inhabiting microfauna in two little islets of Spanish mediterranean coast, particularly the nematofauna. Some regards on ecological and faunistic aspects are exposed. The nematocoenosis is very representative, with detritophageous and saprobiontic forms almost exclusively.

Resumen

Enesta nota se estudia el poblamiento microfaunistico liquenicola en dos islotes volcanicos del litoral mediterraneo español, particularmente la nematofauna. Se expone algunas consideraciones sobre los aspectos ecologicos y faunisticos. La nematocenosis es muy representativa, con formas detritofagas y saprobionticas casi exclusivamente.

Nous avons étudié, dans le cadre de cette recherche, deux îlots d'origine et de nature volcanique, mais ayant des caractéristiques différentes : le Columbrete Grande et l'Ile Mayor. Dans le premier cas, il s'agit d'un îlot du petit Archipel des Columbretes, à 35 Km au large de la Côte continentale Ibérique (Castellon); dans le second cas, l'Ile Mayor est située dans une petite mer littorale, la Mar Meñor (Murcie), au SE, près du Cap de Palos.

En ce qui concerne ces deux sites, il s'agit d'îlots de nature éruptive, mais tandis que les Columbretes sont de roches volcanique basique (type basaltique), l'Ile Mayor est constituée de riparites et riolites récentes, probablement pliocéniques, avec des andésites, d'où l'intérêt de comparer le peuplement microfaunistique de ces deux îlots.

Le matériel prélevé comporte exclusivement des Lichens (*Xanthoria aureola*) dans tous les échantillons. La nature de ce matériel est très uniforme dans les deux îlots ce qui a permis d'établir des comparaisons très valables, avec une certaine similitude dans les résultats. Il s'agit de petites masses de Lichens dont la réaction au milieu est acide (pH = 5-5,5).

La microflore est relativement pauvre en bactéries, mais révèle une abondance de Cyanophycées (*Nostoc, Oscillatoria*). La microfaune hydrophile présente des Rotifères, Tardigrades, Thécamoebiens, Ciliés et Nématodes. La composition relative de cette biocénose hydrophile est approximativement la suivante (par ordre de dominance) : Tartigrades, 40%, Ciliés, 25%, Rotifères, 20%, Nématodes, 10% et Thécamoebiens, 5%.

Nos études ont essentiellement porté sur la Nématofaune. les résultats concernant les Nématodes sont les suivants : *Pelodera (P.) teres*, 42%, *Ditylenchus intermedius*, 19%, *Plectus cirratus*, 13%, *Panagrolaimus rigidus*, 10%, *Tylenchus (F.) filiformis*, 8%, *Mesodorylaimus bastiani*, 3%, *Rhabdolaimus terrestris*, 2% et *Aphelenchoides parietinus*, 2%.

Du point de vue écologique, on constate que l'on retrouve essentiellement des éléments détritophages et saprobiontiques (représentés par des Tylenchoidés, 12%, des Araeolaimoidés, 32% et des Rhabditoidés, 50%), des éléments bryophages (représentés par des Dorylaimoidés, 6%) dans un seul échantillon, avec une espèce (*Mesodorylaimus bastiani*) et enfin, une absence totale de formes prédatrices (Mononchoidés et Tripyloidés).

Dans l'ordre faunistique, les espèces découvertes sont propres aux biotopes de ce type : il s'agit d'une Nématofaune caractéristique bien définie. Elles sont de formes communes et cosmopolites dont l'intérêt biogéographique est très faible. Il faut cependant tenir compte du peuplement récent de ces petits îlots volcaniques.

Bibliographie

GADEA (E.), 1964.- Sobre la nematofauna muscicola y liquenicola de las islas Pitiusas. *P. Inst. Biol. Apl.*, 37 : 73-93.

GADEA (E.), 1973.- Sobre la nematofauna liquenicola de Lanzarote. *Miscel. Zool.*, 3 (3) : 2-6.

GADEA (E.).- Nematodos liquenicolas de Columbretes. *Miscel. Zool.*, 3 (4) : 1-4

GADEA (E.), 1976.- Nematodos liquenicolas de la Isla Mayor. *Miscel. Zool.*, 3 (5) : 13-18.

RAMAZZOTTI(G.), 1958.- Note sulle biocenosi dei Muschi. *Mem Ist. It. Idrobiol. De Marchi*, 10 : 153-206.

I-I5

Chondrichthyes, Osteichthyes, Amphibia, Reptilia et Mammalia, recensés à Porto (Ile de Tinos, Mer Egée)

Nikolaos KYRTATOS

Centre de Recherches Marines et Côtières, Tinos (Grèce) et Institut für Meereskunde, Kiel (R.F.A.)

Abréviations. m : abondant à Porto ; + : observé à Porto ; r : rare à Porto ; a : observé dans d'autres secteurs de Tinos ; i : présence repérée par traces, repaires, émissions sonores, ect ... ; x : présence constatée d'après photos, descriptions ; * : espèces introduites ; A : 1980-89 ; B : 01.10.88-31.01.89 ; C : 26.06.89 - 19.07.89 ; D : 13.10.89 - 10.01.90.

Chondrichthyes	A	B	C	D
Scyliorhinus canicula	a			
Scyliorhinus stellaris	a			
Mustelus mustelus	a			
Galeorhinus galeus	a			
Prionace glauca	r			
Squalus acanthias	a			
Squatina squatina	+			
Rhinobatos rhinobatos	a			
Raja montagui	a			
Raja asterias	a			
Raja miraletus	a			
Raja radula	m	+		+
Raja clavata	a			
Raja oxyrhinchus	a			
Raja sp.(species A)	a			
Raja sp.(species B)	a			
Dasystis pastinaca	+			
Myliobatis aquila	r			
Torpedo marmorata	+			
Torpedo nobiliana	a			

Osteichthyes	A	B	C	D
Sardina pilchardus	m			
Sardinella aurita	m			
Engraulis encrasicolus	a			
Synodus saurus	+			
Myctophum spec.	r			
*Carassius auratus	a			
Anguilla anguilla	r			
Muraena helena	+			
Conger conger	m			
Ariosoma balearium	+			
Belone belone	m	+		
Hirundichthys rondeleti	a			
Trisopterus minutus	a			
Phycis phycis	m	+		+
Gaidropsarus mediterraneus	+			
Gaidropsarus vulgaris	+			
Merluccius merluccius	m			
Hippocampus ramulosus	+			
Syngnathus species	+			
Syngnathus typhle	+			
Zeus faber	+	+		+
Sphyraena sphyraena	+			+
Mugil cephalus	m			
Chelon labrosus	m			
Oedalechilus labeo	m			
Liza aurata	m	m		m
Liza ramada	m	+		
Mugilidae (≥1 species)			m	
Atherina mochon	m		m	m
Atherina hepsetus	m	m	m	m
Atherina boyeri	m			
Atherina species			m	m
Dicentrarchus labrax	+			
Epinephelus caninus	a			
Epinephelus gueza	+			
Epinephelus alexendrinus	+			
Epinephelus aeneus	+			

Osteichthyes	A	B	C	D
Serranus cabrilla	m	+		+
Serranus scriba	m			+
Serranus hepatus	r			
Anthias anthias	r			
Apogon imberbis	+			
Trachurus trachurus	a			
Trachurus mediterreneus	m			+
Trachurus picturatus	a			
Caranx rhonchus	+			
Carenx crysos	+			
Seriola dumerili	+			+
Lichia amia	+			
Trachynotus ovatus	+			
Coryphaena hippurus	+			
Sciaena umbra	m			+
Puntazzo puntazzo	+			
Diplodus sargus	m	m	+	m
Diplodus vulgaris	m	+	+	+
Diplodus annuleris	m		+	+
Lithognethus mormyrus	m	m	+	
Pagellus acarne	m		+	
Pagellus bogaraveo	m		+	
Pagellus erythrinus	+			a
Sparus pagrus	+			
Sparus aurata	+			
Dentex dentex	+			
Dentex macrophthelmus	a			
Spondyliosoma cantharus	+			
Oblada melanura	m		+	+
Serpa salpa	m	m		m
Boops boops	m			m
Spicara maena	m			
Spicara flexuosa	a			
Spicara smaris	m			
Mullus surmuletus	m		+	+
Mullus barbatus	r			
Auxis rochei	a			
Xiphias gladius	r			
Gobius niger	+			
Gobius bucchichii	m			
Gobius cruentatus	m			
Gobius cobitis	m			
Zoysterisessor ophiocephalus	+			
Pomatoschistus minutus	m		+	
Scorpaena porcus	m	m		+
Scorpaena scrofa	+			
Scorpaena notata	a			
Scorpaena maderensis	m	+		+
Trigla lucerna	m			+
Trigla lyra	a			
Eutrigla gurnardus	a			
Trigloporus lastoviza	a			
Aspitrigla cuculus	a			
Lepidotrigla cavillone	a			
Peristedion cataphractum	a			
Cephalacanthus volitans	+			
Bothus podas	m	+	+	
Arnoglossus laterna	a			
Arnoglossus thori	a			
Lepidorhombus boscii	a			
Scophthalmus rhombus	+			
Psetta maxima	+			
Pegusa lascaris	m	+	+	
Pegusa kleini	+			
Solea vulgaris	+		+?	
Microchirus ocellatus	a			
Monochirus hispidus	a			
Symphurus nigrescens(larvae	a			
Belistes carolinensis	a			
Lepadogaster lepadogaster	+			
Lophius piscatorius	r			

Amphibie	A	B	C	D
Bufo viridis	+x			
Hyla arborea	+			
Rana ridibunda	m	i		i

Reptilia	A	B	C	D
Testudo hermanni	+	+		
Testudo marginata	+	+		
Emys orbicularis	+			
Mauremys caspica	+	+		+
Caretta caretta	+			
Hemidactylus turcicus	m			+
Cyrtodactylus kotschyi	m		+	+
Lacerta trilineata	m		+	
Podercis erhardii	m		m	m
Lacertidae (1 species)				+
Reptilia	A	B	C	D
? Anguis fragilis	+x			
Ablepharus kitaibelii	m		+	+
Eryx jaculus	+		+	
Coluber jugularis caspius	m		+	+
Elephe quatuorlineata	+			
Natrix natrix	+			
? Natrix tesselata	+			
Telescopus fallax	+x			
Vipera ammodytes	m			+
Serpentes (1 species)				+

Mammalia	A	B	C	D
Erinaceus europaeus concol	m	+	+	i?
Rhinolophus species	+			
Chiroptera (≥1 species)	+	+	+	+
* Oryctolagus cuniculus	+			+
Lepus capensis	m	+	+	+
Rodentia(≥1 species)	m	+		+
* Rattus rattus	m			
Canis aureus	+	i	i	+?i
Mammalia	A	B	C	D
Vulpes vulpes				
Meles meles	+	+xi		+
Mustela nivalis	+	+		i
Martes foina	+x		+	
Felis s.silvestris x lybica				+
Monachus monachus	+		+	+
Delphinus delphis	m			
Cetacea (1 species)				

Recherches realisées dans le cadre d'un programme de l'Université d'Athènes (Prof.J.Metsakis)

I-I6

L'Avifaune de Porto (Ile de Tinos, Mer Egée Centrale)

Nikolaos KYRTATOS

Centre de Recherches Marines et Côtières, Tinos (Grèce) et Institut für Meereskunde, Kiel (R.F.A.)

Espèces observées à Porto

m = en masse à Porto; + = observés à Porto; r = rare à Porto; a = autres régions de Tinos; x = informations se basant sur des animaux conservés, des photos ou autres témoignages.
A = 1984-1989; B = 1.12.88-10.1.89; C = 26.6.89-19.7.89; D = 13.10.89-10.1.90
Le tableau suivant contient mes observations les plus récentes pour la région de Porto, qui se trouve au sud-est de Tinos (Cyclades). Les oiseaux avec les plus grands vols sont soulignés dans le texte.

	A	B	C	D
Podiceps auritus	+	+		
Podiceps ruficollis	+			+
Podiceps nigricollis	+	+		+
Podiceps species				+
? Gevia stelleta				r
Hydrobates pelagicus	+		+	
Puffinus puffinus	m		m	
Calonectris diomedea	m		m	+
Phalecrocorax aristotelis	+	+		+
Phalacrocorex cerbo		a		r
Pelecanus onocrotalus	r			r
Pelecznus crispus			r	
Ardea cineres	+			
Ardea purpurea	r			
Egretta garzetta	m		+	m
Ardeola ibis	r			
Nycticorex nycticorax	+x			
Plegadis falcinellus	+			
Phoenicopterus ruber	rx			
Cygnus olor	+	+		
Anser anser	rx			
Anas platyrhynchos	+	+		
Anas querquedula	+			
Aythya fuligula	+	+		
Aythya nyroca				+
Anatidae (≥1 species)	+	+		
Mergus merganser	r			
Gyps fulvus	r			
Gypaëtus barbatus	rx			
Aquila chrysaëtos	+	+		+
Hieraaëtus fasciatus	+			+
Buteo buteo	+	+	+	+
Buteo rufinus	a	a		
Pernis apivorus	+	a?		+?
Circus aeruginosus	+	+?		
Circus (cyaneus?) sp.	+	+		
Circus species				+
Accipiter brevipes	+			
Circaëtus gallicus	+	a		
Accipitridae (1 species)				m
Pandion haliaëtus	+	a?		+
Falco peregrinus	+	+		
Falco eleonorae	+			+
Falco tinnunculus	+	+	+	+
Falco (naumanni?)sp.	+	+		
Falco (vespertinus?)sp.			+	
Falco species	+			
??Tetrao urogallus				
Alectoris chuker	+			+
Coturnix coturnix	m			m
Fulica atra		a		
Charadrius alexandrinus	+	+		
Gallinago gallinago	+			
Scolopax rusticola	+			+
Numeinus arquata	+x			
Tringa erythropus	mx			
Tringa totanus	mx			
Tringa hypoleucos			+	
Tringa species				+
Calidris minuta	+			
Scolopacidae A				m
Scolopacidae B				m
Larus marinus	+	+		
Larus argentatus michah.	m	m	m	m
Larus audouinii	+			+
Larus canus	+	+	+?	+
Larus minutus	+	+		
Larus genei				+
Larus ridibundus				+
Risso tridactyla	+	+		+
Chlidonias niger	+		+	+
Sterna hirundo	+			
Sterna species				+
Sterna sandvicensis	+			
Columba livia	+	+		
Streptopelia turtur	m			m
Otus scops	+			

	A	B	C	D
Athene noctua	+	+		+
Apus apus	+		+	
Apus melba			+	
Alcedo atthis	+	+		+
Merops apiaster	m		+	
Upupa epops	+			
?Calandrella brachydactyla	+			
Alauda arvensis	m	+		+
Galerida cristata	m	m	m	m
Lullula arborea	+			
? Eremophila alpestris	+			
Hirundo rustica	m		+	
Hirundo deurica				+
Delichon urbica	m		+	+
Ptyonoprogne rupestris				+
Motacilla flava	+			+
Motacilla (cinerea?)sp.	+	+		+
Motacilla alba	+	+	+	+
Anthus pratensis	m	+?		
Anthus spinoletta spinolet.				+
Anthus campestris			+	+
Lanius collurio	m	+?	+?	+
Lanius (senator?)sp.	+			
Lanius excubitor				+
Lanius minor				+
Bombycilla garrulus				r
Troglodytes troglodytes	+	a		+
Acrocephalus scirpaceus	m			+
Hippolais icterina	m			
Phylloscopus collybita	m	m		m
Phylloscopus sibilatrix				+
Sylvia atricepilla	m	+		+
Sylvia melanocephala			+	+
Sylvia cantillans	+			+?
Regulus ignicapillus	+			+
Ficedula parva	+			+
? Muscicapa striata	+			
Saxicola torquata	m	+		+
Saxicola rubetra	+	+		+
Erithacus rubecula	+	+		+
Phoenicurus ochruros	m	m		m
Phoenicurus phoenicurus	+			+
Luscinia megarhynchos	+			+
Oenanthe oenanthe	m	+	m	+?
Oenanthe hispanica	m		m	
Monticola solitarius				+
Turdus philomelos	m			+
Turdus viscivorus	+x			
Turdus piliaris				+
Turdus merula	+	+		+
Turdus torquatus				+
Parus caeruleus				a
Remiz pendulinus	+			+
Emberiza schoeniclus				+
Emberiza calandra	m	m	+	m
Emberiza cirlus	+	+		+
Emberiza (citrinella?)sp.				+
Emberiza cia	m	+		m
Emberiza species			m	+
Fringilla coelebs	+			+
Fringilla montifringilla				+
Serinus serinus	+			
Carduelis chloris	+			+
Carduelis spinus				+
Carduelis carduelis	m	m	m	m
Acanthis cannabina	m	+?		m
Fringillidae (1species)				m?
Passer domesticus	a	a	a	a
Passer hispaniollensis			+	+
Passer species				+
Sturnus vulgaris	m	+		m
Oriolus oriolus	+			
Carrulus glandarius	r			
Pica pica	+			+?
Corvus monedula	a	a		
Corvus corone	m	m	m	m
Corvus corax	+	+	+	+

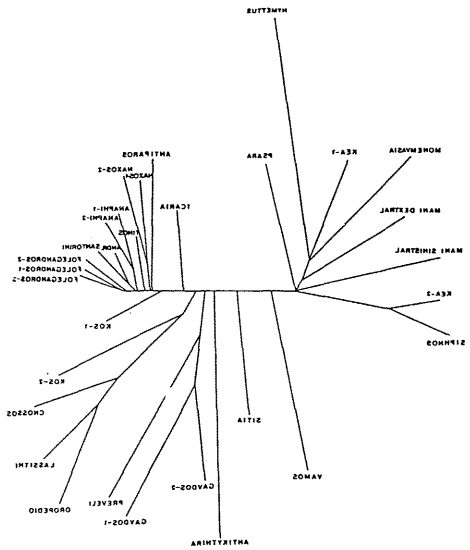
Parmi les oiseaux nichant à Porto, on trouve: Phalacrocorax aristotelis, Falco eleonorae, Larus argentatus, Otus scops, Athene noctua, Alcedo athis, Galerida cristata, Corvus corone, Columba livia (cette dernière espèce aujourd'hui seulement sur la côte au nord de Porto). Pendant toute l'année, on rencontre à Porto: Ph. aristotelis, Buteo buteo, Falco tinnunculus, L.argentatus, G.cristata, Motacilla alba, Sylvia melanocephala, Emberiza calandra, Carduelis carduelis, C. corone, C. corax. On y observe des grands vols saisonniers d'Egretta garzetta, Coturnix coturnix, Tringa erythropus, T.totanus* L. argentatus, Streptopelia turtur, Merops apiaster, Alauda arvensis, G. cristata, Hirundo rustica, Delichon urbica, Anthus pratensis, Lanius collurio, Acrocephalus scirpaceus, Hippolais icterina, Phylloscopus collybita, Sylvia atricapilla, Saxicola torquata, Phoenicurus ochruros, Oenanthe oenanthe, O. hispanica, Turdus philomelos, Emberiza calandra, E. cia, Carduelis carduelis, Acanthis cannabina, Sturnus vulgaris, C.corone, ainsi que des espèces non identifiées appartenant aux familles des Accipitridae, Scolopacidae (A et B) et Fringillidae. Porto est le plus remarquable lieu de passage pour les oiseaux migrants vers les Cyclades. On a une grande variété de biotopes (garrigues, maquis, ruisseaux, marais, dunes, falaises rocheuses, milieux marins). Plusieurs espèces deviennent de plus en plus rares, depuis 2 ans environ, à cause de la destruction des biotopes, due principalement à l'urbanisation.

Geographic Structure in the Genetic and Morphological Differences of Populations of the Genus *Albinaria* in the Aegean Region

A. AYOUTANTI* , C.-B. KRIMBAS* , M. MYLONAS** and J. SOURDIS*

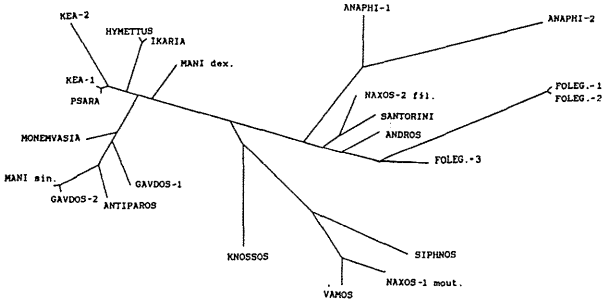
*Department of Genetics, Agricultural University of Athens, Iera Ódos 75, Athens 11855 (Greece)
**Department of Ecology and Systematics, Biology, University of Athens, Panepistimioupolis Ilissia, Athens 15771 (Greece)

The genetic polymorphisms and the morphological variations by which the natural populations of taxa belonging to the polytypic molluscan genus *Albinaria* differ among themselves in the islands of the Aegean archipelago and the adjacent continental lands of eastern Greece have been investigated in order to uncover the patterns of these differences and thus eventually attribute them either to historical (paleogeographical, anthropogenic or due to "recent" dispersion accidents) and/or ecological causes.
An electrophoretic study of 27 genetic markers was carried out in 31 *Albinaria* populations belonging to 15 different species and several



subspecies (their number varying according to the opinion of different taxonomists):14 populations covered the Cyclades, 4 the eastern Aegean islands, 8 Crete and the Gavdos island and 5 the eastern Greece including the Antikythira island. From the data gathered the between populations genetic distances were estimated using Sourdis distance estimator; the application of the Neighbour Joining Method on these distances provided the most reliable dendrogram, depicted above.
This tree is in good accordance in general with the accepted taxonomy of the genus, clustering together populations of the same species found in the same island; furthermore this tree displays an apparent geographic structure (it joins the populations of eastern Greece first with those of Crete and then with those of the east Cyclades). The features of this tree are not easily explained by the advocacy of ecological factors but more easily understood as produced by historic causes. One possibility is that the topology of the tree uncovers the existence of ân old land bridge, the Cretan arc, uniting the Peloponnesus through Crete with Asia Minor; another possibility is that the structure is due to more recent migrational events between nearby lands separated by sea barriers, events extremely rare but not of impossible occurrence.
On the contrary the study of 18 quantitative and 10 qualitative characters regarding the external morphology of the shell in 23 of the 31 populations examined electrophoreticaly, does not provide a clear picture, when all characters are considered together, as the electrophoretic markers do. The dendrogram constructed from distances based on these morphological characters and using the same method for tree construction, produces a dendrogram showing a patchiness rather than an overall geographic structure. But the tree constructed when the qualitative characters are only used shows a definite resemblance to the genetic (electrophoretic) tree mentioned earlier. Simulations showed that it is extremely unlikely this resemblance to be the result of mere chance. Thus we may conclude that qualitative characters, some of which are used in the taxonomy, have a distribution governed also mainly by the same historical factors. On the contrary the quantitative characters, responsible for the patchiness displayed by the tree based on the totality of the morphological characters, have a geographic distribution attributed and shaped by selective factors.

Qualitative characters



L'Insularité : qu'est-ce que cela veut dire au juste ? (Propositions émanant de faits qui se rapportent aux Iles de la Mer Egée)

J. MATSAKIS

Département de Biologie (Ecologie-Taxonomie), Université d'Athènes, Athènes (Grèce)

Où en est-on aujourd'hui avec le "concept" de l'Insularité? Peut-on affirmer que le sens que les biologistes - zoologistes, écologistes, biogéographes, en particulier - attribouent a ce terme et qui se rattache essentiellement à un isolement-confinement "physique", ait pu voir sa dimension biologique mieux degagée qu'il y a quelques années? Et surtout: - Dans quelle mesure pourrait-on prétendre que tous les aspects, évoqués par les uns et les autres, apparaissent actuellement mieux reliés les uns avec les autres, viennent constituer un ensemble suffisamment cohérent et s'inscrire sur un fond biologique, plus ou moins particulier le cas échéant, mais qui s'articule clairement avec les notions fondamentales adoptées a priori par chaque specialiste?

En nous restreignant au départ à des faits relevés dans le secteur géographique égéen, nous discuterons tout d'abord de la portée de "l'isolement et du confinement" et développerons ensuite une série de propositions qui nous semblent ramener les choses à leurs justes proportions.

L'Isolement-barrière. 1/ En Egée la barrière marine (quelques km à quelques dizaines de km) n'est jamais absolue, loin s'en faut: ainsi si l'aire de répartition de certaines espèces, voire des représentants d'un genre, admet quelquefois des limites définies par la "barrière" marine séparant une île du continent ou deux îles entre elles*, il ne se trouve pas un seul cas où cette même "barrière" ne soit absolument ignorée par divers autres taxons zoologiques**. (La répartition insulaire des lézards et serpents suffit en elle-même pour réaliser la difficulté d'une interprétation univoque des faits). 2/ Remplacer le terme "barrière" par celui du "filtre" - évoqué couramment par les paléontologistes - présente parfois des avantages, mais n'est pas suffisant, non plus, pour expliquer la majorité des phénomènes relevés. 3/ Enfin, la présence d'espèces endémiques sur chaque île de l'Egée pratiquement, ne veut nullement dire que l'on ne rencontre pas d'endémiques partagées par deux, trois ou davantage d'îles différentes, pas forcément voisines iimmédiates! (Nous nous permettons de rappeler à ce sujet que nous avions déjà insisté sur le fait qu'il n'y a pas un seul cas où l'aire de répartition de deux espèces endémiques, parmi les centaines connues en Egée, coïncide exactement).

Le Confinement-aire disponible de "petites" dimensions. 1/ En considérant la gamme allant de quelques dizaines à 1000 jusqu'à 2000 km2 env. de superficie (autrement dit, la très grande majorité d'îles sur lesquelles on possède des données suffisantes de comparaison), on ne saurait trouver des indices de déséquilibre flagrant des biocénoses et des faunes, au niveau des invertébrés, voire de petits vertébrés. (Le cas d'un écosystème relativement suivi, celui d'un maquis clair à Naxos, a revelé une richesse et une diversité faunistique très peu différentes de celles d'écosystèmes analogues du continent. Naxos, dans son ensemble, possède une faune reptilienne composée de 10 espèces appartenant à 10 genres différents!). Ce n'est qu'au niveau des plus grands mammifères, connus des paléontologistes, que la faune n'a pu être "équilibrée". 2/ S'il est certain qu'au-dessous d'une valeur, le paramètre superficie influe qualitativement et sous plusieurs rapports sur la composition, la richesse de la faune, des biocénoses et des réseaux écologiques et sur les caractères adaptatifs des espèces participant, on ne saurait mettre en évidence un caractère commun valant pour l'ensemble des îles et pouvant être explicitement associé à l'insularité.

A la suite de cela, nous nous permettrons d'affirmer que les composantes "horizontales" - espace, discontinuité relative, passée ou présente, plus ou moins longue, etc - sont absolument insuffisantes (et pourraient même être trompeuses!) pour saisir ce qui se passe ne serait-ce que dans le cas de la faune d'une seule île ou dans le cas d'un seul groupe zoologique considéré dans l'ensemble des îles. Les phénomènes sont indiscutablement moins simples et il est évident qu'il faut élargir l'optique en prenant aussi en considération les composantes "verticales", autrement dit les relations entre constituants des biocénoses et des faunes. Ceci paraît d'autant plus indispensable qu'il semble offrir des possibilités consistantes d'introduire dans ce même débat les manifestations les plus" impressionantes" après tout de l'Insularité, telles le nanisme et le gigantisme et maintes adaptations inattendues et variées que présentent d'espèces ou formes vivant dans les îles.

Les deux développements qui suivent aideront à préciser notre point de vue quant à l'importance réciproque des composantes "horizontales" et "verticales".

1/ Il nous semble que l'on oublie trop la discontinuité fondamentale de l'aire de répartition de toute espèce ou taxon et de la tendance générale à une diversité maximale, "en tout point" si l'on puis dire, et c'est ainsi que l'on tend à surestimer la discontinuité entre terres et mers (l'insularité notamment), etc. En fait, cette dernière se superpose à celle-là, peut accentuer plus ou moins localement ses implications, mais ne saurait changer au fond la nature des choses.

2/ A notre avis, l'enseignement essentiel et fondamental de "l'insularité" consiste bien moins dans les particularités, en elles-mêmes, de maintes espèces et populations vivant dans les îles (aussi attrayantes qu'elles puissent paraître), qu'au fait qu'elle nous aide à saisir: - d'une part, la portée des processus dynamiques et les interdépendances qui sont en oeuvre dans les conditions "banales" et normales, non-insulaires; - et, d'autre part, la souplesse et les potentialités formidables des organismes. Sous ce rapport, l'insularité nous fait toucher du doigt la complexité du réseau fonctionnel (les composantes "verticales") auquel est integré chaque constituant dans un système normal, épanoui, en même tempe que des interdépendances entre régulations à tout niveau (cycle biologique, taille d'individus, rôle dans les biocénoses, adaptabilités diverses, voire "compatibilités" taxonomiques!). Ce serait l'épanouissement insuffisant du système, l'amoindrissement ou le relâchement du réseau qui permettraient la manifestation de telle ou telle autre "particularité" - plus ou moins aléatoire et plus ou moins transitoire le plus souvent.

En fin de compte, le problème le plus crucial qui se pose est de comprendre comment les interdépendances-régulations multiples et réciproques - dont la réalité ne fait aucun doute - jouent. Notamment, comment la strure faunistique et biocénotique se met en place, elle se reconstitue sans cesse et tend toujours à un étalement et à une diversité maxima. Il ne saurait s'agir de "niches" pré-existantes qui attendent de se remplir, mais plutôt d'un système de positions taxonomiques-faunistiques qui se crée et se met en place, étant rapidement induit par les potentialités des éléments concrets qui se trouvent impliqués à chaque phase. C'est là un problème central, celui-là même auquel on se heurte encore dès que l'on essaie de pousser la synthèse, que ce soit en partant de la biogéographie et de la diversité faunistique, ou de l'écologie, voire de l'évolution au sens large...

---

* Parmi les cas controversés, rappelons celui de Rhodes par rapport au continent et par rapport a Karpathos ou celui d'Ikarie par rapport aux Cyclades et par rapport à Samos, etc.

** Les interprétations biogéographiques apparaissent fréquemment contradictoires suivant le groupe considéré, p.ex. orthoptères ou mollusques, divers autres groupes d'insectes ou isopodes, diplopodes etc.

L-I1

Monitoring Strategies of Marine Pollution

Michel JOANNY

IFREMER - Centre de Brest, Département Environnement Littoral, B.P. 70, 29280 Plouzane (France)

ABSTRACT

"Monitoring", in the context of the assessment and protection of the marine environment, has been defined as the repeated measurement of an activity or a contaminant or of its direct or indirect impact. In practical terms, monitoring can fall within the following three categories :

- monitoring for regulation purposes (control);
- monitoring of levels and trends;
- monitoring for scientific purposes.

The monitoring for scientific purposes is generally the main step for establishing monitoring of levels and trends which in turn provides useful information for defining the parameters of control (monitoring for regulation purposes).

In order to define the monitoring programmes of the marine environment, the following operational objectives, which have a high degree of universality, must be taken into consideration:

- Protection of human health;
- Protection of marine life and its environment;
- Assessment of levels and trends.

Monitoring activities concerning the quality of the marine environment were developed around the world as the scientific knowledge of the problems which had given rise to such activities was acquired. In fact sometimes monitoring activities preceded such knowledge. It is thus legitimate to review the strategies, underlying monitoring programmes. However, such a review and possible revision presupposes a critical look at the results obtained in pursuing the objectives set.

In this context, the author has carried out an in-depth assessment of the monitoring component of the "Long term monitoring and research programme on pollution in the Mediterranean Sea" (MED POL Phase II) of the United Nations Environment Programme (UNEP).

The main recommendations based on this assessment are the following:

- Monitoring objectives must be reformulated in a more coherent way in order to make planning more comprehensible and effective;
- It is necessary to reaffirm the crucial role of the monitoring of pollution sources;
- The first essential phase is to establish beyond the shadow of a doubt the baseline contamination levels, before establishing permanent programmes for certain areas of special concern;
- A biological effects monitoring programme must be devised and implemented within the MED POL framework;
- The quality assurance programme for results must not only be continued but reinforced as well;
- At the same time, all research efforts which might add to the general knowledge of the marine environment must be encouraged in order to promote the optimization of monitoring programmes.

L-I2

Pollution Problems in the Mediterranean and Relevant Research Priorities

Y. HALIM

Faculty of Science - Moharram Bay, Alexandria (Egypt)

ABSTRACT

Concern among the scientific community about the deterioration of local Mediterranean environments since the early 1960s induced FAO and ICSEM to convene a series of international conferences which stimulated pollution research in the Mediterranean. Attention appears to have been focussed at first on the impacts of urban effluents, radioactive, oil and thermal pollution and, later, on trace metals and synthetic organics.

Soon, numerous pollution research projects, either national, bilateral or sponsored by the EEC or UN Agencies were initiated in several parts of the Mediterranean. Some examples are:

- ASCOP, the Italian-Yugoslav Cooperative Project in the Adriatic Sea,
- EROS, the Project on the European River Ocean System,
- MAST, the Marine Science and Technology Programme, (the latter two EEC sponsored)
- POEM, the Physical Oceanography of the East Mediterranean, and
- PRIMO, the International Research Programme in the Western Mediterranean sponsored by IOC and ICSEM.

Coordination between these numerous research efforts is still lacking. A recent World Bank initiative in the Mediterranean is directed at management and protective measures. The MED POL Programme launched by UNEP in 1975 remains the only co-ordinated research and monitoring programme encompassing all Mediterranean countries.

In spite of many limitations, the Pilot phase of this programme developed the infrastructure, induced baseline pollution research and laid the ground for Phase II.

Phase II encompassed twelve research activities and maintained an assistance component, but no order of priority was assigned to the research areas. Substantial scientific information has been generated on epidemiological hazards, toxicity and bioaccumulation of selected substances, eutrophication and abnormal plankton blooms, ecosystem modifications and on the biogeochemical cycle of specific pollutants. The quality and relevance of the data, however, are uneven and the geographical coverage inadequate. Some programme readjustments are needed for the coming MED POL Phase. They should aim at the selection of a smaller number of priority research areas, the quality assurance of the data and a better geographical coverage. The choice of priority areas should obey certain basic criteria:

(a) the geographical-scale: Mediterranean-wide problems should be addressed in priority;

(b) the time-scale: longer time-series are required to differentiate background trends from slow anthropogenic changes;

(c) the scientific data-base: a multidisciplinary data-base on the coastal oceanographic processes should be developed;

(d) the socio-economic pressure: the assessment of the inevitable consequences of the anticipated demographic stress on Mediterranean ecosystems is one of the first priorities;

(e) the implementation of the Protocols and their Annexes: research should aim at the continuous improvement of the Annexes by updating them or proposing amendments as appropriate.

Taking in consideration the recommendations of Mediterranean scientists, the past experience of MED POL and the conclusions of GESAMP on the State of the Marine Environment, six priority research areas are proposed:

1. The comparative study of a specific Mediterranean and basin-wide ecosystem, the Posidonia community.
2. Eutrophication, long-term nutrient build-up and the dynamics of abnormal plankton blooms.
3. The impacts of anticipated global climate change and the development of Mediterranean models.
4. The coastal oceanographic processes, fluxes and biogeochemical cycles.
5. The air-borne fluxes of pollutants in the Mediterranean basin.
6. The consequences of present and anticipated coastal and inland developments and the resulting irreversible damages to the coastal zone.

L

Problem of the selective partitioning of trace metals in various sediment size fractions

Boris S. KRUMGALZ

National Institute of Oceanography, Israel Oceanographic & Limnological Research, Tel-Shikmona, P.O.B. 8030. Haifa 31080 (Israel)

The geochemical cycle of anthropogenic trace metals in the marine environment is determined to a large degree by the interactions of the metals with sediments. One of the parameters affecting trace metal distribution in various sediment fractions is fraction dimension. Therefore, it is recommended that studies related to the anthropogenic heavy metal contamination of sediments be conducted on a particular sediment fraction: either on the sediment fraction less than 0.063 mm, or less than 0.250 mm. The generally accepted opinion is that the smaller the size of the sediment fraction, the larger the amount of trace metals bound to this fraction, and that trace metals are mainly present in the clay/silt fraction consisting of particles with grain size less than 0.063 mm. We studied trace metal distributions in various sediment size fractions for southern Haifa Bay (Israel), and were surprised to observe an anomalous fraction distribution of trace metals and organic matter (Krumgalz, 1989): namely, unusually high enrichment of trace metals and organic matter in the fractions of coarse and medium sand (fractions with particles larger than 0.250 mm). The curves characterizing either trace metals (cadmium, copper, lead, zinc and iron) or total organic matter content distributions on various size sediment fractions have a clearly defined minimum, like a "saddle", for the fine sand fraction of grain size 0.125-0.250 mm. The unusual enrichment of all the studied trace metal and organic matter contents in the coarse and medium sediment fractions (>0.250 mm) was sometimes even more than the enrichment of the same elements in the clay/silt fraction. The explanation of the observed phenomenon was suggested to be the formation of large agglomerates (clusters larger than 0.250 mm) from the smaller particles enriched by contaminants. The formation of such large agglomerates occurs during the generally accepted drying procedures, all of which are carried out without prewashing the studied sediments. During any drying procedures (either freeze-drying or heating), the small sediment particles will be cemented both by dissolved organic matter and by sea salts, present in the marine sediment, to form large agglomerates. Since small sediment particles are enriched by various contaminants, kept on their large specific area by adsorption forces, the total amounts of either trace metals or organic matter retained by each agglomerate particle will be much larger compared to the amounts which could be adsorbed only on the outer surface of such an agglomerate.

The formation of large agglomerates from small particles during the drying procedure will lead to biased distribution curves for such sediments with an increase of the large size sediment fraction at the expense of the smallest sediment fraction. The results obtained demonstrate that the standard mechanical sieving procedure and other sample treatment operations are not vigorous enough to destroy the formed agglomerates. We are sure that such an abnormal fraction distribution can probably be corrected by careful washing of the studied sediments with distilled water before any drying procedure. However, such prewashing may cause another problem: how will the prewashing affect trace metals or organic matter loosely bound on the sediment surface? The agglomerate formation can also lead to incorrect results related to the balance calculations of various contaminants, and will manifest itself when various fractions are used for trace metal studies. Until now, this phenomenon was only observed at a single site, i.e. Haifa Bay. However, we believe that such agglomerate formation is a widespread phenomenon and could be observed at other locations with similar sediment treatment. The possibility of the formation of large agglomerates from small contaminated particles should be seriously considered when developing standard methods related to studies of the anthropogenic metal contamination of sediments.

The widely used "fingerprint" approach to trace the sources of local pollution or of fine sediment fraction movement in particular polluted areas can be used only under certain conditions (Krumgalz, 1988). Among them are the absence of significant trace metal fractionation and sediment fractionation. Therefore this approach cannot be automatically recommended to be applied to any case of sediment pollution studies. This approach can give correct results only for sediment fractions where agglomerate formation does not occur. Another question is, how do trace metal distribution "fingerprints" for an area with only a point pollution source depend on sediment fraction size? In order to answer this question, we studied trace metal distribution in various sediment size fractions in which agglomerate formation was not observed. As a study case, we chose the polluted area in the southern part of Haifa Bay with only one source of contamination (Krumgalz, 1988; Hornung et al., 1989; Krumgalz et al., 1989). Regression analysis of the data obtained in this study demonstrates that the sediment fractions 0.125-0.250 mm and 0.063-0.125 mm have similar trace metal distribution "fingerprints" in most cases. However, the finest fraction (<0.063 mm) possesses "fingerprints" of trace metal distributions which differ from the other fractions, with a few exceptions. It may be concluded, on the basis of selective partitioning of trace metals in various size fractions, that sediments should not be compared only on the basis of chemical composition unless they have similar textural characteristics. In the obtained results, profound selective partitioning of some heavy metals (especially lead) between various grain size sediment fractions was observed. It was found that the lead background increases with a decrease in the fraction size: 15.8±1.8 ppm (fraction 0.125-0.250 mm), 21.3±2.6 ppm (fraction 0.063-0.125 mm), and 38.0±3.0 ppm (fraction <0.063 mm). The background lead content for the sediment fraction <0.250 mm (generally recommended for studies dealing with pollution) is 17.1±1.8 ppm. All these lead background values found for Haifa Bay sediments are in good agreement with those determined by various authors and reviewed by Scoullos (1986).

The results obtained in this study show that some methodological recommendations dealing with studies of trace metal contamination of marine sediments should be periodically reconsidered, especially after new observations are obtained, such as those discussed here.

Acknowledgement

The author thanks the U.S. Agency for International Development (AID) for partly funding this study.

REFERENCES

HORNUNG, H., KROM, M.D. and COHEN, Y., 1989. Trace metal distribution in sediments and benthic fauna of Haifa Bay, Israel. Estuar. Coastal Shelf Sci., 28 : 43-56.

KRUMGALZ, B.S., 1988. Can various heavy metal pollutants be used as tracers for fine grained sediment transport? In: Heavy Metals in the Hydrological Cycle, M. ASTRUC and J.N. LESTER eds., Selper Ltd., London : 467-472.

KRUMGALZ, B.S., 1989. Unusual grain size effect on trace metals and organic matter in contaminated sediments. Mar. Pollut. Bull., 20 : 608-611.

KRUMGALZ, B.S., FAINSHTEIN, G., GORFUNKEL, L. and NATHAN, Y., 1989. Kishon river system as a trap for heavy metal pollution of Haifa Bay. In: Environmental Quality and Ecosystem Stability. Vol. IV-A. Environmental Quality, M. LURIA, Y. STEINBERGER and E. SPANIER eds., ISEEQS Publ., Jerusalem : 355-364.

SCOULLOS, M.J., 1986. Lead in coastal sediments: the case of the Elefsis Gulf, Greece. Sci. Total Environ., 49 : 199-219.

Chemical forms of metals in flocs formed during sludge dumping in the sea

Ronald J. GIBBS* and Michael ANGELIDIS**

*Center for Colloidal Science, College of Marine Studies, University of Delaware, Newark, DE 19716 (U.S.A.)
**Environmental Studies, Papadiamantopoulou 2, 115 28 Athens (Greece)

The dumping of sludge from wastewater treatment plants, into the sea, is used as a sewage sludge disposal method in the USA and some European countries.

As the sludge encounters seawater, the particles it contains coagulate to form flocs, which are settling to the bottom with different settling velocities.

The impact that such a disposal method has on the marine environment depends on the quality of the sludge (urban or industrial) and the characteristics of the sea area where the dumping is done (currents, bottom topography etc) (Pearson 1985). On the other hand, the chemical forms of the metals in the flocs formed after the dumping of the sludge in the sea, have a direct influence on their availability for consumption from the marine organisms of the area, and therefore on the potential harm to the marine ecosystem.

In order to study the process, the mixing of the sludge with seawater during the dumping into the sea was simulated in the laboratory using special designed equipment and the flocs formed were separated in four settling velocities fractions (Gibbs 1986). The chemical characterisation of the metals in the flocs was performed using a sequential extraction technique (Gibbs 1973, Forstner and Wittmann 1979). The metals analysed were Cd, Cr, Cu, Fe, Pb and Zn (Angelidis and Gibbs 1989, Angelidis and Gibbs 1990).

The characteristics of the sludge used in the experiments are presented in Table 1.

TABLE 1

Total and dissolved concentration of metals in Bowery Bay Treatment Plant sludge

	Cd	Cr	Cu	Fe	Pb	Zn
Total (mg/l)	0.540	44.37	76.64	475.4	12.3	165.6
Dissolved (mg/l)	0.058	0.165	0.123	2.30	< 0.50	0.369
(percent)	(10.7)	(0.37)	(0.16)	(0.49)		(0.22)

After the coagulation, most of the mass of the sludge (79.1%) formed large flocs with settling velocities > 6.0 cm/min. In these fast settling flocs, the greater part of the metals was present in the oxidizable phase (organic matter and sulfides) (59.1% of Cd, 81.7% of Cr, 97.8% of Cu, 48.9% of Fe, 90.1% of Pb and 66.6% of Zn). (Table 2). The fast settling flocs contained very small quantities of metals (exception Fe) in the reducible phase, which consists mainly of Fe/Mn oxides (Table 3).

The small flocs, with settling velocity < 0.7 cm/min, represented only the 2.6% of the mass of the sludge. The larger part of their metal content was in the reducible phase (67.3% of Cd, 49.6% of Cr, 56.5% of Cu, 59.2% of Fe, 60.4% of Pb and 89.2% of Zn)(Table 3). The oxidizable phase of these flocs contained considerably lower metal concentrations (Table 2).

The adsorbed phase of the metals was negligible in all settling velocity fractions and the residual (detrital) phase didn't show any particular trend in the different settling velocity fractions examined.

TABLE 2

Relative (%) concentration of oxidizable metals in the different settling velocity fractions (Bowery Bay sludge)

Settling velocity	Cd	Cr	Cu	Fe	Pb	Zn
< 0.7 cm/min	14.9	46.0	37.7	26.5	39.6	7.4
0.7-2.5 cm/min	30.0	41.7	69.2	29.5	39.0	21.5
2.5-6.0 cm/min	35.8	47.7	94.3	53.1	61.9	46.6
> 6.0 cm/min	59.1	81.7	97.8	48.9	90.1	66.6

TABLE 3

Relative (%) concentration of reducible metals in the different settling velocity fractions (Bowery Bay sludge)

Settling velocity	Cd	Cr	Cu	Fe	Pb	Zn
< 0.7 cm/min	67.3	49.6	56.5	59.2	60.4	89.2
0.7-2.5 cm/min	56.5	56.9	30.6	60.3	61.0	74.8
2.5-6.0 cm/min	59.5	51.1	5.0	36.4	35.8	52.7
> 6.0 cm/min	17.6	15.3	0.7	34.9	6.8	32.0

CONCLUSIONS

The above results indicate that there is a significant geochemical difference in the chemical forms of metals, between the large and small flocs which are formed after the dumping of the sludge into the sea. The large (and faster settling) flocs, sink to the bottom near the dumping site, forming a floc blanket containing most of the metals in the oxidizable phase (organic matter and sulfides), and therefore, easily available to the marine organisms living in the area.

On the other hand, the smaller microflocs which may be transported to longer distances by the currents, contain most of their metals in the reducible phase (Fe/Mn oxides) and therefore they are not easily available for uptake by the marine organisms.

The above conclusions suggest that the area directly under the sludge dumping site, is not only receiving most of the mass of the sludge dumped, but also the metals contained in this floc blanket are present in a chemical form that can easily be uptaken by the marine organisms in the area.

The smaller flocs, which travel greater distances, don't seem to represent any serious threat to the marine ecosystem, because they don't represent an important mass of the sludge and because their metal content is in a chemical form which is not easily available to the marine organisms.

REFERENCES

ANGELIDIS M. and GIBBS R.J. 1989. Chemistry of metals in anaerobically treated sludges. Water Research 23 (1) 29-33.

ANGELIDIS M. and GIBBS R.J. 1990. The segregation of metals during the ocean dumping of sludge. The Science of Total Environment (in press).

GIBBS, R.J. 1973. Mechanisms of trace metal transport in rivers. Science 156: 1734-1737.

GIBBS, R.J. 1986. Segregation of metals by coagulation in estuaries. Marine Chemistry 18: 149-159.

FORSTNER U. AND WITTMANN G.T.W. 1979. Metal Pollution in the Aquatic Environment. Springer-Verlag, Berlin-Heidelberg, 486p

PEARSON, T.C. 1985. Disposal of sewage in dispersive and non-dispersive areas: contrasting case histories in British coastal waters. NATO ASI Series: 577-595.

L-II3

Organic pollutants in marine environment of the Montenegro Coast South Adriatic

Josip DUJMOV*, Perica SUCEVIC* and Davor BAZULIC**

*Institute of Oceanography and Fisheries, Split, P.O.Box 114 (Yugoslavia)
**Institute of Public Health of SR Croatia, Zagreb (Yugoslavia)

Organic contaminants from several different classes were analysed in south--eastern part of the Adriatic sea - Montenegro coast. To estimate the level of pollution the conents of organic carbon, total phenols and polycyclic aromatic hydrocarbons were analysed in sea water, while in sediments and marine organisms were determined the contents of aromatic as well as chlorinated hydrocarbons.

The organic carbon concentration is a measure of content of organic matter and in the same time the measure of the productivity of system.

Phenol compounds in aquatic ecosystem could be of synthetic or naturally occuring. The pathological effect of phenols on fish reffered to acute and subacute poisoning.

Chlorinated pesticides (DDT and metabolites, DDD, DDE), polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons (PAH) are ubiquitous pollutants which have a similar environmental fate. On the other hand they have quite different origins and can be used as a tracers for agricultural (DDT), industrial (PCB) and mixed industrial and urban contamination (PAH).

South Adriatic is relatively low investigated and there is no information about organic pollutants contents. It was chosen 7 sampling stations (Fig. 1) and the seawater, sediments, fish and shellfish samples were collected.

The concentrations of organic carbon in seawater were analysed with acid bichromate titrimetric method and total phenols were determined colorimetrically with

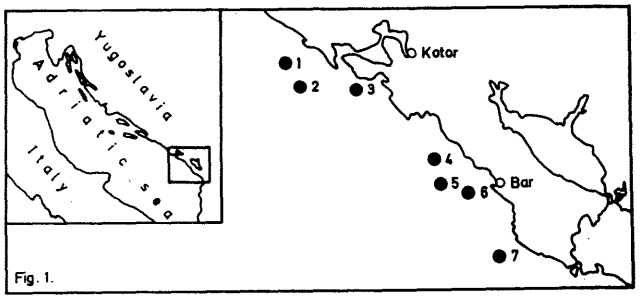


Fig. 1.

antipyrine method. PAH content in seawater, sediments, fish and shellfish were analysed with fluorescence technique (Perkin-Elmer 3000 fluorimeter) with conventional and synchronous scanning mode. Chlorinated hydrocarbons were determined by gas chromatograph (Pye Unicam 4550).

The concentrations of organic carbon in seawater ranged from 0.97 to 4.19 mg C/dm^3 what is in the same level determined in North Adriatic.

The mean value of total phenol concentrations was 1.6 µg/dm^3 determined in September 1988, while in December of the same year it was higher (4.0 µg/dm^3). A very small variability in results in water column shows a good vertical mixing of the sea masses.

The total PAH contents in seawater were at all station below the detection limit of applicable method and are found to be 0.14 ug chrysene equvalents/dm^3. The same values were determined in middle Adriatic and we can conclude that the seawater of the Adriatic sea is not contaminated with these compounds.

Total PAH contents in sediments varied from 0.52 to 3.41 µg/g. It was noticed the increasing trend in PAH contents toward the south, that could be explained with larger terrigeneous influence of Bojana river.

The same group of aromatic compounds were also determined in marine organisms fish (Mullus barbatus) and shellfish (Lithophaga lithophaga). The total PAH contents in fish ranged from 0.66 to 3.08 µg/g while in shellfish it was not determined the large differences in PAH contents between samples and it ranges from 0.22 to 0.73 µg/g. All values of PAH content are given in chrysene equivalents and in relation to dry weight.

The synchronous mode of scanning was also applied for all samples of sediments, fish and shellfish. From the obtained spectra it is evident that fish and shellfish accumulate most aromatics with two rings while in sediments beside these compounds it was found also aromatics with five and more rings.

Chlorinated hydrocarbons in sediments were generally low and not always presented. It was found a larger amount of these pollutants in fish and shellfish especialy DDT and its metabolites.

The contents of HCB in fish varied from 0.01 to 1.27, HCH from 0.01 to 0.42, lindan from 0.28 to 2.26, pp'DDE 0.01 to 4.95, pp'DDD 0.01 to 0.84, pp'DDT 4.17 to 15.14 and PCBs from 0.01 to 297.31 µg/kg. The same group of compounds was also determined in shellfish and the results are as follows: HCB - 0.01 to 0.49, ΔHCH - 0.02 (mean value), lindan - 1.70 (mean value), pp'DDE - 8.18 to 14.42, op'DDT - 1.75, pp'DDD - 0.32 to 0.67, pp'DDT - 2.80 to 3.56, PCBs - 0.01 µg/kg.

L-II4

Aromatic hydrocarbons contamination and characterization of sediments from larger seaports on East Adriatic

Josip DUJMOV and Perica SUCEVIC

Institute of Oceanography and Fisheries, Split, P.O. Box 114 (Yugoslavia)

Aromatic hydrocarbons enter the environment via a wide range of activities: accidental and normal operation from ships, coastal drilling and production operations, refinery and other industrial effluent, natural seeps, municipal effluents and storm sewer runoff and atmospheric transport of combustion products of various fossil fuel compounds (FARRINGTON et al., 1983).

Conventional fluorescence spectroscopy is a useful technique for analysis of aromatic hydrocarbons in marine environment. However, an improvement in resolution of the spectra may be made by varying the excitation wavelength maintained 20-30 nm less than the emission wavelength (LLOYD, 1971). He has also been demonstrated that the wavelength of maximum emission is a function of number of rings in a molecule.

Surface sediments (top 5 cm) were collected with gravity corer from 6 stations at a mouth of larger seaports on east Adriatic (Zadar, Šibenik, Split, Kardeljevo, Dubrovnik and referent station Vis) during July 1988. The fluorescence intensities of hexane extracts were measured in one cm quartz cells using a Perkin--Elmer 3000 fluorimeter.

The results of various types of aromatic compounds expressed as a ratio between each aromatic group and total aromatics obtained with synchronous technique and the content of aromatic compounds analysed with fixed excitation wavelength technique are given in Table I.

Table I. The relative abundance of each group of aromatic hydrocarbons presented in surface sediments obtained from synchronous excitation emission spectra and total aromatic content calculated from fixed excitation technique.

Stations	2 rings aromatics	3 and 4 rings aromatics	5 and more rings aromatics	Total aromatic contents*
Zadar	0.38	0.42	0.20	4.50
Šibenik	0.25	0.41	0.34	60.10
Split	0.25	0.48	0.27	28.99
Kardeljevo	0.71	0.23	0.06	1.44
Dubrovnik	0.24	0.42	0.34	20.26
Vis	0.60	0.20	0.20	0.48

* µg chrysene equivalents/g dry weight of sediments

Examples of the types of relative abundance of aromatics are given in Fig.1.

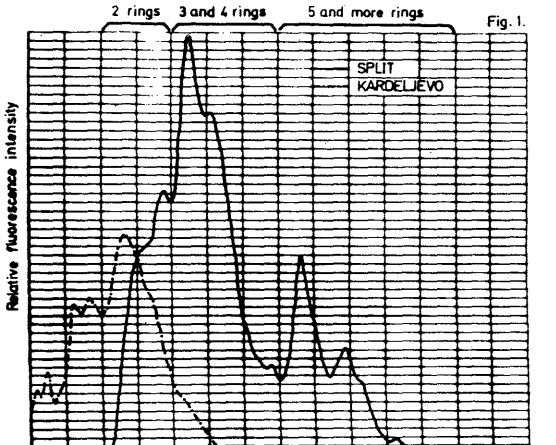


Fig. 1.

According to the results obtained with this investigation it was established that the ratio of various types of aromatic compounds in sediments from a larger seaports of eastern Adriatic coast are of mixed origin of petroleum sources and pyrogenic inputs (fossil fuel combustion).

The synchronous spectra of all samples (except from seaport Kardeljevo and locality Vis) have high content of three and four rings compounds probably as consequence of larger entering the bunker oil in these highly industrialised areas.

In seaports in which are determined the elevated contents of total aromatic hydrocarbons (Šibenik, Split, Dubrovnik) sediment is polluted also with larger amount of pyrogenic fossil fuel compunds.

It seems that light fuel oil discharged to seaport area of Kardeljevo is predominant aromatic compunds.

FARRINGTON, J.W., E.D. GOLDBERG, R.W.RISEBROUGH, J.H. MARTIN and V.T.BOWEN, 1983. Environ.Sci.Technol., 17 (8): 490-496.

LLOYD,J.B.F., 1971. J.Forens.Sci.Soc., 11: 83-94.

L

Chlorinated Hydrocarbons in Red Mullet *(Mullus barbatus)* from the Greek Seas

E. GEORGAKOPOULOS-GREGORIADES and V. VASSILOPOULOU

National Centre for Marine Research, Hellinikon (Greece)

This study reports on the concentration of PCBs and DDTs in the flesh of red mullet collected at 8 locations in Greek waters from 1986 till 1988. Concentrations of chlorinated hydrocarbons and lipids were determined according to the procedure proposed by SATSMADJIS et al (1988). GC analysis was performed with a GC (Varian 3700) equipped with a 63 Ni electron capture detector and a fused silica Megabore column DB-1, 30m long.

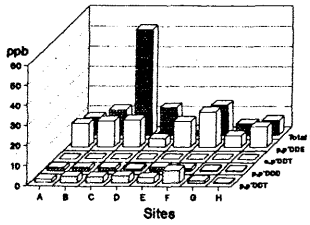


Figure 1. Mean concentrations of DDTs and total PCBs (ppb wet weight) in the flesh of red mullet from Greek waters.
A: Alexandroupolis, B: Chios, C: Pagassitikos, D: Saronikos, E: Rhodes, F: Heraclion, G: Chania, H: Preveza.

The higher mean concentration of total PCBs coincided with the shallow, enclosed gulf of Pagassitikos (52.6 ppb wet weight), where a considerable outflow of urban and industrial wastes takes place (Fig 1). The lowest value (2.6 ppb) was detected off Rhodes island (open S. Aegean Sea) while in the other locations PCBs fluctuated between 5.6 and 15 ppb. The main compound of DDTs was p,p´ DDE (Fig 1). DDTs values ranged from 15.2 to 25.6 ppb at the 5 sites (A, B, C, E, F) of the Aegean Sea. Saronikos Gulf, although exhibiting high p.p´ DDT values, displayed low concentrations of all other DDTs (8.9 ppb). Low DDTs values were also found in the two locations off western Greece (8 ppb off Chania and 11.1 ppb off Preveza).

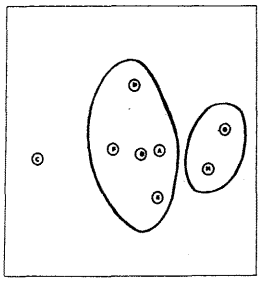
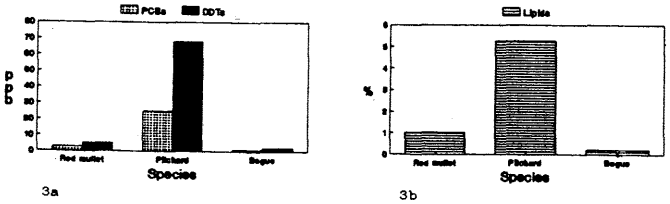


Figure 2. Multidimensional scaling plot for 8 sites according to the concentration of PCBs and DDTs.
A: Alexandroupolis, B: Chios, C: Pagassitikos, D: Saronikos, E: Rhodes, F: Heraclion, G: Chania, H: Preveza.

Nonmetric multidimensional scaling performed on the mean concentations of PCBs and DDTs (Fig. 2), using the PRIMER algorithms (CLARKE & WARWICK, 1989) revealed three groups of sites. Group I was formed by sites A, B, D, E and F (Aegean Sea), which exhibited relatively high DDTs concentrations, fact related to the extensive use of DDT on the close by Mediterranean coast of Asia and Africa during the last decade (PICER & PICER, 1978). Site C (Pagassitikos Gulf) displaying the highest PCBs concentrations was separated from all others (group II), while sites G and H (western Greece) presenting low values of both PCBs and DDTs formed group III.



3a 3b

Figure 3. PCBs, DDTs (3a) and lipid concentration (3b) in red mullet, pilchard and bogue caught in the same area/season.

Chlorinated hydrocarbon (Fig. 3a) and lipid (Fig. 3b) concentration values in red mullet were compared with those of two other species, Sardina pilchardus (pilchard) and Boops boops (bogue), caught in the same area/season. Both values were higher in pilchard and lower in bogue, as compared to those in red mullet. This possibly implies a positive relation between lipids and chlorinated hydrocarbons, as has been found in six species from the NW. Atlantic (STOUT, 1980).

REFERENCES

CLARKE, K.R. & WARWICK, R.M., 1989. Lecture notes. FAO/IOC/UNEP, Part II, 85p.

PICER, N. & PICER, M., 1978. Monitoring of chlorinated hydrocarbons in water and sediments of the north Adriatic coastal waters. IV Jour. Etud. Pollut. CIESM, 147-148.

SATSMADJIS, J., GEORGAKOPOULOS-GREGORIADES, E. & VOUTSINOU-TALIADOURI, F., 1988. Separation of orgtanochlorines on alumina. J. Chromatogr. 437, 254-259.

STOUT, V., 1980. Organochlorine residues in fishes from the northwest Atlantic ocean and the gulf of Mexico. Fish. Bull. U.S. 78, 51-58.

Characterization and Distribution of Organic Matter in recent sediments from Elefsis Bay (Saronikos Gulf, Greece)

Ulrich MANN*, Detlev MULLER* and Christos ANAGNOSTOU**

*Institute of Petroleum and Organic Geochemistry (ICH-5) at the Research Center (KFA) Juelich, P.O. Box 1913, D-5170 Juelich (F.R.G.)

**National Center for Marine Research (NCMR), Aghios Kosmas, 16604 Hellinikon (Greece)

Within Recent sediments from Elefsis Bay, two types of geogenic and two types of anthropogenic organic matter may be expected:

1: From autochthonous, biogenic marine organisms like phyto- and zooplankton as well as from benthos.
2: Wind- or river transported plant debris (spores, pollen, plant tissues).
3: Petroleum contamination from oil refineries, shipyards and harbour areas as well as other organic compounds from industrial sources.
4: Sewage effluents from the Athens metropolitan area.

The objective of our investigations is to provide an organic-geochemical survey of the sediments from Elefsis Bay, to identify the four above mentioned organic matter types and to establish the presence of potential anomalous organic concentrations.

Sediment samples were taken in March and October 1989 using a modified Reineck corer on board the Greek R/V "Aegeio". Recovered sediments constitute about 80% clay plus silt, in which approximantely about one half is represented by carbonate and the other half predominantly by clay minerals.
Many of our basic organic-geochemical results confirm the findings by VOUTSINOU-TALIADOURI & FRAGOUDAKI (1986) who determined total organic carbon contents (TOC) of up to 4%.
Total content of soluble organic matter, as well as relative amounts of aliphatic to aromatic hydrocarbons to heterocompounds (N,S,O), do not exhibit any significant variation, most probably due to the various sources of organic matter within Elefsis Bay. Only the concentration of aromatic hydrocarbons seem to monitor the proximity of industrial effluents.

The individual types of organic matter were elucidated as follows:
Macro- and microscopic observations indicate that the autochthonous biogenic, marine constituents of the sediments from Elefsis Bay are nearly exclusively made up of carbonate shells. Because shell particles are concentrated with the sand fraction, their regional contribution to the sedimentary input can be estimated via the carbonate content. The amount of preserved organic matter, however, has to be identified via the total organic carbon content of the sand fraction. As we have observed, most pelecypods and gastropods preserve at least some of their organic matter within their shells.
Relative amounts of the marine versus terrestrial organic matter present within the sediments were evaluated by concentrations of the C_{15} to C_{18} versus C_{21} to C_{25} aliphatic hydrocarbon fractions. Within the sediments from Elefsis Bay, terrestrial plant material predominates. This is in accordance with the very close shoreline and the wind direction from the inland area. Nevertheless it can also be argued that anthropogenic contamination of Elefsis Bay has reduced the quality of living conditions for marine organisms and therewith the primary availability of marine organic matter. The stress factor within Elefsis Bay is especially expressed by the scarcity of marine species.
As outlined above, a major contamination in Recent Elefsis Bay sediments is represented by petroleum together with other organic compounds. Within all anoxic sediments we found an "Unresolved Carbon Mixture" (UCM) in the C_{15+}-aliphatic hydrocarbon fraction which seems to correlate to an UCM within the C_{15+}-aromatic hydrocarbon fraction. At the reference site outside Elefsis Bay, an UCM could still be identified, however, with a considerable lower concentration. No UCM was observed within the underlying oxic sediments.
Preliminary investigations reveal that the UCM is confined to the clay fraction of the sediment, especially to its adsorption capacity as expressed by the size of specific surface area.
The effects of sewage effluents within Elefsis Bay have not been evaluated so far. However, for this purpose, analyses of low-molecular-weight hydrocarbons are in progress.

The incorporation and preservation of marine, as well as of terrestrial organic matter, in Recent Elefsis Bay sediments, has been demonstrated from the results of our organic-geochemical survey.
Within anoxic sediments, organic, anthropogenic contamination is degraded to a considerably lower extent than within oxic sediments. As organic contamination seems to be strictly tied to clay minerals, we recommend detailed physico-chemical analyses to evaluate the chance and importance of potential remobilization processes.

References:

VOUTSINOU-TALIADOURI, F. and FRAGOUDAKI, St., 1986. Geochemical studies in sediments from a semi-enclosed polluted basin. Elefsis Systems Project Technical Report No.3, N.C.M.R., 12pp.

L-II7

Sensitivity of Colonial Hydroids to heavy metal contaminations

S. PIRAINO* and M. de NICOLA GIUDICI

*New address : Istituto sperimentale Talassografico C.N.R., Via Roma 3, 74100 Taranto (Italia)
Dipartimento di Genetica, Biologia Generale e Molecolare dell'Università, Via Mezzocannone 8, 80134 Napoli (Italia)

Comparably to larval bioassays, hydroid sensitivities to contaminants have been shown to be more relevant respect to other test organisms (3, 4). Results of experimental growth data with a single clone of the athecate hydroid Clavopsella michaeli (Berrill, 1948) exposed to single heavy metal contaminations (Hg++, Cu++, Cd++) are provided here. The stock colony was collected at Ischia (Gulf of Naples) in May 1988, first record in Mediterranean Sea. One-week laboratory experiments and data analysis were carried out according to Stebbing (4), with few modifications (2).

Before the appearance of morphological abnormalities or colony death (1), chemical stresses cause variations in growth rate depending on concentrations and relative toxicities of pollutants. Exposure to different concentrations of three metal ions (Hg++, Cu++, Cd++) resulted in recognizable, reproducible variations of the hydroid growth rate of C.michaeli colonies (Fig.1). Firstly, hormesis appeared: growth significantly increased in the presence of very low concentrations of copper (0.5 , 1 µg/l) and cadmium (1 µg/l) ions while there was only a transient stimulation of growth rate after a 24h-exposure to 0.1 and 1.0 µg/l of mercuric ions. Threshold concentrations causing C.michaeli growth rate inhibition were consistent with environmental levels of many polluted coastal ecosystems. In fact, significant reduction in growth rate occurred with exposure to about 0.5-1.5 µg/l Hg++ (Fig.1a), 2-3 µg/l Cu++ (Fig.1b) or 25-30 µg/l Cd++(Fig.1c). Nevertheless, in these cases, resilience was still maintained: K values quickly rose to control levels, after restoration of uncontaminated conditions (3). Full degeneration of colonies, without possibility of recovery, occurred after exposure to 5 µg/l Hg++ , 10 µg/l Cu++, or 100 µg/l Cd++. Here, different stages of hydranth degeneration have been observed, comparable to those described by Karbe (1) in Eirene viridula.

The process of growth of colonial hydroids appears to be controlled by homeostatic mechanisms which regulate the co-operation of multi-interacting cellular systems during colonial morphogenesis and morphostasis. Such mechanisms counteract the possible inhibitory effect of any external disturbance of low intensity , thus maintaining colonial growth at an optimal, preferred rate . When the counteractive capacity is overloaded, inhibition of growth rate occurs (2, 3, 4). The physiological basis of the control mechanisms of hydroid development still remain unclear. Nevertheless, alterations in hydroid growth rate resulted as early and highly sensitive indexes of environmental stresses (2, 3, 4) and they can constitute a useful tool for the assessment of sublethal episodes of water pollution.

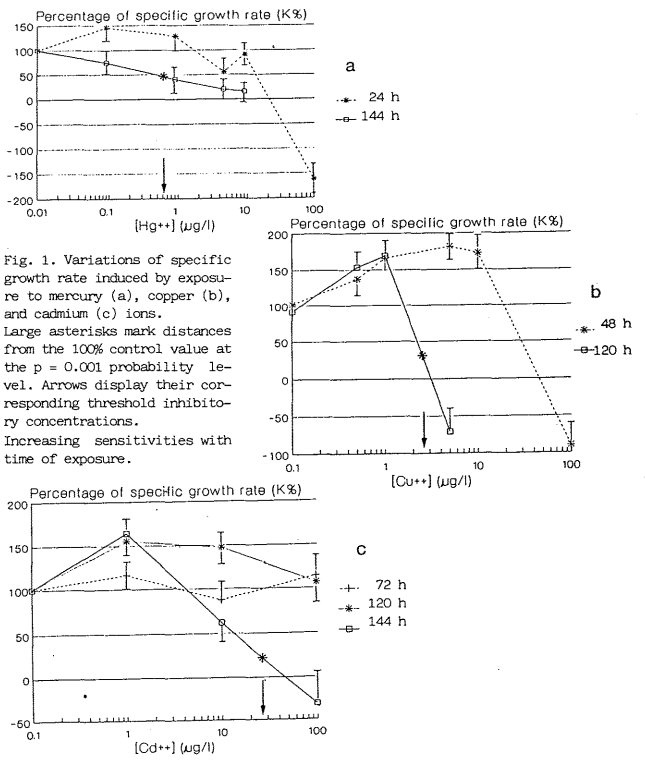


Fig. 1. Variations of specific growth rate induced by exposure to mercury (a), copper (b), and cadmium (c) ions. Large asterisks mark distances from the 100% control value at the p = 0.001 probability level. Arrows display their corresponding threshold inhibitory concentrations. Increasing sensitivities with time of exposure.

ACKNOWLEDGEMENTS
We are indebted to Dr. A.R.D. Stebbing for his invaluable advice and for introducing the first author to hydroid bioassay procedures.

REFERENCES

1. KARBE, L., 1972. Marine Hydroiden als Testorganismen zur Prufung der Toxizitat von Abwassertoffen. Die Wirkung von Schwermetallen auf Kolonien von Eirene viridula. Mar.Biol., 12, 316-28 .
2. PIRAINO, S., 1990. Biologia ed ecologia di idroidi coloniali, Tesi di Dottorato di Ricerca, Universita' di Napoli.
3. PIRAINO, S., in press. The adaptive pattern of growth and reproduction of Clavopsella michaeli (Berrill, 1948). Hydrobiologia, 5th I.C.C.B, Southampton, 1989.
4. STEBBING, A.R.D., 1976. The effects of low metal levels on a clonal hydroid. J. mar. biol. Ass. U.K., 56, 977-94.

L-II8

Analyse d'Hydrocarbures Aromatiques Polycycliques dans l'Environnement Marin Côtier par Chromatographie Liquide / Spectrofluorimétrie

C. RAOUX et P. GARRIGUES

Laboratoire de Photophysique et Photochimie Moléculaire, UA 348 CNRS, Université de Bordeaux I, Talence (France)

INTRODUCTION

Certains Hydrocarbures Aromatiques Polycycliques (HAP) présentent une forte toxicité et/ou des propriétés mutagènes ou cancérigènes. Seize d'entre eux ont été retenus comme polluants prioritaires par l'U.S. Environmental Protection Agency (US EPA). Ces composés, essentiellement d'origine anthropogénique sont présents dans tous les compartiments du milieu marin (eau, sédiment, organismes vivants). Les principales sources de contamination[1] du milieu marin sont les retombées atmosphériques (22%) et les déversements de pétrole (74%). Cependant dans les zones peu contaminées, les quantités présentes dans l'environnement sont généralement faibles (eau: 0,1 ng/l; sédiment: 1 ng/g); aussi est-il nécessaire d'utiliser une technique analytique suffisamment sensible, mais également sélective car les HAP doivent être recherchés dans l'extrait organique total de matrices souvent complexes (sédiment riche en matière organique, tissus biologiques). Le couplage Chromatographie Liquide Haute Pression (CLHP) et spectrofluorimétie (FLUO) permet de réunir ces deux notions fondamentales: sensibilité, sélectivité.

EXTRACTION DES HAP DES DIFFERENTES MATRICES

Une extraction solvant-solvant au pentane est effectueé sur les échantillons d'eau de mer. Les échantillons lyophilisés de sédiments et d'organismes marins sont extraits en extracteur Soxhlet[2,3,4] (sédiment: dichlorométhane, organismes: pentane). Les extraits purifiés sur Florisil (pendant l'extraction pour les organismes, après l'extraction pour les sédiments) sont ensuite directement analysés par CLHP/FLUO.

CHROMATOGRAPHIE LIQUIDE ET SPECTROFLUORIMETRIE (CLHP/FLUO)

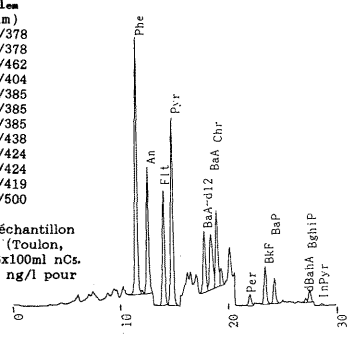
La chromatographie liquide sur phase à polarité inversée (colonne Vydac 201 TP 54, phase C_{18} polymérique, 5µm, 300Å) permet la séparation des seize HAP retenus par l'US EPA[2]. Un gradient de solvant acétonitrile/eau (pompe Milton Roy CM 4000) permet d'optimiser cette séparation. Cependant seulement douze composés sont présentés dans cette étude; en effet le dosage des HAP de faible masse moléculaire (≤164) est délicat à cause des pertes éventuelles de tels composés lors des différentes étapes d'extraction et/ou purification. La détection fluorimétrique (Perkin Elmer LS5) à longueurs d'onde d'excitation (l_{ex}) et d'émission (l_{em}) variables permet d'exciter les HAP et d'observer leur fluorescence, ceci de façon selective en fonction de leur ordre d'élution. En général les couples (l_{ex}/l_{em}) correspondent à des maxima d'absorption et d'émission des HAP recherchés afin d'obtenir la meilleure sensibilité. Parfois cependant, un choix judicieux du couple (l_{ex}/l_{em}) permet pour des composés coélués (benzo(b)fluoranthène et pérylène par exemple),de ne détecter que le composé recherché et ce sans interférence (ici le pérylène).

L'intensité de fluorescence des HAP en solution est inhibée par la présence d'oxygène dissous dans le solvant (effet dit du "quenching" de fluorescence par l'O_2[6]), aussi faut-il dégazer les solvants utilisés en CLHP/FLUO par l'hélium jusqu'à saturation, et de maintenir les solvants sous pression réduite d'He pour éviter toute redissolution de l'O_2[4].

ANALYSE QUALITATIVE

Les rendements de fluorescence des HAP étudiés étant différents, il est nécessaire de déterminer les facteurs de réponse de chaque composé relativement à un étalon interne (ici le benzo(a)anthracène deutéré) qui sera ensuite ajouté en quantité connue à chaque extrait d'échantillon à analyser. Le calcul des facteurs de réponse (intégrateur Shimadzu CR4A) est effectué à partir d'un mélange standard de référence (SRM 1647a)[7] qui contient les HAP étudiés en concentrations certifiées dans l'acétonitrile.

	l_{ex}/l_{em} (nm)
Phe: Phénanthrène	252/378
An: Anthracène	252/378
Flt: Fluoranthène	288/462
Pyr: Pyrène	333/404
BaA: Benzo(a)Anthracène	269/385
BaA-d12: BaA perdeutéré	269/385
Chr: Chrysène	269/385
Per: Pérylène	407/438
BkF: Benzo(k)Fluoranthène	297/424
BaP: Benzo(a)Pyrène	297/424
BghiP: Benzo(ghi)Pérylène	298/419
InPyr: Indéno(123-cd)Pyrène	303/500



Chromatogramme CLHP/FLUO d'un échantillon d'eau de mer de la baie du Lazaret (Toulon, novembre 1989): 3,75 l extrait par 3x100ml nC$_5$. Les concentrations varient de 0,17 ng/l pour le Per à 7,5 ng/l pour le Pyr.

CONCLUSION

La méthode CLHP/FLUO sur phase à polarité inversée permet de doser les HAP polluants prioritaires sans ambiguité dans des matrices souvent complexes grâce à sa grande sélectivité. Elle se caractérise également par une sensibilité élevée: pour un échantilon de 100g d'un sédiment très peu contaminé, la CLHP/FLUO permet de déterminer les teneurs des douze HAP dont la somme est inférieure à 3 ng/g[7] (certaines teneurs individuelles étant inférieures à 0,1 ng/g).

Références:

1. J.M. Neff, Polycyclic Aromatic Hydrocarbons in the aquatic environment, Applied Science publishers, London (1979), pp. 262.
2. P. Garrigues, H. Soclo, M.P. Marniesse and M. Ewald, *Intern. J. Environ. Anal. Chem.* **28,** 121 (1987).
3. M.M. Schantz, B.A. Benner, S.N. Chesler, B.J. Koster, S.F. Stone, R. Zeisler, and S.A. Wise, *Fresenius. Z. Anal. Chem.*, à paraître.
4. P. Michel, dans: Manuel des analyses chimiques en milieu marin, préparé par A. Aminot et M. Chaussepied, CNEXO, Brest (1983), p 337.
5. W. Karcher, R.J. Fordham, J.J. Dubois, P.G.J.M. Claude and J.A.M. Lightart, Spectral atlas of polycyclic aromatic compounds, D. Riedel publishing company, C.E.C. Brussels (1985).
6. C.A. Parker, Photolumiscence of Solutions, Elsevier Publishing Company, Amsterdam (1968), pp. 544.
7. Certificate of Analysis, Standard Reference Material 1647a, National Institut for Standard and Technology (NIST), Gaithersburg USA (1988).
8. P. Garrigues, C. Raoux, D. Ribera, J.F. Narbonne,P. Lemaire, A. Mathieu and M. Lafaurie, *Intern. J. Environ. Anal. Chem.* **38,** 379 (1990).

Etude de la distribution d'une série d'Hydrocarbures Aromatiques Polycycliques dans différentes fractions granulométriques d'un Sédiment Marin Récent

C. RAOUX et P. GARRIGUES

Laboratoire de Photophysique et Photochimie Moléculaire, UA 348 CNRS, Université de Bordeaux I, Talence (France)

INTRODUCTION

La plupart des Hydrocarbures Aromatiques Polycycliques (HAP) présents dans l'environnement sédimentaire marin, sont toxiques ou mutagènes vis à vis des organismes benthiques (algues fixées, poissons, microfaune).

Les différentes distributions relatives de douze HAP[1] appartenant à la liste des polluants prioritaires de l'US Environmental Protection Agency, obtenues dans différentes fractions granulométriques d'un sédiment marin récent (sable grossier, sable fin, silt et argile) ainsi que dans les débris végétaux sont présentées ici.

METHODOLOGIE

Le sédiment étudié a été prélevé dans la baie de Roquebrune à une profondeur de 45 mètres. 200g du sédiment superficiel recueilli et préalablement lyophilisé ont été tamisés par voie humide à l'eau ultrapure de façon à isoler les fractions granulométriques suivantes: silts et argiles (diamètre des particules (dp)< 15µm), sables fins (15µm <dp< 63µm) et sables grossiers (dp> 63µm). Les débris végétaux (essentiellement des débris de feuilles de Posidonies) ont été isolés de la fraction >63µm par flottation. La méthode d'extraction et la technique analytique utilisées sont décrites dans ce présent ouvrage [1].

RESULTATS

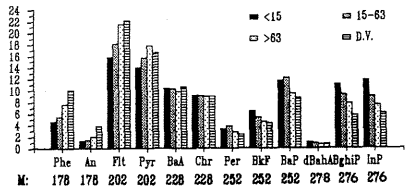
Les débris végétaux (D.V.) possèdent une teneur totale en HAP environ 25 fois supérieure à la moyenne des teneurs observées dans les autres fractions (3,5 µg/g). Les fragments de plantes qui forment une matrice typiquement organique, offrent une surface spécifique beaucoup plus importante que la matrice minérale. Les débris végétaux semblent donc jouer le rôle de "pièges" à HAP au sein de la matrice minérale.

Fraction	% massique	COP(%)	ΣHAP ± ES(µg/g)
<15µ	18,5	1,47	2,94±0,10
15-63µm	45,1	0,34	2,21±0,07
>63µm	37,7	0,26	5,35±0,04
D.V.	1,7	--	93,8±2,0

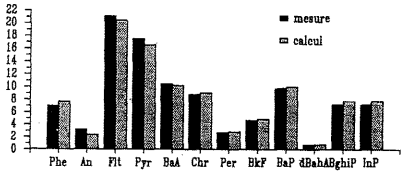
La fraction des sables grossiers (dp>63µm) est environ deux fois plus riche en HAP totaux que les fractions fines (15<dp<63µm et dp<15µm) qui présentent des teneurs totales en HAP peu différentes. Ce résultat et les mesures de carbone organique particulaire (COP) effectuées sur chaque fraction granulométrique, semblent s'opposer aux théories de l'adsorption et de l'affinité des HAP pour les matrices à fort caractère organique; la teneur en HAP la plus forte est en effet observée dans les sables grossiers qui offrent à priori la plus faible surface spécifique, et un taux de COP faible.

L'hypothèse de Readman[2], dont les travaux ont porté sur des particules en suspension en milieu estuarien, et selon laquelle parmi les particules les plus grosses (>100µm), se trouvent des particules organiques de faible densité riche en HAP[3], permettrait d'expliquer cet enrichissement des sables en HAP, également observé par d'autres auteurs[4].

L'étude de la distribution relative des douze HAP étudiés dans chaque fraction permet de mettre en évidence des différences de répartition selon la masse moléculaire (M) des HAP et la taille du substrat:



M≤202: les pourcentages croient lorsque la taille des particules augmente, les D.V. sont en général les plus riches en composés "légers".
M≥252: les pourcentages décroient lorsque la taille des particules augmente, les D.V. sont en général les moins riches en composés "lourds".
M=228: les pourcentages dans chaque fraction sont sensiblement les mêmes.



Ces résultats ne sont pas dus à un lessivage du sédiment lors du tamisage humide qui pourrait provoquer une perte préférentielle des composés les plus hydrosolubles de la fraction fine. En effet les conditions opératoire (récupération et évaporation de l'eau surnageante) et la comparaison des teneurs en HAP dans le sédiment total, obtenues par le calcul (à partir des teneurs dans chaque fraction et de son pourcentage massique) et mesurées expérimentalement conduisent à la même distribution.

De plus, ces résultats sont de nouveau en accord avec les travaux de Readman[1] qui observe également un balancement de la distribution des HAP en faveur des composés de faible masse moléculaire dans les fractions contenant les grosses particules en suspension. L'interprétation d'un tel phénomène reste cependant délicate, des mesures de surfaces spécifiques ainsi que de nouvelles études granulométriques sur d'autres sédiments d'origine différente devrait aider la compréhension de la répartition des HAP dans les différents compartiments sédimentaires.

Remerciements:

Nous remercions le Musée Océanograpique de Monaco et l'équipage du "Winnaretta Singer" pour leur aide durant les missions; ainsi que l'Institut Géologique du Bassin Aquitain pour les analyses de COP. Ce travail a été supporté par la CCE (contrat EV4V-0163-EDB) et l'IAEA (contrat 302-KG-FRA-16412).

Références:

1. C. Raoux et P. Garrigues, Analyse des HAP par chromatographie liquide et spectrofluorimétrie, cet ouvrage (1990).
2. J.W. Readman, R.F.C. Mantoura and M.M. Rhead, *Fresenius Z. Anal. Chem.* 319, 126 (1984).
3. F.G. Prahl, The geochemistry of PAH in Columbia river and Washington coastal sediments, thèse de l'Université de Washington (1982).
4. S.C. Brassel and G. Eglinton, in: J. Albaiges (ed) Analytical techniques in environmental chemistry, Pergamon press, Oxford (1980).

Detergents as indices of organic pollution in Alexandria Coastal Waters

Tarek A. ABOUL-KASSIM

Oceanography Department, Faculty of Science, Alexandria University, Moharam Bey, Alexandria (Egypt)

INTRODUCTION: Dissolved organic compounds in the sea originate from several internal & external sources. Apart of organic compounds in sea water is surface active substances which may change the solubility and physico-chemical state of other micro-constituents in sea water. The problem of pollution by detergents has been and is still discussed on a national and multinational scale, and some detergents are now restricted for domestic use .

The present work is an attempt to study retrospectively the relation between the state of pollution of Alexandria coastal waters by anionic detergents & sewage disposal during 1985-1986.

MATERIALS AND METHODS: The study area (Figure 1) lies off Alexandria between 31° 08'-31° 26' and 29° 47-30° 04'E. It extends for about 38 Km from El-Agami (west) to Abo-Qir Head land (east), including four different zones from the pollution view points. Three of them are completely polluted with domestic sewage and waste waters, while the fourth (El-Agami) is considered the reference zone due to being far away from pollution. Alexandria beaches are highly polluted with domestic sewage and waste waters, receiving on the average about 183X10⁶ m³/yr. Out of this amount, about 36X10⁶ m³, 35X10⁶ m³ and 111.8X10⁶ m³ are discharged annually to zones I, II and III. The situation in zone III is more complicated due to being affected by agricultural run-off (brackish water, 2.57X10⁶ m³/yr) from Umom drain.

Sampling was carried out at regular monthly intervals during August 1985-November 1986 (twice a month). Sampled stations were 13, 7 , 4 & 2 for zones I, II, III & IV,respectively. For the determination of anionic surfactants, water samples were taken and analyzed fresh (within 6 hrs) using the methylene blue method (APHA, 1985).

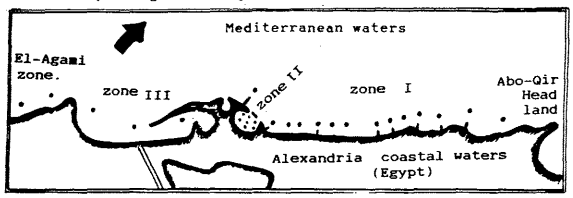


Figure 1: The study area of Alexandria during 1985-1986.

RESULTS AND DISCUSSION: The annual means and ranges of surfactants, salinity & TSM in Alexandria waters are shown in table 1. The monthly variations for anionic surfactants and TSM showed higher values during summer, and lower in winter due to the high sewage disposal in summer (Aboul-Kassim,1987). Based on stational averages, higher values of anionic detergent were recorded at stations directly affected by sewage discharge (zones I, II & III), and lower in El-Agami zone.

According to Cosovic et al. (1985), the total surfactant content of 0.2-0.8 mg/l corresponds to naturally occurring organic substances of unpolluted sea water. Compared with the range and average concentrations of detergents in El-Agami (the reference zone) or even with that of Azmir Bay (Turkey), i.e. 0.42-4.14 (Uysal & Yaramaz, 1988) or that of lake Burullus (Egypt), i.e. 0.17 mg/l (Mahmoud and Beltagy, 1988), the average surfactant levels of zones I, II and III might indicate that Alexandria waters are highly polluted with detergents. The significant inverse correlation between detergents and salinity (r=-0.8791) indicates that detergents in the polluted study area are brought down with sewage disposed into Alexandria coasts.

Table 1: Means and ranges of anionic surfactants, salinity & TSM for surface & bottom waters in the costal waters of Alexandria.

Zone	SURFACTANTS (mg/l)		SALINITY		TSM(mg/l)	
	Surface	Bottom	Surface	Bottom	Surf.	Bottom
I	0.02-4.21 (0.45)	0.02- 4.32 (0.37)	36.03	36.42	25.4	22.7
II	0.40-4.00 (1.33)	0.53- 2.52 (0.93)	33.71	34.10	53.2	47.1
III	0.46-8.31 (1.50)	0.19-12.35 (2.32)	31.72	33.21	145.0	133.0
IV	0.02-0.08 (0.03)	0.06- 0.17 (0.02)	38.94	39.11	3.1	1.2

The levels of anionic surfactants can be used as an index of organic water pollution, where their concentrations in Alexandria waters were strongly correlated with sewage disposal (r=0.9511) & TSM (r=0.8911), the regression equations being:

Amount of Sewage (m³/yr) = 21.341 + 23.731 Surfactants (mg/l),

TSM (mg/l) = 11.264 + 19.211 Surfactants (mg/l). The high levels of detergent in Alexandria is a further support to this assumption.

The actual amounts of detergent loading disposed to Alexandria waters were estimated to be about 86, 109 Kg/day, reaching Alexandria waters through zones I and II, while zone III discharges about 7 tons/day. The large amounts of domestic sewage, agricultural run-off and industrial wastes disposed in zone III is a further support for that highly daily load. The daily discharge of detergents in Alexandria waters is relatively small compared with that given for France in Marseille, i.e 4.00 (Arnoux & Coruelle, 1972) or Cortiou area, i.e 5.00-6.20 (EPOPEM, 1978) depending on the flow rate. Based on personal data, the expected total loading of detergents to the area are projected to be approximately double between now and year 2000.

According to FAO, each individual contributes to urban detergent having sewage an average value of 0.4-1 Kg/yr. Based on the daily discharge values, the population equivalent of the area will vary from 0.40-0.75, indicating that the levels of detergents in Alexandria are still far from seriousness of severe pollution and that the population equivalent is still within the typical range mentioned by FAO.

Since detergents have caused serious pollution problems in natural waters, commercial detergents should be non-toxic to aquatic organisms as well as to be biodegradable by microorganisms.

REFERENCES:

Aboul-Kassim, T.A.(1987). M.Sc.Thesis, Alexandria University, Egypt.
APHA (1980). American Public Health Association (APHA).New York, 1193.
Arnoux, A. and F. Caruelle (1972).In: Marine pollution and Sea lif, pp.174-180. Ruivo M.ed., Fishing news (books) Ltd.
Cosovic,B.,V.Zutic,V.Vojvodic & T. Plese (1985). Mar.Chem.,17:127-139.
Duursma,E.K.& M.Marchand(1974).Oceanogr.Mar.Biol.Ann.Rev.,12,315-431.
EPOPEM (1978).Group EPOPEM. IVes Journees Etud.Pollutions,pp.381-384.
Mahmoud,T.H. & A.I. Beltagy (1988). Rapp.Comm.Int. Mer Medit.,31 (2).
Uysal, H. and O. Yaramaz (1988). Rapp.Comm.Int. Mer Medit.,31 (2).

L-III2

Oxygen studies as sewage pollution indices in a Semi-Closed Basin of Alexandria Coast

T.-A. ABOUL-KASSIM and N.-M. DOWIDAR

Oceanography Department, Faculty of Science, Alexandria University, Moharam Bey, Alexandria (Egypt)

INTRODUCTION: Dissolved oxygen is one of the most important parameter for water masses identification & pollution assessment in the marine environment. Sewage pollution adversely affects aquatic life through oxygen depletion. Dissolved oxygen (D.O), biochemical oxygen demand (BOD) and permanganate value (PV) have been used as pollution indices in a heavily polluted basin; the Eastern Harbour (E.H) of Alexandria (Figure 1); receiving about 35X10⁶ m³/yr of sewage and waste waters.

MATERIAL AND METHODS: Sampling was carried out at regular bimonthly intervals from May 1985 to May 1986. D.O and H_2S (when present) were taken & analyzed according to Strickland and Parsons (1972) and Common Methods of Sea Water Analysis (1969). For determination of BOD, samples were incubated at 20°C for 5 days & analyzed according to APHA (1985). PV water samples were determined according to Carlberg (1972).

RESULTS AND DISCUSSION: D.O and its related parameters 'BOD & PV' have been used as basic water criteria to assess sewage pollution. The oxygen content can be an indicator of organic loading, nutrient input & biological activity. Table 1 shows the annual average concentrations of D.O, BOD & PV for both surface and bottom water layers of the E.H. Except on rare occasions, the E.H water was well oxygenated (annual average 6.00±1.81 mg/l, corresponding to 87.2±29% saturation). However, the surface layer is oversaturated (105%), while the bottom is undersaturated (69%) which is sometimes completely deoxygenated. This dangerous phenomena occurred in May 1985 and June 1987 following a high sewage discharge load, an elevation of air & water temperatures accompanied by dense phytoplankton blooms. The primary cause of water deoxygenation is the presence of substances called oxygen-demanding wastes (mainly organic), easily broken down or decayed aerobically or anaerobically through bacterial activity (Arin, 1974). The D.O budget in the harbour is a balance between the high photosynthetic activity rate (584 g C/m²/yr), leading to a large D.O production and a high load of organic matter that consume large amounts of D.O. Both processes occurred simultaneously in the E.H water & was demonstrated at stations I & V (Figure 1) located in front of sewage outfalls specially in summer when the bacterial activity is maximum.

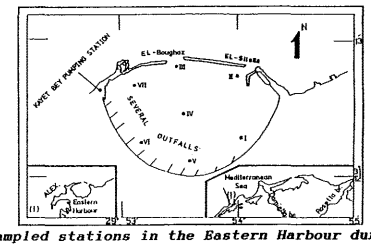


Figure 1: Sampled stations in the Eastern Harbour during 1985-86.

A BOD of 1 ppm is characteristic of nearly pure water, 3 ppm for fairly pure and 5 ppm for doubtful purity (ECPH, 1975). A comparison between these levels & that observed in the present study showed that the average surface BOD values (i.e 3.86±3.32 mg/l) is comparatively higher than those of standard values. This may indicate the presence of a high load of sewage continuously discharging into the harbour and that the BOD_5 levels is still far from seriousness of severe sewage pollution as well as being within the typical BOD_5 values for domestic sewage, i.e. 250-350 g/m³ (ECPH, 1975). The comparatively low BOD_5 in the E.H irrespective of the discharge of large amounts of sewage is mostly due to the effective exchange between fresh Mediterranean waters and the harbour water as well as its short flushing time ; i.e. 5 months. The high surface D.O consumption (annual average 51.3±26%) of the available D.O is related to sewage water of lower density discharging with its high content of organic matter and bacteria.

An interesting way to point out the magnitude of the oxygen-demanding waste problem is to equate the BOD_5 of total daily nationwide wastes from specific source to the number of humans required to produce daily waste with an equivalent BOD_5. Each individual contributes to urban sewage an average BOD_5 value of about 60 gm/day (ECPH, 1975). Based on the daily discharge to the harbour (effluent having a maximum BOD_5 of 380 mg/l) the population equivalent of this effluent water will be 6.33. Based on data from the General Authority of Municipal Waste Water, the expected population equivalents during the years 1990 and 2000 will be 10.08 and 13.67, respectively. However, it is clear that the total waste water pollution loads (BOD_5) are projected to be approximately triple between now and year 2000.

Another way to assess the degree of sewage pollution in the E.H was to measure its organic matter present using permanganate value method. The PV concentrations in the E.H were remarkably low (Table 1). An excellent way to determine the type of waste water discharge, to know if it is or not biodegradable, is by calculating its BOD_5/PV ratio. A BOD_5/PV ratio of 1:1 is characteristic of pure water, 2:1-4:1 for crude domestic sewage, while carbohydrates & proteins rich wastes (food processing wastes) have ratios equal to or greater than those of sewage (ECPH, 1975). The average values of BOD_5/PV ratio in the E.H varied between 0.87-2.00 and 0.73-2.35 for surface & bottom waters. Higher ratios were observed at stations directly affected by sewage discharge. Generally data may indicate that most of the sewage reaching the E.H is of biodegradable character (Aboul-Kassim, 1987).

Table 1: The annual average concentrations of D.O, BOD and PV for both surface and bottom waters in the E.H during 1985-86.

	D.O(mg/l)	% oxy sat.	BOD(mg/l)	PV(mg/l)	BOD/DO(%)
SURFACE	*7.24*	*105*	*3.86*	*3.15*	*51.6*
BOTTOM	*4.89*	*69*	*1.79*	*1.34*	*37.3*

REFERENCES:

Aboul-Kassim, T.A. (1987). M.Sc. Thesis, Alexandria University, Egypt.
Arin, M.L. (1974). Environmental Science and Technology, pp.: 898-902.
Calberg, S.R. (1972). New Baltic Manual. International Council for the Exploration of the Sea. Cooperative Research Report # A(29).
Common Methods for Chemical Analysis of Water (1969). Reprint from Chemical Oceanography. Sec A/C. Univ. of Oslo, Norway: 152pp.
Environmental Control and Public Health (1975). Water analysis, standards and treatment. Eyre and Spottiswoode Ltd., pp.131, ECPH.
Strickland, J.D.H. & T.R. Parsons (1972). Fish. Res. Bd. Canada, Bull. 167, 310pp

L-III3

Impact of sewage pollution on some chemico-physical characteristics of the Eastern Harbour of Alexandria

T.-A. ABOUL-KASSIM and N.-M. DOWIDAR

Department of Oceanography, Faculty of Science, University of Alexandria, Moharam Bey, Alexandria (Egypt)

In recent years, the problem of sewage pollution of Alexandria coastal waters has become a point of national concern. The coastal water of Alexandria receives annually about 183X10⁶ m³ of untreated sewage. About 20% of this amount is discharged to the Eastern Harbour (E.H), rendering it highly fertile. The effect of waste water and sewage discharge on some chemico-physical characteristics of the harbour water were carefully studied and discussed.

The study area is a semi-circular shallow bay, surrounded by Alexandria city, connected to the Mediterranean through two openings. The basin is subjected annually to about 35X10⁶ m³ of unprocessed sewage, rendering its flushing time to be 5 months.

Regular bimonthly sampling during the period 1985-1986 indicated that seasonal variations in water temperatures were directly affected by solar radiation and seasonal changes in air temperature. Thermal stratification was rarely detected. However, in period of calm weather, thermal stratification may occur to a limited extent. The occurrence of a homothermal water column is a general character, particularly in winter. This is mostly related to the effective mixing processes in this basin. The annual average temperature is 22.2°C (Table 1), with an amplitude of 11.9°C.

The transparency of the E.H was relatively high. The annual average being 2.65±0.67m. The remarkably high values at station III (Table 1) is mostly due to its low chl a and total suspended matter (TSM) as well as being relatively subjected to the direct effect of waste water discharged inside the harbour.

The TSM values in the E.H were remarkably high. The annual average amounted to 34.49±21.83 mg/l (Table 1). This high average are normal in such a semi-closed fertile basin, receiving large amounts of raw sewage, demonstrated by the high inverse correlation between TSM and salinity in the harbour ($P<0.001$).

The average Chl a biomass in the harbour water amounted to 5.14±4.71 mg/m³. This indicates that the environment of the harbour is highly eutrophic. The high Chl a is undoubtly due to the rich supply of nutrient salts discharged with the untreated wastes and sewage discharge disposed to the harbour as well as other sources, i.e. 402 Tons nitrogen/yr (El-Nady et al, 1990) and 1.094 Tons phosphorus/yr (Dowidar et al., 1990).

The salinity of the E.H is mostly controlled by the amount of sewage water discharged into the basin and the rate of mixing and exchange of the harbour with the adjoining coastal waters of the Mediterranean Sea. During the last 10 years, salinity values of the harbour were decreasing gradually by more than 4% due to nearly doubling the amount of sewage and waste water discharged to the harbour. The distribution of salinity reveals that surplus water from the harbour flows outward as a mixed surface layer through the main openings (stations II and III), while undiluted Mediterranean water flows into the harbour as a subsurface layer near the bottom. The effect of sewage discharged into the Southern region of the harbour was clear as it lowered the values of salinity at stations I (average 36.89‰.), V (36.94‰.) & to a less extent station VI.

The pH of the harbour water always lies on the alkaline side. The absolutes surface values fluctuated between 7.80 & 8.58, while for bottom samples, the minimum and maximum values varied between 7.56 and 8.43, respectively. The higher surface values than those near the bottom was due to the high photosynthetic activity at the surface and relatively high organic load of the bottom water & surface sediments. Variations in total alkalinity are controlled by physical and chemical processes taking place in the water body. The annual average amounted to 2.42±0.14 meq/l. The average specific alkalinity values calculated for the E.H, i.e. 0.117±0.009 (Table 1) was slightly low compared with 0.126 accepted for oceanic water (Koczy, 1956; Morcos, 1970). The relatively high pH and total alkalinity values recorded in warm months are mostly correlated ($P<0.001$) with the rise in water temperature. The significant correlation, between chl a content and pH may indicate that the pH of the environment could be used as a good indicator for production levels.

Table 1: Annual averages of some chemico-physical parameters in surface and bottom water layers in the Eastern Harbour during 1985-1986.

St. No.	Max. Dep.	Depth of sample	Water Temp. (°C)	Transp. (m)	TSM (mg/l)	Chl a (mg/m³)	S‰	pH	T.Alk meq/l	sp. Alk.
I	S	0.0	22.20	2.43	47.83	13.82	36.89	8.15	2.47	0.121
	B	3.5	22.21		32.50	3.06	38.01	7.98	2.38	0.118
II	S	0.0	21.83	2.71	27.83	4.15	37.25	8.17	2.45	0.119
	B	5.0	22.50		31.20	3.51	37.84	8.22	2.42	0.116
III	S	0.0	22.15	3.79	27.50	4.35	37.48	8.22	2.43	0.117
	M	5.0	21.92		26.67	2.60	37.69	8.12	2.42	0.115
	B	8.5	21.73		24.17	1.66	38.62	8.08	2.35	0.110
IV	S	0.0	22.17	3.13	28.17	5.18	37.07	8.26	2.46	0.120
	M	3.0	21.00		18.00	2.80	38.04	8.11	2.41	0.114
	B	6.0	21.83		22.67	2.97	38.22	8.04	2.40	0.114
V	S	0.0	22.47	1.73	70.17	13.03	36.94	8.19	2.47	0.121
	B	3.5	22.37		27.50	4.07	37.38	8.12	2.40	0.116
VI	S	0.0	22.20	1.93	36.00	6.01	37.04	8.18	2.47	0.121
	B	2.0	22.67		47.67	4.07	37.03	8.19	2.45	0.119
VII	S	0.0	22.30	2.81	31.67	4.16	37.53	8.24	2.44	0.117
	B	5.0	22.10		29.83	2.33	38.40	8.06	2.37	0.117
	S		22.20	2.65	38.45	7.24	37.17	8.20	2.46	0.120
	SD±		4.60	0.67	27.55	5.98	0.91	0.16	0.15	0.009
Average	B		22.10		30.52	3.05	37.92	8.08	2.39	0.114
	SD±		4.20		15.87	1.55	0.42	0.07	0.15	0.008

*S=surface, M=middle, B=bottom.

REFERENCES:

Dowidar, N.M., A.R. Abdel-Moati, T.A. Aboul-kassim and F.E. El-Nady (1990). Rapp. Comm. Int. Mer Medit., CIESM (in press).
El-Nady, F.E., T.A. Aboul-Kassim, N.M. Dowidar and A.R. Abdel-Moati (1990). Rapp. Comm. Int. Mer Medit., CIESM (in press).
Koczy, F.F. (1956). Deep-Sea Res., 3(4):279-288.

Teneur en Métaux et taille de la coquille chez la Moule *Mytilus galloprovincialis* Lamarck. Précautions d'utilisation en Molysmologie

Henry AUGIER*/**, Rémy DESMERGER*/**, Martine EGEA*/**, Eric IMBERT*, Wonkyou PARK*/**, Giovanni RAMONDA*/***

*Centre d'Etudes, de Recherches et d'Informations sur la Mer (CERIMER), Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)

**Laboratoire de Biologie marine fondamentale et appliquée, Faculté des Sciences de Luminy, 13288 Marseille Cédex 9 (France)

***Laboratoire départemental d'Hygiène alimentaire et d'Epidémiologie vétérinaire, 13006 Marseille (France)

Résumé : Les concentrations en cadmium, cuivre, mercure, plomb et zinc ont été déterminées par spectrophotométrie d'absorption atomique sur différents lots de la moule Mytilus galloprovincialis L. prélevés en Darse II du port méditerranéen français de Fos. Les analyses révèlent qu'il existe une corrélation inverse entre les concentrations en métaux et la taille des moules prélevées au même endroit et au même moment. Les conséquences de ces résultats sur les enquêtes molysmologiques utilisant la moule sont discutées.

Metallic rates and shell size of Mytilus galloprovincialis Lamarck mussel. Precaution of use in molysmology.

Summary : A scheme employing atomic absorption spectrophotometry has been developed for the determination of cadmium, copper, lead, mercury and zinc contents in different lots of mussels Mytilus galloprovincialis L. harvested in the Dock II of the mediterranean french harbour of Fos. The analyses show that there is a negative correlation between metal rates and size of mussels harvested in the same area and at the same time. The consequences of these results on molysmological investigations using mussels are discussed.

INTRODUCTION

Par sa résistance à la pollution, sa très large distribution et son pouvoir élevé de concentration des polluants, la moule constitue un matériel de choix très largement utilisé pour caractériser la pollution littorale. Son emploi comme indicateur biologico-biochimique nécessite cependant un échantillonnage rigoureux (AUGIER, 1987). L'influence de la taille des coquilles, qui fait l'objet de cet article, en constitue l'un des aspects majeurs.

METHODES

Soixante moules (Mytilus galloprovincialis L.) ont été récoltées le 13 octobre 1989 en darse II du port de Fos, à 0,5 m. de profondeur, dans un rayon ne dépassant pas 5 m., puis réparties en 5 lots de taille allant de 3 à 8 cm.. Les échantillons, débarrassés de leur coquille, sont lyophilisés et micro-pulvérisés (AUGIER, 1970), puis minéralisés par l'acide nitrique et l'acide sulfurique en utilisant l'oxyde de vanadium comme catalyseur (MALAIYANDI et BARETTE, 1970). Les dosages sont réalisés à l'aide d'un spectrophotomètre d'absorption atomique IL 457 de Lexington Company. Les résultats ont fait l'objet d'un traitement statistique de corrélation des rangs de Spearman (in CAPERAA et VAN CUTSEM, 1988) à l'aide du paramètre :

$r_s = 1-6*\Sigma(Rx_i-Ry_i)^2/(N^3-N)$ pour i de 1 à N (Rx_i,Ry_i : Rang de l'échantillons x et y)

RESULTATS ET DISCUSSION

L'examen des tableaux I et II et de la figure 1 permet de faire les remarques suivantes :

- En raison de leur teneur extrêmement faible, trop proche de la limite de fidélité de la méthode d'analyse employée, le cadmium et le plomb ont été éliminés de la démonstration.
- Les concentrations des échantillons en cuivre, mercure et zinc sont relativement élevées; elles dépassent les normes pour le mercure.
- Il existe une corrélation inverse, statistiquement significative, entre la teneur en cuivre, en mercure et en zinc et la taille des coquilles, les concentrations en métaux dans les moules diminuant progressivement avec l'accroissement de taille des coquilles. Ce résultat confirme ceux obtenus par HAX NIENCHESKI (1982) pour la Méditerranée chez M. galloprovincialis et BOYDEN (1974), COSSA et al. (1980), BOALCH et al. (1981) au plan mondial pour M. edulis.

cm.	Cd	Cu	Hg	Pb	Zn
3-4	<0,3	17,5	0,17	<0,5	524,5
4-5	<0,3	8,8	0,13	<0,5	299,4
5-6	<0,3	4,5	0,12	<0,5	195,3
6-7	<0,3	4,7	0,11	<0,5	192,3
7-8	<0,3	3,2	0,09	<0,5	154,9

Tableau I : Teneur (en ppm de poudre lyophilisée) en métaux dans les moules Mytilus galloprovincialis en fonction de la taille des coquilles.

M.	Taille	Zn	Hg
Cu	-0,9**	0,9**	0,9**
Hg	-1,0**	1,0**	
Zn	-1,0**		

Tableau II : Coefficient de corrélation de Spearman pour les moules Mytilus galloprovincialis de différentes tailles (le signe - indique la corrélation inverse, ** la significative au seuil du risque 5%).

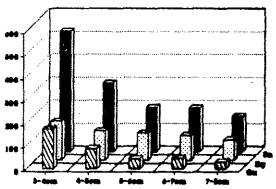


Fig. 1 : Teneurs en métaux dans les moules Mytilus galloprovincialis en fonction de la taille des coquilles. Les teneurs sont exprimées en ppm pour le zinc, en ppb pour le mercure, 0,1 ppm pour le cuivre.

CONCLUSION

Les résultats obtenus confirment l'intérêt d'utiliser la moule comme indicateur de la pollution en raison de son pouvoir élevé de concentration des métaux. Ils soulignent cependant que son utilisation pour caractériser la répartition de la pollution dans un secteur donné ne sera valable que si les moules prélevées dans les différents points du plan d'échantillonnage ont la même taille.

REFERENCES

AUGIER H., 1970.- La lyophilisation, son utilisation en phycologie. Bull. Mus. Hist. nat., Marseille, Fr., 30 : 145-164.

AUGIER H., 1987.- Bio-indicateurs et indicateurs biologico-biochimiques en pollution marine, Actes 8e colloque Intern. Ocean. Medic., 9-12 octobre 1985, Nice. Rev. Intern. Océanogr. Med., Fr., 85-86: 147-150.

BOALCH R., CHAN S. et TAYLOR D., 1981.- Seasonal variation in the trace metal content of Mytilus edulis. Mar. Poll. Bull., U.K., 12 (8) : 276-280.

BOYDEN C.R., 1974.- Trace element content and body size in molluscs. Nature, U.S.A., 251 : 311-314.

COSSA D., BOURGET E. POULIOT D., PIUZE J. et CHANUT J.P., 1980.- Geographical and seasonal variation in the relationship between trace metal content and body weight in Mytilus edulis. Mar. Biol., Germ., 58 : 7-14.

CAPERAA P. et VAN CUTSEM B., 1988.- Méthodes et modèles en statistique non paramétrique. Presses de l'Univ. Laval et Dunod édit., Paris, Fr. : 254-290.

HAX NIENCHESKI L.F., 1982.- Utilisation de Mytilus galloprovincialis comme indicateur de pollution du littoral méditerranéen français par les composés organochlorés et les métaux lourds. Thèse de Doctorat de 3ème cycle d'Océanologie. Université Aix-Marseille II, Fr. : 1-153.

MALAIYANDI M. et BARETTE J.P., 1970.- Anti-fouling Paints. Comm. Priv. Can. Dep. of Agr. Cent. Exp. Farm. Ottawa, Canada : 12-28.

Heavy Metal Concentrations in selected marine species from Milos Island (Aegean Sea)

F. BEI, E. PAPATHANASSIOU and V.-A. CATSIKI

National Center for Marine Research, Agios Kosmas, Hellinikon, Athens GR 16604 (Greece)

Introduction

A considerable amount of work deals with the problem of the accumulation of heavy metals by the marine biota (Howard & Brown, 1987; Santoro & Koepp 1986). During an oceanographic survey in Milos island (Aegean Sea) in October 1988, specimens of Paracentrotus lividus, Patella aspera, Cystoseira sp. and Padina pavonica were collected from different areas in the island in order to determine heavy metal contamination, in an area where natural mineral resources and the establishment of a big electricity plant could alter the environmental background.

Materials and Methods

Samples were collected from five stations along the coast line of Milos Island by SCUBA diving. Metal bioaccumulation was determined using the soft tissues for P. aspera, the gonads for P. lividus and the leaves in plants. Heavy metal concentrations were determined by air-acetylene flame (UNEP 1982) using a VARIAN AA157 Atomic Absorption Spectrophotometer. Statistical analysis include one-way ANOVA and the LSR test.

Table 1. Mean values (avg) and Standard Deviation values (std) of bioaccumulation of the six metals at the 5 stations in the four species. sp1: P. lividus, sp2: P. aspera, sp3: Cystoseira sp. sp4: P. pavonica.

METAL		STATION 1				STATION 2			STATION 3			
		sp1	sp2	sp3	sp4	sp1	sp2	sp3	sp1	sp2	sp3	sp4
Ni	avg	9.30	28.60	21.90	28.40	8.74	26.90	17.60	14.10	25.50	10.20	27.30
	std	5.58	14.69	6.33	8.32	5.25	12.66	4.99	19.37	38.54	7.37	2.54
Cu	avg	4.00	10.10	5.20	5.90	4.29	7.60	4.20	6.30	12.00	4.60	6.70
	std	1.40	2.30	1.70	2.60	2.10	2.68	1.04	3.30	4.30	0.40	0.80
Cd	avg	2.40	8.30	2.40	3.20	2.49	3.70	1.80	3.00	7.90	3.50	3.10
	std	0.80	2.30	0.70	0.90	0.90	1.50	0.10	1.70	2.20	0.90	0.40
Mn	avg	2.20	16.30	27.20	46.50	10.75	32.10	61.70	2.40	6.30	18.60	75.20
	std	1.04	11.80	35.70	5.20	9.70	44.50	24.20	0.80	2.50	3.00	18.90
Cr	avg	3.10	6.17	2.10	4.40	2.48	5.12	2.50	3.60	15.30	1.60	4.10
	std	1.90	4.60	2.20	1.50	1.20	2.30	2.30	2.80	31.30	0.80	1.50
Zn	avg	123.60	56.50	24.40	21.80	120.02	31.85	25.90	117.60	42.60	47.30	30.10
	std	69.30	36.90	8.10	12.30	67.80	18.00	7.50	22.50	5.40	10.60	2.60

METAL		STATION 4				STATION 5			
		sp1	sp2	sp3	sp4	sp1	sp2	sp3	sp4
Ni	avg	7.10	19.10	8.90	19.00	34.90	16.00	17.70	22.00
	std	2.34	13.04	5.91	9.19	19.37	11.80	5.30	6.90
Cu	avg	3.70	12.30	3.60	6.70	5.50	7.90	4.10	5.30
	std	0.70	3.70	0.50	0.40	2.80	2.80	3.30	1.00
Cd	avg	1.90	11.40	2.20	3.20	3.40	5.00	1.60	2.70
	std	0.20	3.90	0.20	0.30	1.20	1.70	0.70	0.30
Mn	avg	1.20	11.30	16.70	74.00	6.30	23.00	65.40	121.30
	std	0.30	3.50	1.80	25.80	4.00	22.80	68.40	9.60
Cr	avg	1.90	5.80	1.50	3.50	18.20	5.20	5.30	4.10
	std	1.40	4.20	1.10	1.20	14.70	4.50	3.60	1.00
Zn	avg	75.80	50.90	22.00	37.30	127.30	43.20	59.10	32.20
	std	41.10	8.70	3.90	4.40	102.70	11.80	41.80	4.80

Table 2. F-ratio (F) and significance level (p) in the four species for the six metals

METAL	P.lividus		P.aspera		Cystoseira sp.		P.pavonica	
	F	P	F	P	F	P	F	P
Ni	8.64	<0.001	0.85	0.498	7.97	0.0001	3.32	0.03
Cu	2.72	0.038	5.74	0.006	1.17	0.336	1.63	0.199
Cd	2.78	0.035	18.17	<0.001	10.92	<0.001	0.99	0.408
Mn	8.53	<0.001	2.27	0.072	3.86	0.008	31.33	<0.001
Zn	0.66	0.619	2.71	0.038	6.64	0.0003	7.32	0.0006
Cr	11.79	<0.001	1.13	0.349	-	-	0.85	0.477

Results and Discussion

Out of the total 226 samples, 66 belong to sea urchins, 66 to limpets and 103 to the two species of algae. The mean concentration values are shown in Table 1. The concentrations of Ni, Cu, Cd, Cr and Zn in P. pavonica show a lot of comparability with the concentrations found in the leaves of Cystoseira sp. (Table 1). In addition, results show that metal concentrations in P. aspera are higher than those in P. lividus. This is particularly emphasised for the determined concentrations of Cd. The explanation for this could be found in the physiology of these two organisms. The limpet is a herbivorous animal and a good indicator species for Cd contamination and usually contain high concentrations of metals under natural conditions, particularly in the visceral mass (Bryan 1976). One-way ANOVA revealed that there are no significant differences in metal content for P. pavonica between the various stations (Table 2). On the contrary the ANOVA test regarding the concentrations of Ni, Cu, Cd and Cr for P. lividus demonstrates differences between two groups of stations, 3 and 5 in the first group and all the other stations in the second group of stations. The differences of the natural environment should be responsible for that rather than contamination areas. In this respect the observed differences in the levels of contamination in the metal concentrations should be due to natural environmental factors like sediments and/or mineral dissemination.

In conclusion, the concentration ranges found in the above mentioned species are comparable with other areas in the Aegean sea (Voutsinou-Taliadouri, 1982; Vasilikiotis et al, 1983; Catsiki, unpublished results) which are considered as clean waters.

References

Bryan G.W.,1976. In: Marine Pollution, R. Johnston (ed), Academic Press pp. 185-302.
Howard L.S.& V.E. Brown, 1987. Mar. Pol. Bull. 18: 451-454.
Santoro E.D. & S.J. Koepp, 1986. Mar. Pol. Bull. 17: 219-224.
UNEP,1982. Reference Methods for Marine Pollution Studies No 11.
Vasilikiotis G., Fytianos K. & Zotou A., 1983. Chemosphere 12 : 75-81.
Voutsinou-Taliadouri F., 1982. Journees Etud. Pollut., CIESM, Cannes 6: 329-333.

L-III6

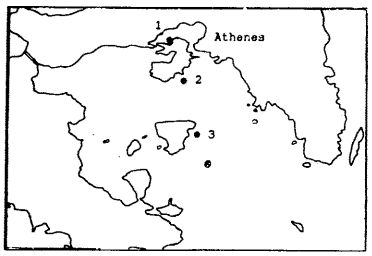
Hg et autres Métaux dans la flore et la faune marines du Golfe Saronikos

V.-A. CATSIKI, F. BEI et C. KATSILIERI

Centre National pour la Recherche Marine, A. Kosmas, Hellinikon 16604 (Grèce)

Le Golfe Saronikos présente la caractéristique d'être le réceptacle final des eaux usées de la ville d'Athènes et de sa vaste région industrielle et portuaire. Ces décharges contiennent des concentrations élevées en métaux lourds qui mettent en danger l'écosystème du Golfe. Dans le cadre du Programme MED.POL, nos recherches ont porté sur la concentration métallique de plusieurs espèces du Golfe Saronikos, durant les années 1984 à 1989 en vue d'étudier la distribution des métaux en des organismes de niveaux trophiques différents et de surveiller la concentration des métaux des tissus des espèces comestibles issues de plusieurs régions du Golfe (Fig. 1). Les stations de prélèvements (1, 2 et 3) ont été choisies de manière à mettre en évidence l'impact des rejets sur la teneur en métaux des organismes.

Figure 1
Stations de prelevements



Les espèces *Ulva lactuca, Posidonia oceanica* (rhizomes), *Mytilus gallopro-vincialis* et *Mullus barbatus*, ainsi que des échantillons de Zooplancton, ont été choisis pour être présentés dans ce travail. Hormis les poissons, les autres espèces ont été récoltées, par plongée autonome à une profondeur d'1 à 4 m. Le dosage des métaux a été effectué par absorption atomique (6). Les résultats de l'analyse de 239 échantillons, concernant le Hg, Cd, Cu, Cr et Ni exprimés en µg/g de poids sec et sous forme de moyennes sont données par les figures 2, 3, 4 et 5. Par la suite, les résultats ont subi une analyse statistique (ANOVA).

Les échantillons de zooplancton ont présenté dans tous les cas les plus fortes teneurs métalliques ($P<0.000$) et les plus fortes variations; en fait le zooplancton est connu pour présenter fréquemment de telles variations métalliques élevées (2). A noter que sauf pour le Hg et l'As, l'enrichissement des métaux aux niveaux trophiques supérieurs est généralement bas (1).

Les organismes filtreurs de gros volumes d'eau, comme les Moules ainsi que des organes de longue durée de vie comme les rhizomes des Angiospermes marines avaient bioaccumulé plus fortement les métaux.

Nos résultats sont en accord avec ceux présentés par le Programme des Nations Unies pour l'Environnement concernant les moyennes et les échelles de concentrations métalliques dans des spécimens de *M. galloprovincialis* et *M. barbatus* collectés en diverses régions de Méditerranée (3).

L'étude des échantillons de Zooplancton et des Moules récoltés à toutes les stations (1, 2, 3) procure des enseignements sur le transport des polluants et spécialement des métaux. Ceux des Algues (station 1 et 2) nforment sur la direction de diffusion des métaux. Ainsi, on remarque que pour le Cu, qui est considéré comme olluant issu de l'égout central d'Athènes, et des industries environnantes (4), les Moules des stations 1 et 2 ɔrésentent des teneurs significativement plus fortes que celles de la station 3 ($P<0.007$). Le Zooplancton évèle le même gradient, mais cette différence n'est pas significative à cause de la grande variabilité des eneurs. La concentration du Cu dans les Algues fait apparaître aussi la même conclusion sur la direction du ransport des rejets (égale vers le Sud et l'Ouest). Les métaux Cr et Cd caractérisent également les rejets (5). Pour le Cr, il existe également un gradient sans toutefois qu'il soit significatif. Par contre, le Cd, bioconcentré ıu même niveau aux stations 1 et 2, semble avoir une source locale à la station 3 qui influence la teneur des ırganismes ($P<0.002$). Le Ni, fortement concentré dans les sédiments du Golfe d'Elefsis (5) présente une ırande variabilité qui a comme résultat l'absence de différence entre les stations.

Figure 2
Concentration metallique du zooplancton

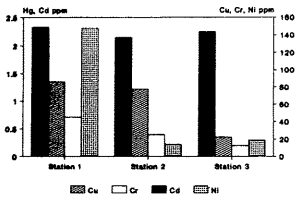


Figure 3
Concentration metallique des moules

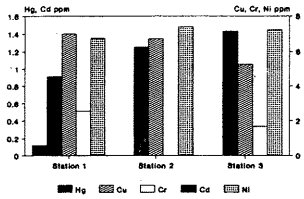


Figure 4
Concentration metallique de Ulva

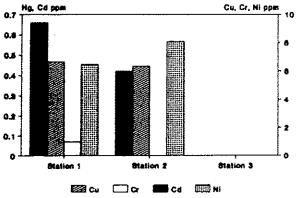


Figure 5
Concentration metallique de Posidonia

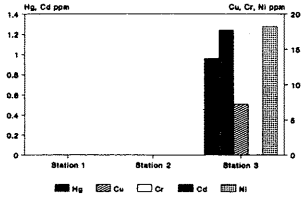


TABLE 1

Resultats de l'analyse statistique entre les stations

	Plancton		U. lactuca		Mytilus	
Metal	F	P	F	P	F	P
Cu	1.353	0.302	0.076	0.788	5.105	0.007[a]
Cr					0.036	0.855
Cd	0.033	0.967	0.769	0.401	6.656	0.002[b]
Ni	1.711	0.229	1.287	0.269	0.487	0.616

Groupes: a: (st3) (st1,st2), b: (st1) (st2,st3)

REFERENCES

(1) FORSTNER U. and WITTMANN G.T.W. (1979). Ed. Springer-Verlag. Berlin, Heidelberg, N.York. pp318-323.
(2) VAN AS D., FOURIE H.O., VLEGGAAR C.M. (1975). S.Afr. J. Sci. 71, pp151-154.
(3) PNUE/FAO/UNESCO/OMS/OMM/AIEA/COI (1986). MAP Tech. Rep. Series No9, UNEP Athens
(4) VOUTSINOU-TALIADOURI F. (1981). Mar. Pol. Bul. Vol.12, No5, pp163-168.
(5) VOUTSINOU-TALIADOURI F., SATSMADJIS J. and IATRIDIS B. (1989). Rev.Int.Oceanogr.Med. Tomes LXXXIII-LXXXIV. pp31-45.
(6) UNEP (1982). Reference methods for Marine Pollution Studies. No 11.

L-III7

The Levels of Heavy Metals Accumulation in some Benthic Organisms living in Izmir Bay

Erkan DEMIRKURT*, Hüseyin UYSAL** and Hatice PARLAK**

*Dokuz Eylül University, Institute of Marine Sciences and Technolog, P.O. Box 478, 35213 Izmir (Turkey)
**Ege University, Faculty of Sciences, Department of Biology, Hidrobiology Sec., Izmir (Turkey)

Izmir Bay has been affected by industrial pollution from the facilities took place arround and domestic effluent from the city (UYSAL and TUNÇER, 1982). The purpose of this study was to determine the level of accumulated heavy metal in several organisms living in the polluted part of Izmir Bay. These samples chosen could be found in most of the part of the bay in every season.

In this investigation the samples which are **Codium tomentosum** Stackhouse **Penaeus kerathurus** (Forskal, 1775), **Solea vulgaris** Quensel, 1806, and **Gobius niger** Linnaeus, 1758 collected from different places of Izmir Bay have been analysed for Hg, Cd, Zn, Pb, Cu, Mn, Fe from December 1987 to December 1988. The samples had been decomposed using the mixtures of HNO_3 - $HClO_4$ (5:1) acids in water bath with maximum temperature 40°C, under reflux system. Hg was determined by cold vapour atomic absorbtion spectrophotometry and the others was determined by flame (Varian Techtron 1250) (BERNHARD, 1976).

. The results have been calculated as µg/kg wet weight. For the statistical evaluation based on the medians and quartiles of data were choosen (TUKEY, 1977).

As the results of these studies median values of Hg and Cd concentrations were ranged between 13-35 µgHg/kg wet weight and 65-138 µgCd/kg W.W. and **S. vulgaris** included minimum amount of these metals while **C. tomentosum** had maximum. Pb values varied between 380-2500 µgPb/kg W.W. in **P. kerathurus** as minimum and in **C. tomentosum** as maximum. Cu and Zn contents were changed in 622-5004 µgCu/kg W.W. and 3904-12016 µgZn/kg wet weight. Maximum Cu and Zn contents were found in **P. kerathurus** and minimum were in **G. niger**. Mn content of **G. niger** was minimum and of **C. tomentosum** was maximum and range between 350-37823 µgMn/kg wet weight. Fe values varied between 5061-160000 µgFe/kg W.W. in **S. vulgaris** as minimum and in **C. tomentosum** as maximum (Table 1.).

The values obtained from this study had shown about similar manner comparing with these mentioned by other authors from different areas of Mediterranean (EMARA, 1982; VASILIKIOTIS at al 1982; TUNÇER, 1988).

Table 1. The levels of heavy metals which were determined in some benthic organisms collected from Izmir Bay (µg/kg W.W.)

Species		Hg	Cd	Pb	Cu	Zn	Mn	Fe
	Mimimum	20	9	724	510	2727	3448	73426
	Lower Quartile	30	70	2057	692	3338	19153	88411
C. tomentosum	Median	35	138	2500	893	4285	37823	160000
	Upper Quartile	42	244	3897	1029	6255	68493	220130
	Maximum	53	470	6720	1737	8600	131837	833776
		n=11	n=9	n=11	n=11	n=11	n=10	n=11
	Mimimum	6	8	66	2730	10015	261	6031
	Lower Quartile	15	14	113	4040	11134	583	8120
P. kerathurus	Median	20	65	380	5004	12016	876	9168
	Upper Quartile	36	143	1965	6465	13857	1090	16162
	Maximum	51	432	4500	9136	15557	2595	27724
		n=12	n=11	n=11	n=12	n=12	n=12	n=12
	Mimimum	5	7	53	266	3011	171	3336
	Lower Quartile	10	20	165	501	3950	343	4454
S. vulgaris	Median	13	121	1297	644	4461	370	5061
	Upper Quartile	26	154	2100	856	5720	567	5558
	Maximum	57	277	5580	1696	9263	775	10694
		n=21	n=17	n=18	n=21	n=21	n=14	n=21
	Mimimum	4	8	26	184	2404	140	2838
	Lower Quartile	12	52	332	436	3110	277	4532
G. niger	Median	19	89	1228	622	3904	350	5720
	Upper Quartile	30	257	2252	960	4868	437	7576
	Maximum	66	476	6613	2794	12500	980	14464
		n=26	n=24	n=26	n=26	n=27	n=21	n=27

REFERENCES

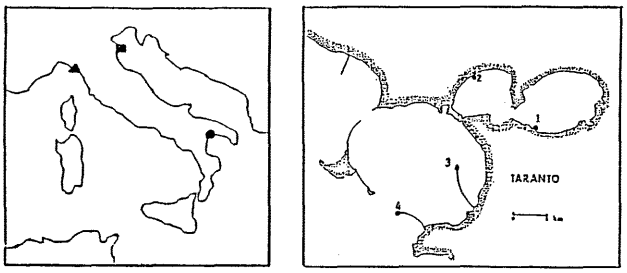
BERNHARD, M. 1976. Manual of metods in aquatic environment research: Part 3. Sampling and analyses of biological material. FAO Fish. Tech. Pap. 158: 124 p.
EMARA, I.H., 1982. Study of some heavy metals in Abu Qir Bay and Lake Idku. VI[es] Journées Etud. Poll. 395-399 Cannes, C.I.E.S.M.
TUKEY, J.M., 1977. Exploratory data analysis - Reading, Mass, Addision- Wesley Publishing Co.: 473 pp.
TUNÇER, S., 1988. Variation et teneurs des métaux lourds chez certaines Algues sur la côte Egéenne Turque. Rapp. Comm. Int. Mer Médit., 31, 2: 157.
UYSAL, H. et TUNÇER, S. 1982. Etude des métaux lourds chez les mollusques danz les différentes zones de la Baie d'Izmir (Turquie). VI[es] Journées Etud. Poll. 307-313 Cannes, C.I.E.S.M.
VASILIKIOTIS, E., FYTIANOS, K. and ZOTOU, A., 1982. Heavy metals in marine organisms of the North Aegean Sea, Greece. VI,[es] Journées Etud. Poll. 303-306 Cannes, C.I.E.S.M.

Tributyltin levels in Mussels and sediments in Italian Coastal Waters

S. GERACI, N. CARDELLICCHIO, C. MARRA and P. PATERNO

Istituto Sperimentale Talassografico C.N.R. Taranto (Italia)

Organotin compounds concentrations in marine environment and their effects on organisms have been studied since the eighties. Many data come from U.S.A. and Great Britain; several works have been made on "Imposex", mostly concerning Nucella lapillus (Gibbs et al. 1987). Viceversa it is not easy to find some literature about organotin compounds concentrations in water and organisms from the Mediterranean sea.
As the presence of such compounds is mainly due to naval antifouling paints, but also to biocides for agricultural and industrial use, we decided to make a preliminary survey in different environments.



●Taranto ▲LaSpezia ■Scardovari

Fig. 1 - The three coastal sites choosen in Italian waters and in the four sampling sites choosen in Taranto basins.

Material and methods.

We have chosen Taranto and La Spezia harbours because in both there are mussels cultivations. Both the harbours have an Italian Military Navy base. Mussels have also been collected from a cultivation located not near an harbour, in the Northern Adriatic sea: Scardovari lagoon, in the Po river delta.
The samples has been made in the first months of 1989. In Taranto, where the Institute is located, mussels samples have been made in different areas(Fig.1). In the same winter season sediment have also been analysed.
TBT and total tin have been determined by mean of atomic spectroscopy with Zeeman graphite furnace (Stephenson and Smith 1988).
Five subsamples containig 15 mussels were analysed for each sample, as well as 5 sediment samples have been analysed in each of the four sampling sites in Taranto.

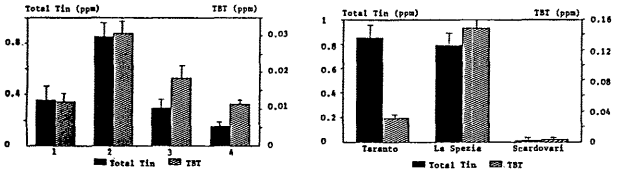


Fig. 2 - Total and Tributyl Tin concentration in the mussels of the four sampling sites in Taranto basins and in the three coastal sampling sites: Taranto, La Spezia and Scardovari.

As we can see in fig. 1, the presence of organotin compounds in the two considered harbours is by far higher than in the Po river delta. In particular in La Spezia harbour TBT values are about four times higher than those in Taranto. Being the total tin concentrations similar in the two harbours, one can think about a different status of degradation processes. We know, in fact, that TBT tends to became Dibutyltin, Monubutyltin and inorganic tin at the end. So higher values observed in mussels from La Spezia may be due to a recent TBT water contamination by antifouling paints not yet degradated.

Table 1. Total and Tributyl Tin concentration in sediments of the four sampling sites in Taranto basins.

Sampling sites		1	2	3	4
Total Tin	(ppm)	0.137	0.362	0.529	0.402
TBT	(ppm)	0.021	0.048	0.015	0.016

TBT values both in mussels and in sediments from the four sampling sites in Taranto basins show a pike at station 2, the nearest to the Navy Arsenal, and a decrease towards the open sea. On the contrary total tin tends to increase towards the open sea (Fig.2). Finally it is interesting that TBT accumulation in sediments, in the range between 0.02 and 0.05 ppm, is more homogeneus and only a little lower than in mussels. Mussels collected from cultivations far from ship traffic (Scardovari) show TBT values lower than one order of magnitude (0.003 ppm) at least.
Sea water TBT concentration and Organotin different degradation status both in Mussels and sediments, will contribute to understand better the true role and risks, for human beings too, caused by this Kind of pollution.

References

GIBBS, P.E., BRYAN, G.W., PASCOE, P.L., & BURT, G.R.,1987. The use of the dog-whelk Nucella lapillus, as an indicator of tributyltin(TBT) contamination. J. Mar. Biol. Ass. U.K. 67, 507-523.
STEPHENSON M.K. and SMITH D.R., 1988. Determination of Tributyltin in Tissues and Sediments by Graphite Furnace Atomic Absorption Spectrometry. Anal. Chem. 1988. 60, 696-698.

Sensitivity of Sea Bass, *Dicentrarchus labrax* early developmental stages on water soluble fraction of Crude Iraq Oil

Branko GLAMUZINA

Laboratory for Mariculture, Institute of Oceanography and Fisheries, P.O. Box 114, 58000 Split (Yugoslavia)

It is well known that early developmental stages of different fish, like herring, plaice, cod, etc., are very sensitive to different types of oil, oil derivatives and oil hydrocarbons. These life stages, especially eggs and larvae represent the most susceptible part of the whole life cycle (Kühnhold, 1977). However, there is no published data on sensitivity of Mediterranean fish species to crude oils normally transported in this area. So, early developmental stages, fertilized eggs, yolk-sac larvae and postlarvae of one typical Mediterranean fish species, Dicentrarchus labrax Linnaeus, 1758, were in our experiments exposed to crude Iraq oil, which is common in tanker traffic in the Adriatic sea.

Eggs, larvae and postlarvae of sea bass used in the experiments were provided by artificial spawning and rearing (Katavić,1986). Water soluble fraction of crude Iraq oil was prepared by methods of Anderson et all., (1974). Experiments were done in triplicate under static conditions, in water bath with ambient sea water (11.2 ^{o} C). Medium was gently mixed by aeration from the jar bottom.

The analysis showed water soluble fraction (WSF) of crude Iraq to be very rich in light hydrocarbons, toluene, xylene, benzene and naphthalenes.

Eggs exposed to WSF in gastrula stage showed high resistance during first 72 hours. Thereafter, all developed embryos died in all concentrations, and only in lowest (10 %) WSF concentration 4.1 % embryos hatched, compared to 75 % in the controls. Most of dead embryos were in different stages of embryogenesis (95 %), and only small number in late gastrula stage. Heartbeat rate in embryos was drastically reduced and only in lowest WSF concentration we observed arithmic heartbeats. All hatched larvae in 10% WSF had spinal deformities and lay immotile on jar bottom. Hatched larvae in control groups had only 0.3 % spinal deformities, regular heartbeat (60 beats per minute) and were very motile.

Short term exposure (24 h) of two day old larvae showed slight increase of mortality toward higher WSF concentrations, but only the highest concentration (50 %) had significantly higher mortality if compared to the controls. Examination of WSF influence on yolk sac resorption showed slowing down of the resorption rate in two higher (30 and 50 %) WSF concentrations which is associated with slower motility of larvae in jars. This has been atributed earlier to narcotic effect of oil hydrocarbons (Kühnhold, 1977).

Postlarvae (20 days old) seemed to be most resistant among studied sea bass stages. Lowest WSF (10%) concentration showed similar mortality during all 96 h exposure as that in the controls. Other concentrations had significantly lower survival after 24 h exposure, but if compared with gilthead sea bream, Sparus aurata postlarvae (Glamuzina et all., 1990), they are more resistant to the exposure to water soluble fraction of crude Iraq oil.

REFERENCES.

ANDERSON, J.W., NEFF, J.M., COX, B.A., TATEM, H.E. and HIGHTOWER, G.M., 1974. Characteristics of dispersion and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish. Mar. Biol. 27, 75-88.

GLAMUZINA, B., TUDOR, M. and KATAVIĆ, I., 1990. The effects of water soluble fraction of crude Iraq oil on eggs, larvae and postlarvae of gilthead sea bream, Sparus aurata Linnaeus 1758. Mar. Biol., (in procedure).

KATAVIĆ, I., 1986. Diet involvement in mass mortality of sea bass (Dicentrarchus labrax) larvae. Aquaculture, 58, 45-54.

KUHNHOLD, W.W., 1977. The effects of mineral oils on the development of eggs and larvae of marine species. A review and comparison of experimental data in regard to possible damage at sea. Rapp. P. -v. Reun. Cons. int. Explor. Mer. 171 : 175-183.

L-III10

Arsenic in the Marine Environment of Five Gulfs of Greece

Apostolos P. GRIMANIS

Radioanalytical Laboratory, National Center for Scientific Research "Demokritos", 153 10 Ag. Paraskevi Attikis, Athens (Greece)

Arsenic (As) is considered a toxic trace element for plant, animal and human organisms. As, and certain arsenic compounds, have been listed as carcinogens by the Environmental Protection Agency of USA. As enters the marine environment through various industrial activities as well as insecticide production and use.

Neutron activation analysis (NAA) is a very sensitive, precise and accurate method for determining As. This paper is a review of research studies concerning As in the marine environment of five gulfs of Greece by NAA performed at our Radioanalytical Laboratory. The objectives of these studies were: (a) to determine the levels of As concentrations in marine samples from 5 gulfs of Greece, (b) to pinpoint As pollution sources and, if possible, to estimate the extent of As pollution, (c) to find out whether edible marine organisms from the Gulfs of Greece receiving domestic, industrial and agricultural wastes have elevated concentrations of As in their tissues that could render them dangerous for human consumption.

A radiochemical NAA method (GRIMANIS 1969) was mostly applied for determining As in seawater and marine organisms. Seawater filtered through 0.45 µm pore size filter. Instrumental NAA was used for As determination in bottom sediments.

Arsenic in the marine environment can be methylated by anaerobic organisms to dimethylarsine (McBRIDE and WOLF, 1971). It appears that in marine organisms the main form is organic As which is much less toxic than inorganic As.

Arsenic has been determined in marine samples collected from 5 Gulfs of Greece (Saronikos, Evoikos, Korinthiakos Gulfs, Kissamos Gulf in Crete and Gera Gulf in Lesbos) shown in the map of Greece (Fig. 1). Saronikos Gulf was the most extensively studied within the framework of the United Nations Environment Programme for Mediterranean Pollution Monitoring Research Project (UNEP/MED POL).

The discharge of industrial and domestic wastes entering Northern Saronikos Gulf through the Athens Sewage Outfall (ASO), a Fertilizer Plant (F.P) and other industries outside Piraeus harbor has led to elevated concentrations of As in seawater and sediments over at least 100 km^2 of the Northern Saronikos Gulf seafloor.

The distribution of As in the water column (total particulate and dissolved) and in sediment core samples (total, [all chemical forms of As present in sediments], 0.5N HCl extractable [anthropogenic As], and residual [non anthropogenic]) from N. Saronikos Gulf was determined:

In seawaters most of the As was found in dissolved form (94-99.9 per cent) with a trend of increasing concentration with depth. Concentrations ranged as follows: 2.4-7.2 µg/l for total As, 2.3-7.2 µg/l for dissolved As and 0.01-0.27 µg/l for particulate As. Maximum values of As were found near the ASO.

In sediments As concentrations (total) increase from background levels of about 10 µg/g to 570 µg/g near the ASO up to 2900 µg/g near the F.P (Perhaps to intermittent dumping of arsenopyrites) Total As concentrations tend to increase with sediment depth. Residual As concentrations are the predominant form in core samples near the ASO; near the F.P extractable As is the predominant form. In sediments from stations not under the influence of the pollution sources As was found to be mainly in residual form.

The partitioning of As (ANGELIDIS and GRIMANIS, 1987) into three fractions (reducible by acidified hydroxylamine hydrochloride [As scavenged by Fe/Mn hydrous oxides), oxidizable by acidified hydrogen peroxide [As contained in organic matter and sulfides] and the residual after the previous extractions [detrital As] of Saronikos Gulf surface sediments was determined by using a sequential extraction technique (SALOMONS and FORSTNER, 1980). The arsenic content in the reducible and oxidizable fractions increases in polluted sediments near the ASO and the FP. In non-polluted sediments the residual fraction is the most important carrier of As.

At a distance of about 5 km from ASO seawater and sediments contain total As concentrations which can be considered natural background levels for Saronikos Gulf.

Fig. 1. GREECE

Gulfs investigated are shown with No.:

1 = Saronikos
2 = Korinthiakos
3 = Evoikos
4 = Gera (Lesbos)
5 = Kissamos (Crete)

Seawater and sediment samples showed higher concentrations of As southwest than southeast of the pollution sources. This distribution suggests a westward transfer of As, probably due to the cyclonic movement of the water masses of the Saronikos Gulf.

No strong accumulation has been detected in seawaters and sediments of Evoikos, Korinthiakos, Kissamos and Gera Gulfs.

Concentrations of As found in the flesh of benthic fish species such as Pagellus erythrinus, Sargus annularis and Mullus barbatus collected from Northern Saronikos Gulf were twice as high as those from other Gulfs of Greece (Evoikos, Korinthiakos, Kissamos and Gera Gulfs). These high concentrations of As were comparable to natural "background" levels so that these benthic fish species do not reflect the very high As concentrations found in seawaters and sediments of N. Saronikos Gulf.

The author feels that it is a personal pleasure to mention the very important contribution of Angelidis M., Griggs, G.B., Hadjistelios, I., Kalogeropoulos, N., Papadopoulou, C., Vassilaki-Grimani, M. and Zafiropoulos, D. to several papers mentioned in this review.

REFERENCES

ANGELIDIS, M. and GRIMANIS, A.P., 1987. Arsenic geochemistry in sediments near the Athens Sewage Outfall. Marine Poll. Bull. 18 (6) 297-298.

GRIMANIS, A.P., 1969. Simultaneous determination of Arsenic and Copper in wines and biological materials by Neutron Activation Analysis. In Modern Trends in Activation Analysis J.R. DeVOE and R.D. LaFLEUR eds., Nat. Bur. Stand. (U.S.) Spec. Publication 312, Vol. 1:184-189.

McBRIDE, B.C. and WOLF, R.S., 1971. Biosynthesis of Dimethylarsine by Methanobacterium. Biochem. 10 (23) 4312-4317.

SALOMONS, W. and FORSTNER, U., 1980. Trace metal analysis on polluted sediments. Part II: Evaluation of environmental impact. Environ. Tech. Ltrs 1, 506-517.

L-III11

Factors controlling secondary productivity (Level 1 and 2) of polluted temperate coastal waters (Izmir Bay, Aegean Sea): a multivariate model

Tufan KORAY, Baha BUYUKISIK and Sevket GOKPINAR

Ege Universitesi, Fen Fakültesi, Biyoloji Bölümü, Hidrobiyoloji Ana Bilim Dali, Bornova, Izmir (Turkey)

In coastal areas that are characterized by well-mixed water column depending on the continuous water movements, inputs of nutrients by rivers and sewages cause a complexity in the planktonic food web. Typically, there exist excessive amounts of phytoplankton in such waters. However, this high primary productivity has not reflected to level 1 and 2 secondary productivity just enough because of complex relationships among species and eu- or hypertrophicated environment such as pollution caused high mortality in certain development stages, different tolerance to different pollutants, variations in feeding habits during the pollution process, pollution controlled competition and even the decreasing of zooplankton filtration rates due to dense phytoplankton cells etc. (BOUGIS, 1976).

In the present study, it was analyzed and discussed how far the eutrophication or hypertrophication have affected zooplankton abundance. The results were represented as a multivariete model.

The samples evaluated in this study were collected with a 5 liter universal series water sampler down to 15 m. depth by 0.5, 2.5, 5.0,10 and 15 m. intervals from 6 stations on a 6 km. line monthly or bimonthly.

As summarized in Table I, individual number of total zooplankton which were mainly produced by nauplii, copepodites and adults of Oithona nana, Acartia clausi and veliger larvae of bivalves, were statistically related with orthophosphate phosphorus, dinoflagellate abundance, density, diatom abundance, total inorganic nitrogen and silica respectively (Figure 1).

In accordance with multiple regression function, the fact that the orthophosphate phosphorus was the most significant parameter, proved that the importance of phosphorus excretion by zooplankton in eu- or hypertrophicated environments. It was clearly determined that the zooplankters feed both dinoflagellates and diatoms due to the phytoplankton succession and variations in density but preferably consumed dinoflagellates. There existed an inverse relationship between total inorganic nitrogen in which the most important ammoniotelic zooplankton excretion products were found, and zooplankton individual number because these compounds were basically included in the system as toxic non-ionic ammonia form by sewages, riverine inputs and degradation of biological materials in such environments.

Silica that might be an important selective factor affecting the ecology of estuarine and coastal phytoplankton (HECKY and KILHAM, 1988) was the least important factor for the zooplankton abundance.

Table I:Statistical parameters of the multiple regression of Zoopl.nb $=(PO_4^{-3}\text{-}P^{1.424})(Din.^{0.129})(10^{0.117\sigma_t})(Dia.^{-0.057})(\Sigma N^{-0.660})(Si^{-1.014})$

Variables	Regression coefficient	Standard errors	Lower limit	Upper limit	F
PO_4^{-3}-P(µg-at l^{-1})	1.42397	0.16030	1.10636	1.74159	141.41
Din.(cells nb.l^{-1})	0.12874	0.03471	0.05996	0.19751	11.76
Density(σ_t)	0.11701	0.00772	0.10171	0.13231	28818.07
Dia.(cells nb. l^{-1})	-0.05719	0.02479	-0.10631	-0.00807	5.32
ΣN(µg-at l^{-1})	-0.65952	0.09763	-0.85296	-0.46607	172.26
Si(µg-at l^{-1})	-1.01405	0.08366	-1.17982	-0.84828	1143.40
Full regression	F=5048.7	p<0.0000	R^2=0.996		$\sigma_{s.}$=0.1521

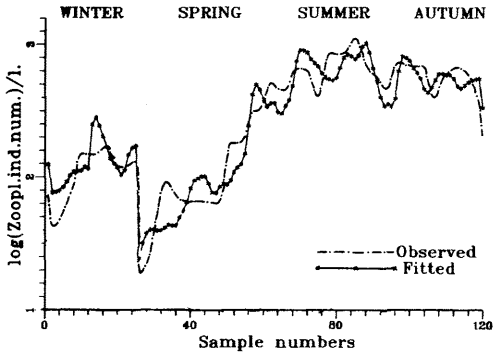


Fig. 1: Graphic representation of the model.

The assimilation of soluble silica by diatoms before each grazing period must give rise to the negative relationship.

REFERENCES.

BOUGIS, P.,1976. Marine Plankton Ecology. North-Holland Publ.Comp. Amsterdam, 355 pp.

HECKY, R.E. and KILHAM, P., 1988. Nutrient limitation of phytoplankton in freshwater and marine environments:A review of recent evidence on the effects of enrichment. Limnol. and Oceanogr. 33(4):796-822.

Les Hydrocarbures Aromatiques Totaux dans les eaux de surface de la Baie de Monaco

C. MARMENTEAU

Centre Scientifique de Monaco, 16 boulevard de Suisse, MC 98000 (Monaco)

Les hydrocarbures aromatiques polycycliques (HAP) présentent des effets toxiques (propriétés cancérigènes) à court et long termes sur les espèces marines et les écosystèmes. Ces propriétés et leur forte concentration dans les pétroles bruts (15 à 30 %), nous ont conduit à étudier leurs variations en baie de Monaco.

L'étude de cette région a été effectuée sur quatre stations à la fréquence d'un prélèvement de surface par quinzaine. Ces stations sont distribuées dans un quadrilatère de 2 milles marins sur 6 milles marins. Trois d'entre elles sont franchement côtières, la quatrième est située à 6,5 milles au large.

Les prélèvements sont réalisés en surface (0 à 20 cm), par le navire océanographique RAMOGE. Les HAP sont mesurés par spectrofluorimétrie (longueur d'onde d'excitation 310 nm, longueur d'onde d'émission 360 nm).

L'ensemble des résultats analytiques obtenus montre des fluctuations dans l'espace et dans le temps, avec des teneurs comprises entre 0 et 9,4 $\mu g\ l^{-1}$. Les valeurs mesurées dans la baie de Monaco sont du même ordre que celles rapportées en Méditerranée occidentale par le PNUE, 1988. Dans l'échelle de

Pollution µg/l.		moyenne		écart type
Absence ou très faible	<0,3	9%	+	9%
Très faible	>0,3 et < 1	39%	+	12%
Faible	> 1 et < 2	33%	+	11%
Significative	> 2	19%	+	8%

Tab.1 - Classification des teneurs mesurées.

pollution proposée par MARCHAND, 1985 (Tab.1), 9% des teneurs ne sont pas l'indice d'une pollution par hydrocarbures aromatiques et 19% présentent une pollution significative supérieure à 2 $\mu g\ l^{-1}$.

	Stations					
	1	2	3	4	moyenne	écart type
1980	1,25	0,96	1,09	1,05	1,09	1,67
1981	1,51	1,54	1,17	1,16	1,33	0,09
1982	1,74	1,51	1,43	2,20	1,73	2,51
1983	1,13	1,01	1,22	1,00	1,09	1,33
moyenne	1,44	1,27	1,23	1,38	1,33	

Tab.2 - Moyennes annuelles et par station.

Les moyennes des quatre années de mesures (Tab.2) sont en général plus fortes sur la station 1 du large que sur les trois stations côtières, avec un minimum pour la station 3 du centre de la Baie.

Couples	1-2	1-3	1-4	2-3	2-4	3-4
Hydrocarbures	0,72	0,60	0,57	0,66	0,51	0,80
p <	0,001	0,01	0,01	0,01	0,01	0,001

Tab.3 - Coefficients de corrélation (logarithmique).

Les corrélations entre stations calculées sur les valeurs logarithmiques (Tab.3) sont significatives au seuil 5%, en particulier entre les stations 3 et 4.

	Stations									
	1		2		3		4			
	E	H	E	H	E	H	E	H	mE	mH
1980	1,21	1,29	1,19	0,81	1,34	0,90	1,39	0,75	1,29	0,93
1981	0,78	2,11	1,07	2,00	0,54	1,80	0,67	1,60	0,75	1,87
1982	1,59	1,87	1,39	1,62	1,40	1,47	2,08	2,29	1,61	1,82
1983	0,78	1,35	1,00	1,02	0,99	1,37	0,85	1,09	0,91	1,20
m	1,20	1,68	1,16	1,35	1,06	1,39	1,26	1,46		

Tab.4 - Moyennes des périodes estivales et hivernales. (E=été, H=hiver, m=moyenne)

Les valeurs annuelles sont généralement en augmentation de 1980 à 1982 (Tab.2) puis baissent en 1983. Le maximum de 1982 diffère significativement au seuil 5% de l'ensemble des valeurs. Les moyennes estivales (Tab.4) sont généralement plus faibles que les moyennes hivernales, à l'exception toutefois des stations 2, 3 et 4 en 1980.

Les processus géochimiques apportent des éléments d'interprétation des différences observées. En été, les températures élevées jouent un rôle important dans l'élimination des substances organiques volatiles à l'interface eau/atmosphère. En hiver ces phénomènes sont ralentis.

Des analyses complémentaires sont nécessaires pour préciser le rôle de ces processus et l'origine des HAP mesurés (rejets pétroliers, retombées atmosphériques, rejets terrigènes, biosynthèse, etc.).

REFERENCES

MARCHAND M. (1985) Processus geochimiques d'apports et de distribution des polluants organiques dans l'environnement marin. Etude appliquée aux hydrocarbures et hydrocarbures halogénés. Thèse de Docteur ès Sciences, Université Pierre et Marie Curie - Paris 6 - 22 nov 1985.

PNUE (1988) Assessment of the state of pollution of the Mediterranean sea by petroleum hydrocarbons. MAP Technical Report Series N°.19. UNEP, Athens, 1988, pp. 130.

Pollution of Saronikos Gulf by Petroleum Aromatic Hydrocarbons

A. MYLONA* , J. HATZIANESTIS** , N. MIMICOS** , R. PSILLIDOU* and E. GREGORIADOU-GEORGAKOPOULOU*

*National Centre for Marine Research, Ag. Cosmas, Hellinikon (Greece)
**National Centre for Research of Physical Sciences "Democritos", Ag. Paraskevi Attikis (Greece)

Saronikos gulf is a semi enclosed bay in Greece. In order to study the pollution status of the gulf, Saronikos is divided into four regions: A (Elefsis bay), B (Western area), C (Internal area), D (External area) (Fig. 1). This work is done whithin the framework of MED-POL program. As a part of this program, samples of water from 1m depth, surface sediments, mussels (mytilus galloprovincialis) and fish (striped mullus and mullus barbatus), collected during 1988-89 are examined for PAHs content.

PAHs content in all samples are determined fluorimetrically, according to the standard methods of IOC (UNESCO, 1982, 1984). Synchronous fluorimetry ($\Delta\lambda$=4 nm) gave information on the constitution of PAHs mixture in samples (TUAN VO-DINH, 1978)

The spatial distribution of dissolved / dispersed petroleum hydrocarbons in water surface samples collected in February 1989 and seasonal distribution of DDPH are shown in Figures 1 and 2 respectively. The isolines of Figure 1 are similar to those of total polyaromatic hydrocarbons in the surface sediments (Figure 3). As concluded from Figures 1 and 3 Elefsis (A) seems to be the most polluted area of the gulf. (DDPH 3.9-11.3 µg/L, sediments 31-71.2 µg/g and mussels 72.9-80 µg/g expressed in chrysene equivalents). This is reasonable, since it is a shallow basin (max. depth 30m) which receives a great amount of sewage from the urban activity of the metropolitan area, as well as from the industries located at the northern part of the gulf.

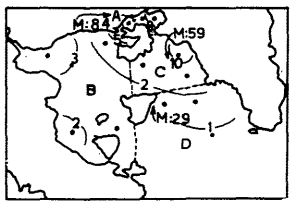


Fig. 1. Surface distribution of DDPH (µg/L) and values of PAHs in mussels (M:µg/g) from Saronikos gulf in chrysene equivalents.

The values of PAHs at the Western part area B, (DDPH 1.9-5.6 µg/L, sediments 5.2-16.1 µg/g) are low, though a slight increase at the upper part may be attributed to the oil refinery, located at the western coastal area.

In the internal basin (C), values of DDPH and PAHs in sediments appear higher than those in area B but clearly lower than those in Elefsis bay (DDPH 1.9-13.1 µg/L, sediments 9.5-29.5 µg/g, mussels 55.1-63.5 µg/g). Indeed the internal part of the gulf is polluted from Athens central sewage outfall.

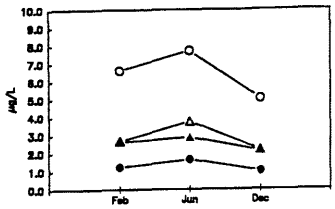


Fig. 2. Seasonal distribution of DDPH (0.5 m depth) in Saronikos gulf during 1989 (-O- area A, -Δ- area B, -▲- area C, -●- area D).

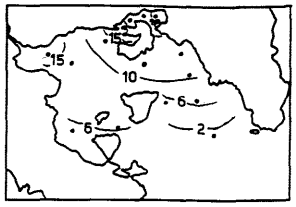


Fig. 3. Surface distribution of PAHs (µg/g) in sediments from Saronikos gulf, in chrysene equivalents.

Finally low values at the external part (DDPH 0.6-2.1 µg/L, sediments 0.8-6.2 µg/g, mussels 22.4-31.7 µg/g) are well explained by the fact that part D is the area of Saronikos gulf where renewal of water masses takes place twice a year.

Concentrations of PAHs in fish muscles collected in the gulf during 1988-89 show mean value of 22.4 ng/g for striped mullet and 14.5 ng/g for mullus barbatus correspondingly.

The above results indicate that it should not be concerned that pollution of Saronikos gulf has affected fish although mussels and sediments appear higher values of PAHs, playing the role of concentrators.

The synchronous fluorescence spectra show the presence of naphthalenes. Moreover the wide range of aromatic compounds appearing at the fluorescence spectra (Fig. 4) indicates the petroleum origin of PAHs examined.

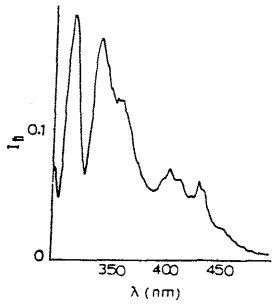


Fig. 4. Typical synchronous fluorescence spectrum ($\Delta\lambda$=4nm) of PAHs extract in hexane, from Saronikos gulf sediments.

REFERENCES

1. a) UNESCO (1982). IOC Manuals and Guides N° 11.
   b) UNESCO (1984). IOC Manuals and Guides N° 13.
2. TUAN VO-DINH (1978). Multicomponent analysis by synchronous fluorescence spectroscopy. Anal. Chem., 50 :396

L-III14

Heavy Metal Toxicity on *Idotea baltica* (Crustacea, Isopoda)

M. de NICOLA GIUDICI, C. GAMBARDELLA and S.-M. GUARINO

Dipartimento di Genetica, Biologia Generale e Molecolare - Università di Napoli, Via Mezzocannone, 8 - 80134 Napoli (Italia)

Stazione Zoologica "Anton Dohrn", Villa Comunale, 80121 Napoli (Italia)

Résumé

On décrit la toxicité acute (LT_{50}) de 6 métaux lourds (Cd, Cu, Cr, Hg, Fe, Zn) sur des femelles, des males et des juvéniles de l'isopode I. baltica. Des concentrations subletles de Cd ou Cu produisent des retards de survie et de croissance, et notamment des altérations du sex-ratio. Nos résultats confirment la susceptibilité des populations à des contaminations chroniques.

Environmental stresses caused by heavy metal contamination resulted in population disturbance, consequently reflecting the whole ecosystem biotic relantionship (1). It has been showed (2, 3, 4) that acute toxicity tests (LT_{50}) are unable to state the true ecological damages if no correlated to long term effects, being the persistence of a species more easily affect by continuous sublethal contamination than by a single massive one.

Idotea baltica, a crustacean isopod widely distribuited along marine coasts, constitutes a very important link between detritus and grazing food chains (5).

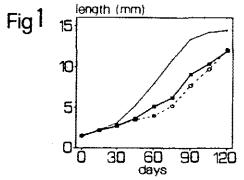
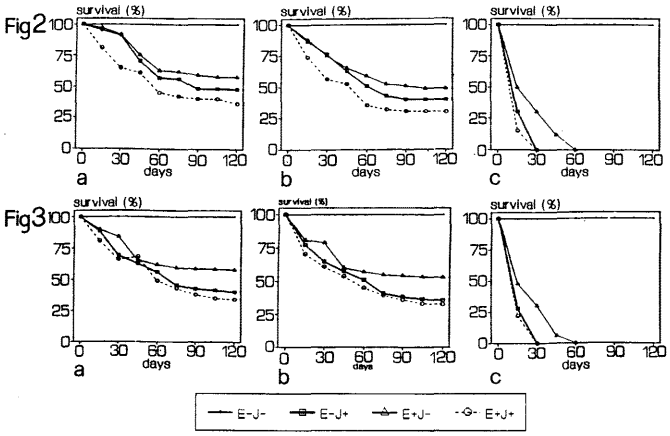


Fig.1 Body growth (as mm lenght) of juveniles bred SW (— control) in 0.5 mg·l⁻¹ of Cd (-●-) or Cu (-⊖-)
These data refer only to females.
Fig.2 Survival of I.b. juveniles with 0.005 (a), 0.01 (b) and 0.5 mg·l⁻¹ of Cd.
Fig.3 Survival of I.b. juveniles with 0.005 (a), 0.01 (b) and 0.5 mg·l⁻¹ of Cu.



Under standard laboratory conditions acute toxicities of Cd^{+2}, Cu^{+2}, Cr^{+4}, Hg^{+2}, Fe^{+2}, Zn^{+2} were evaluated by means of LT_{50} separately on males, females and juveniles exposed to several concentrations of metal ions, rancing from 0.01 to 10 mg·l⁻¹. An increasing scale of toxicity, $Cd^{+2} < Fe^{+2} < Zn^{+2} < Cu^{+2} < Cr^{+4} < Hg^{+2}$, has been evaluated. Juveniles result more sensitive than adults ($p<.01$) and, for low concentrations of Cd^{+2} or Cu^{+2} only, males appeared more sensitive than females ($p<.01$).

Since Cd^{+2} and Cu^{+2} are more frequently recorded in coastal waters, their long-term effects has been studied on growth rate, sex-ratio and survival of juveniles. Low contaminations (0.5 mg·l⁻¹, 0.01 mg·l⁻¹, 0.005 mg·l⁻¹) during: i) embryonic development (E^+J^-), ii) juvenile development (E^-J^+), iii) both embryonic and juvenile development (E^+J^+), were performed.

The highest concentration (0.5 mg·l⁻¹) induces significative modifications in all tested biological parameters. When sex differentation takes places, sex-ratio measured on day 60, appears strongly modified, females largely exceeding males (75% and 84% respectively for Cd and Cu). This indicates a higher male sensitivity respect to the females during the first two month of development. Consequently the growth rate was determined at this concentration only for females specimens, whose lenght is strongly reduced ($p<.01$) by both Cd and Cu treatment (Fig.1).

No modifications of growth and sex-ratio is given by exposure to 0.005 mg·l⁻¹ or 0.01 mg·l⁻¹ Cd or Cu, while the survival is significantly affected (Fig.2,3), resulting the embryonic and juvenile treatment (E^+J^+) the most toxic and the embryonic treatment (E^+J^-) less. The Cu is more toxic than Cd in the juvenile treatment (E^-J^+).

No morphological differences between exposed and control animals never appeared.

In conclusion the acute toxicity test indicates the Hg the most toxic and the Cd the less one. The chronic toxicity test indicate that 0.5 mg·l⁻¹ affects strongly growth rate, sex-ratio and survival up to the total disappearance of Idotea baltica population. On the other hand the lower concentrations (0.01 - 0.005 mg·l⁻¹) mainly reduce the survival up to about 40%-60% of the control values with a general repercussion on the community.

REFERENCES

1) Ravera O. (1984) - Cadmium in freshwater ecosystem. EXPERENTIA, 40: 1-13
2) de Nicola Giudici M., Migliore L., Guarino S.M. & Gambardella C. (1987) - Acute and long term toxicity of cadmium on Idothea baltica Pall. (Crustacea, Isopoda): MAR. POLL. BULL., 18: 454-458.
3) de Nicola Giudici M. & Guarino S.M. (1989) - Effects of chronic exposure to cadmium or copper on Idothea baltica Pall. (Crustacea, Isopoda). MAR. POLL. BULL., 20(2): 69-73.
4) Gould E., Thompson R.J., Buckley L.J., Rusanowsky D. & Sennelfelder G.R. (1988) - Uptake and effects of copper and cadmium in the gonads of the scallop Placopecten magellanicus: Concurrent metal exposure. MAR. BIOL. 97: 217-223.
5) Saleema H. (1979) - Ecology of Idotea baltica (Isopoda) in the Nothern Baltic. OPHELIA 18(1): 133-159.

L-III15

The Filtration Rate in the Mediterranean Mussel *Mytilus galloprovincialis* as a parameter to assess the toxicity of Zinc and Copper acting together

E. PAPATHANASSIOU

National Centre for Marine Research, Agios Kosmas, Hellinikon, Athens 16604 (Greece)

The effects of two heavy metals, copper and zinc, acting together on the filtration rate of the Mediterranean blue mussel Mytilus galloprovincialis was studied, providing data on the synergism or antagonism between these two trace metals. This study also tried to evaluate a fairly simple and rapid procedure for screening and monitoring pollutants and effluent.

The animals were obtained in early December 1988 from a mussel farm located near the Salamis Island (Saronikos Gulf, Greece) and were kept at a depth of about 1 m. for a period of 4 weeks with mortality less than 0.8%. All experiments were conducted in a constant temperature room with 18±2 ° C. The nominal concentrations, in the 21 experimental aquaria, that were used to study the effects on the filtration rate, made up from a stock solution, were the following: Conc.1: 0.025 ppm Cu + 0.25 ppm Zn; Conc. 2: 0.05 ppm Cu + 0.5 ppm Zn; Conc. 3: 0.1 ppm Cu + 1 ppm Zn; Conc. 4: 0.2 ppm Cu + 2 ppm Zn; Conc. 5: 0.3 ppm Cu + 3 ppm Zn; Control. Measurements of the above solutions showed very small variation from the actual values.

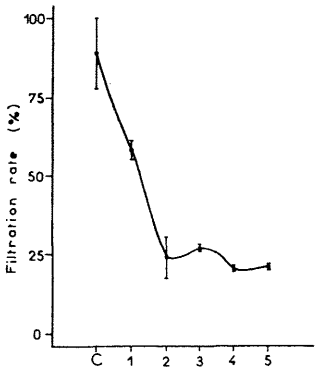


Fig 1. Effect of Cu and Zn on the filtration rate as percentage of the controls after 20 min. Vertical lines represent 95 % confidence limits.

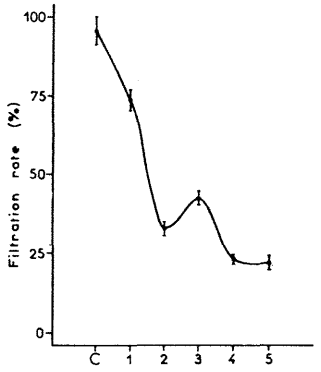


Fig 2. Effect of Cu and Zn on the filtration rate as a percentage of the controls after 40 min. Vertical lines represent 95 % confidence limits.

Following the procedure described by Abel & Papathanassiou (1984), samples of about 20 ml of water were removed after 20 and 40 min and measured, using a Perkin-Elmer/Hitachi Spectrophotometer. The formula described by Coughan (1969) was then used to determine the filtration rate. Three replicates were made for each combination of the concentrations including the controls. For the first period (0-20 min) there was a significant difference between groups ($F=10.008$, $p = 0.0006$) namely between the controls and the lowest concentrations and all other concentrations (Fig 1). Significant differences were also observed for the second period (20-40 min) ($F=7.187$, $p = 0.0025$) (Fig 2). The sensitivity from these experiments resembles to a large extent the filtration rate of the control samples of Mytilus edulis described by Abel (1976) and relatively lower than that described by Abel & Papathanassiou (1984); they took their samples from the local fish market (commercial supply) while in this experiment the animals were collected from a relatively undisturbed site offshore from the Salamis Island. Another factor which could also affect the filtration rate is the season in which the experiments are carried out. Abel & Papathanassiou (1984) experimented during the summer months, at the peak of the spawning season, while the present experiments were conducted during the winter months, preceding spawning, when lower metabolic activity is involved. Similar experiments in bivalves showed that when heavy metals are applied individually, the filtration rate is generally lowered (Cappuzo & Sasner, 1977; Watling & Watling, 1982; Howell et al, 1984; Mathew & Menon, 1984).

The concentration 1 is not significantly different from the controls, which suggests that the filtration rate is not affected under this environmental regime. The higher filtration rate reported for animals exposed at concentration 3, is unknown and must be related to the different physiological state of the animals, suggesting that the elevated activity observed at the low concentrations may alone be due to the increased metabolic rate to compensate the metal stress (Mathew & Menon, 1984). The decrease of the filtration rate that was observed for low concentrations suggest that at this level there is a reduction in the filtration rate due to the presence of heavy metals. The combination of concentrations of the two metals in the present study suggest that copper and zinc have certainly synergist effects but no additive ones. Finally there are advantages and disadvantages in using M. galloprovincialis as a test organism in the Mediterranean region. Among these are such extraneous factors as the organism's size and age, its habitat and seasonal variations. Some lack of precision in the results may be resolved if a lot of specimens are used. There are also the added effects caused by the possible metal-metal interactions and the time period during which the experiment should be conducted.

References

Abel P.D. 1976. Mar. Pollut. Bull., 7(12): 228-231
Abel P.D. & E. Papathanassiou 1984. FAO Fish. Rep. 334 Suppl. : 1 -7.
Capuzzo J.M. & .J. Sasner Jr. 1973.In: Physiological responses of Marine biota to pollutants. Verneberg & Vernberg (eds) Academic press, 1973 pp 225-237
Coughan J. 1969. Mar. Biol. 2: 356-358.
Howell R., A.M. Grant & N.E.J. Maccoy 1984. Mar. Pollut. Bull. 15:436-439
Mathew R. & N.R. Menon 1984. Mahasagar 17:
Watling H.R., R.J. Watling 1982. Cont. Tox., 29: 651-657.

Marine Pollution by Determination the Total Phenolic Compounds in El-Mex Bay, Alexandria (Egypt)

M.-A. SAID and M.-S. EL-DEEK

National Institute of Oceanography & Fisheries, Kayet Bey, Alexandria (Egypt)

El-Mex Bay, west of Alexandria, has a mean depth of 10m. Its surface area is of about 19.4 km^2 and its volume 190.3 x 10^6 m^3. It receives a heavy load of waste water (2.4 x 10^9 m^3/year) both directly from industrial outfalls and indirectly from lake Maryut via El-Mex Pumping Station. Throughout the period from January 1988 to January 1989, seven marine trips were carried out in El-Mex Bay area using a motor boat. In four of them, temperature, salinity, dissolved oxygen and the total phenolic compounds were measured at surface and bottom from seven sampling stations. Fig.1, presents El-Mex Bay area and locations of the sampling stations. Phenol determinations were carried out colorimetrically with antipyrine method using a Shimadzu-Double-Beam model spectrophotometer UV-150-02. The method is described in the Standard Methods of Water Analysis published by the American Public Health Association (1985). Table 1, illustrates the total phenol concentration at some stations in El-Mex Bay area. The total phenol is generally presented in higher concentrations in the near-shore stations decreasing seawards.

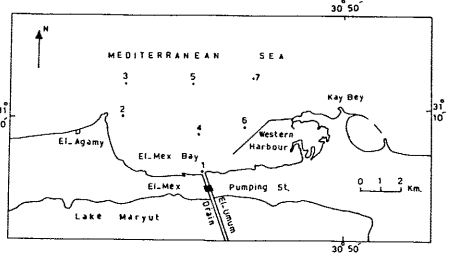


Fig.1. El-Mex Bay area.

Table 1. Total phenol concentration (ppm) at some selected stations.

Station No	January Surface	January Bottom	February Surface	February Bottom	April Surface	April Bottom	June Surface	June Bottom
1	186.25	100.74	212.08	202.56	154.44	125.89	231.11	76.40
2	184.76	85.38	207.46	143.29	183.94	101.96	147.10	52.48
7	62.54	25.17	90.13	21.21	87.16	44.05	77.22	38.07

The statistical analysis between data sets of the total phenolic compounds and temperature, salinity and dissolved oxygen during the period of investigation are listed in table 2.

Table 2. Linear regression analysis.

Parameter	n	$\bar{x}$	A	B	r	significant
Temperature	44	19.83	32.33	-0.070	-0.390	no
Salinity	44	29.67	43.83	-0.136	-0.626	yes
Dissolved oxygen	44	2.22	19.46	-0.040	-0.186	no

The weak correlation ($r < 0.4$) could be attributed to another independent factors such as meteorological or biological conditions. For $r = 0.4$ is not fairly bad for such type of study. Our value of ($r = -0.626$) confirms the high degree of correlation between the total phenolic compounds and salinity that was apparent from table 2. Negative values of r indicate a line going down to the right (as one of the values increases the other decreases).

Referring to table 10A (Neil R. Uliman, 1978), we find that the critical values of correlation corresponding to n = 44 are 0.2976 (at the 5% level of significant) and 0.3848 (at the 1% level of significant). Our computed coefficient was 0.626, which far exceeds even the upper value of 0.3848. Then there is a significant linear relationship between the total phenolic compounds and salinity. Fig.2. represents the best linear equation for the data given. The regression line is only for predicting phenol values from salinity-values.

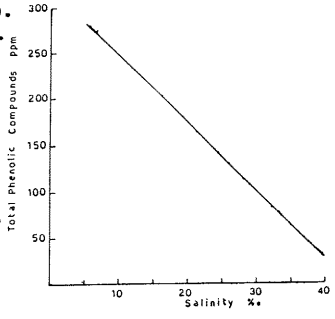


Fig 2 : A possible regression line to predict the total phenolic compounds from salinity.

References :

American Public Health Association. 1985. Standard Methods for the Examination of Water and Wastewater, 16th Edition. APHA. AWWA. WPCF, New York, 1268 p.

Neil R. Uliman. 1978. Elementary Statistics : An Applied Approach. John Wiley & Sons Inc., New York, 372 p.

Effect of Pollution on the Hydrochemical Characteristics of Different Water Types in El-Mex Bay Area, West of Alexandria, Egypt

M.-A. SAID , M.-S. EL-DEEK , Th.-H. MAHMOUD and M.-A. SHRIADAH

National Institute of Oceanography & Fisheries, Kayet Bey, Alexandria (Egypt)

El-Mex Bay, west of Alexandria, has a surface area of about 19.4 km^2 and volume 190.3 x 10^6 m^3. It receives a heavy load of wastewater (2.4 x 10^9 m^3/year). Seven marine trips were carried out in El-Mex Bay area during the period from January 1988 to January 1989 using a motor boat. Temperature, salinity, pH, alkalinity, dissolved oxygen, oxidizable organic matter, hydrogen sulphide, phenolic compounds and nutrients salts were measured at surface and bottom from seven sampling stations. The present work is an attempt to illustrate the extent of the influence of the polluted water on the characteristics of El-Mex Bay waters and to shed more light on the pathways of the pollutants in the Bay.

Based on the distribution of surface salinity in the investigated area, four types of water are identified :

1- Mediterranean Sea water (S) of salinity > 38.50‰.
2- Diluted sea water (D) with a salinity range from 30 to 38.50‰.
3- Mixed water (M) of salinity 10 to 30‰, and
4- Mixed land drainage (L) with a salinity of less than 10‰.

According to El-Maghraby and Halim (1965), Said (1979) and Abdel-Moati and Said (1987), the salinity value 38.50‰ was taken to represent the inner boundary of the neritic water off alexandria. This value still could be generally accepted and will be used here to identify the limits within which the diluted sea water extends horizontall seawards. The hydrochemical characteristics of the water types referred to the mentioned above are listed in table (1). The most important features which distinguish water type "L" from other types are the low salinity, low oxygen content, high concentration of hydrogen sulphide, organic matter, alkalinity, chlorophyll a, nutrient salts (which is mainly present in the ammonia form) and total phenolic compounds. In contrast, water type "S" free from the effects of drainage water has high salinity values and relatively high oxygen content but low alkalinity, hydrogen sulphide, organic matter, chlorophyll a, and nutrient salts. The study pointed out also that water types "M" and "D" are affected to a certain extent by land drainage water which does indeed more clear in "M" water type than in "D" water type.

Table (1). Seasonal variations of the hydrochemical characteristics of average values for the different water types (L, M & D respectively).

Parameter / Month	T °C	Dissolved Oxygen mlO_2 L-1	Organic matter mgO_2 L-1	Alkalinity millieq.L-1	Ammonia uM	Nitrite uM	Nitrate uM
January, 1988	14.20	1.79	9.94	5.40	32.20	2.52	0.08
February,1988	14.93	1.52	7.07	4.76	40.74	1.74	2.70
April, 1988	21.07	1.70	1.46	4.36	57.66	3.87	4.41
June, 1988	27.25	0.85	2.39	2.87	7.54	0.63	0.67
August, 1988	28.41	0.81	6.66	5.62	72.20	4.87	19.50
November 1988	19.60	3.12	1.68	5.61	***	***	***
January, 1989	14.20	2.93	6.62	5.66	***	***	***
January, 1988	14.80	2.21	3.66	4.03	24.05	3.06	8.78
February,1988	15.45	1.82	4.80	3.89	31.91	0.41	3.40
April, 1988	19.50	2.08	2.66	3.45	28.40	4.17	9.29
June, 1988	26.50	2.21	1.72	3.14	3.78	17.24	22.27
August, 1988	28.??	1.60	5.26	4.19	16.89	3.57	16.15
November 1988	22.40	3.50	3.99	4.37	***	***	***
January, 1989	14.80	3.47	5.29	3.56	***	***	***
January, 1988	15.27	2.28	4.80	2.82	4.97	0.59	0.17
February,1988	16.00	3.37	2.40	3.23	8.83	0.77	3.58
April, 1988	19.70	2.55	1.20	3.04	12.71	2.66	17.49
June, 1988	26.28	2.00	1.94	3.40	5.46	7.62	16.71
August, 1988	---	---	---	---	---	---	---
November 1988	22.72	3.68	0.95	3.78	***	***	***
January, 1989	15.27	3.35	4.31	3.08	***	***	***

*** not sampled.

References :

Abdel-Moati, A.R. & M.A. Said. 1987. Hydrographic structure of the Mediterranean shelf waters off the Egyptian coast during 1983-1986. J. Thalassographica, 10(2) : 23-39.

El-Maghraby, A.M & Y. Halim. 1965. A quantitative and qualitative study of plankton of Alexandria waters. Hydrobiologia, 25 : 221-238.

Said, M.A. 1979. Effect of oceanographic and meteorological factors on the transport of pollutants in Abu Qir Bay. M.Sc. Thesis, Alexandria University, 95 p.

L-III18

Evolutions chimique et biologique à long terme de sédiments artificiellement contaminés par de l'acétate de Plomb

G. STORA*, A. ARNOUX** et C. DIANA**

*Centre d'Océanologie de Marseille, Station Marine d'Endoume, 13007 Marseille (France)
**Labarotoire d'Hydrologie, Faculté de Pharmacie, 13385 Marseille (France)

Introduction

L'effet à long terme des pollutions chroniques ou accidentelles ne peut être étudié de façon satisfaisante que par une simulation aussi proche que possible des conditions naturelles. L'expérimentation in situ répond à cette exigence. Pour étudier les effets du plomb sur les processus de colonisation et la dynamique de la macrofaune benthique, un dispositif expérimental a été conçu mettant en jeu les facteurs du milieu naturel sur des sédiments d'abord défaunés puis différemment traités: sans polluant (témoin expérimental), avec acétate de plomb et avec acétate de Plomb + plomb tétraéthyle (ARNOUX et al 1988). Pour des raisons de protection le dispositif expérimental a été placé à proximité de tables de Mytiliculture permettant d'étudier l'incidence sur les sédiments pollués de l'apport régulier d'un matériel riche en matière organique, constitué en majeure partie de pelotes fécales et de pseudofèces. Dans ce travail sont présentés les résultats obtenus avec les sédiments contaminés à l'acétate de plomb.

Méthodologie.

Nous ne reviendrons pas sur le dispositif expérimental installé dans le golfe de Fos par 5 m de profondeur, décrit par ailleurs (STORA et al 1987). La quantité d'acétate de plomb dans les vases sableuses contaminés correspondait en début d'expérience à 1g.Pb.Kg-1. Pendant deux ans, des prélèvements de trois modules, destinés à l'analyse chimique et biologique, ont été réalisés mensuellement durant les six premiers mois puis tous les deux mois jusqu'à la fin de l'expérience. Au cours de la deuxième année la mise en place de pièges sur le fond a permis d'analyser et de quantifier lé flux particulaire entre deux prélèvements sur le site expérimental..

Résultats.

D'un point de vue biologique, les peuplements installés dans les modules témoins et les modules contaminés présentent une dynamique concomitante comme le montre l'évolution temporelle des densités de la macrofaune benthique (Fig 1). L'enrichissement du milieu en matière organique se traduit par une augmentation régulière des taux de carbone organique dans la couche superficielle (2 cm) des modules corrélée à une élévation du Cuivre bioconcentrés dans les fèces de Moules. Cet apport de matériel particulaire s'accompagne d'une chute importante des concentrations d'acétate de plomb.

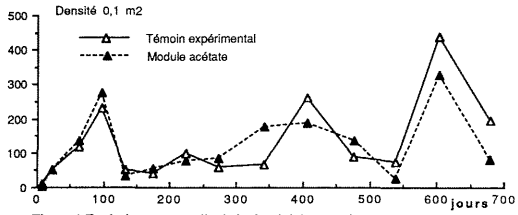


Figure 1.Evolution temporelle de la densité des peuplements macrobenthiques.

Discussion et conclusions

Une analyse factorielle de correspondance a été réalisée, basée sur les tableaux faunistiques établis en fonction du nombre d'individus de chaque espèce récoltée au cours du cycle d'étude dans les sédiments des modules témoins et acétate. A partir des résultats obtenus, une étude de corrélation de rang (coefficient

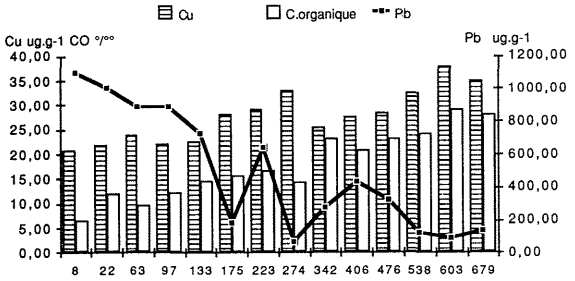


Fig 2. Evolution temporelle du Cuivre , du carbone organique et de l'acétate de Plomb dans la couche superficielle (2cm) des modules contaminés

de Spearman) a été effectuée entre l'ordination des prélèvements le long des axes retenus et les différents paramètres analysés .Le tableau 1 regroupe les pourcentages d'inertie des trois premiers axes et les paramètres présentant une corrélation significative avec l'évolution des prélèvements le long de ces axes. .

	Axes	% inertie totale	Facteurs	Coefficient Spearman	Coefficient théorique.005
Témoin expérimental.	1	21	N Ammoniacal	-0,8451	
			CO surface	0,8418	0,46
	2	18	P.Phosphates	-0,6659	
	3	13	Matière calcinable	0,6055	
Module Acétate	1	27,88	P.phosphates (EI)	-0,8626	
			CO surface	-0,9602	0,48
			CU Surface	-0,6758	
	2	15,52	Pb lyophilisé	0,6868	
	3	11,77	Non déterminé		

Tableau 1. % d'inertie des 3 premiers axes et coefficients de corrélation

Dans les modules témoins, les corrélations significatives obtenues sur les 3 axes avec les différents facteurs mesurés traduisent l'influence prépondérante sur la dynamique du peuplement de la matière organique initiale et celle apportée par les tables . Pour les modules acétate Pb, les corrélations entre l'évolution des prélèvements le long de l'axe 1 et la variation des taux d'orthophosphates dans l'eau interstitielle et du carbone organique dans la couche superficielle, marquent là encore une influence majeure de la matière organique autochtone et apportée. L'incidence de l'effet table est corroborée par la corrélation obtenue avec le cuivre , traceur du flux de fèces de moules. L'influence de la contamination du milieu par l'acétate de plomb n'apparait que sur l'axe 2. La hiérarchie existant entre les axes 1 et 2 démontre le rôle prépondérant de la matière organique. La contamination des modules par l'acétate de Plomb ne constitue donc pas le facteur primordial régissant la dynamique du peuplement .

Bibliographie

ARNOUX A., STORA G., VACELET E., VITIELLO P., 1988. Etude expérimentale dans le milieu naturel, de sédiments artificiellement contaminés par différentes formes chimiques d'un métal (Plomb): Evolution chimique et biologique du sédiment. Rapport PIREN-ATP Ecotoxicologie 22 pages +Figures.

STORA G., ARNOUX A., DIANA C., 1987. L'expérimentation *in situ* en tant que critère d'évaluation des effets de la pollution : Etude des mécanismes évolutifs et du repeuplement de sédiments pollués. FAO Fish. Rep. (352) Suppl.229-251.

L-III19

Estimation of land-based pollution and waste loads in Hellonitis Bay, S-W. Greece

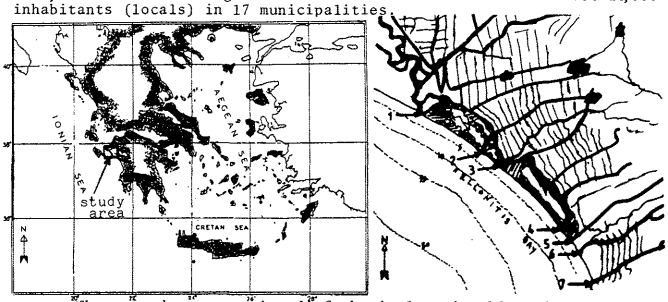
B.-S. TSELENTIS*, J. DETORAKIS**, X. KONDAKIS and S. LIVADITOU

*Laboratory of Public Health, Medical School, University of Patras, P.O. Box 1045, Patras 261 10 (Greece)

The main aim of the investigation was to assess the overall environmental health of Hellonitis Bay, since it is considered a favourite holiday resort for many local and foreign tourists.

The sandy beach is about 10km. long and borders mostly on agricultural land, as well as tourist resorts, small villages and summer homes.

Since no data were available for the area, an inventory of potential land-based pollution sources was created in the first part of the study. The area investigated covered ca. 300km² and included about 25,000 inhabitants (locals) in 17 municipalities.



The second part consisted of chemical & microbiological measurements throughout a period of 1 year (March 1989-March 1990), on a regular basis (March-October every 10 days, October-March monthly).

METHODOLOGY: Microbial parameters (Total coliforms, E.Coli) were measured in sea water every 150m along the beach, 3-4m away from the coast at a depth of 1.5m, as well as in the main outlets (Fig.) of which Nos 1,3,7 are rivers and Nos 2,4,5,6 agricultural run-offs.

Chemical parameters (NH_3, NO_4, NO_3, Total P, BOD, COD, dissolved oxygen and organophosphorus insecticides), were measured in all seven (7) outlets.

RESULTS: 1) All 7 outlets were shown to be polluted with microbes to a lesser or greater extent (No 1>4,5,6,7>>2,3). The microbial load increased during the summer months correlating well with the greater number of visitors to the area and thus indicating illegal sewage dumping. This, however, did not affect the sea, which continued to show no measurable pollution at most sampling stations, other than those close to the 7 outlets. Weather conditions (waves, wind etc.), however, do affect the microbial pollution of several areas of the beach.

MICROBIAL CONTAMINATION ($X10^{10}$ microbes/day)

	MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
No	Tt.Coli	E.Coli	Tt. Coli	E.Coli	Tt.Coli	E.Coli	Tt.Coli	E.Coli	Tt.Coli	E.Coli	Tt.Coli	E.Coli
1	1,500	1,000	7,100	6,700	11,500	10,500	37,000	35,900	43,000	41,000	1,100	900
3	200	100	380	310	550	500	8,500	8,000	2,200	1,900	2,500	2,000
7	1,500	1,200	3,000	2,100	2,500	2,000	3,300	2,900	250	200	150	100
Σ2456	1,660	1,500	2,400	2,260	2,000	1,680	1,480	1,370	350	250	102	60

2) There is an increase (5x) of the organic load during the months of August and September (see Table), and river No 1 seems to be responsible for 97% of the total amount. Measurements on smaller streams leading into this river, have indicated that the increased organic load originates from tomatoe canning factories that operate at this time of year.

AVERAGE FLUXES (kg/day)

	MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
No	BOD	Tot.N	BOD	Tot.N	BOD	Tot.N	BOD	Tot.N	BOD	Tot.N	BOD	Tot.N
1	3,800	290	5,500	850	3,000	930	33,000	1,600	34,000	2,000	14,000	7,000
3	340	87	770	126	560	110	170	50	155	25	490	30
7	390	52	320	48	340	40	44	10	-	-	55	12
Σ2456	370	75	660	100	580	77	60	6	-	-	-	-

CONCLUSIONS: The investigation clearly indicates that measures have to be taken in order to preserve the environmental health and stability of the coastal ecosystem.

Thus it is proposed: i) To build a facultative lagoon that will receive the microbial and nutrient load of all outlets except No 1, since the flow and chemical parameter measures are small enough to be tackled by such facultative aerobic/anaerobic conditions and,
ii) Solve the problem of increased organic loads (No 1) and flows (12,000m³/day) by operating wastewater treatment plants in all the canning industry of the area.

REFERENCES:

WHO (1982), Rapid Assessment of Sourses of Air, Water and Land Pollution . WHO offset publ. No 62

UNEP (1982), Ref. Methods for Mar. Studies No 11.

UNEP/WHO (1983), Determination of Faecal Coliforms in Seawater by the Membrane Filtration Method Rev. 1.

Standard Methods for the Examination of Water and Wastewater (1985) 16th Edition.

EPA-600/8-80-038 (1980), Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples.

L

Survey of Heavy Metal Distribution in Greek Sediments

F. VOUTSINOU-TALIADOURI

National Centre for Marine Research, Hellinikon, Athens 16604 (Greece)

Several oceanographic investigations have been carried out within the last 15 years in order to study heavy metal distribution in Greek surface sediments. Samples were collected from various polluted or partly polluted Greek areas, as well as from some unaffected regions. Collection of the samples was made using a 0.1m² van Veen grab. For the determination of the metals, 5g of the dry material was shaken with 2N HCl for 16 hours at room temperature. The leachates were processed on a Perkin-Elmer 305 B A.A.S. (SATSMADJIS,J.& VOUTSINOU-TALIADOURI,F. 1981). The study of each of the above mentioned areas lasted from one to five years.

Table I: Metal concentrations of Greek unpolluted regions.

	Fe	Cr	Ni	Mn	Zn	Co	Cu	Pb	σ of q	v of q	Q	Ref.
	(—%—)	(—————————ppm—————————)										
Kavala	0.8-2.6	20-278	11- 47	65- 417	24-90	0-10	4-24	5-36				4
(mean)	1.4	105	22	273	67	5	16	30				
q	**0.82**	**1.03**	**0.24**	**0.45**	**1.37**	**0.42**	**0.89**	**1.50**	**0.45**	**54.07**	**0.84**	
Thermaik.	1.2-2.2	66-120	55-105	215- 740	32-74	14-18	8-28	11-27				4
(mean)	1.8	95	81	465	48	16	17	18				
q	**1.06**	**0.93**	**0.87**	**0.76**	**0.98**	**1.33**	**0.94**	**0.90**	**0.17**	**17.37**	**0.97**	
Pagassit.	1.3-2.7	50-186	32-228	290-2790	38-72	8-22	9-25	19-30				7
(mean)	1.8	105	90	980	58	15	17	24				
q	**1.06**	**1.03**	**0.97**	**1.60**	**1.18**	**1.25**	**0.94**	**1.20**	**0.21**	**18.38**	**1.15**	
N.Euboek.	0.3-3.0	40-250	50-300	120-1000	9-46	3-30	–	–				4
(mean)	1.9	157	207	557	31	20	–	–				
q	**1.12**	**1.54**	**2.22**	**0.91**	**0.63**	**1.67**	–	–	**0.58**	**42.73**	**1.35**	
S.Euboek.	0.6-1.5	37- 97	25-144	165- 555	25-44	4-15	3-15	12-27				4
(mean)	1.2	66	76	370	36	10	9	20				
q	**0.71**	**0.65**	**0.82**	**0.60**	**0.73**	**0.83**	**0.50**	**1.00**	**0.15**	**21.20**	**0.73**	
Elefsis	0.8-1.1	50- 65	80- 95	280- 325	55-68	7-10	28-33	25-32				9
(mean)	1.0	60	90	320	60	8	30	30				
q	**0.58**	**0.59**	**0.97**	**0.52**	**1.22**	**0.67**	**1.67**	**1.50**	**0.45**	**46.71**	**0.96**	
Navarino	0.2-3.0	12-251	8-123	243- 600	7-81	4-15	0-32	2-28				5
(mean)	2.3	180	91	460	62	12	23	19				
q	**1.35**	**1.76**	**0.98**	**0.75**	**1.26**	**1.00**	**1.28**	**0.95**	**0.31**	**26.93**	**1.17**	
Patraik.	1.6-3.2	55-119	60-132	750-2610	43-88	11-23	16-43	11-20				4
(mean)	2.8	100	110	1420	72	19	35	16				
q	**1.65**	**0.98**	**1.18**	**2.32**	**1.47**	**1.58**	**1.94**	**0.80**	**0.50**	**33.63**	**1.49**	
Messolon.	1.0-2.8	56-112	40-112	470-1380	30-80	6-16	8-34	6-17				4
(mean)	1.9	73	80	764	60	11	23	12				
q	**1.12**	**0.72**	**0.86**	**1.25**	**1.22**	**0.92**	**1.28**	**0.60**	**0.26**	**25.95**	**1.00**	
Amvrakik.	0.5-3.0	27-177	33-188	323-3820	12-80	4-30	2-31	7-21				6
(mean)	2.2	125	131	870	62	18	24	12				
q	**1.29**	**1.22**	**1.41**	**1.42**	**1.26**	**1.50**	**1.33**	**0.60**	**0.28**	**22.32**	**1.25**	
Lesbos	0.3-2.1	40-247	20-315	172-1126	18-43	0-19	3-12	10-39				4
(mean)	1.2	155	89	447	32	9	8	28				
q	**0.71**	**1.52**	**0.96**	**0.73**	**0.65**	**0.75**	**0.44**	**1.40**	**0.38**	**42.22**	**0.89**	
Milos	0.3-0.6	10- 19	6- 21	113- 251	15-18	2- 4	2- 4	2- 7				8
(mean)	0.4	14	12	170	17	3	3	5				
q	**0.23**	**0.14**	**0.13**	**0.28**	**0.35**	**0.25**	**0.17**	**0.25**	**0.07**	**33.26**	**0.22**	
East Aeg.	1.4-3.3	52-157	39-291	280-2640	25-55	8-24	4-29	11-22				4
(mean)	2.2	86	131	861	38	15	17	17				
q	**1.29**	**0.84**	**1.41**	**1.41**	**0.77**	**1.25**	**0.94**	**0.85**	**0.27**	**24.77**	**1.09**	

Analysis of the data indicates that polluted subregions can be identified in some of the studied areas. In Kavala Bay, the oil-platforms and the fertilizer factory raise the amounts of Pb (322-908ppm), Zn (110-510ppm) and Cu (45-226ppm), while in Thermaikos Gulf, the industrial effluents, as well as, the domestic wastes raise more or less the concentrations of all metals Fe (2.2-5.3%), Cr (140-390ppm), Ni (105-290ppm), Mn (295-1340ppm), Zn(74-2600ppm), Co (19-37ppm), Cu (28-200ppm) and Pb (28-330ppm). The industries and the city of Volos cause a slight enrichment of the values of Cr (66-70ppm), Ni (46-53ppm), Zn (72-94ppm), Cu (27-39ppm) and Pb (30-53ppm) in surface sediments of Pagassitikos Gulf. In the adjacent N. Euboekos Gulf, a Fe-Ni alloy smelting plant causes heavily enriched values of Fe (3.0-25.4%), Cr (250-12000ppm), Ni (300-3550ppm), Mn (1140-4560ppm), Zn (46-320ppm) and Co (30-212ppm). Surface sediments in Elefsis Bay, show heavy metal pollution [Cr (70-390ppm), Zn (100-1680ppm), Cu (20-230ppm),Pb (40-400ppm) and Cd (0.2-2.5ppm)] due to the influence of industrial effluents and domestic wastes from three and a half million people of the greater Athens area. Finally, in Navarino Bay, a tanker shipwreck caused an enhanced Pb-value (53ppm). Our values are comparable with those reported by other investigators (VARNAVAS et al.,1984, ANGELIDIS et al., 1984, etc). However, a close comparison is not attempted herein because of the different extraction methods used.

Table I shows metal concentrations of unaffected sections from the polluted regions, as well as metal concentrations from other unpolluted Greek areas. Comparison of metal concentrations in the various unpolluted areas may be made with the use of an enrichment ratio q (q = mean concentration of a metal for each area/mean concentration of a metal for all areas). From Table I is evident that the coefficient of variation of q does not vary considerably between regions (17.37-54.07). Factor Q (the mean value of all q ratios for each area) gives an idea about the concentration level of the metals in each area comparing with the mean values of all unpolluted Greek regions. In the classification that follows regions characterized with coeff. of variation > 50.00 (arbitrary selected) are excluded. Hence, the unpolluted areas (according to their metal concentrations) may be arranged as follows: Patraikos Gulf (Q=1.49); N.Euboekos G. (Q=1.35); Amvrakikos G. (Q=1.25); Navarino B. (Q=1.17); Pagassitikos G. (Q=1.15); East Aegean Sea (Q=1.09); Messolonghi L. (Q=1.00); Thermaikos G. (Q=0.97); Elefsis B. (Q=0.96); Lesbos Isl. (Q=0.89); S.Euboekos G. (Q=0.73); Milos Isl. (Q=0.22).

REFERENCES

1.ANGELIDIS,M.,ZAFIROPOULOS,A.P.& GRIMANIS,A.P.1982.HCl extractable and residual trace element conc.in sediments around the Athens sewage outfall.**VIes Journees Etud.Pollutions, Cannes, C.I.E.S.M.**:339-343.
2.SATSMADJIS,J.& VOUTSINOU-TALIADOURI,F.1981.Determ. of trace metals at concent. above the linear calibration range by electrothermal A.A.S. **Analyt.Chim.Acta**,131,:83-90.
3.VARNAVAS,S.P.,PANAGOS,A.G.& LAIOS,G.1984.Heavy metal distribution in surface sediments from the Kalamata Bay, Greece.**VIIes Journees Etud.Pollutions, Lucerne, C.I.E.S.M.**:267-274.
4.VOUTSINOU-TALIADOURI,F.1988.Geochemical Study of sediments from N.Euboekos Gulf,Greece.**Ph.D.Thesis,Univers. of Patras.** 265p.
5.VOUTSINOU-TALIADOURI,F.1988.Heavy metal concentrations in surface sedim. of a semi-enclosed Gulf.**1st Chem.Symp.of Cyprus& Greece,**:451-455
6.VOUTSINOU-TALIADOURI,.1989.Heavy metals in surface sediments from a semi-enclosed embayment of the Ionian Sea:Amvrakikos Gulf in **Heavy Metals in the Environment**,(J-P Vernet ed.).:367-370.
7.VOUTSINOU-TALIADOURI,F.(unpubl.data).Geochem.Study of Pagass.Gulf.
8.VOUTSINOU-TALIADOURI,F.&FRAGOUDAKI,S.1990.Geochemical study of sediments from Milos Island.**Technical Report, N.C.M.R.**
9.VOUTSINOU-TALIADOURI,F.,SATSMADJIS,J.&IATRIDES,B.1989.Impact of Athens Sewage & Industrial Discharge on the Metal Content of Sediments from Piraeus Harbour & Elefsis Bay.**Rev.Int.Oceanogr.Med.,93-94.**:31-45.

M-I1

Répartition et dynamique des peuplements de Micromycètes du Littoral Roumain de la Mer Noire, au cours de l'année 1989

Mucader M. APAS

Institut Roumain de Recherches Marines, Constanta (Roumanie)

Au cours de l'année 1989, nous avons étudié l'évolution saisonnière des peuplements de Micromycètes du sous-système pélagique de l'écosystème côtier, dans le secteur marin de Constanta, où nous disposons de données comparatives antérieures (APAS, 1987, a, b).

Les zones étudiées sont: le profil Constanta jusqu'à 30 milles marins et au large, jusqu'à 100 milles marins ainsi que le profil NW-SE Portita, jusqu'à la plate-forme de forage "Gloria".

Les résultats obtenus se rapportent à cinq périodes de travail: novembre 1988, février, mai, juillet et octobre 1989. Du point de vue qualitatif, nous avons décelé, par culture et par microscopie, 44 taxons appartenant aux classes des *Phycomyçètes* et *Deutéromycètes* et aux ordres des *Saprolégniales, Péronosporales, Mucorales, Hyphomycètes, Blastomycètes* et *Coelomycètes*. Du point de vue quantitatif, nous avons distingué deux grands groupes écologiques, champignons filamenteux et champignons levuriformes.

Les représentants des familles *Cryptococcacées* (18) et *Moniliacées* (14) sont les plus fréquemment rencontrés, suivis ensuite, à des différences considérables, par les *Mucoracées* (7) et *Dématiacées* (5).

Les formes euryhalines dominent qualitativement et quantitativement (80%). Les *Hyphomycètes*, en majorité filamenteuses, sont faiblement représentées par des *Tuberculariacées* asporogènes.

Selon la saison, le nombre des taxons déterminés a été: 11 en automne (novembre 1988), 14 en hiver (février 1989), 17 au printemps (mai 1989) et 8 en été (juin-juillet 1989).

En automne (1988), les genres dominants parmi les *Hyphomycètes* et les *Blastomycètes* sont respectivement *Cladosporium* (21,12%), *Rhodotorula* (16,43%) et *Candida* (43,50%), qui ont des capacités de pathogénicité, véritables indicateurs de pollution fongique des eaux.

Durant l'hiver, le mycoplancton est surtout dominé par les Cryptococcacées *Rhodotorula* (45,80%), *Candida* (30,17%) et *Geotrichum* (6,32%), ainsi que les Dématiacées *Penicillium* (6,32%) et *Cladosporium* (5,95%).

Au cours des deux saisons suivantes (printemps et été), la dominance des *Blastomycètes* et des *Hyphomycètes* est sensible jusqu'à de grandes profondeurs et distances de la côte.

Dans la dynamique globale de la mycoflore planctonique étudiée lors des cinq expéditions, le groupe écologique Levuriforme s'est imposé par sa fréquence et par sa production de spores, à l'exception de l'été. En effet, à cette époque, ils furent rencontrés en proportions presque égales à celles des espèces filamenteuses. Leur taux, dans les échantillons analysés, oscille entre 62,68% et 87,30%.

La plupart des taxons identifiés sont essentiellement marins et d'eau saumâtre, une petite partie étant dulçaquicole et terricole, avec une large labilité écologique.

La production de spores la plus concentrée est observée, en février, dans les stations du large, ainsi qu'aux grandes profondeurs (20 milles marins/20 m; 30 milles marins/ 30 m). Le phénomène de concentration des propagules de cette saison est déterminé par les complexes fongiques *Penicillium-Cladosporium* et *Rhodotorula - Candida-Geotrichum*. Au cours de ce mois, le phénomène de floraison fongique a eu la plus grande ampleur (55040 propagules/l - valeur totale; 3239 propagules/l - valeur moyenne).

En octobre, les quantités de Mycoplancton de la zone côtière (Constanta - plate-forme "Gloria") connaissent une augmentation ininterrompue par rapport aux mois précédents et aux autres secteurs. Toutes les valeurs dépassent constamment 1000 propagules/l, totalisant une production de 18540 propagules/l, parmi lesquelles les espèces levuriformes avec un taux de 64% du total et les champignons filamenteux avec un taux réduit de 36%.

La présence permanente des espèces à capacité pathogène dans nos échantillons, *Candida*, *Geotrichum* et *Aspergillus*, en quantités considérables, prouve, sans aucun doute, l'existence de stocks disponibles de sels nutritifs, surtout organiques, qui stimulent le développement constant de ces souches indicatrices d'eaux fortement polluées. Ce développement aboutit à de vrais phénomènes de floraisons fongiques, mis en relief par bon nombre de nos études.

Références

APAS (M.-M.), 1987 a.- Données préliminaires sur les populations de Micromycètes de la zone des embouchures du Danube. *Cercetari marine,* IRCM, 20

APAS (M.-M.), 1987 b.- Structure et évolution des populations de Micromycètes de la zone Constanta pendant l'année 1987.*Cercetari marine,* IRCM, 20

M-I2

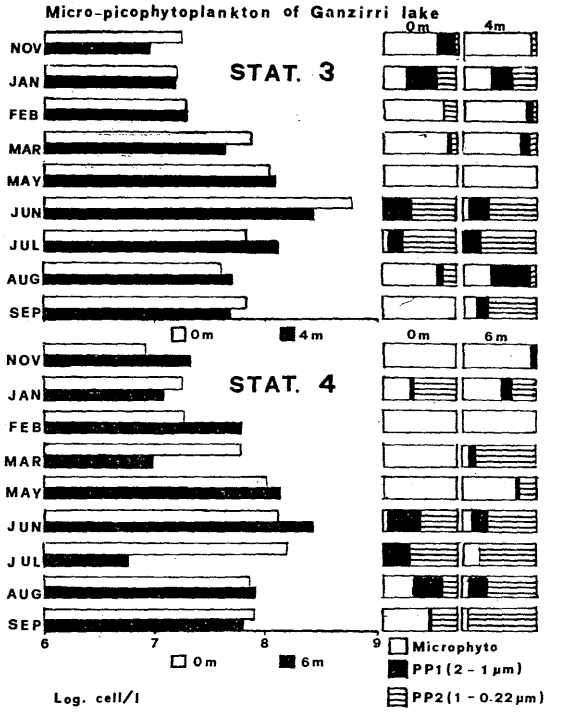
Picoplankton and Picophytoplankton in a Brackish Environment. (Lake of Ganzirri-Messina)

V. BRUNI , M.-L.-C. ACOSTA POMAR and G. GIUFFRE

Dipartimento di Biologia Animale ed Ecologia Marina, Università, Contrada Papardo, 31, 98166, Messina (Italia)

The present paper deals with the space-temporal variations of the micro-nano and picoplanktonic populations in a brackish environment near the Straits of Messina (Lake Ganzirri-Messina).

The ecological approach of this study follows that suggested by Sieburth (1981) and other authors.The planktonic organisms can be divided into different sized fractions within which different nutritional modalities can be recognized.



This method proves to be useful in fully understanding the relationship between the energy flows in the aquatic ecosystem.

The present research deals only with the above mentioned components capable of autoregulation.

The change in the picophytoplanktonic components (eucaryotic and procaryotic) in relation with the populations belonging to the nano and microphytoplankton has been demonstrated.

Moreover, a statistical study has been carried out on the total picoplanktonic and autofluorescent components in order to obtain some information about the homogeneity of the distribution of these organisms.

The non-randomization percentage has also been calculated.

For this purpose, monthly samplings have been carried out at two stations , on the surface and near the bottom.

Direct counts of the total picoplanktonic cells , autofluorescent (Porter and Feig, 1980, modified), nano and microphytoplanktonic (Utermohl, 1958) components have been studied on water samples.

The microbiological parameters have been evaluated in relation to several environmental parameters in order to point out any eventual interdependence.

The results obtained are shown in figure.

During the period of our observation, the micro-nano- and picophytoplanktonic organisms at the two stations ranged between 5,82 x 10^8 cell/l (stat.3, 0m ,June) and 8,3 x 10^8 cell/l (stat.4, 0m, November).

The micro-and nanoplanktonic component represents nearly 100% of the whole autotrophic population in the month of May ,whereas the picophytoplanktonic component is predominant in the summer months.

Moreover,the results show a succession within the pico-, nano- and micro phytoplankton populations. In particular, as far as the picoplankton is concerned, an evident prevalence of the eucaryotic component is predominant in Winter and Spring, even though its absolute values seldom reach 10^6 cell/l; afterwards a bloom of the procaryotic component occurs and reaches its maximum density (5,7 x 10^6 cell/l) in June, a month during which it represents nearly the whole autotrophic population. This evident predominance lasts until July.

Furthermore, during the year, the eutrophic characteristics of the lake bring about several micro-and nanoplanktonic, mono-and oligospecific blooms with an alternation of the main taxonomic groups.

Diatoms are particularly prevalent in winter, leading to a prevalence of peridineana by the beginning of Spring and followed by a lasting diffusion of small size diatoms (Thalassiosira sp. and Scheletonema costatum).This succession of autotrophic populations of different size led us to take into consideration the different biotic and abiotic factors which may affect the dynamics of these populations.

References

Porter K.G. and Feig Y.S. 1980. The use of DAPI for identifying and counting aquatic microflora. Limnol. Oceanogr., 25, 943-948.

Sieburth J. Mcn. 1979. Sea microbes. Oxford University Press, New York, 80-82.

Utermöhl H. 1958. Zur vervollkommung der quantitativen Phytoplankton-Methodik. Mitt. int. Ver. Limnol., 9, 1-38.

M-II1

Prediction of the environmental impact of coastal population on the quality of the sea

Günay KOCASOY

Department of Chemical Engineering, Bogazici University, 80815 Bebek-Istanbul (Turkey)

ABSTRACT

The increase of coastal population -especially by tourists- is something considered as flourishing of the socio-economic conditions of the district. Too little -if any- attention is given to the effects caused by this situation. In the present study taking into consideration the quality of the seawater as the main parameter affecting the population of tourists, an attempt has been made in order to predict the variation of the quality of seawater with population. To achieve that, the beaches were classified according to their use -and consequently the amount of wastewater discharged into the sea -into four groups: I)coasts that are used only for swimming and recreational purposes, II) coasts used simultaneously for dwelling, swimming and recreational purposes, III) coasts along which only dwellings exist, and IV) natural and man-made harbours.

Bodrum -one of the most popular touristic resorts of Turkey -was selected as the experimental site where six beaches; one from group I, one from group II, one from group III, two from group IV and one transitional group I-II, were selected as the survey areas. Three stations close to each other in approximately 10-20 meters from the shore were chosen for sampling. Samples collected at all three stations at each survey beach were mixed to obtain a typical composite sample. Samples were collected three times a day - early in the morning before people started coming to the beach; at noon when the beach was most crowded; and late in the afternoon when people started to leave the beach. During the survey 40320 observations were made from December 1985 to February 1988. Parameters such as atmospheric pressure, air temperature, cloudiness, sunny period, prevailing wind direction and its speed, precipitation, light intensity, turbidity, seawater temperature, pH, colour, salinity and coliform concentration were determined. Assuming the concentration of the total coliform as the most important microbial pollution indicator for beaches an attempt has been made for the determination of the variation of coliform concentration as a function of the remaining parameters. To achieve this a multilinear regression program was used in which the number of total coliform was treated as the dependent variable while the others were accepted as independent variables. As a result of this analysis, the following relation was obtained:

$$N = \frac{(C_1 \sqrt{P} + C_2)}{10^{A-3}}$$

$$A = \frac{\ln(I^{0.29}\, Tu^{-0.072}) + 1.22}{0.95^{\theta-20}}$$

where

A is a parameter affecting the die-off of bacteria due to environmental conditions,
N is the number of total coliforms per 100 milliliters,
I is the intensity of light (lux),
Tu is the turbidity (FTU),
θ is the temperature of seawater (°C),
P is the population density (number of people/100m^2),
C_1 is the population density coefficient and
C_2 is the coastal characteristic coefficient.

The coefficients C_1 and C_2 of this equation have been found to have the values given below:

Coast Group	C_1	C_2
I	15.7	0.020
I-II	78.4	0.223
II	220.5	0.682
III	281.7	0.293
IV	1310.5	2173.0

Parameters such as BOD, total nitrogen, total phosphorus etc. proved that they didn't contribute significantly to the total coliform concentration. The correlation obtained between actual determined values and the values estimated by the derived equation is above 86 percent.

The results obtained by this study is a significant contribution for the prediction of the environmental impact of tourist population to seawater quality and consequently for the prevention of the deterioration of the environment and protection of public health.

REFERENCES

Curi, K., "Use of a Statistical Model for the Determination of Die-away Rate of Coliforms", in *Environmental Systems Planning, Design and Control*, Pergamon Press, 1977.

UNEP, "Tourism and the Environment", *Journal of Industry and Environment, Vol.7, No1*, 1984.

WHO, *Health Criteria and Epidemiological Studies Related to Coastal Water Pollution*, UNEP/WHO, Copenhagen, 1977.

WHO, *Environmental Sanitation in European Tourist Areas*, EURO, Report Series 18, WHO, Copenhagen, 1980.

M-II2

Comparative survival of fecal indicators in seawater

R. CORNAX*, M.-A. MORINIGO*, L. DIONISIO**, E. MARTINEZ-MANZANARES*, M.-A. MUNOZ* and J.-J. BORREGO*

*Department of Microbiology, Faculty of Sciences, University of Malaga, 29071 - Malaga (Spain)
**Health Regional Administration of Faro, 8001, Faro (Portugal)

Introduction

The high inactivation rates in the marine environment of total and fecal coliforms are an important shortcoming for the use of these microorganisms as indicator of remote and viral pollution (1). Other microorganisms such as fecal streptococci and several groups of bacteriophages (Coliphages, F-specific phages and *Bacteroides fragilis* phages) have been proposed as alternative fecal indicators because of their higher survival capacity in sea water.

The objective of this study was to evaluate the effect of marine water upon the stability of several indicators microorganisms under laboratory conditions.

Material and Methods

To study the comparative survival of bacteria and bacteriophages an Erlenmeyer flask with 900 ml of unpolluted seawater was inoculated with 100 ml of sewage. The mixture was incubated in the dark at 18°C for up to 15 days. Bacterial and bacteriophages survivors were enumerated at time 0 and subsequents days (3, 7, 10 and 15 days) using the following growth media and assay techniques.

Bacterial counts:
Total coliforms (**TC**), fecal coliforms (**FC**) and fecal streptococci (**FS**) were enumerated by spread technique using m-Endo agar (Difco Lab. Detroit Mich.), m-FC agar (DIFCO) and m-Enterococcus agar (Difco) plates. When there was a low concentration of bacteria, membrane filtration procedure (2) was used for the analysis.

Phages count:
Specific phages of the strains *Escherichia coli* C (**CP**) (ATCC 13706) and *E.coli* K12 Hfr (**K12P**) (PC0008) were enumerated by the double agar layer method (3). Selective counts of F-specific bacteriophages (**FSP**) were obtained using *Salmonella typhimurium* WG49 as bacterial host (4). To evaluate the possible interference by somatic *Salmonella* phages (**SSP**) parallel counts were also made using F$^-$ strain (*S. typhimurium* WG45). Phages actives against *Bacteroides fragilis* HSP 40 (**BFP**) were enumerated by the soft agar overlay method (5) using the samples decontaminated by membrane filtration (0.45 µm filters previously treated with 3% beef extract at pH 9,5).

Results and Discussion

Figure 1 (A and B) shows the effect of the marine water on the survival of the microorganisms. Fecal and total coliforms showed the highest rate of inactivation in seawater whilst the die-away rate of fecal streptococci was more closely paralleled that of bacteriophages, excepting coliphages that did not present a significant inactivation after the sampled period.

F-specific and *B. fragilis* bacteriophages were the groups of phages that showed the least stability in seawater. Low survival of some members of F-specific phages as f2 have been described by others authors (6).

Because of the lower persistence of coliform bacteria in marine water these microorganisms can be useful indicator of enteric bacterial pathogens but not of virology pollution. Somatic coliphages can be more appropriated indicator microorganisms.

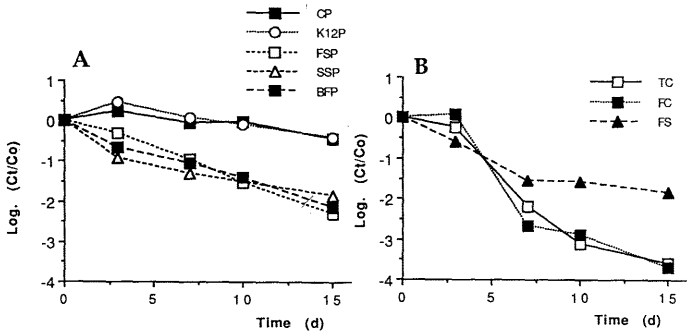


Figure 1 (A and B) : Microbial inactivation in seawater.

References

1. FATTAL, B.; R.J. VALS; E. KATZENELSON & H.I. SHUVAL, (1983). *Water Res.* **17**:397-402.
2. APHA, AWWA & WPCF (1985). *Standard Methods for the Examination of Water and Wastewater*, APHA, Washington, D.C.
3. HAVELAAR, A.H. & W.M. HOGEBOOM. (1983). *Antonie Van Leeuwenhoek J. Microbiol.* **49**:387-397
4. HAVELAAR, A.H. & W.M. HOGEBOOM (1984). *J. Appl. Bact.* **56**:439-447.
5 TARTERA, C & J. JOFRE (1987). *Appl. Envir. Microbiol.* **53**: 1632-1637
6. BITTON, G; S.R. FARRAH; R.H. RUSKIN; J. BUTNER & Y.J. CHOU (1983). *Ground Water* **21**:405-410

M-II3

Characterization of survival stages of enteric bacteria in natural aquatic ecosystems

I. BARCINA, J.-M. GONZALEZ, J. IRIBERRI and L. EGEA

Departamento de Microbiologia e Inmunologia, Facultad de Ciencias, Universidad del Pais Vasco, Apdo. 644, 48080 - Bilbao (Spain)

Differentiation between culturable and non-culturable (somnicells) enteric bacteria in natural waters have attracted very much attention in last years (Barcina *et al*, 1989; Roszak & Colwell, 1987). Until now, that classification have been studied only for enteric bacteria inoculated in aquatic ecosystems in the absence of natural microbiota (Barcina *et al*, 1989; Roszak & Colwell, 1987), and numbers of CFU (colony-forming-units) on selective culture media were the single parameter estimated when natural microbiota were present (Mc Cambridge & Mc Meekin, 1981; Rhodes & Kator, 1988).

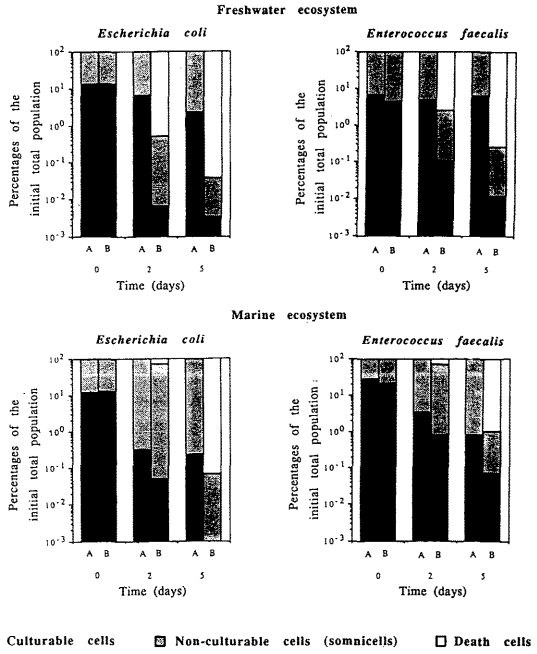


FIGURE 1. Characterization of survival stages of *Escherichia coli* and *Enterococcus faecalis* in freshwater and marine ecosystems when natural microbiota were absent (A) and present (B).

This study was undertaken to differentiate between culturable and non-culturable cells of enteric bacteria inoculated in natural aquatic systems both in the presence and in the absence of natural microbiota. To reach this objective, enteric bacteria were stained with rhodamine isotiocyanate (Landry *et al*, 1987). So, these labelled cells maintained their culturability. Similar counts of CFU were obtained with both the evolution of stained and non-stained enteric bacteria in the water samples. Fractions of culturable, non-culturable and death enteric bacteria were determined throughout the experiences (Figure 1). From these results, the real effect of natural protozoa on the elimination of inoculated enteric bacteria can be estimated from the difference between direct counts of rhodamine stained bacteria in the absence and presence of natural microbiota. An important fraction of somnicells were detected in the presence of natural microbiota (Figure 1) and that lead us to deduce the inadequacy of plate counts on selective culture media to estimate numbers of enteric bacteria, which remain in natural waters.

REFERENCES.

BARCINA, I., J. M. GONZALEZ, J. IRIBERRI & L. EGEA. 1989. Effects of visible light on progressive dormancy of *Escherichia coli* cells during the survival process in natural fresh water. Applied and Environmental Microbiology 55: 246-251.

LANDRY, M. R., J. M. LEHNER-FOURNIER, V. L. FAGERNESS, J. A. SUND-STROM & K. E. SELPH. 1987. Discriminate feeding of marine protozoa on living versus heat-killed bacteria. EOS 68: 1782.

MC CAMBRIDGE, J., & T. A. MC MEEKIN. 1981. Effect of solar radiation and predacious microorganisms on survival of fecal and other bacteria. Applied and Environmental Microbiology 41: 1083-1087.

RHODES, M. W., & H. KATOR. 1988. Survival of *Escherichia coli* and *Salmonella* spp. in estuarine environments. Applied and Environmental Microbiology 54: 2902-2907.

ROSZAK, D. B., & R. R. COLWELL. 1987. Metabolic activity of bacterial cells enumerated by direct viable count. Applied and Environmental Microbiology 53: 2889-2893.

M-II4

Microbiological evaluation of the water quality in a Mussel culture area (Sardinia)

A. CONTU, P. MELONI, A. COIS, M. SAU and M. SCHINTU

Istituto di Igiene e Medicina Preventiva, Università di Cagliari, Via Porcell 4, 09100 Cagliari (Italia)

About 500,000 m^2 of the inner part of the Olbia Gulf is occupied by mussel culture nurseries (Fig.1). The partially treated or untreated domestic and industrial wastes flowing into the area have contributed to lower its already precarious hygienic and sanitary standards (Contu et al., 1988). The harbour of Olbia is also located in this area.

The aim of the present study is to investigate whether the vicinity of an area exposed to high faecal contamination can affect the microbiological quality of the water in the mussel nurseries. The geomorphology of the Gulf could enhance the effect both of the sea currents and of the metereological conditions in transporting contaminants in the direction of the nurseries. This is hazardous to the public health and at the same time calls for a check on the suitability of the nurseries. Seven sampling stations have been located in the Gulf. In order to evaluate the entity of the transport of contaminants in depth, the samples were taken at - 0.5 m and -4 m at each station. Nylon nets containing mussels that had been kept for 48 hours in clean seawater, were placed in each station at the two depths 2 weeks before each sampling. The following indicators of faecal pollution were considered: Total Coliform, Faecal Coliform , Salmonella and Escherichia coli phages in the mussels; Total Coliform, Faecal Coliform and Enterococci in the water. Both mussel and water samples were collected monthly for 14 months starting from May 1986. Moreover the most important streams and effluents from wastewater treatment plants flowing in the Gulf were monitored. The water was analysed according to the Standard Methods for Water and Wastewater (1985), and the mussels according to the Gazzetta Ufficiale DM 24/7/1978.

The bacteriological analyses of the seawater have shown widespread faecal contamination of the whole area throughout the period of observation. The period between May 1986 and February 1987 showed the highest values of indicators of faecal pollution , which was referred to the whole water body . Contamination was highest in the innermost part of the Gulf and in the surface layers, and showed a tendency to decrease in direction of the open sea.

The same trend was confirmed in the mussels , at the surface and in depth.

The results point out: 1) a hazard of bacteriological pollution due to the discharge of organic substances and nutrients near the nurseries 2) the usefulness of the analyses carried out in depth 3) that the mussels can be used to show presence of faecal pollution indicators and their transport.

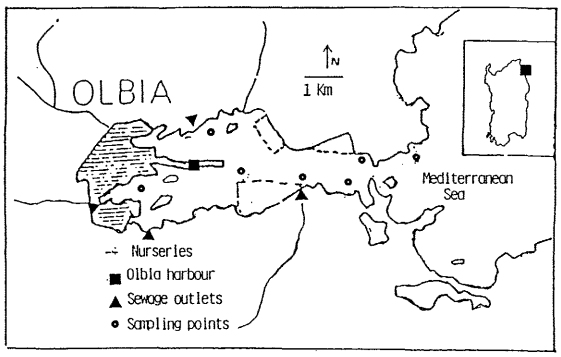


Figure 1. The inner part of the Olbia Gulf (Sardinia)

REFERENCES

Contu A., Sarritzu G., Bordigoni M., Meloni P. and Schintu M. (1988). Rapp. Comm. int. Mer Medit., 31, 2 ., Athenes

Gazzetta Ufficiale dellla Repubblica Italiana. DM 27/7/1978

APHA, AWWA, WPCF (1985). Standard Methods for Examination of Water and Wastewater

ACKNOWLEDGEMENTS

This work has been supported by Ministero della Pubblica Istruzione (Quota 40%) The Authors wish to thank Mr Mauro Bordigoni and Mr Mario Marras for sample collection and analyses.

Relation between densities of indicator organisms and *Staphylococcus aureus* in sea water

Mladen SOLIC and Nada KRSTULOVIC

Institute of Oceanography and Fisheries, Split (Yugoslavia)

The distribution of Staphylococcus aureus and its relation to the indicators of faecal pollution were studied at 17 stations in the coastal area of Split (Central Adriatic) during the summer period in 1989. Areas with different degrees of pollution (from very low to high) were chosen for the study.

The average values of S.aureus concentration ranged from 16 to 1000/100 ml, total coliforms from 20 to 100000/100 ml, faecal coliforms from 4 to 25100/100 ml and faecal streptococci from 2 to 7900/100 ml sea water (Fig.1).

The relation of S.aureus with each of the studied groups of indicators was analysed. In the total number of samples no correlation was established with total coliform and faecal coliform, and scarcely a significant one with faecal streptococci. However the analysis of S.aureus and indicators of faecal pollution in samples with different degrees of pollution showed different results (Tab.1). Faecal coliforms were used as the criterion to evaluate the degree of pollution of the studied area which was accordingly divided into less polluted area up to 100 FC/100 ml) and more polluted one (over 100 FC/100 ml).

Table 1. Correlations established between concentrations of Staphylococcus aureus and indicator organisms.

	<100 FC/100 ml			>100 FC/100 ml			Total samples		
	r	n	P	r	n	P	r	n	P
TC	-0.11	43	-	0.49	20	0.05	0.07	63	-
FC	0.10	50	-	0.41	23	0.05	0.17	73	-
FS	-0.05	50	-	0.61	23	0.01	0.24	73	0.05

In cases of low polluted sea water no correlation between S.aureus and indicators of faecal pollution was established whereas in more polluted sea water there was a correlation between them.

The highest correlation coefficient was established between S.aureus and faecal streptococci, the indicator of faecal pollution with the longest period of survival (1,2). It could be explained by the fact that S.aureus is more chlorine resistant in sea water (3), which probably causes its longer period of survival in relation to indicator organisms.

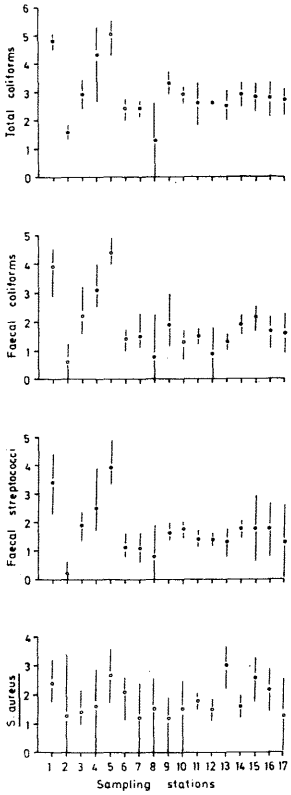


Fig.1. Ranges and mean values of indicator organisms and Staphylococcus aureus (log n/100 ml)

References

1. Fujioka,R.S.,H.H.Hahimoto, E.B.Siwak and R.H.F.Young. 1981. Effect of sunlight on survival of indicator bacteria in sea water. Appl.Environ. Microbiol., 41: 690-696.

2. Tudor,M.,M.Šolić and N. Krstulović. 1989. T_{90} of total coliforms, faecal coliforms and faecal streptococci in the Kaštela Bay. Acta Adriat., 30 (in press).

3. Bergey's Manual of Determinative Bacteriology (8th edit.). 1975. R.E.Buchanan and N.E. Gibbons. Ed. Williams and Wilkins Co. Baltimore.

Recovery of stressed Coliforms from seawater samples

J.-J. BOREGO, M.-A. MORINIGO, R. CORNAX, M.-A. MUNOZ, E. MARTINEZ-MANZANARES and P. ROMERO

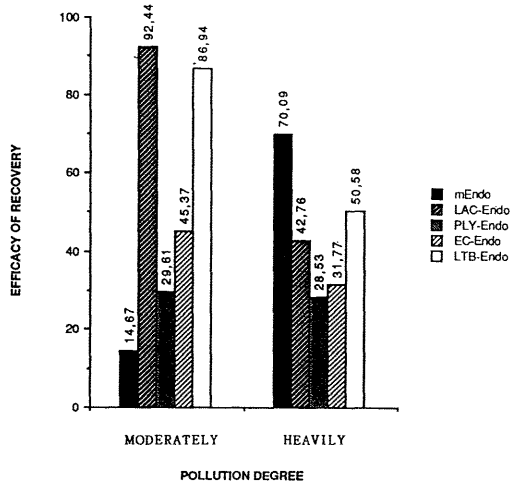
Department of Microbiology, Faculty of Sciences, University of Malaga, 29071 - Malaga (Spain)

The 16th edition of Standard Methods for the Examination of Water and Wastewater [1] and the World Health Organization guidelines [8] specified mEndo agar as the choice medium for coliform enumeration. Several authors have pointed out that this medium has several shortcomings, such as: (i) low recoveries of injured and stressed coliforms [4-6]; and (ii) poor differentiation among coliforms and non coliforms [2-3]. For this reason, a comparative study of the standard method for the enumeration of coliforms (MF and mEndo agar) and several resuscitation methods to recover the stressed coliforms from seawater has been the main objective of the present work.

Seawater samples were collected from ten beaches on the coast of Malaga (Spain). The membrane filtration technique was carried out as described by Standard Methods [1]. The filtrations were five-fold replicated for each one of the methods tested with 0.45µm membrane filters (Millipore Ibérica, Madrid, Spain). Phosphate-buffered saline [1] was used as diluent solution. Four resuscitation membrane filtration methods were conducted according to established procedures [4, 6,7] using Millipore HC-type filters and the following resuscitation media: LAC broth [3]; PLY agar (Difco); EC broth (Difco); and LTB broth (Difco). When the media were liquids, filters were placed onto sterile pads (Millipore) saturated with sterile broth (LAC, EC or LTB), and incubated at 36°C for 2 h. The filters were then transferred to mEndo agar plates and incubated for an additional 22 h. The recovery efficacy of each medium is calculated with respect to the maximal count obtained for one medium and sample, applying the following equation: Relative Percentage of Recovery (Medium A) = (Count on medium A)/ (Maximum count on any medium) x 100.

The comparison of the quantitative recovery of coliforms on the different media tested was carried out using 60 seawater samples with different faecal pollution degree(30 moderately polluted and 30 heavily polluted). The efficacy of recovery of each method is represented in Fig. 1. All the methods detected high percentages of coliforms from the samples analysed, except LAC-Endo resuscitation method, which obtained 1% of the coliform recovery from MIS sampling station in comparison with the best method . Statistically significant differences of the efficacy of recovery were obtained for each sample groups, moderately and heavily polluted seawater, and for the media mEndo, LAC-Endo and LTB-Endo. The best methods for the recovery of coliforms from moderately polluted seawater were LAC-Endo and LTB-Endo, with figures of 92.4% and 86.9% of recovery, respectively, in comparison with 14.7% obtained for the standard method (mEndo). On the other hand, for samples with high pollution degree, the best efficacy of recovery was obtained for m Endo agar (70.1%) in comparison with PLY-Endo and EC-Endo methods which achieved only percentages of 28.5 and 31.8%, respectively.

In short, it seems to be that the pollution degree of the samples affect significantly the recovery of stressed and non-stressed coliforms, being advised the use of the resuscitation methods for samples with a low or moderate pollution degree.



REFERENCES

1. APHA, AWWA & WPCF (1985). Standard Methods for the Examination of Water and Wastewater, APHA, Washington, D.C.
2. Avila, M.J.; M.A. Moriñigo; R. Cornax; P. Romero & J.J. Borrego (1989). J. Microbiol. Methods **9**: 175-193.
3. Evans, T.M.; R.J. Seidler & M.W. Lechevallier (1981). Appl. Environ. Microbiol.**41**:1144-1151.
4. Lechevallier, M.W.; S.C. Cameron & G.A. McFeters (1983). Appl. Environ. Microbiol. **45**: 484-492.
5. McFeters, G.A.; G.K. Bissonnette; J.J. Jezeski; G.A. Thompson & D.G. Stuart (1974). Appl. Microbiol. **27**: 823-829.
6. McFeters, G.A.; S.C. Cameron & M.W. Lechevallier (1982) Appl. Environ. Microbiol. **43**: 97-103.
7. McFeters, G.A.; M.W. Lechevallier & M.J. Domeck (1984) US Envrion. Prot. Agency.
8. WHO/UNEP (1982) Coastal water quality control in the Mediterranean Sea. WHO, Copenhagen.

M-II7

Evaluation of the ß-Glucuronidase Test with the multiple tube technique for specific determination of *Escherichia coli*

M.-C. BALEBONA, M.-A. MORINIGO, R. CORNAX, D. CASTRO, P. ROMERO and J.-J. BORREGO

Department of Microbiology, Faculty of Sciences, University of Malaga, 29071 - Malaga (Spain)

The use of *Escherichia coli* as an indicator of the sanitary quality of water and seafood products has been classically recommended by different official organizations (APHA, 1985; Greenberg & Hunt, 1985; WHO, 1977), since this microorganism provides a measure of fecal contamination. According to the APHA (1985) two methods are currently available for enumerating *E. coli* from those samples: the Most Probable Number (MPN) procedure and the membrane filtration (MF) technique. Both present advantages and disadvantages, but the former requires the need of presumptive and confirmatory tests, which are costly, time-consuming and arduous.

Recent reports of fluorogenic assay procedures have shown the promise for a rapid and specific detection of *E. coli* in seawater (Mates, 1987; Gauthier *et al.*, 1988), seafood (Rippey *et al.*, 1987) and foods (Robinson, 1984). This new method relies on the almost exclusively presence of the enzyme ß-glucuronidase in *E. coli*. This enzyme cleaves a fluorogenic substrate, 4-methylumbeliferyl-ß-D-glucuronide (MUG) to yield an end product, 4-methylumbeliferone, which is fluorescent under UV light.

In the present study, a comparative study of MPN technique using MacConkey purple supplemented with MUG as presumptive broth and nutrient agar with MUG as confirmatory test from seawater, sediment and shellfish samples was carried out.

All the strains isolated with positive fluorescence in nutrient agar-MUG from the gas-positive and fluorescence-positive tubes were identified as *E. coli*. On the other hand, the isolates positive in gas and fluorescence from the tubes and MUG-negatives on nutrient agar were identified as: *Klebsiella pneumoniae* (66.7%), *E. coli* (16.7%) and *Enterobacter agglomerans* (16.7%) from seawater samples; *K. pneumoniae* (100%) from sediment samples; and *K. pneumoniae* (33.3%), *E. coli* (33.3%), *E. cloacae* (14.8%), *E. sakazakii* (4.8%), *Citrobacter freundii* (4.8%), *Serratia liquefaciens* (4.8%), and *Buttiaux agrestis* (4.8%) from shellfish samples. The high frequency of *E. coli* MUG-negative detected in these samples from tubes presumptively positive may be explained by the negative effect exerted by the selective agents contained in the MacConkey-purple broth, which could affect the permease of the ß-glucuronidase activity, or may be a competence effect exerted by the background flora present in the shellfish, or a self-activity of ß-glucuronidase by the shellfish tissues (Koburger & Miller, 1985; Holt *et al.*, 1989).

A high proportion of the strains MUG-negative on nutrient agar isolated from the gas-positive tubes were identified as *K. pneumoniae*. This result agrees with those reported by Rippey *et al.* (1987) and Damoglou *et al.* (1988), being considered the mainly false-positive species in the coliform analysis.

In Table 1 the characteristics of MPN tubes in which *E. coli* was isolated are shown. *E. coli* was verified in about 90% of fluorescent tubes. Only one *E. coli* strain as isolated from fluorescence-negative and gas-positive tubes, and MUG-positive on nutrient agar. For this reason, this methodology is considered to increase the accuracy of the MPN technique to isolate *E. coli* from samples of different sources.

TABLE 1.- Percentages of *Escherichia coli* isolated from MPN tubes (MacConkey-purple broth).

SAMPLE	MUG Tubes +	MUG Tubes -	Gas Tubes +	Gas Tubes -	mFC Colony Typical	mFC Colony NonTypical	AN-MUG +	AN-MUG -
Seawater	91	17	64.7	ND	76.5	20	100	14.3
Sediment	100	17	78.6	0	93.8	0	100	22.6
Shellfish	84	0	70.8	0	71.4	21	100	0
Total	90	12	70.9	0	78.7	14.6	100	15,5

References

- APHA (1985). Standard Methods for Examination of Water and Wastewater. American Public Health Association, Washington, D.C.
- Damoglou, A.P.; Rubick, R.& Hough, B. (1988). Lett. Appl. Microbiol. 7: 177-179.
- Dexter, F. (1981). Appl. Environ. Microbiol., 42: 184-185.
- Gauthier, M.J.; Borrego, J.J. & Torregrossa, V. (1988). Final Report UNEP/WHO, Project Grant. Athens.
- Greenberg, A.E. & Hunt, D.A. (1985). Laboratory procedures for the examinations of seawater and shellfish. American Public Health Association, Washington, D.C.
- Holt, S.M.; Hartman,P.A. & Kaspar, C.W. (1989). Appl. Environ. Microbiol. 65: 229-232.
- Koburger, J.A. & Miller, M.L. (1985). J. Food Prot. 48: 244-245.
- Mates, A. (1987). Final Report UNEP/WHO Project Grant. Athens.
- Rippey, S.R.; Chandler,L.A. & Watkins, W.D. (1987). J. Food Prot. 50: 685-690.
- Robison, B.J. (1984). Appl. Environ. Microbiol. 48: 285-288.
- WHO (1977). Health criteria and epidemiological studies related to coastal water pollution. Report of a group of experts jointly convened by W.H.O. and U.N.E.P. (Athens). W.H.O. Copenhaguen.

M-II8

Specific determination of *Salmonella* strains using a phage-typing scheme

D. CASTRO, M.-A. MORINIGO, M. JIMENEZ-NOTARIO, R. CORNAX, M.-C. BALEBONA and J.-J. BORREGO

Department of Microbiology, Faculty of Sciences, University of Malaga, 29071 - Malaga (Spain)

Phage-typing is a practical method for bacterial differentiation based upon the sensitivity and high specificity of the strains to bacteriophages.

There are numerous potentially pathogenic serotypes of *Salmonella* and some of them can possess an epidemiological relevance. The methods actually applied to study the epidemiological markers of these strains are based on serological and antimicrobial resistance characteristics. However, these markers offer a low discrimination rate and they are unable to determine the epidemic outbreaks. For this reason, a single, wide-spectrum phage-typing scheme may provide additional advantages with respect to the classical typing methods (Gershman & Markowsky, 1983).

A phage-typing scheme, comprising 25 bacteriophages isolated from sewage on 12 *Salmonella* serotypes, were used as a possible epidemiological marker and/or determinative tool of *Salmonella* isolates, regardless their source or serotype.

A total of 224 *Salmonella* strains, belonging to the 20 serotypes most frequently isolated from waters in Malaga (Spain) (Moriñigo *et al.*, 1988), were analysed using the phage-typing techniques described by Adams (1959) and Anderson (1962).

On the basis of the phage set lytic activity, 117 phage-types have been recognized. Table 1 shows the phage-patterns obtained from the different serovars of *Salmonella* tested. Only one strain could not be typable by this method, however self-agglutinable, non-motile and monophasic strains of *Salmonella* can be determined by the phage-typing method.

The detection frequency of the different phage-types of the same serotype is relatively low (less than 5%), which coincides with the results obtained by other authors (Gershman, 1976; Bouzoubaa *et al.*, 1985).

In short, the results obtained indicate that: (i) no significant relationship was observed between the susceptibility of the strains to specific bacteriophages and their somatic antigenic characteristics. (ii) All the strains belonging to C1 serogroup present a narrow and specific sensitivity pattern to bacteriophages, which implies the possible diagnostic use of this phage set. (iii) A close relationship between the phage-types on *S. typhimurium* and *S. enteritidis* was observed, which indicates a possible common source or epidemiological route.

TABLE 1.- Phagetypes from the different *Salmonella* serotypes tested.

Serotype	Serogroup	Number of Strains	Number of Phagetypes
S. blockley	C2	27	15
S. bovis-morbificans	C2	2	2
S. braenderup	C1	2	2
S. enteritidis	D1	21	6
S. infantis	C1	7	6
S. london	E1	20	10
S. menden	C1	1	1
S. montevideo	C1	1	1
S. muenchen	C2	4	2
S. ohio	C2	24	15
S. oranienburg	C1	1	1
S. paratyphi C	C1	1	1
S. potsdam	C1	4	3
S. richmond	C1	3	3
S. senftemberg	E4	6	4
S. taksony	E4	1	1
S. thompson	C1	15	9
S. typhimurium	B	45	24
S. virchow	C1	7	7
S. weltevreden	E1	3	3
Self-agglutinable	-	24	17
Non-motile	-	3	3
Monofasic	-	1	1

References

- Adams, M.H. 1959. Bacteriophages. Interscience Publishers Inc., New York.
- Anderson, E.S. 1962. Brist. Med. Bull., **18** :64-68.
- Bouzoubaa, K.; K.V. Nagaraja; J.A. Newman & B.S. Pomeroy. 1985. Avian Dis., **30** : 358-361.
- Gershman, M. 1976. Appl. Environ. Microbiol., **32** : 190-191.
- Gershman, M. & G. Markowsky. 1983. J. Clin. Microbiol., **17** : 240-244.
- Moriñigo, M.A.; R. Cornax; M.A. Muñoz; D. Castro; P. Romero & J.J. Borrego. 1988. Rapp. Comm. int. Mer Médit., 31, 1(175).

M

Influence of temperature and nutrients on R+ plasmid conjugation transfer from an environmental *E. coli* strain

A. FERNANDEZ-ASTORGA, J. IRIBERRI, L. EGEA and I. BARCINA

Departamento de Microbiologia e Inmunologia, Facultad de Ciencias, Universidad del Pais Vasco, Apdo. 644, Bilbao (Spain)

The increase in the number of bacteria capable of transfer resistance plasmids, detected in aquatic systems, may be due not only to an increase in dumpings, but also to the fact that in these ecosystems processes of plasmid transfer actively occur. Mc Nichol *et al.* (1982) suggested that the latter may be the origin of the formation of plasmid pools.Toranzo *et al.* (1984) reported the possibility that the pathogen microorganims may participate in *in situ* conjugations processes in aquatic systems. Scanferlato *et al.* (1989) remarked the survival of G.E.M.s in these systems.

The incidence of these facts on public health requires that more detailed studies be done on those systems which are potentially suitable for plasmid transfer by conjugation. Because *in situ* experiments are subjet to numerous environmental factors, not always predictable nor controlable, *in vitro* experimental models are necessary, despite their multiple limitations.

The aim of our first experiments was, therefore, to determine the ambient factors which may limit plasmid transfer by conjugation in aquatic systems.

From the freshwater system isolations, we chose as donor a plasmid containing *E.coli* strain, R+ to ampicillin and gentamicin. As the recipient strain we used a non plasmid containing *E.coli* K12, J62, chromosomic resistant to nalidixic acid. As inoculum we used 10^8 u.f.c. of donor and 0,5 10^8 u.f.c. of recipient strain, in 5ml of mating medium. Transconjugants were selected and counted on Mc Conkey agar (OXOID) plates, suplemented with ampicillin (64 µg/ml) and nalidixic acid (32 µg/ml).

In order to determine the influence of the river temperature, mating experiments were carried out in T.S.B. broth (OXOID) during 2 hours, at 20°C (mean river temperature), and that the control 37°C. The transfer frequencies obtained both at 20°C and 37°C were of the order of 10^{-3} (n° of transconjugants /n° of initial donors). These results suggest that the river temperature is not a limiting factor for transfer by conjugation.

To determine the minimun nutritional requirements, mating experiments were done on T.S.B. and on a series of decreasing T.S.B. concentrations and finally in the absence of nutrients (autoclaved distilled water). The inocula were obtained in standard conditions and later washed 3 times with P.S.B.(pH 7,2). Our first results show a decrease in transfer frequency, parallel to the decrease in nutrient concentration, although the frequency values obtained never were below 10^{-6}. We must highlight that transfer frequency values are obtained even in the absence of nutrients.

M

REFERENCES.

McNichol, L.A., Barkay, T., Voll, M.J. and Colwell, R.R. (1982). Plasmids carriage in *Vibrionaceae* and other bacteria isolated from the aquatic environment. J. Wah. Acad. Sci. 2:60-66

Toranzo, A.E., Combaro, P., Lemos, M.L and Barja, J.G. (1984). Plasmid coding for transferable drug resistance in bacteria isolated from cultured rainbow trout. Appl. Envirom. Microbiol. 48: 872-877

Scanferlato, V.S., Orvos, D.R., Cairns, J.Jr. and Lacy, G.H. (1989). Genetically engineered *Erwinia carotova* in aquatic microcosms. Survival and effects on functional groups of indigenous bacteria. Appl. Envirom. Microbiol. 55: 1477-1482.

Virulence factors of environmental strins of *Aeromonas hydrophila*

J.-J. BORREGO, D. CASTRO, M.-A. MUNOZ, R. CORNAX, M.-C. BALEBONA and M.-A. MORINIGO

Department of Microbiology, Faculty of Sciences, University of Malaga, 29071 - Malaga (Spain)

In recent years, the high development of the aquaculture of fish and shellfish has originated an increase of the problems related to the infections of these animals by different pathogenic microorganisms.

The infective capability of the pathogenic microorganisms is generally related to the presence of virulence factors. These virulence factors seem to make possible the attachment of bacteria to host cells and enterotoxin synthesis by increasing the invasive capability of the strains [4]. One of the most important factors involved in the virulence of the pathogenic strains consists of an efficient iron-sequestering system mediated by siderophores [2,6], which allows the bacteria to grow in the iron-limiting conditions imposed by the high-affinity iron-binding proteins present in the organic fluids [7].

In this study the presence of haemolytic activity and the production of diffusible siderophores by *A. hydrophila* strains isolated from water environments and animals (shellfish and fish) were analyzed.

ß-haemolytic isolates were identified on blood agar plates consisting of Blood Agar Base (Difco) and 5% washed sheep erythrocytes. The haemolytic activity was recorded like clearance of the medium around the growth zone after 24 h at 25°C.

A. hydrophila strains were cultured in M9 minimal medium supplemented with 0.2% (w/v) Casamino Acids (Difco). The iron chelator ethylenendiamine-di-(o-hydroxyphenyl acetic acid) (EDDA) was added at a concentration of 10 µM to achieve the iron limitation conditions.

The production of siderophore compounds by the strains was tested on blue agar plates as described by Schwyn & Neilands [9]. The method is based on the fact that the dye chrome-azurol S (Sigma) incorporated into the medium, can form stable complexes with iron. Therefore, when a strain is able to produce a diffusible siderophore (which removes the iron from the complex) the colour turns to yellow-orange around the colony after 24-48 h at 25°C.

The ability of the strains of *A. hydrophila* to grow under iron-limiting conditions and the haemolytic activity were tested to verify their role as putative virulence factors and to demonstrate the relationship with the plasmid content of the strains.

More than 75% of the strains tested gave an orange halo between 6-8 mm after 48 h, and less than 10% of the strains were negative in producing siderophore activity. Similarly, the majority of the strains (more than 90%) tested showed haemolysis activity. A higher number of isolates that showed siderophore and total haemolysis activities were obtained from seawater and animals in comparison with the number of strains from freshwater environment (23.3%, and 11.7% vs 6.7%, respectively).

The relationship between siderophore production and plasmid content was strong, since more than 74% of the strains with siderophore possessed plasmids, although the percentage varied depending on the source of strain (between 85% for freshwater strains and 68% for seawater strains). In the case of the haemolytic activity the percentage of strains with this characteristic which harbor plasmids is lower than for siderophore (about 60%).

The relationship between the presence of plasmids and some pathogenic characteristics of the strains, such as enterotoxigenicity, haemolysin production or presence of surface antigens have been reported in human pathogens, mainly *Enterobacteriaceae* [4,5,8,12]. However, for other species, correlation between virulence factors and plasmid profiles have only been reported in some instances. From the results obtained in this study, it may be concluded that there is a close relationship between the presence of plasmid and the siderophore production, since more than 70% of the strains with siderophores also possessed plasmids. This conclusion is supported by the curing experiments where the plasmidless derivatives showed a loss of the ability to grow in iron-limiting conditions. These results are in agreement with those reported by Crosa [1], Crosa et al. [3] and Walter et al. [11] for *Vibrio anguillarum* strains. However, about 30% of the strains analysed retained the iron-sequestering system after loss of plasmids. These results indicate that the genes coding for this system in *A. hydrophila* are located in both plasmid and chromosome. Similar conclusions were obtained by Valvano et al. [10] studying the aerobactin iron transport system in human invasive strains of *Escherichia coli* K1, and Lemos et al. [7] in anguibactin-mediated system of *V. anguillarum* strains.

In the present study, more than 90% of the strains studied had a haemolytic activity being higher in the strains isolated from animals (100%) than in those isolated from water environments (about 80%). This property seems to be chromosome-coded since plasmidless strains maintained the haemolytic activity. The role of the haemolysins in the pathogenicity of *A. hydrophila* is difficult to establish. In our opinion, the haemolysins could increase the availability of iron by the microorganisms by mean of the erythrocyte lysis, and in this way, there must be a close correlation between haemolysin production and the iron-using system.

References

1 Crosa JH (1980). Nature (Lond) **283**:566-568.
2. Crosa JH (1984). Ann Rev Microbiol **38**:69-89.
3. Crosa JH, Hodges LL, & Schlewe M (1980). Infect Immun **27**:897-902.
4. Evans DG, Silver RP, Evans DJ, Chase DG, & Gorbach SL (1975). Infect Immun **12**: 656-667.
5. Gemski P, Lazere JR, & Casey T (1980). Infect Immun **27**:682-685.
6. Griffiths E (1987). In: Bullen JJ, Griffiths E (eds) Iron and Infection. Chichester, UK: John Wiley & Sons Ltd, pp 69-137
7. Lemos ML, Salinas P, Toranzo AE, Barja JL, & Crosa JH (1988). J Bacteriol **170**:1920-1925.
8 Mazaitis AJ, Maas R, & Maas WK (1981). J Bacteriol **145**:97-106.
9. Schwyn B, & Neilands JB (1987). Anal Biochem **160**:47-56.
10 Valvano MA, Silver RP, & Crosa JH (1986). Infect Immun **52**:192-199.
11. Walter MA, Potter SA, Crosa JH (1983). J Bacteriol **156**:880-887.
12. Zink DL, Feeley JC, Wells JG, Vanderzant C, Vickery JC, Roof WD, & O'Donovan GA (1980). Nature (Lond) **283**:224-226.

M-II11

Distribution et rôle des bactéries dans les Systèmes Océaniques

Armand BIANCHI

Microbiologie Marine, CNRS U.P.R. 223, Faculté des Sciences de Luminy Case 907, Marseille (France)

(Résumé*)

1. La zone littorale. La production bactérienne hétérotrophe représente de 20 à 40% de la production primaire quotidienne. Pendant la floraison des algues les bactéries présentent une grande versatilité nutritionnelle, orientée vers l'utilisation des composés organiques dissous de faible poids moléculaire. Lors du déclin du phytoplancton ces bactéries sont remplacées par des cellules mieux équipées en exoenzymes leur permettant de dégrader les composés de poids moléculaire élevé constituant les algues mortes. L'assimilation d'azote dissous par ces micro-organismes conduit à une production d'azote organique particulaire (sous forme de cellules bactériennes) de l'ordre de 7 µg atN l^{-1} h^{-1}, et à la régénération de 0.50 µg at.N.NH_4 l^{-1} h^{-1}.

Les microprédateurs peuvent se développer à des taux de croissance de 1,7 à 2,7 j^{-1}, équivalents à ceux des bactéries qu'ils ingèrent à des taux horaires pouvant atteindre 70% de leur propre volume. Ces capacités d'ingestion expliquent l'efficacité des prédateurs dans la régulation des effectifs microbiens.

L'étude de l'impact d'un apport fluviatile sur les microflores a été étudié au niveau du débouché du Rhône en Méditerranée. Les micro-organismes phototrophes et les hétérotrophes sont plus abondants dans les eaux du fleuve que dans l'eau de mer, mais les activités (taux d'incorporation de thymidine et de leucine) sont similaires dans les deux systèmes, avec une plus forte activité par cellule dans l'eau de mer. Dans la couche d'interface les concentrations bactériennes sont faibles, mais les taux d'incorporation des traceurs sont doubles par rapport à ceux mesurés dans l'eau de mer et dans l'eau douce.

2. Le milieu pélagique. Les concentrations, les biomasses et les activités bactériennes diminuent avec la profondeur d'eau. Ces diminutions sont irrégulières, liées aux variations de concentration en matériel énergétique. Les activités métaboliques doivent être mesurées en respectant les conditions de température et pression de leur niveau d'origine. Une étude comparative (prélèvement et culture d'eau profonde sans décompression, mise en incubation *in situ* par submersible) montre que la décompression pourrait provoquer une inhibition des activités respiratoires. Dans les conditions du milieu profond l'essentiel de la matière organique serait essentiellement respirée et consacrée au métabolisme cellulaire de base.

Les microflores associées aux particules sont taxonomiquement et physiologiquement différentes des bactéries libres dans l'eau. Siège principal de la nitrification dans la colonne d'eau, elles peuvent fonctionner comme des couples d'oxydo-réduction où peuvent cohabiter des bactéries aérobies telles les nitrifiantes, et des anaérobies telles des méthanogènes méthylotrophes. On retrouve dans le matériel particulaire certaines espèces de bactéries également isolées des tractus digestifs de la faune marine.

3. L'interface eau-sédiment. Pour définir dans quelle mesure les bactéries associées au matériel particulaire déposé s'intègrent dans la microflore des sédiments on a comparé les souches isolées de plusieurs centaines d'échantillons d'eau et sédiments prélevés au niveau de l'interface benthique. Ces comparaisons ont montré la très nette distinction entre les microflores des eaux proches du fond, composées essentiellement de pseudomonades, et les microflores, plus hétérogènes, des sédiments les plus superficiels où ce groupe est minoritaire. A cette différenciation taxonomique des communautés microbiennes pélagiques et benthiques correspond une différenciation physiologique. Dans les masses d'eaux profondes les bactéries disposent essentiellement de matériel organique dissous, le matériel particulaire labile ayant été dégradé lors de sa chute. Le métabolisme de ces microflores est surtout orienté vers l'utilisation des composés organiques de faible poids moléculaire. Dans le sédiment de surface la réserve organique comprend du matériel particulaire frais produit par la macrofaune benthique. Ce matériel est scindé en petites molécules avant utilisation, d'où la fréquence et la diversité des exoenzymes produites par les bactéries des sédiments superficiels par rapport aux capacités exoenzymatiques réduites des microflores des eaux sus-jacentes.

4. Les sédiments. Dans les 10 premiers mm, des effectifs en bactéries hétérotrophes viables importants (plusieurs millions de bactéries/ml de sédiment) n'ont pu être observés que dans les zones lagunaires ou la frange littorale. Au delà d'une centaine de m de profondeur d'eau les effectifs dans les sédiments superficiels sont plus faibles, limités à quelques milliers ou dizaines de milliers de cellules viables par ml.

Dans l'épaisseur sédimentaire les effectifs des microflores diminuent rapidement. Quelle que soit leur concentration à la surface du sédiment, on observe très fréquemment une diminution des effectifs bactériens de l'ordre d'une puissance de 10 lors à chaque passage du film de surface (inférieur à 1 mm) à la pellicule sous-jacente de 2mm, puis à la couche de 2cm et au sédiment de subsurface (2 à 10 cm). Les passées sédimentaires stériles alternent avec des niveaux bactériologiquement actifs. On a pu dénombrer plusieurs millions de bactéries viables par ml de sédiment dans des niveaux agés de plusieurs millions d'années. Ces microflores anciennes ne sont pas sporulées, leur persistance implique donc le maintien d'une activité métabolique, limitée mais permanente depuis leur dépôt. Ces conditions permettent une activité géochimique microbienne au cours de la diagenèse précoce.

Dans les sédiments le principal facteur de régulation des activités microbiennes est la nature et la concentration des accepteurs terminaux d'électrons. Selon les concentrations en oxygène moléculaire, en substrats fermentescibles, en nitrate, en sulfate, la matière organique est préférentiellement dégradée par le type bactérien le mieux adapté qui devient prédominant. Il impose ses produits métaboliques qui seront repris plus ou moins rapidement par d'autres chaînes microbiennes. En milieu anoxique la minéralisation est donc réalisée par une succession de réactions d'oxydo-réduction, effectuées par différents types bactériens spécifiques. Dans des sédiments on peut mettre en évidence la présence concomitante de populations microbiennes aérobies et anaérobies, distribuées dans des microniches à leur échelle de taille. Les microaérophiles, qui exigent la présence d'oxygène moléculaire mais à une concentration inférieure à celle de l'air paraissent bien adaptées aux environnements sédimentaires. Parmi les activités anaérobies la sulfato-réduction se traduit par centaines de µmoles de sulfate réduit par litre de sédiment et par jour, alors que la respiration nitrate et la méthanogénèse concernent seulement quelques µmoles à quelques dizaines de µmoles de nitrate consommé ou de méthane réduit. En milieu marin, dominé par la sulfato-réduction, la méthanogénèse découle surtout de la réduction de la triméthylamine.

La distribution des bactéries constitue un patchwork, mais leur rôle doit être considéré comme un continuum dans lequel les microflores opèrent en associations à l'échelle d'espace de leur taille microscopique et à l'échelle de temps de leur vitesse de génération, mais dont les conséquences sur l'environnement interviennent à l'échelle planétaire et au niveau des temps géologiques.

* Synthèse des travaux du Laboratoire de Microbiologie Marine.

M-III1

Antibiotic resistance of *Aeromonas hydrophila* strains isolated from several sources

J.-J. BORREGO, M. BOSCA, D. CASTRO, R. CORNAX and M.-A. MORINIGO

Department of Microbiology, Faculty of Sciences, University of Malaga, 29071 Malaga (Spain)

Aeromonas hydrophila, a motile gram-negative rod, causes several diseases among poecilotherm and homeotherm animals, including haemorrhagic septicemia, red sore, gastroenteritis and endocarditis [2,3,5]. Several bacterial phenotypic properties, such as resistance to antimicrobial drugs or virulence determinants have been demonstrated to be plasmid encoded. The presence of plasmids in these pathogenic microorganisms may possess a potential public health hazard, since they may be transferred from animals to humans either directly or indirectly [1,4,6,7].

In this study the antibiotic resistance profiles of *A. hydrophila* strains isolated from water environments and animals (shellfish and fish) were analyzed. Furthermore, the loss of the resistance to any antimicrobial agents after curing experiments of the strains was also considered. Drug sensitivity patterns of 60 strains of *A. hydrophila* isolated from animals (shellfish and fish) and water (freshwater and seawater) samples were determined by disk diffusion using Mueller-Hinton agar (BioMerieux, Spain). The following chemotherapeutic agents and concentrations were used (µg/ disk): amikacin (30), ampicillin (10), carbenicillin (100), cephalothin (30), chloramphenicol (30), colistin (10), gentamicin (10), kanamycin (30), nalidixic acid (30), neomycin (30), nitrofurantoin (300), B polimyxin (300 U), prystanamycin (15), streptomycin (10), sulphadiazine (1000), sulphamethoxazole-trimethoprim (1.25 + 23.75), tetracycline (30), and tobramycin (10). All the antibiotic disks were supplied by BioMerieux.

Curing experiments were carried out using acridine orange (Sigma, USA), following a modification of the techniques described by Winckler et al. [8]. Cells were grown in Brain-Heart-Infusion broth (BHIB, Difco, USA) for 24 h, and 2-ml aliquots were added to 1-ml of fresh broth, incubating for 3 h at 26°C. Then, 1-ml of a solution of acridine orange (20 µg/ml) was added, and the culture was centrifuged at 3,500 x g for 20 min. The supernatant was eliminated, and 2-ml of fresh BHIB were added to the pellet, incubating at 35°C for 2-6 h. After this period of time the strains were tested in relation to the loss of antibiotic resistance and plasmid profiles.

The overall percentage of drug-resistance (Table 1) indicated that more than 90% of the strains were resistant to ampicillin (91.7%), cephalothin (91.7%), tetracycline (96.7%), and prystanamycin (93.3%), which may be considered like a natural or chromosomal resistance to these drugs. On the other hand, percentages of resistance lesser than 5% were obtained for gentamicin (3.3%) and amykacin (0%).

Although the percentage of resistance of all three groups of strains was quite similar, some differences were found according to the source of isolation (Table 1). In fact, resistance to gentamicin was only detected on the strains from seawater. Similarly, higher percentages of resistance to carbenicillin, chloramphenicol, sulphamethoxazole-trimethoprim, and nalidixic acid were obtained on the strains isolated from water in comparison with those from strains of animal origin. For streptomycin, tobramycin, and kanamycin the percentages of resistance obtained for the freshwater strains were significantly lower ($p < 0.01$) than for the other strains. Finally, neomycin resistance was more frequently detected among the strains isolated from marine animals (20%) than from the other environments (about 4%).

All the derivative isolates from the acridine orange treatment were tested for plasmid content and drug resistance patterns. Table 1 reports the percentages of drug-resistance presented by the strains after the curing assay. The strains of *A. hydrophila* isolated from the three environments carried resistance genes located in the bacterial chromosome for the antibiotics ampicillin, cephalothin, tetracycline, carbenicillin, prystanamycin and nitrofurantoin. In contrast, the cured plasmidless strains lost simultaneously their resistance to tobramycin, neomycin, gentamicin, sulphadiazine and kanamycin. The resistance to nalidixic acid, streptomycin, sulphamethoxazole-trimethoprim, chloramphenicol and colystin are linked to chromosomal and plasmid genes.

Table 1. Resistance to 18 chemotherapeutic agents in the strains of *A. hydrophila* depending on the source of isolation before and after curing experiments

Drugs	Source							
	Freshwater (n=23)		Seawater (n=27)		Animals (n=10)		Total (n=60)	
	Before[a]	After[a]	Before	After	Before	After	Before	After
Ampicillin (Am)	87[b]	87	92.6	92.6	100	100	91.7	91.7
Amikacin (AN)	0	0	0	0	0	0	0	0
Carbenicillin (Cb)	69.6	69.6	74.1	74.1	10	10	61.7	61.7
Cephalothin (Cf)	87	87	92.6	92.6	100	100	91.7	91.7
Chloramphenicol (C)	65.2	43.5	51.9	48.1	20	20	51.7	41.7
Colistin (Cl)	26.1	21.7	18.2	11.1	20	10	21.7	15
Gentamicin (Gm)	0	0	7.4	0	0	0	3.3	0
Kanamycin (K)	4.3	0	18.5	0	10	0	11.7	0
Nalidixic acid (NA)	60.9	34.8	59.3	44.4	10	10	51.7	35
Neomycin (N)	4.3	0	3.7	0	20	0	6.7	0
Nitrofurantoin (FM)	78.3	78.3	81.5	81.5	60	60	76.7	76.7
Polimyxin B[c] (PB)	4.3	ND	11.1	ND	10	ND	8.3	ND
Prystanamycin (Pr)	87	87	96.3	96.3	100	100	93.3	93.3
Streptomycin (S)	43.5	13	85.2	33.3	80	20	68.3	23.3
Sulphadiazine (Sd)	78.3	0	74.1	0	60	0	73.3	0
Sulphamethoxazole (SXT)	69.6	13	63	22.2	30	10	60	16.7
Tetracycline (Te)	95.6	95.6	96.3	96.3	100	100	96.7	96.7
Tobramycin (NN)	8.7	0	14.8	0	20	0	15	0

[a] Before and after curing experiments

[b] Percentage of resistant strains.

[c] All the strains resistant to Polimyxin B did not harbored plasmid

ND: Not determined

REFERENCES

1. Aoki T, Arai T, & Egusa S (1977). Microbiol Immunol. **21**:77-83.
2. Hazen TC, Raker HL, Esch GW, & Fliermans CB (1978). J Protozool **25**:351-355.
3. Hulzinga HW, Esch GW, & Hazen TC (1979). J Fish Dis **2**:263-277.
4. Joseph SW, Daily OP, Hunt WS, Seidler RJ, Allen DA, & Colwell RR (1979). J Clin Microbiol **10**:46-49.
5. Ljungh A, Popoff M, & Wadstrom T (1977). J Clin Microbiol **6**:96-100.
6. Toranzo AE, Barja JL, Potter SA, Colwell RR, Hetrick FM, & Crosa JH (1983). Infect Immun **39**:1220-1227.
7. Toranzo, A.E., Combarro, P., Lemos, M.L. & Barja, J.L. (1984). Appl. Environ. Microbiol. **48**, 872-877.
8. Winkler, U., Ruger, W., & Wackemagel, W. (Eds.) (1976) in Bacterial, Phage and Molecular Genetics, pp. 127-130, Springer-Verlag, New York.

Résistance aux antibiotiques et aux métaux chez des *Bacillus cereus* isolés de sols aurifères provenant de régions différentes

Z. MOUREAU*, J. SWINGS**, F. BERHIN***, E. SULTEN*, K. VAN HONACKER**, J. REMACLE***, B. CHAMPENOIS* ET H. NEYBERGH****

*Institut royal des Sciences naturelles, rue Vautier 29, 1040 Bruxelles (Belgique)
**Laboratorium voor Microbiologie, Ledeganckstraat 35, 9000 Gent (Belgique)
***Laboratoire d'Ecologie microbienne, B22, Sart-Tilman, Liège (Belgique)
****Service Géologique de Belgique, rue Jenner 13, 1040 Bruxelles (Belgique)

INTRODUCTION

Depuis 1988 nous nous intéressons au rôle des Bacillus du groupe cereus dans la localisation des gisements aurifères (Neybergh et al. 1989 et 1990). En effet,il apparaît que ces bactéries,à la fois résistantes à certains antibiotiques et à certains métaux,sont compétitivement favorisées dans les sols métallifères. Elles peuvent donc servir d'indicateurs.

Un des aspects de notre travail fut de caractériser une centaine de Bacillus prélevés dans des zones aurifères d'origines géographiques différentes et de vérifier leur résistance à 14 antibiotiques et à 5 métaux.Il est apparu 2 types de populations en fonction de leur résistance à des antibiotiques particuliers.

MATERIEL ET METHODES

99 souches bactériennes ont été isolées de sols présumés aurifères du Limousin(France),des Cévennes(France),de la Croix-Scaille(Belgique)et du Soudan(Afrique). La résistance aux antibiotiques suivants a été étudiée au moyen de pastilles placées sur boites de gélose Mueller-Hinton:

Néomycine(30 µg)	Amoxycilline(25 µg)	Streptomycine(10 µg)
Colistine(10 µg)	Pénicilline G(10 U)	Erythromycine(15 µg)
Kanamycine(30 µg)	Carbenicilline(100 µg)	Polymyxine B(300 U)
Ampicilline(10 µg)	Tetracycline(30 µg)	Chloramphenicol(30 µg)
Gentamicine(10 µg)	Rifampicine(30 µg)	

Par la suite,la CMI (concentration minimale inhibitrice) de la colistine a été vérifiée sur 9 souches au moyen de galeries ATB CMI. Les souches ont été caractérisées au moyen de galeries API CHB 50 et par analyse des acides gras suivant la méthode MIS(Microbial Identification System;Microbial ID,Inc; Delaware,USA).

Les CMI du cuivre,du zinc,de l'antimoine et de l'arsenic ont été déterminées,en milieu de culture liquide,pour un ensemble de souches appartenant au groupe précédent.

RESULTATS ET CONCLUSIONS

Les résultats de l'étude de la résistance aux antibiotiques ne se révélèrent significatifs que pour l'amoxycilline,la colistine,la pénicilline,l'ampicilline et la carbenicilline. En conséquence seuls ces derniers ont été pris en considération par la suite. En mettant les résultats sous forme d'histogramme on distingue 2 populations à résistance différente. Ceci est mis en évidence dans le tableau ci-joint. On y constate notamment que les souches de type II sont absolument résistantes à 10 µg de colistine par pastille. Une recherche de la CMI sur 9 souches du groupe B.cereus a montré que la résistance a atteint 5 fois 16 mg/l, 3 fois 32 mg/l et même 1 fois 128 mg/l.

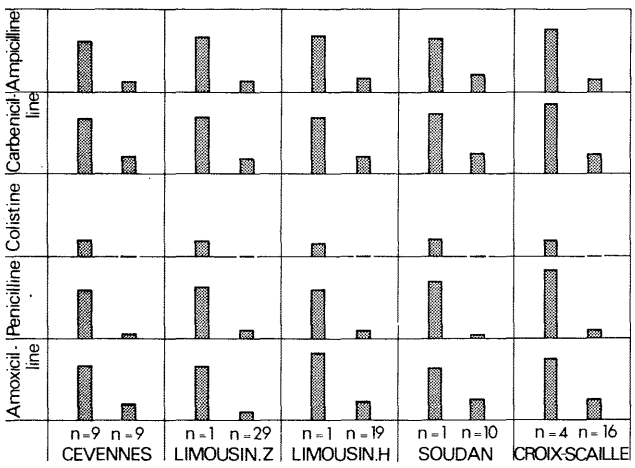
Les souches testées se sont révélées particulièrement résistantes au zinc,à l'antimoine et à l'arsenic. Ces 2 derniers métaux sont connus comme étant souvent associés à l'or. Leurs CMI s'élevaient au maximum à 40 mM d'antimoine, 2.5 mM d'arsenic et 2 mM de zinc.

Après caractérisation des souches,on a pu constater que le type II appartient au complexe des Bacillus cereus-mycoïdes-thuringiensis tandis que les autres,du type I,appartiennent à des Bacillus divers: B.subtilis, B.laterosporus, B.megaterium et B.alvei.

La population de type II est nettement résistante à la colistine, ce qui pourrait faire de cet antibiotique un critère de détermination. En outre la colistine,qui est en fait une bactériocine produite par des Bacillus du sol, agit essentiellement sur les Gram-négatif,ce qui pourrait jouer un rôle dans les phénomènes de compétition dans les sols.

DIFFERENCIATION DES POPULATIONS I ET II PAR LA RESITANCE AUX ANTIBIOTIQUES. COMPARAISON DE LA MOYENNE DES ZONES D'INHIBITION PAR A.B. ET PAR REGION

(n=nombre de souches dans chacune des populations)



Neybergh,H.and al.(1989) Biochemical prospection: application to gold deposit research. Study of the relationship between the Bacillus cereus content and gold content in the soil. Intern.symposium "Gold 89 in Europa".Toulouse 1989.

Neybergh,H.and al.(1990) Study of the Bacillus cereus-mycoïdes-thuringiensis complex present in auriferous soils.Intern.Symp.Geoch.Prosp.Prague, août 1990 à paraître.

Linkage of heavy-metals and antibiotics resistance of bacterial strains isolated from the marine environment

Manuel AVILES , Antonio DE VICENTE , Juan C. CODINA and Pedro ROMERO

Laboratorio de Microbiologia, Facultad de Ciencias, Universidad de Malaga, 29071-Malaga (Spain)

Introduction.

The resistance ability of some microbial groups against heavy metals and antibiotics has been detected frequently. Some studies show that the strains resistant to these agents can be isolated from different environments, such as gastrointestinal tract of man and domestic animals, aquatic environments, soils and clinical samples (3,4,5). The high frequencies of resistant strains may be caused by the selection process induced by heavy metal pollution of these environments and the widespread use of antibiotics in agriculture and medicine. Genetic transfer is considered to be another factor responsible for increasing the isolation frequencies of these strains. The purpose of this study is to determine the relationship between heavy metal and antibiotic resistance patterns of microorganisms (bacterial indicators and pathogens) isolated from the marine environment (water, shellfish and sediments).

Material and Methods.

Samples were collected in the marine area near the Guadalhorce river mouth and in beaches affected by sewage discharges in Málaga (Spain). The studied microorganisms belong to two groups: fecal pollution indicators (Coliforms and Fecal Streptococci), and pathogens (*Pseudomonas aeruginosa*, *Salmonella* spp, *Aeromonas hydrophila*, *Vibrio* spp, and *Staphylococcus* spp). The culture media employed for isolation of the microorganisms were: Endo agar, KF agar, Cetrimide agar, XLD agar, mA agar, TCBS agar and Mannitol salt agar for each microbial group, respectively. The study of heavy metal and antibiotic resistance patterns were determined by the agar dilution method and the disk diffusion method, respectively (6).

Results and Discussion.

The results obtained are summarized in Table 1, which shows the most frequent patterns of multir.esistance to metals and antibiotics of each microbial group. *Pseudomonas aeruginosa* presents the widest resistance profile; it should be noted that this is the general profile, and in addition some strains are also resistant to other agents, such as arsenate, streptomycin or sulfamides. These results are in agreement with those obtained by other authors (2,4,6).

In general, for Gram-negative microorganisms, except for *Salmonella* spp, the resistance patterns generally include the resistance to arsenate and amoxycillin, which seems to indicate a possible association of the resistance to both agents. Among Gram-positive microorganisms, the resistance pattern of *Staphylococcus* spp is more similar to the Gram-negative patterns, than to that of the Fecal Streptococci. Fecal Streptococci do not present a significant resistance to heavy metals. The linkage of resistance to mercury and amoxycillin is observed in *P. aeruginosa* and some Coliform strains, according to the results obtained by other authors (1,4).

TABLE 1. Heavy-metal and antibiotic multi.resistance patterns of bacterial strains frequently isolated from the marine environment.

MICROORGANISMS	RESISTANCE PATTERNS	FREQUENCY (%)
P. aeruginosa (n=25)	Cd-Cr-Hg-AMX-CF-K-C-NA-SXT	28.0
	Cd-Cr-AMX-CF-K-C-NA-SXT	28.0
	Cd-Cr-Hg-AMX-CF-K-NA-SXT	12.0
Coliforms (n=56)	As-Hg-AMX	28.5
	As-AMX-CB-S-G	8.9
Salmonella spp (n=15)	–	–
A. hydrophila (n=32)	As-AMX-CF	40.6
Vibrio spp (n=22)	As-AMX-TE	36.3
Staphylococcus spp (n=12)	Cr-AMX	41.7
Fecal Streptococci (n=41)	Zn-S-K-L-G	31.7

As: Arsenate
Cd: Cadmium
Cr: Chromium
Hg: Mercury
Zn: Zinc

AMX: Amoxycillin
CB: Carbenicillin
CF: Cephalothin
C: Chloramphenicol
K: Kanamycin
L: Lyncomicin

NA: Nalidixic Acid
S: Streptomycin
G: Sulfamides
TE: Tetracicline
SXT: Trimethoprim-Sulfamethoxazole

References:
1 JOLY, B.; R. CLUZEL; P. HENRI & J. BARJOT, 1976. Ann. Microbiol. (Inst. Pasteur), 127B: 57-68.
2 JOLY, B.; J. ALAME; R. CLUZEL & D. PEPIN, 1979. Ann. Microbiol. (Inst. Pasteur), 130B: 341-347.
3 KELCH, W.J. & J.S. LEE, 1978. Appl. Environ.Microbiol., 36: 450-456.
4.MARQUES, A.M.; F. CONGREGADO & M.D. SIMON-PUJOL, 1979. J. Appl. Bacteriol., 47: 347-350.
5.NAKAHARA, H.; T. ISHIKAWA; Y. SARAI; I. KONDO; H. KOZUKUE & S. SILVER, 1977. Appl. Environ. Microbiol., 33: 975-976.
6.de VICENTE, A., 1986. Tesis Doctoral. Universidad de Málaga.

This work was supported by a grant of Consejería de Educación y Ciencia de la Junta de Andalucía.

M-III4

Effect of Mercury on marine bacterial population

Antonio DE VICENTE, José L. GARCIA, Juan C. CODINA and Manuel AVILES

Laboratorio de Microbiologia, Facultad de Ciencias, Universidad de Malaga, 29071-Malaga (Spain)

The importance of the adaptation of aquatic microbial communities in response to the exposure to certain pollutants or stress factors is largely accepted. However, this adaptation may be due to three different mechanisms: induction of specific enzymes, genetic changes that produce new physiological abilities or selection of specific organisms. In general, these changes produce a lower diversity in the population, some microbial groups disappearing whereas the population is enriched in groups with high tolerance to the environmental stress. Mercury has been one of the most studied pollutants in relation with microbial communities in recent years (1,3). The aim of this work was to study the response of a bacterial population to mercury

Material and Methods.

We reported the effect of the addition of different concentrations of mercury (50 and 500 ppb), in the form of $HgCl_2$, to non-polluted seawater obtained from Málaga Bay (Spain), on the viability of the marine microbial population and the mercury resistance levels of this heterotrophic bacterial population, kept in darkness conditions, at 20°C for 48 h. Total count of viable cells was done on seawater agar. Resistant bacteria count was done on the same medium to which 10 mg/l or 30 mg/l of $HgCl_2$ were added. The plates were incubated at 20°C, for 5 days. This experiment was repeated five times and average values of log c.f.u./ml ($X \pm S/2$ of five experiments) at 0, 10, 24 and 48 h are shown in Figures 1-4. We used the plate count method because of its simplicity, although it has been heavily criticised as a method for estimating the number of viable bacteria in the marine environment. However, some authors (2), have demonstrated that plate count of mercury resistant bacteria is a representative index of these populations.

Results and Discussion.

In Figure 1, it can be seen that in normal conditions, with a virtual lack of mercury in seawater, the aquatic bacterial population remained stable during all the assay, both in the total number of bacteria, and in the number of resistant bacteria. On the other hand, in these conditions of lack of the selective agent in water, approximately 10% of the bacterial population were mercury-resistant, growing in culture media with 30 mg/l of $HgCl_2$, and 20-30% were resistant to 10 mg/l of $HgCl_2$.

As seen in Figure 2, the addition of mercury leads to an important alteration in the microbial flora, producing a remarkable initial decrease in the total viable bacterial population, after the addition of 500 ppb of mercury. Although the population goes through an initial adaptation, it quickly recovers, so after 48 h, counts of more than 10 times higher than those obtained in non-stressed medium are attained. Figure 3 shows the behaviour of the mercury-resistant bacterial population when the stressing agent is added to seawater. A clear increase in the resistant bacterial population is produced, and at 48 h this exceeds the resistant bacterial population count in seawater without mercury almost by two orders of magnitude.

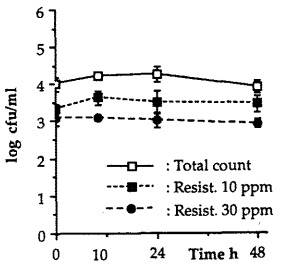


FIG. 1: SEAWATER (0 ppb Hg).

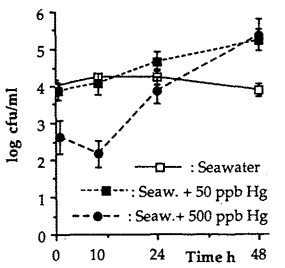


FIG. 2: TOTAL COUNTS.

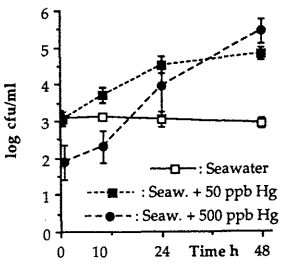


FIG. 3: Hg RESISTANT COUNTS (30 ppm).

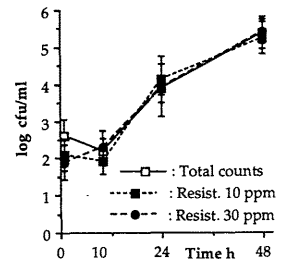


FIG. 4: SEAWATER + 500 ppb Hg.

When the population is subjected to a stress by the addition of mercury (especially when 500 ppb of mercury were added), a selection of mercury-resistant microorganisms is produced in the short adaptation phase, and then, although only 10% of initial bacterial population is resistant (as we can see in Figures 1 and 4), after 10 hours, all the heterotrophic bacterial population is mercury-resistant (Figure 4). These results seem to confirm that there is an adaptation of the microbial population in response to the external selective pressure of mercury, through the selection of the bacteria resistant to this agent, with an increase of this population from approximately 10% to 100%.

References:

1 BARKAY, T. & H. PRITCHARD, 1988. Microbiological Sciences, 5: 165-169.

2 NELSON, J.D. & R.R. COLWELL, 1975. Microbial Ecology, 1: 191-218.

3 ZELIBOR, J.L.; M.W. DOUGHTEN; D.J. GRIMES & R.R. COLWELL, 1987. Applied and Environmental Microbiology, 53: 2929-2934.

M-III5

Glutathione protects the Unicellular Marine Alga *Acetabularia* against Cadmium Toxicity

G.-Y. QIU*, F. REGOLI**, A. BOSSUS***, G. NUYTS***, D. VAN DER BEN**** and S. BONOTTO***

*Department of Virology and Molecular Biology, Wuhan University, Wuhan, Hubei (P.R. China)
**Dipartimento di Biomedicina Sperimentale, Infettiva e Pubblica, Sezione di Biologia e Genetica, University of Pisa, Pisa (Italia)
***Department of Radioprotection, C.E.N./S.C.K., Mol (Belgium)
****Institut royal des Sciences naturelles de Belgique, Bruxelles (Belgique)

The giant unicellular marine alga Acetabularia acetabulum is used in many laboratories as a model for experimental research in the field of fundamental and applied ecotoxicology (Arapis et al., 1988).

In recent studies we have found that cadmium, at concentrations $\geq$ 0.9 µM, provoked a strong (> 50%) inhibition of cellular differentiation (cap formation) in both whole and enucleated cells (van der Ben et al., 1988a,b ; Bonotto et al., 1989 ; Qiu et al., 1989). This response of Acetabularia to cadmium intoxication prompted the search for protective substances against this toxic metal.

The tripeptide glutathione, which has a protective effect against ionizing radiations (Bonotto and Netrawali, 1969) and oxidation damages, was supplied to Acetabularia, alone (0.1 mM) or in combination with cadmium (0.9 and 1.8 µM). In addition, glutathione was added to the algae two days after cadmium, to reveal whether the effects of this metal could be reversed.

All together, the results showed a strong protective effect of glutathione against cadmium toxicity. Moreover, parallel experiments with the gamma emitting isotope ^{109}Cd, in combination with glutathione, suggested that the protective mechanism probably involved both extracellular and intracellular processes, leading respectively to a decrease of cadmium penetration into the cell and to a reduction of its availability for toxic interactions with cellular constituents.

References

ARAPIS, G., PUISEUX-DAO, S., BAEYENS, W. and S. BONOTTO (1988) Utilisation de l'algue unicellulaire géante Acetabularia acetabulum comme modèle pour des études dans le domaine de la toxicologie fondamentale et appliquée. Rapp. Comm. int. Mer Médit., 31, 2, p. 182.

BONOTTO, S., CINELLI, F., QIU, G., KAREZ, C., ROMEO, M., BOUQUEGNEAU, J.-M. and van der BEN, D. (1989) Experimental approach to the study of the response of the giant unicellular marine alga Acetabularia to metal pollution. 5th European Ecology Symposium, Anthropogenic perturbations of ecological systems : the need for transfer from principles to applications, Siena, Italy, September 25-29, 1989. SITE NOTIZIE, Boll. Soc. Ital. Ecol., 10, 196.

BONOTTO, S. and NETRAWALI, M.S. (1969) Radiolysis and radioprotective effect of glutathione. Int. J. Radiat. Biol., 15, 275-278.

QIU, G.Y., NUYTS, G., van der BEN, D. and BONOTTO, S. (1989) Protective effect of manganese in whole Acetabularia cells treated with cadmium. Second joint meeting of the Belgian and Dutch societies of plant physiology, University of Antwerp, November 24, 1989. Abstracts, p.40.

van der BEN, D., VANDENHOUTEN, C., NUYTS, G., BOSSUS, A., KAREZ, C., BOUQUEGNEAU, J.-M. and BONOTTO, S. (1988a) Experimental approach to the study of the contamination of the coastal environment by cadmium. Arch. Int. Physiol. Biochim., 96, PP45.

van der BEN, D., VANDENHOUTEN, C., KAREZ, C., PUISEUX-DAO, S., BAEYENS, W. and BONOTTO, S. (1988b) Uptake, distribution and biological effects of cadmium in the unicellular marine alga Acetabularia acetabulum. Rapp. Comm. int. Mer Médit., 31(2), 183.

M

Cinétique de la rétention et de la digestion de *Klebsiella pneumoniae* par l'éponge *Ephydatia fluviatilis*

E. RICHELLE-MAURER*, G. Van de VYVER* et Z. MOUREAU**

*Université Libre de Bruxelles (Belgique)
**Institut royal de Sciences naturelles de Belgique (Belgique)

Les éponges se nourrissent par filtration en retenant un large spectre de particules allant de 0,1µm à 50 µm, parmi lesquelles les bactéries. Depuis plusieurs années, les mécanismes de la nutrition bactérienne des éponges sont étudiés dans notre laboratoire en utilisant des germes marqués (Willenz et al 1986). Ces travaux mettent en évidence l'efficacité de la nutrition bactérienne et l'existence de différences dans les taux de rétention et de digestion selon les espèces bactériennes (Richelle et al 1988 c, 1990). Les caractéristiques morphologiques des bactéries interviennent probablement à divers niveaux pour rendre compte de ces résultats.

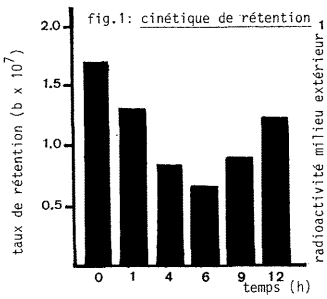
Nous avons, dans le présent travail, étudié la rétention et la digestion d'une bactérie capsulée, Klebsiella pneumoniae par l'éponge d'eau douce Ephydatia fluviatilis. Ceci permet d'évaluer l'impact de la présence d'une capsule sur la nutrition.

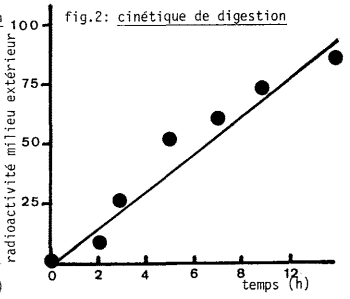
Méthodes: elles ont été décrites précédemment (Huysecom et al 1988a,b): des éponges âgées de 10 jours, à jeûn ou nourries pendant différents temps à l'aide de suspensions bactériennes non marquées sont incubées pendant une heure dans une suspension de bactéries marquées à la thymidine tritiée (2ml 10^7 b/ml).
La cinétique de la rétention est établie en mesurant la radioactivité au niveau des éponges et du milieu extérieur au cours du temps.
Pour étudier la cinétique de la digestion, les éponges sont placées dans un milieu minéral frais non radioactif après l'incubation d'une heure en présence de bactéries marquées. La radioactivité est ensuite suivie au niveau des éponges et du milieu extérieur. La filtration de ce dernier sur filtre millipore 0,45µm permet de déterminer s'il y a égestion de produits de la digestion ou non.

Résultats et discussion

Rétention: (figure 1) la cinétique de rétention de K.pneumoniae montre un effet de l'état nutritionnel de l'éponge sur le taux de rétention c'est-à-dire sur le nombre de bactéries retenues par heure.
K. pneumoniae est retenue plus efficacement par les éponges à jeûn (86%). Après nourrissement, le taux de rétention décroît jusqu'à atteindre 38% de sa valeur initiale, pour augmenter ensuite après 9 heures de nourrissement.

Digestion: (figure 2) on observe une augmentation linéaire de la radioactivité dans le milieu extérieur et une diminution correspondante de celle-ci dans les éponges. Ceci provient de l'égestion de résidus de la digestion et non de bactéries qui seraient rejetées par l'éponge sans être digérées. Le nombre de bactéries digérées par heure, calculé d'après la droite de régression, est estimé à 7,7 % du nombre de bactéries ingérées, soit 1,3 10^6 b/h/ éponge issue de 50 gemmules.





Ces résultats mettent en évidence que K.pneumoniae, malgré sa capsule est retenue et digérée par E. fluviatilis mais à un taux moindre que E.coli (Huysecom et al 1988 a). Par ailleurs, ils confirment la relation existant entre rétention et digestion.

En conclusion, de l'ensemble des travaux effectués sur la rétention et la digestion des bactéries par les éponges d'eau douce, il apparaît que les taux différentiels de rétention et de digestion sont liés tant à l'espèce d'éponge qu'à l'espèce bactérienne. Ils peuvent être explicités de la manière suivante:
A jeûn, la digestion n'intervenant pas, le taux de rétention dépend de la capacité de phagocytose spécifique de l'éponge et de l'espèce bactérienne, les caractéristiques morphologiques de celles-ci (taille, capsule, amas ou chaînettes) étant probablement un facteur déterminant. L'intervention de récepteurs spécifiques a été suggérée mais n'a pas encore été mise en évidence. Des expériences de nutrition simultanée avec deux bactéries devraient permettre d'y répondre.
Après nourrissement, le taux de rétention des bactéries est modulé par l'efficacité de leur digestion par l'éponge. Rétention et digestion sont donc étroitement liés comme nous avons pu le montrer lors de l'étude de la digestion d'E.coli par trois espèces d'éponges (Richelle et al 1990). A une efficacité de rétention élevée correspond une bonne assimilation des bactéries.

Références

Huysecom J., E.Richelle-Maurer,Z.Moureau et G.Van de Vyver.1988 a. Rétention et digestion d'E.coli par l'éponge E. fluviatilis. Rapp. Comm. int. Mer Médit.,31, 2,184.
Huysecom J., E. Richelle-Maurer, G. Van de Vyver et B. Vray. 1988 b. Effect of bacterial concentration on retention rate and growth of the freshwater sponge E.fluviatilis. Physiol. Zool. 61 (6), 535-542.
Richelle-Maurer E., J. Huysecom, Z. Moureau et G. Van de Vyver.1988 c. Etude comparative de la digestion de trois espèces bactériennes par E. fluviatilis. Rapp. Comm. int. Mer Médit.,31, 2, 184.
Richelle-Maurer E., G.Van de Vyver et Z. Moureau. 1990. Efficiency of freshwater sponge nutrition on bacteria. in Microbiology of poecilotherms 231-234.
Willenz P., B. Vray, M.P. Maillard et G.Van de Vyver. 1986. A quantitative study of the retention of radioactiveiy labelled E.coli by the sponge E.fluviatilis. Physiol. Zool., 59 (5) 495-504.

Fractionnement physique des eaux interstitielles de sédiments marins : analyse des glucides de la matière organique dissoute

E. CHOURY, M. RICHOU et J. BENAIM

Laboratoire de Recherches de Chimie Marine des Organométalliques, Université de Toulon et du Var, 83957 La Garde (France)

Dans les eaux naturelles, les métaux Cu^{2+}, Zn^{2+}, Cd^{2+}, sont reconnus comme toxiques dans leur forme libre pour les systèmes biologiques tels que le phytoplancton, les algues, les poissons . Les métaux complexés par des ligands organiques ou inorganiques apparaissent beaucoup moins toxiques. La littérature s'accorde en général pour désigner les composés à masses moléculaires inférieures à 1000 daltons comme responsables de ce phénomène(KRAMER et DUINKER, 1980). Néanmoins ces résultats ont été obtenus avec des fractions humiques (géopolymères) extraites des eaux ou de sédiments et non à partir de la matière organique dissoute (MOD) dans son intégralité.

Dans les eaux interstitielles (EI) de sédiments marins prélevés en zone littorale, nous avons mis en évidence l'importance relative élevée des biopolymères par rapport aux géopolymères (30 à 80%) (BENAMOU et al. 1989). Les biomolécules dans ces proportions ne peuvent plus être négligées dans une étude de phénomènes de complexation métaux -matière organique . Ces molécules sont susceptibles d'interactions avec les métaux (BIZRI-KHAYAT,1983;JOHN et HAAS,1986) et donc responsables de leur transport et de leur biodisponibilité.

Dans une précédente étude , nous avons montré le rôle non négligeable des acides aminés dans les phénomènes de complexation de certaines fractions des EI (BOUSSEMART,1989). Nous poursuivons ce travail par l'étude, qualitative et quantitative des glucides . Dans le même but d'appréhender la totalité de la MOD , les échantillons d'EI ne sont soumis à aucune extraction ni traitement chimique avant le fractionnement physique par ultrafiltration (seuil de coupure à 1000 daltons) et chromatographie par perméation de gel (G-15). Le couplage de ces deux techniques offre l'originalité de montrer que 70 à 90% du carbone organique dissous de la MOD appartient à la fraction dite inférieure à 1000 daltons . En effet , l'ultrafiltration à circulation tangentielle sous pression (2 bars) avec une membrane en polysulfone éther, favorise la séparation des petites molécules de l'ensemble de la MOD avec un bon rendement. D'autre part, la chromatographie par perméation de gel , avec l'eau de mer comme éluant , se révèle être un outil efficace pour séparer la matière organique très complexe des EI.

La polydétection des fractions issues de la G-15 par absorption UV, spectrofluorimétrie , mesure de carbone organique dissout permet de mettre en evidence plusieurs familles de composés telles que les acides fulviques (géopolymères) , les acides aminés (BOUSSEMART et al. 1990). La méthode de "dérivation précolonne" avec la DNS hydrazine (MOPPER etal. 1983) est appliquée au mélange de glucides contenu dans les EI. La chromatographie liquide haute performance (HPLC) en phase inversée nous permet de séparer les dansyl - hydrazones formées . La fluorescence (excitation: 370nm; émission: 540nm) est utilisée pour la détection . Les temps de rétention et aires des pics de 11 étalons glucides permettent d'identifier et d'évaluer les sucres présents dans chacune des fractions.

Cette étude a permis de préciser la nature et l'importance des glucides dans les différentes fractions obtenues à partir de la MOD des eaux interstitielles de sédiments marins pour différents sites , par rapport aux autres familles de géo et biomolécules.

BENAMOU, C., RICHOU, M., BENAIM, J. 1989. Importance relative des bio-et des géopolymères dans les eaux interstitielles : utilisation de la spectrofluorimétrie et essais biochimiques . *Water research*, 23(9):1127-1136.

BOUSSEMART, M. 1989 . Méthodes de caractérisation physico-chimique de la matière organique dissoute dans les eaux interstitielles de sédiment marin cotier. *Thèse, Université de Toulon.*

BOUSSEMART, M., RICHOU, M., FEVRIER, G., BENAIM,J. 1990 . On the detection of low-weight natural organic molecules from marine interstitial waters in gel chromatography. *Environmental Technology letters.*(in press).

BIZRI-KHAYAT, Y.,1983 . Coordination du plomb II par des ligands multifonctionnels à atomes donneurs N, O, S. Thèse d'état, *Université de Claude Bernard, Lyon.*

JOHN, W., et HAAS, JR., 1986 . Complexation of calcium and copper with carbohydrates. *Marine chemistry*,19 : 299-304.

MOPPER, K., et JOHNSON, L. 1983. Reversed-phase liquid chromatographic analysis of Dns-sugars. Optimisation of derivatization and chromatographic procedures and applications to natural samples.*Journal of chromatography*, 256 : 27-38.

M-VI1

Dynamique mensuelle des composants chimiques fondamentaux de l'espèce *Actinia aequina* (L.)

Natalia ROSOIU

Institut Roumain de Recherches Marines, Constanta (Roumanie)

SUMMARY

Dry tissue of Actinia aequina is rich in proteins (54.81 %), lipids (15.53 %) and glycogen (23.4 %). The content of total phosphorus is high, with values ranging between 0.60 % - 1.19 % of dry weight. The smallest values occurred during september and november, and the highest ones during february and march. No significant correlation with the quantitative variations of the other tested biochemical compounds was found.
The following 19 aminoacids were identified by chromatography: cystine, cysteine, lysine, hystidine, arginine, asparagine, aspartic acid, serine, glycine, glutamic acid, threonine, alanine, proline, γ-aminobutyric acid, phenylalanine, methionine, valine, tyrosine and leucine. Cystine, cysteine, alanine, proline, tyrosine and valine were always present but in very variable amounts. Lysine, hystidine, arginine and methionine remained rather unchanged during the year. The periods of maximum accumulation (may, august and october) for cystine, cysteine, hystidine, asparagine, aspartic acid, serine, alanine (excepting may) and γ-aminobutyric acid, coincide with those of proteins. An almost perfect parallelism of the curves of lysine, arginine, phenylalanine and methionine is observed.

Actinia aequina (L.) est peu connue du point de vue biochimique, bien qu'elle présente une biomasse importante dans les zones rocheuses de faible profondeur du littoral roumain de la mer Noire. Dans le présent travail nous nous proposons d'étudier la dynamique mensuelle des composants biochimiques fondamentaux de cette espèce.

L'analyse des résultats obtenus nous a permis de constater que:

- La teneur en eau oscille entre 80,53% et 88,37 % du tissu frais, étant maximale pendant les mois de mars, juin, août et pendant la période octobre - décembre.

- La teneur en cendre est plus élevée au cours des mois d'automne et d'hiver, oscillant entre 5,23 % et 11,93 % du tissu sec.

- Les protéines varient entre 35,56 % et 73,63 % du poids sec, avec des valeurs plus élevées vers la fin du printemps et pendant tout l'été.

- Les lipides présentent une dynamique similaire à celle des protéines, leurs valeurs maximales - jusqu'à 19,55 % du poids sec - étant observées en juillet-août et novembre-décembre.

- Les glucides varient en rapport inverse des protéines; on enregistre des valeurs plus faibles à la fin du printemps et pendant tout l'été, avec le maximum de 46,17 % en avril. La plupart des glucides sont présents sous forme de glycogène comme substance énergétique de réserve. La teneur maximale en glycogène (38,02 % du tissu sec) a été remarquée en avril.

En tenant compte des valeurs moyennes, on peut considérer qu Actinia aequina est une espèce riche en protéines, en lipides et en glycogène (respectivement 54,81%, 15,53 % et 23,40% du poids sec).

- La teneur en phosphore est élevée, avec des valeurs comprises entre 0,60 et 1,19% du tissu sec. Les quantités minimales sont observées en septembre et novembre, et les quantités maximales en février-mars. On n'a mis en évidence aucune corrélation significative avec les quantités des autres composants biochimiques testés.

- On a décelé, par chromatographie, 19 acides aminés: cystine, cystéine, lysine, hystidine, arginine, asparagine, acide aspartique, sérine, glycocolle, acide glutamique, thréonine, alanine, proline, acide γ-aminobutyrique, tyrosine, méthionine, valine, phénylalanine et leucine.

Quelques-uns des acides aminés sont constamment présents, mais en quantités variables: cystine, cystéine (0,85 - 20,39 %); alanine (3,59 - 21,23 %); proline (1,27% - 19,04 %); tyrosine (0,18 % - 11,05 %); valine (0,53 % - 9,72 %). La lysine (1,83 % - 6,62 %), l'hystidine (1,62 % - 4,95 %), l'arginine (1,05 % - 5,83 %) et la méthionine (0,81 % - 5,40 %) enregistrent ordinairement des valeurs moyennes qui oscillent moins au cours de l'année. La thréonine, le glycocolle, l'acide glutamique, l'acide γ-aminobutyrique et la phénylalanine sont présents en petites quantités, leurs limites de variation étant respectivement 0,12% - 1,48 %; 0,27% - 2,12 %; 0,24 % - 2,75 %; traces - 3,32 % et 0,49 % - 3,43 % du tissu sec.

Les périodes d'accumulation maximale (mai, août et octobre) des acides aminés soufrés, hystidine, asparagine, acide aspartique, sérine, alanine (à l'exception du mois de mai) et acide γ-aminobutyrique, coïncident avec celles des protéines. L'acide glutamique et le glycocolle varient inversément à la concentration des protéines. Un parallélisme presque parfait est constaté entre les courbes de la lysine, l'arginine, la phénylalanine et la méthionine.

Pour les animaux marins euryhalins, qui vivent en eaux ayant une salinité variable, le glycocolle, l'alanine, la proline et l'acide glutamique - sous forme d'acides libres - jouent un rôle important dans les processus d'osmorégulation. En ce qui concerne Actinia aequina du littoral roumain, on a mis en évidence des quantités importantes d'alanine et de proline, mais de faibles concentrations en glycocolle et en acide glutamique. Il est probable que chez cette espèce le glycocolle et l'acide glutamique participent dans une moindre mesure aux processus d'osmorégulation (ROSOIU et BADEA, 1976).

Actinia aequina, ainsi que d'autres invertébrés du littoral roumain, présente un taux élevé en acides aminés basiques (lysine, hystidine, arginine) et acides aminés soufrés.

Références bibliographiques

ROSOIU N., BADEA M., 1976 - Cercetări Marine (Recherches Marines), IRCM Constanţa, 9 supl., 223 - 231.

M-VI2

Quelques données sur l'activité de la Pepsine, la Trypsine et la Chymotrypsine de certaines espèces d'Invertébrés et poissons du Littoral Roumain de la Mer Noire

Natalia ROSOIU

Institut Roumain de Recherches Marines, Constanta (Roumanie)

SUMMARY

The activity of pepsin, trypsin and chymotrypsin was measured in the protein extracts of Actinia aequina, Rapana thomassiana, Squalus acanthias, Odontogadus merlangus euxinus and Engraulis encrassicolus ponticus. Our work has brought some contributions to the detection of several proteolytic enzymes. Data comparison showed that the proteolytic activity had a number of specific particularities depending respectively on the organism, on the organ and on tissue. Detection and knowledge of the degree of activity of these proteases may constitute an experimental premise for their utilization in different applicative scopes.

En vue d'une meilleure valorisation des ressources biologiques du littoral roumain de la mer Noire, nous avons étudié l'activité de la pepsine, de la trypsine et de la chymotrypsine provenant des organes et tissus d'un coelentéré (Actinia aequina), d'un gastéropode (Rapana thomassiana) et de trois espèces de poissons (Squalus acanthias, Odontogadus merlangus euxinus et Engraulis encrassicolus ponticus).

Les activités enzymatiques ont été déterminées dans des extraits protéiques totaux obtenus à partir d'un gramme de tissu broyé dans 10 ml d'eau distillée. L'activité de la pepsine a été déterminée par la méthode ANSON (in COLOWICK & KAPLAN, 1955), en utilisant comme substrat l'hémoglobine à un pH de 2,0; l'activité de la trypsine et de la chymotrypsine ont également été déterminées par la méthode ANSON, mais avec l'hémoglobine dénaturée comme substrat à un pH de 7,5 et 8,0 respectivement (ROSOIU et al., 1981).

En étudiant la distribution des activités protéolytiques par organes et tissus, on a obtenu les résultats suivants:

- Chez Rapana thomassiana, l'activité protéolytique de pH 2,0 est nulle dans les bronches, les glandes salivaires, la glande vitellogène, l'hépatopancréas, le manteau, le pied et le corps entier. Par contre, dans l'estomac, les reins et les testicules les valeurs observées ont été respectivement de 3950, 2635 et 6625 nmoles tyrosine/mg protéine/minute, à 37°C.

- Dans les extraits protéiques obtenus du corps entier d'Actinia aequina, des organes et des tissus de Rapana thomassiana on n'a pas décelé d'activité tryptique. Chez Squalus acanthias, l'activité tryptique est nulle dans le foie. Dans les autres organes étudiés il y a eu une faible activité enzymatique (de 45,4 nmoles tyrosine/mg protéine/minute, 37°C, dans les oeufs, 833,2 nmoles tyrosine/mg protéine/minute, 37°C, dans l'estomac).

Quant aux espèces de petits poissons marins que nous avons analysées, l'activité tryptique était intense. Nous avons enregistré des valeurs allant jusqu'à 14 026 nmoles tyrosine/mg protéine/minute, 37°C dans les viscères d'anchois.

La plus grande activité protéolytique de pH 8,0 (18 887 nmoles tyrosine/mg protéine/minute, 37°C) a été décelée chez Actinia aequina. Pour Rapana thomassiana on a trouvé une activité chymotryptique seulement dans l'hépatopancréas (645 nmoles tyrosine/mg protéine/minute, 37°C) et dans les reins (895 nmoles tyrosine/mg protéine/minute, 37°C). Chez Squalus acanthias, l'activité protéolytique de pH 8,0 n'a pu être mise en évidence dans les oeufs, le foie et l'hépatopancréas. Dans l'estomac, l'activité chymotryptique a été de 2550 nmoles tyrosine/mg protéine/minute, 37°C.

Dans les viscères pleins d'oeufs et de laitance d'Engraulis encrassicolus ponticus on a mis en évidence une intense activité protéolytique de pH 8,0, à savoir 18 804 nmoles tyrosine/mg protéine/minute, 37°C, comparable à celle signalée chez Actinia aequina.

Les recherches continuent en vue de l'extraction et de la purification des enzymes protéolytiques des espèces étudiées chez lesquelles on a décelé une activité maximale.

Références bibliographiques

COLOWICK S.P., KAPLAN N.O., 1955 - Methods in Enzymology, 2, Academic Press, New York, 3 - 169.

ROSOIU N., SERBAN M., PANAIT M., 1981 - Cercetări Marine (Recherches Marines), IRCM Constanţa, 14, 223.

M

Caractéristiques biochimiques et spectrales de l'Hyaluronidase extraite et purifiée de l'espèce *Engraulis encrassicolus ponticus* du Littoral Roumain de la Mer Noire

Natalia ROSOIU et Mircea CRASMARU

Institut Roumain de Recherches Marines, Constanta (Roumanie)

SUMMARY

The hyaluronidase extracted and purified from the Engraulis encrassicolus ponticus viscera and gonads is a homogenous enzyme preparation. Its degree of purity is similar to that of the Merck hyaluronidase. The spectral characteristics and the electrophoretic pattern in agarose gels,in veronal buffer pH 8.9, of the two enzymes are similar,suggesting that there is a structural ressemblance between the fish and the bovine testis hyaluronidase. At a nearly neutral pH, that is identical to that of the body fluids, the purified fish hyaluronidase exhibits a high enzyme activity "in vitro" of at least 50 USP/mg and at the same time a high specific activity "in vivo" for the depolymerization of the conjunctive tissue similar to the imported injectable drug "Hyason".

Dans nos travaux antérieurs nous avons présenté des données concernant l'extraction et la purification de l'hyaluronidase des poissons Engraulis encrassicolus ponticus,Odontogadus merlangus euxinus et Sprattus sprattus sprattus (ROSOIU et al.,1985 a),la cinétique enzymatique en absence et en présence d'un activateur (ROSOIU et al., 1985 b, 1986 a,b, 1987), ainsi que les caractéristiques physico-chimiques de l'hyaluronidase extraite et purifiée de l'espèce Engraulis encrassicolus ponticus (ROSOIU et al., 1986 c).

Afin d'obtenir une enzyme à haute pureté utilisable dans l'industrie pharmaceutique, nous avons continué les recherches sur l'hyaluronidase extraite et purifiée à partir de l'espèce Engraulis encrassicolus ponticus,en initiant une étude biochimique et spectrale qui sera comparée à l'hyaluronidase obtenue des testicules de bovins (réactif Merck et médicament injectable d'importation "Hyason").

Les valeurs d'absorption mesurées à 230-300 nm de quelques solutions aqueuses d'hyaluronidase des testicules de bovins (réactif Merck) et d'hyaluronidase de poisson,de 300 UI/ml, sont très proches, les variations s'inscrivant en $\Delta E = 0,008$.Les absorptions à 280 nm et à 260 nm, pour les deux hyaluronidases, s'inscrivent dans les limites admises par la Pharmacopée Britannique. Les différences entre les valeurs d'absorption à 270 nm et à 290 nm sont très proches, étant respectivement de 0,045 pour l'hyaluronidase testiculaire et de 0,040 pour celle obtenue du poisson.

De l'examen des spectres en UV des deux hyaluronidases, on observe que l'allure des courbes est presque identique,présentant une bande d'absorption entre 260 nm et 290 nm, caractéristique pour les transitions du type n-π^* spécifiques des liaisons hétérogènes.A 278 nm on obtient les maximums d'absorption identiques,ce qui suppose l'existence d'un composant hétérocyclique dans les deux préparations.

L'examen des spectres en IR prouve que les bandes d'absorption des deux hyaluronidases se trouvent dans des domaines voisins,et l'allure des courbes est semblable; on remarque néanmoins certaines bandes avec des domaines différents d'absorption, à savoir: 1530-1610 cm^{-1}, 2900-3400 cm^{-1} pour l'hyaluronidase des testicules de bovins (réactif Merck).et 1060-1110 cm^{-1},1310-1320 cm^{-1} pour l'hyaluronidase extraite et purifiée des viscères de poisson.En même temps,on observe certaines bandes qui apparaissent dans des domaines du même ordre de grandeur, mais légèrement déplacées, et l'absorption maximale à des longueurs d'onde voisines (1280-1340 cm^{-1} et l'absorption maximale à 2200 cm^{-1} pour l'hyaluronidase animale,contre 1220-1300 cm^{-1} et l'absorption maximale à 2300 cm^{-1} pour l'enzyme extraite du poisson).

Nous sommes d'avis que ces données, ainsi que l'allure des courbes, un peu différentes dans le domaine 1000-1160 cm^{-1}, sont dues à la présence de certains ingrédients de stabilisation dans l'enzyme animale, qui manquent dans le cas de l'enzyme extraite du poisson.

Les électrophorégrammes obtenus par migration en gel d'agarose en tampon barbiturè, à un pH de 8,9, mettent en évidence le même nombre de fractions protéiques, une répartition similaire et des mobilités identiques, les deux hyaluronidases étant des produits enzymatiques homogènes.

En conclusion, malgré les différences spectrales signalées, en raison des caractéristiques de similitude nombreuses,nous estimons que les deux hyaluronidases analysées présentent des similitudes structurales. En même temps, la teneur relativement grande en calcium nous autorise à considérer l'hyaluronidase provenant d'anchois comme une Ca-enzyme, formée de 16 acides aminés, parmi lesquels prédominent la cystine, la cystéine, la tyrosine, l'asparagine et la méthionine. La teneur élevée des groupements -SH et -S-S, donnée par les acides aminés soufrés, confère à l'hyaluronidase de poisson un haut degré de thermostabilité et une activité maximale à +40°C et +60°C (ROSOIU et al., 1986 c, 1987).

A un pH voisin de la neutralité, identique à celui des liquides de l'organisme,l'hyaluronidase d'anchois manifeste une intense activité enzymatique "in vitro", d'au moins 50 USP/mg et 25 UI/mg respectivement, et,en même temps, une intense activité spécifique "in vivo", de dépolymérisation du tissu interstitiel,semblable à celle de l'échantillon d'importation:le médicament injectable "Hyason" (ROSOIU et al., 1989).

Références bibliographiques

ROSOIU N., SERBAN M., VOINESCU I., 1985 a - Cercetări Marine (Recherches marines), IRCM Constanţa, 18, 245.

ROSOIU N., VOINESCU I.,1985 b - Cercetări Marine (Recherches marines) IRCM Constanţa, 18, 235.

ROSOIU N., VOINESCU I., 1986 a - Rapp.Comm.int.Mer Médit., 30, 2.

ROSOIU N., PANAIT M., 1986 b - Cercetări Marine (Recherches Marines), IRCM Constanţa, 19, 165.

ROSOIU N., CRASMARU M., PANAIT M., 1986 c - Cercetări Marine (Recherches Marines), IRCM Constanţa, 19, 157.

ROSOIU N., SERBAN M., VOINESCU I., POPESCU M., 1987 - Rev.roum.Biochim., 24, 1, 61.

ROSOIU N., SERBAN M., TANASESCU M., POPESCU M., CRASMARU M., 1989 - Rev.roum.Biochim., 26, 2, 145.

La biocalcification chez le Corail rouge, *Corallium rubrum*. 2. Approches Biochimique et Physiologique

Denis ALLEMAND et Marie-Christine GRILLO

Centre Scientifique de Monaco, Laboratoire de Biologie Marine, Musée Océanographique, MC 98000 (Monaco)

Bien que le squelette du Corail rouge de Méditerranée (*Corallium rubrum*) représente sa valeur économique, il est surprenant de constater que son mode de formation n'a jamais été étudié. Afin de tenter de combler cette lacune, le but de notre travail est, par une approche multidisciplinaire, de comprendre les mécanismes de biocalcification chez cette espèce.

Une étude morphologique des tissus à l'origine de la formation des structures calcifiées est présentée dans la commission zoobenthos. Le présent rapport montre nos résultats préliminaires concernant la composition de la matrice organique des structures squelettiques, ainsi qu'une approche physiologique grâce à la mesure de la production d'acidité et de la cinétique d'absorption de calcium par la colonie.

Plusieurs octocoralliaires ont déja servi de modèle biologique pour étudier la biocalcification (Kingsley et Watabe, 1983, 1989; Goldberg, 1988). Parmi ceux-ci, le Corail rouge présente l'originalité de posséder un axe central entièrement calcifié, alors que celui-ci est en grande partie constitué, chez la plupart des autres espèces, par une matrice cornée de nature protéique faiblement calcifiée (Kingsley et Watabe, 1983). Cette différence fournit donc matière à une étude comparative qui permettra de mieux comprendre les mécanismes cellulaires de la biocalcification et de son contôle.

ANALYSE BIOCHIMIQUE DES STRUCTURES CALCIFIEES.

En collaboration avec P. Simon (Musée d'anthropologie préhistorique de Monaco), nous avons montré, par diffractométrie à rayons X, que la phase minérale des deux types de structures calcifiées (spicules et squelette axial) est constituée de carbonate de calcium ($CaCO_3$) cristallisé sous la forme de calcite fibreuse. On note aussi la présence d'une faible quantité de magnésium.

Quel que soit le type de formation squelettique, il apparait qu'elle possède toujours une phase organique (dite matrice organique) liée à la phase minérale, dont la proportion est cependant trés variable (de 0,01 % à presque 20 %) (Weiner *et al.*, 1983). Cette matrice organique joue un rôle important dans le contôle de la biocalcification (Lowenstam et Weiner, 1989). Il est cependant admis dans la littérature que le squelette du Corail rouge manque totalement de matrice organique (Bayer, 1964).

Les fractions squelettiques (spicules et axe) sont obtenues aprés savoir dissous les tissus (NaOH N). Elles sont ensuite décalcifiées (à l'acide acétique pH4 ou à l'EDTA 0,5M pH8). A ce stade, nous avons obtenu une fraction organique représentant de 0,5 (squelette axial) à 0,9 % (spicules) du poids initial du squelette. Cette matrice organique se présente sous deux formes (séparées par centrifugation 10 000 g):

- l'une insoluble représentant de 55 % (axe) à 59 % (spicules) de la fraction organique,
- l'autre soluble.

L'analyse de cette phase organique montre qu'elle est composée d'environ 70 % de carbohydrates, 25 % de protéines et 5 % de lipides.

Afin de déterminer le poids moléculaire des protéines des deux fractions, nous avons effectué une électrophorèse sur gel de polyacrilamide en milieu SDS. Il n'a pas été possible de colorer ces protéines de façon classique (coomassie, argent). Cette difficulté, signalée par Venkatesan *et al.* (1986) lors de l'isolation de la matrice organique des spicules d'Oursin (*Strongylocentrotus purpuratus*), a été contournée en réalisant une iodation des protéines. Il semblerait qu'une protéine de 50 kD soit présente dans les deux phases. La phase insoluble possédent en outre une (des) protéine (s) de haut poids moléculaire (sup. à 300 kD).

La proportion de matrice organique trouvée dans les structures squelettiques du Corail est cependant trés inférieure à celle d'autres Octocoralliaires pour lesquels des valeurs de 4 à 6 % dans les spicules ont été rapportées (Kingsley et Watabe, 1983; Goldberg, 1988). Les valeurs que nous avons trouvées se rapprochent beaucoup plus des coquilles de Mollusques (Cariolou et Morse, 1988) ou des pièces squelettiques d'Oursin (Weiner *et al.*, 1983).

CINETIQUE D'ABSORPTION DE ^{45}Ca PAR UNE COLONIE.

Nous avons suivi l'incorporation de ^{45}Ca dans les différents compartiments d'une colonie de Corail rouge (tissus, squelette axial, spicules) de 30 minutes à 24 heures. L'équilibre isotopique est atteint dans les tissus en 5 heures environ. A partir de ce moment, on peut estimer que les RAS se sont égalisées entre le calcium tissulaire et le calcium dans l'eau de mer. Le dépôt de calcium dans les structures squelettiques peut alors être calculé (les valeurs de flux de ^{45}Ca sont calculées par rapport à la quantité de protéines tissulaires de la colonie ou du morceau de colonie étudié):

tissus:	4,96 +/- 0,69 nmol Ca (soit 198 ng Ca)/ 24h. mg protéine.
squelette:	6,20 +/- 1,45 nmol Ca (soit 248 ng Ca)/ 24h. mg protéine.
Spicules:	17,10+/- 3,90 nmolCa(soit 684 ng Ca)/ 24h. mg protéine.

Ces résultats montrent que les spicules sont le siège d'une intense activité de calcification. Afin de déterminer si l'activité de calcification était homogène dans l'ensemble de la colonie, nous avons mesuré la répartition du ^{45}Ca dans les différents compartiments de l'apex à la base de la colonie. Nos résultats ne montrent que de faibles différences (non significatives) en ce qui concerne le calcium absorbé par les tissus ou déposés sur le squelette axial. Par contre, les spicules présents dans les zones apicales et basales présentent une activité de calcification variant d'un facteur 2 par rapport à la zone médiane de la colonie. La quantité de spicules par rapport à la quantité de protéines reste cependant constante dans toute la colonie. Cette répartition suggère que les zones basales et apicales de la colonie sont le siège d'une spiculogénèse intense. Par contre, la formation de l'axe central est constante de la base à l'apex de la colonie. Kingsley et Watabe (1989) ont montré, chez *Leptogorgia virgulata* , une répartition similaire de l'absorption de ^{45}Ca au niveau des spicules et des tissus.

Nous avons d'autre part étudié les mécanismes de transport de calcium. Celui-ci est saturable, et possède une affinité pour le calcium (K_m) de l'ordre de 6 mM.

EVOLUTION DE L'EXCRETION D'H^+ PAR UNE COLONIE.

Afin de mesurer l'activité métabolique générale d'une colonie de Corail, nous avons mesuré son excrétion globale d'acide sur des périodes de temps variables. Nos résultats montrent que la production de H^+ n'est pas constante dans le temps. Elle évolue autour d'une valeur moyenne de 0,15 µequiv. H^+/ 30 min. pour une colonie d'environ 50 polypes, mais peut être totalement nulle sur des périodes de temps variable de quelques minutes à plus d'une heure. Cette production de H^+ est fonction du nombre de polypes ouverts. Ces résultats suggérent que l'activité métabolique du Corail est variable dans le temps, sans que l'on puisse cependant en dégager un cycle net. Il faut donc s'attendre à ce que la calcification présente aussi de telles variations.

Les résultats préliminaires présentés ici permettent d'esquisser un premier modèle de la biocalcification chez le Corail rouge (*Corallium rubrum*).

REFERENCES

BAYER F.M. (1964). Bull. Mar.Sci. Gulf & Caribb. 14: 465-478.
CARIOLOU M.A., MORSE D.E. (1988). J. Comp. Physiol. B. 157: 717-729.
GOLDBERG W.M. (1988). Histochem. 89: 163-170.
KINGSLEY R.J., WATABE N. (1983). Comp. Biochem. Physiol. 76B: 443-447.
KINGSLEY R.J., WATABE N. (1989). J. Exp. Mar. Biol. Ecol. 133: 57-65.
LOWENSTAM H.A., WEINER S. (1989). On Biomineralization. Oxford University Press.
VENKATESAN M, SIMPSON R.T. (1986). Exp. Cell. Res. 166: 259-264.
WEINER S., TRAUB W., LOWENSTAM M.A. (1983). Organic matrix in calcified exoskeletons. in: Biomineralization and biological metal accumulation. Westbroek P. et De Jong E.W. eds., Reidel Publishing Company, pp 205-224.

M-VII2

Réponse de *Pseudomonas aeruginosa* au stress marin

Amina BAKHROUF* , Michel J. GAUTHIER** et Moncef JEDDI*

*Laboratoire de Microbiologie, Faculté de Pharmacie de Monastir, Monastir (Tunisie)
**I.N.S.E.R.M. Unité 303, 1 Avenue Jean Lorrain, 06300 Nice (France)

Pseudomonas aeruginosa exposé au stress osmotique et au jeûne en milieu marin est profondément modifié. Il donne, à côté des formes bacillaires, des formes ovoïdes dont la taille est inférieure à 0,45 µm. Son unique flagelle disparaît. Diverses sortes de colonies sont alors obtenues selon la durée d'incubation en eau de mer et le milieu de récupération :

- des colonies muqueuses : obtenues après un à cinq jours d'incubation en eau de mer sur des géloses nutritives additionnées de 15, 20 ou 25g de NaCl/litre,elles présentent les mêmes caractères biochimiques sur Api 20 NE et Api Zym que la souche parentale.

- des colonies rugueuses : obtenues sur la gélose nutritive normale (GN), sur la gélose nutritive additionnée de 23g de NaCl (GN NaCl) et sur la gélose nutritive préparée à l'eau de mer (GN EM). Elles présentent de légères modifications phénotypiques par rapport à la souche initiale. Celles qui sont obtenues après des périodes d'incubation dépassant cinq mois sont plus profondément modifiées, elles élaborent un pigment jaune localisé au niveau des colonies, donc non diffusible dans la gélose. Son intensité dépend de la durée de vieillissement et de la lumière. Ces colonies ont un % GC de 59,8, ce qui confirme qu'il s'agit de colonies de *P. aeruginosa*.

Les caractères de ces colonies varient selon la nature des milieux de récupération.

Au cours de son incubation en eau de mer, *P. aeruginosa* devient plus actif sur les galeries Api Zym : il y a apparition d'une ß-galactosidase, d'une α et d'une ß-glucosidase et d'une valine arylamidase.

Après de longues périodes d'incubation dans l'eau de mer (dépassant 8 mois), il ne disparaît pas mais donne des colonies jaune à rouge, à culture très lente nécessitant plus de deux semaines d'incubation à une température de 24°C et de très petite taille (1 mm de diamètre). Ces colonies sont inactives sur Api 20 NE. Après culture en eau de mer additionée de bouillon nutritif à 5 %, elles donnent des colonies typiques de *P. aeruginosa* avec production caractéristique de pyocyanine et de pyoverdine.

Ces modifications peuvent avoir une influence sur la spécificité des méthodes utilisées pour le dénombrement de la bactérie dans les échantillons marins.

REFERENCES

BORTHAKUR, D., DOWNIE, J. A., JOHSTON, A.W.B. and LAMB, J.W., 1985. Psi a plasmid linked *Rhizobium phaseoli* gene that inhibits exopolysaccharide production and which is required for symbiotic nitrogen fixation. *Molecular and General Genetics,* 200:278-282.

COLWELL, R. R., BRAYTON, P.R., GRIMES, D.J., ROSZAK, D.B., HUQ, S.A. and PALMER,L.M., 1985. Viable and non culturable *Vibrio cholerae* and related pathogens in the environment : Implications for release of genetically engineered microorganisms. *Biotechnology*, 3:817-820.

GAUTHIER, M.J., MUNRO, P.M. and LAUMOND, F.M., 1987. Morphological and Physiological modification of enterobacteria (*Escherichia coli* model) in sea water. *First International Symposium of Microbial Ecology of the Mediterranean sea.* Sorrento (Naples), Italy.

M-VII3

p-Nitrophenylphosphatase activity in Marine Microalgae *Tetraselmis suecica*

J. BLASCO , L.-M. LUBIAN and R. ESTABLIER

Instituto de Ciencias Marinas de Andalucia (C.S.I.C.) 11510 Puerto Real (Spain)

Many species of algae are capable of obtaining phosphorus from esters in order to sustain growth in the absence of orthophosphate. Two enzymes, acid and alkaline phosphatases have been found in some species of marine microalgae. The cells contain two pools of phosphatases: 1) adaptative membrane enzymes responsible for phosphorus assimilation from the environment and 2) constitutive enzymes indispensable for intracellular formation of phosphomonoesters (Kluenzer & Perras, 1965; Lien & Knutsen,1973). However, the phosphohydrolases of algae have been rarely characterized biochemically. In this paper, the influence of pH, temperature, substrate and Pi concentration on phosphatase activity of crude cell-free extracts and whole cell of *Tetraselmis suecica* (Prasinophyceae) were analyzed.

The algae were grown in culture medium f/2 and collected at the postexponential growth phase.

Two extraction procedures for preparing crude cell-free extracts were carried out. In the first, the algae were filtered through a glass fiber filter (Whatmann GF/C), the filter was ground with glass powder in presence of buffer 100 mM Tris-HCl, pH 7.0. In the second extraction procedure, the culture was centrifuged (3.000 r.p.m for 15 minutes), the supernatant discharged and the pellet washed twice with 0.6 M NaCl. Finally 3 ml 100 mM Tris-HCl were added and sonicated for 20 minutes in two steps. The resulting extract was employed for the determination of phosphatase activities. The reaction mixture contained 1.0 ml buffer, 0.1 ml of substrate and 0.1 ml extract. When the influence of Pi was analyzed 0.1 ml of PO_4^{3-}(0-100µM) was added to the reaction mixture. The assays temperature was 40°C and the incubation time ranged from 30 to 60 minutes. The substrate concentration employed for Km and Vmax analysis ranged from 0 to 50 mM

For the whole cell phosphatase activity three series of tubes were prepared with a reaction mixture containing : a) 0.5 ml buffer + 25 µl substrate; b) 0.5 ml buffer + 0.5 ml filtrate culture + 25 µl substrate and c) 0.5 ml buffer + 0.5 ml microalgae culture diluted 1:5. The reaction mixture was incubated for 120 minutes at 20°C. Five ml of NaOH 0.1 M were added after completion of the incubation. In the case of a) 0.5 ml filtrate culture were added before the measurement. The substrate concentration for calculation of Km and Vmax ranged between 0 and 16 mM.
Results were expressed as µmol p-nitrophenol.culture $l^{-1}.min^{-1}$ for crude cell-free extracts and whole cell phosphatase activities.

In the assays carried out with crude cell-free extracts, the extraction procedure (grinding with powder glass or sonication) was very important in the preferential solubilization of enzymes. In both cases,the enzyme activity had two peaks at pH 5.5 and 8.5, but the ratio of them (pH 5.5/pH 8.5) for enzyme activity for grinding and sonication was 16.0 and 0.46 respectively.

Microscopical observations of residual pellets after two extraction procedures showed a great proportion of entire cells in the first case whereas total cell disintegration ocurred in the second one. Therefore, it should be considered that sonication results in a total cell disintegration with solubilizing of the membrane-bound enzyme, but when grindind with powder glass is employed, only a partial solubilitazion is observed.

The optimal temperature for phosphatases activities at pH 5.5 and 8.5 was found to lie within the range 40-45°C. The activation energy(Kcal.mol^{-1}) was 9.56 and 7.90 for pH 5.5 and 8.5 respectively, whereas the corresponding Km and Vmax values at pH 8.5 were 1.64 mM and 10.735 µmol.$l^{-1}.min^{-1}$. The PO_4^{3-} 100 µM inhibited competitively phosphatase activity at pH 8.5 (Ki=2.14 mM). In the range 1-10 µM inhibition was not observed for this phosphatase activity.

An exocellular phosphatase activity (pH 8.5) in incubation mixture was observed for this marine microalga, but within the range 0-100 µM PO_4^{3-} the inhibition was not clearly noticed.

The whole cell phosphatase activity showed an optimal pH 8.5, which corresponds to an alkaline phosphatase. The Km and Vmax values were 0.58 mM and 16.750 µmol $\cdot l^{-1} \cdot min^{-1}$.As in the case of the exocellular activity in the range 0-100 µM PO_4^{3-} an inhibition was not clearly observed.

REFERENCES.

KLUENZER, E.J. & J.P. PERRAS.- 1965. Phosphatases of marine algae. *Biol. Bull.*,128:271-284.

LIEN, T. & G. KNUTSEN.- 1973. Synchronous cultures of *Chlamydomonas reinhardi*: Properties and regulation of repressible phosphatases. *Physiol. Plant.*,28:291-298

M

Influence de la régulation osmotique pour la survie et l'adaptation d'*Escherichia coli* dans le milieu marin

Violette A. BREITTMAYER et Michel J. GAUTHIER

I.N.S.E.R.M. Unité 303, 1 Avenue Jean Lorrain, 06300 Nice (France)

La survie des bactéries pathogènes dans les milieux marins ou dans les estuaires a été l'objet de nombreuses études depuis plus d'un siècle (revue dans GAUTHIER et PIETRI, 1989). Cette survie dépend de nombreux facteurs physiques, chimiques et biologiques plus ou moins spécifiques de l'environnement marin. Si l'on excepte la lumière, dont l'effet bactéricide a été démontré, il semble que le maintien des bactéries entériques dans ces conditions dépend surtout de la présence de matières nutritives organiques ou minérales, qui peuvent éviter à ces germes organophiles un jeûne trop sévère. Cette carence nutritionnelle a été considérée comme le facteur majeur d'évolution vers la dormance, ou passage à l'état viable mais non cultivable (GRIMES and COLWELL, 1986).

Au cours des deux dernières années, nous avons apporté diverses données expérimentales montrant que les bactéries entériques sont capables de résister à l'activité antagoniste de l'eau de mer, voire même de s'adapter au milieu marin, lorsqu'elles peuvent réguler leur pression de turgescence et restaurer leur équilibre osmotique au moment de leur arrivée en mer (MUNRO et al., 1987, 1989).

L'influence des mécanismes d'osmorégulation sur la survie d'*Escherichia coli* (espèce considérée comme modèle) dans l'eau et les sédiments marins, a été analysée grâce à l'utilisation de nombreuses souches mutantes déficientes en chacun des systèmes de contrôle osmotique connus : accumulation d'ions potassium, accumulation ou synthèse (à partir de précurseurs intracellulaires comme la choline) de proline ou de bétaïnes (essentiellement glycine bétaïne, GB), synthèse intracellulaire de divers osmolytes compatibles avec le métabolisme comme le glutamate ou le tréhalose (revue dans CZONKA, 1989). Il a été conclu de cette étude préliminaire que *tous les processus qui permettent aux cellules d'équilibrer leur pression osmotique avant leur contact avec l'eau de mer aident à l'établissement d'un état de protection* très efficace, sous lequel elles persistent dans un état viable, cultivable et potentiellement virulent pendant de longues périodes (T90 à l'état normal, **2 à 3 jours,** à l'état protégé : **2 à 4 mois).** Sous cet état, les bactéries entériques conservent leur structure normale et maintiennent un certain nombre de propriétés qui disparaissent rapidement dans les cellules non protégées (MUNRO et al., 1987).

Deux des processus impliqués dans l'osmorégulation pourraient avoir une plus grande importance du point de vue écologique : **la synthèse intracellulaire d'osmolytes compatibles,** et **le transport de bétaïnes à partir du milieu.** Ce sont en effet deux voies par lesquelles les bactéries entériques transportées par les eaux usées pourraient restaurer leur équilibre osmotique dans les divers compartiments du milieu marin : eau, sédiments, surfaces d'algues, ou tractus digestif d'animaux. Tous deux nécessitent théoriquement la croissance, même très restreinte, des cellules leur assurant le maintien d'un niveau métabolique relativement important.

La protection conférée par l'accumulation de bétaïnes (qu'elles soient d'origine exo ou endogène) a fait l'objet de tests plus approfondis, visant à définir dans quelle mesure elle peut se développer *dans les conditions marines, soit dans les eaux oligotrophes, soit dans les sédiments contenant des quantités variables de matières organiques.* On sait en effet que ces amines quaternaires (I) sont présentes dans les sédiments marins et sont produites par de nombreux micro-organismes, végétaux et animaux pour leur adaptation aux milieux salés (KING, 1988), (II) agissent comme osmoprotecteurs pour une grande variété de micro-organismes, (III) sont accumulées par les bactéries entériques même lorsqu'elles sont présentes à l'état de traces (µg/kg) et (IV) restaurent immédiatement le métabolisme des cellules en état de choc osmotique.

Dans les eaux marines oligotrophes, nous avons montré que ni l'expression de gènes codant pour les systèmes de transport de la GB (*proU, proP),* ni le fonctionnement de ces systèmes ne permettent le transport et l'accumulation de cet osmolyte. Par contre, dans certains sédiments marins à haute concentration en carbone organique (C.O.T.) et en ions phosphates, ces gènes sont exprimés et les deux systèmes ProP et ProU fonctionnent, conférant aux cellules l'état de protection mis en évidence auparavant. Nous avons en outre montré qu'en présence de GB, les cellules d'*E. coli* peuvent échanger plus facilement *entre elles* certains plasmides de résistance aux antibiotiques (plasmide RP4, résistance à kanamycine, ampicilline, tétracycline).

En conséquence, il semble que certaines eaux eutrophisées et surtout certains sédiments marins puissent être considérés comme des zones "à risque", car ils pourraient jouer le rôle de réservoirs pour les bactéries entériques (indicateurs et pathogènes) et conférer à ces germes une résistance accrue au milieu marin. Ces formes résistantes, relativement **adaptées** aux conditions marines, seraient en particulier beaucoup plus aptes à survivre dans la colonne d'eau, après leur remise en suspension par les courants, les vagues ou les marées. En outre, ces zones seraient beaucoup plus favorables à la dissémination "in situ" des gènes plasmidiques hébergés par les bactéries d'origine intestinale (humaine ou animale).

REFERENCES

CZONKA, L.N., 1989. Physiological and genetic responses of bacteria to osmotic stress. Microbiol. Rev. 53 : 121-147.

GAUTHIER, M.J. et PIETRI, C., 1989. Devenir des bactéries et des virus entériques en mer. In : M. Bianchi, D. Marty, J.-C. Bertrand, P. Caumette et M.J. Gauthier (eds). Micro-organismes dans les écosystèmes océaniques. Masson, Paris, pp. 319-342.

GRIMES, D.J. and COLWELL, R.R., 1986. Viability and virulence of *Escherichia coli* suspended by membrane chamber in semitropical ocean water. FEMS Microbiol. Lett. 34 : 161-165.

KING, G.M., 1988. Distribution and metabolism of quaternary amines in marine sédiments. In : T.H. Blackburn and J. Sorensen (eds.). Nitrogen cycling in marine environments. John Wiley & Sons Ltd, N.Y., pp. 143-173.

MUNRO, P.M., GAUTHIER, M.J. and LAUMOND, F., 1987. A previous growth of enteric bacteria on a salted medium increases their survival in seawater. Lett. Appl. Microbiol. 4 : 121-124.

MUNRO, P.M., GAUTHIER, M.J., BREITTMAYER, V.A. and BONGIOVANNI, J., 1989. Influence of osmoregulation processes on starvation survival of *Escherichia coli* in seawater. Appl. Environ. Microbiol. 55 : 2017-2024.

Influence de certains paramètres physico-chimiques sur la fixation du Cadmium par *Vibrio parahaemolyticus*

René L. CLEMENT , Gilles N. FLATAU , Michel J. GAUTHIER et Fereydoun MAHDYOUN

Institut National de la Santé et de la Recherche Médicale, Unité 303 "Mer et Santé", 1 Avenue Jean Lorrain, 06300 Nice (France)

L'industrialisation génère une augmentation de la concentration des métaux lourds dans l'environnement, et parmi ceux-ci, le cadmium, élément sans fonction biologique connue. Dans le milieu marin, la fixation de ce métal par les bactéries dépend entre autres, de facteurs physico-chimiques tels que le pH, la salinité, la température, le potentiel d'oxydoréduction. La plupart des auteurs ne prennent en compte que la variation d'un paramètre, bien que la teneur en oxygène dissous décroit considérablement dans la colonne d'eau (Khalid, 1980).

Le but de cette étude était donc de comparer l'influence de ces facteurs environnementaux dans un milieu non nutritif simulant l'eau de mer, en aérobiose ou en anaérobiose, par *Vibrio parahaemolyticus,* bactérie aérobie facultative, ubiquiste des milieux estuariens et côtiers marins.

Quel qu'ait été le facteur considéré, la fixation du métal était une fonction monotone croissante du temps. Elle dépendait du pH, de la teneur en NaCl, de la température, et dans certains cas, de l'oxygénation du milieu.

A pH 8,5, les cellules de *Vibrio parahaemolyticus* immobilisaient une quantité appréciable de métal pendant les 2 premières heures de contact. Excepté ce pH alcalin, l'acidification du milieu a significativement favorisé la fixation du métal en 4 heures aussi bien en aérobiose qu'en anaérobiose. Le pH jouerait donc un rôle important lors de la fixation du métal sur ou dans les cellules bactériennes, en modifiant l'état ionique du métal, et/ou en changeant la réponse biologique au niveau cellulaire, par perturbation structurale ou fonctionnelle des enveloppes (Gauthier et Flatau, 1980 ; Campbell et Stokes, 1985).

L'influence de la concentration en NaCl sur la fixation du cadmium par la souche test pourrait provenir des variations subséquentes de la teneur en chlorures du milieu, donc des formes chlorées du métal (Gauthier et Flatau, 1980 ; Flatau et coll., 1986). La fixation du métal en aérobiose et en anaérobiose était une fonction décroissante de la teneur en NaCl. La cinétique de fixation était beaucoup plus rapide en milieu à faible salinité (5g NaCl/l) dans les 2 conditions d'oxygénation, ce qui, outre la modification de la forme du métal pouvait, être la conséquence, (i) d'une augmentation de la perméabilité cellulaire (Bertrand et Larsen, 1988), (ii) d'une accélération de la fixation du métal consécutive à une activation du métabolisme et en particulier de l'activité respiratoire (Clément, 1985 ; Gauthier et coll., 1986), (iii) d'une augmentation du nombre de sites de fixation du métal sur les enveloppes.

La quantité de cadmium fixé par cette bactérie mésophile était par ailleurs une fonction croissante de la température dans les deux conditions d'oxygénation. Cette augmentation pouvait donc être liée au métabolisme énergétique (aucune croissance à 4°C)

Les variations physico-chimiques du milieu revêtent, donc à l'évidence, une grande importance sur un plan écotoxicologique, car elles modifient très largement la forme ionique des métaux et influencent directement l'état structural et fonctionnel des cellules bactériennes réceptrices. C'est particulièrement le cas pour le milieu marin, où la concentration saline influe d'une manière déterminante sur la spéciation du métal et le métabolisme des micro-organismes.

Références

BERTRAND J.C., LARSEN H., 1988. La "bactérie marine" : mythe ou réalité. In : *Les micro-organismes dans les écosystèmes océaniques.* Ed Bianchi M., Marty D., Bertrand J.C., Caumette P. et Gauthier M., Masson et Cie, Paris.

CAMPBELL P.G.C., STOKES P.M., 1985. Acidification and toxicity of metals to aquatic biota. *Can. Fish Aquat. Sci.,* 42 : 2034-2049.

CLEMENT R.L., 1985. Etude écophysiologique de la résistance et de l'accumulation du cadmium par les bactéries hétérotrophes marines à Gram négatif. *Thèse Ecole Pratique des Hautes Etudes.* Marseille, France p. 59.

FLATAU G.N., CLEMENT R.L., GAUTHIER M.J., 1986. Influence of salinity and organic matter on cadmium accumulation by a marine pseudomonad. *Microbios Letters.,* 32 : 141-1

GAUTHIER M.J., FLATAU G.N., 1980. Etude de l'accumulation du cadmium par une bactérie marine en fonction des conditions de cultures. *Chemosphere.,* 9 : 713-718.

GAUTHIER M.J., CLEMENT R.L., FLATAU G.N., AMIARD J.C., 1986. Accumulation du cadmium par les bactéries marines à Gram négatif selon leur sensibilité au métal et leur type respiratoire. *Oceanologica Acta.,* 9 : 333-337.

KHALID R.A., 1980. Chemical mobility of cadmium in sediment -water systems. In: Ecological Cycling 257-304. Ed. J.O. Nriagu N.Y. U.S.A.

M-VII6

Role of some organic substrates in Cadmium uptake by a Marine Bacterium

G.-N. FLATAU , R.-L. CLEMENT , F. MAHDYOUN and M.-J. GAUTHIER

I.N.S.E.R.M. Unité 303, 1 Avenue Jean Lorrain, 06300 Nice (France)

INTRODUCTION

It has been shown for a long time, that microorganisms are able to take up metals and particularly cadmium from their medium (Tornabene and Edwards, 1972; Gauthier and Flatau, 1980). The amount of cadmium absorbed seems to be an intrinsic characteristic of the strain rather than that of the species (Tynecka et al., 1981 a, b) and cadmium sensitive strains generally take up more cadmium than resistant ones (Gauthier et al., 1986). For a given strain however, the cellular content of cadmium also depends on extrinsic physicochemical parameters like temperature, pH (Titus and Pfister, 1982), salinity or the presence of organic matter (Flatau et al., 1986).

Saccharose (SAC), glucose (GLU), sodium succinate (SUC), gluconate (GLC), acetate (ACE), glycerophosphate (GLY), pyruvate (PYR), organic substrates eventually used as carbon sources or involved in the tricarboxylic cycle were therefore investigated to determine their possible role in the fixation of cadmium by a marine pseudomonad. As sensitivity to metals of microorganisms greatly depends on their nutritional state (Brynhildsen et al., 1988), this study was carried out on freshly harvested cells (fresh cells) and starved cells.

RESULTS AND DISCUSSION

Although the presence of glucose stimulated respiratory activity in fresh cells, it induced a decrease of 27 % in the cellular amount of cadmium. In starved cells however, glucose stimulated respiratory activity and induced an increase of 27 % in the cellular amount of cadmium. This could suggest the presence of an efflux mechanism which would be activated in non limited cells only, as supposed by Brynhildsen et al., (1988). On the other hand, the addition of energy and carbon (as glucose) may have energized the transport of cadmium in starved cells as it was supposed for the transport of zinc in *Escherichia coli* (Bucheder and Broda, 1974).

The other substrates had a more attenuated effect on Cd uptake by fresh cells. A trend in the inhibition of Cd uptake was supposed but could not be confirmed because of the too slight variations of the results relative to their variance.

On the other hand, a significative stimulation of Cd uptake in starved cells by the tested substrates was observed (Fig. 1), which was not correlated to the stimulation of respiratory activity.

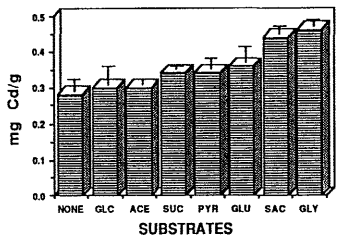


Fig. 1 : *Stimulation of cadmium uptake by starved cells in the presence of gluconate (GLC), acetate (ACE), succinate (SUC), pyruvate (PYR), glucose (GLU), saccharose (SAC) and glycerophosphate (GLY), (final concentration, 2g/l).*

In conclusion, the uptake of cadmium greatly depends on the nutritional state of cells at least for the tested strain. In starved cells, the supply of energy and carbon stimulated Cd uptake, probably because this latter was probably an energy-dependend mechanism (Flatau et al., 1989). On the other hand the absorption of cadmium could be limited by efflux mechanisms activated in non limited organisms.

LITERATURE CITED

Brynhildsen, L., Lundgren, B.V. Allard, B. and Rosswall, T. 1988. Effects of glucose concentrations on cadmium, copper, mercury and zinc toxicity to *Klebsiella aerogenes* sp. *Appl. Environ. Microbiol.* 54 : 689-693.

Bucheder, F. and Broda, E. 1974. Energy dependent zinc transport in *Escherichia coli. Eur. J. Biochem.* 45 : 555-559.

Flatau, G.N., Clément, R.L. and Gauthier, M.J. 1986. Influence of salinity and organic matter on cadmium accumulation by a marine pseudomonad. *Microbios Lett.* 32 : 141-146.

Flatau, G.N., Clément, R.L., Mahdyoun, F., Leblanc, G. and Gauthier, M.J. 1989. Role of transmembrane electrical potential on cadmium fixation by a marine pseudomonad. *Res. Microbiol.* 140 : 553-562.

Gauthier, M.J., Clément, R.L., Flatau, G.N. et Amiard, J.-C. 1986. Accumulation du cadmium par des bactéries à Gram négatif selon leur sensibilité au métal et leur type respiratoire. *Oceanologica Acta.* 9 : 333-337.

Gauthier, M.J. et Flatau, G.N. 1980. Etude de l'accumulation du cadmium par une bactérie marine en fonction des conditions de cuture.*Chemosphere.* 9 : 713-718.

Titus, J.A. and Pfister, R.M. 1982. Effects of pH; temperature and Eh on the uptake of cadmium by bacteria and an artificial sediment. *Bull. Environ. Contam. Toxicol.* 28 : 697-704.

Tornabene, T.G. and Edwards, H. 1972. Microbial uptake of lead. *Science.* 1976 : 1334-1335.

Tynecka, Z., Gos, Z and Zajac, J. 1981a. Reduced cadmium transport by a resistance plasmid in *Staphylococcus aureus. J. Bacteriol.* 147 : 305-312.

Tynecka, Z., Gos, Z. and Zajac, J. 1981b. Energy depend efflux of cadmium coded by a plasmid resistant determinant in *Staphylococcus aureus. J. Bacteriol.* 147 : 313-319.

M-VII7

Partial characterization of Glutamic Oxaloacetic Transaminase from the Clam *Ruditapes philippinarum* (Mollusca, Bivalvia)

J. PUPPO and J. BLASCO

Instituto de Ciencias Marinas de Andalucia (C.S.I.C.) 11510 Puerto Real (Spain)

Molluscs are the principal subjects of marine pollution biomonitoring because of their widespread occurrence in coastal areas, their ability to accumulate various pollutants, and their tolerance to pollution. Biochemical indices of metabolism are subtle indicators of the physiological state of the organism. An important indice of the metabolism of molluscs under altered environmental conditions may be the activity levels of enzymes involved in adaptative readjustments (Goromosova & Tamozhnyaya, 1979). One of these enzymes could be the transaminase GOT (glutamic oxaloacetic transaminase, E.C.2.6.1.1), catalyzing the interconvertion of aspartate into 2-oxoglutarate, an intermediate of Krebs cycle. This enzyme, as well as the transaminase GPT (glutamic pyruvic transaminase, E.C.2.6.1.2), has been found in all the body tissues from all the molluscan species investigated (Bishop et al., 1983). Studies on kinetic characterization of the aminotransferase GOT showed a wide variability in the kinetic properties according to the species. This paper presents results of the kinetic characterization of GOT from *R. philippinarum*, as a first step of a further toxicological study in which this enzyme activity will be evaluated as a biochemical indicator of physiological stress induced by heavy metal exposure.

Material and methods.

Samples of *R. philippinarum* were obtained from a clam farm (Bay of Cádiz, Spain) in January and February 1990. Clams were depurated 24 hours in filtered sea water. Gills and digestive gland extracts were made by homogeneization in a mortar with glass powder in an adequate volume of the extraction buffer (80 mM Tris/HCl, pH=7.5, 0.25 M sucrose, 5 mM EDTA, 2 mM DTT and 1mM PMSF). The homogenate was filtered through a gauze, sonicated and centrifugated at 27000 g for 15 minutes. Then, the supernatant was filtered through a Sephadex G-25 column to remove endogenous salts, as well as some metabolites, and was used as the enzyme source for kinetic characterization assays. GOT activity was spectrophotometrically measured in the direction of oxaloacetate formation, following NADH oxidation at 340 nm in a coupled malate dehydrogenase reaction. The reaction mixture in a final volume of 2.5 ml contained 0.4 ml enzyme extract in adequate dilution, 0.6 U/ml de malate dehydrogenase, 1.2 U/ml de lactate dehydrogenase, 0.18 mM NADH, 80 mM phosphate buffer (pH=5.0-8.0) or 80 mM Tris/HCl buffer (pH=7.5-10), aspartate (0.1-100 mM) and 2-oxoglutarate 0.01-6 mM).

Results and discussion.

Figure 1 shows the effect of pH on GOT activity. GOT activity in Tris/HCl buffer is greater than in phosphate buffer, indicating a possible inhibitory effect of ion phosphate. The optimal pH for the glutamate oxaloacetate transaminase seemed to be at pH 8.0. This pH value is in agreement with those reported in other species of bivalves (7.7-8.5) by Bishop et al. (1983).

The apparent Km values for aspartate and 2-oxoglutarate at pH 8.0 in gills and digestive gland enzymes are listed in the following Table:

Organ	Km (asp)	Km(2-og)
Gills	0.73 mM	0.065 mM
Digestive gland	0.69 mM	0.076 mM

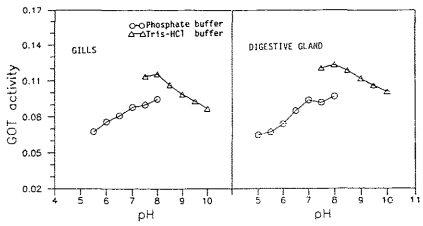


Fig.1. Effect of pH on GOT activity from gills and digestive gland.

These Km values are similar to those reported for the GOT from mussel gills (Paynter et al., 1984) and from squid axoplasm (Bishop et al., 1983). The double reciprocal plots of initial velocity versus substrate concentrations were clearly linear showing no co-operative effects in the enzyme (the Hill coefficient was aproximately equal to 1 in all the cases). The pH effect on the Km for aspartate and 2-oxoglutarate was also studied. No appreciable variation in the value of Km for 2-oxoglutarate was found, whereas a considerable increase of Km for aspartate was detected at pH 6 (Km = 1.36 mM). This strong reduction of the enzyme affinity to aspartate with a decreasing pH was also found in GOT mussel gills by Paynter et al. (1984). Figure 2 shows the effect of incubation temperature on GOT activity from gills and digestive gland. After a 5 minutes preincubation period, reaction was initiated with addition of 2-oxoglutarate, and NADH oxidation was measured for 2.5 minutes. Thermic denaturation of the enzyme occurs above 50°C. The activation energy, calculated from Arrhenius plot, was the same in gills and digestive gland (11.597 Kcal/mol).

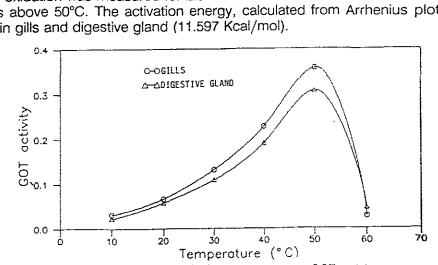


Fig.2. Effect of incubation temperature on GOT activity.

References.

BISHOP, S.H., ELLIS, L.L. AND BURCHAM, J.M.- 1983. Amino acid metabolism in molluscs. In: Hochachka, P.W. (ed.), *The Mollusca*, vol. 1, Academic Press, New York, pp. 243-327.

GOROMOSOVA, S.A. AND TAMOZHNYAYA, V.A.- 1979. Level of transaminase activity in tissues of mussel under normal conditions and in hypoxia. *Biologiya morya* (Kiev), No. 48, pp. 70-75.

PAYNTER, K.T., HOFFMANN, R.J., ELLIS, L.L AND BISHOP, S.H.- 1984. Partial characterization of the cytosolic and mitochondrial aspartate aminotransferase from ribbed mussel gill tissue. *J. Exp. Zool.*, 231, pp. 185-197.

O-I1

Progress in the Understanding of the Eastern Mediterranean Sea

Allan R. ROBINSON
Harvard University, DAS, Cambridge, MA (U.S.A.)

The basin scale general circulation of the Eastern Mediterranean is now known to consist of a number of sub-basin scale cyclonic and anticyclonic gyres linked by jets and currents. Variabilities include changes in shape, location and strength of the gyres and gyre oscillations, and meander and bifurcations of the currents and jets. Other sub-basin scale vortices and currents are recurrent or transient and jet segments and filaments interleave and interconnect the field of sub-basin scale eddies and gyres. A smaller but energetic synoptic or mesoscale exists, consistent with an internal Rossby radius of $\sim$ 10 km, which interacts with the sub-basin scale features. This new picture has emerged from the coordinated and pooled field data (1985–1987) from the first phase of the POEM program, based on objective analysis of this data set. A systematic taxonomy is presented. Dynamical issues concern the local dynamics of the sub-basin scale feautres, their linked interactions which constitute the dynamics of the general circulation and the physics of the sub-basin/mesoscale processes. The Harvard dynamical models are initialized with the analyzed fields. The dynamically adjusted and interpolated data provides the best possible three- and four-dimensional fields based on the observations, which are suitable for research requiring detailed transport and dispersion, e.g. biological and chemical studies. Detailed energy and vorticity studies of the physical fields reveal process. The complexity of the system is addressed by initialization and studies of sub-basin scale features and subregions as well as the entire Eastern Mediterranean basin.

O-I2

The General Circulation of the Eastern Mediterranean

Paola MALANOTTE RIZZOLI
Massachusetts Institute of Technology, Cambridge, MA (U.S.A.)

A review is first given of the past phenomenological beliefs and the related structure of the general circulation. Major water mass formation processes are identified and the water masses pathways are discussed. This historical picture is then reanalyzed in view of the most recent observational evidence provided by the general surveys of the POEM program. This new picture of the general circulation reveals sub-basin scale gyres to be the building blocks of the circulation, interconnected by jets and coastal currents that transport and mix the surface and intermediate water masses. The deep circulation is comprised of a single thermohaline cell that originates in the southern Adriatic - northern Ionian sea with the deep water spreading towards the eastern Levantine Basin. Numerical modelling simulations are finally reviewed and discussed with relationship to the above new phenomenology.

O-I3

Status of and the potential for the understanding of the western Mediterranean Sea

Claude MILLOT

Antenne COM, B.P. 330, 83507 La Seyne-sur-Mer (France)

This paper focuses on the circulation of the water masses because we now have relatively good data sets and seemingly efficient theoretical models, which allows us to expect a correct understanding of this basic phenomenon in the very near future.

The gross features of the circulation, at least in regions where it is relatively stable, and mainly for what concerns the surface layer of Modified Atlantic Water (MAW), have been established several decades ago from a quite-surprisingly very reduced number of hydrological casts. But, it is only since a few years that satellite data and long current time series have provided us with a significantly improved description of the mesoscale variability of the circulation and, to a lesser extent, of its seasonal variability.

We first review the most important results concerning the mesoscale variability, recently obtained in the Alboran Sea and in the Algerian and northern basins mainly. This variability manifests itself either as fluctuations of the major coastal currents, such as meanders, or as coherent structures resulting from instability processes affecting these currents, such as eddies. The space (some tens to a few hundreds of km) and time (a few weeks to several months) scales of these mesoscale phenomena, as well as their relatively intense signature in remotely-sensed and in situ measurements, allow an efficient description of their characteristics: it is obvious that the importance of these phenomena has been greatly underestimated for a long time. Now, even if they are easily measured and relatively well described, the understanding and modelling of the mesoscale phenomena are generally far from being satisfactory.

Interesting results have also been obtained concerning the seasonal variability, in the Straits of Gibraltar and Sicily and in the Corsican Channel as well. As the actual working of the whole sea -which basically transforms surface waters into deeper ones during the winter- is seasonal, one could expect a clear corresponding variability of the circulation. But this takes no account i) of the characteristics of the Strait of Gibraltar which constrains the exchanges with the ocean to be more or less maximal, ii) of the relatively large intensity of mesoscale phenomena and other subinertial variations of the flows and iii) of the fact that direct current measurements are neither numerous nor long enough to give an accurate estimation of the transports. Now, even if not easily estimated, the seasonal variability may be expected to be quite well understood with numerical models.

A better understanding of this seasonal variability is the primary objective of PRIMO, a several-year "International Research Programme in the Western Mediterranean" supported by IOC and ICSEM, in which most of the physical oceanographers interested in the western Mediterranean Sea are involved. Our strategy is to conceive an experiment aimed i) to specify more accurately the major characteristics of the seasonal variability of the circulation and ii) to check for all the mechanisms expected to be responsible for such a variability.

Another point to which it would certainly be fruitful to pay more attention concerns the mean paths described by the Levantine Intermediate Water (LIW) and by the western Mediterranean Deep Water (MDW). In fact, on the basis of hydrological and direct current measurements, it seems obvious that both water masses basically flow cyclonically along the continental slope in the whole sea. This is of primary importance, because such paths offer simple conditions to check for the validity of numerical models (for LIW) or because the forcing mechanisms are far from being obvious (for MDW); moreover, we suspect the circulation at depth to significantly influence, at least in some regions, the circulation of the surface layer.

Finally, we emphasize the relatively close similarities which exist with other semi-enclosed seas such as the eastern Mediterranean Sea and the Japan Sea, and we underline the various interests of companion studies.

O-I4

Some recent aspects of the modelling of the Circulation of the Mediterranean Sea

M. CREPON*, G. MADEC*, L. MORTIER*, M. CHARTIER**, C. HERBAUT* and S. SPEICH*

*LODYC, University of Paris 6, Paris (France)
**CEA, Paris (France)

In this work, we present several process studies which have been obtained with the 3D primitive equation numerical model of LODYC prior to make a realistic model of the circulation of the Western Mediterranean Sea.

First, deep water formation is investigated with a high resolution three dimensional model. A rectangular basin is forced by various sea surface heat and salt fluxes. A 1,000 thick patch of dense water is formed within the forcing area, which is surrounded by a cyclonic vortex. Meanders develop at the periphery of the patch and then tend to occupy the whole patch area. Energy studies show that the meanders are generated through a baroclinic instability process. These features agree with observations. Sensivity studies of the space and time variability of the forcing are presented. It is found that these variabilities greatly affect deep water formation. Deep water formation appears to depend on a convective process parameterized by a simple non-penetrative convective adjustment and on the vertical motion induced by baroclonic instability. The two processes are strongly linked. Furthermore, deep convection induced by the thermohaline forcing drives an horizontal cyclonic circulation of the same order of magnitude as that estimated from observations. Hence it is found that thermohaline forcing is important in driving the Mediterranean circulation andthat it must be included in any numerical model of this area.

Second, the behavior of the Algerian current is investigated. The current is forced by an initial field of density in a periodic rectangular channel. After a long time which is of the same order as that observed on the physical simulations made on the large rotating table of Grenoble, meanders develop. Their wavelength is of the same order as those observed in nature and in the physical simulation. These meanders are due to baroclinic instability and their characteristics fit an analytical theory which has been developed.

Third, the generation of the flux through the strait of Gibraltar and the formation of the Almeria-Oran front is investigated. A fixed density gradient is imposed between the Mediterranean Sea and the Atlantic Ocean. It is maintained constant by a newtonian restoring on climatological values. This procedure generates a realistic flux through the strait which has some degrees of freeedom and allows variability linked to variations in the density gradient. Furthermore, the gyres of the Alboran Sea are generated and their behavior is discussed.

O-II1

Objective analysis of biological data from P.O.E.M. Cruises

A. BERGAMASCO*, S. RABITTI** and E. PIERAZZO*

*Istituto Studio Dinamica Grandi Masse-CNR, San Polo 1364, 30125 Venezia (Italia)
**Istituto di Biologia del Mar-CNR, Riva dei sette Martiri 1364/A, 30122 Venezia (Italia)

Objective analysis is essentially an interpolation technique used to estimate a given physical quantity at points where there are no measurements, from data available at different locations. This technique is based on the Gauss Markov theorem which gives an expression for the least square error linear estimate of variables, given the measurements at a limited number of data points. In order to have a better correlation function the statistical Baysean theory could be applied to experimental data.

The application of these techniques are shown in processing the P.O.E.M. cruises data (POEM01 10/21-11/8 85, POEM03 11/1-11/14 86, POEM05 8/31-9/14 87) to produce maps of the Ionian distribution of O_2, $N\text{-}NO_3$, $N\text{-}NO_2$, $N\text{-}NH_3$, $P\text{-}PO_4$, $Si\text{-}SiO_4$, chlorophyll and total suspended matter.

The typical objective analysis maps will be compared with the dynamic fields obtained from the oceanographic data of the same campaigns.

O-II2

The upper layer circulation in the Sea of Marmara as inferred from the hydrographic data

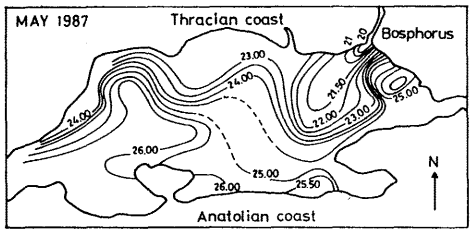
S. BESIKTEPE, T. OGUZ and H.-I. SUR

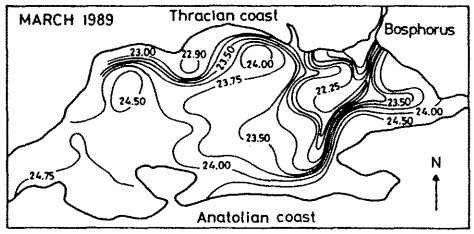
Middle East Technical University, Institute of Marine Sciences, P.O. Box 28, Erdemli, 33731, Icel (Turkey)

The Sea of Marmara, together with the Bosphorus and Dardanelles Straits, forms the Turkish Straits (TS) which constitutes an oceanic system joining two of the world's largest isolated seas with extremely different water mass properties. The low salinity waters of the Black Sea, formed as a result of excess of precipitation and run-off over evaporation, are transported to the Mediterranean through the TS as a surface flow. In return, the saltier and heavier waters of the Mediterranean Sea, generated by the excess of evaporation over fresh water input, flow as an undercurrent to the Black Sea. In evolution through TS, they generate a transitory state between the two extremes found in the adjoining seas, with constraints imposed by the hydrodynamical controls of the two straits as well as the interactions of the straits with the Sea of Marmara and the interactions of the entire system with the atmosphere.

The Bosphorus upper layer flow enters the Bosphorus-Sea of Marmara junction region in the form of a shallow and narrow turbulent buoyant jet with currents in excess of 2 m/s. Immediately south of the junction region, the jet tends to spread asymmetrically with more intense currents concentrated towards the Anatolian side. The surface flow, proceeding in the southerly direction, then bifurcates into two branches. As one branch turns eastward and enters into the Izmit Bay, the main branch turn anticyclonically toward west-northwest in the direction of the Thracian coast. Inside the westward curling main flow, the surface waters form a quasi-permanent sub-basin scale eddy. The size and the strength of the eddy varies depending on the atmospheric conditions and the strength of the outflow from the Bosphorus. Most drastic changes occur when the region is under the effect of south westerlies during the winter months. Under these conditions, the jet core emanating from the Bosphorus tends to deflect towards the Thracian side and the anticyclonic eddy has an elongated shape along the coast. The upper layer flow, upon reaching the Thracian coast of the basin, then proceed westward in the form of a baroclinically unstable meandering rim current along the topographic slope.

For surface outflows having an internal hydraulic control present at the exit to the adjacent basin, as observed in the Bosphorus, the left-hand attachment of the flow immediately outside the channel exit and the resulting generation of the anticyclonic eddy occur when the flow acquires negative relative vorticity with a magnitude comparable to the Coriolis parameter (Wang, 1987). This negative vorticity is generated by strong upward vertical velocity induced during the critical transition of the outflow (Wang, 1987).





The linear baroclinic stability analysis developed for two-layer channel flows with sloping bottom topography (Mysak, 1977), adapted for the Sea of Marmara indicates that the westward moving rim current is indeed baroclinically unstable. The wavelength and period of the most unstable waves are found to be O(90 km) and O(5 days) respectively.

REFERENCES

Mysak, L.A., (1977): On the stability of the California Undercurrent off Vancouver Island. J. Phys. Oceanogr., 7, 904-917.

Wang, D.P., (1987): The strait surface outflow. J. Geophys. Res., 92, 10807-10825.

Variabilité des caractéristiques hydrologiques profondes de la Méditerranée sous l'effet de forçages climatiques

Jean-Pierre BETHOUX* , Claudie BOURNOT** , Claude LAMBERT*** , Jean RAUNET* et Dominique TAILLIEZ*

*LPMC, Université Paris 6, CNRS, B.P. 8, 06230 Villefranche-sur-Mer (France)
**INSU/IUT, Faculté des Sciences, 29287 Brest (France)
***CFR, B.P. 1, 91198 Gif-sur-Yvette (France)

Dans les années 1960 et 1970 le Basin Nord Occidental a constitué une zone test internationale d'étude des processus de formation d'eau profonde (MEDOC Group, 1970; Tchernia, 1974). De l'analyse des campagnes océanographiques (Prieur et al., 1983; Lacombe et al., 1985) ressort une variabilité interannuelle des eaux denses néo-formées du bassin Occidental. Elle se traduit par l'occurence épisodique de maxima ou minima de T et / ou de S au voisinage du fond, bien au delà de la région septentrionale de formation et plongée d'eaux denses.

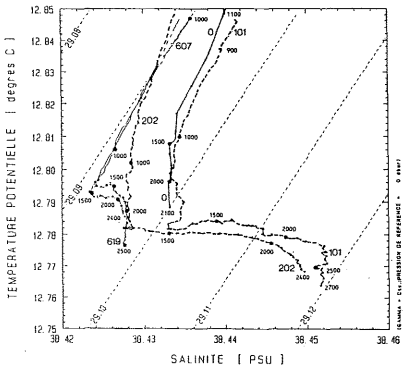


Fig.1- Agrandissement du diagramme température potentielle/salinité en Méditerranée Occidentale (stations 101, 202, 607, 619 et 0) pour les eaux profondes (z>900m) avec indication de quelques profondeurs (en m).
Enlargement of Θ/S diagram in the Western Mediterranean stations 101, 202, 607, 619 and 0, for deep-water (z>900m) with some depths (in m).

Les mesures réalisées au cours des campagnes MEDATLANTE (programme JGOFS-France 1989-90), à 7 mois d'intervalle, permettent de donner une nouvelle image spatio-temporelle de cette variabilité des eaux profondes aux stations 101 et 607 situées au centre du bassin Algéro-provençal (40° N, 6° E) et aux stations 202 et 619, à l'extrémité est de la mer d'Alboran (36.39 N, 1° W), visitées en décembre 1988 et août 1989, ainsi qu'en une station 0, en mer Ligure, au large de Nice, en juillet 1989. Les diagrammes Θ-S de la figure 1 sont des agrandissements pour la couche 800m-fond . En décembre 88, les eaux profondes aux stations 101 et 202 montrent une nette augmentation de la salinité, environ 0,02 psu , entre 1200-1300m et le fond (2400 et 2700m), pour une diminution de température d'environ 0,01 à 0,02°C. En ces mêmes stations (607 et 619), revisitées en août 89, la même couche profonde 1200m-fond ne montre plus qu'une augmentation de salinité de l'ordre de 0,005 psu, pour une diminution de température équivalente à celle de décembre. De plus, en la station 0 de mer Ligure, en juillet 89, le profil profond Θ-S peut être apparenté à celui des stations 607 et 619 en août 89. Compte tenu de la position géographique des stations 607, 619 et 0, la structure des eaux profondes du bassin Algéro-provençal apparait homogène tant en décembre 88 qu'en août 89, mais avec une modification de la salinité profonde entre ces deux périodes. Ces nouvelles donnes: homogénéité spatiale et échelle de temps de 7 mois sont à verser au dossier d'étude de variabilité annuelle des eaux profondes (Lacombe et al., 1985)).

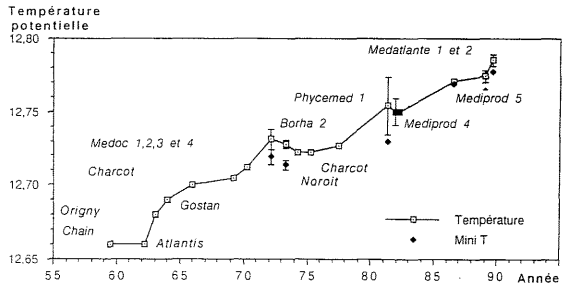


Fig.2- Température potentielle moyenne (carré blanc) et minimale (losange noir) avec quelques écarts-type entre 2000m et le fond, lors de missions effectuées entre 1969 et 1989.
Mean (white square) and minimum (black rhomb) potential temperature and some standard deviations between 2000m depth and the bottom, data acquired from 1959 to 1989.

Indépendamment de cette variabilité intérannuelle, il apparait également que la température des eaux situées à 2 000 m et au delà subit entre 1959 et 1989 une augmentation continue, tandis que la masse spécifique reste comprise entre 29.09 et 29.12. Sur la figure 2 ont été reportées en fonction du temps, les températures potentielles profondes (moyennes des données pour une profondeur z > 2 000 m) proposées par LACOMBE et al. (1985), ainsi que les températures potentielles minimales observées autour de 2000 m, lorsqu'elles diffèrent des valeurs de fond. Ont été également reportées les données correspondantes des campagnes PHYCEMED 1 , MEDIPROD 5 et MEDATLANTE. Entre 1959 et 1989, tant les températures moyennes que les valeurs minimales, quand elles existent, accusent une croissance de 0,12°C. La précision des mesures océanographiques de température, d'une part, et, d'autre part, depuis 1969, l'acquisition de profils verticaux continus par bathysonde CTD attestent de la réalité physique de l'évolution constatée de ces températures profondes (z > 2000m). Par ailleurs, la comparaison des données de température des missions PHYCEMED 1 et MEDATLANTE , en trois zones du bassin Occidental, (mer Ligure, bassin Algéro-provençal et mer d'Alboran) montre que l'évolution des températures de la couche 2000m-fond se retrouve également dans la couche 500m-fond. La variation moyenne de la température de cette colonne d'eau, entre 1981 et 1989 est de 4,1 10^{-3} °K /an, ce qui, reporté sur la période trentenaire 1959-1989 donne un dΘ total de 0,12 °K, soit la variation précédemment déterminée dans la couche 2000m-fond. Ce résultat atteste d'une évolution globale de toutes les eaux profondes du bassin Occidental. Cette élévation de température des eaux profondes provient de celle des eaux superficielles lors de la formation hivernale d'eau dense, et donc d'une modification continue du climat. La modélisation en flux de la formation d'eaux denses doit permettre d'utiliser l'information en température des eaux profondes pour évaluer la variation du climat au dessus de la Méditerranée et donner une estimation de l'effet de serre.

REFERENCES BIBLIOGRAPHIQUES

H. LACOMBE, P. TCHERNIA et L. GAMBERONI, *Prog.Oceanog.*, 14, 1985, p.319-338.
MEDIPROD 5 ,L.PRIEUR, communication personnelle, 1990.
MEDOC GROUP, *Nature* , 227, 1970, p.1037-1040.
PHYCEMED 1-1981, R.Chesselet et J.P.Gouillou, communication personnelle
L.PRIEUR,J.P.BETHOUX,J.H.BONG, D.TAILLIEZ,Rapp.Comm.int.MerMédit.28,1983,p.51-53.
P. TCHERNIA, *Colloques Internationaux du CNRS*, 215, p.17-21, 1974.

Water fluxes across the Balearic Channels in June 1989. Doppler profiling and geostrophic computations

A. CASTELLON , E. GARCIA-LADONA and J. FONT

Institut de Ciènces del Mar (CSIC), 08003 Barcelona (Spain)

The three Balearic channels close the Catalan Sea by the S and E, while by the NE it is open to the general southwestwards flow of the NW Mediterranean. By means of regional water and salt budgets, Bethoux (1980) calculated this inflow to have an annual mean flux of 0.8 Sv. Some 0.4 Sv should leave the basin through the southern sill, while other 0.4 Sv return to the Liguro-Provençal basin by the N of the islands.

After an extensive analysis of hydrographic data, Font et al. (1988) concluded that the circulation in the Catalan Sea is controlled by two shelf/slope fronts. The main southwestward flow continues alongslope the Liguro-Provençal current from the Gulf of Lions, with a flux ranging from 1.5 - 2 Sv in winter to 1 Sv in summer. The outflow through the southern channel was estimated to be lower, especially in summer. Very variable exchange has to occur through the other two and less deep sills. A return current to the NE contours the Balearic continental shelf, and its flux was calculated to be of the order of 0.5 Sv off Mallorca.

During a cruise of the Spanish R/V "Garcia del Cid" in June 1989, high horizontal resolution (2 to 5 miles) CTD and ADCP sections were performed in the three channels and in the northern edge of the Catalan Sea.

ADCP profiles down to about 350 m (without pitch and roll compensation) were averaged every 5 minutes, both during CTD stations and underway. Absolute velocity values were calculated by bottom tracking over the continental shelf or by a reference level of zero velocity at 300 m. A reasonably good match between the two methods was observed in all the sections. Four hours of ADCP profiling close to an Aanderaa mooring allowed an intercalibration of both types of current-meters at three levels: mean differences in speed were in the range of 2 to 4 cm/s.

This first ADCP survey in the region evidenced the frontal jet character of the southwestward flow along the peninsular slope, with a strong weakening in the southern part (Font & Castellón, 1989). Maps of current vectors at different depths in the four border sections (e.g. fig.1) show the inflow and outflow patterns as it would be expected at the begining of the summer in the surface layer (Font et al., 1988). In the northern section the Catalan (to SW) and Balearic (to E) frontal currents are clearly present. The irruption of Modified Atlantic Water by the Balearic sills is a remarkable feature, together with the very low outflow in the south.

Although the analysis of all the ADCP data has not been completed, a quite good agreement has been found, on both velocity distributions and transport in the surface layer, with geostrophic computations. Water flux values in the four sections have been calculated as: 0.9 Sv Catalan current inflow, 1.2 Sv Balearic current outflow, 0.05 Sv inflow in the northern channel, 0.1 outflow (north) and 0.5 inflow (south) in the central channel and 0.3 outflow (west) and 0.2 inflow (east) in the southern channel.

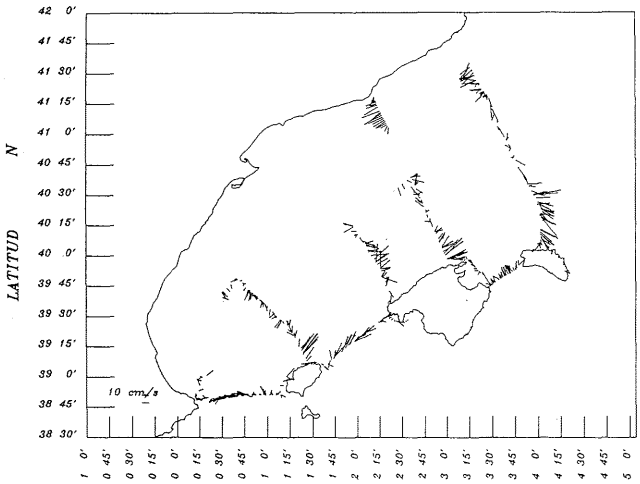


Fig.1 Rough ADCP velocities at -30 m measured in June 1989

This research has been supported by CAICYT Project PB86-0628 "Frontogenesis, spatial variability and induced circulation in a density front"

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

Font J. and Castellón A. (1989) First direct observation of a frontal jet along the continental slope off the NE Spanish coast (NW Mediterranean) by acoustic Doppler profiling. AGU/ASLO 1990 Ocean Sciences Meeting, EOS Trans., 71(2): 142

Font J., Salat J. and Tintoré J. (1988) Permanent features of the circulation in the Catalan Sea. Oceanol.Acta, sp.v. 9: 51-57

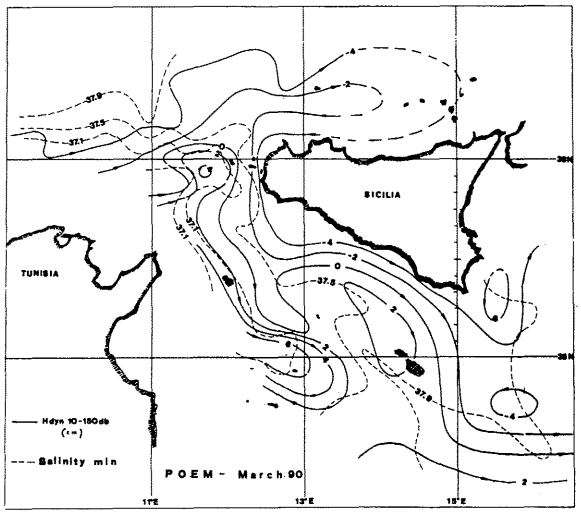
O-II5

Seasonal variability of the surface circulation in the Channel of Sicily

A. DE MAIO, M. MORETTI, E. SANSONE and G. SPEZIE

Istituto di Meteorologia e Oceanografia - IUN - Via Acton 38, 80133 Napoli (Italia)

The seasonal variability of the surface marine currents in the Channel of Sicily is discussed on the basis of hydrological and surface current data collected by the Institute of Meteorology and Oceanography in the framework of the POEM project.



The surface flow patterns which resulted from the surveys of September 1987 and March 1990 are considered as they represent the typical summer and winter situations, and because the fair meteorological conditions which prevailed during the surveys allowed a good set of observations on the whole area. The patterns, as resulted from the analysis of the hydrological data, are supported by both the direct current measurement recorded on board R.V. Bannock while at station, and by the NOAA satellite imagery. They show a NW to SE meandering path with well defined cyclonic and anticyclonic gyres on its sides.

In summer time a frontal system having Atlantic Water (AW) in the south part of the channel and higher salinity water on the Sicily continental shelf, is seen. It is oriented NW - SE with meanders of 100 nautical miles wave lenght and 20-40 nm amplitude. Velocities close to 40 cm/s resulted by both direct and indirect methods. A few cyclonic gyres about 20 nm in diameter are well seen down to 50 meters. The results match fairly well with the thermal front shown by the imagery of the NOAA satellite during the same period.

In winter the mixed layer formed over the Sicily continental shelf is missing, and the area is characterized by a cyclonic flow along the Sicilian coasts as far as the Ionian sea. The AW is easyly recognized through the subsurface salinity minimum distribution which follows the geostrophic flow in the south part of the channel and turns toward the African coast (Fig. 1).

Moreover the two sets of observations point out that between Tunisia and Sicily the AW keeps always the same salinity values (37.0-37.1). In summer, the AW flows out of the channel around Malta Island and reaches the western Ionian basin. In winter the AW layer is shifted toward the African coasts and leaves the channel far south.

O-II6

Temporal variations of the principal water masses of the Levantine Basin

Artur HECHT

Israel Oceanographic and Limnological Research, Tel-Shikmona, Haifa 31080 (Israel)

The principal water masses of the Mediterranean Sea, the ingressing Atlantic Waters (AW) and the egressing Levantine Intermediate Waters (LIW) are defined, intuitively, as the subsurface salinity minimum and the subsurface salinity maximum, respectively. These are definitions of extrema points on a profile and, therefore, are inadequate for any quantitative estimates, such as the volume of those water masses or the boundaries of the respective layers. Moreover, these water masses are not homogeneously and isotropically distributed throughout the basin, and in this respect salinity profiles from different parts of the basin can differ significantly from each other. Finally, there is conclusive evidence of patches or pockets of those waters trapped and maintained for long periods of time inside mesoscale or small scale eddies both inside the Mediterranean (e.g. HECHT et al. 1988, OZSOY et al. 1989) and outside the Mediterranean in the Atlantic Ocean (e.g. ARMI and ZENK 1984, ARMI et al. 1989).

The MC series of cruises, a series of twenty cruises carried out in the southeastern Levantine basin at relatively short intervals over a period of five years, presents us with the opportunity to attempt an objective determination of the boundaries of the AW and LIW for the limited region of the cruises and, following that, to attempt the investigation of the seasonal variability of these water masses. From the data of those cruises, we computed climatological temperature and salinity profiles, as well as cruise average profiles, i.e. the level by level averages of the measured temperatures and salinities for all the cruises or for a particular cruise, respectively (HECHT et al. 1988).

The limits of the AW and LIW layers were determined on the climatological salinity profile by defining them, arbitrarily, as the extremum (minimum or maximum as the case may be) plus the respective standard deviation for the AW (38.86+0.16) and less the respective standard deviation for the LIW (38.97-0.05). While the definition of the LIW resulted in what may be considered a reasonable value, the layer defined as AW appeared to overlap the LIW layer. One can find some arbitrary solution for the AW definition problem, such as using the upper boundary of the LIW as the lower boundary of the AW. Obviously, this kind of definition obscures any temporal variations, but it is simple, convenient, and provides us with a layer depth. Moreover, one can use these definitions, via the climatological S/T diagram, to determine a temperature associated with these particular water masses.

At the straits of Gibraltar, Sicily, and Dardanelles, the ingressing as well as the egressing waters vary seasonally (e.g. CARTER 1956, UNLUATA and OGUZ 1983, GRANCINI and MICHELATO 1987). One could therefore expect a seasonal variation in the water masses within the basin as well. In order to obtain some information on temporal variations, one can determine the salinity extrema and the respective standard deviations on each of the cruise profiles. A few of the cruise average salinity profiles did not yield a clearly identifiable extremum of one kind or another. In particular, the MC21 of December 1982 did not seem to have either a minimum or a maximum salinity. An attempt to investigate seasonal variations by depicting those values on a compressed time series of cruise average salinity profiles (i.e. cruise average salinity profiles arranged according to the date they were measured within the year irrespective of the year in which they were measured) appeared to result in some seasonal trend as far as the AW is concerned (a deeper and narrower layer as the year progresses), but random fluctuations with respect to the LIW.

Therefore the cruise salinity average profiles were restored to their original sequential order. This did not seem to yield more information on the behavior of the AW; they still seemed to be deeper and the layer narrower towards the end of the year. However, from February 1979 (MC11) and until November 1981 (MC19), the LIW appeared to be at an almost constant level (271±7 dbars) with an average of 38.95±0.02. In May 1982 (MC20), we observe a decrease in the level of the salinity maximum, and in December 1982 (MC21), we could not find either a minimum or a maximum on the cruise average salinity profile. Following that, the salinity maximum level is less constant and at a shallower depth (187±0.30 dbars) and has a higher value (39.02±0.02).

For the sake of comparison, the overall average of the salinity maxima is 38.98±0.04 and the overall average of the depth of the maxima is 228±47 dbars. Thus, one may legitimately ask what is the accuracy of our measurements and what is their long term stability. As it is well known, for all practical purposes, the deep waters of the Mediterranean sea can be considered invariant. During the MC series of cruises, we found that the average salinities below 1000 dbars were completely stable (e.g. 38.70±0.02, 38.68±0.01 and 38.676±0.009 at 1000, 1500 and 2000 dbars, respectively).

As to the reasons for this change, one may well remember that the winter of 1982-1983 was the onset of one of the largest El-Nino events of the last century. Its repercussions were felt all over the world, and some of its effects may have reached as far as the eastern Mediterranean. Indeed, in retrospect, we already observed some anomalous behavior of the salinity in the May 1982 cruise (MC20) and more intensive in the December 1983 cruise, after which the salinity seems to return to "normal" behavior. However we have no explanation to connect the events. On the other hand, the continuous diversion of fresh waters from the Mediterranean basin, e.g. the damming of the Nile which, according to OREN and HORNUNG (1972), has already affected the coastal waters of Israel, is expected to change the water exchange regime between the Mediterranean, the Atlantic and the Black Sea (NOF 1979). Finally, some changes in the previously "stable" characteristics of the Mediterranean waters were observed in the western basin and linked to possible climate changes (LACOMBE et al. 1985, CHARNOCK 1989). In particular, LACOMBE et al. (1985) suspect a change in the LIW and suggest their close monitoring.

REFERENCES.

ARMI, L. and ZENK, W., 1984. Large lenses of highly saline Mediterranean water. J. Phys. Oceanogr., 14 (10): 1560-1576.

ARMI, L., HEBERT, D., OAKEY, N., PRICE, J.F., RICHARDSON, P.L., ROSSBY, H.T. and RUDDICK, B., 1989. Two years in the life of a Mediterranean salt lens. J. Phys. Oceanogr., 19 (3): 354-371.

CARTER, D.B., 1956. The water balances of the Mediterranean and the Black Seas. Publ. Climatol., Centerton NJ, Drexel Inst. Technol., Lab. Climatol. 9: 123-175.

CHARNOCK, H., 1989. Temperature and salinity changes in the deep water of the western Mediterranean basin. Communicated at the third POEM Workshop, Harvard, USA.

GRANCINI, G. and MICHELATO, A., 1987. Current structure and variability in the Strait of Sicily and adjacent area. Annales Geophys. 5B (1): 75-88.

HECHT, A., PINARDI, N. and ROBINSON, A.R., 1988. Currents, water masses, eddies and jets in the Mediterranean Levantine Basin. J. Phys. Oceanogr., 18 (10): 1320-1353.

LACOMBE, H., TCHERNIA, P. and GAMBERONI, L., 1985. Variable bottom water in the Western Mediterranean. Progress in Oceanogr., 14: 319-338.

NOF, D., 1979. On man-induced variations in the circulation of the Mediterranean Sea. Tellus, 31 (6): 558-564.

OREN, O.H. and HORNUNG, H, 1972. Temperatures and salinities of the Israel Mediterranean coast. Bull. Sea Fish. Res. Stn., Haifa, No. 59: 17-31.

OZSOY, E., HECHT, A. and UNLUATA, U., 1989. Circulation and hydrography of the Levantine basin. Results of POEM coordinated experiments 1985-1986. Prog. Oceanogr., 22: 125-170.

UNLUATA, U. and OGUZ, T., 1983. A review of the dynamical aspects of the Bosphorus. In: NATO Advanced Workshop on the Atmospheric and Oceanic Circulation in the Mediterranean, La Spezia, Italy, Sept. 7-14, 1983. H. CHARNOCK, ed. (in press).

O

O-II7

On the vertical structure of the Black Sea Currents

V.-S. LATUN

Academy of Sciences, Sevastopol (U.S.S.R.)

The available measurements and diagnostic calculations generally provide a similar vertical structure of the horizontal current velocity (Latun, 1989a). Currents attain their maximum speed (about 90 cm/s) in the near-surface levels. Then, they tend to reduce typically by about 25% at the depth of 75m and drops by 50-60% towards 100m and then decrease gradually toward deeper levels. The flow is almost unidirectional within the zone of Main Black Sea Current (MBSC) down to the depths of 300-500m. In the deep anticyclonic eddies, where the vertical structure may extend down to the depth of about 1000m, the circular currents attain a difference of approximately 5 cm/s between the 500m and 1000m. On the other hand, such difference are virtually nonexistent outside the anticyclonic eddies.

The present work reports briefly findings of the hydrological and current measurements performed at five stations throughout the water column at eight levels between 10m and 1500m for about two weeks period (Latun, 1989b). The stations are situated in a cross-like grid with a distance of approximately 20 miles to the central one which is located about 60 miles southwest of the tip of the Crimean peninsula. All these five current stations are found within the zone of MBCS. An additional current measurements have been performed for a longer period at some distance from the former mooring locations and outside the MBSC stream. It was found that the flow has a cyclonic character in the MBSC. In the 500-1000m layer, the mean velocity was about 2.5 cm/s. In the deeper layers, a stronger flow in the opposite direction is measured with maximum hourly- and daily-averaged values of 20 cm/s and 15 cm/s, respectively, at the depth of 1500m. The average value for whole measurement period of 12 days is found as 11 cm/s. The latter average value of deep currents was further found to be approximately geostrophic. Utilizing measured value of the mean meridional density gradient of $4.1*10^{-5}$ g cm^{-3}/20 miles for the 500-1500 m layer, zonal component of the geostrophic flow is determined as 11±2 cm/s at the depth of 1500m.

The measurements demonstrated that the flow has considerable temporal variability throughout the water column. The periodogram, obtained by means of Buys-Ballot method, reflects presence of most dominant oscillations with periods of 17 and 4 hours, corresponding to the local inertial period and the first mode cross-sea seiching period, respectively. Inertial oscillations are observed at all depths and dominate the kinetic energy of the system at some levels when the geostrophic balance is disturbed. Inertial oscillations are found to be the most dominant wave in the MBCS stream oscillation. In one of the stations, the density of the surface flow kinetic energy is found to increase from 16 to 55 J/m^3 which in fact corresponds the maximum energy increase taking place during one inertial period. This feature is found to penetrate in the whole water column indicating its hydrostatic origin. After two inertial periods, the aperiodic component of the deep flow attains a new energy level as a result of the change in the geostrophic balance of the flow. At 300m depth level, the kinetic energy increases from 6 to 56 J/m^3 within two inertial periods, thereafter the contribution of inertial oscillations to the whole energy decreases from 91% to 17%. During the first inertial period, well-pronounced 4-hours seiche oscillations are also observed. The characteristic seiche flow velocity is estimated as 10 cm/s which contributes to 15% of the total kinetic energy. In the following inertial period, the seiche flow velocity is reduced by a factor of 4-5 and its contribution therefore becomes negligible. After the second inertial period, the oscillations are weakened considerably, the mean current is intensified with a change in its direction from cyclonic to anticyclonic. The anticyclonic character of the flow is preserved for at least two more inertial periods. On the other hand, at 1500m depth level, the anticyclonic character of the flow has been observed persistently throughout the 12 days measurement period. An increase of kinetic energy from 6 to 9 J/m^3 is observed even at this level.

A hypothesis on the deep countercurrent generation mechanism has also been made using the combined analyses of temporally and spatially varying density and velocity fields.

REFERENCES

Latun, V. S. (1989a). "Vertical structure of the Black Sea currents. Expeditional research of the Black Sea (Spring 1988)". Ac. of Sci. of the Ukr. SSR. MHI, Sevastopol, 1989, 158pp. Dep. VINITI, 15.05.89,N3240-V89, (in Russian).

Latun V. S. (1989b). "On the motion of the Black Sea deep layers. Detailed oceanographical research of the Black Sea." Ac. of Sci. of the Ukr. SSR, MHI, Sevastopol, 1989, p.9-16, (in Russian)

O-II8

Courants et niveaux de marée en trois régions cruciales de la Mer Méditerranée

Ferruccio MOSETTI

Cattedra di Misure Oceanografiche, Università, Trieste (Italia)

Jusqu'à un passé récent en ce qui concerne les marées existaient seulement des enregistrements qui, bien que très longs, étaient limités aux niveaux. Les courants ont été mesurés seulement quelques fois, sporadiquement, ou, presque toujours, sur des intervalles trop courts pour être utilisables avec précision. Nous pouvons disposer maintenant de séries enregistrées de courant et suffisamment développées pour séparer, à l'aide de filtres convenables, la contribution de la marée aux autres causes du courant. Les courants de marée peuvent aussi être examinés à l'aide de modèles hydrodynamiques. Ce travail traite des mesures et de quelques modèles.

En Méditerranée, trois zones cruciales ont été prises en considération, tant pour les marées de niveau, que pour les courants. Les mesures de niveau connues (depuis longtemps), ont été intégrées, par de récentes mesures directes et continuelles du courant. Avec quelques applications des modèles, nos connaissances sur la dynamique des bassins sont améliorées.

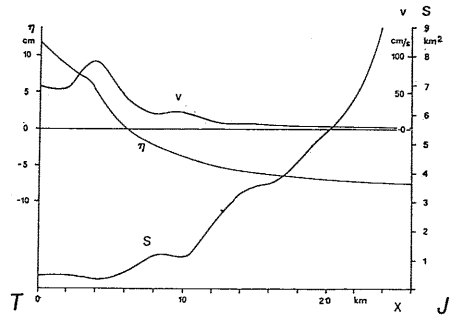
Les zones étudiées sont : l'Adriatique septentrionale, avec les golfes de Venise et Trieste, le détroit de Messine et le golfe du Gabès en Tunisie. L'étude est limitée à la composante lunaire principale M2, quelques comparaisons relatives aux autres composantes sont toutefois effectuées.

Les trois zones ont des caractéristiques très intéressantes pour les marées. Dans les golfes de Venise et Trieste, les niveaux de marée sont parmi les plus développés de la Méditerranée (amplitude 27 cm à Trieste pour la M2 et une excursion totale - en syzygie - de 1.1-1.2 mètres). Toutefois, les courants de marée sont relativement faibles : en mer ouverte, le courant total de marée atteint, seulement en quelques points, des valeurs de 10cm/s. Ils sont presque sans importance pour le renouvellement des eaux excepté dans les canaux lagunaires (Grado-Marano, Venise) où les vitesses totales arrivent à 1-1.5 m/s, avec à peu près 60-80 cm/s pour la seule composante M2. A l'intérieur du golfe de Trieste, le courant de M2 décrit des ellipses assez aplaties, axe principal orienté NE, amplitude 4-5 cm/s et déphasage d'environ 90°, relativement aux marées de niveau à Trieste. Les marées diurnes présentent à peu près la même allure et des amplitudes comparables. Dans les golfes de Trieste et Venise, les plus grands facteurs de mouvement sont les courants du vent. La situation mesurée est confirmée par un modèle hydrodynamique.

Dans le détroit de Messine on relève, en échelle mondiale, les courants les plus forts, avec de petits dénivellements, bien que sur grande pente. La composante M2 de niveau présente un déphasage presque parfait de 180° entre les extrêmes N et S, avec une amplitude de 12 cm en mer Tyrrhénienne méridionale et 6 cm à l'embouchure de la mer Ionienne. La vitesse moyenne du M2 dans la zone la moins profonde du détroit est de 80 cm/s avec des valeurs maximales de 155 cm/s (Antinoeud de courant avec noeuds à l'extrême). Le noeud du niveau se situe dans la zone la moins profonde. La figure reporte les profils de vitesse (v) et de niveau - amplitude de M2 (η) le long du canal entre *T* embourchure Tyrrhénienne et *J* embouchure Ionienne. La section S, reportée en correspondance, donne également la dimension du canal. Un courant total (complexe des marées avec contribution du vent) de bien 355 cm/s a été mesuré en 1980. Le courant diurne est aussi fort (30 cm/s); on découvre aussi les harmoniques inférieures : dans les spectres du courant, on relève des marées 1/10 diurnes.

Les ellipses semi-diurnes (avec différents sens de rotation -noeuds de vitesse-) sont aplaties sur la direction du canal s'amortissant en profondeur. La phase de l'axe principal du courant M2 est de 114° (phase g) tandis que sur la côte Sicilienne (Ganzirri 316°) elle est à peu près en opposition. Hormis le classique noeud du courant M2, les courants diurnes ont également des noeuds dans le canal ainsi que les plus brèves composantes. Des modèles ont confirmé cette situation.

Le golfe du Gabès a, notoirement, les plus fortes marées semi-diurnes de la Méditerranée (48 cm de M2, contre 3.8 pour la K1). Par contre, le courant est faible. Des mesures, sur la traverse de Malte, ont révélé de très faibles courants semi-diurnes (noeud du courant, tandis que le noeud du niveau est proche, à Pantelleria). Le total du courant calculé sur la ligne Cap Bon - Trapani est de 27 cm/s, surtout en densité.



REFERENCES

MOSETTI, F., 1988.- Some news on the currents in the Straits of Messina. *Bollettino di Oceanologia Teorica e Applicata*, VI, 3.

MOSETTI, F. et PURGA, N., 1989.- The semi-Diurnal Tides in the Sicily Strait. *Il Nuovo Cimento*, C, 12,3.

VILLAIN, C., 1952.- *Bull. Inform. C.O.E.C.* 4,3 et 4,8.

O-II9

Objective Analysis of P.O.E.M. Greek data : General circulation features and water masses in the Eastern Mediterranean (March/April 1986, September/October 1987)

K. NITTIS*, A. THEOCHARIS** and A. LASCARATOS*

*University of Athens, Department of Applied Physics, 33 Ippokratous str., 10680 Athens (Greece)
**National Centre for Marine Research, Aghios Kosmas, Hellinikon, 16604 (Greece)

During POEM-2-86 (March/April) and POEM-5-87 (September/October) major cruises in the Eastern Ionian, NW Levantine and Southern Aegean, CTD data were collected, using an SBE-profiler on board R/V AEGAIO, from a large number of stations with almost nominal spacing of 0.5 degrees in latitude and longitude.

Measurements were taken at a rate of 33/sec, averaged in situ by software over one second intervals, thus obtaining measurements at about 0.7 decibar intervals, followed by 3 point interpolation to nominal depths (every dbar). CTD salinity was calibrated against water sample salinity, measured by an AUTOSAL salinometer. Intercalibration was carried out, based on common stations occupied by two ships, as simultaneously as possible, in the framework of the POEM coordinated field experiments. Finally, tha data were analysed objectively , using a homogeneous isotropic correlation function, for an optimal estimation of the circulation and water mass distribution during the two above mentioned major seasonal cruises. The produced objective maps of dynamic height reveal an intense mesoscale circulation pattern during both realizations. Various persistent and/or seasonal cyclonic and anticyclonic eddies of different sizes and structure, as well as intense currents are identified in the region.

The objective analysis of the late winter 86 data revealed (fig. 1) : a.- The large meandering cyclonic Rhodes gyre, with an E-W orientation, extending up to the SE of Crete. b.- The western part of the Asia Minor Current is clearly seen boardering the Rhodes gyre to its north and west. An important feature of the winter 1986 circulation is the branching of the Asia Minor Current into the Aegean through the eastern Cretan straits where it transports Levantine waters. c.- The meandering Mid-Mediterranean Current, located between 34 and 35 N, flowing to the east. It carries considerable amounts of AW towards the Levantine Basin. d.- The strong presence of the "Pelops" anticyclonic gyre SW of Peloponnisos in the E. Ionian. e.- The general cyclonic circulation pattern in the Central Cretan Sea, which could be characterized as a continuation of the Asia Minor Current after its entrance in the Aegean through the Kasos strait. f.- The major circulation patterns observed are maintained also in the intermediate depths (300-400 dbars).

During the late summer experiment, a series of large cyclonic and intense anticyclonic gyres predominate in the Levantine and Ionian regions (fig. 2) : a.- The major quasi-permanent cyclonic Rhodes Gyre with an almost N-S orientation, is relatively restricted to the east. b.- West of the Rhodes Gyre and SE of Crete, an intense anticyclone (not present in winter), named "Ierapetra" gyre, is observed.Its presence squeezes the Rhodes Gyre to the east. Geostrophic velocities at the borders of the anticyclone reach 50 cm/sec. Waters coming out

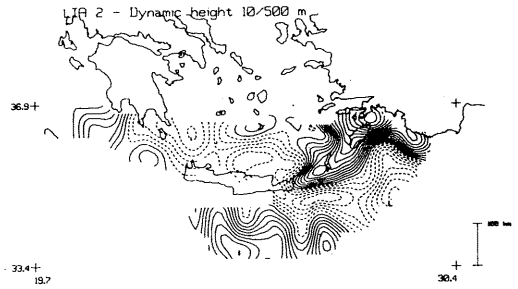


Figure 1.

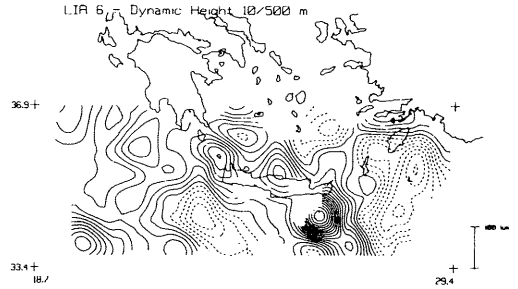


Figure 2.

of the Cretan Sea through the strait of Kasos are canalized between the Ierapetra and Rhodes gyres. c.- The Asia Minor Current meanders around the Rhodes Gyre and bifurcates at Rhodes and Karpathos Straits entering and exiting again the Aegean. Its net transport into the Aegean is minimal compared to that of late winter. d.- The Mid-Mediterranean current is shifted to the south compared to its winter position, between 33.5 and 34 N. e.- In the Ionian, three major circulation features predominate: the persistent Pelops Anticyclone, the large cyclone to the SW of Crete and an anticyclone at the southwesternmost part of the study area (34 N, 19 E). The core of the LIW is trapped by the deep Pelops gyre, while considerable amounts of AW along their eastward route from the Ionian to the Levantine, are recirculated in the Ionian by the cyclone SW of Crete. f.- In the Cretan Sea a series of three anticyclonic eddies predominate, while the meandering circulation is reversed compared to that of the late winter period. g.- The distribution of the salinity minima shows that surface and subsurface layers in the Ionian are occupied by relatively "new" AW, while in the Levantine side the AW can be characterized as "older".

O-II10

The Black Sea Circulation: its mesoscale and sub-mesoscale variability as inferred from hydrographic and satellite observations

T. OGUZ*, P.-E. LA VIOLETTE** and U. UNLUATA*

*Middle East Technical University, Institute of Marine Sciences, P.O. Box 28, Erdemli, 33731, Icel (Turkey)
**Naval Oceanographic and Atmospheric Research Laboratory, Stennis Space Center, MS 39529 (U.S.A.)

Quasi-synoptic hydrographic data and satellite imagery are used to describe the circulation and the structural variability of the Black Sea with particular emphasis given to the circulation along the Turkish coast. The data enables to provide several features of the circulation which were not identified earlier and reveals the complexity of the basin-wide cyclonic circulation system. The data indicates that the circulation is characterized by multiple scales of motion and involves, in general, a well-defined meandering rim current and strongly interacting eddy fields ranging from sub-basin scale gyres to sub-mesoscale eddies interconnected with each other by strong jets and filaments. The filaments, often with dipole eddies at their terminus, extend from the shelf-slope region into the offshore waters. The disposition of these offshore filaments imply crucially important dynamical processes related to the shelf-deep basin exchanges. The mesoscale eddies and other fine structure features interact continuously with the mean flow and therefore generates a highly interactive, energetic and temporally variable picture of circulation. The large scale quasi-synoptic features of the general circulation is basically governed by the spatially variable wind stress field and further modified by the thermohaline forcings and the topography.

Along the Turkish coast, the meandering rim current and the mesoscale eddies are confined over the shelf/slope topography conforming to the 200-2000m isobaths. The flow structure is characterized by wave-like disturbances superimposed on the mean flow. The meanders have typical offshore extent of about 75 km from the shelf break and typical alongshore wavelengths of 100-150 km. The features translate eastwards and are often streed by the topography and evolve continuously in time through the instability mechanism. The vertical shear, necessary for the baroclinic instability mechanism, is originated by the strong upper layer flow advecting waters of the cold intermediate layer and relatively weaker flow in the subhalocline waters. Embedded within the meandering rim current, there exists a series of coastal eddies which are all anticyclonic, usually evenly spaced and have alongshore scales of O(100km).

A quantitative evidence for the baroclinic instability mechanism is provided by means of a simple two-layer channel model having uniformly sloping cross-channel topography.

O

Round Table on PRIMO, an International Research Programme in the Western Mediterranean (Tuesday October 16 th 1990)

Claude MILLOT

Antenne C.O.M., B.P. 330, La Seyne-sur-Mer (France)

Most of the physical oceanographers interested in the western Mediterranean have the common will to involve all the available observational and theoretical tools during the same period of time in order to get answers as accurate as possible to some basic questions. This is the rationale for PRIMO, the acronym (in the language of most of the riparian countries) standing for "International Research Programme in the Western Mediterranean"; PRIMO is supported by both IOC/UNESCO and ICSEM.

Several meetings were necessary to reach a consensus on the fact that, first of all, we had to get a better understanding of the general circulation of the water masses. More specifically, we decided that the first step should be to focus on the seasonal variability of the circulation; the major reason is that some of us still disagree about the characteristics and driving forces for such a signal which is fundamental since the actual working of the whole sea, i.e. transformation of surface waters into deeper ones, is seasonal too.

Therefore, our strategy for the first step of this programme is to conceive an experiment based on the available observations and theoretical works and aimed i) to specify more accurately the major characteristics of the seasonal variability and ii) to check for all the mechanisms expected to be responsible for such a variability. Next steps will probably focus on mesoscale and/or regional phenomena.

The outline for an action plan, elaborated in June 1990 by a group of experts, will be presented during this round table to the whole community in order to be improved and definitively drawn up.

Water Masses in the Pagassitikos Gulf, Greece, in 1989

Stavros BARBETSEAS and Irene ZODIATOU

National Centre for Marine Research, Agios Kosmas - Ellinikon 16604 Athens (Greece)

Hydrographic data from four cruises in the Gulf of the Pagassitikos, during 1989, are seasonally evaluated.

A lower salinity water layer prevails at the surface all over the Pagassitikos Gulf, especially in summer, owing to the Aegean water entering the study area and the almost permanent stratification. In the surface of the Bay of Volos, the lower salinities observed at the NW part can result from the influence of the fresh water from the source "Bourboulithres" flowing into the NW end of the Bay. During August and November two water masses were observed, in the surface layer only, one in the Bay of Volos and another one in the remainder of the Gulf. However, there was only one water mass in February and May.

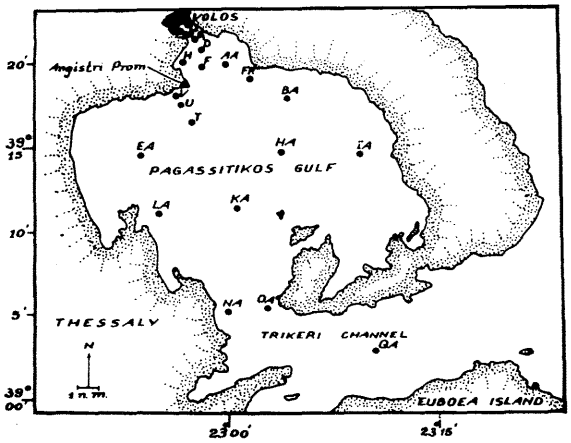


Fig.1 : The Pagassitikos Gulf, showing the positions of the hydrological stations.

At locations not deeper than 60m, the water column comprised mainly two layers, with the upper one as far down as 20m. At the deep stations (>60m),a third layer formed below 40 to 50 m. The thickness of the surface layer varied from 20 to 40m, depending on the season and the morphology. The higher temperatures and lower salinities in the surface layer were observed in August, owing to strong stratification. In Winter, the temperature dropped and the stratification became weaker, but persisted because of the halocline. However, in February, the water column was thoroughly homogeneous.

REFERENCES

GABRIELIDES, G.P. and THEOCHARIS,A.C.,1978. "Physical and chemical characteristics of Pagassitikos gulf, Greece.", Thalassographica, 2, 2, 135-153.

LASKARATOS, A. and THEOCHARIS, A., 1984. "A contribution to the Physical Oceanographic study of the Pagassitikos Gulf". Minutes of the 1st Hellenic Conference on Oceanography and Fishing, Athens, 50-55.

THEOCHARIS, A. and LASKARATOS, A., 1984. "Water type formation and spreading in Pagassitikos Gulf (NW Aegean)". XXIX Congress CIESM, Oct.1984.

O-IV2

A Methodology for Analyzing Climatological Data in the Western Mediterranean. Perspectives in Variational Inverse Modelling

Pierre BRASSEUR

GHER, University of Liège, B 5 Sart-Tilman, ULg., B-4000 Liège (Belgium)

The knowledge of the dynamical structures associated with the general circulation in the Western Mediterranean is unceasingly growing as numerical models [Beckers, 1988] together with in situ observing systems become more and more sophisticated. The ultimate objective being the design of a 3-D realistic model, it is fundamental to confront the results stemming from numerical simulations with the extensive set of hydrographic data collected since the beginning of the century.

A variational inverse model, initially developed for the study of continental seas, has been tuned to phenomenons typical of the Mediterranean Basin. It allows to reconstruct, on the basis of local measurements (such as C.T.D. profiles carried out at pin-point hydrographic stations), continuous fields of the state variables representative of the general circulation and its evolution during the seasons. In this model, the 3-D structure of the Sea is reproduced by using a set of N layers, each of them being characterized by a density which is constant along the vertical and variable in the two horizontal directions. Although the vertical discretization may vary with the abundance and the spatial distribution of the data, three layers at least are necessary in order to reproduce adequately the Atlantic surface water, the Intermediate Levantine water and the dense water in the deep ocean. In each layer, the horizontal distribution of density (or any other scalar variable) is obtained by applying the weighted residual method to the equation

$$(\nabla^2\nabla^2\rho - \alpha\nabla^2\rho) + \sum_{k=1}^{N_d} \mu_k(\rho_k - d_k) + \gamma(\boldsymbol{u}.\nabla\rho - \tilde{\lambda}\nabla^2\rho) = 0$$

The first term is a smoothing operator equivalent to the variational principle [Brasseur, 1989]:

$$\mathrm{Min}\, J(\rho) = \int\int_D \left[\left(\frac{\partial^2\rho}{\partial x^2}\right)^2 + \left(\frac{\partial^2\rho}{\partial y^2}\right)^2 + 2\left(\frac{\partial^2\rho}{\partial x\partial y}\right)^2 + \alpha\left(\frac{\partial\rho}{\partial x}\right)^2 + \alpha\left(\frac{\partial\rho}{\partial y}\right)^2 \right] dx\,dy$$

where the "tension" parameter α has been introduced so as to take into account the frontal structures disclosed by physical, chemical and biological data. The second term is this by which the observations d_k, measured at (x_k, y_k), are assimilated into the continuous solution at $\rho_k = \rho(x_k, y_k)$. The weighting factors μ_k are fixed according to the confidence intervals associated with every data. They depend on the statistical quality of the measurements (systematic errors) as well as on the filtering required to cancel out processes representative of small scale motions. Moreover, the interpolation procedure is driven dynamically by an advection-diffusion relation with γ as a weighting factor. The velocity field $\boldsymbol{u}(x, y)$ is obtained by assuming that the flow within each layer is in geostrophic balance and satisfies the thermal wind equation, so that

$$\frac{\partial \boldsymbol{u}}{\partial x_3} = \frac{g}{\rho_0 f}\mathbf{e}_3 \wedge \nabla\rho .$$

The turbulent diffusion coefficient $\tilde{\lambda}$ plays a role similar to the tension parameter α in the smoothness operator.

On the basis of climatological data collected in the Western Mediterranean, one can reconstruct typical 3-D configurations depicting the state of the Sea during the seasons by using the Variational Inverse Model. Of course, the above-mentioned equations concerning the reconstruction of buoyancy fields may be written for other kinds of data such as temperature, salinity, nutrients, phytoplankton, chemical tracers... The main objective is to describe, from the data, the standard patterns which recur from one year to another within the global system. Preliminary results show that the Variational Inverse Model makes up a practical tool for the understanding of fundamental questions as: what are the driving forces of the general circulation in the Northern part? what are the mechanisms responsible for the genesis and the cohesion of frontal structures?

In a subsequent stage, the reconstructed fields may be used as initial and boundary conditions in the framework of a general numerical model [Brasseur and Nihoul, 1990]. Indeed, the non-linear features of primitive equations models require the use of adequate auxiliary conditions to reproduce as much as possible realistic situations. The complementary nature between the direct approach based on evolution equations and the inverse method for the visualization of data will become essential for the understanding of the whole Mediterranean System.

REFERENCES

BECKERS J.M. 1988. Modélisation Mathématique et Numérique de la Mediterranée occidentale, Thèse de fin d'études d'Ingénieur Civil en Mécanique-Physique, Juin 1988, Université de Liège.

BRASSEUR P., 1989. Analyse de données océanographiques par le modèle variationnel inverse, Thèse de fin d'études d'Ingénieur Civil en Mécanique-Physique, Juin 1989, Université de Liège.

BRASSEUR P. and NIHOUL J.C.J, 1990. Data processing and initialization scheme in the Northern Bering Sea by Variational Inverse Models. AGU Ocean Sciences Meeting, New Orleans.

O-IV3

Observations of Currents and Temperature on the Adriatic Shelf in Summer

Ivana CEROVECKI*, Zoran PASARIC*, Milivoj KUZMIC* and Mirko ORLIC**

*Centre for Marine Research, Ruder Boskovic Institute, Zagreb (Yugoslavia)

**Faculty of Science, University of Zagreb, Zagreb (Yugoslavia)

Current and temperature data were collected between 12 August and 10 September 1989 at three stations near the north-eastern Adriatic coast, in the framework of Adriatic Scientific COoperation Programme (ASCOP). Time series have been low-pass filtered in order to remove inertial and tidal oscillations. The low-passed data provide information about residual and wind-driven dynamics of the North Adriatic in summer.

The main feature of the current time series is variability at time scale of about ten days. Therefore, the analysed one-month period has been divided into three nearly equal subintervals with almost constant direction of current vectors. For each subinterval residual currents have been calculated and are presented in Figure 1. They indicate the existence of cyclonic gyre in the northernmost part of the Adriatic Sea. In the southern part of the measurement polygon anticyclonic gyre is observed at the beginning of the experiment, whereas cyclonic gyre is found there at the end of the experiment. The latter circulation pattern, consisting of two cyclonic gyres that dominate the open Adriatic waters, is typical for the summer period (Orlić, 1989). Present current records suggest shifting of the gyres at the time scale of about ten days. A similar phenomenon has been observed by Italian researchers in the north-western part of the Adriatic Sea. Some evidence for such a current variability in the summer 1979 is presented by Michelato (1983) and analysed in a modelling framework by Malanotte-Rizzoli and Bergamasco (1983). Accerboni et al. (1989) have reported on the similar current variations in the summers of 1983 and 1984.

During the analysed measurement interval only two wind episodes have been recorded (each lasting for about a day). Consequently, measured variations in circulation pattern may be attributed to thermohaline forcing, as was also pointed out by Malanotte-Rizzoli and Bergamasco (1983) for the summer 1979. Alternatively, such a variability can be interpreted in terms of baroclinic waves propagating through the North Adriatic.

The two wind episodes have generated response which has considerably changed current field for a short period of time. Temperature records at three analysed locations have shown that both wind episodes induced vertical mixing and appreciable decrease of surface water temperature.

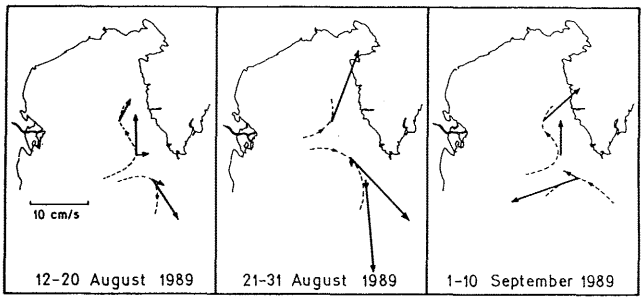


Figure 1. Surface (——) and bottom (——) residual currents and schematic representation of streamlines (---) in the North Adriatic during the summer 1989.

ACKNOWLEDGEMENT. We are indebted to dr. J. Brana and other colleagues from Centre for Marine Research in Rovinj for organizing and carrying out measurements.

ACCERBONI, E., MICHELATO, A., SCARAZZATO, P., VIEZZOLI, D., 1989. Caratteristiche dinamiche e termoaline dell'Adriatico centro-settentrionale nel periodo primavera - estate. Bollettino di Oceanologia Teorica ed Applicata, Numero speciale : 19-39.

MALANOTTE-RIZZOLI, P., BERGAMASCO, A., 1983. The dynamics of the coastal region of the northern Adriatic Sea. Journal of Physical Oceanography, 13 : 1105-1130.

MICHELATO, A., 1983. Caratteristiche della circolazione delle acque costiere dell'Emilia-Romagna. Eutrofizzazione dell'Adriatico - Ricerche e linee d'intervento, Bologna: 149-168.

ORLIĆ, M., 1989. Salinity of the North Adriatic: a fresh look at some old data. Bollettino di Oceanologia Teorica ed Applicata, 7 : 219-227.

O

Deep Water Formation in the Aegean Sea

I.-F. GERTMAN*, I.-M. OVCHINNIKOV** and Y.-I. POPOV*

*State Institute of Oceanography (Sevastopol, Odessa), U.S.S.R. State Committee of Hydrometeorology (U.S.S.R.)

**The Southern Branch (Gelendzhik) of the P.P. Shirshov Institute of Oceanology, U.S.S.R. Academy of Sciences (U.S.S.R.)

The hypothesis for the deep water formation of the Athos and Chios basins,as result of the deep convection mixing in the open sea areas, cannot explain the existence of water with potential density σθ 29.35 - 29.40, which fill the deep cavities of Aegean Sea.

Resent studies of the Aegean deep sea water has been done, only during the second half of the 1980th decate working separetly, the soviet R/V "Jacob Gakkel" as well as the greek R/V "Aegaio".

The observatibns in March 1987 (Theocharis,Georgopoulos 1988 & Georgopoulos,Theocharis,Zodiatis,Christianidis 1988) and in February and March 1988 (Gertman,Popov 1989) shows that the formed dense waters (29.37-29.38) east of Limnos island move sliding toward the Skiros hollow (29.35-29.42) and fill it.Then through the deepest trough in the area are spread to the south-southeast, to the deep cavities of Chios basin and in certain cases even reaching the Cretan basin.

Displacement of the thermochaline front between the waters, originating from Black Sea and Levantine Sea towards the north (φ=40),create the possibility to the dense water to flow towards the Athos basin through the passage between Imvros island and peninsula Kallipolis.At this area the dense water of the shelf carried away in the bottom layer by the northen currents. Further displacement of the front to the north permits the deep water formation to occur in the Athos basin,at the northen side of the crest between the islands Limnos and Imvros.Deep water with this origin characterized by smaller values of temperature and salinity in the north deep trough than those of Skiros (T>0.30 deg.C, S>0,15psu), while the density is approximately the same.

The deep water formation of the Athos and Chios basins in the shelf of Limnos can be seen at the horizontal distribution of potential density in the bottom layer of Aegean Sea (Fig.1,R/V Jacob Gakkel,January-February 1990).It is necessary to mention the predominance of the deep water formation in the shelf, which characterizes mainly the north part of Aegean Sea.In the Cretan Sea, as well as in other areas of Mediterranean Sea,the deep water is formed mainly by convection mixing in the open sea at the centre of cyclonic gyres.In the eastern part of the Cretan Sea was found water originating from Chios basin,while in the western part appears the influence of dense water which is coming sliding from the shelf zone of north Cyclades islands.

As its seems from the above results, it is attracted to sed more light on these phenomena, so combined efforts would help greatly to aproach succesfuly such a problem.

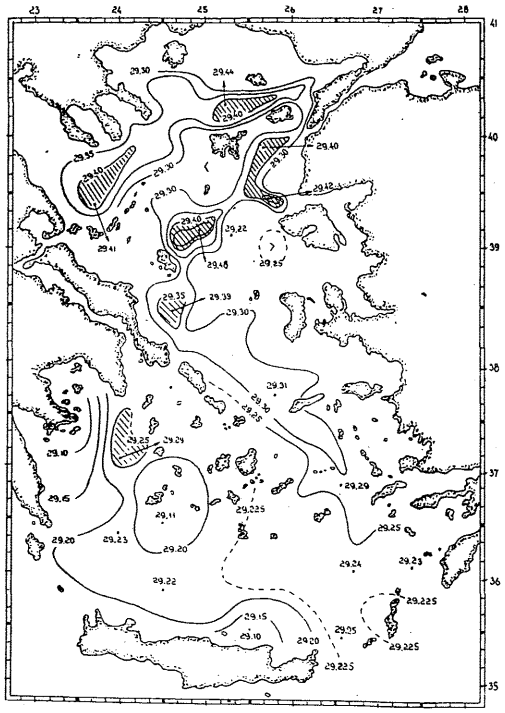


Fig.1. The distribution of potential density (σθ) near the bottom in the Aegean Sea (R/V Jacob Gakkel).

REFERENCES

GEORGOPOULOS D.,THEOCHARIS A.,ZODIATIS G.,CHRISTIANIDIS S.,1988
On the formation of dense water over the shelf areas of the northen Aegean Sea, XXXI Congress ICSEM, Athens, Oct.1988.

GERTMAN I.M.,POPOV Y.I.,1989
Analysis and genesis of the Aegean Sea water masses in a dense grid of stations, winter 1988. UDK 551.465(262.41), Sevastopol, VINITI 1201-B89.

THEOCHARIS A.,GEORGOPOULOS D.,1988
Existence of dense waters over the northern Aegean plateaux, National Centre for Marine Research,1945-1965-1985,Athens.

Programme de Contrôle Océanographique de la Baie d'Izmir entre 1988 et 1989 (Turquie) : I-Aspects hydrodynamique et physico-chimique

S.-L. GOKCEN, A.-O. AKYARLI, S. CIRIK et E. IZDAR

Institut des Sciences et de Technologie Marine, Université de Dokuz Eylül, P.K. 478 35213 Izmir (Turquie)

La baie d'Izmir se situe dans la partie Ouest de la Turquie. Elle attire l'attention à cause des eaux polluées de sa partie inférieure : les effluents domestiques et industriels de la troisième grande ville de Turquie, plus d'un million et demi d'habitants, s'y déversent. De plus, le fleuve Gediz y charrie des déchets parfois toxiques d'origine agricole. D'autre part, l'apport d'eau du large reste limité à cause de la morphologie et du manque de profondeur de cette baie.

Ces dernières années, la municipalité a pris certaines mesures pour contrôler la pollution de la baie. Parmi celles-ci, un projet de grand canal vise à collecter les eaux usées par l'intermédiaire d'émissaires pour les rejeter dans la partie extérieure de la baie, après épuration.

Afin de découvrir la meilleure façon d'utiliser la baie d'Izmir comme milieu collecteur, nous avons instauré, depuis décembre 1987, un programme de contrôle océanographique avec un soutien financier de la municipalité. Dans ce cadre, nous surveillons les aspects bioécologique, hydrodynamique et physico-chimique. Le présent travail relate les deux dernières parties de ce programme.

Au cours de la recherche hydrodynamique, les courants en des périodes courtes (9 st.) et longues (2 st.) ainsi que le niveau de la mer (3 st.) ont été mesurés. Dans le cadre des expériences physico-chimiques, des mesures et des prélèvements (T.°C, Salinité, turbidité, conductivité, pH, oxygène dissous, sels nutritifs, métaux lourds) ont été effectués, mensuellement, en 32 stations.

Tenant compte des résultats hydrodynamiques :

a) on ne relève pas de stratification de densité dans la baie, sauf en été; du fait de cette caractéristique, les eaux se déplacent en bloc;

b) en cas de vent dominant N.E., on constate dans la partie extérieure de la baie, la présence, le long de la côte Ouest, d'un courant venant du large et d'un autre longeant la côte Est, vers le large;

c) à cause de la présence d'îles, en particulier de celle d'Uzunada, une certaine masse d'eau n'arrive pas à pénétrer en baie moyenne et retourne;

d) il est très probable qu'il existe une zone de remous, dans la partie Est, de l'île d'Uzunada.

En ce qui concerne les paramètres physico-chimiques :

a) la conductivité, la salinité et la température varient selon les saisons et le degré de pollution. Leurs valeurs minimales et maximales sont les suivantes : 39,00-58,85 mmho, 35,00-39,50 %0,10,80-29, 80°C;

b) la matière en suspension diminue de l'intérieur vers l'extérieur de la baie (190 - 5 mg/l);

c) le pH varie dans les limites basiques, 8,00 - 9,00, tandis que l'oxygène dissous oscille entre 3,50 et 9,80 mg/l;

d) les concentrations maximales et minimales de sels nutritifs (nitrite, nitrate et phosphate) sont 0,1-6,0, 0,11-39 et 0,30-103 ug/l;

e) l'accumulation des métaux lourds (Hg, cd) dans l'eau et dans le sédiment n'atteint pas de niveau critique.

REFERENCES

AKYARLI (A.O.), 1988.- Current and sea level measurement performed in the Izmir Bay. Proceeding of the symposium of Environment, 1988, Izmir, 12p.

GOKCEN (S.L.) & CIRIK (S.), 1989.- Rapport du projet de recherches marines de la baie d'Izmir (en turc). D.B.T.E. projet code No: 063, Izmir (Turquie).

O-IV6

A radio-tracked drifting buoys system for the study of mesoscale near surface currents in the Mediterranean

Agusti JULIA

Institut de Ciències del Mar (CSIC), 08003 Barcelona (Spain)

The use of radio-tracked drifting buoys in the study of near surface currents has been introduced in different ocean regions in the last ten years (Davis et. al., 1982). The tracking from a ship of current dragged buoys, by means of directional reception of individual radio signals, allows an almost continuous positiong of several buoys in a relatively large area. An oceanographic vessel equiped with a calibrated rotating antenna and a radio direction finding system, can simultaneously follow the trajectory of a set of buoys while performing other research work. Fig. 1 is an example of a trajectory calculated from 59 different bearings of a surface buoy released on June 1989 in the area of the Balearic current. The successive triangulations are corrected from the error introduced by the time lag between consecutive bearings.

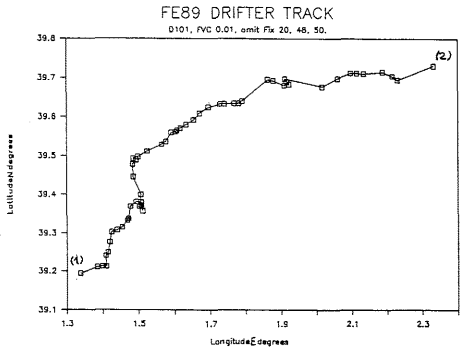


Fig. 1 Drifter trajectory obtained during FE89 cruise. Each calculated position is represented by a small square. Released (1) on June 14th 1989 at 12.49h and recovered (2) on June 18th at 12.52h

Our group (FEPOG) has been using this method in four different cruises since 1986 in the Catalan Sea (NW Mediterranean) where it has shown to be very useful in the study of mesoscale near surface phenomena, as frontal filaments (Wang et al., 1988) or inertial oscillations (Font et al., 1988; Salat et al., 1989). The space (few tenths of kilometers) and time (few days) scales typical of mesoscale processes in the Mediterranean make the system very suitable for such kind of studies in the region.

In the first two cruises, in cooperation with the Marine Sciences Research Center of the State Univ. of New York, we used drifters constructed by Lunar Electronics Co. (San Diego, U.S.A.), based on an original prototype by Russ E. Davis, and a receiving system developped in the Scripps Institution of Oceanography. Since 1988, in the frame of a Spanish research project (CAICYT PB86-0628), we have been developing a new system based on the same antenna commutation circuit structure, and used it in 1989 with a modified buoy model that kept the initial operating frequency band but introduced simplifications in the servicing of the buoy body.

Due to the fact that the original buoys were designed to operate in the 216 Mhz band, important interference problems can appear when using them in Europe, where that band is reserved to aircraft communications and navigation beacons. To have a system adequate for mesoscale studies in the Mediterranean, we have designed a complete new transmiter and direction finder that operates in the 430 Mhz band.

The new buoys, that have the same external shape and size in order to keep their dynamic characteristics, have been essayed during a cruse in 1990 with excelent results. Since the frequency of operation of the new system is aproximatively the double of the early one, the size of the direction finding antennas has been reduced to the half, allowing a more easily installed on board. We also took benefit from two other facts: First, the receiver noise level at 430 Mhz is lower than the corresponding at 216 Mhz. Second, since the size of the transmiter antenna is also the half of the one used at 216 Mhz, we have been able to design an antenna with higher efficiency without significative increase in its length. The result has been a very important increase in the signal to noise level for the same power consumption of the buoys. The effective range is actually limited by the Earth shape to 25 to 30 Km.

Davis R.E., Dufour J.E., Parks G. J. and Perkins M.R. (1982) Two inexpensive current following drifters. Scripps Institution of Oceanography. Ref. No. 82-28.

Font J., Salat J. and Wang D.P. (1988) Lagrangian and Eulerian observation of inertial oscillations in the shef break offshore the Ebro River Delta (Catalan Sea, NW Mediterranean). Rapp.Comm.int.Mer Médit., 31(2): 201

Salat J., Font J., Tintoré J. and Wang D.P. (1989) Inertial oscillations in a shelf/slope region of the Northwestern Mediterranean. Annal.Geophys., 1989 EGS sp. issue: 122

Wang D.P., Vieira M., Salat J., Tintoré and La Violette P.E. (1988) A shelf/slope frontal filament off the northeast Spanish coast. J.Mar.Res., 46: 321-332

O-IV7

On eddies formation in the Northwestern part of the Main Black Sea Current

L.-A. KOVESHNIKOV

Marine Hydrophysical Institute, Ukrainian SSR Academy of Sciences, Sevastopol (U.S.S.R.)

The investigations of the different scales eddies are of considerable importance in modern oceanography. It is due to the important role which they play in oceanic processes. According to recent data the eddies formation in the region of the Main Black Sea Current(MBSC) by its meandering is a remarkable feature of the Black Sea circulation. Analysis of a large set of hydrographic data has identified the regions with intensive meandering of MBSC, which have the largest probability of eddies formation. One such region is the part of MBSC over the continental slope of the northwestern part of the Black Sea. It is known that there is a quasi-stationary anticyclonic eddy in this region. This eddy can be seen on AVHRR-IR images.

This paper describes the thermo-haline structure of the anticyclonic eddy and its main parameters in detail, based on data from three hydrographic surveys in the northwestern part of the Black Sea (October-December, 1987). The distance between the hydrographic stations was 20' at the latitude and 30' at the longitude. The time interval between the surveys was approximately one month. All dynamic computations were based on a common reference level of 300 m.

The anticyclonic eddy was observed in the first and the third surveys; it was not observed in the second survey. Data of most interest were obtained in the third survey. These are described below.

On the dynamical topography map the stream of MBSC and the large anticyclonic eddy (AE), extending approximately 50 n miles at the longitude and 30 n miles at the latitude, are seen clearly. Geostrophic velocities of MBSC are upto 38 cm/sec and those of the AE upto 30 cm/sec. The stream of MBSC was displaced to the south. The AE penetrated from the surface to a depth of 300 m.

The sinking of the water inside the AE was considerable. The depth of the 8°C isotherm at the center of the AE was 170 m , and 90 m at the periphery. The depth of the 21 ppt isohaline was 190 m at the center and 100 m at the periphery, while the corresponding depths of the 16 sigma-t isopycnal were 170 m and 80 m respectively.
The difference between the temperatures at the center of the AE and its periphery changed sign with depth, due to the existence of the Cold Intermediate Water Layer (CIWL). Therefore the same eddy had both a warm core and a cold core, depending on the depth.

In our case the temperature was higher from the surface to a depth of 70 m at the center of the eddy than at the periphery. From 70 m to 300 m (depth of AE penetration) the temperature was lower in the center than at the periphery. The lens of the coldest water with temperature less than 6.5°C was found at the layer 80 - 110 m at the center of the AE.

Our observations show that the AE does not exist continuously in this region of the Black Sea.

The mechanism, the conditions of generation and development of anticyclonic eddies are the subjects of future investigations. However, it is clear that the meandering stream of MBSC is the main cause of the generation of these eddies. Possibly, the meridianal displacement of the MBSC plays an important role. The stream, moving across the continental slope, is situated sometimes in the shallow waters and sometimes in the deep waters. The maximum of the AE development will be at the deep waters, when the MBSC stream is situated at its southern-most location, and the minimum of AE development will be at the shallow waters, when the stream is situated at its northern-most position. In the latter case the AE may vanish.

The result of our present investigation is in agreement with earlier observations of the existence of the quasi-stationary AE in the continental slope region of the Black Sea north-western part.

REFERENCES

S. T. Kaminsky, L. A. Koveshnikov, Yu Sh. Chigogidze (1988) Quasi-stationary eddy at the north-western part of the Black Sea. In: The processes of the formation and inter-annual variability of hydrophysical and hydrochemical fields of the Black Sea, Acad. Sciences of the UKr SSR, MHI, Sevastopol, 1988, pp 29 -35 (in Russian)

O

The Levantine water in the Tyrrhenian Sea : double diffusion and basin scale mixing

Robert MOLCARD

Laboratoire d'Océanographie Dynamique et de Climatologie, Tour 14, 4, Place Jussieu, 75252 Paris (France)

Double diffusive processes have now been encountered in many oceanic regions. They occur sporadically in space and in time and can increase the vertical diffusion coefficient by several order of magnitude. In this paper, an attempt is made to parameterise this micro-scale phenomena. The salt and heat fluxes, calculated from salt-finger theory, can be compare to the salt and heat balance in the Levantine Intermediate Water (LIW) tongue during its incursion in the Tyrrhenian basin, which offers a natural model to undertake such a study. Similar objectives have been pursued in the mediterranean out flow off Gibraltar (Lambert & Sturges, 1977. Hebert, 1988).

The Tyrrhenian sea is a semi-enclosed basin with a large opening of 180nm in the south between Sicily and Sardinia. The average depth is 1000m with a deep channel of 2000m in the eastern part, communicating between Sicily and Tunisia with the western basin. In the northern part it is opened to the Ligurian sea, between Corsica and the italian mainland. The deepest passage, on the corsican side, only reaches 410m.

Most of the LIW which enters the basin following the sicilian cost, between 300 and 600m, is believed to return to the western basin with a southward flow along the sardinian cost (Garzoli & Maillard,1979). All the hydrological sections (from the presently available data base) achieved between Sicily and Sardinia indeed show two distinct cores of warmer and saltier water having respectively in and out geostrophic flow. Estimates of these flows are however strongly dependent on the chosen reference levels: Climatological data of the section have been inversed using Singular Value Decomposition method (Mémery & Wunsch, 1989) in order to deduce more realistic values of the water, salt and heat fluxes through this section.

It has also been shown (Molcard & Tait, 1977) that double diffusive processes of salt finger type (Williams, 1975) are present in the deep basin of the Tyrrhenian sea and are responsible for the large homogeneous layers separated by sharp interfaces observed in the region. Laboratory and theoretical investigations directed at estimating the associated diapycnal salt fluxes (Stern, 1976. Turner, 1967. Schmitt, 1988) lead to an estimate of the average vertical salt flux out of the LIW.

The loss of salt and heat in the LIW during its incursion in the Tyrrhenian basin can therefore be compared to the expected loss due to double diffusion. Required time for the necessary amount of salt and heat to be drawn out of the levantine water, according to the vertical salt flux deduced from double diffusion theory, is discussed in view of the expected renewal time of the LIW deduced from the in and out fluxes, and the present knowledge of the general circulation in the basin.

O

REFERENCES.

GARZOLI, S. and MAILLARD, C., 1979. Winter circulation in the Sicily and Sardinia straits region. Deep Sea Res. 26 A, 993-954.

HEBERT, D.,1988. Estimates of salt-finger fluxes. Deep Sea Res., Vol. 35, No. 12 , 1887-1901.

LAMBERT, R. B. and STURGES, W., 1977. A thermocline staircase and vertical mixing in the thermocline. Deep Sea Res. 24, 211-222.

MEMERY, L. and WUNSCH, C., 1989. Constraining the North Atlantic Circulation with Tritium data. Journal of Geophys. Res. (in press).

MOLCARD, R. and TAIT, R.I., 1977. The steady state of the step structure in the Tyyrhenian sea. A voyage of discovery. Supplement to Deep Sea Res. Pergamon Press, pp. 221-233.

SCHMITT, R.W., 1988. Mixing in a thermocline staircase. In: Small scale turbulence and mixing in the ocean. Elsevier Oceanography Series, Vol. 46, New York, pp. 435-452.

STERN, M.E., 1976. Maximum buoyancy fluxes across a salt finger interface. Journal of Marine Research, 34, 599-611.

TURNER, J.S., 1967. Salt fingers across a density interface. Deep Sea Res. 14, 599-611.

Heat Storage in the Western Mediterranean Sea

Paola PICCO

Università di Genova, Dipartimento di Scienze della Terra-Sezione Geofisica, Viale Benedetto XV, 5 16132 Genova (Italia)

Heat budget plays an importan role in the dynamic of the oceans. Several studies on the heat exchanges between the atmosphere and the sea surface and on heat and water budgets can be found in literature, but only few works regard the heat storage in the Mediterranean Sea.

In this work are presented some results which describe the geographical distribution of the heat storage in the first 100 m. of Western Mediterranean Sea, based on climatological data of sea temperature.

Data used come from the ENEA-CREA La Spezia (I) environmental data-bank. The WMTS (Western Mediterranean Temperature Salinity) data-set is made of about 12,000 TS profiles for the Western Mediterranean from 1911 to 1985 selected with a resolution of 0.5 degree square to obtain monthly mean profiles. Vertical resolution is that of standard levels.
Monthly heat storage in J/m^2 is computed by:

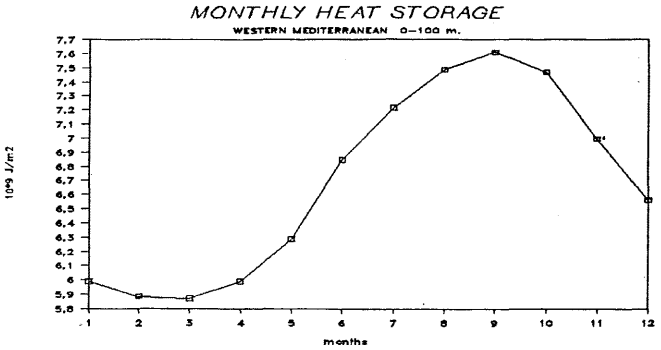
$$H = \varrho\ Cp \sum_{i} 1/2\ [T(i)+T(i+1)]\ [Z(i+1)-Z(i)]$$

ϱ = 1027 Kg/m^3 seawater density
Cp= 1,487 $J/Kg^{\circ}K$ specific heat capacity
Zi= i-level depth
Ti= i-level temperature

The error assuming ϱ and Cp constant is negligible compared with other sources of errors. Computation was performed for the 0-100 m. and for the 0-300 m. layers.

The annual trend of the monthly mean heat storage in the two considered layers for the entire Western Mediterranean shows that most of the heat storage variation occurs in the first 100 m. The amplitude of the annual signal for the 0-300 m. layer is only about 2% grater then the 0-100 one. Heat storage in the first 100 m. ranges from a minimum of 5.9 $10^9 J/m^2$ in March to a maximum of 7.6 10 J/m2 in September (Fig.1).

The geographical distribution of the amplitude of the annual signal shows an high variability (Fig.2). It can give an idea of the amount of the heat exchange in a region and it is in good agreement whit some general circulation schemas. Higher values (more then 2.6 $10^9 J/m^2$) are reached in the Algerian Provencal Basin; in the Alboran Sea, the inflow of Atlantic Waters makes the signal amplitude rather small (about 1.4 $10^9 J/m^2$). Low values are also found in the Ligurian Sea and in the Gulf of Lion (less then 1.6 $10^9 J/m^2$). Here the maximum of the heat storage is reached in October instead of September as in the other regions.



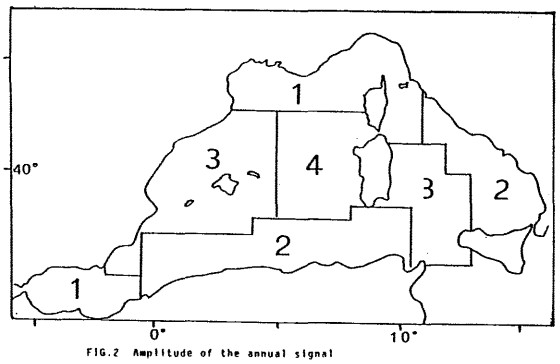


FIG.2 Amplitude of the annual signal

1 1.2-1.6 10E9 J/m2
2 1.6-2.0
3 2.0-2.4
4 2.4-2.8

References

LEVITUS,S. 1984:Annual Cycle of Temperature and Heat Storage in the World Ocean.J.Phys.Oceanogr.,14,727-746

PICCO,P.MANZELLA,G.M.R. 1988:Nuovo data-set di temperatura e salinita' per il Mediterraneo Occidentale.Boll.Geof.,IV,37-53

PICCO,P. 1990:Climatological Atlas of Western Mediterranean Sea. ENEA (in press)

WYRTKY,K. and UHRICH,L. 1982:On the Accuracy of the Heat Storage Computation.J.Phys.Oceanogr.,12,1411-1416

O-IV10

Horizontal Circulation of the Eastern Mediterranean Waters during the Winter and Summer seasons

M.-A. SAID

National Institute of Oceanography & Fisheries, Kayet Bey, Alexandria (Egypt)

ABSTRACT

The water circulation of the Eastern Mediterranean at the free sea surface and at the 50, 100, 300 and 500 db surfaces was computed during the winter and summer seasons using the dynamic method. The reference level was taken at the 1000 db surface. The used data were taken from 1338 hydrographic stations collected from several expeditions carried out by different countries during the last 20 years (1963-1982). 680 stations were collected in the winter season and 658 stations in summer (obtained from the Hydrographic Data Centre B, Moscow). Vertically unstable stations were either corrected for temperature or salinity or rejected if many levels of instability were observed. The average values of temperature and salinity of these collected data were computed, using the optimum interpolation of the correlation algorithm, in stations distributed in a regular net one degree longitude by one degree latitude for winter and summer seasons.

The fulfilment calculations evidenced the considerable stability of the geostrophic water circulation in the eastern and central basins of the Mediterranean Sea. The most existence features of the geostrophic circulation during the winter and summer seasons were : the vast cyclonic gyre in the Levantine Sea, enveloping the southern part of the Aegean Sea; the cyclonic gyre in the Ionian Sea; and the anticyclonic gyre in the Libyan Sea and near the Egyptian coast.

These main features of the dynamic relief were also observed by several authors, and testified the stability of the Mediterranean water circulation through long standing survey. However, some distinctions were obtained from the present work when comparing with the previous works.

The geostrophic current velocity varied between 5-10 cm/sec in the Libyan Sea, 15-25 cm/sec near the Egyptian coast and between 35-40 cm/sec in the eastern part of the Levantine Sea. At the straits of Crete island, it reached 15-30 cm/sec. Particular noticeable differences between the winter and summer surface current velocity in the eastern and central basins of the Mediterranean Sea were not found.

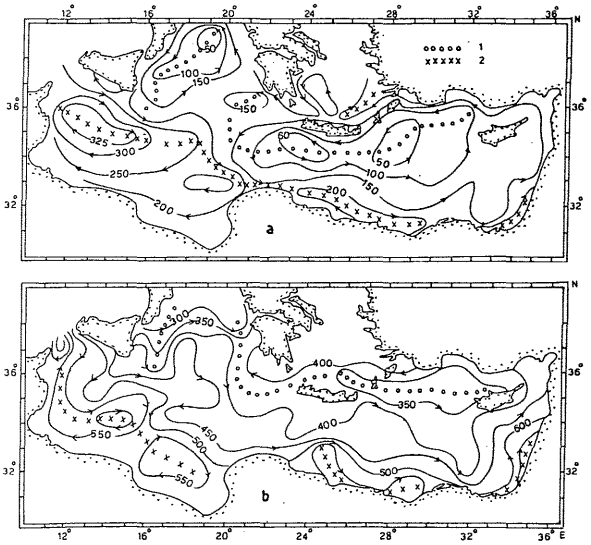


Fig.(1). Dynamic relief (dyn. mm.) of the free sea surface during : a- winter and b- summer seasons.
1- depression and 2- crest of the dynamic relief.

REFERENCES

Ovtchinnikov, I.M. 1966. Circulation in the surface and intermediate layers of the Mediterranean Sea. Oceanology, 6(1): 49-59.

Ovtchinnikov, I.M. 1976. Water circulation in the Mediterranean Sea. In : Borkov ed." Hydrology of the Mediterranean Sea ", Leningrad, pp. 240-313.

O-IV11

Calculation of Wind-Driven Currents in the Mediterranean Sea

M.-A. SAID

National Institute of Oceanography & Fisheries, Kayet Bey, Alexandria (Egypt)

The average wind speed over the Mediterranean Sea is not more than 6-7 $m.sec^{-1}$. This wind causes a current at the sea surface with an average velocity of about 5 $cm\ sec^{-1}$ (Ovchinnikov, 1966). The aim of the present work is to calculate the wind-driven current in the Mediterranean Sea, on the basis of Ekman's formula, using Krasuck and Saoskan's method (1970). The atmospheric pressure gradient, the curvature of the isobars and latitudes are the main parameters in calculating the wind-driven currents.

The velocity of the wind-driven current according to the empirical correlation which depends on the wind speed W and the geographical latitude ϕ is given by :

$$V = \frac{KW}{\sqrt{\sin \phi}} \qquad (1)$$

The coefficient K represents the relation between the current velocity and the wind speed. The transmission of wind energy to the sea is carried out by several processes. One of them is the energy transmission throughout the tangential wind stress, which is given by :

$$\tau = C \rho W^2 \qquad (2)$$

where, τ - wind stress, ρ - air density, W - wind speed, and C - coefficient of tangential wind stress. The second process, is the orbital wave motion. In this case, the velocity of water particla (V') at the surface is given by :

$$V' = \left(\frac{\pi H}{L} \right) C_o \qquad (3)$$

where, H - wave height, L - wavelength, and C_o - wave velocity.

On the basis of the mentioned above, particularly the intercommunication between wind, wave and currents, a monograph (Fig.1) was constructed by Krasuck and Saoskan (1970) for simplifying the problem of short-term prediction of the wind-driven currents in the ocean. In order to select the synoptic situation which causes strong drift current at the sea surface, the weather charts of January, February and March for eight winter seasons were analysed (Synoptic Bulletin, 1970-1977). From these charts, the cyclons appeared during winter once or twice in a month. The more considerable pressure gradient over the Mediterranean Sea was observed during the periods 28-31 January 1975 and 15-18 January 1976. During these periods the atmospheric pressure in the centres of the cyclons over the sea was less than 1000 mb (Fig.2).

The obtained surface circulation pattern of the Mediterranean waters from the pure wind-driven current calculation during the period of investigation (15-18 January, 1976) is shown in Fig.3. The calculated velocity values of the drift current are in general more than 20 $cm.sec^{-1}$. The highest values (40-60 $cm.sec^{-1}$) are observed in the along the Libyan and Egyptian coasts and in the southern part of the Aegean Sea. The lowest values (10-20 $cm.sec^{-1}$) are observed in the Western Mediterranean and in the northern part of the central basin.

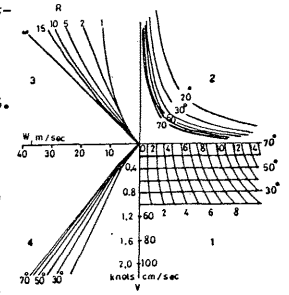


Fig.(1). Monograph for calculating the wind-driven currents.
(after Krasuck and Saoskan, 1970).

The obtained wind-driven current scheme of the Mediterranean is agreable mostly with the previous circulation models based on either dynamic and/or numerical methods.

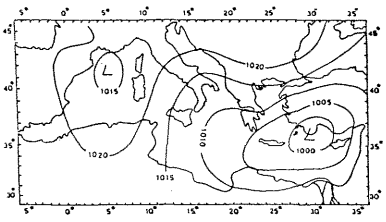


Fig.(2). Distribution of the atmospheric pressure (mb) over the Mediterranean Sea during the period 15-18 January 1976.

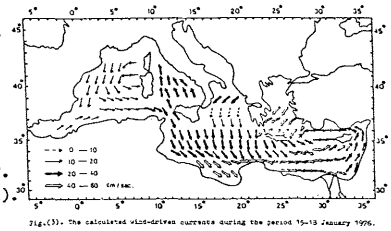


Fig.(3). The calculated wind-driven currents during the period 15-18 January 1976.

References

Krasuck, V.C. & I.M. Saoskan. 1970. On the calculation of wind-driven currents in the ocean. Meteorology & Hydrology, 9 : 68-74 (In Russian).

Ovchinnikov, I.M. 1966. Circulation in the surface and intermediate layers of the Mediterranean. Oceanology, 6(1) : 48-59.

Synoptic Bulletins. 1970-1977. Moscow, GMC, USSR (In Russian).

On the formation of the intermediate water masses off the Egyptian Mediterranean Coast

M.-A. SAID and A.-M. KARAM

National Institute of Oceanography & Fisheries, Kayet Bey, Alexandria (Egypt)

The presence of an intermediate water characterized by a secondary maximum of salinity in the Mediterranean Sea has a very peculiar phenomenon. Regions of formation of this water mass have been already more or less identified in the Mediterranean Sea. Along the Egyptian Mediterranean coast, the formation of this intermediate water mass was studied by Morcos (1972), who suggested that the area to the east of longitude 29° E and west of Alexandria is a secondary source of formation of the intermediate water. In addition, Abdel-Moati and Said (1987) suggested that the area infront of Damietta is another region of formation. The aim of the present work is to identify more accurately the locations of the formation of this water mass on the Egyptian Mediterranean shelf and its spreading using the isopycnic analysis.

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 145 hydrographic stations in winter. 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 winter season.

Our study confirms the findings of Morcos (1972) and Abdel-Moati and Said (1987). Besides, a new source has been identified which appears as a region of salinity > 39.30 ‰ (Fig.1) and a relatively high temperature > 17.00°C (Fig.2). The salinity distribution on the σ_θ = 28.80 (Fig.1) indicates that the saline warm water flows away from the continental shelf to the northwest in a high-salinity tongue and it reaches the open sea with values as low as 38.95 ‰. This supports the suggestion of Morcos (1972) that more than one starting point representing various sources of formation of the intermediate water mass of maximum salinity are present in the Levantine basin.

The irregularties which appear particularly for the lateral salinity distribution west of 27° E (Fig.1) might be attributed to mesoscale noise in the data. In fact it needs more stress in the future work in order to get more clear picture of the thermohaline flow paths.

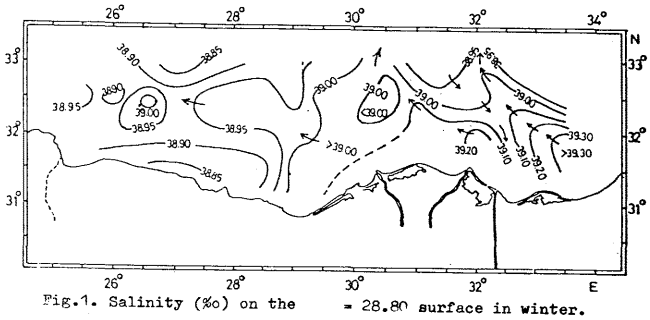


Fig.1. Salinity (‰) on the σ_θ = 28.80 surface in winter.

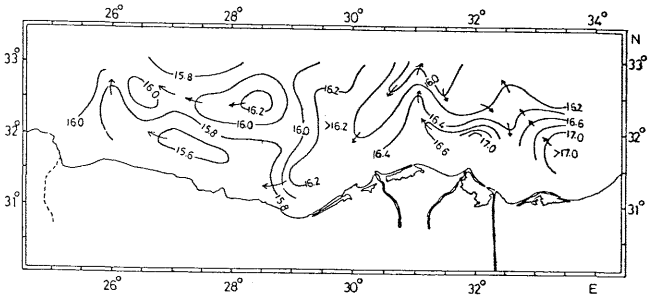


Fig.2. Potential temperature on the σ_θ = 28.80 surface in winter.

References

Abdel-Moati, A.R. and M.A. Said. 1987. Hydrographic structure of the Mediterranean shelf waters off the Egyptian coast during 1983-1986. J. Thalassographica, 10(2) : 23-39.

Morcos, S.A. 1972. Sources of Mediterranean intermediate water in the Levantine Sea. In : Studies in Physical Oceanography, attribute to George Wüst on his 80th birthday, 185-206.

Contribution of the Rhone River water discharges to the dynamics of the Gulf of Lions in Autumn 1986

Jordi SALAT*, Antonio CRUZADO** and Michel PANOUSE***

*Institut de Ciències del Mar, Pases Nacional s/n. 08003 Barcelona (Spain)
**Centre d'Estudis Avançats, Camí de Santa Barbara, 17300 Blanes (Spain)
***Laboratoire Arago, 66650 Banyuls de la Marenda (France)

The Gulf of Lions (NW Mediterranean) was covered by two oceanographic surveys, Pelagolion I and II, at the end of summer and at the end of autumn 1986. The main objective was to understand the role of the Rhone river water discharges on the pelagic production in that region at different seasons. Every cruise consisted on a series of CTD+Rossette casts scattered in the Gulf with a very fine survey in the vicinity of the river mouth. In this presentation, the results derived from CTD casts are summarized and discussed.

The main feature observed in the geostrophic velocity fields, obtained in both cruises (fig. 1), is the presence of the Liguro-Provençal-Catalan current contouring the shelf break, from east to west, with a maximum speed of about 35 cm/s, 15 miles south of Toulon (6°E) at the entrance to the region. This main current is present at all levels. Part of the water entering is deflected towards the river mouth along the north coast and another part flows to the south, mainly in summer, forming a cyclonic eddy. The main flow is minimum in the central part of the Gulf and it is enhanced again at the exit, directed towards the south 15 miles east of Cap Creus (42°20'N)

The main result concerning the dynamics is an anticyclonic eddy found in both cruises, in the nortwest quadrant of the Gulf, centered on (43°N 3°30'E). River discharges produce a thin low salinity surface layer spreading over the vicinity of the river mouth. This water is trapped by the eddy and reconducted towards the coast allowing a long residence time and mixing. By this process, the initial thin surface layer of low salinity near the river mouth is converted to an homogeneous body of dilluted water exposed to the local weather events in the coastal zone. This area acts as a reserve of the characteristic water type of the Gulf, one of the most important waters of continental influence present in the Western Mediterranean. For example, this reserve of dilluted water, after strong cooling in central winter, and spreading through the bottom of the shelf break, as described by Fieux (1974) may be one of the sources of the subsurface salinity minimum found along the Catalan coast (Salat & Font, 1987).

At the beginning of summer, Allain (1960) found traces of such structures allowing the recirculation of the dilluted water towards the coast. Therefore, by that season, the river runoff is usually much higher and the mixing layer above the thermocline is thinner than in autumn which allow a major spreading of surface low salinity layer as found by Castellón et al. (1985) in late spring. The summer observations of Millot (1981) show also an anticyclonic circulation in this area with local coastal upwelling events and downwelling in the center.

On the offshore side of the main current appears another anticyclonic eddy centered on (42°10'N 4°20'E) which seems to be very persistent. This eddy is completely uncoupled with the rest and the water in this region is not affected at all by the continental influence. Probably this eddy will play a major role on the deep water formation process during winter.

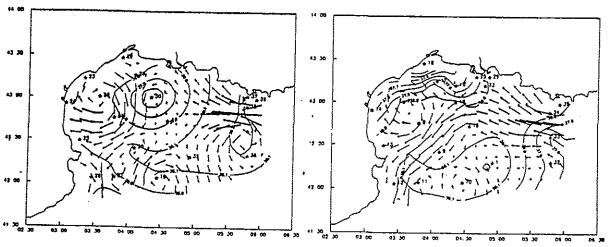


Figure 1. Geostrophic current and salinity fields at 10 m depth. a) at the end of summer 1986 b) at the end of autumn 1986

References

Allain C., 1960. Topographie dynamique et courants généraux dans le bassin occidental de la Méditerranée. Rev. Trav. Inst. Sci. Tech. Pêches Marit., **24**,1: 121-145.

Castellón A., J. Salat & M. Masó, 1985. Some observations on Rhone fresh water plume in the catalan coast. Rapp. Comm. int. Mer. Médit., **29**,3: 119-120.

Fieux M., 1974. Formation d'eau dense sur le plateau continental du Golfe du Lion. Colloques Internationaux du C.N.R.S., **215**: 165-189.

Millot C., 1981. La dynamique marine sur le plateau continental du Golfe du Lion en été. Thèse Doctorat. Univ Paris VI.

Salat J. & J. Font, 1987. Water mass structure near and offshore the Catalan coast during winter in 1982 and 1983. Annales Geophysicae, **5B**,1: 49-54.

O-IV14

The bitter lakes between the past and present

Girgis F. SOLIMAN* and Selim A. MORCOS**

*National Institute of Oceanography & Fisheries, Anfoushi, Alexandria (Egypt)
**Division of Marine Sciences, UNESCO, 75700 Paris (France)

The Bitter Lakes of Suez Canal were characterised with layers of salt deposits of about 13m thick.After the opening of the Suez Canal in November 1869, a salt barrier of salinity greater than 65 ‰ was formed in the lakes which acted as an obstacle for the migration of the marine organisms between the Mediterranean and the Red Seas.

Four cruises were conducted in the Bitter Lakes during summer periods (1982-1986), to study water circulation, decrease of salinity with time, and situation of the salt barrier in the lakes. Temperature, salinity and currents were measured at different depths. The mean water level during the same period was also obtained.

A minimum salinity of about 43.5 ‰ has been recorded during the last few years. A difference in salinity values of about 1.0 ‰ is observed between winter and summer seasons in comparison with that obtained in 1966 (4.0 ‰).The water in the Great Bitter Lake circulates in clock- and anti-clock wise directions conformable with the tidal currents. Due to the prevailing north winds in summer, the water piles up in the southern part of the Great Bitter Lake, which generates an anticyclonic motion in the verical plane as well as drives a southward current depending on the amount of water flowing from Lake Timsah, Lake Menzelah and the Mediterranean Sea.

After the last deepening and widening of Suez Canal and Bitter Lakes in 1976,the evaporation potential is highly significant factor in increasing the salinity of the lakes during summer. Such increase is estimated as 1.2 ‰ . Finally, the salt bed is about to be exhausted and its effect on salinity is insignificant. The salt barrier which has been dominating for more than hundred and twenty years is going to be disappeared. Presently, the migration of the marine organisms between the joined seas can occur occasionally at any time without any osmotic problem.

O-IV15

Dynamical modal analysis for the Coastal Seas around Turkey

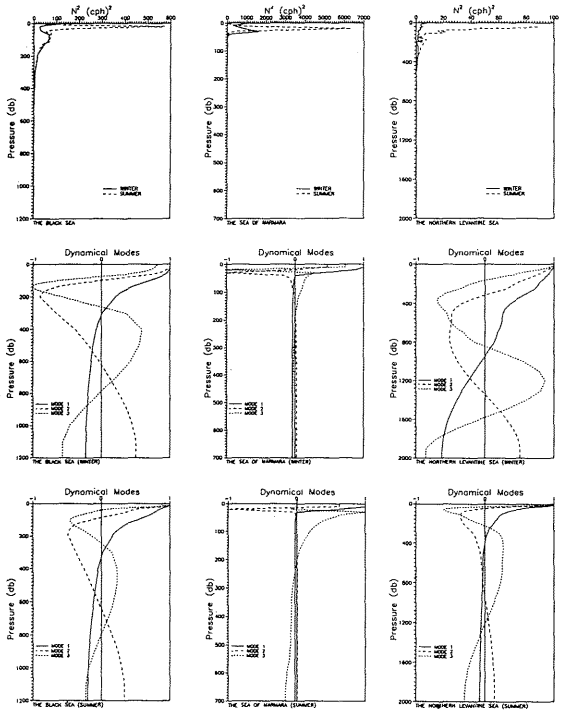
H.-I. SUR, T. OGUZ and U. UNLUATA

Institute of Marine Sciences, METU, P.O. Box : 28, 33731, Erdemli-Icel (Turkey)

The hydrographic data collected in six surveys of R/V Bilim in the Black Sea (BS), the Sea of Marmara (MS) and the Northern Levantine Sea (NLS) during 1988-1989 are used to perform the vertical modal analysis. Utilizing the Brunt-Vaisala frequency (N^2) and geopotential anomaly profiles obtained from averaged density field over the region, the relative contribution of the dynamical modes to the observed field of motion are determined by solving the vertical structure equation for each cruise.

The computed N^2 profiles show that the BS, MS and NLS are characterized by distinctly different stratification properties. In the BS, both the winter (April 1989) and summer (September 1988) N^2 profiles display presence of a two-layer stratification comprising the upper layer of 150m with substantial density variations and the layer beneath possessing almost no variations below 300m. The summer and winter N^2 profiles only differ within the uppermost 20-30m in response to seasonal thermohaline forcings. The stratification observed in MS for the winter (March 1989) and summer (September 1989) reveals even stronger two layer structure with a sharp pynocline at 25m separating two water masses. We note that the values of N^2 is one order of magnitude greater that those for the BS. In the NLS of the Mediterranean basin, the winter (March 1989) and summer (July 1988) N^2 profiles have substantial differences. The summer case reveals a surface layer of about 40m and subsequent transitional layer extending down to 80m with significant N^2 variations. The winter case, on the other hand, possesses no seasonal variations and is governed by relatively small density differences in the water column as implied by small values of N^2.

Modal analyses of the data show that the amplitudes of the first baroclinic mode in the Black Sea for both summer and winter seasons are confined to the surface layer and have zero crossings at 300m. The first baroclinic Rossby radius of deformation (R1) is found to be 19 km in each season. The first and third baroclinic modes respectively contain 80% ,10% of the total available potential energy (TAPE) in summer although the first mode contains 92% of the TAPE in winter In NLS, R1 is determined as 8 km and 11 km for the winter and summer cases, respectively.



The first baroclinic mode has a zero crossing at 400m and the second at 50m and 900m for the summer case. The first mode contains 90% of the TAPE. The winter analysis, however, reveals substantially different modal structure. The zero crossing of the first mode occurs at 950m and the second at 320m and 1320m. The first mode contains only 82% of the TAPE. 14% of it is found in the second baroclinic mode. The MS exhibits completely different modal structure. R1 is determined as 15km and 20 km for the winter and summer cases, respectively. The TAPE is partitioned as 50% and 48% between the first and second baroclinic modes in the summer case. This partition occurs between the first three successive modes as 32%, 38% and 20% for the winter case.

Some Aspects of Neutral Surfaces

Athanasios J. THEODOROU

Ministry of Environment, Planning and Public Works, 12, Varvaki St., Athens (11474) (Greece)

The development of the concept of a "neutral surface"[1].

A water parcel that moves adiabatically retains its original potential density, despite changes in its in-situ temperature and in-situ density due to the pressure changes. Thus, for an appropriately defined reference pressure, a potential density surface is a surface of movement for a resident water parcel; if the water is stable, any displacement of the parcel from this surface will be counteracted by the buoyancy forces. However, the definition of the appropriate isopycnal surfaces, on which to follow the spreading of water masses in the ocean interior is far from straightforward. The variation of the in-situ density in the ocean is dominated by pressure effects, and due to the non-linear nature of the equation of state of sea-water, it is not satisfactory to define density surfaces relative to any single pressure level.

The idea of a "perfect" neutral surface.

The concept of hydrostatic stability in the vertical direction can be extended to the three-dimensional movement of a water parcel, and in particular to the surface of neutral buoyancy delineated by the locus of all possible neutral paths of the parcel in question.

Approximating a "perfect" neutral surface: Underlying Problems.

Moving a parcel along a neutral surface implies the knowledge of the local water properties and in particular the variations of θ and S with pressure. However, the oceanographic reality provides data at discrete depths of a network of stations, sometimes widely spaced. Thus some approximate approach is needed. Implicit in the preceding discussion are the problems of where to start a neutral surface and how to extend it. Any observational level (p_A, S_A, T_A) of an arbitrary 'reference station' A, can be used as a 'reference level' to start a neutral surface. However, if our objective is to follow the spreading of a particular water mass, then we should start it from a level, at which the presence of this water mass is established. The major problem in extending the neutral surface is what reference pressure to use in calculating the densities to be compared; in particular, the in-situ density cannot be used due to the effect of the pressure. Thus, the selection of an 'appropriate' reference pressure is crucial and reflects an ambiguity inherent in any method of approximating an 'ideal' neutral surface. Another problem in extending the surface is whether to use throughout the originally selected 'reference parcel', (S_A, T_A) or to redefine the latter from station to station. Related to the last problem is the configuration of the station-network available. Some possibilities to overcome these problems exist. These and their respective utility was considered and the results obtained were sometimes widely different. This is probably due to the "reference parcel" being redefined between widely spaced stations, with contrasting thermohaline properties.

Effects of the compressibility dependence on the thermo-haline properties of a water parcel.

To clarify the above statement a 'path-dependency' test was conducted, i.e. a neutral surface was traced in a network of closely-spaced stations arranged in a closed loop, so that the neutral surface in question was started and in the absence of 'path-dependency' was expected to return to the same level at the original station. The results indicate that redefining a 'reference parcel' from station to station in extending a neutral surface does not, in general, return the surface in question to its original level. This path-dependency is presumably an expression of the inherent ambiguity concerning the depth(pressure) at which a neutral surface occurs, and it is ultimately a manifestation of the dependence of the (adiabatic) compressibility of sea-water on temperature and salinity. However, this problem can be circumvented by the method proposed.

Method proposed.

A set of water parcels with observed temperatures and salinities can be used to start a set of neutral surfaces. The levels at which the adiabatic density gradients for each of these water parcels intersect the in situ density profile at each station in a data set determine the levels of each of the neutral surfaces at that station. The neutral surfaces thereby defined were found to exhibit no path-dependency and their analysis has provided meaningful results[2].

Applications.

Data from the Mediterranean Sea are used to obtain a number of neutral surfaces, which portray vividly the spreading patterns of the Levantine Intermediate water and also of the Deep water in the Eastern Mediterranean.

References.

[1] THEODOROU A., (1983). "The impact of Norwegian Sea overflows on the water masses and deep circulation of the north-east Atlantic". Ph.D.thesis, University of East Anglia, Norwich, England.301 p.

[2] HARVEY J.G., THEODOROU A., (1986) "The Circulation of the Norwegian Overflow Water in the Eastern North Atlantic", Oceanologica Acta, Vol. 9, No. 4, 393-402.

A Synthesis of the Levantine Basin Circulation and a Retrospective Review of its variability

Emin OZSOY

Institute of Marine Sciences, Middle East Technical University, P.K. 28, Erdemli, Icel, 33731 (Turkey)

A series of recent data sets from the Levantine Basin of the Eastern Mediterranean illustrate the complexity of its dynamics. The region is populated with synoptic and meso-scale dynamic features. Heteregenous water masses are generated as a result of highly variable atmospheric and thermohaline forcings. The sub-basin scale gyres are in close contact with each other, resulting in interacting, basin-wide turbulent features. The pattern of bifurcations of the mid-Levantine jet is variable on an interannual basis, in relation to the the evolution of the general circulation in the multiply connected domain. Secular qualitative variations can be detected in the general circulation patterns derived from the set of recent observations. The flow encircling Cyprus is partially blocked in the first phase of the experiments. In later surveys, the Cilicia and Lattakia basins are flushed with new water masses carried in the cores of incident eddies, and the pattern of basin-wide circulation is modified, with a major part of the mid-basin jet flowing coherently along the mainland coasts and cyclonically around Cyprus. Based on these results, the general circulation of the Levantine Basin appears considerably different and more complex than the traditional descriptions of it.

O-V2

Circulation and mesoscale phenomena in the Algerian Basin

M. BENZOHRA* and C. MILLOT**

*I.S.M.A.L., B.P. 90, Alger 1er Novembre (Algérie)
**Antenne de C.O.M., B.P. 330, 83507 La Seyne-sur-Mer (France)

The Mediprod 5 experiment was carried out in 1986-1987 in order to investigate the Algerian Basin's dynamics between 0° and 5°E in the light of new hypotheses (Millot, 1985, 1987-a,b). This experiment was mainly based on a one-month campaign (June 1986) during which were collected ≈100 CTD casts (0-800m) and on current-meters set in place on 8 moorings at depths of 100m, 300m, 1000m and sometimes 2000m for a 9-month duration.

All the θ-S diagrams display the classical Mediterranean θ-S form. We have focused our attention on the Mediterranean Winter Water (MWW, formed in the north-western Mediterranean Sea and characterized by a θ minimum) and on the Levantine Intermediate Water (LIW, formed in the Eastern Mediterranean Sea and characterized by relative maxima of θ and S). It is first interesting to note that, in agreement with previous authors, relatively low θ_{min} of 12.63-12.70°C were encountered in the western Algerian Basin; it is also in that specific region that we have found the overall (with respect to nearly the whole southern part of the Western Mediterranean) lowest values of θ_{max} (≈13.06°C) and S_{max} (≈38.47), while the highest values of θ_{max} (≈13.45°C) and S_{max} (≈38.57) we have encountered were within an offshore eddy (Millot, 1987-b).

As most of the CTD casts were distributed along and across sections in a ≈80km coastal zone, we have estimated mean across and alongshore gradients of θ_{min}, θ_{max} and S_{max} and of their associated immersions; to seaward, θmax and Smax increase and θmin does not change, while all these parameters increase significantly eastwards. During the June campaign and during the 9-month experiment as well, the averaged currents at all depths and all locations were directed eastwards. The hydrological data analizes with the core method and the dynamical observations are coherent, thus leading us to refine our circulation schemes.

The first point is that both MWW and LIW, which flow southwards along the eastern Spanish coasts, are probably entrained from Spain towards Algeria coasts by the flow of Modified Atlantic Water (MAW). Then, MWW and LIW flow eastwards in the Algerian coastal zone and interact with the surrounding water masses; during this path, the coastal and well-mixed (it rounded along all the southern European coasts) LIW interacts with the offshore and less-mixed LIW probably entrained from Sardinia towards the interior of the basin by mesoscale eddies. Therefore, the θ_{max} and S_{max} in the Algerian coastal zone increase eastwards while LIW flows eastwards.

Basic statistics, empirical orthogonal functions (EOF) and spectral analyses performed on the 9-month time series support the distinction between a coastal and an offshore zones we have made in the previous papers. Even if all the averaged currents are directed eastwards, the vertical structure of the mesoscale phenomena down to ≈2000m is complex in the coastal zone and quite similar offshore. It stands out from vertical complex correlations that the upper layers in both zones are roughly disconnected from the deeper ones; this result is supported by EOF because only one surface-intensified mode accounts for more than 95% of total variance.

At 100m and from West to East in the coastal zone, the averaged currents decrease while variance ellipses show broad fluctuations slightly increasing, thus probably showing that energy transfer occurs from the mean towards the fluctuations. This result is consistent with satellite and *in situ* observations of eddies growing while propagating eastwards.

Significant (99%) horizontal correlation between two records (mean currents of ≈1km/day) collected at ≈1000m and ≈10 km apart, gives a mean phase speed of ≈5km/day. This value is supported by those inferred from spectral analysis (3-7 km/day in a 20-30 day band). This is also the value already deduced from i) the analysis of all the available infrared imagery and ii) our current measurements displaying a powerful anticyclonic mesoscale eddy propagated from ≈0° (early July 1986) to 5°E (late November 1986).

Millot C., 1985: Some feature of the Algerian Current. J. Geophys. Res., 90, C4, 7169-7176.

Millot C., 1987a: Circulation in Western Mediterranean Sea. Oceanol. Acta, 10, 2, 143-149.

Millot C., 1987b: The circulation of Levantine Intermediate Water in the Algerian Basin. J. Geophys. Res., 92, C8, 8265-8276.

O-V3

Circulation in the Sporades Basin and Thermaikos Shelf (NW Aegean Sea) during the ECOAEGAIO-I Experiment

X. DURRIEU de MADRON*, F. NYFFELER* and E.-Th. BALOPOULOS**

*University of Neuchâtel, 11, Rue E. Argand, 2007 Neuchâtel (Switzerland)
**National Centre for Marine Research, 16604 Hellinikon (Greece)

Recent quasi-synpotic hydrographic data collection, carried out during the ECOAEGAIO-I cruise (June 1987), allowed the study of the spring circulation in the Sporades Basin and on the Thermaikos Shelf (Fig. 1).

Fig. 1 The investigation area (shaded)

Shallow dynamic topography (Fig. 2a) shows the renewing of surface water. The surface circulation is globally anticlockwise throughout the study area. Intrusion of Aegean Sea water, from offshore, appears along the northern coastline of the basin. Part of this water penetrates the shelf, while the rest flows southwestward along the slope. The current on the shelf is dominantly northeastward, and appears as a meandering flow directed by small eddies. Outflow of lower salinity waters, originating from large river inputs, takes place along the western coastline.

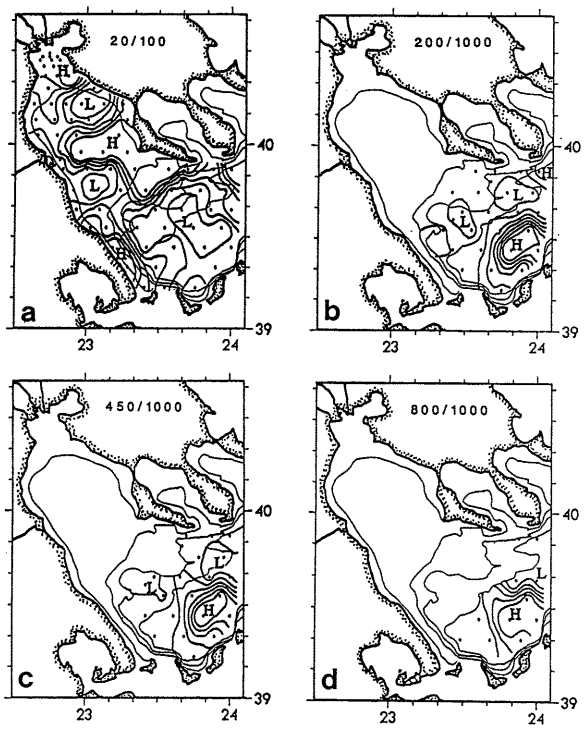


Fig. 2 Dynamic topographies of a) 20 dbar relative to 100 dbar b) 200 dbar relative to 1000 dbar c) 450 dbar relative to 1000 dbar d) 800 dbar relative to 1000 dbar

Deeper dynamic topographies show the circulation patterns in the basin. The shelfbreak depth map (Fig. 2b) depict a sharply defined clockwise eddy in the southwestern part of the basin. This gyre is roughly delineated by the 800 m isobath and remains clearly identifiable down to deeper levels (Fig. 2c and d). Two anticlockwise cells appear between the slope and the main eddy (Fig.2c and d). These secondary cells are nestled in the canyon valleys, formed by the broad open slope that practically separates the basin in two parts. The circulation features in the basin are found to be composed of different water masses and are persistent with increasing depth. Furthermore, they are believed to be constrained and generated by the bottom topography.

O

Mesoscale activity in the Catalan Current (NW Mediterranean) from May 1987 to December 1989

Jordi FONT

Institut de Ciències del Mar (CSIC), 08003 Barcelona (Spain)

In the frame of a research project on shelf/slope frontal dynamics in the NW Mediterranean (Spanish CAICYT PB86-0628), a current-meter mooring was maintained from May 1987 to December 1989 near the shelf break off the Ebro delta (40°43'4"N, 1°21'34" E). This site has resulted to be representative of the general southwestward flow in the region (Font, 1990) and very close to an area where an energetic mesoscale filament has been described (Wang et al., 1988).

One of the aims of this current study was to identify the occurrence of mesoscale events as perturbations of the general circulation in periods from 3 to 20 days. Aanderaa RCM7 current-meters were deployed at -15, -50 and -100 m with a sampling interval of 30 min. and an instrument maintenance about every two months. In total 85% of good data were recovered.

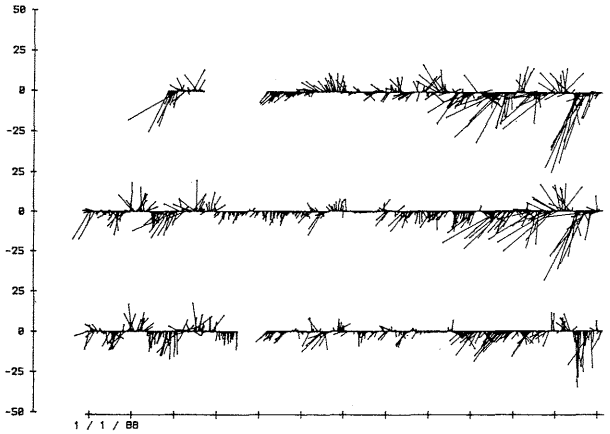


Fig. 1 Low-passed currents (33 h filter) at the three levels sub-sampled every 24 h, for the period 1 January - 31 December 1988

A first estimation of the mesoscale activity has been done with the same method used by Taupier-Letage & Millot (1986) in the Ligurian Sea: the variance of the two components of the velocity vector has been calculated by 20-day periods shifted 10 days, for the whole set of data. Low-passed and daily subsampled currents (fig. 1) were used for this calculation.

The three levels show a similar behaviour during the three years of observations, especially the intermediate and deep current-meters. After a quiet summer period, a sudden increase in mesoscale activity takes place by mid October (fig.2) and is maintained until the end of December. During winter the activity slowly decreases and a secondary and narrower maximum appears in June. The filament observed by Wang et al. (1988) in 1986 would correspond to one of these short active periods.

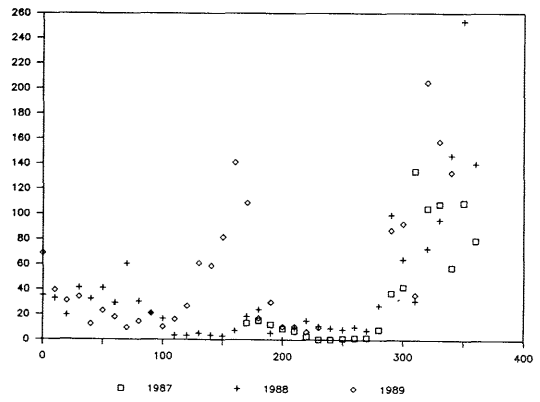


Fig.2 Mesoscale activity in cm^2/s^2 at -50 m for the three years

Font J. (1990) A comparison of seasonal winds with currents on the continental slope of the Catalan Sea (NW Mediterranean). J. Geophys.Res., 95: 1537-1546

Taupier-Letage I. and Millot C. (1986) General hydrodynamical features in the Ligurian Sea inferred from the DYOME experiment. Oceanol.Acta, 9(2): 119-131

Wang D.P., Vieira M., Salat J., Tintoré and La Violette P.E. (1988) A shelf/slope frontal filament off the northeast Spanish coast. J.Mar.Res., 46: 321-332

Deep convection in the Levantine Sea

I.-F. GERTMAN*, I.-M. OVCHINNIKOV** and Y.-I. POPOV*

*The State Institute of Oceanography, U.S.S.R. State Committee of Hydrometeorology, Sevastopol, Odessa (U.S.S.R.)

**The Southern Branch of the P.P. Shirshov Institute of Oceanology, U.S.S.R. Academy of Sciences, Gelendzhik (U.S.S.R.)

Thermochaline analysis of the deep water in the Eastern Mediterranean shows (El-Gindy, El-Din,1986), that in their formation besides Adriatic and Cretan waters also participate the water of the Levantine Sea (5-15%).

Most of the favourable conditions, under which the winter convection in the Levantine Sea can be developed down to great depths, were occured in the Rhodos gyre area. The center of eddy activity appeared as a sourse of the LIW formation (Ovchinnikov,I.M., 1983,1984), under moderate winter conditions in 1977 and 1982,and with the convection mixing to be in the "pre-condition phase" (MEDOC Group 1969) reaching the depths of 150-200m. Modeling of this process showed that under more severe winter conditions, when in the center of Rhodos gyre the water cooling reach <=14deg.C, the convection can be spread down to the bottom participating in the formation of the Eastern Mediterranean deep water (Ovchinnikov,Plachin,1984). Field experiment on the board of R/V "Jacob Gakkel", during more severe winter conditions 1987, confirm the numerical computation results (Gertman, Popov, Trigoup, 1987).

Before the time of our field works, arctic air invasion occured from 2 to 5 March 1987 in the Rhodos gyre area. Then, during the first phase of the sampling period (7-23 March 1987), the north-western air (with speed up to 20m/sec) predominated with the Ta-Tw to be varied from 4 to 10 deg.C. At the same time the daily (13/3/1987) maximum heat loss in the area of Rhodos gyre reached the value of 76 Mjoule/m^2. Similarly at the MEDALPEX experiment (March 1982), during the deep water formation in the western basin, the maximum heat loss was 60 Mjoule/m^2 (Vakalyuk, Gudz, Popov, 1987). Therefore more greater heat loss from the sea surface, during the arctic air invasion in the Rhodos gyre area (2-5/3/1987), resulted the formation of the surface cool (14deg.C) and dense (29.25) water which excessed the density of the water layer below them (29.20). This caused an active convection mixing down to 700m (Fig.1), corresponding to the "energetically mixing phase". During this phase the dense water was sunk along of the formed water dome, while in the center of the water dome, water from the intermediate layer was raised to the surface. In the moment of the field sampling, less saline water (38.8-38.9) raised from the intermediate depths to the surface and restored the stratification in the surface layer. Therefore in the layer below it the convection mixing turned into the phase of "sinking and spreading".

Comparision of the observations, sampled one month after (during the second phase (16-23/4/1987) with the results sampled during the first phase, showed that the restoration of the thermochaline structure in the area of the water dome occured mainly from the horizontal turbulence and the gradually density stratification in deep layers. The changes which observed during the one month period, permit us to assume that the complete disapperance of the water dome may occured in the following 2-3 months, up to the middle of the summer.

We have to mention that the deep convection in the Rhodos gyre area (down to 800-1000m) observed also during winter 1989 and 1990.

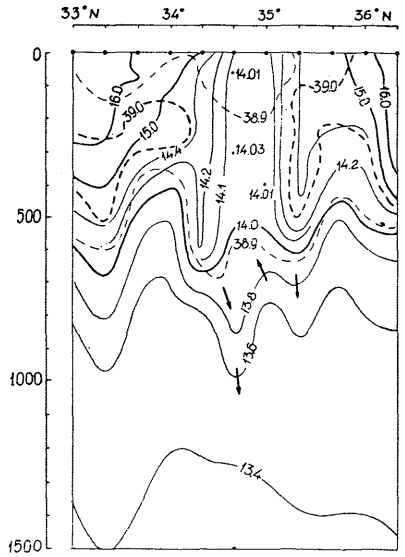


Fig.1. Temperature and salinity, south-north section along 28° 40 E 14-16.03.87 (R/V Jacob Gakkel)

REFERENCES

El-Gindy, A.A.H. and El-Din, S.S.H., 1986. Water masses and circulation patterns in the deep layer of the Eastern Mediterranean, Oceanologica Acta, vol.9, N°3, 239-248.

Gertman, I.F.,Popov, Y.I., Trigoup, V.G.,1987. Evidence of deep convection in Levantine Sea (March 1987), UPK 551.465.41(262), Sevastopol, VINITI 8.09.1987 N°6581-B87.

MEDOC Group,1969, Lacombe, H., Tchernia, P., Ribet, I., Frasset, R., Swalow, I.C., Miller, A.R., Stommel, H., 1970. Observation of formation of deep water in the Mediterranean Sea, 1969. Nature 1970 vol.227, N°5262, 1037-1040.

Ovchinnikov, I.M., 1983. On the renewal of the major water masses of the Mediterranean Sea, Oceanology, T.23, N°6, 960-962.

Ovchinnikov, I.M., 1984. Intermediate water formation in the Mediterranean Sea. Oceanology, T.24, N°3, 217-225.

Ovchinnikov, I.M., Plachin, E.A., 1984. Formation of Mediterranean intermediate water in Rhodos cyclonical gyre. Oceanology, T.24, N°3, 417-420.

Vakalyuk, Y.V., Gudz, P.K.,Popov, Y.I., 1987. Thermohaline and dynamic structure of the water of the Ligurian Sea according to MEDALPEX data. Anales Geopysical 5B(1), 31-36pp.

O-V6

Estimation of covariance fields in the Ionian from P.O.E.M. Data

N. PINARDI* , K. NITTIS** , A. LASCARATOS** , A. THEOCHARIS*** and G. KORRES**

*IMGA-CNR, Via Emilia Est, 770, 41100 Modena (Italy)
**Department of Applied Physics, University of Athens, 33 Ippocratous St., 10680 Athens (Greece)
***National Center for Marine Research, Athens (Greece)

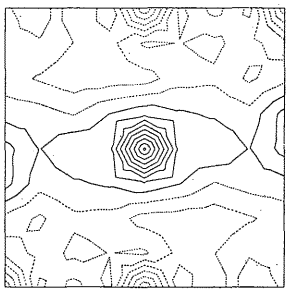
We present an extensive analysis of hydrological data in the Northern Ionian Sea. This data set merges italian and greek data sets from the POEM-V-87 general circulation survey of september 1987 and covers the Northern Ionian Sea as shown in Fig. 1. The goal of this study is to calculate the covariance matrices for various physical fields such as temperature, salinity and dynamic height.

The data set consists of about 150 stations of CTD casts which were used to calculate the dynamic height profiles at 11 standard depths (5, 30, 75, 125, 175, 250, 400, 600, 800, 1100 and 1650 meters) referred to 2000 meters (or about the average depth of the region shown in Fig. 1). These standard depths were chosen because they reproduced the continuos dynamical mode eigenvalues for the first four modes whithin a few percent of accuracy (first , second and third Rossby radii of deformation are 11.4 km, 5.8 km, 3.9 km respectively).

The dynamic height covariance matrices show a well defined correlation scale which decreases with depth and is shaped elliptically, with the ratio of minor to major axis encreasing with depth. In Fig. 2 we show a 600 × 600 km^2 domain of contoured covariance function for the 250 m level, in the middle of the Levantine Intermediate Water (LIW) layer. The data have been binned into 75 × 75km^2 bins since the nominal station spacing is half a degree of latitude and longitude. The covariance function has a larger zonal than meridional scale at all levels below 30 meters indicating the presence of a large scale trend and the tendency for the motion to be highly correlated in the zonal direction. Despite this anisotropy we calculated the decorrelation scale, a, and decay scale, b, of the covariance function as if it was a perfect circle and decaying as a gaussian function. We estimated that $a = 150$ km, $b = 100$ km at 5 and 30 m; $a = 120$ km, $b = 80$ km at 75 m and $a = 90$ km, $b = 60$ km at all the remaining levels. Furthermore we note that the covariance matrix shows secondary peaks at some of the LIW levels indicating the presence of multiple scales in the field.

Fig. 1

Fig. 2



The salinity, S, and temperature , T, covariance matrices are similar between themselves in the LIW and deep layers but not at the surface where the salinity shows a larger decorrelation scale with respect to the temperature field. Below 250 m. and above 600 m, the T and S covariance functions are elliptically shaped with the major axis oriented in the NE-SW direction while the dynamic height covariance has its major axis aligned in the zonal direction. This indicates that salinity and temperature effects are compensating at these levels where LIW is present. Below 600 m the T and S covariances become similar to the dynamic height ones, showing the alignement of their major axis in the zonal direction.

O-V7

Does the Almeria-Oran Front disappear sometimes?

Jordi SALAT , Arturo CASTELLON and Jordi FONT

Institut de Ciències del Mar, P. Nacional s/n. 08003 Barcelona (Spain)

One of the most important fronts in the Western Mediterranean is the well known Almeria-Oran front, in the eastern limit of the Alboran sea. It has been described by several authors (see Tintoré et al., 1988, for a synthesis on the subject) as the western limit of the Mediterranean waters at surface (S>37.5). It can be traced not only by the important salinity gradients but also by temperature, fluorescence, nutrients, and, of course by the density. This properites contribute to the possibility to see this front markedly by satellite images (infrared or visible).

This front is a dynamical feature over all the surface layer up to 150-200 m depth but sometimes, due to the intense thermocline in summer, it can be hidden below, while in winter, the surface signature of the front appears clearly.

With this background, a cruise was planned for March 1990 to do an intense study of the front: CTD stations, XBTs, two current-meter moorings,TS, fluorescence and Doppler current-meter underway measurements, and AXBT flyghts. The cruise was done from 5 to 21 March 1990. Unfortunately, the area was only covered partially because the bad weather conditions did not allow us to work for many days and only one of the planned flyghts was successful. The current-meters are still there and they will be recovered next month. Nevertheless, the whole information still has some sense and we present here a summary of the "very hot" first results, three weeks after the end of the cruise.

The main result was that **the front was not there.** No important gradients of density were found and surface salinity was everywhere neatly lower than 37.5 (fig. 1). TS diagrams show always the signature of the Atlantic water over all the region. The continuous underway TS analysis in the way back to Barcelona showed high salinities only north of the Eivissa channel (38°30'N) and only the stations in this channel did not show the signature of the Atlantic water. The field of doppler measured currents and the geostrophic calculations show the main path of the Atlantic water coming from Gibraltar (fig. 2) which is very similar to the classical picture obtained by Lanoix (1974) in summer.

It is still too early and the information obtained in the cruise needs a more detailed study to draw some conclusions on this results but some idea can be exposed now. The winter 1990 has been very warm and water remained stratified in temperature (in most places temperature was over 15°C in the first 50 m, which indicates that this was not a recent warming of surface water but that winter processes were not strong enough to delete the last summer stratification). Under these circumstances, the Atlantic water had been spreading over all the region during all the winter while the Mediterranean water remained in depth. Bearing in mind this situation, we can see a conspicuous front near Cape Gata (fig. 1) which separates the most recent Atlantic water from the older one. This particularity is corroborated by the TS diagrams of the stations in its vicinity (fig. 3). This remainder of front can be the "seed" of the Almeria-Oran front. By mid April a French cruise will be done in the area and we will see if this new information can help to be more concludent.

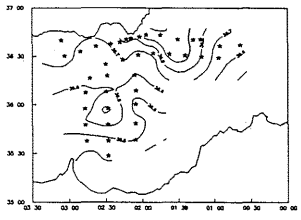


Figure 1. Salinity distribution at 10 m depth

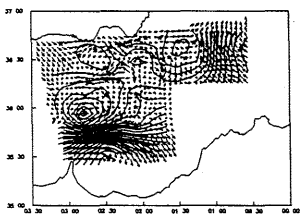


Figure 2: Dynamic height and Doppler measured currents at 10 m depth

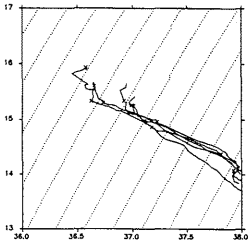


Figure 3. TS diagram of stations in the vicinity of the front.

References

Lànoix F., 1974. Projet Alboran. Etude hydrologique et dynamique de la Mer d'Alboran. Rapp. Techn. OTAN,**66**: 39 p.

Tintoré J., P.E. La Violette, I. Bladé & A. Cruzado, 1988. A Study of an Intense Density Front in the Eastern Alboran Sea: The Almeria-Oran Front. J. Phys. Oceanogr.,**18**(10): 1384-1397

O

General features of the Ligurian current inferred from the PROLIG 2 experiment

C. SAMMARI*, C. MILLOT* and L. PRIEUR**

*Antenne du Centre d'Océanologie de Marseille, B.P. 330, 83507 La Seyne-sur-Mer (France)
**Laboratoire de Physique et Chimie Marines, B.P. 8, 06230 Villefranche-sur-Mer (France)

This paper presents the analysis of current meter data collected in the core of the Ligurian current on 4 moorings at depths of 100m, 400m and between 800 and 1950m (PROLIG 2 experiment; May-December 1985).

Basic statistics (standard deviations, time scales, vertical complex correlations and spatial correlations) show differences at 100m between the May-September and the October-December periods; during this second period, the space and time scales of the structures decrease while the standard deviations increase. Spectral estimates were also calculated from one-month time series divided into 3 non-overlapping pieces; from this analysis, it appears that certain current fluctuations mainly occur from October to December, in agreement with satellite infrared observations. These differences are linked to the seasonal variability of the Ligurian current.

EOF analyses performed at each mooring show that only one mode accounts for ≈ 95% of the total variance; this mode, which is surface intensified, is such that the currents at all depths are roughly along the principal directions.

At 100m, the time scales of the u components (major axis) are ≈ 4-10 days during the first period and ≈ 3-6 days during the second one while those of the v components (minor axis) are ≈ 3-5 days during both periods. Spectral analyses, presented in the energy-preserving aera form, show that the u components at all depths display broad maxima at ≈ 10-20 days and ≈ 3-5 days all year long; the first frequency band is not evidenced on the v components for which the amount of energy in the ≈ 3-5 days band at 100m is larger than for the u component. These two bands probably correspond to different types of instability of the Ligurian current.

Coherences on the vertical in the ≈ 10-20 days band are slightly significant at 95% only between some pairs of records. At all locations and over the whole water column, the u components show high (significant at the 95% level) vertical coherences in the range ≈ 4-5 days with almost zero phase lags, while no significant coherences are computed for the v components. Therefore, the fluctuations of the Ligurian current, which are clearly characterized by periods of ≈ 10-20 days and ≈ 3-5 days, have relatively complex structures on both the vertical and the horizontal.

Correlations between moorings located ≈ 5km apart in the alongshore direction indicate that the velocity fluctuations propagate with a mean velocity of ≈ 10 km.day^{-1}. Cross spectra between these moorings provide significant coherences in the two above-mentionned frequency bands. For the lowest frequencies (≈ 10-40 days), the phase speeds are roughly ≈ 3-9 km.day^{-1}. In the other band (≈ 3-5 days) these phase speeds are ≈ 9-15 km.day^{-1}.

We complete theses analyses with satellite infrared images and applications of simple analytical models to provide a new insight on the Ligurian current's dynamics.

Flows and water mass exchanges between the Aegean and Ionian Seas through the Straits of Kithira and Antikithira (late summer, 1987)

A. THEOCHARIS, E. PAPAGEORGIOU and G. ZODIATIS

National Centre for Marine Research, Hellenikon 16604 (Greece)

Circulation patterns in the region of the Western Cretan Straits and water mass distribution and exchange between the Aegean and Ionian Seas, in late summer 1987, are presented. The results are based on hydrographic and current measurements obtained on board R/V "Aegaio" in the framework of the POEM-5-87 major cruise. CTD data from 47 stations in the SW Aegean and Eastern Ionian are combined and discussed with current measurements from two moorings placed at Antikithira and Kithira Straits.

The surface layer is mostly occupied by waters of high salinity (38.90-39.26) with an exception in the NW Cretan Sea and Antikithira Strait, where waters of relatively lower salinity (38.85) are detected, coming from the N and W Aegean. The LIW occupies a thick (600-800m) intermediate layer on the Ionian side, while on the Aegean side waters of the same characteristics can be detected down to the bottom (1300m). The Deep Water of the Eastern Mediterranean is present only in the Ionian below 1200m.

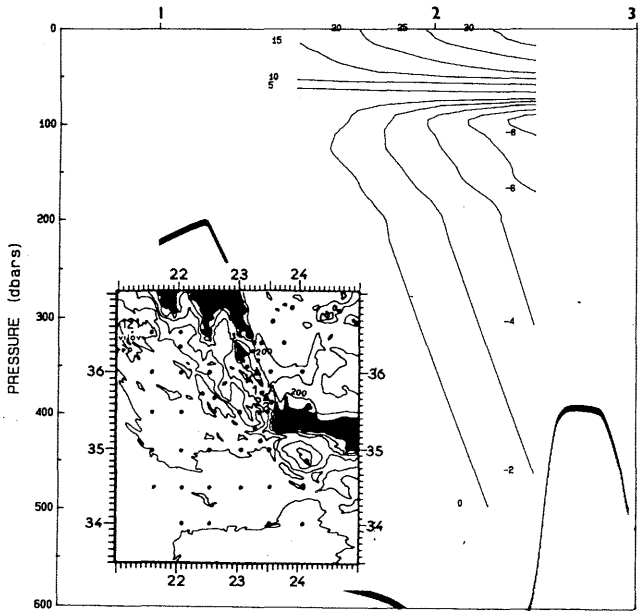
The surface dynamic topography relative to 500dbars reveals: (i) a large but relatively shallow cyclonic eddy southwest of Crete; (ii) the large and deep anticyclonic gyre, named "Pelops", southwest of Peloponnisos; (iii) an anticyclonic flow surrounding the islands of the Kitherian Straits and influencing the surface circulation in the Straits; and (iv) a cyclonic flow region in the western Cretan Sea.

Branch of the AW coming from the western Ionian and propagating towards the Levantine Basin is recirculated in the Ionian by the large cyclone SW of Crete. Portions of this AW are transfered by the existing anticyclone into the Aegean through the Kithira Strait. The "Pelops" anticyclone, on the other hand, entraps the core of the LIW and carries it in deeper layers (>500m).

Through the Antikithira Strait a surface (0-80m) outflow from the Aegean to the Ionian is indicated by both the geostrophic calculations (figure) and current measurements. The surface geostrophic velocities reach 30cm/sec while at 50m depth the geostrophic and currentmeter velocities show the same values, 12-15 cm/sec. At the Southern part of this strait in intermediate (300m) and deeper (700m) layers a rather weak inflow is observed with velocities decreasing with depth and ranging from 8 to 2 cm/sec

In the Kithira Strait an inlfow at surface is detected. The current measurements performed at the Aegean side of the strait show intermediate and deep currents with a westward component more pronounced. Velocities range between 5 to 10 cm/sec at 300m, while at 700m they do not exceed 3 cm/sec.

Apart from the above described flows through the Kitherian Straits, which correspond to the period of CTD measurements, a temporal evolution of current regime is derived from the long-term



Geostrophic Velocities in cm/sec across the Antikithira Strait (25 September, 1987)

(25/9-15/11/87) current measurements. The directions of the currents most of the time were steady during this period. At Antikithira Strait currents at 50m have a westerly direction with mean velocity 9 cm/sec, at 300m NNE direction with mean velocity 5.5 cm/sec while at 700m a SSE direction with mean velocity 3cm/sec. The above directions indicate continuous outflow at surface, weak outflow in deep layers and inflow at intermediate depths. At Kithira Strait (Aegean side) the intermediate (300m) and deep (700m) current measurements show that currents follow the bottom topography having a constant SSE direction and mean velocities 5.5 and 2 cm/sec respectively.

O-V10

Atlantic Water in the Northeastern Ionian Sea

Athanasios J. THEODOROU

Ministry of Environment, Planning and Public Works, 12 Varvaki Street, Athens (114 74) (Greece)

INTRODUCTION

THE ATLANTIC WATER (AW) that flows into the Mediterranean Sea, through the Strait of Gibraltar, is recognized by its relatively low salinity. The spreading pattern of the AW in the Eastern Mediterranean is not unambiguously documented -see inter alia MALANOTTE-RIZZOLI, HECHT (1988); and also, ÖZSOY, HECHT and ÜNLÜATA (1989). In the Ionian sea, the AW has been known to occur intermittently (HOPKINS; 1978). When it exists, the AW stands out above the more saline waters of Levantine origin (WÜST; 1961). Occasionally, the AW itself is partly overtopped by the relatively warmer and more saline surface water (SW); and, in this case, its signature is a subsurface salinity minimum. The northward propagation of the AW in the Ionian Sea, especially under strong southerly winds, extends to the Strait of Otranto (HOPKINS; loc. cit) entering the Adriatic as a surface inflow, via the eastern side of the Otranto Strait, in winter (OVCHINNIKOV; 1966) . In this paper the main objectives will be to delineate the extent of the Atlantic water influence on the water masses and circulation in the northeastern Ionian Sea, and estimate its penetration in the Adriatic Sea, during late winter early spring 1986.

DATA AND METHODS

CTD data were collected by R.V. "AEGAION" at 22 stations in the northeastern Ionian Sea, during POEM-01-1986 Cruise (15-24 April 1986). The data were subjected to conventional methods of analysis.

RESULTS AND DISCUSSION

Distribution of characteristics at the surface

In the northern part of the study area, relatively heavy water is flanked by lighter water, which is consistent with a cyclonic movement. In the southern part, the closed isolines, separating relatively lighter water in the centre from heavier water at the periphery, stand out. This is indicative of anticyclonic motion, and induces a horizontal convergence at the surface and a divergence at depth, so that vertical motion (sinking) would occur in the centre.

Isopycnal Surface Analysis

The analysis rests on three isopycnals that have been chosen so that to cover spatially the entire range of AW presence within the study area.

Topographies

On the uppermost surface, the small differences in depth do not give much indication of the direction of the flow. However, on the deeper surfaces, over the northern part of the study area, there is a mild downward slope in a manner which indicates, assuming geostrophy, a weak cyclonic flow relative to the deeper water. The same topographies provide also, under the aforementioned assumptions, an anticyclonic flow in the southern part of the study area.

Salinity distribution

At the southernmost part of the study area interpenetrating tongues occur, which might indicate an anticyclonic circulation in this part of the study area, in agreement with the dynamic inferences from the configurations of the topographies of the same isopycnal surfaces, and also from the distribution of the properties at the sea-surface.

Water Mass Analysis

The spreading pattern depicted by all the charts, (showing the percentage concentrations of the main water masses on each of the isopycnal surfaces considered), corresponds closely to that inferred from the analysis of the salinity distribution on the same isopycnal surfaces, and demonstrates the extent of the influence of the AW in the northeastern Ionian Sea.
It is evident that the major influence of the AW is mainly restricted within the area of the inferred cyclonic flow, whilst its influence is being diminished southwards, being practically absent from the area of the deduced anticyclone.

Geostrophic Fluxes

The geostrophic circulation pattern indicates the presence of a cyclonic flow over the northern part of the study area, (with which the largest transport of AW is associated); whilst in the southern part of the study area, the circulation connected with the area of maximum steric height yields an anticyclonic flow, (transporting negligible amounts of AW).

CONCLUSIONS

CTD data, collected in the northeastern Ionian Sea during late winter/early spring 1986, are used to identify the extent of Atlantic water (AW) influence on the water masses and local circulation. It is shown that a major portion of the AW stream is fed by the cyclonic circulation, which occurs north of 37°30'N, into the Adriatic Sea; whilst only a negligible fraction thereof participates in the large-scale anticyclone which dominates the area south of 37°30'N.

REFERENCES

HOPKINS, T., 1978. Physical processes in the Mediterranean basins. In: Estuarine Transport Processes (edited by B. Kjerfve, Univ. of South Carolina Press).

MALANOTTE-RIZZOLI, P, HECHT, A.,1988. Large-scale properties of the Eastern Mediterranean: a review, Oceanol. Acta, 11, 4, 323-335.

OVCHINNIKOV, I.M.,1966. Circulation in the surface and intermediate layers of the Mediterranean.- Oceanology 6: 48-59.

ÖZSOY, E., HECT, A., and Ü. ÜNLÜATA, 1989. Circulation and hydrography of the Levantine Basin. Results of POEM coordinated experiments 1985-1986. Prog. Oceanog., 22, 125-170.

WÜST, G., 1961. On the vertical circulation of the Mediterranean Sea.- J. Geophys. Res., 66: 3261-3271.

O-VI1

Diagnostic/Metagnostic Modelling of the Western Mediterranean's General Circulation with a 3D primitive equations k-ε Model

Jacques C.J. NIHOUL

GHER, University of Liège (Belgium)

ABSTRACT

An essential characteristic of a mathematical model is its *accuracy*, i.e. its ability to reproduce reality in the framework of the model's objectives. In this regard, one must make a distinction between *diagnostic models* which emphasize accuracy in state space and *metagnostic models* which emphasize accuracy in physical space.

A diagnostic model is generally devised to investigate, in details, particular mechanisms, scrutinize the behaviour of the specific state variables and elucidate fundamental questions. Very refined in its representation of, sometimes, rather subtle processes, it may be content with very crude approximations of the physical world (constant depths, rectilinear coasts, infinite ocean, steady two-dimensional fronts, rigid sea surface ...).

A metagnostic model, on the contrary, is in general called upon to tackle a practical situation and may not ignore the real field conditions (depths, coastlines, actual atmospheric forcing ...). Its aims however is to assess the consequences of particular events and provide the marine nowcasts and forecasts which will assist interdisciplinary field studies, planning and management. The model must be sound, expeditious and efficient but is not required to provide detailed information on the delicate machinery subtending its parameterization schemes.

From a purely scientific point of view, of course, the distinction is meaningless. Processes must be studied thoroughly using models of increasing sophistication and realism, converging to a truly *prognostic model*.

However the convergence is generally slow (It appears to have been particularly stagnant, in fact, in the case of the Western Mediterranean's General Circulation).

Modellers participating in huge interdisciplinary research programs may not be satisifed, in answering the biogeochemists' questions, with current, temperature, salinity ... fields calculated in a hypothetical square box rigid lid ocean. The answers must be realistic and require the operation, on a routine basis, of a system-oriented (as opposed to process-oriented) metagnostic model.

In illustration, the GHER metagnostic model developed and run for the study of the Western Mediterranean's General Circulation in the scope of the EEC EROS 2000 Project is briefly described with emphasis on the parameterization of sub-grid scale processes.

It is shown that the model reproduces well the main trends of the general circulation and evidences essential synoptic processes such as deep water formation, coastal upwellings, gyres ... .

The model, tuned in to diagnostic modelling, is then applied to process studies, jointly and severally with the LODYC diagnostic model in the scope of the EEC Euromodel Project.

It is shown how parallel diagnostic and metagnostic simulations can improve, continuously, both types of models ; diagnostic studies providing useful information to improve the mathematical representation of dominant processes, metagnostic nowcasts and forecasts supplying realistic boundary conditions by which one can progressively free oneself of the rigid wall box-ocean limitations.

O

The numerical simulation of the month to month variability of the Western Mediterranean's Circulation

Jean-Marie BECKERS

National Fund of Scientific Research Belgium, GHER University of Liège, B 5 Sart-Tilman, ULg., 4000 Liège (Belgium)

The GHER 3D primitive equation model uses as state variables the velocity vector $\boldsymbol{u}$, temperature T, salinity S, turbulent kinetic energy k and a generalized "pressure" q. By means of the usual Boussinesq approximation and the assumption of hydrostatic equilibrium, the primitive equations are then transformed by an original twofold vertical coordinate change (BECKERS 1988). The resulting equations in the transformed space are then (buoyancy $b(T, S)$ is used for this presentation)

$$\frac{\partial H\hat{\boldsymbol{u}}}{\partial \hat{t}} + \hat{\nabla}\cdot(H\hat{\boldsymbol{u}}\hat{\boldsymbol{u}}) + \frac{\partial}{\partial \hat{x}_3}(H\hat{u}_3\hat{\boldsymbol{u}}) + f\boldsymbol{e}_3\wedge H\hat{\boldsymbol{u}} =$$

$$-H\nabla q + \frac{\partial}{\partial \hat{x}_3}\left(\tilde{\nu}\frac{L^2}{H^2}\frac{\partial H\hat{\boldsymbol{u}}}{\partial \hat{x}_3}\right) + \hat{\nabla}\cdot\{\tilde{\kappa}\hat{\nabla}(H\hat{\boldsymbol{u}})\} \qquad (1)$$

$$\frac{\partial Hb}{\partial \hat{t}} + \hat{\nabla}\cdot(H\hat{\boldsymbol{u}}b) + \frac{\partial}{\partial \hat{x}_3}(H\hat{u}_3 b) =$$

$$\frac{\partial_i}{\partial \hat{x}_3}\left(\tilde{\lambda}^b\frac{L^2}{H^2}\frac{\partial Hb}{\partial \hat{x}_3}\right) + \hat{\nabla}\cdot(\tilde{\kappa}^b H\hat{\nabla}b) \qquad (2)$$

$$\frac{\partial Hk}{\partial \hat{t}} + \hat{\nabla}\cdot(H\hat{\boldsymbol{u}}k) + \frac{\partial}{\partial \hat{x}_3}(H\hat{u}_3 k) = H\left(\tilde{\nu}\left\|\frac{\partial \boldsymbol{u}}{\partial x_3}\right\|^2 - \tilde{\lambda}^b\frac{\partial b}{\partial x_3}\right)$$

$$+H(\pi^o - \epsilon) + \frac{\partial}{\partial \hat{x}_3}\left(\tilde{\lambda}^k\frac{L^2}{H^2}\frac{\partial Hk}{\partial \hat{x}_3}\right) + \hat{\nabla}\cdot(\tilde{\kappa}^k H\hat{\nabla}k) \qquad (3)$$

The numerical scheme used is a finite volume scheme designed for an efficient time stepping (based on the mode splitting technique) on a vector computer. The model has already been tested under rather crude boundary conditions but has simulated successfully the deep water formation in the northern basin of the Western Mediterranean Sea (J.M. BECKERS and J.C.J. NIHOUL 1990). Indeed, the non-linear model indeed is based on a turbulent parameterization allowing strong vertical mixing when hydrostatic instabilities occur. The $k - l$ turbulence closure scheme is also adapted to simulate mesoscale turbulence not resolved by the general circulation model and special care is taken of the mixing associated with the mesoscale wind field. The need of appropriate boundary conditions is readily seen and the simulation of the month to month variability is only possible under the condition that these atmospheric data are available, especially for turbulent quantities like turbulent kinetic energy k on Fig.1.

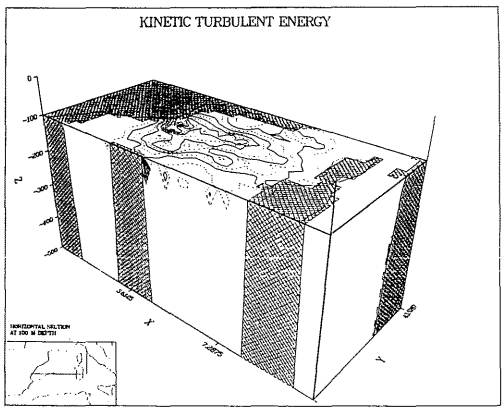


Fig.1.

REFERENCES

BECKERS J.M. 1988. Modélisation Mathématique et Numérique de la Mediterranée occidentale, Thèse de fin d'études d'Ingénieur Civil en Mécanique-Physique, Juin 1988, Université de Liège.

BECKERS J.M. and J.C.J. NIHOUL 1990. Application of a 3D model to the Western Mediterranean. Accepted for publication in Journal of Marine Systems.

Data assimilation of the Eastern Mediterranean climatology using the adjoint method applied to the GFDL circulation model

A. BERGAMASCO* and P. MALANOTTE RIZZOLI**

*Istituto Studio Dinamica Grandi Masse-CNR, San Polo 1364, 30125 Venezia (Italia)
**MIT, Center for Meteorology and Physical Oceanography, Department of Earth, Atmospheric and Planetary Sciences Cambridge, MA 02139 (U.S.A.)

The objective of model fitting is to find the model state minimizing the misfit between the data and their model counterparts. The best fit is determined by the values of the independent variables that minimize the cost function. This technique was applied to assimilate the Eastern Mediterranean climatology in terms of wind stress field, termperature and salinity distributions.

The GFDL general circulation model was adapted to the Eastern Mediterranean with 0.25 degree of resolution and 17 vertical levels, and coupled with the adjoint version of the same model in order to fit the model to data to have a steady state solution.

The output fields of velocity, temperature, salinity and streamfunction are compared with the ISDGM multilevel model spinup.

O-VI4

Stratification effects on the wind-induced currents in the Northern Adriatic

Mario BONE and Gordana BEG

Institute of Oceanography & Fisheries, Split (Yugoslavia)

ABSTRACT

Three-dimensional multilevel model has been used to examine summer stratification effects on the currents induced by scirocco and bora winds in the northern Adriatic. Persistency of motions has been observed in the stratified fluid.

L'effet de l'influence de la stratification d'été sur les courants induits par le Scirocco ét la bora, vents du Nord de la Mer Adriatique, est examiné à l'aide du modèle tridimensionnel. On a observé la persistance des mouvements du fluide stratifié.

The passage of cyclones over the Adriatic Sea is characterized by scirocco and bora winds which cause characteristic flow patterns well studied for homogeneous winter situation. A number of papers have recently appeared reporting numerical modeling studies of wind-induced currents in the northern Adriatic during the winter. Two basic approaches have been made. The first one is based on the vertically averaged equations (Stravisi, 1977) and the second one on the three-dimensional spectral Heaps model (Kuzmić and Orlić, 1987, Orlić et al, 1986). Both methods are unable to include the effect of stratification, so to do that we must use three-dimensional multilevel model with equation of continuity of density.

During the summer the Adriatic region is under the influence of subtropical high pressure and only its northern part feels the influence of the cyclonic activities. In this paper we will examine the influence of summer stratification on currents induced by scirocco and bora winds in the northern Adriatic.

The model used in this paper is based on: (1) momentum equations including local change of velocity, Coriolis force, gradient force in Boussinesq approximation, vertical stress and horizontal stress, (2) equation of continuity of density including advection and turbulent exchange, (3) hydrostatic equation and (4) equation of continuity for volume. The Bowden relation is taken to describe horizontal dependence of vertical exchange coefficients (Heaps, 1974). To describe its vertical dependence we assumed surface and bottom boundary layers with coeficients increasing going off them (Pearce and Cooper, 1981). Along the solid boundary zero normal horizontal flow and zero diffusion transport are assumed while a radiation condition is postulated at the open boundary. At the surface the wind stress is taken as a quadratic function of wind velocity and for the bottom friction linear low will be used. Initial condition is the state of rest with density lineary increasing with depth. Differential equations of motions and continuity were translated into finite difference equations using the leapfrog-time and staggered-space approximation. It should be mentioned that this model gives the same results in homogeneous fluid as model developed by Stravisi and models based on the Heaps approach (Bone, 1990).

Above described model was run in the following numerical experiment. Simulations were performed for 24 hours with scirocco wind followed by 24 hours bora and 48 hours with no wind, the situation characteristic for passage of cyclones over the Nord Adriatic in the summer. Homogeneous wind forcing was assumed for scirocco while for bora heterogeneity in the wind field was taken into account. In order to examine stratification effects the same numerical experiment was performed for stratified and for homogeneous sea. For each run four fields were analyzed : sea-level displacement, vertically averaged current, surface current and bottom current. During the wind forcing the main differences in stratified and homogeneous case are caused by gradient currents. Wind currents acting on initial density field induce characteristic topographically controled gradient currents. The most pronounced difference in the current response were observed in the free oscillating period where we could notice the greater persistency in baroclinic than barotropic mode due to gradient currents.

This is the first time that the effects of stratification were considered for wind induced currents in the northern Adriatic. Under the same forcing conditions, the differences between currents in a stratified fluid and currents in a homogeneous fluid are about 20% of the wind induced current intensities while the flow patterns are mostly the same.

REFERENCES

1. BONE M. (1990): Modelska studija struja vjetra u sjevernom Jadranu viseslojnim modelom. Acta Adriat., 32, (In press).

2. HEAPS N.S. (1974): Development of a three-dimensional numerical model of the Irish Sea. Rapp. P.-v. Réun. Cons. Int. Explor. Mer, 167, 147-162.

3. KUZMIĆ M., ORLIĆ M. (1987): Wind-induced vertical shearing: ALPEX/MEDALPEX data and modelling exercise. Annales Geophysicae, SB, 103-112.

4. ORLIĆ M., KUZMIĆ M., VUČAK Z. (1986): Wind-curl currents in the northern Adriatic and formulation of bottom friction. Oceanologica Acta, 9(4), 425-413.

5. PEARCE B.R., COOPER C.K. (1981): Numerical circulation model for wind-induced flow. J. Hydraulics Div., 107, 285-302.

6. STRAVISI F. (1977): Bora driven circulation in northern Adriatic. Istituto Talassografico Trieste, Pubbl. No. 536.

O-VI5

Process Studies of the Complex Mesoscale Circulation Observed in the Western Mediterranean Sea

George W. HEBURN

Naval Oceanographic & Atmospheric Research Laboratory Stennis Space Center, MS (U.S.A.)

Satellite observations of the Mediterranean Sea reveal extremely complex circulation patterns which are highly time-dependent. This is in stark contrast to the simple idealized flow patterns presented in historical studies based on limited in-situ observations. These pre-satellite studies were based on collections of data which were not synoptic in time nor space and resulted in overly smooth idealized flow patterns.

A series of process studies using a hierarchy of numerical ocean models has been undertaken in an attempt to illucidate the dynamics controlling the observed circulation. The numerical models used are variations of a multi-layered primitive equations model. The simplest version is a one-active layer, reduced gravity model forced by winds, inflow/outflow mass flux and/or density variations. The results from this simplest version yields flow patterns which are qualitatively similar to the historical representations, but do not help to understand the highly time-dependent mesoscale variability observed in the remotely-sensed data.

Adding additional complexities, such as multiple layers and thus allowing for baroclinic instabilities; bottom topography; realistic non-climatic wind stress, etc., increasingly adds to the realism of the numerical simulations. However, with the more complex models, it becomes increasingly evident that simple explanations for the causes of the observed mesoscale variability will not be forthcoming. By a systematic series of process studies, various responses to the specified forcing can be ascertained. The results to date reveal that no single forcing mechanism by itself can explain all the variability and in most cases a combination of forcing mechanisms are required to produce a simulation of the observed circulation patterns.

O

Application of the GHER 3D k -ε Model to the study of the general circulation and associated synoptic/mesoscale structures in the Western Mediterranean Sea

Jacques C.J. NIHOUL, J.-M. BECKERS and S. DJENIDI

GHER, University of Liège, Liège (Belgium)

The GHER model is a primitive equation, fully 3D (multi-level), time dependent, non-linear, baroclinic model with a k-ε turbulence closure. The state variables are the three components of the velocity vector, the buoyancy (or the temperature and salinity), the pressure (or the surface elevation), the turbulent kinetic energy, the energy dissipation rate (or the mixing length) and the concentrations of passive constituents.

The model has been described in earlier publications (e.g. Nihoul and Djenidi 1987, Nihoul et al 1989, Nihoul and Beckers 1989).

In the frame of the quasi-hydrostatic approximation, the vertical component of the momentum equation reduces to a simple balance between buoyancy and vertical grandient of $q = p/\rho o + gx_3$.

The mesoscale energy production rate is proportional to the 3/2 power of the wind stress. The coefficient of proportionality is a function of depth and of the flux Richardson number.

The computer code translation of the mathematical model is greatly facilitated by the introduction of new coordinates : the hat-coordinates (The hat-coordinates are quite similar to the so-called "σ-coordinates" used in Meteorology and are simply rechristened here to avoid confusion with isopycnal or "iso-σ" coordinates used in Oceanography).

The advantage of the new coordinates and associated variables is that horizontal and vertical length and velocity scales are then of the same order, the water column has everywhere the same height while the top and bottom boundary conditions reduce to zero vertical (hat) velocity.

Furthermore the comparison of the vertical velocities in real and hat coordinates provides a more complete understanding of vertical motions, separating what is due to the bathymetry of the basin (upsloping and downsloping) and what is due to Ekman circulation (upwelling and downwelling).

Considering the important variations of the Western Mediterranean's bathymetry, the three-dimensional model is applied conjointly to two superposed interconnected layers, the surface layer's depth following the shelf's bathymetry on the shelf and remaining at maximum shelf's depth in the deep-sea. The introduction of two different hat-coordinate systems has also the advantage of allowing a better representation of the vertical stratification. Indeed with a single hat-coordinate transformation for the whole basin, lines of equal $\hat{x}_3$ when retransformed to physical space cut the isopycnals and there is a risk that diffusion in hat-space destroys the vertical stratification.

The numerical model uses a mode-splitting technique based on the simultaneous resolution of a depth-integrated model to compute the surface elevation. The advection term is represented by either a centered-difference scheme, a Lax-Wendroff scheme or an upwind-difference scheme, according to the numerical requirements. The numerical method is implicit in the vertical but, to avoid numerical erosion of the pycnocline, the "implicity factors" of the advection and diffusion terms are modified at each mesh and at each iteration. Hydrostatic instabilities, as in cases of deep water formation, are taken into account using an original parameterization of the diffusion coefficients, generalized from Nihoul's formula for the stably stratified case (Beckers, 1988, 1990).

At the air-sea interface, all fluxes (momentum, heat, ...) are imposed and calculated from the available atmospheric data.

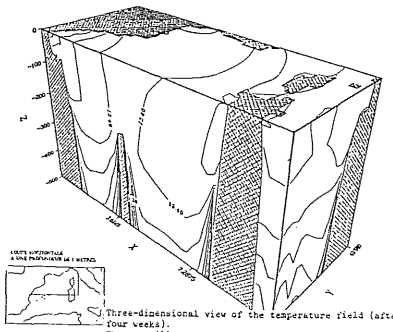
At the bottom, heat and salt fluxes are assumed to be zero but the flux of momentum (bottom stress) and the turbulent kinetic energy production rate are calculated using an analytical model of the bottom Ekman layer. (This solution gives the classical quadratic friction law for small bottom layer meshes but has the advantage on the logarithmic approximation to allow a veering of the velocity vector with height when the grid spacing near the bottom increases).

At the coasts, heat and salt fluxes are set to zero except at the mouths of main rivers like the Rhône. The velocity perpendicular to the coast is zero and a quadratic friction law is imposed for the tangential velocity.

At the straits, observed transports (integrated inflowing or outflowing velocities) are imposed. The boundary conditions for the other variables are basically of the Orlanski type but they are adapted to the numerical scheme and modified to make it possible to take a measured value into account when such a value is available.

RESULTS

The model can successfully reproduce the main trend of the general winter circulation and essential related large scale processes such as local secondary gyres, meandering of frontal currents, wind-induced upwellings and downwellings, dense water formation ...



Three-dimensional view of the temperature field (after four weeks).
The capability of the model of simulating dense water formation is demonstrated by the intense mixing at the center of basin due to dry, relatively cold winds.

NIHOUL, J.C.J., DJENIDI, S. (1987). Perspective in three-dimensional modelling of the marine system. In : Three-Dimensional Models of Marine and Estuarine Dynamics, Nihoul J.C.J. (ed.), Elsevier Publ.Co., Amsterdam, 1-33.

NIHOUL, J.C.J., BECKERS, J.M. (1989). Preliminary results of a three-dimensional model of the Western Mediterranean's General Circulation. In : Research in the North Western Mediterranean, Proceedings of the EROS 2000 Workshop, Paris 7-9 March 89, H. Barth (ed.), Commission of the European Communities, Bruxelles.

NIHOUL, J.C.J., DELEERSNIJDER, E. and DJENIDI, S. (1989). Modelling the general circulation of shelf seas by 3D k-ε models. Earth Science Reviews, 26, 163-189.

Development and applications of the coastal quasigeostrophic ocean model to the case of multiple coasts and multiply connected domains

Emin OZSOY*, Carlos LOZANO**, Ralph MILLIFF*** and Allan ROBINSON**

*Institute of Marine Sciences, Middle East Technical University, P.K. 28, Erdemli, Icel 33731 (Turkey)
**Harvard University, Division of Applied Sciences, Cambridge, MA 02138 (U.S.A.)
***National Center for Atmospheric Research, Oceanography Section, Boulder, CO 80307 (U.S.A.)

The Harvard quasigeostrophic ocean model has been generalized to be applicable to semi-enclosed or closed ocean domains bounded by multiple segments of coasts and/or multiply connected geometry. Inviscid coastal boundary conditions and consistency constraints are required and the Greens function methods are utilized in the solution algorithm. The performance of the model is guaranteed by comparison with analytical solutions of Flierl (1977) and cases derived from them. The methodology is applied to the quasigeostrophic dynamical modeling of the Levantine Basin. The robustness of the method is illustrated by the stable preliminary predictions and sensitivity runs.

O-VI8

3D Mathematical Modelling of currents and dispersion in the Northern Adriatic

Rudi RAJAR

University of Ljubljana, FAGG, Hydraulic Department, 61000 Ljubljana (Yugoslavia)

Among the different measures for water-quality improvement in the Northern Adriatic, mathematical modelling plays a significant role. Some measurements of current velocities, temperature, and salinity were also executed in 1984-86, mainly in the Piran and Koper Bays.

The mathematical model is three-dimensional, nonlinear, and includes equations simulating dispersion of heat, salinity or contaminants.These parameters affect the density according to the equation of state and variable density in return influences the velocity field (For details see Rajar, 1989). A one equation turbulence model is used for the vertical distribution of the "turbulence viscosity", (based on the eq. for turbulence kinetic energy) including the influence of stratification which is expressed by the Richardson number (Rajar et al, 1989).

The possiblity to simulate the transport of contaminants gives the possibility to extend the present hydrodynamic model into a water-quality model. The model is used also to simulate circulation in lakes.

With the model we have simulated the circulation in the whole Northern Adriatic and especially in the Trieste Bay (Fig. 1) and Piran Bay and Koper Bay, which are parts of the Trieste Bay, where the water quality is most endangered.

The results of the modelling show that the very polluted water from the Italian po river reaches the Yugoslav coast at different meteorologic conditions. For the Trieste Bay (Fig. 1) many simulations were made and compared with the results of measurements. It was shown that the tidal forcing and the wind forcing are of the same order of magnitude. Fig. 1 represents simulation of currents during falling tide, with the wind increasing during the day up to 4,5 m/s. A relatively strong stratification took place (9°C and 1,6 °/oo difference in temperature and salinity at the surface and at the depth of 22 m). The bulk movement of the water is out of the region (during falling tide), with the right deflection due to the Coriolis effect.

Weaker winds (Fig. 1) cause only the surface layer to move with the wind; no destratification takes place. The measurements confirm this fact. Simulation and also the observations show that more than two days of strong "Bura" wind are necessary to "mix" the stratified layers.

In the smaller Piran Bay and Koper Bay, the tidal influence is small compared with the wind forcing. However, we have studied the circulation due only to tidal forcing, since conditions for dispersion of contaminants are the worst in windless days. Summarized results of measurements during the periods of week winds (v < 2 m/s) show a cyclonic circulation during rising tide in both bays. During falling tide, anticyclonic circulation is formed in the Piran bay, but in Koper bay again a kind of cyclonic vorex is formed, presumably due to flow out of the Trieste bay and around the cape, which closes the Koper Bay at the North.

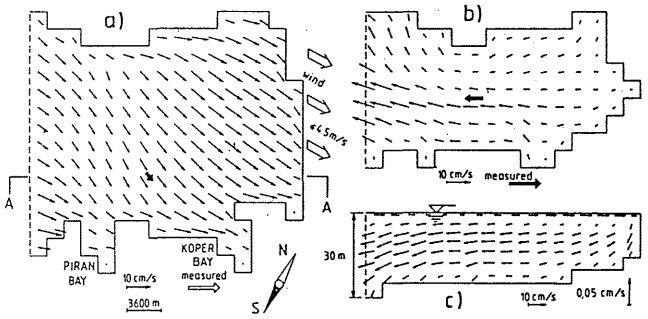


Fig. 1 Computed currents in the Trieste Bay a. Surface currents b. Bottom currents c. Vertical cross-section A-A

REFERENCES:

RAJAR, R., ČETINA, M., TONIN, V., 1989. Influence of linearisation and of Vertical Distribution of Turbulent Viscosity on 3D Simulation of Currents, Hydrocomp Conference, Dubrovnik, June, 13.-16.

RAJAR, R., 1989. Three Dimensional Modelling of Currents in the Northern Adriatic Sea, XXIII Congress of IAHR, Ottawa, Avgust 21.-25.

RAJAR, R., 1990. Three Dimensional Mathematical Model of Currents and of Transport of Pollutants in the Adriatic. VIII. Congress CMWR, Venezia, June, 13.-16.

O-VI9

Dynamical coupling between the Mediterranean Sea and the atmosphere. Boundary conditions at the air-sea interface

Françoise ROBE

GHER, University of Liège (Belgium)

ABSTRACT

In oceanography, the need of accurate boundary conditions at the air-sea interface is critical. Indeed the coupling between the atmosphere and the sea is intense, especially via the turbulent fluxes of humidity, temperature, and momentum. A parameterization of these fluxes is then required. To achieve this, one needs to couple hydrodynamical and meteorological models.

A 2-D integral coupled ocean-atmosphere model has then been developed to simulate the transient interactions between the two boundary layers. The heat, water, and momentum exchanges at the interface are investigated, notably to analyze the clouds generation, their possible persistence and the resultant feed-back on the oceanic variables. The solar and IR radiative fluxes are parameterized as functions of the temperature and humidity profiles and vary then with the meteorological events.

This model has already been tested in the Tropics where the dynamics of the coupled ocean-atmosphere system has been proved to be highly dependent on the advective rates and the turbulent fluxes at the interface. The model embedded in an atmospheric GCM and in the GHER Oceanic GCM is applied to the Mediterranean Sea, providing more accurate turbulent fluxes as boundary conditions for the modelling of the general circulation, and on the other hand, contributing to the parameterization of the incidence of meteorological conditions upon the formation of dense waters.

The development and the generalisation of this kind of coupled model will therefore give a highly expected tool to the modellers of the Mediterranean Sea.

O

Dynamical T-S analysis of Mediterranean Sea water masses

Emil V. STANEV* and Jean-Marie BECKERS**

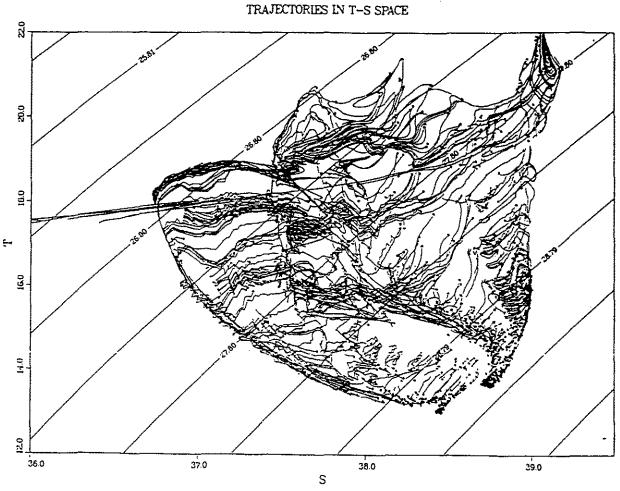
*Department of Meteorology and Geophysics, University of Sofia (Bulgaria)
**National Fund of Scientific Research, GHER University of Liège (Belgium)

T-S analysis was widely applied to study the water masses in the Mediterranean Sea. In the pioneering work of Wüst (1960), the efficiency of the core method to investigate intermediate and deep circulation was manifested. However, classical T-S analysis does not incorporate any local or remote physical information concerning the displacements of the particles in T-S space. This can be easily understood, since no such information existed in that time when the T-S analysis was developed. At present, numerical models provide us with a valuable information which can be used to increase substantially the understanding that can be obtained from the T-S analysis.

In the analysis proposed in the present paper the hydrological data are used to initialise a numerical model which we use as a tool to define the velocity field. Further, the displacement of Lagrangian particles in the T-S space is analysed in order to find some general properties of the water masses formation and mixing along trajectories.

Based on Levitus' (1982) data set, a combination of robust diagnostic and fully prognostic techniques is used to evaluate for the Mediterranean Sea a climatology consistent with the physics of the Princeton OGCM. Model experiments are carried out with 28 levels and with a horizontal resolution of $\Delta\lambda = 1/3$, $\Delta\phi = 1/4$. The model is forced mechanically by wind stress taken from Hellerman and Rosenstein's (1983) data. Sea surface temperature and salinity are prescribed from Levitus' (1982) data. Exchange flows in the Strait of Gibraltar are explicitly prescribed with 1.5 10^6 m^3s^{-1} each. At the most, model adjusted salinities and temperatures depart from Levitus' initial data by 0.02 and 0.05°C in deep layers and by 0.1 and 1°C in the pycnocline. The simulated circulation is generally cyclonic. Velocity profiles reveal a subsurface jet at about 50m advecting Atlantic water eastwards. With increasing depth a reversal of zonal flow is simulated with a core at about 300m advecting Levantine Intermediate Water westwards. The model simulated T-S indices for the entire Mediranean Sea does not deviate substantially from the initial ones. For about 5% of the grid points Lagrangian displacement $\vec{x}$ is calculated from $\vec{x} = \vec{v}(\vec{x})$, see the figure, where velocity $\vec{v}$ is taken from the model data. The trajectories illustrate the preferable mixing patterns. Their analysis can be used to define the general processes of water masses formation and transformation what is the topic of this paper.

TRAJECTORIES IN T-S SPACE



REFERENCES

Hellerman S. and M. Rosenstein, 1983. Normal monthly wind stress over the World Ocean with error estimates. Journal of Physical Oceanography, 17, 158-163.

Levitus S., 1982. Climatological atlas of the world ocean. NOAA Prof.Paper. 13, 173pp., 17 microfiche, U. S. Govt. Printing office, Washington, DC.

Wüst G., 1960. Die Tiefenzirkulation des Mittelländischen Meeres in der Kernschichten des Zwischen und Tiefenwassers. Deut. Hydrogr. Zeit., 13, 3, 105-131.

Bio-Optical Variability in the Western Mediterranean

Robert A. ARNONE and Paul E. LA VIOLETTE

Naval Oceanographic and Atmospheric Research Laboratory, Stennis Space Center, MS, 39527 (U.S.A.)

Ocean color satellite data were used to investigate the monthly and spatial variability of phytoplankton pigment concentration and diffuse attenuation coefficient (k(490)) in the western Mediterranean Sea. Coastal Zone Color Scanner (CZCS) composite products (Feldman, 1989) for 1979-1980 were used to define the bio-optical variabilities in specific regions: the Ligurian Sea, Gulf of Lion, Balearic Sea, Central Algerian Basin, Algerian Current, and Alboran Sea.

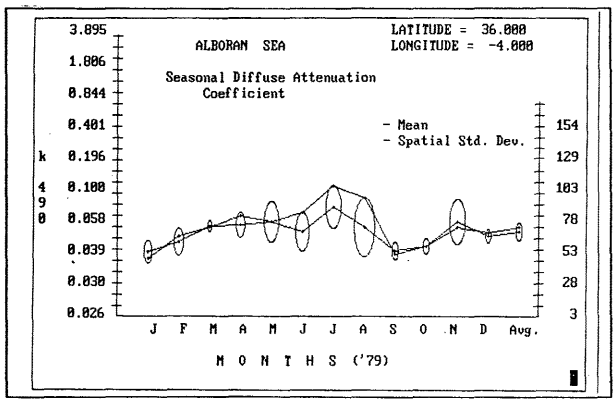
The development of mesoscale ocean features and bio-optical evolution of water masses in these regions were characterized by monthly CZCS imagery. The imagery were averaged into 20 km pixel resolution and processed by standard atmospheric removal methods (Gordon and Clark, 1980). Ratio algorithms (Gordon and Clark, 1980; Austin and Petzold, 1980) applied to these results produced monthly mean and standard deviation bio-optical properties. Although ocean color represents only the integrated upper ocean (approximately the first attenuation length), the surface distributions depict the bio-optical climate of the sea (since stronger biological responses occur near the surface).

The composite monthly results show that the evolution of biological and optical properties in the western Mediterranean interacts strongly with the regional surface circulation. The results also indicate a biological response to meteorological forcing of the Mistral. The biological repercussions of coastal processes and its effects on the large scale biological budget of the sea is also evidenced.

The mean phytoplankton distribution for the entire Western Mediterranean indicates that the lowest concentrations occur in September. High concentrations vary seasonally from region to region. The Alboran Sea has the highest concentrations as well as the strongest seasonal variability (the strongest bloom occurring in July (1 mg/m3) with a secondary bloom in November) (figure). The Gulf of Lion also shows a bi-modal pigment seasonal distribution, with maximums (0.4 mg/m3) occurring in April and December. The central Algerian Basin maintains a weak seasonally stationary phytoplankton distribution (<0.1 mg/m3). As a result of the regional ocean dynamics, the Algerian current exhibits significant spatial variability with elevated concentrations occurring in June.

The monthly standard deviation of the bio-optical properties is similarly associated with the surface circulation. High standard deviations occur in energetic areas such as ocean fronts and upwelling regions do to the response of phytoplankton to the rapidly changing physical processes. Thus, the locations of high monthly bio-optical changes are coincident with positions of fronts and eddies within the several ocean basins and within coastal areas.

This study illustrates the biological seasonal evolution of surface waters in the Western Mediterranean. This biological climate may be used to assess the amplitude and frequencies of seasonal biological productivity (Lohrenz et al, 1988). The study confirms a direct coupling of the overall general circulation and the surface biological phytoplankton distribution. CZCS imagery indicates that elevated phytoplankton concentrations associated with coastal processes extends well offshore and may have an impact on the regional water mass biological character.



References:

Austin, R.W. and T. J. Petzold, "The determination of the diffuse attenuation coefficient of sea water using the coastal zone color scanner" in *Oceanography from Space,* J.F.R. Gower, ed.,Plenum, New York, 239 (1981)

Feldman, G. "Ocean Color" EOS 70:23 p634 (1989)

Gordon, H. R. and D. K. Clark, "Atmospheric effects in the remote sensing of phytoplankton pigments", Boundary-Layer Meteorology 18,229-313 (1980)

Gordon, H. R. and D. K. Clark, "Clear water Radiances for atmospheric correction of coastal zone color scanner imagery," Appl. Optics, 20:24, 4175-4180

Lohrenz, S. E., R. A. Arnone, D. A. Wiesenburg, and I. P. DePalma, Satellite detection of transient enhanced primary production in the western Mediterranean Sea, Nature 335(6187) 245-247, 1988.

O-VII2

TEMPO Experiment : Characteristics of the circulation in the Northern Tyrrhenian Sea

V. ARTALE* , M. ASTRALDI** and G.-P. GASPARINI**

*ENEA, CRE Casaccia, P.O. Box 2400, 00100 Roma (Italia)
**CNR Stazione Oceanografica, Pozzuolo di Lerici (Italia)

The Tyrrhenian circulation is largely cyclonic, with very weak currents organized in two main structures bordering at about 40° North of latitude. The early observations (e. g. Krivosheya and Ovchinnichov (1973) and Moen (1984)) indicate that, whereas the wind can be considered responsible for the basin-wide circulation, the wind blowing from the Bonifacio Strait is the principal source of energy for the cyclonic structure in the north.

In order to evaluate the characteristics of the circulation in this part of the basin, an experimental program involving annual current measurements at different places together with periodic hydrographic campaigns and drifting buoys, has been carried out from September 1989 as a part of the international project TEMPO (Tyrrhenian Eddy Multi-Platform Observation Experiment). The purpose of this project is the investigation of the Tyrrhenian circulation by an integrated use of different data collected from different platforms (satellite, aircraft and ship). In the following a preliminary description will be given of the conditions existing in the fall season with a particular focus on the vertical structure of the water column and the circulation pattern at various depths.

The extension of the mixed layer varies from 20m in the central area to 45m in the southern part of it, just underlined by a well developed thermocline. The surface layer of Modified Atlantic Water (MAW) has its core (pointed out by a minimum in salinity) at about 50m of depth, nearly uniform all over the area, while the core of the Levantine Intermediate Water (LIW) is at 350-400m of depth and has the highest values in the southernmost part of the basin.

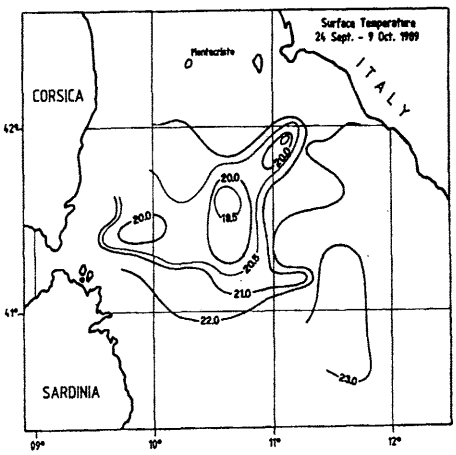
The horizontal distribution of the surface temperature shows that the lower temperatures are found in the central basin. Close to the 41° parallel a marked frontal structure develops in the surface layer (MAW), dividing the colder water in the north from that warmer in the south. In the intermediate and deep layers the temperature and salinity values decrease progressively along a southeast-northwest direction, having the highest gradients near the 41th parallel. The density distribution at all depths is consistent with a cyclonic circulation of the water mass involving most of the water column.

The current measurements at all the observed depths (50, 150 and 350m) show a cyclonic pattern with very low mean values (3cm/s or less), the highest values being recorded near the boundary frontal system.

The computation of the surface dynamic depths starting from a reference level of 350m, indicates the presence of a cyclonic gyre having the same velocity values as those directly observed.

Finally the trajectory of the surface drifting buoy released near the frontal signature shown in the horizontal temperature distribution, fully supports the indication that the area is affected by a cyclonic circulation, that is stationary for the considered period.

In conclusion all the measurements indicate that a cyclonic circulation having a very low dynamics prevails in the northern Tyrrhenian basin. From the surface signature of this structure, easily detectable in the thermal maps of the area, important indications can be obtained for the comprehension of the structure below.



REFERENCES

KRIVOSHEYA, V.G. And I.M. OVCHNNIKOV, 1973. Peculiarities in the geostrophic circulation of the waters of the Tyrrhenian Sea, Oceanology, 13: 822-827.

MOEN J., 1984. Variability and Mixing of the surface layer in the Tyrrhenian sea: Milex-80, Final Report. SACLANTCEN Report SR-75, 128p.

O-VII3

AVHRR/2 observations of the Tyrrhenian eddy during TEMPO

E. BOHM* , R. FRANCIONI* , R. LEONARDI** , S. MARULLO* and R. SANTOLERI**

*Telespazio, Earth Observation Division, Via Tiburtina 965, 00156 Roma (Italy)
*Istituto di Fisica dell'Atmosfera, CNR, P. le Sturzo 31, 00144 Roma (Italia)

The large scale circulation in the Tyrrhenian Sea is mainly cyclonic. Superimposed on this large scale circulation is a pair of eddies rotating in opposite direction and separated by a zonal front (henceforth called front) running at approximately 40° N. The northern eddy (henceforth called Tyrrhenian Eddy) is cold core and cyclonic while the southern is anticyclonic and relatively warmer.

The Tyrrhenian Eddy Multi-Platform Observations (TEMPO) experiment, whose intensive phase was carried in September 26th - October 9th, 1989, was devoted to both improving the understanding of the air-sea interaction dynamics of the North Tyrrhenian Sea and testing a methodology based on simultaneous observations collected from different platforms in view of the ERS-1 launch.

The utilization of AVHRR/2 data for TEMPO reflected the two phases into which TEMPO was divided: 1) an extended phase involving analysis of a long time series of images to select the most appropriate period for the execution of the oceanographic campaign and 2) an intensive phase, during the two-week campaign to support ship and aircraft operations by indicating frontal position and strength and to provide a source of synoptic data for the subsequent analysis.

One year worth of satellite imagery was examined in order to construct the statistics of persistence, intensity and evolution of the front and the Tyrrhenian Eddy. The edges of the SST front and the Tyrrhenian Eddy were digitized for each AVHRR/2 image. Analysis of the digitized frontal time series indicates the presence during fall and winter of a zonal SST front between Sardinia and the Italian Peninsula which is only visible in some of the spring and summer images. During the transition period between summer and fall the front evolves into a well organized cyclonic eddy which persists for the entire winter. An occasional cyclonic eddy, visible in some of the summer images, appears to be related to periods of intense wind in the Strait of Bonifacio. These observations support Moen's (1984) hypothesis which relates the presence of the North Tyrrhenian Eddy to baroclinic adjustment to the forcing by the wind stress curl. The radius of the Tyrrhenian Eddy varies from 50 to 75 km while the temperature difference between the eddy core and the surrounding waters ranges from 1 °C (in winter) to 2.5 °C (in fall).

On the basis of the AVHRR/2 observations from the extended phase the period September-October appeared to offer the best compromise between the need for cloud-free imagery and the likelihood of sampling the formation stages of the Tyrrhenian Eddy.

During the intensive phase, NOAA-11 passes received by the Italian Meteorological Service were processed by Telespazio in Rome. From each acquired pass a SST image of the Northern Tyrrhenian Sea was atmospherically corrected, remapped to Mercator projection, compressed (down to 20% of the original size) to save on transmission time and cost and relayed via Inmarsat to the ship approximately two hours after the satellite pass. On the ship the image was decompressed and presented on a PC screen. On the basis of the looks at this imagery the scientists on board the ship directed the ship to the area of strong SST fronts to perform multi-platform observations. The analysis of the images collected during the intensive phase indicates that a transition between a summer and a winter condition occurred. Namely, the imagery of 19-20 September displays a meridionally banded SST structure that progressively disappears, as well as a zonal SST front. From 21 September onwards the zonal front appears to evolve into a cyclonic cold core eddy which can be observed starting 30 September. This transition process may have indeed been accelerated by the passage of an atmospheric perturbation which lasted the 28 and 29 September.

REFERENCES

MOEN J., 1984. Variability and Mixing of the surface layer in the Tyrrhenian sea: Milex-80, Final Report. SACLANTCEN Report SR-75, 128p.

O

Quelques méthodes d'analyse d'images satellitaires appliquées à la Méditerranée

François CAUNEAU et Lucien WALD

Centre de Télédétection et d'Analyse des Milieux Naturels (CTAMN), Ecole Nationale Supérieure des Mines de Paris, Rue Claude Daunesse, Sophia-Antipolis, 06565 Valbonne (France)

La communication a pour objet de présenter quelques apports de la télédétection spatiale à la connaissance des processus physiques en Méditerranée. Les différentes fenêtres spectrales d'observation disponibles opérationnellement sont passées en revue, appuyées par quelques exemples.

1 - L'utilisation d'imagerie satellitaire à des fins océanographiques implique un traitement préalable de ces images. Les comptes numériques issus du satellites doivent être étalonnés puis corrigés des effets perturbateurs de l'atmosphère. Puis les images sont naviguées afin d'être superposables à une référence cartographique. Un exemple sur le golfe du Lion illustre ces traitements.

2 - L'observation de la surface marine dans le domaine visible donne accès à la quantité de lumière rétrodiffusée vers le satellite. Une modélisation fine de la transparence atmosphérique permet de calculer puis de cartographier la quantité d'énergie solaire reçue à la surface (Diabaté *et al.* 1989). On accède ainsi à la composante ondes courtes du bilan radiatif sur une échelle synoptique avec une résolution spatiale de 5 km. Ceci est illustré par la cartographie de cette composante en Méditerranée occidentale de 1983 à 1985.

3 - Le domaine infra-rouge fournit une mesure de la température de surface de la mer. La fréquence temporelle de fourniture d'images par les satellites permet diverses applications, depuis la climatologie des températures de surface jusqu'à l'analyse de phénomènes transitoires. La télédétection permet en outre la mesure des échelles spatiales et temporelles des processus. Les trois premiers exemples portent sur la mer Ligure. L'analyse répétitive sur plusieurs années des thermographies de la mer Ligure permet de caractériser les phénomènes de la circulation générale. Les variations saisonnières de la distribution des gradients thermiques superficiels sont ainsi finement décrites (Wald, Nihous 1980). Les instabilités dynamiques ont une signature thermique permettant leur repérage. Ainsi des ondes de basse fréquence ont été suivies et analysées en termes d'ondes baroclines de grande amplitude, en accord avec un modèle analytique à deux couches (Crépon *et al.* 1982). Les images satellitaires de la mer Ligure exhibent des structures tourbillonnaires. Une étude statistique de la distribution spatiale de ces tourbillons et de leurs caractéristiques de forme met en évidence la faible dispersion des diamètres autour d'une valeur moyenne de 30 km, ainsi qu'une grande hétérogénéité de la répartition de ces tourbillons dans la mer Ligure. La plupart des tourbillons sont observés près du Cap Corse, et sont anticycloniques. Ce résultat confirme les mesures in-situ de la campagne DYOME, et les complète en offrant une extension spatiale des conclusions de cette campagne (Wald 1985). L'analyse statistique de la structure turbulente du champ de température à moyenne échelle par fonctions de structure montre que la température se comporte comme un traceur passif, en accord avec la théorie de turbulence quasi-géostrophique de Blumen (1978) prédisant la conservation simultanée de l'énergie totale du système et de l'énergie potentielle disponible à la surface de la mer. Cette conclusion permet d'envisager l'estimation du champ de courant superficiel à partir de thermographies à l'aide d'un modèle numérique d'advection instationnaire de la chaleur. L'imagerie satellitaire fournit les dérivées temporelles et les gradients thermiques assimilés par le modèle, qui une fois intégré le long des isothermes donne une cartographie de la fonction de courant (Wald 1985).

4 - L'utilisation des hyperfréquences en océanographie spatiale permet de s'affranchir de la couverture nuageuse, et d'améliorer ainsi la fréquence temporelle des observations de l'état de surface de la mer. Les instruments diffusiomètre et radar à synthèse d'ouverture (SAR) embarqués à bord du satellite européen ERS1 devant être lancé en 1991 donneront accès au champ de vent de surface ainsi qu'au spectre d'état de surface. On montre comment ces informations peuvent rééchantillonnées dans le temps et dans l'espace et combinées avec des données météorologiques standards afin d'être assimilées dans des modèles de prédiction de houle. On utilise pour cela, soit des méthodes d'estimation autorégressive, soit des méthodes variationnelles (Cauneau, Bernard 1990).

Références :

Blumen, W., 1978. Uniform potential vorticity flow : Part 1. Theory of wave interactions and two-dimensional turbulence. *Journal of Atmospheric Sciences*, 35, 774-783.

Cauneau, F., Bernard, R., 1990. Oceanic latent heat flux autocorrelation functions from the SEASAT SMMR : results. Submitted to *Journal of Geophysical Research.*

Crépon, M., Wald, L., and Monget, J.M., 1982. Low frequency waves in the Ligurian sea during December 1977. *Journal of Geophysical Research*, 87, C1, 595-600.

Diabaté, L., Moussu, G., Wald, L., 1985. Description of an operational tool for determining global solar radiation at ground using geostationnary satellite images. *Solar Energy*, 42, 3, 201-207.

Wald, L., 1985. Apport de la télédétection spatiale en infra-rouge proche et moyen à la connaissance du milieu marin. Thèse d'Etat, Université de Toulon, 259 p..

Wald, L., Nihous, G., 1980. Ligurian sea : annual variation of the sea-surface thermal structure as detected by satellite NOAA 5. *Oceanologica Acta*, 3, 4, 465-469.

O

Some circulation features in the Adriatic Sea - a satellite View

Paul E. LA VIOLETTE* and Miroslav GACIC**

*Mississippi State University Research Center, John C. Stennis Space Center, 39529, Mississippi (U.S.A.)
**Institute of Oceanography & Fisheries, P.O. Box 114, 58000 Split (Yugoslavia)

Surface general circulation in the Adriatic Sea is characterized by the inflow in a wide area along the Albanian and Yugoslav coasts. Along the Italian coast narrow coastal jet of outflowing current prevails during the entire year. Within the Adriatic Sea basin the cyclonic circulation pattern is perturbed by very prominent bottom features such as Palagruža Sill, and by strong transient wind events. Also, the water exchange between the Ionian and Adriatic Sea and the circulation pattern change on the seasonal time scale.

The temperature contrast between the inflowing and outflowing waters is very strong and during the summer the outflowing waters are warmer than the inflowing ones. On the other hand, during the winter the surface coastal jet along the Italian coast consists of very cold and fresh water coming from Po and other Italian rivers. Due to these temperature contrasts number of quasi-permanent thermal fronts are evident. Their positions depend on the transient wind forcing, freshwater inflow and on the intensity of water exchange through the Strait of Otranto.

Superimposed on this general circulation pattern, number of mesoscale features (eddies, gyres, filaments) have also been evidenced. Their typical length scales are of the order of ten kilometers and they are not easily evidenced by the classical hydrographic surveys. Here we present some satellite IR images of the Northern and Southern Adriatic and discuss mesoscale features which are superimposed on the general circulation.

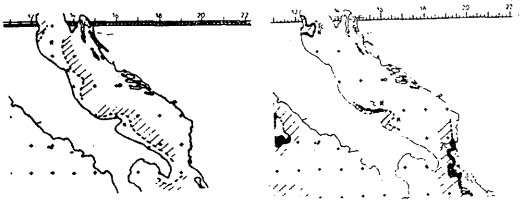
O-VII6

Thermal Fronts in the Adriatic Sea

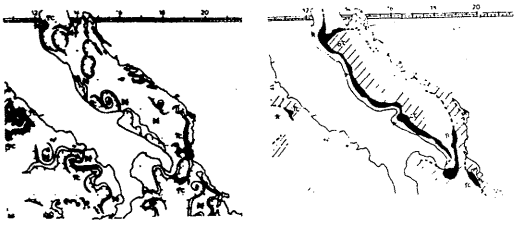
Mira MOROVIC
Institute of Oceanography & Fisheries, 58000 Split (Yugoslavia)

Analysis of infra-red images of surface temperature published in monthly bulletin SATMER were used to study thermal fronts in the Adriatic sea in the period from september 1980 to january 1987.

The largest part of the period studied there were thermal fronts in the Adriatic sea ,showing regular changes in the course of year.Mostly fronts are typical coastal fronts parallel to the coast but sometimes are broken into several transversal fronts or form small eddies ,at the edges of coastal fronts. The most frequent seasonal shapes of thermal fronts were identified (see fig.),and their existence understood in relation to freshwater inflow,seasonal heating and cooling,synoptic disturbances and advection of warmer water through Otranto strait.



Thermal fronts in spring and summer.



Thermal fronts in autumn and winter.

Satelite infra-red images provide more complex isotherm pattern than it was obtained with temperature measurements at sea. Surface isotherms were also used for comparison with typical Adriatic water types formation ,

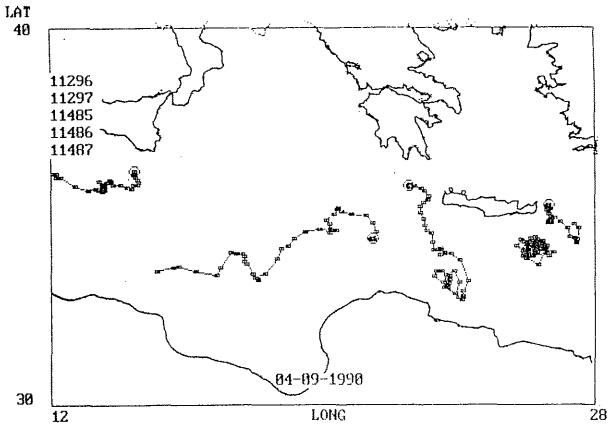
O-VII7

Satellite Infrared (thermal) Imagery and drifter buoy trajectories in the Eastern Mediterranean

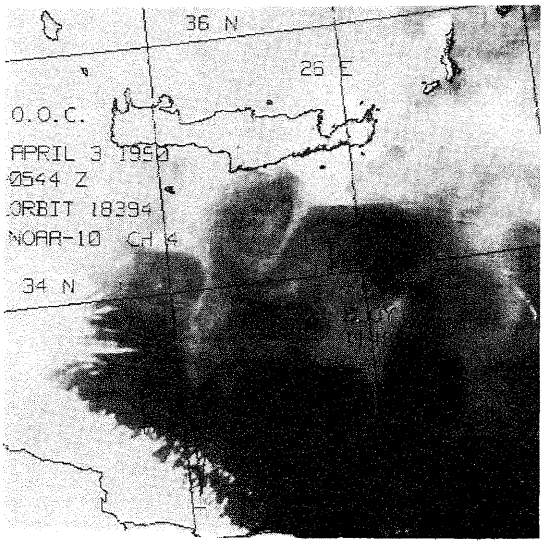
James A. PRICE* , Bill BURNETT* , R.-L. PICKETT** and Paul E. LA VIOLETTE***
*Naval Oceanography Office, Stennis Space Center, MS 39529-5004 (U.S.A.)
**Naval Oceanographic and Atmospheric Research Laboratory, Stennis Space Center, MS 39529-5004 (U.S.A.)
***Mississippi State University, Stennis Space Center, MS 39529-5004 (U.S.A.)

Six satellite-tracked METOCEAN drifter buoys were air-dropped into prominent frontal features and eddies in the eastern Mediterranean on 25 February, 1990. The purpose of these releases was to monitor the movements of these ocean features over an extended period and to compare them with simultaneous surface thermal patterns of the ocean features provided by NOAA AVHRR-Infrared imagery. At the time of this writing (early April) five of the drifters are still transmitting. This short report will detail some information of oceanographic interest found in a preliminary analysis of this combination drifter buoy-satellite imagery data set.

Figure 1 below shows the trajectories of the five remaining buoys (the sixth buoy only remained operative for 26 days). Note that the westernmost drifter was dropped in the general location of the Maltese front, the second in the eastern Mediterranean East-West front, the third west of Crete, the fourth in the permanent eddy found south of Crete, and the remaining eddy positioned just east of Crete to detect the influence of the outflow of the Aegean sea water on the Cretean eddies. We will discuss the information provided by the buoys in that order.



Of all the drifters, the buoy contained in the warm, anticyclonic eddy south of Crete (which for convenience, we have called the Cretean Eddy) has shown the most interesting trajectory. Figure 2 below shows the trajectory of the buoy for the period 2 March through 9 April superimposed on a satellite image for 3 April. An eddy was first reported in this location by Unluata et al. (1989) during field work associated with POEM. Our preliminary examination of two years of cloud-free imagery of the region indicates that an eddy approximately 45 km in diameter is a permanent feature off the southeast corner of Crete.



We thought it odd that the buoy has remained entrained in the eddy since it was dropped in February, despite the fact that at times it was quite close to the thermal rim seen in the AVHRR imagery. The location of the feature is obviously related to the bathymetry of the region. The data shows the buoy making a complete loop within the eddy every three to five days, maintaining a fairly constant speed (50 cm/sec, the speed varying according to its distance from the center of rotation). The movement and imagery indicate the eddy has also moved closer to Crete during the buoy monitoring period.

Driving mechanisms of Upwelling in the Sicily Channel

E. ZAMBIANCHI*, V. ARTALE**, S. MARULLO* and R. SANTOLERI***

*Earth Observation Division, Telespazio - Rome (Italy)
**CRE Casaccia, ENEA - Rome (Italy)
***Institute for Atmospheric Physics, CNR - Rome (Italy)

We present the results of the analysis of a long time series of NOAA-AVHRR data taken over the Sicily Channel. Sea Surface Temperature values were derived from cloud-free AVHRR data over one year (1986) by means of a split-window algorithm (Dalu et al., 1985).

The dynamics of the studied area is very complex, since it is a crucial point for the water mass exchanges between the Eastern and the Western Mediterranean Sea.

In particular, satellite images indicate the presence of two different surface water masses, which are separated by the strong "Maltese front".

Our first effort was the investigation of the seasonal variability of the front, which greatly influences the hydrographic characteristics of the studied area.

After that, our attention was focussed on upwelling events occurring on the Southern coast of Sicily.

Cold water patches extending southward are very frequently seen offshore Mazara del Vallo. These patches mirror the bottom topography suggesting that the upwelling is stronger in the shallower areas such as the Adventure Bank.

The transient characteristics of the observed upwelling events suggest that the meteorological forcing plays an important role in generating the upwelling in that area. On the other hand, the influence of an amphidromic point for the semidiurnal tidal component, located near the island of Pantelleria, which may well affect the interfacial depth pattern (Artale et al., 1989), was also investigated.

The results of our study, carried out by means of a statistical analysis performed on several parameters extracted from the images (upwelling indices), show the different role played by the various factors.

REFERENCES

V. Artale, A. Provenzale, R. Santoleri (1989): Analysis of Internal Temperature Oscillations of Tidal Period on the Sicilian Continental Shelf. Cont. Shelf Res., 9, 10, 867-888.

G. Dalu, A. Viola, S. Marullo (1985): Sea Surface Temperature from AVHRR-2 Data. Il Nuovo Cimento, 8C, 1, 6, 793-804.

O

Satellite Oceanography in the 1990'S

T.-H. GUYMER

Institute of Oceanographic Sciences, Deacon Laboratory, Wormley, Godalming (U.K.)

During the coming decade a number of space platforms capable of observing the oceans will be launched, beginning with ERS.1 and culminating with the advent of the operational systmes of the polar platforms. This paper reviews the achievements of oceanographic remote sensing by considering the parameters which can be obtained, their accuracy, and the ways in which such data have been used. The particular advantages of microwave sensors are highlighted. Some of the more important limitations of these techniques are also discussed.

Plans for statellite oceanography in the next few years are described in the light of past experience and emphasising the role which it will play in programmes of European interest. A trend towards combining data from different spaceborne sensors with sub-surface measurements and with models is foreseen. Such techniques are required not only for understanding and predicting large-scale climatic change, e.g. in the World Ocean Circulation Experiment, but for the more specific problems associated with regional oceanography, e.g. the Mediterranean.

An example of the latter is the Tyrrhenian Eddy Multi-Platform Observant (TEMPO) experiment of which an overview description is given. In autumn 1989 research groups from Italy, Germany and the UK participated in a two-week experiment to study an eddy/frontal system using a ship, aircraft and satellites. The satellite sensors were the AVHRR on NOAA satellites and the radar altimeter on GEOSAT. The ship was used to map the temperature and salinity structure of a 200 x 200 km area, making regular surface and upper air meteorological measurements. As it did so, it was used to deploy mooring and drifting floats for estimating currents. On board the aircraft was a microwave scatterometer and an infra-red radiometer which measured variations in surface roughness and sea surface temperature respectively. Near real-time satellite imagery was available for operational planning. Fortunately, the eddy became well-developed at the begining of the experiment and the observational programme was very successful. Objectives in the analysis phase include relating the IR and microwave remote sensing signatures to each other and to sub-surface structure, and obtaining a better understanding of the eddy and its role in affecting transports between the Tyrrhenian Sea and the rest of the western Mediterranean. Future observational phases are also planned during the lifetime of ERS-1.

Since the Mediterranean can be regarded as a natural laboratory for investigating oceanic processes the results of TEMPO are likely to be of general relevance to future synergistic studies of the global ocean.

O-VIII1

The 1985-1986 Gibraltar Experiment Hydraulic Control

Thomas H. KINDER* and Harry L. BRYDEN**

*Office of Naval Research (U.S.A.)
**Woods Hole Oceanographic Institution (U.S.A.)

During 1985-1986 a consortium of scientists from Spain, Morocco, France, the United Kingdom, Canada, and the United States studied the fluid dynamics of the flow through the Strait of Gibraltar. Individual scientific groups had various objectives, including the effect of the strait on the large scale oceanic circulation, the level of dissipation and small scale structure in the strait, and the forcing of the subinertial flows. The central theme for the experiment, however, was the role of hydraulic control in the dynamics of strait flows. We will discuss the new results in the understanding of hydraulic control as it applies to the Strait of Gibraltar.

Nearly 40 years ago Stommel and H. G. Farmer used hydraulic control and mixing conditions to infer estuarine dynamics. These ideas also appeared fruitful for the understanding of semi-enclosed seas and their straits, and they had been applied to the Mediterranean prior to the Gibraltar Experiment. It was clear that hydraulic control at the strait could profoundly alter the interaction of the Mediterranean Sea and the Atlantic Ocean. In this regard, there were three questions addressed by the Gibraltar scientists:

1. Does internal hydraulic control exist in the Strait of Gibraltar?

2. If so, how does it work? Existing theory considered an ideal strait: single sill, two-layer stratification, regular lateral and bottom boundaries, no rotation, no friction, and steady flow. Could simple theory illuminate the flow in the strait, and which of the idealizations are fundamental?

3. Once the strait dynamics are understood, how can this understanding be integrated into knowledge of the Mediterranean system?

Although work on strait dynamics and on Gibraltar Experiment data continues, there are answers to these questions. The existence of internal hydraulic control within the strait is well established. In particular, the time dependence of the flow and the multiple-sill and contraction geometry of the strait are fundamentally important. The hydraulic control has a profound effect on the Mediterranean, being a key factor in establishing its stratification.

We will present a brief overview of these results, drawing on the work of many Gibraltar investigators. Particularly active in the application of hydraulic theory have been Armi, D. M. Farmer, Bormans, Thompson, Garrett, Stommel, Canizo, and Dalziel. We will focus on the lessons of steady two-layer flow in the strait under the constraint of hydraulic control, and its ramifications for the Mediterranean Sea.

O-VIII2

Interannual variability of the air - sea interaction along the eastern Adriatic Coast

V. KOVACEVIC, M. GACIC and B. GRBEC

Institute of Oceanography & Fisheries, Split (Yugoslavia)

Recent worldwide scientific interest in the air-sea interaction on climatic time scales in different regions has revealed that sea-level and sea-surface temperature variations are good tracers of ocean circulation, water mass and heat balance variabilities.

In order to study air-sea interaction at the climatic time scales, six variables from three locations along the eastern Adriatic coast were analysed in period from 1959 to 1984. Station Pula represents shallow northern Adriatic area with the River Po mouth on the other side of the coast, Split represents middle Adriatic channel area and Dubrovnik represents the southernmost coastal area characterised by the narrow and smooth shelf. The 35-year data set contains monthly means of air-pressure (PRE), air-temperature (ATE), relative humidity (HUM), sea-surface temperature (SST) and sea-level (LEV), as well as monthly totals of rainfall (RAN). Missing data were linearly interpolated after comparing two nearby stations. Instead of PRE data set at Pula, that could not be extrapolated because of the lack of measurements at a nearby position, mean monthly PRE at Trieste (Italy) were used. After applying a symmetrical 24m214 filter smoothed curves are obtained (Figure 1), containing signals of few-year periods with different amplitudes for different variables. Trends are evident in ATE, SST and RAN, not necesserily of the same sign at all the stations.

The EOFs of the filtered data sets at three stations show features of interaction between sea and atmosphere variables.

Dominating variance at Pula (constituting 35% of the total variance) is accounted for by the connection between PRE and LEV, suggesting their out-of-phase variability. Beside the "inverted barometer" effect, PRE variations are in a conjuction with the frequency of atmospheric disturbances passing over the area (cyclones and anticyclones), and their characteristic wind systems, which affect advection and changes in LEV. With the small percentage of their individual variances, ATE and SST correlations are present in the first mode, too. In the second mode (30%) good interrelation between RAN, HUM, PRE and SST variations was obtained, which explains that evaporation and latent heat flux (represented by the SST) may be affected by meteorological forcing (fluctuations in a frequency of atmospheric disturbances). In the third mode (17%) ATE variations are coupled to an out-of-phase RAN variations. The thermal forcing (SST-LEV correlation) at this station is not evident.

The first mode at Split (38%) gives very good correlation among PRE, RAN and LEV, suggesting that the PRE decrease (connected to increased frequency of lows on the long-term time scale) is followed by the RAN increase that can both yield a LEV increase. The second mode explains almost the same percentage of the total variance (37%) as the first one, extracting exclusively thermal effect in LEV variations (in-phase changes of ATE, SST and

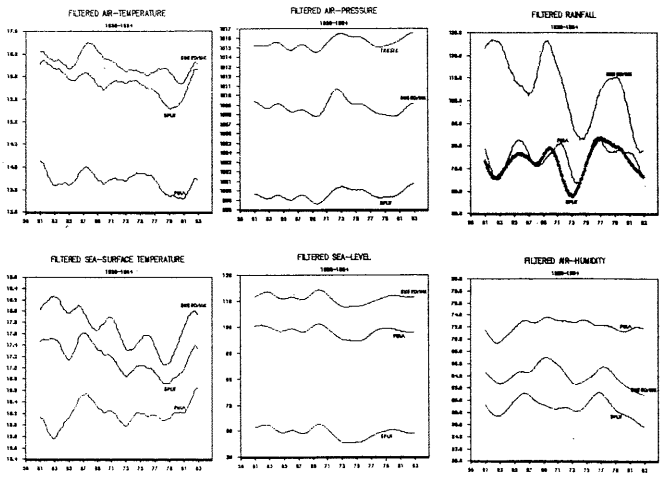


Figure 1.

LEV). The third mode (19%) explains the greatest part of HUM variability, without acceptable physical explanation.

The first mode at Dubrovnik (48%) contains the largest percentage of the LEV variance (70%). It can be related to the combined influence of the thermal forcing, RAN and to a lesser extent, PRE forcing. Correlation between SST and ATE is weaker than in Split and SST appears strongly dependent on PRE in the second mode (21%). This can be explained in terms of the advection of warmer and saltier water from the Ionian sea. The advection from the south should induce stronger SST, as well as LEV variations, in southern than in the northern part of Adriatic, with no obvious relation to ATE. In order to confirm this, salinity data should be taken into account, as they are a good indicator of stronger Levantine water inflow to the Adriatic.

In conclusion it may be pointed out that sea-level changes along the coast of the northern Adriatic are induced by the meteorological forcing due to long-term changes of a frequency of passing cyclones over the area, with the atmospheric pressure being the most effective. In the central Adriatic influence of the thermal forcing due to the air-sea heat exchange is very pronounced in sea-level variations. In the southern Adriatic thermal forcing is less effective than in the central Adriatic, and heat balance is prevalently due to advective processes.

O

Climatic variability in the Northeastern Mediterranean and Black Sea

A. LASCARATOS* , M. GACIC** and T. OGUZ***

*University of Athens, Department of Applied Physics, 33, Ippokratous str., 10680 Athens (Greece)
**Institute of Oceanography & Fisheries, 58001 Split, P.O. Box 114 (Yugoslavia)
***Institute of Marine Sciences, P.K. 28, Erdemli, Icel (Turkey)

The general circulation of the Eastern Mediterranean has been the object of many research efforts. It is known to be dominated by important basin and sub-basin features such as gyres, jets, eddies, meandering currents reflecting its complex geometry, bathymetry and highly variable atmospheric forcing. Its seasonal and higher frequency variability and their regional dependence have been studied in sufficient details in number of studies (see Hopkins, 1978; Malanotte-Rizzoli and Hecht, 1988; Ozsoy et al., 1989). Yet, almost nothing is known about the eventual existence and importance of interannual variability, on time scales of decades or so, of the general circulation of E. Med. The recent interest on climatic oscillations and trends brings this subject to actuality, since the oceans should respond to changes in atmospheric forcing.

In this paper, we examine the low frequency variability, on time scales of decades or so, of coastal sea surface temperatures (SST) in the northeastern Mediterranean and Black Sea, and their eventual relation to atmospheric temperature (AT). Changes in SSTs, especially if they are not totally coherent all over the area, can be considered as an indication of changes in the density field, and therefore circulation.

The long-term variabilities were studied using monthly means of SSTs and ATs from 20 stations covering the Adriatic, Ionian, Aegean and Black Sea. The data were checked qualitatively for spurious spikes and unrealistic values. The common data set was formed for the period 1955 - 1984. The largest variance in both SST and AT time-series is contained in the annual cycle. In order to study longer term variability, the annual variations and other high-frequency signals having periods shorter than two years were eliminated by means of the 24m214 filter (Thompson, 1983).

The resulting time-series do show the existence of quite important variations of SST and AT inside the area during the study period. The main features of these variations are :

a.-Both SST and AT time-series in the Aegean and southern Adriatic Sea show a constant trend of decrease (0.5-1.0 deg.C.) from the early 1960's to the early 1980's. This trend is not however present either in the northern Adriatic or in the Black Sea.

b.-The Black Sea and, to a lesser extend, Aegean Sea AT and SST time series show two distinct periods with respect to the prevalent time scale of variability. The period from 1957 - 1972 is characterized by energetic oscillations at the time scale of about four to five years in which the SST and AT are well correlated. The second part of the records, however displays less energetic and regionally less coherent higher frequency oscillations. This distinction is found not to be evident in the Adriatic Sea.

c.-There exists, in general, a good positive correlation between SST and AT time series. This correlation seems to be best in the northern Adriatic, northern Aegean and Black Sea :

The Adriatic Sea may be divided into two main parts. The entire northern part represents the continental shelf and should display more energetic response to the atmospheric forcing and freshwater inflow. The southern part has a narrow shelf adjacent to the deep central area and is influenced by the interaction with the Ionian Sea and exchange through the Otranto Strait. The Aegean Sea may also be divided into two parts from the point of view of the meteorological and oceanographic conditions. The northern basin has a large continental shelf and its circulation is mainly governed by the inflow from the Dardanelles and cold outbreaks from the northern coast. The southern basin communicates with adjacent basins through the Cretan straits with the rest of the E. Mediterranean and is largely affected by its circulation. Finally, the Black Sea has very limited interaction with the rest of the region due to the fact that the Turkish Straits are narrow and shallow.

It seems therefore that the SST signal can be split in two parts: The local forcing (AT) and the horizontally advected (by currents) heat. This is very clearly seen in the Adriatic where as one moves from north to south (from Pula to Split and Dubrovnic), that is from the shallow and isolated north to the deeper and more open to communication south, the relation between SST and AT becomes weaker as a result of horizontally advected heat.

d.-A common feature of the southern Aegean (Iraklion), Ionian (Katakolon) and southern Adriatic Sea (Dubrovnik) is a strong SST decrease from 1975-1976 to 1980-1981 followed by the sudden increase of more than 1.5 C in a two-year period. This feature was not observed in AT time-series suggesting that it is related to oceanographic processes i.e. probably to the horizontal heat advection. This event, very well correlates with already observed similar decrease of the upper 50 m integrated salinity (-0.7 p.p.t.) in the Western Aegean for the same period followed by a sudden increase to original values in 1982, itself very well correlated with an inverse oscillation of the Aegean sea level (Lascaratos, 1989)

As a concluding remark, we can say that the present initial study has shown the existence of important long term interannual variability in SST's in the Northeastern Mediterranean and Black Sea, themselves an indication of possible changes in the surface density field on those time scales. The continuation of this work should include more atmospheric parameters such as atm. pressure, rainfall and wind and oceanographic parameters shuch as salinity and sea level.

REFERENCES

HOPKINS,T.(1978) Physical Processes in the Mediterranean Basins. In: Estuarine Transport Processes, B.Kjerfve, ed. Univ. of South Carolina Press, 269-310.

LASCARATOS,A.(1989) Interannual variations of sea level and their relation to other oceanographic parameters. Boll. di Oceanologia Teorica ed Applicata, Vol. VII,4, 317-321.

MALANOTTE-RIZZOLI,P. and A.HECHT(1988) Large scale properties of the Eastern Mediterranean Sea: A Review. Oceanologica Acta, Vol 11, No 4, 323-335.

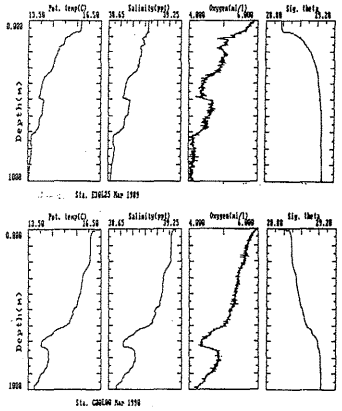
OZSOY E., A. HECHT and U.UNLUATA (1989) Circulation and hydrography of the Levantine Basin. Results of POEM coordinated experiments 1985-1986. Progress in Oceanography, Vol. 22, 125-170.

Large scale inversions in the North Levantine Basin

M.-A. LATIF , T. OGUZ , E. OZSOY and U. UNLUATA

Middle East Technical University, Institute of Marine Sciences, P.O. Box 28, 33731, Erdemli, Icel (Turkey)

Measurements carried out by R/V Bilim during 1988-1990 in the north east Levantine basin show inversions associated with large scale intrusions of anamolus water masses at depths between 500-900 m. The thickness of the intrusions is between 100 m and 200 m, and they are observed primarily in the fronts between the Rhodes cyclonic gyre and the adjacent anticyclonic eddies. The measurements were taken with a SBE-9 CTD continuous profiling system. The temperature and salinity values of the intrusions differentiate them from the well known Levantine intermediate water (LIW). Both warm and cold intrusions have been observed. The warm water intrusions have relatively higher oxygen than the ambient water; the opposite is true for the cold intrusions. Examples of a warm and a cold intrusion are shown below. At station E30L25 (N34°30 ,E29°25), the intrusion layer is located between 500 m and 700 m; its temperature and salinity are higher by 0.2°C and 0.08 ppt, than the ambient. The intrusion at station G00L30(N36°,E29°30) extends between 600 m and 750 m, and its temperature and salinity are lower by 0.3°C and 0.1 ppt than the ambient. The potential density profile shows that the intrusions are hydrostatically stable.



The temperature, salinity and the oxygen content indicate that the cold intrusions result from lateral sliding of the upwellwing water of the Rhodes gyre towards the periphery of the gyre. The sources of the warm intrusions are the two,anticyclonic gyres centered approximately at N34°E30°, and at N36°E30°30 . While the main intrusion layer is stable, Brunt Vaisla frequency plots show that the interface regions are unstable, implying a gradual mixing between the two water masses.

O-VIII5

A coupled generation-propagation model for internal tides, with an application to Gibraltar

Agostino LONGO, Maria MANZO and Stefano PIERINI

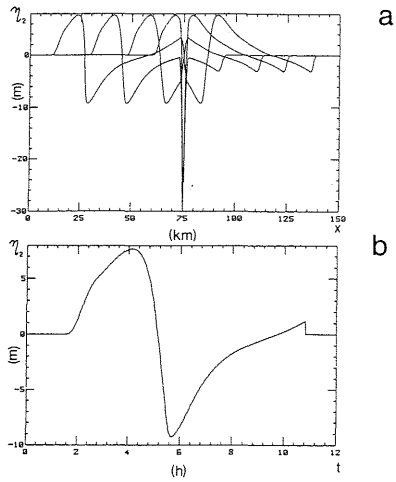
Istituto di Oceanologia, Istituto Universitario Navale, Via Acton, 38, 80133 Napoli (Italia)

The internal tides, i.e. those long internal waves generated by the interaction of a tidal current with variations in bottom topography, have been recognized in many oceanic sites, near the shelf edges and particularly in straits, were tidal currents are very strong and shallow sills are present. The propagation of such internal tides out of the straits where they are generated gives rise to dispersive internal waves and to strong one-sign current pulses accompanied by solitary isopycnal displacements. An example of this is given by the internal tides generated in the strait of Gibraltar, whose eastward propagation out of the strait leads to the solitary internal patterns observed in the Alboran sea (KINDER, 1984), that were recently described through a two dimensional, nonlinear dispersive model (PIERINI,1989).

In this propagation model the internal tide in the strait of Gibraltar was prescribed as a function of time on the basis of the knowledge of field data. A more general theoretical approach should imply the determination of the internal tide by means of a generation model, whose input is given by the mean flows and tidal currents. This problem was faced by the authors, and a one-dimensional nonlinear hydrostatic two-layer model with topography was thus developed (LONGO, MANZO and PIERINI, 1990a-b)) and applied to the region of interest.

In Fig. (a) an example of internal sémidiurnal tide at times t=3,6,9,12 hours is shown for a maximum tidal current U=0.4 m/s in the absence of mean flows and for geometrical and hydrographic values representative of the strait of Gibraltar at the Camarinal sill (centered at x=75 km). During the first half tidal cycle an internal disturbance develops near the sill. When the tide slackens and then reverses the perturbation thus generated travels away from the underwater barrier giving rise to an internal tidal cycle. The domain of integration is much longer (150 km) than the real strait, but this is required to avoid the interaction of the waves with the ends of the domain. On the other hand, a time series taken near the obstacle (within the strait) does represent the correct response. Fig. (b) shows such a time series at 10 km from the center of the sill

The signal in the example of Fig. (b) is suitable as an input for the 2D propagation model by PIERINI (1989). Therefore this is an example of how a wave generation model can be used in conjunction with a wave propagation model. The oceanographic information needed to feed this coupled model now reduces to the knowledge of the mean and tidal flows in the strait.



REFERENCES

LONGO, A., MANZO, M. and PIERINI, S., 1990a). Models for the generation of stationary internal disturbances and internal tides in straits. Ann. Ist. Univ. Navale (Napoli), in press.

LONGO, A., MANZO, M. and PIERINI, S., 1990b). A model for the generation of nonlinear internal tides in the strait of Gibraltar. In preparation.

KINDER, T. H., 1984. Net mass transport by internal waves near the strait of Gibraltar. Geophys. Res. Lett., 11, 987-990.

PIERINI, S., 1989. A model for the Alboran Sea internal solitary waves. J. Phys. Oceanogr., 19, 755-772.

O-VIII6

Fractal fronts in the Mediterranean Sea

S. MARULLO*, A. PROVENZALE**, R. SANTOLERI*** and V. ARTALE****

*Telespazio, Roma (Italia)
**Istituto di Cosmogeofisica del CNR, Torino (Italia)
***Istituto di Fisica dell'Atmosfera del CNR, Roma (Italia)
****ENEA-CRE Casaccia, Roma (Italia)

We study the fractal and statistical properties of surface temperature fronts in the Mediterranean Sea. Temperature isolines have been obtained by satellite measurements and refer to quite different climatological conditions. The principal result is that the temperature isolines display the properties of fractal curves with a fractal dimension of about 1.3. This result is consistent with other analyses of turbulent isolines and isosurfaces both in laboratory flows(1) and in geophysical flows (perimeter and surface area of clouds and rain fields(2) and perimeter of plancton patches in the sea). It is interesting to recall that drifter trajectories in large and meso-scale ocean flows display the properties of fractal curves, again with a dimension of about 1.3,(3,4,5) a fact that suggests the existence of a precise relationship between fluid parcel trajectories and temperature isolines. We briefly discuss some of the possible implications of these results and compare our findings with the results of numerical simulations.

(1) K. R. Sreenivasan, R. Ramshankar and C. Meneveau, Mixing, entrainment and fractal dimensions of surfaces in turbulent flows, *Proc. R. Soc. Lond.*, **421**, 79 (1989)

(2) S. Lovejoy and B. B. Mandelbrot, Fractal properties of rain and a fractal model, *Tellus*, **37A**, 209 (1985)

(3) A. R. Osborne, A. D. Kirwan, A. Provenzale and L. Bergamasco, Fractal drifter trajectories in the Kuroshio extension, *Tellus*, **41A**, 416 (1989)

(4) A. Provenzale, A. R. Osborne, A. D. Kirwan and L. Bergamasco, The study of fluid parcel trajectories in large scale ocean flows, in *Nonlinear Topics in Ocean Physics*, A. R. Osborne Editor, Elsevier, in press (1990)

(5) A. Provenzale, A. R. Osborne, A. D. Kirwan, Fractal trajectories in the Pacific Ocean, in preparation.

O

Theoretical determination of the fractal dimension of fluid parcel trajectories in large and meso-scale flows

A.-R. OSBORNE and R. CAPONIO

Istituto di Fisica Generale dell'Università/Istituto di Cosmo-Geofisica del C.N.R., Corso Fiume 4, 10133 Torino (Italia)

Recent work suggests that Lagrangian parcel trajectories in large and meso-scale flows can have a fractal dimension (OSBORNE, et al, 1986, 1989; PROVENZALE, et al, 1989). Drifter trajectories may be viewed as fractal curves in the plane of the ocean's surface and have typical fractal dimensions of about 1.30 ± 0.06 in a range of scales normally attributed to geostrophic turbulence. There are several fundamental questions which we address with regard to these results (OSBORNE and PROVENZALE, 1989; OSBORNE and CAPONIO, 1990a, b):

(1) One normally thinks of solutions to partial differential equations as being reasonably smooth, well-behaved differentiable functions. How can it theoretically be possible for the *dynamical* motions of particle trajectories to *physically* be fractal curves?

(2) What are the *physical implications* of fractal trajectories on fluid flows in general?

(3) What new, *unique physical information* can the fractal dimension give us with regard to large scale flows?

(4) Can the fractal dimension be of use in solving the *inverse problem*, i.e. determination of the general circulation from drifter trajectories?

(5) What relation does the fractal dimension have to fluid properties such as *anisotropic and anomalous diffusion* in fluids?

(6) What are the implications on *fractal front propagation* and on *fractal frontogenesis*?

To address these questions we discuss a simple, nonlinear Hamiltonian model for describing particle motions in large and meso-scale oceanic and atmospheric flows. The model predicts nonlinear fluid parcel trajectories in 2-D where the stream function power spectrum has the form $k^{-\gamma}$ (γ const), while the velocity spectrum is given by $k^{-\delta}$, $\delta=\gamma-3$. The equations of motion are

$$\dot{\mathbf{x}} = u_{rms}\hat{\mathbf{k}}\times\nabla\psi(\mathbf{x},t)$$

The over-dot denotes time derivative, $\mathbf{x}(t)=[x(t),y(t)]$ is the parcel position in the xy-plane, $\hat{\mathbf{k}}$ is the unit vector perpendicular to this plane, $\nabla = (\partial_x,\partial_y,\partial_z)$ and u_{rms} is the assumed rms velocity of the flow. $\psi(x,t)$ is the stream function or Hamiltonian, which is here given a stochastic representation in two dimensions. The dispersion relation is $\omega = uk$, where $k = |\mathbf{k}|$, and u is constant. Using this model as a basis we apply both analytical and numerical methods to show that fluid particle trajectories: (1) while differentiable and chaotic at small scale, may be *fractal space curves* at larger scale and (2) undergo *anomalous transport*.

We identify a "stochasticity parameter" $\mu=u/u_{rms}$ which characterizes the flow: (a) When $\mu = 0$ the Hamiltonian is time independent and exactly integrable, but the system is nevertheless fully nonlinear. For specific initial conditions $\mathbf{x}(0)=\mathbf{x}_0$, $\mathbf{x}(t)$ lies on the contour given by $\psi(\mathbf{x}_0)$=const. For $0\le\delta\le1$, $\mathbf{x}(t)$ is a fractal curve in the xy-plane with dimension $D=2/(\delta+1)$, $1\le D\le2$, and has *anomalous absolute diffusion* $\langle|\mathbf{x}(t)-\mathbf{x}(0)|^2\rangle = \mathcal{D}t^{2/D}$, for $\mathcal{D}$ the diffusion coefficient. (b) For $\mu << 1$ and finite, the flow is chaotic and of *KAM* (Kolmogorov-Arnol'd-Moser) *type*, i.e. the Hamiltonian consists of $\psi(x)$ plus a perturbation. The KAM "surfaces" are very nearly fractal contours of $\psi(x)$. $\psi(x,t)$ varies slowly in time and stochastic layers are formed. (c) For $\mu < 1$, the flow is chaotic and lies in a *trapping regime* characterized by *vortices* and *vortex hopping*. (d) When $\mu\lesssim1$, clustering occurs, and isolated clumps of activity appear, evidently the remnants of the vortices. (e) For $\mu \gtrsim 1$, the flow is *fully stochastic*, equivalent to a *nongaussian random walk* in the plane. Example trajectories are given in Figure 1.

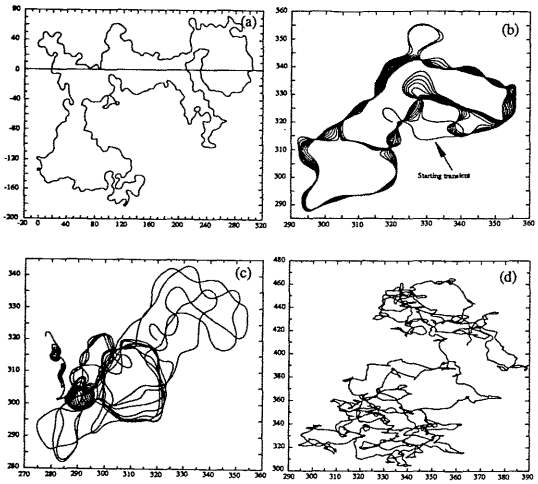


Figure 1. Particle trajectories for a velocity spectrum $k^{-0.5}$; the units are kilometers; u_{rms} = 7 km/day. (a) $\mu=0$, the motion is periodic, and the trajectory is a fractal curve with dimension D=1.33. (b) $\mu=0.0014$, the motion is of KAM type and stochastic layers form. (c) $\mu=0.014$, the motion lies in the vortex/vortex-hopping regime. (c) $\mu=1.4$, the motion is fully stochastic, a nongaussian random walk in the plane.

REFERENCES

OSBORNE, A. R., KIRWAN, JR., A. D., PROVENZALE, A. and BERGAMASCO, L., 1986 A search for chaotic behavior in large and mesoscale motions in the Pacific Ocean. Physica D 23: 75-83.

OSBORNE, A. R. and PROVENZALE, A., 1989 Finite correlation dimension for stochastic systems with power-law spectra, Physica D 35: 357-381.

OSBORNE, A. R., KIRWAN, JR., A. D., PROVENZALE, A. and BERGAMASCO, L., 1989 Fractal drifter trajectories in the Kuroshio extension, Tellus 41A: 416-435.

PROVENZALE, A., OSBORNE, A. R., KIRWAN, JR., A. D. and BERGAMASCO, L., 1990 The study of fluid parcel trajectories in large scale ocean flows. In Nonlinear Topics in Ocean Physics, A. R. Osborne ed., Elsevier, Amsterdam.

OSBORNE, A. R., and CAPONIO, R., 1990 Fractal Trajectories and Anomalous Diffusion for Chaotic Particle Motions in 2-D Turbulence, submitted for publication.

OSBORNE, A. R., and CAPONIO, R. (1990) The Transition From Chaos to Stochasticity in 2-D Turbulence, In Nonlinear and Turbulent Processes in Physics, A. G. Sitenko, V. E. Zakharov and V. M. Chernousenko eds.

Experimental Study of nonlinear internal waves in infinite or semi-infinite ocean

Dominique P. RENOUARD

Institut de Mécanique de Grenoble, 38041 Grenoble Cédex (France)

Experiments were performed on the large 14m diameter rotating platform, and showed that an important parameter for long nonlinear internal waves is the ratio of a characteristic length of the wave upon the internal Rossby radius of deformation. These experiments suggested new theoretical developments, in order to get an unified view of both linear and nonlinear waves in rotating fluid.

From the experiments, it appeared clearly that, in infinite rotating fluid, when the rotation is strong, i.e. when the Rossby radius of deformation is smaller than, or of the same order of magnitude as the characteristic wave-length, there is no solitary waves, but only dispersive waves, and the analysis shows that there is also the possibility of periodic waves, propagating faster than the critical phase-speed, and with a horizontal crest, i.e. Sverdrup waves. In infinite fluid, when the rotation is weak or very weak, i.e. when the Rossby radius of deformation is larger or much larger than the characteristic length, then there is either solitary waves solutions of the Ostrovskiy equation, or solitary waves solutions of the Korteveg-de Vries equation, respectively. Experimentally, it is easy to show that there exist solitary waves, with an horizontal crest, propagating with a celerity which is function of the amplitude, and a characteristic length inversely proportional to the square root of the amplitude, i.e. fulfilling the K.d.V. conditions. But with the wave generator that we used, we could not observe Ostrovskiy solitary waves.

In semi-infinite ocean, for all cases, we observed nonlinear Kelvin waves, propagating along the side-wall. But the shape of the wave greatly depends of the initial condition. When this condition is bi-dimensional, as in the infinite ocean, then the wave crest is curved backward, as in a channel, and that curvature is likely due to the superposition of a Kelvin solitary wave and Poincaré waves propagating at the same phase-speed. Actually, it can be shown that Poincaré waves are but superpositions of Sverdrup waves propagating in two symetrical directions. But when the initial condition is three-dimensional, and roughly correspond to a Kelvin wave, then what is observed downstream is a nonlinear Kelvin wave, with a crest perpendicular to the side, and propagating with a celerity faster than the critical phase-speed.

To our knowledge, it is the first time that such a complete set of experimental data and analytical developments is available, for long nonlinear waves in rotating fluid.

Now, if the generation mechanism is a cylindrical body moving along a vertical wall and all located in the lower layer, if the lower layer is thinner than the upper layer, then the body generates nonlinear Kelvin waves which propagate downstream in front of the body, as in a channel, and their crest is curved backward. The amplitude and number of waves observed at a given place downstream the body, is function of the distance between the body and the wall, as well as of the diameter of the body. If the lower layer is thicker than the upper layer, then there is no wave generation, but only an upwelling generation, and the front of this upwelling moves at the critical phase speed. This models the upwelling and waves generated by an island located near a coast. Some experiments were also realized with a cape, and gave similar results.

O-VIII9

Double diffusive activities in the Cretan Sea during late Summer 1987

G. ZODIATIS

National Centre for Marine Research, Aghios Kosmas, 166 04, Athens (Greece)

The profiles of the hydrological characteristics (T,S) finestructure are examined in the Cretan Sea during the POEM-5 cruise, September - October 1987. CTD (SBE-9) data from 20 stations (Fig.1) averaged to 1 data per second of the original data which sampled at 33 Hz with a lowering speed of about 0.75 m/sec. The data interpolated with 1 dbar spacing and then are used for different finestructure analyses.

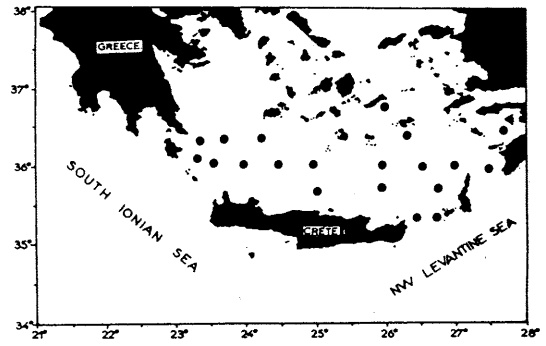


Fig.1 The study area showing the location of the hydrographic stations during the POEM-5 cruise.

One of the mechanisms that can generate the finestructure of the T-S characteristics is the double diffusive convection (Fedorov 1978, Karlin 1988 et al.). Generally is considered that the double diffusion and especially the salt fingering is an important process for the vertical transportation of heat and salt in the water column resulted by the different values of α and β coefficients (Turner 1985).

To find the nature and the strength of double diffusive activities, in the Cretan Sea, the parameter of Turner angle (Tu) is computed at depths between 100-500 dbars.

The observed profiles structure, at the majority of the examined depth interval, indicate that salt fingering process might be occured. The hydrological conditions of the water at the above water columns are warm and saline water overlying colder less saline water, characterizired as LIW of Cretan Sea. Turner angle profiles verify the prevalence of the salt fingering regim.

The stability regimes of double - diffusion (salt fingering, diffusive, stable, unstable), for all stations in the investigated area, are illustrated in the Turner angle (Tu) histogram (Fig.2). The stipped areas indicate the salt fingering and diffusive layering portions. The maximum Tu volume of 58% corresponding to the salt fingering while only 11% for the diffusive convection.

The above vertical distribution of Tu shows the predominance role of salt fingering process in the formation of the finestructure of Cretan water at intermediate depths.

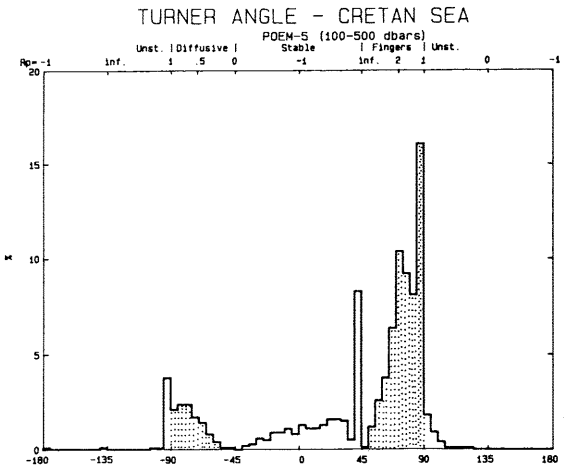


Fig.2 Turner angle histogram with the stability regimes of double - diffusion for all stations in the Cretan Sea, late summer 1987.

REFERENCES

Fedorov K.N., 1978. The Thermohaline Finestructure of the Ocean, Pergamon Press Marine Series vol.2.

Karlin L.N., Kloukov E.Y., Koutko V.P., 1988. Finestructure of the Hydrophysical Characteristics at the Upper Layer of Ocean, Hydrometeoizdat.

Turner J.S., Convection in Multicomponent Systems, Natur Wissenschaften, 72, N.2, 70-75pp.

O-IX1

Atmospheric Long Range Transport of pollutants to the North Western Mediterranean

Marta ALARCON*, Antonio CRUZADO* and Sergio ALONSO**

*Centre d'Estudis Avançats de Blanes, Blanes (Spain)

**Department of Physics, Group of Geophysical Fluid Dynamics, Balears Islands University (Spain)

Large quantities of substances of natural or anthropogenic origin enter the marine environment through the atmosphere, from both coastal and distant sources. This is especially true for semienclosed seas such as the Mediterranean Sea. Preliminary estimations of the fluxes of substances such as Hg, Cd, Pb and Cr, confirm that the atmospheric transport for these substances is, at least, comparable in magnitude to the riverine inputs (MED POL, 1989).

In a recent study (Alarcon and Cruzado, 1990) the nutrient fluxes (nitrate, nitrite, ammonia, phosphate and silicate) indicate that the deposition amounts are of the same order of magnitude to that of the vertical diffusive fluxes from deep waters into the photic zone. Therefore the atmosphere could be an important source of nutrients for the marine productivity, mainly in oligotrophic waters, as is the greatest part of the Mediterranean Sea.

The meteorology of the Mediterranean region is particularly variable both spatially and temporally, and this variability is due, partly, to the hilly orography. The topography behind the coastline around all the Mediterranean is complex. This can interact with the long range atmospheric flux inside the boundary layer influencing the horizontal transport and the vertical mixing of the substances by complex mechanisms.

At first, the knowledge of the deposition processes of the aerosol particles, combined with transport models should allow an evaluation of the net transfer rate from air to sea of particulate matter.

Computation of air parcel trajectories is a very powerful tool to estimate the long-range transport of substances. In this study we have computerized an isentropic method due to Petersen and Uccellini (1979) to simulate long- distance transport of substances.

The isentropic approximation reduces a tridimensional trajectory computation to a bidimensional problem. The air parcel moves above isentropic surfaces. Although only the horizontal components of the wind are used, the vertical velocity of the particle is not ignored. It is implicitly taken into account through the contour and the temporal variation of the isentropic surface.

Trajectories are computed applying an explicit system of equation based in the theory of the "discrete model" developed by Greenspan (1972), to the atmospheric equations of the movement. Trajectories are constructed in an isentropic framework, from the movement equations, where the pressure fields are represen- ted by the Montgomerystream fuction, CpT+gz.

The model calculates parcel positions in time steps of 900 s. A trajectory segment is integrated by 48 time steps. Acceleration is computed from the gradient of the Montgomery streamfunction, and then velocity and position are interpolated for the next time step. The process is repeted for the succesive time steps to complete a 12 hours trajectory segment.

The stability of this process is discussed by Petersen and Uccellini (1979), and conclude that this explicit method is stable for time increments between 300 and 1800 s.

REFERENCES

Alarcon,M and Cruzado,A; (1990): Nutrient inputs into the North-Western Mediterranean Sea. EROS 2000, second workshop, Blanes.

Greenspan,D; (1972): A new discrete mechanics with applications. J. Franklin Ins., 294, 231-240.

MED POL; (1989): Airborne pollution of the Mediterranean Sea. MAP Technical Reports Series No.31.

Petersen,R and Uccellini,LW; (1979): The computation of isentropic atmosferic trajectories using a 'discrete model' formulation. Mon. Weather Rev., 107,566-574.

Les apports d'eau douce en mer de Monaco

M. BOISSON*, L. PRIEUR** et J.-L. RAPAIRE*

*Centre Scientifique de Monaco (Monaco)
**Laboratoire de Physique et Chimie Marines, Villefranche-sur-Mer (France)

L'hydrologie côtière est, devant Monaco, en grande partie régie par le courant Ligure. Les eaux superficielles sont poussées vers la côte par ce courant. L'eau douce, principal vecteur des polluants, se mélange avec ces eaux de surface et est ainsi maintenue près des côtes (ASTRALDI M.et all.1988). Déja GOSTAN (1967) signalait une corrélation entre les variations du débit des fleuves voisins de Monaco et les changements de salinité de surface. BONG (1983) attribue l'observation d'une dessalure devant Nice au passage des eaux de l'Arno dont l'embouchure est à plus de 100 km. Nous nous proposons, en comparant les variations de débit de la Roya aux changements de salinité dans la baie, de déterminer le temps de transit et la zone d'extension de l'eau apportée par la Roya en baie de Monaco.

La salinité a été mesurée au cours de deux périodes. La première de 1976 à 1978 où la salinité de surface a été mesurée toutes les semaines dans la baie à 27 stations réparties suivant un quadrillage régulier et au large, à une station située à 6,5 milles servant de témoin. La deuxième entre 1978 et 1983 où la salinité de la colonne d'eau a été mesurée bimensuellement aux immersions standard, à trois des 27 stations précédentes et au témoin jusqu'au bas de la couche euphotique. Le débit de la Roya a été relevé quotidiennement à Breil/Roya. Ce débit est significativement corrélé à la pluviométrie du bassin Ligure.

Résultats: L'apport d'eau douce à l'eau de mer de la baie a été estimé en comparant les salinités de surface à celle du témoin. En moyenne il peut être représenté par une lame virtuelle d'eau douce, non mélangée à l'eau sous-jacente, d'épaisseur e1= 11mm pendant la première période. Durant la deuxième période cette lame est deux fois moins épaisse d'où un rapport e1/e2= 2, alors que celui du débit de la Roya pour ces deux mêmes périodes est R1/R2 = 1,6.

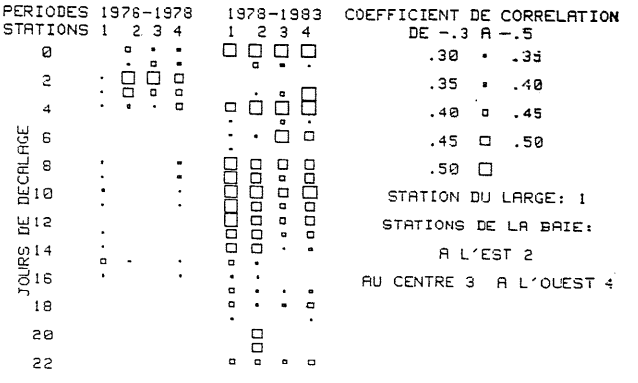
Le débit de la Roya et les salinités sont corrélés. Le maximum de corrélation s'obtient en décalant le débit de la Roya de deux jours pendant la première période et de quatre jours pendant la deuxième période (tableau). Pour cette dernière période les corrélations et les pentes des droites de régression sont systématiquement plus élevées. Les différences de pente sont significatives et plus importantes au large qu'à la côte.

Le débit d'eau douce passant devant Monaco est proportionnel à celui de la Roya et est égal à "e.b.v" avec e épaisseur de la lame d'eau douce, b la largeur de la bande de propagation de l'eau douce vers le large, v la vitesse du courant. Si R est le débit de la Roya, T le temps de transit entre la Roya et la baie de Monaco, ε le temps de parcours entre le point de mesure du débit de la Roya et son embouchure, on constate, en comparant les deux périodes auxquelles on affecte respectivement les indices 1 et 2:

(e1b1v1)/(e2b2v2) = R1/R2 et v1/v2 = (T1+ΔT)/T1 avec T2-T1 =ΔT
selon les observations e1/e2 = 2, R1/R2 = 1,6 Δ T = 2 jours
Si ε =0 et T1=2 on a:
b1/b2 = 1/2, T2 = 4 jours, v1= 9,2 cm/s et v2 = 4,6 cm/s.

D'une manière plus réaliste, avec ε = 1 on trouve T1 = 1 jour, T2 = 3 jours, b1/b2 = 1/3,75 v1= 18,5 cm/s et v2 = 6,17 cm/s. v2 est ainsi à 3% près la vitesse de la composante parallèle au rivage du courant mesuré à -20 mètres sur le plateau continental de Monaco (ASTRALDI M. et all. 1988).

En admettant un temps de parcours ε de l'ordre d'un jour, il apparaît que pendant la deuxième période les eaux douces se sont étalées environ quatre fois plus vers le large que pendant la première période (b1/b2 = 3,75) alors que pendant la première période le débit de la rivière était 60% plus fort, et la vitesse du courant trois fois plus grande. Or cette deuxième période se caractérise par une sécheresse (BETHOUX N. et all 1983) qui conduit à un flux plus faible du courant Ligure (PRIEUR L. et all. 1983). On conclut, en admettant que la sècheresse soit une conséquence de conditions météorologiques clémentes, que l'eau douce déversée à la côte se détecte d'autant plus loin et d'autant plus longtemps que l'on se trouve en période de beau temps.



BIBLIOGRAPHIE
ASTRALDI M - BOISSON M - GASPARINI GP - RAPAIRE JL - 1988. La dynamique des courants devant Monaco. Rapp. Comm. Int. Mer Médit. 31,2 p.198
PRIEUR L - BETHOUX JP - BONG JH - TAILLEZ D -1983. Particularités hydrologiques et formation d'eau profonde dans le bassin Liguro-Provençal. Rapp. Comm. Int. Mer Médit. 28,2 p. 51-53.
BETHOUX N - BOISSON M - RAPAIRE JL - VAISSIERE R - 1983. Anomalies de salinité observées en 1981-1982 dans la baie de Monaco. Rapp. Comm. Int. Mer Médit. 28,2 p. 163-168.
BONG JH - 1983. Contribution à l'étude du courant Ligure et de sa variabilité spatio-temporelle à moyennes échelles. Thèse 3ème cycle Univ. Paris VI 83 p.
GOSTAN - 1967. Remarques sur les minimums de salinités observés dans les eaux littorales du golfe de Gênes. Cah. Océanogr. COEC. 19, 6 ; pp. 469-476

Radiation Measurements in the Tyrrhenian Sea during TEMPO

E. BOHM*, R.-M. LEONARDI**, S. MARULLO*, R. SANTOLERI** and M.-E. SCHIANO**

*Telespazio, Earth Observation Division, Via Tiburtina 965, 00165 Roma (Italy)
**Istituto di Fisica dell'Atmosfera, CNR, P. le Sturzo 31, 00144 Roma (Italy)

Measurements of the various components of the radiation budget were made from the R/V Minerva of the Italian National Research Council (CNR) in the North Tyrrhenian Sea , during the 1989 Tyrrhenian Eddy Multi-Platform Observations (TEMPO) experiment (September 26 - October 9, 1989).

The two main objectives of TEMPO were the investigation of the structure of the North Tyrrhenian Sea and intercalibration and validation of measurements from different sources (satellite, aircraft and ship) in order to study the upper ocean response to the atmospheric forcing in the vicinity of eddies and fronts.

Budget measurements were aimed at quantifying both air-sea radiative exchanges, as one of the possible forcing of dynamic of the basin, and to study the effect of a sea surface temperature (SST) front on the terms of radiative budget.

The short- and long-wave irradiances were directly measured by two piranometers and two pyrgeometers, respectively. The instruments were gimbal mounted on the upper bridge of the ship. Two instruments were used for each measured component, in order to avoid the shadows of ship superstructure and provide redundant information for quality control purposes. The long-wave exitance was calculated from sea surface temperature measured by radiometer, mounted on a boom over the bow of N/O Minerva. All the data were sampled at 1 Hz quality controlled and averaged over 1 minute time intervals.

The short-wave upwelling radiance and albedo were calculated from smoothed observations of Payne (1972) relating albedo to solar zenith angle and short-wave trasmittance.

Each component of the balance was analyzed to examine its behavior across the SST front associated with the Tyrrhenian Eddy. The presence of the eddy has been evidenced by means of the SST radiometer measurements and confirmed either by the satellite images or by the hydrographic data obtained during the cruise. The difference of temperature between the eddy and the surrounding waters results approximately 2.5°C. A strong correlation between the upwelling and downwelling long-wave radiation was observed in the vicinity of the front revealing a correspondence between atmospheric and marine structure across the Tyrrhenian front.

The daily mean short-wave irradiance ranges from 150 to 220 Wm^{-2} while the daily long-wave irradiance ranges from 420 to 470 Wm^{-2} and therefore its contribution to the net budget is more relevant. The daily value of the upwelling infrared radiance is rather constant over the entire period (420 Wm^{-2}).

The net radiation budget was computed from our data. The daily mean value ranges from to 180 to 300 Wm^{-2} and is modulated by the behaviour of the visible downwelling radiation. The nocturnal budget shows a negative trend from 50 to approximately 0 Wm^{-2} in agreement with the transition to colder weather conditions typical of this period of the year.

Several empirical models exist in literature to evaluate the short and long wave irradiance from weather measurements, these models are tested only for open ocean, while their possible use for a close basin, like the Mediterranean Sea, is to be verified. Therefore, empirical formulae for calculating short-wave radiative flux were compared with measurements. A formula by Lamb (1964) for determining the incident solar flux given solar altitude, cloud amount and cloud type, agrees with our measurements within 10%. Similar results were obtained comparing our data with the empirical formulae of Reed (1977).

Comparison between long wave irradiance and empirical formulae is planned in order to test the different models for the Mediterranean Sea case.

REFERENCES

LUMB, F.E., The influence of cloud on hourly amounts of total solar radiation at sea surface, Quart. J. R. Met. Soc., 90, 43-56, 1964
PAYNE, R.E., Albedo of sea surface, J. Atmos. Sci., 29, 959-970, 1972
REED, R.K., On estimating insolation over the ocean, J. Phys. Oceanogr., 7, 482-485, 1977

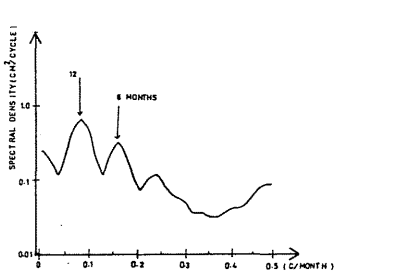
O-IX4

The surge variability and its relation to meteorological conditions at Alexandria (Egypt)

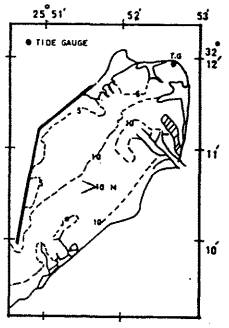
A.-A. H. EL-GINDY* , Sharaf S.-H. EL-DIN** and Z. MOURSY***

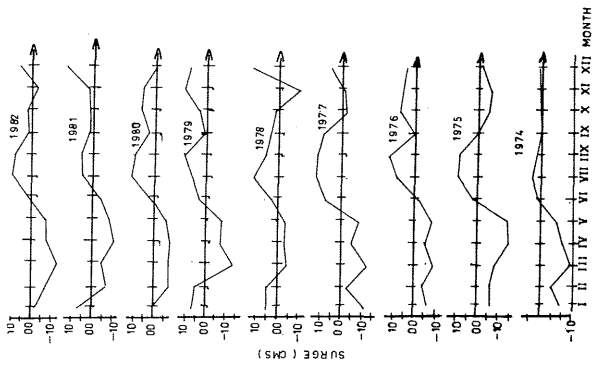
*Qatar University, Marine Science Department (Qatar)
**Alexandria University, Faculty of Science, Oceanography Department, Alexandria (Egypt)
***Institute of Fisheries and Hydrography, Anfoushy, Alexandria (Egypt)

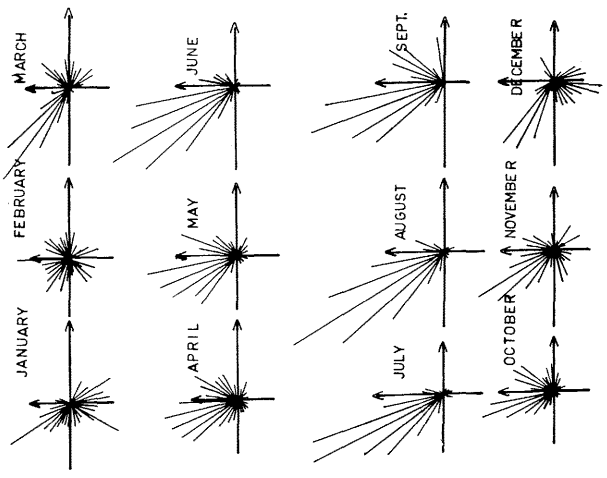
This work presents the general meteorological conditions affecting the surge height at Alexandria.Different time scales are discussed and investigated on the basis of previous studies as well as on analysis of sea level and meteorological data in the Western Harbour.The mechanisms of surge generation in Summer and Winter storms are discussed .The monthly mean surge time series are characterized by one year cycle with high surge in Summer and low surge in Winter, this evidence was explained by the atmospheric pressure gradient in Summer as well as persistent wave action by NW winds.The daily mean surge for a year record showed decreasing spectral denisty from low to high frequency range with no peaks in the range of 2 to 72 days period. The conditions of occurence of strong and moderate storm surge conditions are explained.
Some strong surge events which happens when a deep Cyclone center passes nearby the Egyptian Coastal Zone,with strong W or SW winds are described, and the number of stormy days in Decmber, January, February and March are tabulated for the period (1974-1983) , to show the probability of occurence of storm during winter season at Alexandria.



Spectral denesity of monthly mean surge in the Western Harbour of Alexandria (1974-1983) with 120 data pionts and 30 lags.







O-IX5

On the radiative Components of the heat Budget over the Sea

Giuseppe FLOCCHINI

Dister, Sezione Geofisica, Università di Genova (Italia)

The knowledge of the radiative budget over the sea is very important because it contributes towards the heat surface budget more than other fluxes.Moreover,the knowledge of its components is very important not only for the understanding of many meteorological and oceanographical problems but also because it supplies to biologists and oecologists useful informations for the analysis of the ecosystems.

The sea surface receives the solar and atmospheric radiations from above which are partly absorbed and partly reflected;simultaneously the sea losses heat as long-wave radiation and with convective exchanges ,evaporation and other mechanisms of smaller importance.Direct measurements of radiative fluxes over the sea surface are relatively few because of the difficulties of these measurements.Generally the radiative fluxes over the sea regions are estimated on seasonal or monthly scales by empirical formulas which use as "imputs" the meteorological parameters that are more easily measurable.Up to new,the direct measurements of the radiative fluxes were made only in Pacific and Atlantic areas and in some coastal regions in order to determine the surface heat budget over the sea.

The present work reports the measurements of the radiative fluxes made during the oceanographic cruise of the Minerva ship in Sardinian and Tyrrhenian seas on second half of August 1987.The measurements were made with stationary ship and on the 2000 m bathimetric.The downward ($\downarrow$) and upward ($\uparrow$) radiation fluxes were measured continuously by means of Moll-Gorczynski thermopiles which were linked to an electronic recorder ;the sensors for the incident radiation were installed on the quarter-deck and those for the fluxes coming from the bottom on the end of a boom 6m long and about 3 m above the sea surface.A cardan system has been used in order to keep the apparatus horizontal on average during the pitch and the rolling of the ship.The sensors receiving the short-wave (0.29-2.8 μ) radiation were covered by means of semispherical quartz domes while the surface of the elements for the long-wave (0.29-60 μ) radiation was covered by a moulded polyetilene dome.The calibration of the solarimeters was made before and after the cruise ;the constants deduced from the two calibrations differed by only about 1% . The maximum mistake which may concern the short-wave fluxes,G,is smaller than 5% with low solar heights and only 1.5% during the central hours of the day while the mistake for the long-wave radiations ,L,can be 10% ; this high value is consistent with those generally attributed in literature to measurements of this type.The long-wave radiation in presence of global radiation was determined as difference between the values obtained by thermopiles covered with lupolene and quartz respectively;therefore in the daytime the portion attributable to the long-wave radiation was obtained with these semidirect measurements.The amount of radiation penetrating the sea was obtained by subtracting the reflection loss from the global incoming radiation.All the fluxes are given in W/m^2 and they were considered as positive if downward and negative in opposite way.At the beginning of every hour were measured also the meteorological parameters (atmospheric pressure , air and sea surface temperature,wet-bulb temperature,wind,overcast) in order to determine the surface heat budget.

The surface radiative budget,Q_R ,can be expressed by the following relation :

$$Q_R = G\downarrow + G\uparrow + L\downarrow + L\uparrow$$

where : $G\downarrow$ and $G\uparrow$ are the incident and reflected solar radiation respectively ,$L\downarrow$ is the long-wave atmospheric radiation and $L\uparrow$the long-wave radiation of the sea plus the atmospheric radiation reflected by the sea itself.

The hourly values of $G\downarrow$varied between 417.4 W/m^2 (August 20th) and 279.7 W/m^2 (August 27th).The difference is mainly the result of a different amount of clouds;during the 20th August the sky was completely clear while on 27th day at morning the sky was almost completely covered by low and middle-level clouds . The $G\uparrow$ mean hourly values varied between 28.7 W/m^2 and 18.1 W/m^2 .In average, the mean hourly values of $G\downarrow$were 383.1 W/m^2 and those of $G\uparrow$25.7 W/m^2.The variations of the global incident mean hourly fluxes were more marked than those of the global reflected solar radiation as showed by the values of the standard dev.. Therefore a great amount (about 94 %) of the solar radiation penetrating the sea increases the water temperature and therefore the long-wave flux outgoing the sea surface.The atmospheric radiation was always smaller,expecially with clear sky,than the long-wave coming from the sea;the first component varied between 345.8 W/m^2 and 354.8 W/m^2 while the $L\uparrow$ values were between 413.8 W/m^2 and and 429.1 W/m^2 ;on average during the whole period the values of the incident and outgoing long-wave fluxes were 351.3 W/m^2 and 421.0 W/m^2 respectively;the upward flux was more unchangeable.The measured values of the atmospheric radiation are in reasonable agreement with those estimated from the formula proposed by BRUTSAERT.Measurements of atmospheric radiation made to West of Sardinia by means of Meteosat at 12h GMT April 29th have given a value of 320 W/m^2.

During the measurement period the average short-wave radiation balance,Q_S,was 357,4 W/m^2 while the long-wave balance,Q_l,was negative (-69.7 W/m^2) ;so the average Q_R value was positive and equal to 287.7 W/m^2. These values emphasize the primary importance which the radiative components have in determining the heat balance of the sea surface in August in the central Sardinian and Tyrrhenian seas.Moreover,their knowledge is useful in calibrating the satellite systems.

O

Estimation of the vertical eddy diffusion coefficient of heat in the Gulf of Trieste (Northern Adriatic)

Vlado MALACIC

Marine Biological Station Piran, Institute of Biology, University of Ljubljana, JLA 65, 66330 Piran, Slovenia (Yugoslavia)

Vertical eddy diffusion coefficient of heat (VEDCH) has been computed from a least squares trigonometric fit of temperatures at four levels of the water column from January 1986 to September 1989. This coefficient is supposed to be in the form of a constant and a time and depth function. In climatological time scales, the constant coefficient is sufficient for the description of the annual temperature changes in the lower part of the water column. For the upper part of the column, the possible range of values of the coefficient for the shallow Gulf of Trieste were estimated.

The solution of the diffusion equation of heat can be proposed, where the only source term of heat is due to irradiance absorption varying through the year, and where the VEDCH is supposed to be dependent on the vertical gradient of temperature, annual surface irradiance, and on the absorption coefficient estimated from the Secchi disc measurements. The temperature measurements done for several years at the fixed station, one mile from the coast at the entrance of the Gulf of Trieste were then fitted with the form of the solution of the diffusion equation, where the trigonometric time dependency was assumed (Fig. 1). Annual variation of VEDCH was estimated from annual irradiance cycle, from measurements of Secchi disc depth and from phase shift changes with depth of trigonometric fits of temperature measurements. The method was in principle already discussed by Fjeldstad (1933). This can also be the base for other estimations of vertical turbulent diffusion parameters, like the coefficient of turbulent diffusion of nutrients.

VEDCH at the entrance of the Gulf of Trieste has values from $1.7 - 2.5 * 10^{-4}$ m^2/s, the variations being naturally the greatest at the surface. VEDCH for the upper part of the water column reaches its minimum in the summer, when a strong temperature stratification is present. In the lower part of the water column,

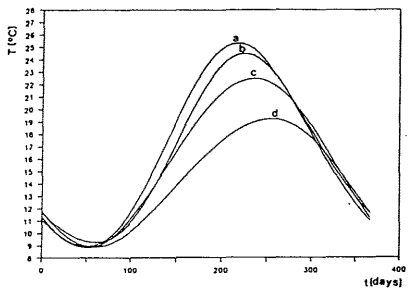


Figure 1

Trigonometric fits of temperatures taken from four depths at the station F(45°32.33'N, 13°33.10'E) at the entrance of the gulf of Triestefrom January 1986 to September 1989 for: a) 0 m, b) 5 m, c) 10 m, d) 21 m depths (bottom).

the annual variations of VEDCH are almost negligible and VEDCH has bigger values from those at the surface, about $2.5 * 10^{-4}$ m^2/s.

The above result was obtained from a simple one-dimensional diffusion model of heat, by using a hypothetical solution for temperature and a hypothetical form of VEDCH, which was depended only on the temperature stratification for simplicity. The solution has been adapted to the least squares fits trigonometric solutions of temperature at the four depths. The effect of salinity stratification at the surface (Stravisi, 1983), which reduces the VEDCH at the surface during the season, and the surface fluxes of heat and advection (Stravisi and Crisciani, 1986) still remains to be considered and was discussed in Malačič (1990).

References

FJELSTAD J., 1933. Wärmeleitung im Meere. Geophysiske Publikasjoner, v.10, no.7, 20pp. Oslo.
STRAVISI F., 1983. The vertical structure annual cycle of the mass field parameters in the Gulf of Trieste, Boll. Ocean. Teor. e Appl., 1 (3), 239-250.
STRAVISI F., Crisciani F., 1986. Estimation of surface heat and buoyancy fluxes in the Gulf of Trieste by means of bulk formulas, Boll. di Oceanol. Teor. ed Appl., 4 (1), 55-61.
MALAČIČ V., 1990. Estimation of the vertical eddy diffusion coefficient of heat in the Gulf of Trieste (Northern Adriatic), Oceanol. Acta (submitted).

Résultats préliminaires sur l'utilisation des paramètres météorologiques standard au pronostic de la structure thermique de la couche superficielle de la mer

Adriana POPA

Laboratoire de Géologie Marine et Sédimentologie - Constanta (Romania)

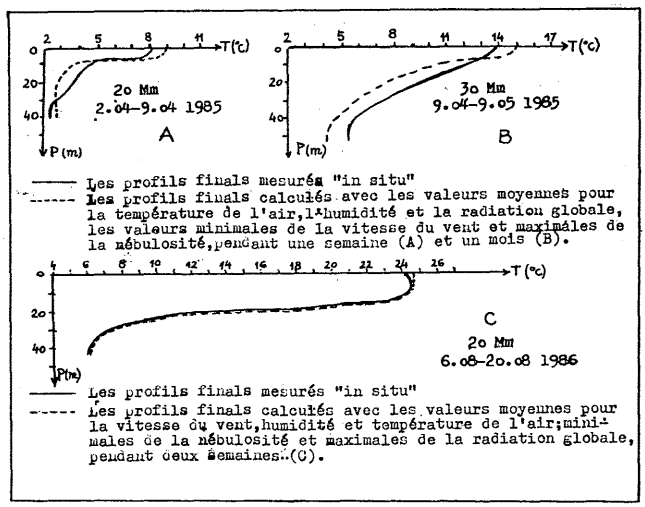
Le travail présente les résultats obtenus par l'application d'un modèle unidimensionnel du type "plaque" (1) à la simulation de la structure thermique de la couche superficielle de la mer. Dans ce modèle, l'évolution de la température de la couche mélangée - considérée comme une plaque avec la température et la vitesse constantes, au-dessus d'une couche en repos - est l'effet de deux mécanismes antagoniques: le premier - la formation d'une stratification stable comme densité à la suite de l'absorbtion de la radiation solaire en eau, et le second - le mélange vertical dû au "shear" généré par la tension tangentielle du vent. Le critère du mélange est considéré le numéro Froude de la plaque, c'est-à-dire le rapport entre l'énergie cinétique disponible pour le mélange et l'énergie potentielle de la stratification de densité. Le modèle néglige les processus de diffusion et d'advection, en considérant seulement l'échange local vertical d'énergie thermique et cinétique. Grâce aux conditions spécifiques du plateau continental roumain, on a inclus dans le calcul des variations de densité un terme propre aux variations de salinité, calculées selon la tendance et l'oscillation annuelle de la salinité à chaque profondeur, ainsi qu'elles résultant de l'analyse statistiques des rangs de valeurs mesurées pendant les campagnes hydrologiques. Les données d'entrée dans le modèle furent les profiles réels de température et de salinité, mesurés au point voulu, au moment temporel considéré comme initial, ainsi que la vitesse et la direction du courant dans la couche superficielle.

Pour le calcul des composantes du bilan thermique (2) à l'interface air-eau, au lieu des valeurs "in-situ" des paramètres météorologiques on a utilisé les valeurs mesurées à la station Constanța côte, pour la vitesse du vent et la température de l'eau appliquant les corrections résultées de la corrélation statistique de certaines séries de mensurations simultanées, à la côte et au large, de ces deux paramètres.

Les résultats du roulement du modèle (programmé en langage FORTRAN) pour une période de 12 ans, avec le pas du temps de 6 heures et le pas de profondeur de 1 m, dans un point situé à 30 Mm Est Constanța, ont été rapportés aux profils réels de température et salinité mesurés pendant les campagnes hydrologiques dans ce point-là. La concordance des profils mesurés et calculés est bonne pour la couche supérieure avec une épaisseur d'environ 10 m (écarts au-dessous de 2°C) et moins bonne aux profondeurs plus grandes. Pour les périodes de temps plus courtes (de quelques semaines jusqu'à un mois), la concordance est bonne sur tout le profil.

Afin d'utiliser le modèle en régime de pronostic, il faut le coupler à un modèle similaire de pronostic des paramètres météorologiques de durée moyenne ou longue. En absence d'un tel modèle, on a tenté d'éluder la nécessité d'utilisation des valeurs mesurées "in situ" de ces paramètres, en optimalisant les rangs longs des valeurs mesurées à la côte, à l'aide du calculateur. Dans ce but, on a analysé séparément l'influence de chaque paramètre météorologique (vent, température de l'air, humidité, nébulosité, radiation globale)sur chacune des composantes du bilan thermique prise à part (chaleur sensible, d'évaporation et effective), ainsi que sur la quantité totale de chaleur échangée entre l'air et l'eau par la surface de séparation.

Etant donné qu'en dehors de la radiation reflétée aucune autre composante du bilan thermique ne dépend linéairement des paramètres météorologiques, et que les fonctions de dépendance sont complexes et rendent difficile l'optimalisation analytique des équations de chaque composante, on a testé diverses variantes d'entrée des paramètres météorologiques,



calculant les profils de température pour chaque variante et les comparant à ceux mesurés à divers intervalles de temps: une semaine, deux semaines et un mois, en deux points situés à une distance de 20 et respectivement 30 Mm de la côte. On a dressé environ 70 variantes pour chacun des deux points, en combinant les valeurs minimales, moyennes et maximales des paramètres météorologiques analysés par statistique pour chaque jour et chaque heure de l'intervalle du temps pronostiqué, comparativement à la variante des valeurs mesurées de ces paramètres sur la côte. La comparaison des profils de température indique qu'au printemps on peut utiliser, pour le pronostic d'une semaine, une variante qui se sert des valeurs moyennes des longs rangs de données mesurées sur la côte pour la température de l'air, l'humidité et la radiation globale, des valeurs minimales de la vitesse du vent et des valeurs maximales de la nébulosité (l'écart maximal de la température calculée par rapport a celle mesurée sur tout le profil a été de 0,85°C). En été, une variante formée des valeurs moyennes de la vitesse du vent, de l'humidité et de la température de l'air, auxquelles s'ajoute les valeurs minimales de la nébulosité et celles maximales de la radiation globale, conduit à la reproduction fidèle du profile de température, qui, deux semaines après, a un écart de moins de 0,3°C par rapport à celui mesuré.

Références bibliographiques

1. THOMPSON R.O.R.Y., 1976 - Climatological numerical models of the surface mixed layer of the ocean. J.Phys.Oceanogr., vol. 6, nr. 4.
2. FRIEHE C.A., SCHMITT K.T., 1976 - Parametrization of air-sea interface fluxes of sensible heat by bulk aerodynamic formulas. J.Phys.Oceanogr., vol. 6, nr. 6.

O-IX8

Computation of the Surface Heat Flux by means of bulk formulas in El-Max Bay, Alexandria (Egypt)

M.-A. SAID

National Institute of Oceanography & Fisheries, Kayet Bey, Alexandria (Egypt)

El-Mex Bay, west of Alexandria, extends for about 15 km and has a mean depth of 10m. It's surface area is of about 19.4 km^2 and its volume 190.3 x 10^6 m^3. It receives a heavy load of wastewater (2.4 x 10^9 m^3 / year) both directly from industrial outfalls or indirectly from Lake Maryut via El-Mex Pumping Station.

Throughout the period from January to December 1988, 12 trips were carried out in El-Mex Bay area using a motor boat. Temperature and salinity were measured at discrete depths from seven hydrographic stations. In particular, monthly data were there given as function of depth describing the mass field characteristics of the water column through a year of 1988. The monthly mean climatological data from Ras El-Tin Meteorological Station at Alexandria for the 15 years (1970-1984) have been used for the computations of the heat flux.

The total upward heat flux Q from the sea surface consists of the upward flux of long wave radiation Q_l, latent heat flux Q_e and the sensible heat flux Q_c less the absorbed global irradiation Q_s :

$$Q = Q_l + Q_e + Q_c - Q_s \qquad (1)$$

Formulas for computation of Q_l, Q_e and Q_c are taken from Stravisi and Crisciani (1986) which are given according to Gill (1982). A detailed discussion of the formulas is presented in Stravisi and Crisciani (1986). Rate of absorption of global solar irradiation Q_s is given by

$$Q_s = (1 - A_n) Q_n$$

where A_n is the sea surface albedo and can be calculated from tables (Kolesnikov, 1970). Q_n is the global solar irradiance calculated at the sea level using Timofeev's equations (1970). The heat flux (1) released from the sea surface is the difference $Q = Q_b - Q_\theta$ between an input flux Q_b through the other boundaries, mainly due to advection, and

$$Q_\theta = C_w \rho h \frac{\partial \theta}{\partial t}$$

representing the rate of heat storage in the sea, in a vertical water column of depth h and unit horizontal surface; θ is the vertical mean seawater temperature, C_w = 3.98 x 10^3 JKg^{-1} K^{-1} is the average seawater specific heat at constant pressure. The boundary heat flux Q_b in a basin can be computed once Q and Q_θ have been evaluated.

The monthly mean values of the computed heat flux are listed in table 1.

Table (1). Monthly and annual surface heat fluxes (Watts / m^2) from El-Mex Bay.

	January	February	March	April	May	June	July	August	September	October	November	December	Year
Q_l	76.15	79.55	82.97	83.34	79.18	72.86	66.24	64.42	66.95	69.12	71.64	73.79	73.83
Q_e	96.05	100.58	108.58	109.48	115.91	130.42	148.67	152.17	149.93	119.43	103.45	103.27	119.83
Q_c	18.20	10.90	-0.84	-7.70	-9.46	-9.03	-7.28	-4.40	00.00	3.55	7.91	16.93	1.58
Q_s	109.81	158.21	223.82	290.67	315.68	368.29	355.87	318.55	255.03	186.90	132.28	103.56	234.87
A_n	0.080	0.073	0.066	0.061	0.062	0.054	0.054	0.054	0.060	0.068	0.077	0.082	0.066
Q_n	101.02	146.66	209.05	272.94	293.92	348.40	336.65	301.35	239.73	174.19	122.09	95.07	220.26
Q	89.38	44.37	-18.14	-87.82	-110.29	-154.15	-129.02	-89.16	-22.85	17.91	60.91	98.92	-25.00
Q_θ	-18.00	14.98	15.04	24.97	61.66	56.10	21.20	-15.36	-28.40	-21.40	-52.11	-59.28	00.00
Q_b	71.38	59.35	-2.50	-62.85	-48.63	-98.05	-107.82	-104.52	-51.25	-3.49	8.80	39.64	-25.00

For a better comprehension of the "heat sink" character of El-Mex Bay, the flux Q_θ of heat stored in the Bay has been computed, using a mean depth h = 10m, together with the heat Q_b advected from the Bay (Fig.1). The heat storage values vary from -59.28 in December to 61.66 W m^{-2} in May. The flux Q_b is negative during the period from March to October with an average of -59.89 W m^{-2}. From November to February, it varies between 8.80 and 71.38 W m^{-2}.

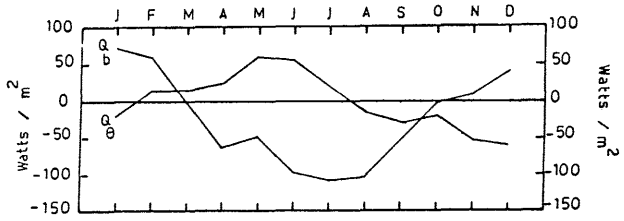


Fig.1. Annual cycle of the heat storage Q_θ and the advected heat flux Q_b in El-Mex Bay.

References

Gill, A.E.1982. Atmospheric-Ocean dynamics. Acad. Press, New York,662p

Kolesnikov, A.Q.(ed).1970. Atlas of the heat balance of Oceans. Morsk. Gidrofiz. Inst. : Sevastopol. (In Russian).

Stravisi, F.& F. Crisciani.1986. Estimation of surface heat and Buoyancy fluxes in the Gulf of Trieste by means of bulk formulas. Bollett. di Oceanologia Teoricaed Applicate, 6 : 55-61.

Timofeev, N.A.1970. On the external components of the heat balance in the oceans. Marine hydro.inves.,No 1, Sevastopol, 148-165 (In Russian)

O-IX9

Seasonal Heat Budget of the Southeastern Mediterranean Waters off the Egyptian Coast during 1983-1986

M.-A. SAID* and A.-R. ABDEL-MOATI**

*National Institute of Oceanography & Fisheries, Kayet Bey, Alexandria (Egypt)

**Oceanography Department, Faculty of Science, Alexandria University (Egypt)

Heat-budget components of the Mediterranean waters off the Egyptian coast were studied from August 1983 to July 1986. During this period, eight cruises were carried out to the southeastern Mediterranean between longitudes 29° 45'E and 33° 45'E using RV Noor Ya Nabi. Two separate data sets were used in this study : standard meteorological measurements and hydrographic data. These meteorological measurements were taken every 3h while the ship was on station and used to compute the surface heat budget. During each cruise, temperature and salinity were measured at discrete depths from 24 stations located along eight sections extending perpendicular to the coast. Temperature corrections were made using calibration curves. Salinity was measured on a Beckman induction salinometer (Model RS-7C).

The components of the heat budget of the shelf waters of the Egyptian Mediterranean coast were computed using Timofeev's equations (1970 & 1983), for details refer to Said (1987). From the calculations, the amount of heat loss through the sea surface due to back radiation is not more than -68.11 to -83.73 W m^{-2}. The heat loss due to conductive heat exchange ranged between -0.47 and -50.85 W m^{-2}, and that due to evaporation varied between -91.17 and 205.57 W m^{-2}. Hence, evaporation was the main component affecting the monthly and seasonal fluctuations in the heat budget. Table 1 indicated the quantity of heat loss through the sea surface due to evaporation at the offshore stations.

Table 1 . Heat loss (W m^{-2}) due to evaporation from the sea surface at the stations off the Egyptian coast.

	1983	1984		1985			1986	
	August	February	July	October	April	July	February	July
El-Agami (AG)	-	-98.69	-	-113.88	-113.15	-152.62	-104.46	-165.74
Rosetta (RS)	-153.40	-101.19	-147.15	-112.16	-117.83	-159.80	-108.44	-163.87
Burullus (BR)	-151.68	-102.53	-143.72	-114.19	-126.87	-158.09	-108.44	-
Damietta (DM)	-112.47	-97.35	-123.09	-114.66	-129.62	-134.97	-103.42	-122.78
Port Said (PS)	-121.22	-	-120.13	-114.19	-132.04	-133.40	-104.81	-118.72
El-Tina (TN)	-154.80	-	-154.18	-155.27	-146.73	-173.86	-134.55	-163.87
Bardawil (BD)	-	-	-161.99	-	-150.44	-183.86	-	-154.49
El-Arish (AS)	-	-	-143.56	-	-	-	-	-156.37

Computed values of heat content (expressed as Kg W m^{-2}) from surface to 100m for the offshore stations using the formula described by Pattullo et al (1969) are listed in table 2.

Table 2 . Heat content, surface to 100 m depth, at stations off the Egyptian coast. Values in kg W m^{-2}.

	1983	1984		1985			1986	
	August	February	July	October	April	July	February	July
El-Agami (AG)	-	82.95	-	104.95	83.87	100.77	86.20	104.93
Rosetta (RS)	98.67	83.73	100.81	98.68	86.71	106.64	87.85	106.17
Burullus (BR)	98.02	83.39	97.93	100.42	86.34	98.85	87.58	-
Damietta (DM)	99.72	82.82	95.17	98.45	87.19	100.50	88.64	100.36
Port-Said (PS)	-	-	107.55	102.25	86.62	106.22	89.71	97.68
El-Tina (TN)	104.80	-	105.44	101.44	84.92	101.59	88.48	100.33
Bardawil(BD)	-	-	99.13	-	86.62	118.71	-	104.95
El-Arish (AS)	-	-	96.40	-	-	-	-	100.83

In the present work, the most important results are contained in tables 1 & 2. In order to compare the time series of evaporation and heat content, a mean value was obtained for each parameter for each cruise (Fig.1); the heat loss from the sea surface due to evaporation increases with increasing heat content.

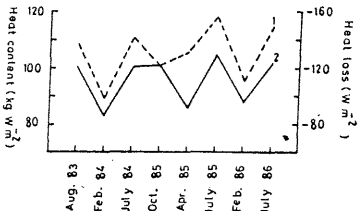


Fig.1. Quantitative comparison of the series of : 1- heat loss due to evaporation (W m^{-2}), and 2- heat content (Kg W m^{-2}) for Mediterranean waters off the Egyptian coast.

References

Pattullo, J.G.; W.V. Burt & S.A. Kulan. 1969. Oceanic heat content off Oregon : its variations and their causes. Limn.& Oceanog.,14(2):279-287

Timefeev, N.A.1970. On the external components of the heat balance in the oceans. In the marine hydrographical investigations, No 1, Morsk. Gidrofiz. Inst. : Sevastopol, 148-165 (In Russian).

Timofeev, N.A.1983. Radiation regime of oceans. Kiev, 24/p

Satellite Observations of Upwelling in the Gulf of Salerno

E. SALUSTI* and E. ZAMBIANCHI**

*INFN, Department of Physics, "La Sapienza" University, Rome (Italy)
**Earth Observation Division, Telespazio, Rome (Italy)

The northern Tyrrhenian Sea is characterized by rather strong dynamics: the steady presence of a large eddy in correspondence of the Strait of Bonifacio is at present under investigation (see Moen, 1984; Böhm et al., 1990). On the contrary, the dynamics of the southern Tyrrhenian Sea are rather weak, and only small scale phenomena are interesting from a physical oceanography viewpoint, such as the tidally generated internal waves in the Strait of Messina (Alpers and Salusti, 1983).

Here we describe a study performed on an area of the Southern Tyrrhenian sea, the Gulf of Salerno.

We analyzed the onset and the evolution of upwelling events by means of satellite-derived Sea Surface Temperatures of the Gulf. It appears as though the upwelling front observed in the SST fields present typical patterns of frontal instabilities, presumably due to the strong shear associated with the wind-induced flow. This hypothesis seems to be confirmed by the observed patterns generated by the intrusion of wind driven waters into a relatively calm hydrographic situation -- see for instance the mushroom-shaped features which can be frequently seen in this zone.

Therefore, the time evolution of the upwelling is studied in relationship with the meteorological forcing: particular attention is devoted to the role of orography in determining the prevalent wind direction.

We also show how bottom topography strongly affects the shape of the cold water patches.

REFERENCES

W. Alpers, E. Salusti (1983): Scylla and Charybdis Observed from Space. J. Geophys. Res., 88, cf, 1800-1808.

E. Böhm, R. Francioni, R. Leonardi, S. Marullo, R. Santoleri (1990): AVHRR/2 Observations of the Tyrrhenian Eddy during TEMPO. Présentation submitted to this meeting.

J. Moen (1984): Variability and Mixing of the Surface Layer in the Tyrrhenian Sea: Milex-80, Final Report. SACLANTCEN Report SR-75, 128p.

O

New observations on superficial waters circulation in the Western part of the Black Sea

G. SERPOIANU, F. SMOCOV and V. MALCIU

Romanian Marine Research Institute, Constantza (Romania)

The paper presents the results of a drifting floats (bottles) experiment effectuated on August 2nd 1988 in the central area of the Romanian continental shelf of the Black Sea (fig.1). A number of 870 drifting bottles have been launched and 225 of them were recovered, along the entire western part of the Black Sea from Odessa to Bosporus and in the southern part from Bosporus to Sinop. This experiment follows a more ample one (5000 drifting bottles launched in 3 stages, June, July and August 1976) - whose results were published by Serpoianu and Nae (1977).

For the explanation of the drifting floats traces, daily resultants of the wind direction and speed for the month of August at Constantza have been calculated, using hourly meteorological observations (fig.1 a). The obtained data reveal wind inconstancy, a cha - racteristic of summer season at Romanian coast. This explains the instability of sea currents, emphasized by the identification places of the drifting floats (see fig.1).

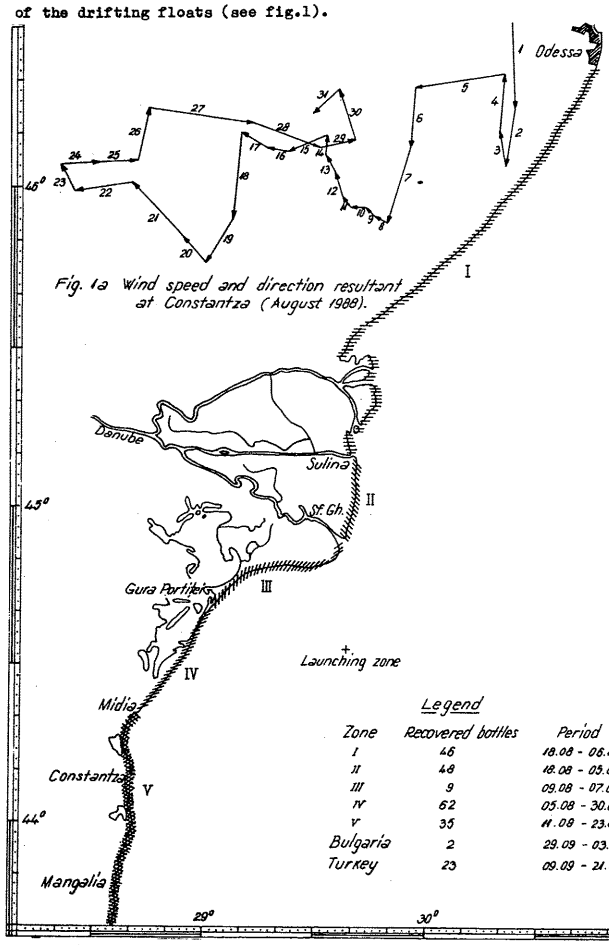


Fig. 1a Wind speed and direction resultant at Constantza (August 1988).

Fig. 1 Results of the drifting bottels experiment (August 1988).

We must notify that 67 % of the total recovered floats have been identified in August, exclusively from Odessa to Mangalia. At Bulgarian coasts 3 drifting bottles have been recovered and at the Turkey coasts 23. One should remark that after the first 3 days from the launching, the winds induced southward and northward currents. On 5 August, after strong easterly winds, the first drifting bottles reached the shore. Between 6 and 14 August the wind blew strong from north in the first two days and from south-east after that but with reduced intensity. Than, in 3 consecutive days (15, 16, 17 August) easterly winds determined the presence of the drifting bottles in the entire zone from Odessa to Mangalia (see fig.1 and 1 a). We consider that all the recovered floats in this area reached the shore until 24 August but a part of them were identified after that.

The constant westerly winds between 24 and 29 August determined a seaward drift of the bottles which had not reached the shore yet and than they were carried southward by the western cyclonic Black Sea current, a fact proved by the identified floats at Bulgarian and Turkey coasts.

O-IX12

The exchange of water between the Mediterranean and the Red Seas through the Suez Canal

Girgis F. SOLIMAN*, Selim A. MORCOS** and Nabil HELALI***

*National Institute of Oceanography & Fisheries, Anfoushi, Alexandria (Egypt)
**Division of Marine Sciences, UNESCO, 75700 Paris (France)
***Suez Canal Authority, Ismailia (Egypt)

Seasonal water exchange is exhibited between the Mediterranean and the Red Seas which is highly controlled with the specific characteristics of the water body of the Suez Canal and the belonging lakes. Six hydrographic surveys - mostly in summer - have been conducted along the canal between Port-Said and Port-Tawfik during the period 1982-1986. Four cruises were involved in-depth surveys and have been undertaken to investigate the current regime particularly in summer. Temperature, salinity and currents have been observed. The mean water level along the canal was taken into consideration. It should emphasize that the last two cruises of August and September 1986 gave an evidence of peculair patterns of the water movement in summer and winter. The southward current set on earlier than that previously experienced. Consequently, the northward current regains its original direction more earlier.

Southward current regime along Suez Canal is highly affected by the significant amount of fresh waters discharged from Lake Timsah, Lake Menzelah and the entrainment of relatively low saline water from the Mediterranean which have been prevailing before the construction of the Aswan High Dam. Presently, its amount fluctuates from year to year and consequently infuences the water circulation in the canal. The prevailing north wind also plays an important role in driving the water into the northern and the southern parts of the canal. The water of the central part is affected by the high saline water from the Bitter Lakes and the low saline water discharging from the sweet canal at Ismailia and driven by the tidal currents. A current of more than 30 cm/sec is observed in the northern part of the canal which could be related to the high water level recorded at El-Kantara.

The last deepening and widening of Suez Canal is assumed to influence the resident time of the water in the Bitter Lakes and its water salinity. The resident time of the water in the lakes is expected to be about three to four months. The minimum salinity of 43.5 ‰ is reached in the last few years and the salt barrier is disappearing, which is revealed by the free movements of the marine organisms between the Mediterranean and the Red Seas.

O-IX13

Chaoctic Behavior of Sea Level Oscillations in a Mediterranean semi-enclosed Basin

G.-N. TRIANTAFYLLOU*, A.-A. TSONIS*, J.-B. ELSNER*, A. LASCARATOS** and C. KOUTITAS***

*Department of Geosciences University of Wisconsin-Milwaukee, Milwaukee, WI 53211 (U.S.A.)
**Department of Applied Physics University of Athens, 33 Ippocratous st. 10680, Athens (Greece)
***Department of Civil Engineering, Aristotle University, Thessaloniki, 54006 (Greece)

We investigate the properties of a marine dynamical system by means of time series of the sea level height at four locations (Souvala, Ag. Marina, Vouliagmeni, Salamina) in the Saronikos Gulf of the Aegean Sea. Measurments were carried out from 7/86 to 9/87 by the University of Athens. The temporal resolution ot the records is 10 min.

In order to characterize the dynamics, we estimate the dimension of the underlying system and we compute its Lyapunov exponents. Our analysis was carried out for each station individually and when feasible for the concatenated time series (all stations together).

We adapted a decorrelation time equal to 600x10 min. From the data of every station the state vector was generated and the phase space was produced for embedding dimensions two to twelve. For every embedding dimension the scaling exponent (correlation dimension) was estimated. In every station the scaling exponent reaches a saturation value, which specifically is: 8.8 (Salamina), 8.7 (Souvala), 8.6 (Ag. Marina), and 9.1 (Vouliagmeni). The estimated correlation dimensions are not integers suggesting that the attractor is not topological but is a fractal set (chaotic attractor). The calculations were performed using the CRAY computer in the National Center for Supercomputing Applications in Urbana, Illinois.

The Lyapunov exponents are related to the mean rate of divergence of nearby trajectories in phase space and measure therefore, how unpredictable is the evolution of the dynamical system. They were calculated for every station separately and for the concatenated time series. In doing that, we assume that the concatenated series could have been just one observable from our dynamical system. This assumption is justified from the results reported above which indicate that the four stations behave more or less as being parts of a single dynamic system encompassing the whole gulf.

Thus, for example, the calculated Lyapunov exponents for Salamina and for the concatenated time series are: (Salamina (N=62,184) 0.091, 0.036, -0.006, -0.051, -0.106, -0.237), (All stations (N=233,213) 0.095, 0.038, -0.008, -0.046, -0.105, -0.256).

In all cases we obtain two positive Lyapunov exponents. This is an indication of chaotic attractor in higher than three dimensions.

The fact that the magnitude of the two positive Lyapunov exponents differs by a factor of three indicate that the chaotic dynamics arise from the interplay of two indepedent mechanisms of instability one of which is more important than the other.

The sum of the two largest positive exponents is found between 0.090 and 0.133/10 min. This is an estimate of the Kolmogorov entropy whose inverse (inverse of divergence rate) provides an estimate of the mean predictability time of the signal. Thus we obtain that the signals involved have an intrinsic predictability time of at least one hour but less than two hours.

There are at least three negative exponents. Since the largest positive exponent is about a factor of two greater than the absolute value of the largest negative exponent it may be that a time scale dominating the system exist.

In almost all cases we observe a very close to zero negative value for the third Lyapunov exponent. This is in accordance with the fact that one of the exponents must always be zero expressing that there is no contraction along the direction of the orbit.

From the estimation of the dimension of the attractor and the calculation of the Lyapunov exponents, of the underlying dynamical system, we have provided strong evidence that the variability of sea level in a part of the Aegean Sea can be attributed to a single chaotic dynamical system of a few degrees of freedom with a low dimensional attractor.

REFERENCES

ECKMANN, J.P., S. OLLIFSON-KAMPHORST, D. RUELLE and S. CILIBERTO. 1986. Lyapunov exponents from time series. Phys. Rev. 34A: 4971-4979.

GRASSBERGER, P., and I. PROCACCIA. 1983b. Measuring the strangeness of strange attractors. Physica 9D:189-208.

KEPPENE, C.L. and C. NICOLIS 1989. Global properties and local structure of the weather attractor over Western Europe. J. Atmos. Sci. 46: 2356-2370.

PROVENZALE, A., A.R. OSBORNE and L. BERGAMASCO. 1989. Lagrangian parcel trajectories in simple deterministic and stochastic models of geophysical relevance. Abstract volume of the General Assembly of the Geophysics Society, Barcelona, Spain, 13-17 March 1989.

THEILER J. 1987. Efficient algorithm for estimating the correlation dimension from a set of discrete points. Phys. Rev. A., 36: 44456-4462.

TSONIS, A.A. and J.B. ELSNER. 1988. The weather attractor over very short time scales. Nature 333: 545-547.

O

TEMPO experiment : Airborne measurements

V. WISMANN, S. RIEGER, A. VIOLA and W. ALPERS

Institut für Meereskunde, Universität Hamburg, Troplowitzstr. 7 2000 Hamburg 54 (Federal Republic of Germany)

A cold patch north-east of the Bonifacio Strait has been observed during the TEMPO experiment (Santoleri and Guymer 1989, Viola 1989) from NOAA infrared images, as well from aircraft and ship measurements.

This patch indicate the presence of a cyclonic eddy corresponding to a region of cold water, which several authors attributed to forcing by the wind tunneled from the Bonifacio Strait, in particular during the Summer (Krivosheya and Ovchinnikov 1973).

The German Polar-4 aircraft of the Alfred Wegener Institute was equipped with the Rotating Antenna C-Band Scatterometer (RACS) and a KT-4 infrared radiometer, to evaluate the wind field (Wismann 1989) and the sea surface temperature over the experimental area.

Simultaneous measurements of the normalized radar cross section and of the radiometric sea surface temperature were performed for nine flight missions between September 28 and October 10, 1989.

The measurements of the thermal structure of the sea surface obtained by KT-4 and NOAA satellite show a high correlation although the absolute values measured show a difference of 2° C, between the two platforms.

Fortunately due to the meteorological condition the formation and the evolution of the cold eddy could be observed by the NOAA images. Infact strong westernly wind were blowing before the campain started. The wind tunnelling and the divergence flux, responsible for the eddy cooling could only be observed two times during the campain. As an example in Fig. 1 is presented the flight performed on October 7 when the wind speed was up to 10 m/s from West.

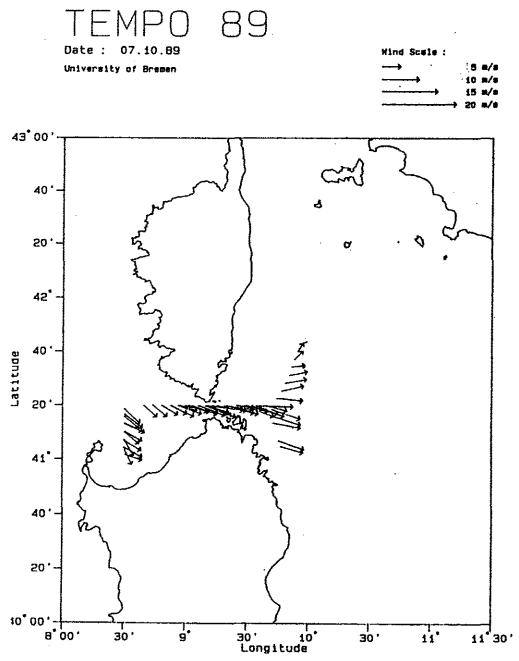


Figure 1

REFERENCES

Krivosheya V.G. and Ovchinnikov I.M. 1973: Peculiarities on the geostrophic circulation of the waters of the Tyrrhenian Sea. Oceanology 13, 822-827.

Santoleri R. and T. Guymer 1989: Tyrrhenian Eddy Multiplatform Observation (TEMPO experiment), Scientific Plan 12 pp.

Viola A. 1989: Tyrrhenian Eddy Multi Platform Observation (TEMPO experiment) Experimental/executive Plan 16 pp.

Wismann V. 1989: Ocean wind field measurements with a Rotating Antenna C-Band Scatterometer, Proc. IGARSS 89 Conference, Vancouver 1740-1743.

Problems and Applications of Satellite Scatterometer Wind Data on the Mediterranean Sea

Stefano ZECCHETTO

CNR, Istituto per lo studio della Dinamica delle Grandi Masse, San Polo 1364, 30125 Venezia (Italia)

The experience achieved in using the Seasat scatterometer data in the Mediterranean Sea is presented focusing on both meteorological and oceanographic (storm surge) applications.

The general problem of scatterometer validation in small basins is also discussed in describing the methodology and giving examples applied to the Adriatic Sea. Implications for the ERS-1 mission are then considered.

Finally, the problem of wind retrieval is outlined according to the results of the experimental ESA C-band campaigns and of the more recent theoretical formulations of the equation linking the Normalized Radar Cross Section to the wind speed and direction.

P-I1

Vertical distribution of Zooplankton and Micronekton in the deep Levantine Sea

Horst WEIKERT

Institut für Hydrobiologie und Fischereiwissenschaft, Universität Hamburg, D - 2000 Hamburg 50 (F.R.G.)

In January 1987, oblique stratified tows from 4000 m to the surface were made in the Levantine Sea southeast of Crete using a 1 m^2 Mocness. The device was equipped with nine black 333 µm nets. Zooplankton (<0.5 cm) and micronekton (>0.5 cm) from two profiles were arbitrarily distinguished on the basis of their total lengths. In addition, a larger, >1.0 cm group was established (Fig. 1). This is commonly defined as micronekton or macrozooplankton (BLACKBURN, 1977).

Maximum concentrations of zooplankton (68,000 specimens/10^3m^3) were found in the 0-100 m surface layer. A secondary maximum (11,000 specimens/10^3m^3) was found at 600 to 750 m. Below this layer, the numbers decreased exponentially to 30 specimens/10^3m^3 or less at depths greater than 2750 m. Copepods were predominant, accounting for 56 to 96 % of the animals. Ostracods were abundant (16 - 23 %) at 1450 to 3000 m, displacing the copepods that decreased to 75 % and less. In the deep-sea, the copepod plankton was largely monogeneric. The genus Haloptilus constituted 83 to 93 % of the calanoids at 100 to 300 m. Eucalanus (75 - 90 %) abounded at 450 to 1250 m, and Lucicutia was predominant (up to 94 %) below 1850 m (WEIKERT and TRINKAUS, in press).

The profiles for the micronekton were similar to those for the zooplankton, but the numbers were 1.5 to 2 orders of magnitude lower than those of zooplankton. There was no secondary maximum in the >0.5 cm group, which outnumbered the >1.0 cm group in the upper 900 m and below 1650 m. Below 2250 m, no organisms >1.0 cm were caught, and the smaller micronekton rapidly decreased from 10 to 1 animal/10^3m^3 and less. The organisms found at these greatest depths are small chaetognaths, which may have been contaminants from the upper layers. In the top 600 m, chaetognaths were predominant, accounting for 72 to 100 % of the individuals caught. In the >0.5 cm group, which seems to reflect the abundance of carnivores in the net samples best (WEIKERT, in preparation), remarkable abundances of about 40 % of the total were also found down to 750 m. Between 450 and 1450 m, fishes numerically increased in importance to between 35 and 75 %, and at 1050 to 1650 m, decapods became abundant (16 - 36 %). Mysids were predominant below 1450 m, constituting 20 to 40 % of the total.

In summary, among the mesopelagic and bathypelagic faunas, there was a clear depth distribution of taxa. In the micronekton, a spatial segregation pattern was indicated among the major groups, whereas in the zooplankton, this was observed only at the genus level. Below about 2000 m, the numbers of zooplankton and micronekton specimens were strongly reduced in comparison with other seas. The overall bathymetric decrease in zooplankton is significantly stronger than in the great oceans (WEIKERT and TRINKAUS, in press). Also, the vertical distribution of micronekton in the Levantine Sea differs from that in the open ocean at similar latitudes. For example, ANGEL and BAKER (1982) collecting micronekton in a net with a 4.5 mm mesh size reported groups at depths of at least 4500 m in the northeastern Atlantic Ocean. Obviously, the zooplankton and micronekton are poorly adapted to the ecological conditions in the Levantine Sea caused by the increased temperatures of its intermediate and deep water masses.

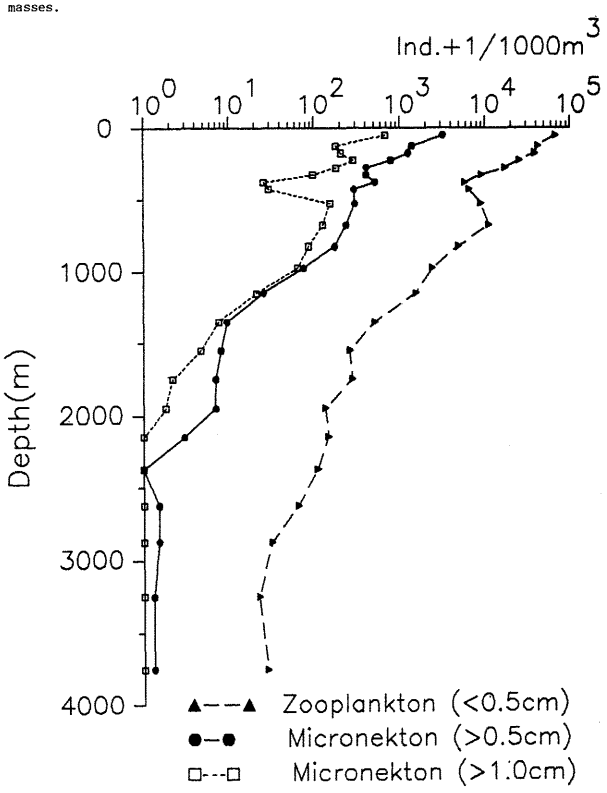


Figure 1: Numerical zooplankton and micronekton profiles from southeast of Crete (day, log-linear scale). Siphonophores omitted.

REFERENCES

ANGEL, M. V. and BAKER, A. de C. 1982. Vertical distribution of the standing crop of plankton and micronekton at three stations in the northeast Atlantic. Biol. Oceanogr. 2: 1 - 30.

BLACKBURN, M. 1977. Studies on pelagic animal biomasses. In: Ocean sound scattering prediction, N. R. ANDERSEN and B. J. ZAHURANEC (eds.). Plenum Press, New York and London: 283 - 299.

WEIKERT, H. and TRINKAUS, S. Vertical mesozooplankton abundance and distribution in the deep Eastern Mediterranean Sea SE of Crete. J. Plankton Res. (in press).

P-I2

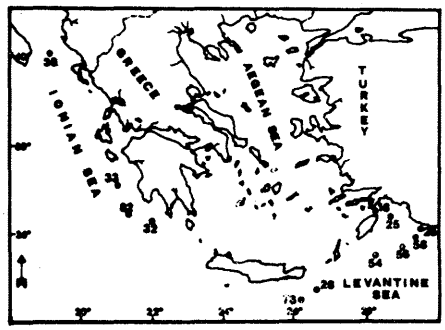
On the vertical distribution and composition of deep-water Copepod populations in the Eastern Mediterranean Sea

M.-A. PANCUCCI-PAPADOPOULOU, I. SIOKOU-FRANGOU and E. CHRISTOU

National Center for Marine Research, 16604 Athens (Greece)

As few studies have been carried out on the synthesis and vertical distribution of deep-water copepods in the Eastern Mediterranean Sea (Greze, 1963; Delalo, 1966; Vaissière & Seguin, 1980; Scotto di Carlo & Ianora, 1983), our knowledge on this subject is still far from being complete. Within the framework of the "Open Sea Oceanography" project, during March 1986 and 1988, zooplankton samples were collected from different layers from the surface to the bottom with a WP-2 closing net at 12 stations situated in the Ionian and Levantine Seas (Fig.1). The results presented here come from the analysis of samples collected at depths greater than 500m up to 4800m (Vavilov deep). Only for two stations the first examined layer was 250-1000m and 300-1000m respectively.

The density (individuals per cubic meter) revealed differences between layers as also between areas. In the Levantine Sea, it varied from 0.38 to 3.66 ind/m^3 and in the Ionian from 3.89 to 6.51 ind/m^3, for the 500-1000m layer. The latter values are in accordance with those recorded by Scotto di Carlo et al. (1984) in the Tyrrhenian Sea. From 1000 to 2000m values ranged between 0.18 and 1.27 ind/m^3, while below 2000m density did not exceed 0.1 ind/m^3. A total of 98 copepod species were identified, their number decreasing with depth. Among those of the deeper layer, some individuals of species usually inhabiting the upper layers were found and must be probably considered as contaminants (Oncaea media, Oithona plumifera, O. helgolandica, Lucicutia flavicornis, Corycella rostrata, Euaetideus giesbrechti and Mecynocera clausi). However, we must point out that, in the Eastern Mediterranean, the water temperature below 500m is higher than that of the western Mediterranean (Miller et al., 1970) and this might explain the presence of surface species in deeper layers. Another point worth mentioning is the presence of many carcasses below 1000m, especially in the Levantine Sea, as well as some unidentified Calanoida (adults and copepodits).



From our results, the prevailing species for the 500-1000m layer were: Eucalanus monachus (the most abundant in both seas), Oncaea mediterranea, Spinocalanus spp., Clausocalanus spp., Haloptilus longicornis and Mormonilla minor. It is notable that the latter was not found at stations 25, 26, 54, 56 and 58, while it was present at the neighbouring stations 18 and 28. The abundance of H. longicornis and E. monachus in the Eastern Mediterranean in comparison with that of the Western Mediterranean has also been reported (Scotto di Carlo and Ianora 1983).

Below 1000m, relatively few species were found, the most common being E. monachus, Oncaea spp. and Clausocalanus spp.. Two species, namely Lucicutia longispina and Lucicutia longiserrata were found only below 1000m. As for the deeper examined layer (3000-4800m), very few copepods were found, most of them surely contaminants from the above layers. At layers deeper than 1000m we must also mention the presence of a discrete number of copepodits, mainly belonging to the genus Clausocalanus, Calanus, Lucicutia, Pleuromamma and some unidentified, as well as some copepod nauplii up to 4800m.

For many of the recorded species our results showed a quite similar vertical distribution with those of previous works in the same layers either in the Western or in the Eastern Mediterranean. However, some differences exist, related to several species. So, as for Lucicutia curta, this species in our samples seems to have a very wide migration or wider distribution in relation with previous informations. The species Monacilla typica and Gaetanus kruppi were not found below 1000m, while they have been referred deeper at the same areas. This could be attribute to their low abundance in the Eastern Mediterranean, according also to Scotto di Carlo and Ianora (1983). On the contrary, Mormonilla minor seems to have a wider distributional spectrum than previously referred, because we found it up to the greatest depth (4800m). As for Oithona helgolandica and Oithona plumifera, their vertical distribution seems to be extended up to 1000m, while their presence in deeper water may be considered as contaminant. Eucalanus elongatus, already referred up to 2000m for the Ionian Sea (Scotto di Carlo & Ianora, 1983) and in the layer 100-500 for the Levantine Sea (Delalo, 1966), did not appear in our samples below 500m.

Of the 98 identified species, we must point out that :

- 14 (Clausocalanus jobei, C. lividus, C. mastigophorus, C. parapergens, Diaixis pygmaea, Euchirella rostrata, Gaetanus kruppi, Haloptilus angusticeps, H. spiniceps, Lucicutia lucida, Oncaea notopus, O.obscura, Pleuromamma robusta and Scolecithricella tenuiserrata) are recorded for the first time in the Levantine Sea.
- 2 (Calocalanus adriaticus and Chiridius armatus) consist first record for the Ionian Sea.
- 2 (Clausocalanus pergens and Heterorabdus spinifrons) are first records for both Seas.
- 1 (Euchirella intermedia) is first record for the Eastern Mediterranean Sea.
- 1 (Lucicutia longispina) is first record for the Mediterranean.

These results must urge us to continue our investigations on the deep water zooplankton, trying to give answers to the many problems concerned.

REFERENCES

DELALO, E.P., 1966. Okeanogr. Kom. Akad. Nauk SSSR, 62-81 (in Russian).
GREZE, V.N., 1963. Okeanologicheskiie Issled, 9, 42-59 (in Russian).
MILLER,A.R.,P.TCHERNIA,H.CHARNOCK & P.A.McGILL,1970. Woods Hole, USA, 190pp
SCOTTO DI CARLO,B.& A.IANORA, 1983. Rapp.Comm.int.Mer Medit., 28,149-151
SCOTTO DI CARLO,B.,A.IANORA,E.FRESI &J.HURE,1984 J.Plan.Res., 6,1031-1056
VAISSIERE,R. & G.SEGUIN, 1980. Oceanol. Acta., 3, 17-29.

P-I3

Appendiculaires mésopélagiques, indicateurs potentiels des couches riches en matière organique

Gabriel GORSKY*, Philippe LAVAL*, Marsh J. YOUNGBLUTH** et Isabelle PALAZZOLI*

*UA 716, Observatoire Océanologique, 06230 Villefranche-sur-Mer (France)
**Harbor Branch Oceanographic Institution Inc., Ft Pierce, Fla. 33450 (U.S.A.)

L'étude des couches profondes est techniquement complexe. L'utilisation des submersibles pour l'échantillonnage et l'observation devient une méthode importante permettant de mieux comprendre le fonctionnement et la distribution des populations dans la colonne d'eau, et permet aussi l'estimation et le prélèvement des particules organiques en suspension (Youngbluth 1984).

Malgré le petit nombre de campagnes océanographiques consacrées à l'étude du milieu aphotique marin à l'aide de submersibles, il apparaît que le macrozooplancton gélatineux joue un rôle plus important que prévu dans le flux de la matière organique. De manière générale, ces animaux délicats généralement détruits par les méthodes classiques de capture appartiennent aux différents groupes zoologiques: Ctenophora, Cnidaria, Siphonophora, Tunicata. Les filtreurs gélatineux, herbivores, exercent une pression trophique importante sur la production phytoplanctonique. La rapidité de leur développement entraîne des pullulations saisonnières. D'autre part les prédateurs gélatineux, semblent contrôler l'expansion des herbivores majeurs dans l'océan (Andersen and Nival 1986).

Un nombre de travaux croissant montre l'importance des appendiculaires dans le processus de production, d'agrégation et de transport des particules organiques (Alldredge and Silver 1988). Selon Davoll et Youngbluth (1990), la présence de ces filtreurs à des profondeurs allant jusqu'à 1000 m est universelle et peut contribuer significativement (5-10%) au transfert du carbone organique vers les couches plus profondes.

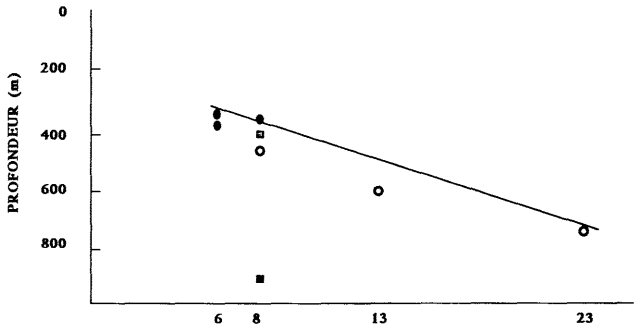
Plusieurs campagnes océanographiques utilisant le submersible CYANA (IFREMER) et son navire porteur, le NOROIT (IFREMER), ont été effectuées dans la zone du front Liguro-Provençal, sur la radiale Nice-Calvi, entre les années 1985 et 1989. La présence d'un appendiculaire mésopélagique du genre *Oikopleura* (nov. sp.), en cours de description (R. Fenaux com. pers.), a été mise en évidence. Les observations ont démontré sa présence indépendamment de l'année ou de la saison (Laval et al. 1989 et observations non publiées). La profondeur de sa première apparition dans la colonne d'eau augmente avec la distance à la côte (voir Figure).

La zone examinée est la zone d'un front permanent où la circulation entraîne la biomasse des couches superficielles vers les profondeurs (Boucher et al. 1987). Cette biomasse semble être la source nutritive de ces filtreurs. Selon les résultats obtenus durant différentes campagnes,on observe une augmentation de la concentration de la matière organique et les valeurs maximales se trouvent dans la couche des appendiculaires mésopélagiques (données non publiées).

Lors des plongées effectuées durant la campagne MIGRAGEL II (observateur M. Youngbluth), une autre espèce d'appendiculaires appartenant probablement au genre *Pelagopleura* a été observée à partir des profondeurs avoisinant 800 m.

Les appendiculaires sont des filtreurs passifs ayant une courte durée de cycle vital et peu de réserves lipidiques. Ils sécrètent des structures mucilagineuses à l'aide desquelles ils filtrent et ingèrent des particules en suspension. Ils abandonnent périodiquement ces structures pour en sécréter des nouvelles (Fenaux 1985). Ainsi ils modifient le spectre de taille des particules dans leur environnement par l'agrégation des particules de petite taille en grandes amas mucilagineux. Ces amas deviennent des microcosmes ayant une activité biologique (Davoll and Silver 1987). Récemment il a été démontré que les couches où l'on trouve les populations d'appendiculaires mésopélagiques sont celles pour lesquelles l'oxygène dissous a la valeur minimale et l'activité ETS (potentiel respiratoire, Savenkoff 1990) la valeur maximale.

Il est donc possible que des appendiculaires soient des indicateurs des couches riches en matière organique. C'est uniquement en utilisant des méthodes nouvelles (submersibles, caméras et pompes immergées etc.) que l'on pourra valider ou invalider cette hypothèse.



Ci-dessus, les profondeurs de la première apparition de l'appendiculaire mésopélagique observé durant la campagne MIGRAGEL II au printemps 1988. Les cercles noirs représentent les plongées de nuit, le carré grisé la plongée du matin, les cercles blancs les plongées du jour et le carré noir la profondeur de la première apparition du genre *Pelagopleura*. La droite correspond au début de la couche des appendiculaires mésopélagiques.

REFERENCES

ALLDREDGE, A. and SILVER, M. W., 1988. Characteristics, dynamics and significance of marine snow. Prog. Oceanogr. 20, 41-82.
ANDERSEN, V. and NIVAL, P., 1986. Ammonia excretion rate of Salpa fusiformis Cuvier (Tunicata: Thaliacea): Effect of individual weight and temperature. J. Exp. Mar. Biol. Ecol., 99, 121-132.
BOUCHER, J., IBANEZ, F. and PRIEUR, L., 1987. Daily and seasonal variations in the spatial distribution of zooplankton populations in relation to the physical structure in the Ligurian Sea Front. J. mar. Res. 45: 133-173.
DAVOLL, P. J. and SILVER, M. W., 1987. Marine snow aggregates: Life history sequence and microbial comunity of abandoned larvacean houses from Monterey Bay, California. Mar. Ecol. Prog. Ser. 33: 111-120.
DAVOLL, P.,J. and YOUNGBLUTH. M., J., (1990). Heterotrophic activity on appendicularian (Tunicata: Appendicularia) houses in mesopelagic regions and their potential contribution to particle flux. Deep-Sea Res. 37, 2, 285-294.
FENAUX, R., 1985. Rythm of secretion of oikopleurid's houses. Bull. Mar. Sci. 37, 2, 498-503.
LAVAL, Ph., BRACONNOT, J. C., CARRÉ , C., GOY, J., MILLS, C., and MORAND, P., 1989. Small scale distribution of macroplankton in the Ligurian Sea (Mediterranean) as observed from the manned submersible CYANA. J. Plankt. Res. 665-675.
SAVENKOFF, C., 1990. Etude de la répartition spatio-temporelle des activités biologiques de part et d'autre du Front Liguro-Provençal. Thèse de Doctorat, Univ. d'Aix-Marseille II.
YOUNGBLUTH, M. J., 1984. Manned submersibles and sophisticated instrumentation: Tools for oceanographic research. In: Proc. of SUBTECH 1983 symp. London: Soc. of Underwater Technlogy, 335-344.

P-II1

The Phytoplankton composition and population enrichment in gelatinous "macroaggregates" in the Northern Adriatic during the Summer of 1989

Noelia REVELANTE and Malvern GILMARTIN

Department of Zoology, University of Maine, Orono, Maine 04469 (U.S.A.)

Summary

Phytoplankton cell densities in the gelatinous "macroaggregates" were up to 4 orders of magnitude higher than in surrounding water. Microplankton exhibited the highest enrichment factors relative to nano- and picoplankton (20X and 12X respectively). A high association of the diatoms Nitzschia longissima and Nitzschia closterium with the "macroaggregates" suggested aggregate formation at an earlier time or site.

In the summer of 1988 and 1989 dense patches of large (up to 2m maximum dimension) gelatinous mucous "macroaggregates" were observed in the northern Adriatic Sea. The brownish-yellow masses were initially observed in the upper water column, or floating at the surface where they often coalesced into extensive "blankets". Subsequently, the gelatinous masses extended throughout the water column, and by early autumn had settled to the bottom. The "macroaggregates" were similar to but very much larger than "marine snow" aggregates reported from other regions.

Samples were collected along an east-west trans-Adriatic trophic gradient between the Po delta, Italy and the Istrian peninsula, Yugoslavia. Eight to ten "macroaggregates" were collected in syringes by divers at 10 meters, together with samples of the "surrounding" water, fixed with formaldehyde, and stored at 2-3°C until enumeration. Collected "macroaggregates" (N=72) with volumes ranging from 2.5 to 17 ml, were subsequently homogenized and pico- and nanoplankton counted by fluorescence microscopy. Microplankton samples were enumerated by the Utermohl method (Hasle, 1978).

The average population densities of all three size classes in the seawater increased from east to west toward the Po delta area. In contrast, the "macroaggregate" population densities, with the exception of the nanoplankton component, did not exhibit a significant east to west gradient. In fact, there was a tendency for the micro- and picoplankton densities to be higher in the "macroaggregates" at the eastern station.

Densities of all phytoplankton size classes were enriched in "macroaggregates" relative to the surrounding seawater, although the degree varied among different fractions. The levels of enrichment ranged up to four orders of magnitude. The average enrichment factors for the picoplankton ranged from 38 to 668, with means ca. 5-fold higher at the eastern relative to the western side of the transect. The average nanoplankton enrichment factors ranged from 46 to 491, with similar means at the eastern and western sides. The average microplankton enrichment factors ranged from 227 to 13,009, with means 3 to 5-fold higher at the eastern side. The microplankton enrichment was ca. 12-fold higher than the nanoplankton and ca. 20-fold higher than the picoplankton.

The "macroaggregate" enrichment by some microplankton species exceeded 4-5 orders of magnitude. The diatoms Nitzschia longissima/N. closterium showed the highest association with an average enrichment of 12,236X (c.v. 67; n = 64) relative to the surrounding water at 10 m. This strongly suggests that the "macroaggregates" may have accumulated this particular component earlier in time or at a different site. Nitzschia longissima/N. closterium, both temporally and spatially, was the dominant microplankton component in the "macroaggregates", irrespective of changes in the species composition of the microplankton in the surrounding water.

The microplankton population densities in the seawater at the "macroaggregate" collection depth (10 m), were very significantly correlated with the cell densities of "other" species, indicating that species other than Nitzschia longissima/N. closterium made up the bulk of the microplankton population at that depth. However, microplankton cell densities at the surface were strongly correlated with the Nitzschia longissima/N. closterium cell densities, suggesting that this component contributed significantly to the microplankton population at the surface. These interrelationships imply a "macroaggregate" origin higher in the water column than the 10 m depth where they were collected.

Conclusions

- The temporal variations of microplankton cell densities in "macroaggregates" did not reflect variations in cell densities in the surrounding water (c.v. 45 vs 140) indicating that contemporary processes in the "macroaggregates" were independent of those in the surrounding water.
- Very significant correlations between enrichment factors and "macroaggregate" cell densities, combined with poor correlations with seawater cell densities, suggest that growth within the "macroaggregate" was more dependent on the environment within the "macroaggregate" than on contemporary process in the surrounding seawater.
- A consistent dominance by Nitzschia longissima/N. closterium of "macroaggregate" microplankton, in spite of changes in the dominance rank in the surrounding seawater community, further implies that Nitzschia became embedded in the gelatinous matrix at an early stage of "macroaggregate" formation.
- Collectively these tentative conclusions support the concept that the origin of the "marcoaggregates" occurred at an earlier time and/or different site than where they were collected.

References

Hasle, G. 1978. The inverted microscope methods I: Sournia, A. (ed.). Phytoplankton Manual. Monographs on Oceanographic Methodology 6. Paris, pp. 88-96.

P-II2

Structure des populations phytoplanctoniques près de Fano (Adriatique Septentrionale)

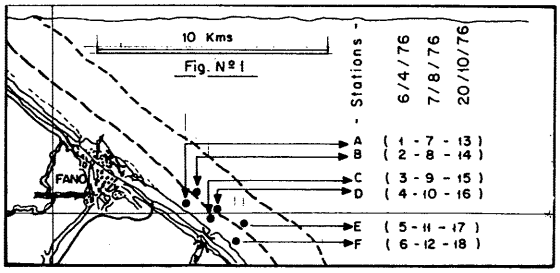
R. LALAMI-TALEB* et Y. LALAMI**

* Ecole normale supérieure de Kouba
** INESSM, Université d'Alger (Algérie)

L'évolution spatio-temporelle de la structure des peuplements phytoplanctoniques dans les eaux de Fano sera examinée comme pour les notes précédentes - *Rapp. Comm. Int. Mer Médit.* 30.2 (1986) et 31.2 (1988) - globalement par le calcul de l'indice de diversité de SHANNON (Hs) et de l'équitabilité (E) et graphiquement en hiérarchisant les distributions d'abondances et en les confrontant aux modèles mathématiques de MOTOMURA, PRESTON, Mac ARTHUR et MANDELBROT.

L'ajustement de ces modèles aux données observées a pu être apprécié par la distance d'HELLINGER, dont la visualisation a été réalisée grâce à la méthode de l'Analyse en Composantes Principales (ACP). Cette dernière a l'avantage de donner une vue globale du modèle le plus performant.

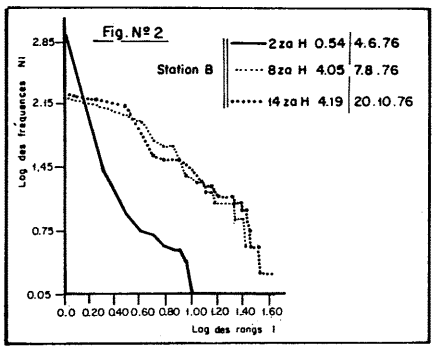
Les échantillons nécessaires à une telle étude ont été prélevés dans six (06) stations différentes (notées A, B, C, D, E, F) visitées le 6 Avril, le 7 Août et le 20 Octobre de l'année 1976 (niveaux 4 et 6 mètres) (Figure 1).



L'examen de ces échantillons nous amène aux conclusions suivantes (figure 2) :

- **Avril 1976** : Nous sommes en présence d'un stade 1 typique au niveau de la station B (pour 06 mètres : Hs = 0,54 et E = 0,13), stade bien illustré par un diagramme concave dû à la dominance de *Skeletonema costatum*. Dans les autres stations, l'allure plus rectiligne des diagrammes rangs-fréquences provoquée par le développement plus marqué des espèces de rangs 2 et 3, ainsi que les valeurs appréciables des diversités et des équitabilités, mettent en évidence une étape intermédiaire entre les stades 1 et 2.

Des quatre modèles qui font l'objet de notre étude, seul celui de MANDELBROT semble plus performant. Sa constante Y néanmoins, indique un mauvais broutage de la microflore algale par le zooplancton herbivore.



- **Août 1976** : La structure des peuplements montre que nous avons, au cours de cette période, un stade 2 de la succession (E variant de 0,70 à 0,89). Les ajustements observés permettent de constater que les modèles qui s'adaptent le mieux à cette structure sont ceux de MOTOMURA et de Mac ARTHUR.

Le modèle de PRESTON s'ajuste lorsque l'espèce de rang 1 manifeste une légère dominance par rapport aux autres espèces équilibrées, ce qui se traduit graphiquement par un léger redressement de la branche supérieure gauche.

- **Octobre 1976** : La communauté phytoplanctonique fanoise tend vers le stade 3 ou fin de succession. Ceci est bien démontré par l'allure de plus en plus linéaire des diagrammes de FRONTIER et par un bon ajustement au modèle de MANDELBROT et à un degré moindre à celui de PRESTON (plus proche du stade 2).

En outre, la constante Y du modèle de MANDELBROT est proche de sa valeur optimale 1 ce qui laisse supposer des interrelations satisfaisantes entre phytoplancton et zooplancton herbivore.

Enfin, soulignons qu'un stade juvénile ne s'ajuste à aucun des quatre modèles. Il en est de même lors d'une "succession secondaire" qui a pour origine le développement anarchique d'une espèce durant la période de stabilité des eaux.

REFERENCES BIBLIOGRAPHIQUES

FRONTIER (S.), (1976).- Utilisation des diagrammes rang/fréquence dans l'analyse des écosystèmes. *Bull. Rech. Océan.* 1 (3) : 35 - 48.

FRONTIER (S.), (1977).- Réflexions pour une théorie des écosystèmes. *Bull. Ecol.* 8 (4) 445 - 464.

GONZALEZ (P.-L.), (1979).- Contribution au choix des modèles de distribution d'abondances. *Rapport de stage de D.E.A. de Mathématiques pures et appliquées*, U.S.T.L. Montpellier

LALAMI-TALEB (R.), (1983).- Biologie et structure des populations phytoplanctoniques de l'Adriatique. Comparaisons avec d'autres zones de la Méditerranée et en particulier avec la Baie d'Alger. *Thèse Doctorat d'Etat Es-Science*, U.S.T.L. Montpellier. 512 p.

LLOYD (M.) and GHELARDI (R.-J.), (1964).- A table for calculating the "equitability" component of species diversity. *J. Animal Ecol.* 33. 217 - 255.

MARGALEF (R.), (1967).- Ritmos, fluctuaciones y sucesion. In Castellvi J. *et al. Ecologia marina, Caracas, Fundacion la Salle* : 454 - 492.

P-II3

Stabilité interannuelle de la distribution de la production planctonique associée au Front Liguro-Provençal (Secteur Corse)

A. GOFFART et J.-H. HECQ*

Unité d'Ecohydrodynamique, Institut de Physique, 4000 Liège, Sart-Tilman (Belgique)

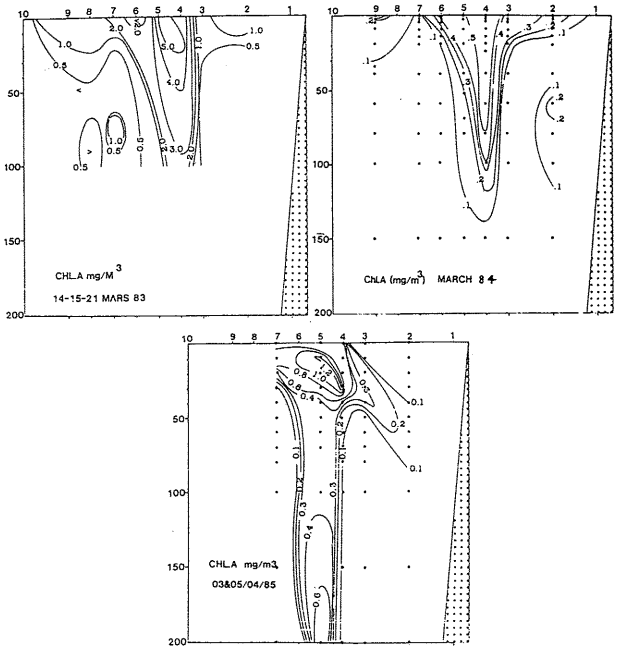
La stabilité interannuelle des caractéristiques printanières du front Liguro-Provençal (secteur Corse) et de la production planctonique associée a été établie à partir de campagnes océanographiques menées depuis 1982 à bord du navire océanographique "Recteur Dubuisson". Les mesures ont été réalisées sur la radiale Nice - Calvi en mars et avril 1983, 1984, 1985, 1986 et 1988, au départ de Calvi, et jusqu'à 31 milles au large.

Au printemps, un fort gradient de salinité sépare les eaux côtières d'origine atlantique ($S^{o}/_{oo} < 38.2$) des eaux centrales du bassin ligure ($S^{o}/_{oo} > 38.4$). Un front thermique est associé au front halin.
Le front thermohalin sépare la région du large, non stratifiée, de la zone côtière, stratifiée et plus stable. Au printemps, les isopycnes s'inclinent avec une pente de 1.6 % du front jusqu'à la côte.
La zone frontale, d'une largeur de 2 à 3 milles, est située en surface entre 11 milles (station 3) et 16 milles (station 5) de la côte. Les variations hebdomadaires et interannuelles (de printemps à printemps) de la position moyenne du front et de sa largeur sont comparables.

A cette période, les maxima de biomasses phytoplanctoniques sont toujours situés en surface, au niveau de la zone frontale (figure 1). Les concentrations maximales ont été observées en 1983 et en 1988 (3 - 5 mg Chl.A / m ^{3}, détermination spectrophotométrique de la chlorophylle). Au niveau du gradient, du phytoplancton vivant est trouvé en quantité significative à une profondeur supérieure à la couche euphotique (100 - 200 mètres). La distribution verticale de la chlorophylle A suggère un transport du phytoplancton le long des isopycnes dans la région du front. Les premières analyses fines (HPLC) de la composition pigmentaire du phytoplancton réalisées au niveau du gradient montrent que certains phytopigments pourraient être utilisés comme traceurs des mouvements verticaux des masses d'eau .

Au printemps, les maxima de biomasses zooplanctoniques sont situés entre la côte et le front (10 - 40 mg Poids sec / m ^{3}). Les Copépodes herbivores dominent les populations à 90 %.

Figure 1: Distribution verticale de la chlorophylle A (mg Chl.A / m3), entre 0 et 200 mètres de profondeur. Les stations1 à 10 sont situées sur la radiale Calvi - Nice. La station 1 est à 1 mille de la côte Corse, la station 10 à 31 milles:



Références

Hecq J.H., Bouquegneau, J.M., Djenidi S., Frankignoulle M., Goffart A. and Licot M. (1986). Some aspects of the Liguro-Provençal frontal ecohydrodynamics. Marine Interfaces Ecohydrodynamics, Ed. J.C.J. Nihoul, Elsevier Oceanography Series, Amsterdam, 42, 257-271.

Brohée M., Goffart A., Frankignoulle M., Henri V., Mouchet A. et Hecq, J.H. (1989). Variations printanières des communautés planctoniques en baie de Calvi (Corse) en relation avec les contraintes physiques locales. Cah. Biol. Mar., 30, 321-328.

* Chercheur Qualifié F.N.R.S.

A yearly study of 13C/12C isotopic ratio variations in the Calvi's Bay Plankton

Patrick DAUBY, Florentina MOSORA and Martine VERTEZ

Department of Oceanology, University of Liège, Institute of Physics B5, B-4000 Sart Tilman (Belgium)

As they allow the delineation of organic matter fluxes between and through the different compartments of terrestrial and marine ecosystems, the analysis of stable isotope ratios are now more and more turned to account in ecological sciences. Plankton, as a major source of organic matter in marine either food webs or sediments was already quite well isotopically studied: several researches were carried out on geographical variations or on the influence of physical/chemical parameters on its isotopic content.

The present research deals with an unapproached aspect of isotopic plankton ecology, i.e. measurements of 13C/12C ratio variations throughout a complete year cycle; moreover, it was done in Mediterranean, an area about which very few data are available (Descolas-Gros and Fontugne, 1988).

Samples were conducted from March 1, 1983, to February 27, 1984, in the Bay of Calvi (Corsica) using a WP2 standard net (50 µm mesh size) hauled from 120 m depth to surface. These samples, after acid treatement to remove carbonates, were transformed in CO2 by combustion at 900°C under pure O2 atmosphere, and then analyzed mass spectrometrically (Varian MAT CH5). Results are expressed refered to PDB international standard in δ notation.

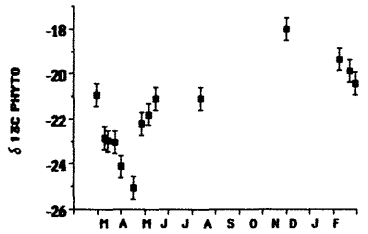
Stable carbon isotope ratio analyses in the plankton of Calvi show a sharp decrease (more than 4%) from March to May, during algal bloom (see picture), and then a slow increase from the end of spring to the beginning of winter. These variations cannot be linked to any environmental parameter as temperature or salinity. However, they tally with changes in phytoplankton population structure: prevalence of Diatoms (mainly Chaetoceros) during springtime bloom, and then founding of a mixed population wherein Dinoflagellates are dominating as water temperature increases. When considering a hinge temperature of 17°C between the two kinds of populations, we get the relationships δ13C/T°C:

δ13C = -1.23 T° - 4.99 (r=0.91) beneath 17°C

δ13C = 0,14 T° - 24.45 (r=0.87) over 17°C

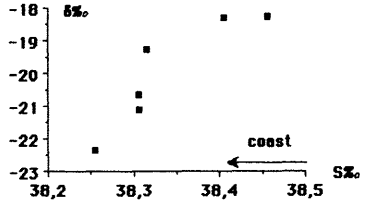
These two relationships are quite well corresponding to changes observed in the floristical composition of the samples and should be confirmed by stable isotope ratio measurements on cultured phytoplankton populations.

When considering the variations of the dissolved carbonate system throughout the year, it also appears that the fractionation Δ(phytoplankton-ΣCO2) decreases as water temperature increases (from -19 to -24%), for the first kind of



population (Diatoms), and that, at the opposite, it increases (from -24 to -20‰) with temperature for the second population (Dinoflagellates). So there is a smaller discrimination against CO2 by these organisms at higher temperatures.

Some samples were also collected at the vicinity of the liguro-provençal frontal zone, from Corsican coasts to about 30 miles to northwest. This front is characterized by a strong salinity gradient.



Stable isotope ratio measurements show that δ13C increase with salinity (4‰ for 0.2‰) and can be used to distinguish the Levantine waters from the Atlantic ones.

REFERENCES

Descolas-Gros C., Fontugne M., 1988. Carboxylase activities and carbon isotope ratios of Mediterranean phytoplankton. *in* "Océanographie pélagique méditerranéenne" Minas H.J., Nival P. eds., Oceanol. Acta, 245-250.

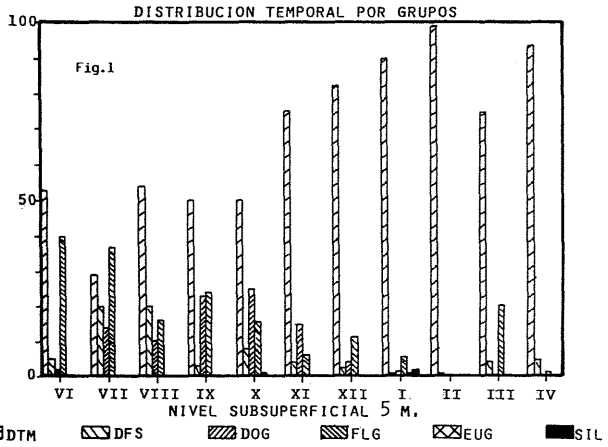
Phytoplankton of El Campello Coast (Alicante, Spain) : seasonal distribution

C. GOMIS, J.-A. ALCOBER and M.-J. SANZ

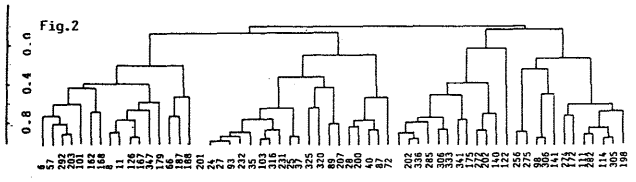
Departament de Biologia Vegetal, U.D. Botanica, Facultat Biologicas, Universitat de Valencia. C/Dr Moliner 50, Burjassot, 46100 Valencia (Spain)

There are few studies on Alicante coast phytoplankton distribution, so we achieved the seasonal phytoplankton study of El Campello coast where we sampled during one year (monthly) between April 1987 and March 1988 at 0, 5 and 15 m of depth. We also collected samples of El Campello sport harbour during the same period of time, but every 15 days (at only one depth). Sea water samples, collected with bottles, were analysed with counting method (SOURNIA, 1978).

The diatoms were dominant all the year, their amount being always greater than 50%, except in July (Figure 1), while they arose until 90% in winter months. Dinoflagellates and Coccolitophorids were the next representative groups with maximum values during summer and autumn respectively. Rarely they arose the 15% of the total amount. Furthermore there were a few groups less numerous i.e. : Silicoflagellates (Dictyocha, representative genus) especially in winter, a few Euglenidae species (mainly Eutreptiella sp.) and some Cyanophyceae species (with a higher biomass and diversity in harbour station).



With the data from counting samples we made a correlation matrix and UPGMA clusters (in SNEATH, 1973). This statistical analysis showed similar association groups for every point (both points) and every depth (Figure 2). So, we can see 4 main groups that should be correlated with a seasonal factor, and 9 subgroups at 0.4 association level. The A and B subgroups look as a spring community, with very characteristic species : Amphora coffaeiformis (8), A. augustata (6), A. laevis (11), Nitzschia longissima f. genuina and reversa (167, 168), N. fraudulenta (162), Leptocylindricus danicus (101) and Rhizosolenia imbricata (203). The C, D and E subgroups look as a winter community with characteristic species of colonial



Diatoms of winter bloom, i.e. : Asterionella japonica (24), A. mediterranea (25), Chaetoceros brevis (37), Ch. curvisetum (40), Bacteriastrum hyalinum (27), B. mediterraneum (28), Thalassionema nitzschioides (232), Ceratulina bergonii (35). The F group is composed of summer and autumn species, mainly Coccolitophorids (Syracosphaera pulchra and Rabdosphaera clavigera f. stylifer (336, 333), Dinoflagellates (i.e. : Oxitum varibile (285) and Euglenophyta Euptreptiella marina (341). Finally, the groups G, H and I look as a summer cummunity with Diatoms (i.e. : Hemialus hauckii (98) and Rhizosolenia alata (198), and small Dinoflagellates (i.e. : Oxytoxum gladiolus (282), Prorocentrum lima (256), Gyrodinium fusiformis (275) and Scrippsiella trochoidea (305).

All these data show El Campello coast as a oligotrophic environment (cellular concentrations often up to 50 cells/ml) with characteristic seasonal communities and Shannon-Weaver diversity generally above 4 bits.

Our results are very similar to Mediterranean seasonal cycle proposed by different authors (ESTRADA, 1979, 1982; MARGALEFF, 1969, 1982; RODRIGUEZ, 1982).

REFERENCES

ESTRADA, M. (1979).- Observaciones sobre la hetereogeneidad del fitoplancton en una zona costera de el mar Catalan. Inv. Pesq., 43 (3): 663-666.

ESTRADA, M. (1982).- Ciclo anual del fitoplancton en la zona costera frente a Punta Endata (Golfo de Vizaya). Inv. Pesq., 33 : 345-380.

MARGALEF, R. (1969).- Composicion especifica del fitoplancton de la costa catalano-levantina (Mediterraneo occidental) en 1962-1967.

MARGALEF, R. (1982).- Ecologia. Ed. Omega.

MARGALEF, R. (1989).- El Mediterraneo Occidental. Barna.Ed.Omega.

RODRIGUEZ, J. (1982).- Oceanografia de el mar Mediterraneo. Madrid. Ed. Piramide.

SNEATH, P. (1973).- Numerical Taxonomy. W.H. Freeman . San Francisco.

SOURNIA, A. (1978).- Phytoplankton Manual. UNESCO. Monogr. Oceanogr. Methodol.

P-II6

Contribution to the Phytoplankton study in Ionian Sea (Zakynthos Island)

O. CHRISTAKIS and O. GOTSIS-SKRETAS

National Center for Marine Research, 16604 Agios Kosmas (Greece)

Abstract. The present study represents an attempt to describe and evaluate qualitatively and quantitatively the phytoplankton population of Zakynthos strait. Sampling in the above mentioned area (Fig. 1) was performed during January and April 1988. Samples were counted in an inverted microscope.Low values of cell concentrations were usually recorded both in January and April. Data from tables 1 and 2 show that the maximum values of phytoplankton concentration were usually recorded at the depth of 40-50m. Dinoflagellates dominated both January and April samples. In January this group was represented by 24 species, while in April 13 species of dinoflagellates were recorded; "naked dinoflagellates", mostly of the genera Gymnodinium, Amphidinium and Gyrodinium, Gymnodinium simplex, Gymnodinium pygmaeum, and Amphidinium sp, were the most abundant among them. In January diatoms were represented by 21 species, 13 species belonged to the "pennatae" group, which are typical in neritic waters (Kimor and Berdugo, 1966). In April, 21 diatom species were recorded, 14 species belonged to the "pennatae" group. Nitszchia closterium, Navicula spp, Thalassiothrix frauenfeldii, Skeletonema costatum, Rhizosolenia stolterfothii, Thalassiosira sp. were among the dominant diatom species. Coccolithophores, though always present were recorded in very low values; the most common species among them were Syracosphaera pulchra, Calyptrosphaera sphaeroida, Calyptrosphaera insignis, Calyptrosphaera oblonga, Coccolithus sp., Rabdosphaera tubulosa and Pontosphaera huxleyi. Silicoflagellates were rare and were represented mainly by one species, Dictyocha fibula. Finally the group "Other groups" which consisted from two phytoflagellates Rhodomonas sp. and Cryptomonas sp. seemed to play an important role in two stations (St.9 and St.10). The μ-flagellates, though always present in relatively high values, were not included in the evaluation of the total cell concentration, since their contribution to the primary production has not been estimated yet (Smayda 1980).

The low cell concentration of phytoplankton, in combination with the relatively high number of species, confirmed the oligotrophic character of the examined area.

The relatively low values of phytoplankton concentration which were recorded during the April cruise, may reflect a decline of the phytoplankton population after the spring bloom and the beginning of the summer minimum (Rouhiainen & Georgieva, 1982).

The Ionian sea is generally characterized by oligotrophic conditions. The maximum values of cell concentrations were usually recorded at the depth of 50m as well in Central and Southern Aegean (Souchenia, 1961; Rouhiainen & Georgieva, 1982; Pagou and Gotsis-Skretas, 1988).

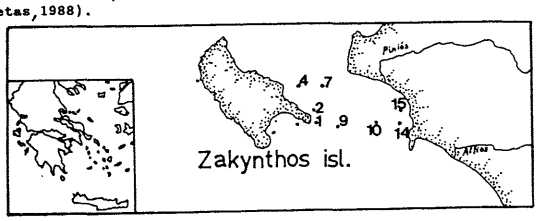


Fig.1 Sampling stations

Table 1. Phytoplankton groups (cells/l) in January 1988.

Taxa	D (m)	St. 1	4	7	10	14	15
Diatoms	0	1080	560	80	800	280	240
	20	1400	720	1120	840	520	600
	40	1240	1120	640	3360	720	680
Dinofl.	0	1240	520	360	800	480	400
	20	1480	1000	680	3720	1480	840
	40	2160	920	1000	1280	2000	600
Coccol.	0	320	360	120	80	80	120
	20	240	240	120	680	360	520
	40	160	720	240	480	440	360
Silic.	0	160	40	40	40	-	-
	20	-	40	120	-	80	40
	40	120	-	-	-	40	-
Other	0	-	-	-	960	-	-
groups	20	-	-	-	800	-	-
	40	-	-	-	1760	-	-
Tot. phyt.	0	2800	1480	600	2680	760	760
	20	3120	2000	2040	6040	2440	2000
	40	3680	2760	1880	6880	3210	1640
μ-flagel.	0	720	160	200	1640	400	240
	20	520	1000	800	2000	760	760
	40	960	560	600	2960	680	880

Table 2. Phytoplankton groups (cells/l) in April 1988.

st.2	D(m)	0	10	20	30	50	
Diatoms		360	720	840	800	1000	
Dinofl.		800	480	1720	1720	3080	
Coccol.		520	80	560	560	360	
Silic.		80	-	40	40	160	
Other gr.		-	-	-	-	-	
Tot. phyt.		1760	1280	3120	3120	4600	
μ-flagel.		800	560	1380	1380	1880	
st.4		0	10	20	27		
Diatoms		760	1240	1240	640		
Dinofl.		1560	1240	1200	1520		
Coccol.		120	120	360	280		
Silic.		80	80	80	-		
Other gr.		-	-	-	-		
Tot. phyt.		2520	2680	2880	2440		
μ-flagel.		2360	1240	1120	1040		
st.9		0	25	50	75	100	150
Diatoms		320	400	760	520	400	80
Dinofl.		1200	1440	1720	1840	680	280
Coccol.		400	640	680	520	200	
Silic.		80	40	120	400	120	
Other gr.		1440	1880	1640	360	280	80
Tot. phyt.		3440	4400	4920	3640	1280	440
μ-flagel.		8650	5252	4360	2880	2600	2210

References.

Kimor B. & Berdugo V., 1966. Bull. Sea Fish. Res. Stat. Israel 45:6-31.

Pagou K. & Gotsis-Skretas O., 1988. Rapp. Comm. int. Mer Medit., 31, (2),220.

Rouhiainen M.I. & Georgieva L.B., 1982. Ekologiia Moria, 8:24-36.

Smayda T.J., 1980. Physiological Ecology of phytoplankton. Blackwell Scientific publications, Oxford, pp 493-570.

Souchenia L.M., 1961. Okeanologia. 6: 1039-1045.

P-II7

Detection of Phytoplankton seasonality trends based on k-dominance curves

Lydia IGNATIADES* and Michael KARYDIS**

*Nuclear Research Center "Democritos", Aghia Paraskevi, Attiki (Greece)
**Department of Environmental Studies, University of the Aegean, 81100 Mytilini (Greece)

Phytoplankton studies at community level have been widely used to describe temporal and spatial distributions. However, the analysis of data using estimators such as cell numbers, biomass or diversity indexes may not be adequate to extract all information regarding the seasonal trends.

In the present investigation a graphical representation of the k-dominance curves based on samples of ranked species abundance (in decreasing order) was examined as a possible procedure to describe temporal patterns of phytoplankton distribution. The advantage of distribution plots as k-dominance curves is that the detection of differences among assemblages is based on the distribution of species abundances among individuals.

Data from five stations (1) of Saronicos Gulf collected at four seasons were analysed by the univariate analysis including the estimation of the Shannon-Weaver diversity index and the plotting of the k-dominance curves (2).

The results are shown in Figure 2. It is seen that the k-dominance curves detected high species richness in the January samples at all stations. In April all curves had similar horizontal pattern indicating species homogeneity in the area. Phytoplankton heterogeneity was established again in July and continued in October showing also differences among the stations. The seasonal changes in species richness and heterogeneity among stations might be associated with the hydrography of the area and the eutrophication conditions prevailing at cetain stations (1).

The results of species diversity (Table 1) approaching those of k-dominance curves can describe temporal changes in phytoplankton assemblages by presenting the relative importance of each species in a sample and without reducing a serie of data to a single number as a diversity index. Also, they can possibly characterise the eutrophication status of an area.

However, questions of statistical significance of the differences between k-dominance curves inevitably arise and so, the application of univariate tests as well as the statistical evaluation of similarities (3) are under investigation.

Table 1 The Shannon-Weaver diversity Index calculated for five stations

St.	Jan.	Apr.	Jul.	Oct.
S1	2.325	0.473	0.240	0.629
S2	2.659	0.445	1.726	1.825
S3	2.557	0.305	1.546	1.984
S5	1.956	0.177	0.837	1.795
S9	1.891	0.477	0.533	1.952

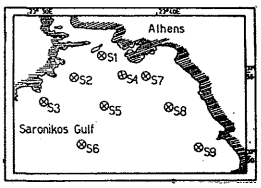


Figure 1 Stations location

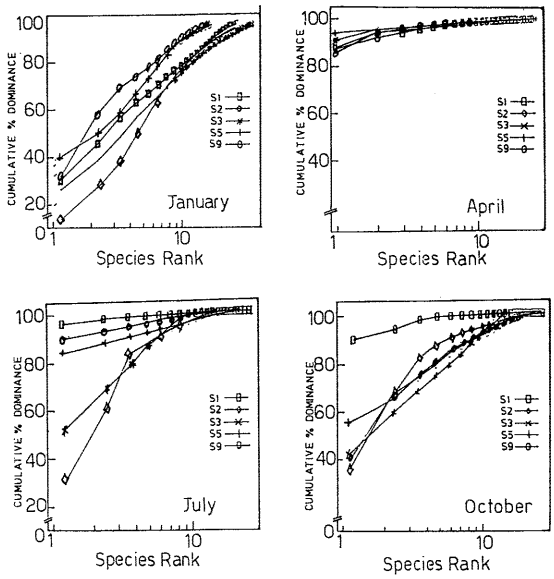


Figure 2 - Series of k-dominance curves of phytoplankton assemblages showing the seasonal trends.

Acknowledgement: The present work was supported by a FAO/UNEP grant.

REFERENCES

1. Karydis, M., Ignatiades, L. and Moschopoulou, N., 1983: An Index Associated with Nutrient Eutrophication in the Marine Environment. Estuarine, Coastal and Shelf Science, 16: 339-344.

2. Lambshead, P.J.D., Platt, H.M. and Shaw, K.M., 1983: The detection of differences among assemblages of marine benthic species based on a assessment of dominance and diversity. J. nat. Hist. 17: 859-874.

3. Clarke, K.R., 1990: Comparisons of dominance curves. J. exp. Mar. Biol. Ecol. (in press).

Seasonal variability of some Phytoplankton community structure parameters

K. PAGOU, U. CHRISTAKI and V. GIALAMAS

National Centre for Marine Research, Aghios Kosmas, 16604 (Greece)

Seasonal variability of two important parameters of phytoplankton structure, species diversity H and the Diatom/Dinoflagellate ratio, were studied in a coastal station (12m depth) of Saronikos Gulf during the period from 17 November 1988 to 22 January 1990.

Water samples were collected weekly from 1m depth by an Hydrobios sampler and analyzed for chlorophyll-a (UNESCO/SCOR, 1966), while phytoplankton cells were counted in an inverted microscope.

Phytoplankton diversity H was calculated from Margalef's formula (1958) and the relative contribution of Diatoms and Dinoflagellates to the total standing stock was estimated by the Diatom cell concentration /Dinoflagellate cell concentration. The seasonal variation of Margalef's diversity index and the Diatom/Dinoflagellate ratio was analyzed by spectral and autocorrelation analyses (Legendre & Legendre, 1983).

The ranges and mean values of some selected phytoplankton parameters are given in Table I.

TABLE I. Range and mean value of selected phytoplankton parameters in 1m depth, during the period 17/11/1988 - 22/01/1990.

	Chlorophyll-a µg/l	Total Phytoplankton X10³ cells/l	H Margalef bits/individual	Diatoms/ Dinoflagellates
Range	0.20-6.95	0.56-447.95	0.14-4.51	0.14-1915.00
Mean	0.88	367.16	2.66	110.88

The autocorrelogram (Fig.1a) for Margalef's diversity index indicated that this parameter has not a dominant and significant seasonal fluctuation. This result was also confirmed by spectral analysis. The lack of a seasonal pattern for the diversity index (fig.2a) could be attributed to the unstable coastal environment. Species diversity is the modulation along a time axis of species evenness by species richness and any positive response of the two components of diversity to environmental "noise" is thus amplified at the diversity level (Legendre, 1973).

On the other hand the autocorrelogram (Fig.1b) for Diatom/ Dinoflagellate ratio indicated a significant oscillation of the order of about 20 weeks. This indication was further examined by spectral analysis (fig. 2b), which confirmed that the dominant frequency at the variance spectrum was 0.05 cycles/week (1 cycle/20 weeks), suggesting a seasonal pattern for the Diatom/Dinoflagellate ratio.

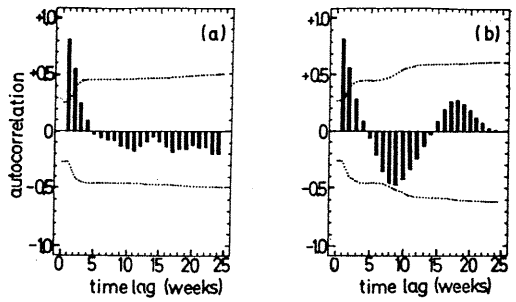


FIG.1. Autocorellation for: a) Margalef's diversity index, b) Diatom/ Dinoflagellate ratio, during the period from 17-11-88 to 22-01-90. Dashed lines indicate confidence interval for a probability of 0.05.

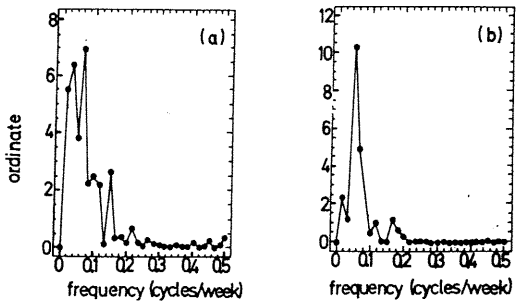


FIG.2 Variance Spectrum for: a) Margalef's Diversity index, b)Diatom/ Dinoflagellate ratio during the period 17-11-88 to 22-01-90.

REFERENCES.

LEGENDRE, L. 1973. J. Ecol., 61, 135-149.

LEGENDRE, L. and LEGENDRE, P. 1983. Numerical Ecology (Elsevier, New York).

MARGALEF, R. 1958. General Systems, 3, 36-71.

UNESCO/SCOR, 1966. Monographs on oceanographic methodology. UNESCO, Paris: 69pp.

Variations quotidiennes des populations phytoplanctoniques durant une période automnale en un point fixe de la Côte Libanaise

Marie ABBOUD-ABI SAAB

Centre de Recherches Marines, CNRS, B.P. 123, Jounieh (Liban)

Les caractéristiques des populations phytoplanctoniques dans le milieu nature sont variables à diverses échelles du temps (HARRIS, 1980). Les études des variations à court terme, de l'ordre du jour, suscitent beaucoup d'attention (COTE and PLATT, 1983; SOURNIA et al., 1987).

Les variations quotidiennes des populations phytoplanctoniques, liées aux changements des conditions météorologiques et de celles du milieu, ont été étudiées en surface durant 31 jours d'une période automnale (6 oct. - 5 nov. 1981) en une station côtière (Fig. 1).

Durant cette période, la température de l'eau a diminué de 27,5 jusqu'à 24,5°C (Δ = 3°C); par contre la température atmosphérique a diminué de 27 à 19°C (Δ = 8°C). La salinité a été relativement stable (39,2 - 39,3‰). La mer était la plupart du temps calme à peu agitée et agitée pendant quelques jours, surtout à la fin de la période d'étude (Fig. 2).

Les populations phytoplanctoniques sont dominées par les Diatomées (en moyenne 93%) et leurs effectifs varient entre 1000 et 111 300 cell./l (moyenne = 20 930; C.V. = 116%). Les densités des populations de Diatomées varient entre 850 et 106 000 cell./l (moyenne = 19 500; C.V. = 119%), alors que celles des Dinoflagellés varient entre 100 et 6 375 cell./l (moyenne = 1 136; C.V. = 133%).

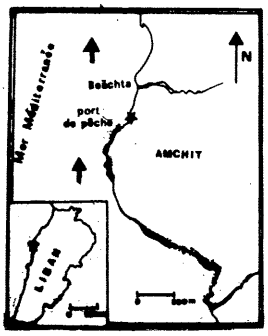


Fig. 1. Localisation du lieu du travail (★) avec indication de la direction du courant marin général (→).

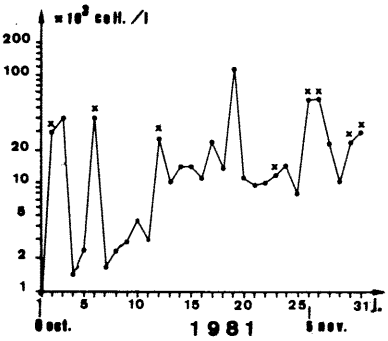


Fig. 2. Variations quotidiennes des densités des populations phytoplanctoniques (cell./l) en un point fixe de la côte Libanaise (6 oct.- 5 nov. 1981) (x indique une mer agitée).

Les populations de Diatomées sont surtout composées des espèces rencontrées d'habitude lors de la poussée automnale, comme Rhizosolenia delicatula, R. fragilissima, Leptocylindricus danicus et Chaetoceros curvisetus. Le nombre de Diatomées d'origine benthique augmente dans l'eau après une période de mer agitée. Des espèces réputées côtières comme Licmophora abbreviata, Nitzschia closterium et d'autres sont toujours présentes dans le milieu.

Les Dinoflagellés ne sont pas abondants durant cette période; on rencontre surtout des Dinoflagellés nus des genres Amphidinium, Gymnodinium et Gyrodinium ainsi que certaines espèces réputées côtières comme Scrippsiella trochoidea et Coolia sp.

La courbe des variations du phytoplancton total présente des pics d'augmentation sporadiques qui correspondent généralement à des jours où la mer est agitée; ainsi ce total passe de 100 à 30 900 cell./l. du 5ème au 6ème jours et les exemples sont nombreux (11-12; 16-17; 25-26; ... jours) (Fig. 2). Ceci peut être dû à des espèces benthiques qui enrichissent le milieu pélagique, peut-être aussi à une advection d'espèces du large; d'ailleurs la corrélation est significativement positive entre l'état de la mer et le phytoplancton total, ainsi qu'entre le premier et les Diatomées.

Si on élimine les pics sporadiques, surtout ceux du début de la période, on remarque une augmentation progressive de l'effectif phytoplanctonique due à la poussée automnale observée sur la côte Libanaise (ABBOUD-ABI SAAB, 1985). Cette poussée, analysée à l'échelle hebdomadaire et mensuelle, a montré, contrairement à la poussée printanière, une augmentation régulière de l'effectif phytoplanctonique et l'absence des pics sporadiques.

L'effet des conditions climatiques et hydrologiques qui règnent durant cette période ne peut pas être écarté: en effet, une période de calme, entre octobre et novembre, caractérise cette région, ainsi que la présence d'une stratification nette des couches d'eau. Ces conditions ont pour conséquence l'amortissement de l'effet climatique et météorologique sur les couches d'eau superficielles; cet effet est plus sensible et mieux décelable évidemment dans une station très côtière et peu profonde (z = 2 m), même à courte échelle (ici quotidienne); mais une fois que l'effet de la perturbation disparaît, la courbe générale reprend son évolution normale.

REFERENCES

ABBOUD-ABI SAAB, M., 1985. Etude quantitative et qualitative du phytoplancton des eaux côtières libanaises. Lebanese Science Bulletin, 1 (2) : 197-222.

COTE, B. and PLATT, T., 1983. Day-to-day variations in the spring-summer photosynthetic parameters of coastal marine phytoplankton. Limnol. Oceanogr., 28 : 320-344.

HARRIS, G.P., 1980. Temporal and spatial scales in phytoplankton ecology. Mechanisms, methods, models and management. Can. J. Fish. Aquat. Sci., 37 : 877-900.

SOURNIA, A., BIRRIEN, J.-L., DOUVILLE, J.-L., KLEIN, B. and VIOLLIER, M., 1987. A daily study of the diatom spring bloom at Roscoff (France) in 1985. I. The spring bloom within the annual cycle. Estuar. coast. Shelf Sci., 25 : 355-367.

P-II10

Effect of some nutrients and their combinations on the growth of *Ankistrodesmus falcatus*

Ramses R. ABDALLA*, Esha EL-AUYTI** and Zeinab M. EL-SHERIF*

*National Institute of Oceanography and Fisheries, Alexandria (Egypt)
**Botany Department, Faculty of Science, Cairo University (Egypt)

INTRODUCTION.

The purpose of this work is to investigate some algal nutrient relationships. The regression coefficient was used as a measureof the relationship between two dependants or more excluding the influence of a certain number of other physical and chemical factors which might simultaneously affect the variables considered. This paper is dealing with the effect of N, P, Fe and their intereffects on the growth of Ankistrodesmus falcatus var. mirabile W.& G.S. West.

MATERIAL AND METHODS.

The alga was cultured in modified Chu 10 solution, by adding the cations as chloride salts and the anionsas sodium salts (Chu,1942). The complementary effect of the three variables was evaluated by applying central-composite rotatable design (Cochran & Cox,1957) where each factor varied at 5 levels (-1.682, -1, 0, +1, +1.682). The scale of neutral variable change was chosen to be logarithmic,so the real element concentration was as follows: N(0.5, 1, 3, 9, 19 mg/l), P(0.214, 0.4, 1, 2.5, 4.67 mg/l), Fe (0.053, 0.1, 0.253, 0.64, 1.21mg/l) Experiments were performed in triplicates. Cultures were grown in incubator at light intensity 5 K lux and temperature of 25 ± 1 °C.

RESULTS AND DISCUSSION.

Equations (1-4) represent the regression models describing the dependence of culture growth (Y) cell/ml on the different concentration levels of N, P, and Fe for the different days of experiment.

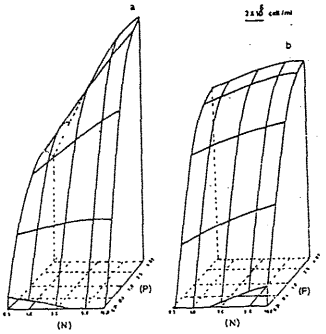
$$Y_4.10^6 = 8623 + 797\,X_N - 121\,X_F - 126\,X_{PF} - 1618\,X_N^2 - 643\,X_P^2 - 665\,X_F^2 \quad (1)$$

$$Y_6.10^6 = 14929 + 2485\,X_N - 403\,X_{NF} - 935\,X_{NPF} - 3067\,X_N^2 - 1483\,X_P^2 - 867\,X_F^2 \quad (2)$$

$$Y_8.10^6 = 16811 + 6003\,X_N + 1642\,X_P + 818\,X_{NP} - 562\,X_{PF} - 926\,X_{NPF} - 1981\,X_N^2 - 131\,X_P^2 - 667\,X_F^2 \quad (3)$$

$$Y_{10}.10^6 = 18133 + 7992\,X_N + 1386\,X_P + 1097\,X_{NP} - 1168\,X_N^2 - 1308\,X_P^2 - 693\,X_F^2 \quad (4)$$

For the second day of growth (Y_2), it was not possible to obtain adequate model. This may be attributed to the lag phase of growth during that time. The analysis of data showed that, allover the time of experiment, cultures were mainly affected by the simple linear regression effect of N. The effects of P and Fe were missed during some days of growth. This does not mean that at that particular time,P or Fe has no effect on algal growth,their effect can be easily detected through their intereffect for either one with the other or with N. Cultures were also affected by 2 unlike intereffects, the positive intereffect of N with P and the negative one of P with Fe. The synergistic effect of simultaneous N and P addition on culture growth has been discussed by several authors (Gatham & Rhee,1981 a,b ;Abdalla,1986), increasing nitrate concentration in culture media stimulates both N and P uptake by algal cells, establishing different amounts of cell N and P needed for cell division. The natural intereffect of P with Fe on algal growth is positive (Abdalla,1986;Abdalla et al.,1986).The unexpected negative nature in our case can be attributed to the fact that the concentration level for P and Fe used in this experiments was too high compared with the levels used in the previous mentioned papers. From the chemical point of view, in alkaline medium, the unchelated ferric ion,when the phosphate at a high level,enhances the formation of unsoluble ferric phosphate, lowering iron concentration, which negatively affects culture growth. The results of the present investigation show that the influence of variables acting together (interaction effects) are more important in understanding the dependence of culture growth on the concentration levels of nitrogen, phosphorus and iron.The relationship between algal growth and the concentration of N and P at the 8th day of growth is illustrated in Fig.a, where iron is at a level of (-1)0.1mg/l while Fig.b represents the same relationship when iron at the higher level (+1) 0.64 mg/l.



REFERENCES.

Abdalla,R.R.,1986. The combined effect of nitrogen,phosphorus and iron on the growth of Selenastrum gracile Reinsch. Aquatic Botany, 23, 371-381.

Abdalla, R.R., Samaan,A.A. and El-Sherif, Z.M.,1986. Effect of some nutrients and their combinations on the growth of Nitzchia palea (Kutz) W.Sm. Rapp. Comm.Int. Mer. Médit. 30 (2). 189. (condensé des travaux).

Chu, S.P.,1942. The influence of mineral composition of the medium on the growth of planktonic algae. J.Ecol., 30: 284-325.

Cochran,W.G. and Cox,G.M.,1957. Experimental Designs. 2nd end. Wiley Publication in Applied Statistics, Wiley, New York.

Gotham,I.J. and Rhee,G-Y.,1981 a. Comparative kinetic studies of phosphate limited growth and phosphate uptake in phytoplankton in continuous culture. J.Phycol., 17: 257-265.

Gotham,I.J. and Rhee,G-Y.,1981 b. Comparative kinetic studies of nitrate limited growth and nitrate uptake in phytoplankton in continuous culture. J.Phycol., 17: 309-314.

P-II11

The winter Phytoplankton of the North Suez Canal, January 1990

M.-M. DORGHAM

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

Phytoplankton as well as other organisms of the Suez Canal in general and Port Said in particular, is attractive to the marine biologists. The importance of Port Said area comes from being the northern entrance of the Suez Canal, the biota of which is affected by the northward current passing the Canal from October to July and reaching its maximum in winter (MORCOS, 1967). Such current carries the plankton organisms from the Indo-pacific Red Sea habitat to the Atlanto-Mediterranean habitat, and though facilitates the immigration of species between the two habitats.

During January 1990, samples were collected from 7 stations distributed inside the Canal, in the Harbour and outside the Harbour. Qualitative samples were collected by oblique hauling of a fine net with 55 µm mesh size, and the quantitative samples (one litre each) were collected from the surface water by Niskin bottle.

The winter (January) phytoplankton of Port Said was composed of 73 taxa of diatoms and 64 taxa of dinoflagellates. Remarkable number were neritic or littoral. The phytoplankton community was dominated by the diatoms: Nitzschia delicatissima, Lithodesmium undulatum, Chaetoceros curvisetum, Ch. decipiens, Leptocylindrus danicus, Rhizosolenia stolterfothii, Thalassiothrix frauenfeldii, Coscinodiscus gigas and Cyclotella meneghiniana. Some of dinoflagellates were common such as Ceratium furca, C. lineatum, C. egyptiacum and Protoperidinium cerasus. Several brackish and fresh water forms were observed in the area possibly transferred from the adjacent Lake Manzalah. The distribution pattern of phytoplankton species in Port Said showed obvious homogeny among the stations, but with different abundances. Such homogeny is attributed to the current regime in the Canal during winter (DOWIDAR, 1976).

In the water samples, the standing crop varied between 30636 cells l^{-1} and 890000 cells l^{-1} with an average of 349275 cells l^{-1}. The lowest crop was observed at the proper Mediterranean stations, while the highest crop was found near the inlet of the brackish water to the Canal. The leading species of the standing crop were Nitzschia delicatissima forming 36-71% of the total crop, Skeletonema costatum (5-25%), Cyclotella meneghiniana (18-19%) and Leptocylindrus danicus (5-7%).

The species composition and the standing crop of phytoplankton in Port Said varied significantly from those recorded by DORGHAM (1974) and DOWIDAR (1976). These variations are related to changes in factors acting in the Canal during the past two decades, such as increase of oil pollution and water disturbance due to the ship movements in the Canal and the widening processes of the Canal.

The most characteristic feature of the winter phytoplankton was the existence of several species, which were recorded by HALIM (1970) and DOWIDAR (1976) as Red Sea immigrants, namely; Coscinodiscus gigas, Biddulphia sinensis, Ceratium breve and C. egyptiacum in addition to Rhizosolenia shrubsolei, R. alata, R. calcar-avis and Guinardia flaccida, which might be also Red Sea immigrants, particularly in winter. Moreover, other Indo-pacific forms such as Hemidiscus hardmanianus, Ceratium schmidtii, C. lineatum, C. recurvatum, Protoperidinium ovatum and P. conicum v. assamushii were not recorded previously in the study area or in the eastern Mediterranean. Some of these species were found in significant density in the net samples. Therefore, they may be regarded as immigrants from the Red Sea. STEINITZ (1968) stated that introduction of individuals of species already represented in the involved area is immigration at least from the numerical point of view.

REFERENCES

DORGHAM, M.M., 1974. The plankton diatoms of Port Said area. M.Sc.Thesis, Alexandria Univ., Egypt.

DOWIDAR, N.M., 1976. The phytoplankton of the Suez Canal, Acta Adriatica, 18(14) : 241-256.

HALIM, Y., 1970. Microplancton des eaux égyptiennes. III. Espèces indo-pacifiques ou érythréennes à l'extrême nord du Canal de Suez. Journées Etud.Planctonol., Rapp. Comm. int. Mer. Médit. : 57-59.

MORCOS, S.A., 1967. Effect of the Aswan High Dam on the current regime in the Suez Canal. Nature, 214(5991) : 901-902.

STEINITZ, H., 1968. Remarks on the Suez Canal as pathway and as habitat. Rapp. Comm. int. Mer. Médit., 19(2) : 139-141.

P-II12

Variations in the surface and volume of three Diatoms along the Suez Canal

M.-M. DORGHAM, N.-M. DOWIDAR and Y. HALIM

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

The diatoms Rhizosolenia shrubsolei, R. calcar-avis and Guinardia flaccida were chosen to assess the variations in their surface and volume in relation to variations in temperature, salinity and water density. The samples were collected from Suez Bay, Bitter Lake and Port Said in winter and summer 1970. Conceiving the cell as a closed cylinder, the surface-A and the volume-V for 100 cells of each species from the 3 regions were calculated, based on the length and diameter of the cells.

For R. shrubsolei, the A as well as A/V ratio were higher in summer than in winter in Suez Bay and Bitter Lake. Such condition may be related to the decrease of the water density in summer in both regions (Table 1). Otherwise, Port Said population showed smaller A in summer than in winter, but its A/V was higher in summer (Table 1). This may be related to the lower salinity of Port Said and accordingly the A/V must be increased to keep the cell float.

For R. calcar-avis, the summer population of Suez Bay was not treated due to its rarity. Population of this species showed more or less different pattern from that of R. shrubsolei. In the Bitter Lake and Port Said, the summer A was lower than in winter (Table 1). However, the A/V for the two populations were higher in summer. This behaviour is contrary to that of R. shrubsolei and may indicate that the light requirement of R. calcar-avis is relatively high and it may proliferate in water of high temperature and high salinity. This may also is in agreement with the ecological affinity of this species as it is a tropical and subtropical species.

Region	Season	Temp.	Salinity	σt	R. shrubsolei A(mm^2) X 10^{-4}	R. shrubsolei V(mm^3) X 10^{-6}	R. shrubsolei A/V	R. calcar-avis A(mm^2) X 10^{-4}	R. calcar-avis V(mm^3) X 10^{-6}	R. calcar-avis A/V	Guinardia flaccida A(mm^2) X 10^{-4}	Guinardia flaccida V(mm^3) X 10^{-6}	Guinardia flaccida A/V
Suez Bay	W	15	41.2	30.61	313	137	229	800	843	94	215	193	111
	S	30	41.7	27.01	318	135	236	-	-	-	211	195	108
Bitter Lake	W	14	44.6	33.18	339	148	229	1192	1521	78	291	308	94
	S	29	45.8	30.39	461	287	161	818	735	111	159	112	142
Port Said	W	15	37	26.76	350	177	198	1091	1409	77	248	261	95
	S	28.5	38	24.51	240	108	222	512	450	114	273	254	108

Table 1- Temperature, salinity, water density and average surface and volume of the 3 diatom species in the 3 regions in winter (W) and summer (S).

For Guinardia flaccida, spatial variations of A were more pronounced than the seasonal variations. However, in the Bitter Lake, the A as well as A/V were remarkably higher in winter than in summer and in the mean time, the summer A was the lowest for the 3 regions in both seasons (Table 1). This may indicate that Guinardia flaccida, a south temperate species probably does not prefer the very surface water of the Bitter Lake with high temperature, salinity and illumination, particularly in summer; it therefore may sink down.

Thus the 3 diatom species showed more or less different pattern of seasonal and spatial variations of the A and A/V. These variations may be related to the variations in temperature, salinity and water density as well as specific gravity and ecological affinities of the different species. The interaction between these factors leads to increase or decrease in the surface and volume of the cells in order to keep their floating level.

P-II13

Size variations of *Guinardia flaccida* (Castracane) Peragallo in different zones of the Suez Canal

M.-M. DORGHAM, Y. HALIM and N.-M. DOWIDAR

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

The variations in cell dimensions of the diatom Guinardia flaccida in 3 separate zones of the Suez Canal were examined in winter and summer. The observed variability is tentatively ascribed to the effect of temperature and salinity variations.

The sampled zones were: Suez Bay-S (S‰ :41.2-41.7‰.), the Bitter Lake-B (S‰:44.6-45.8‰.) and Port Said-P (S‰:37.39‰). Samples were collected in February (temp.:14-15°C) and July (temp.:29-30°C). Length-L and diameter-D of 100 cells from each zone were measured in both winter and summer. The data were statistically treated according to SNEDECOR (1956) and HAYSLETT (1970).

The cell dimensions of Guinardia flaccida were subjected to remarkable variations in the 3 zones of the Canal. The summer population at S exhibited significant increase in cell diameter and insignificant decrease in length compared to winter (Table 1 and Figs. 1&2). In B, both cell dimensions decreased significantly in summer. The P individuals were subjected to remarkable increase in cell length and decrease in diameter during summer. Analysis of variance indicated highly significant (HS) seasonal variations in the cell dimensions (Table 1).

Zone	Parameter	F ratio	
S	L	2.87	NS
	D	7.02	HS
B	L	10.39	HS
	D	344.63	HS
P	L	89.04	HS
	D	90.82	HS

Table 1- Seasonal variations. Analysis of variance of length & diameter in the 3 zones.

Remarkable spatial variations in the length and diameter were also observed among the 3 populations in winter and summer. In winter, variations between the S and B populations were highly significant (Table 2), where B population tended towards the longer and wider individuals. The P population exhibited shorter lengths than those of both S and B, indicating a highly significant variation. (Table 2). Otherwise, the variations in the cell diameter between P and B were not significant (NS). In general, regional variations in the cell dimensions among winter populations were significant. The summer populations of S&B showed significant regional variations (Table 2). The B individuals were mostly longer and narrower. The P population exhibited highly significant variations in length compared to S&B(Table 2). However, cell diameter of P varied remarkably from that of B, while it was comparable to that of S.

The results indicate that variations in cell dimensions may be related to variations in temperature and salinity.

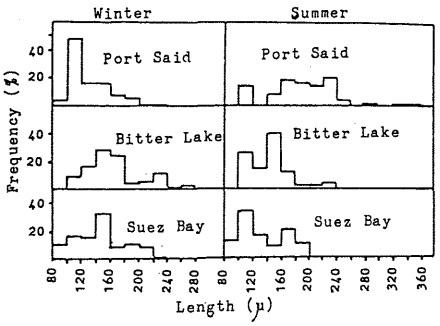


Fig. 1- Different components of cell length (% frequency) in the studied zones in winter and summer.

Parameter	S-B	B-P	P-S	S-B-P
		Winter		
L	HS	HS	HS	HS
D	HS	NS	HS	HS
		Summer		
L	HS	HS	HS	HS
D	NS	HS	NS	HS

Table 2- Spatial variations, analysis of variance of L&D in winter and summer.

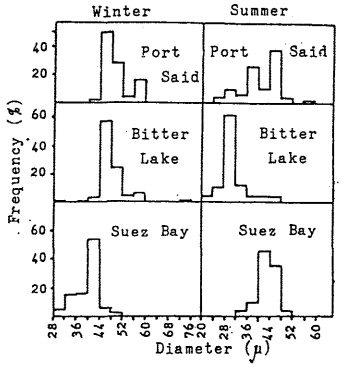


Fig. 2- Different components of cell diameter (% frequency) in the studied zones in winter & summer.

REFERENCES

HAYSLETT, M.S., 1970. Statistics made simple. Publ. W.H.Allen, London.

SNEDECOR, 1956. Statistical methods. The Iowa State College Press, Iowa USA.

P-II14

Microplankton Assemblages in the Gulf of Aqaba, Red Sea, during the Destratification Period

Amir NEORI*, Nurit GORDON* and Baruch KIMOR**

*Israel Oceanographic & Limnological Research, National Center for Mariculture, P.O. Box 1212, Eilat 88112 (Israel)

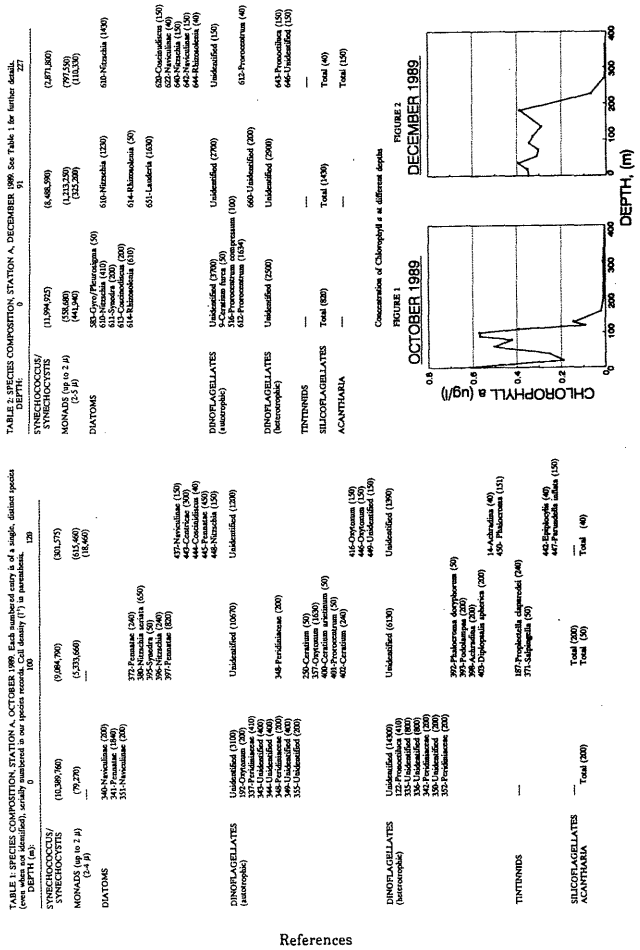
**Technion - Israel Institute of Technology, Faculty of Agricultural Engineering, Haifa 32000 (Israel)

The samples from two cruises, during October and December 1989, were analyzed for species composition and chlorophyll concentration at the surface layer, near 100 m and just below the thermocline, at our Reference Station A at the northern end of the Gulf of Aqaba. The two cruises covered the end of the eight-month stratification period and the incipient annual winter overturn, respectively. The taxonomic groups studied, collected by the FTF (Filter Transfer Freeze) technique [1] included the cyanobacteria, monads and silicoflagellates of the pico and nanoplankton and the diatoms and dinoflagellates of the larger phytoplankton. (Tables 1-2).

During the October cruise (Fig. 1), a pronounced chlorophyll maximum was observed at the surface. A second chlorophyll maximum was observed between 60-100 m, followed by a steep decline at greater depths. This state was typical of the whole stratification period. During the second cruise (Fig. 2), the chlorophyll values remained similar down to 200 m, followed again by a steep decline. These differences between the two cruises correspond to the hydrographic data, which indicate a strong stratification in October and no stratification down to 200 m in December (B. Lazar, pers. comm.).

The samples collected during the two cruises differed both in general taxonomic representation of the microplankton components and in the distribution of species composition assemblages with depth. Thus, for example, the dinoflagellates, tintinnids and acantharia were far better represented in October than in December. As to the depth distribution, in October different species assemblages were recorded at each depth, while in December such a comparison showed a substantial overlap. As with chlorophyll concentration, these temporal and depth related differences in species assemblages can be correlated to the hydrographic conditions existing at the time. Qualitatively similar relationships had been observed off the Mediterranean coast of Israel [2].

The overall autotrophic biomass (data not shown) showed three maxima (0, 60 and 110 m) in October, but was stable with depth down to 200 m in December. Cyanobacterial biomass was significant in all depths over the thermocline, averaging 20-30% of the total microplankton biomass. The heterotrophic biomass was significant and increased rather steadily with depth down to 100 m in October, while it was low and varied with depth in December. The fraction of heterotrophs in the microplankton biomass was much higher in October (25%) than in December (12%). This feature can be related to the level of nutrient recycling, which is considered to be more important in the photic zone of highly oligotrophic and stratified waters [3].



References

1. Hewes, C.D. and Holm-Hansen, O. 1983. A method for recovering nanoplankton from filters for identification with the microscope: the filter-transfer-freeze (FTF) technique. Limnol. Oceanogr. 28: 389-394.
2. Kimor, B., Berman, T. and Schneller, A. 1987. Phytoplankton assemblages in the deep chlorophyll maximum layers off the Mediterranean coast of Israel. J. Plankton Res. 9(3): 433-443.
3. Eppley, R.W. and Peterson, B.J. 1979. Particulate organic matter flux and planktonic new production in the deep ocean. Nature 282: 677-680.

P-III1

Sur le Plancton épibenthique

F. VIVES*, E. ARIAS** et M. DELGADO**

*Instituto de Estudios Avanzados de las Islas Baleares (Espana)

**Instituto de Ciencias del Mar (Espana)

Dans cette communication, nous étudions le comportement du plancton du premier mètre d'eau au-dessus du fond marin (plancton de l'épibenthos), en rapport avec les paramètres physiques des eaux .

L'étude des variations de la température nous montre des changements dans ces eaux profondes le long de l'année, différents selon qu'il s'agit de fonds situés au-dessous ou au-dessus de la thermocline estivale;

Les sels nutritifs montrent aussi des fluctuations le long de l'année mais, dans des aires peu profondes, s'observent des valeurs notablement élevées qui permettent le développement de populations végétales importantes, à la différence de ce qui se passe dans les zones plus profondes (supérieures aux 50 m) pour lesquelles la lumière est un facteur limitant, donnant lieu à des productions primaires particulièrement basses.

En ce qui concerne le sédiment, on observe une relation directe entre la quantité de chlorophylle-a du plancton et celle du sédiment, quoique ce parallélisme n'existe pas toujours; c'est pour cela qu'à partir des données obtenues, nous pouvons envisager l'influence de la sédimentation du phytoplancton présent dans la colonne d'eau sur l'abondance de la chlorophylle-a du sédiment.

Malgré celà, nous devons considérer l'existence de chlorophylle-a autochtone due au benthos; toutefois à partir de 50 m. de profondeur, la lumière qui atteint le fond est trop faible pour maintenir cette population phytobenthonique.

D'autre part, les coefficients pigmentaires D_{430}/D_{664} des échantillons du sédiment des fonds supérieurs aux 50 m., sont beaucoup plus élevés que ceux du plancton néritique.

L'étude séquentielle des populations naturelles du zooplancton de la zone épibenthique a montré, d'une façon très nette, que les groupes zoologiques étaient représentés par un petit nombre d'espèces très abondantes en individus et par un grand nombre d'espèces accompagnatrices à faibles densités en individus.

Les groupes les mieux représentés sont les Protozoaires, les Siphonophores, les Chaetognathes, les Copépodes, les Euphausiacés et les Thaliacés, aux espèces nombreuses. En tenant compte des aspects écologiques respectifs, il est fait référence aux concentrations presque monospécifiques qui parfois tapissent le fond marin: nous pouvons citer comme espèces :

Orbulina universa et Aulacantha scolimantha (Protozoaires) qui forment de juin à novembre, une proportion très importante de la biomasse planctonique et qui dans certains prélèvements, sont presque monospécifiques.

Parmi les Siphonophores, Chelophyes appendiculata et Muggiaea atlantica qui montrent leurs plus grandes concentrations de l'année respectivement d'avril à mai et de mars à septembre.

Les Chaetognathes Sagitta setosa et S. enflata, très abondants en automne, qui sont d'une richesse extraordinaire, spécialement la première.

Quatre espèces de Copépodes (parmi les 70 trouvées dans le premier mètre) qui sont spécialement abondantes : Calanus helgolandicus, Acartia clausi, Pleuromamma gracilis et Temora stylifera avec des localisations différentes : les deux premières sont phytophages par excellence et les deux dernières,carnivores-omnivores.

Parmi les Euphausiacés, on a noté la présence d'importantes populations d'Euphausia krohni à partir de septembre, sur les fonds supérieurs aux 50 m, ainsi que en avril de grands essaims de Salpa fusiformis (disparaissant en mai). Cette dernière espèce, sur le plateau, se trouve dans toute la colonne d'eau, mais nous devons tenir compte de la migration verticale qu'effectuent les salpes pendant le jour. Ainsi, les individus de cette espèce, à midi, se trouvent concentrés sur le fond jusqu'à 150 m de profondeur.

Pour terminer, on développe quelques considérations sur l'abondance plus ou moins grande de ce plancton épibenthique en rapport avec la migration verticale du zooplancton, et sur une migration possible dans le sens horizontal et dans le temps (vers le large et vice-versa), pour finir en discutant si cette migration est en rapport direct ou non avec la température : la thermocline, en s'enfonçant à mesure que l'été passe, constituerait une frontière naturelle thermique pour un certain nombre d'espèces tandis que pour d'autres, elle resterait totalement indifférente.

BIBLIOGRAPHIE

ALLDREDGE,A.L. & J.M. KING. 1977.-The distance demersal zooplankton migrates above the benthos : implications for predation. Mar. Biol. 84 : 253-260.

HAMMER, W.M. & J.H. CARLETON. 1979.- Copepod swarms attributes and,role in coral reef ecosystems. Limnol. and Oceanogr. 24 : 1-14.

OHLHORST, S.L. 1982.- Diel migration pattern of demersal reef zooplankton. J. Exp. Mar. Biol. Ecol., 60 : 1-15.

OMORI, M. and W.M. HAMMER. 1982.- Patchy distribution of zooplankton : Behavior population assessment and sampling problems. Marine Biology, 72: 193-200.

UEDA, H., A. KUWAHARA, M. TANAKA and M. AZETA. 1983.- Underwater observation on copepod swarms in temperate and subtropical waters. Marine Ecol.- Progr. Ser., 11: 165-171.

Les Chaetognathes bentho-planctoniques en Méditerranée

Jean-Paul CASANOVA

Laboratoire de Biologie animale (Plancton), Université de Provence, 3, Place Victor Hugo, 13331 Marseille Cédex 3 (France)

C'est à Doncaster que l'on doit la première mention de Chaetognathes bentho-planctoniques profonds,lorsqu'il décrivit (*in* lo Bianco, 1903) deux nouvelles espèces de Spadelles récoltées dans des dragages en face de Naples : *Spadella musculosa*, entre 100 et 1000 m, et *S. profunda*, à 1000 et 1100 m. Mais cette découverte fut rapidement oubliée; en effet, Ritter-Zahony (1913), l'éminent spécialiste de l'époque, mit la première en synonymie avec *S. cephaloptera* et considéra la seconde comme une *Sagitta* récoltée lors de la remontée de la drague. L'improbabilité de son interprétation est pourtant évidente : d'une part, *S. musculosa* ne peut avoir été confondue avec *S. cephaloptera*, nettement plus petite (5,5 mm au maximum en Méditerranée, contre 7 mm), et vivant à moins de 50 mètres de profondeur; d'autre part, ainsi que le notait déjà Ghirardelli (1952), la longueur du segment caudal de *S. profunda* (50% de LT) ferait davantage penser à *Pterosagitta draco* qu'à une *Sagitta*, éventualité que Doncaster lui-même avait repoussée. Tokioka (1939; 1965) est le seul auteur à ne pas avoir écarté a priori la validité de ces deux espèces, opinion que je partage puisque, à partir de 1986, j'ai découvert une dizaine d'espèces bentho-planctoniques profondes nouvelles, parmi lesquelles deux en Méditerranée occidentale, appartenant aux genres *Spadella* et *Archeterokrohnia*.

Spadella birostrata

En 1987, j'ai décrit cette espèce des parages de Gibraltar et de la mer d'Alboran, sur des fonds compris entre 150 et 555 m, et l'ai retrouvée en 1988 vers 300 m de profondeur sur le haut du talus continental en face d'Arcachon, dans des prélèvements épibenthiques effectués à l'aide d'un traîneau (Sorbe, 1983), cet engin s'avérant mieux adapté que les dragues à la récolte de ces organismes vivant posés sur le fond. J'avais dénombré un millier de spécimens dans les 6 prélèvements dont je disposais alors, soit en moyenne 4,8 spécimens/m^3 d'eau filtrée dans la couche échantillonnée, comprise entre 0 et 50 cm du fond, avec un maximum de 7 spécimens/m^3. Et lorsqu'on sait qu'en mer d'Alboran le niveau préférentiel de cette espèce se situerait vers 500 m, il est à prévoir que s'il en est de même dans le golfe de Gascogne, elle a un rôle très important dans l'écosystème bentho-planctonique à ce niveau.

Une comparaison avec la Méditerranée me paraissait intéressante. J'ai donc demandé à examiner une vingtaine de récoltes effectuées à l'aide d'un autre type de traîneau (Ledoyer,1983), sur le banc des Blauquières, au Sud-Ouest des îles d'Hyères et au Nord de la Corse (fig.1), à des profondeurs comprises entre 146 et 463 m[1]. Les engins de récolte étant différents et les volumes d'eau filtrée n'ayant pas été mesurés, il est difficile de faire des comparaisons quantitatives. On peut dire cependant que les Chaetognathes y sont moins fréquents que dans le golfe de Gascogne puisque seulement présents dans 7 des 21 traits réalisés à des profondeurs du même ordre, c'est-à-dire au-delà de 200 m. Il s'agit là aussi de *Spadella birostrata*, qui atteint ici des tailles supérieures à celles des spécimens atlantiques, puisque le plus grand mesure 11,5 mm (10 mm dans le golfe de Gascogne). Un examen attentif de ces spécimens montre qu'il ne peut s'agir de l'une des deux espèces de Doncaster. En effet, les crochets sont lisses, ce qui exclut *S. musculosa* aux crochets légèrement serrulés, et les dents postérieures sont moins nombreuses que les dents antérieures (3 à 4 contre 7 à 8), ce qui exclut *S. profunda* qui a le même nombre de dents antérieures et postérieures (7 à 8 contre 8).

Archeterokrohnia palpifera

C'est à partir de deux spécimens, prélevés dans un dragage à 2000 m de profondeur en face des côtes sud-occidentales de la Corse, que j'ai décrit cette espèce, en 1986. Elle appartient à la famille des Hétérokrohnidés, généralement de grande taille, bien représentée dans l'Atlantique à proximité du fond, à partir de 1300 m de profondeur. Il ne serait donc pas étonnant que d'autres espèces de ce genre ou du genre voisin *Heterokrohnia* soient présentes en Méditerranée.

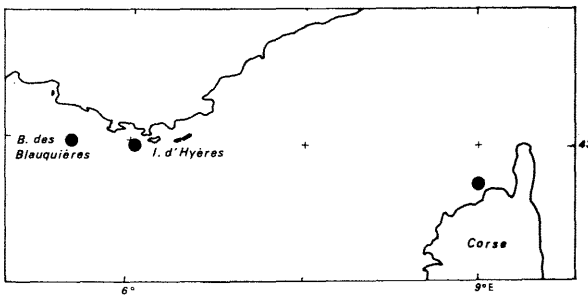


Fig.1.- Carte des chalutages ayant fourni des exemplaires de *Spadella birostrata*.

Ainsi, il existe des Chaetognathes bentho-planctoniques en Méditerranée, depuis la côte jusqu'à la plaine abyssale : *Spadella cephaloptera*, commune dans la zone néritique, notamment dans les herbiers de Posidonies, *S.birostrata*, jusqu'à présent connue entre 146 et 555 m ; vers 1000 m, selon Doncaster, existeraient deux autres espèces de *Spadella* ; enfin, plus profondément, la place serait occupée par la famille des Hétérokronidés.

Ce schéma rappelle celui observé dans l'Atlantique, à la différence près qu'il n'y a pas de discontinuité dans ce peuplement : en effet, j'ai pu observer des Spadelles (*S. equidentata*) jusqu'à 1500 m de profondeur dans des récoltes du N.O. "Discovery" (résultats non publiés), les premières espèces d' *Heterokrohnia* apparaissant vers 1300 m. Il se pourrait donc que des prospections plus nombreuses révèlent aussi en Méditerranée une succession ininterrompue de ces espèces plus ou moins liées avec le fond.

1) Je remercie le Dr. P.M. Arnaud (Station Marine d'Endoume) de m'avoir confié ce matériel.

Références

Casanova (J.-P.),1986.- *Rapp. Comm. int. Mer Médit.*, 30 (2), P-III 4 : 196.
———— , 1987.- *Bull. Mus. natn. Hist. nat., Paris*, 4è sér., 9, section A, n°2 : 375-390.
———— , 1988.- *Rapp. Comm. int. Mer Médit.*, 31 (2), P-II 18 : 239.
Doncaster (L.) *in* Lo Bianco (J.), 1930.- *Mitt. zool. stn, Neapel*, 16 : 266-268.
Ghirardelli (E.) , 1952.- *Pubbl. Staz. zool. Napoli*, 23 : 296-312.
Ledoyer (M.) , 1983.- *Téthys*, 11 (1) : 67-81.
Tokioka (T.) , 1939.- *M em. imp. mar. Biol*, 7 (1) : 129-140.
———— , 1965.- *Publ. Seto mar. biol. lab.*, 12 (5) : 335-357.
Ritter-Zahony (R.Von), 1913.- *Dt. Südpol.- Exped. 1901-1903*, 13 (Zool. V) : 1-71.
Sorbe (J.-C.), 1983.- *Ann. Inst. océanogr.*, Paris, 59 (2) : 117-126.

Les peuplements d'Euphausiacés de la zone épibenthique de la Méditerranée Nord-Occidentale

Bernadette CASANOVA

Laboratoire de Biologie animale (Plancton), Université de Provence, 3, Place Victor Hugo, 13331 Marseille Cédex 3 (France)

La prospection en Méditerranée des Euphausiacés dans la zone épibenthique profonde (par 2400 à 2700 m de fond) n'avait jamais été faite , alors qu'on les y avait observés grâce au bathyscaphe (Pérès *et al*, 1957 ; Pérès , 1958 , 1960 ; Bernard, 1958). Or, comparer les captures faites au voisinage du fond avec celles que nous connaissions dans le domaine pélagique sur le même secteur, était particulièrement intéressant , d'autant plus que nous avions constaté que, pour certaines espèces au moins, la filtration des boues sédimentaires pouvait constituer un apport alimentaire (Casanova,1974).

Les récoltes proviennent de la campagne Biomède I (août 1976) entre les côtes de la Provence et de la Corse occidentale, soit entre 41 et 42° N et entre 15 et 9° E. Les 15 prélèvements effectués avec la drague épibenthique (Hessler et Sanders, 1967) à plus de 2000 m ont été positifs, alors que le rendement de la drague Charcot n'était que de 20% et celui de la drague spatangue de 5%. Bien que l'ouverture de l'engin soit relativement faible (0,80 x 0,25 m), comparée à celle d'un filet à plancton de type classique, il faut reconnaître que la capture en un seul dragage de 5 à 6 espèces sur les 13 connues en Méditerranée est intéressante ; il est vrai que la durée du trait (plus de 4 heures) n'y est sans doute pas étrangère.

Neuf espèces ont été récoltées, à savoir : *Nematoscelis megalops* , *Meganyctiphanes norvegica, Euphausia krohni, Stylocheiron longicorne* (forme longue), *Euphausia hemigibba, Thysanopoda aequalis, Stylocheiron abbreviatum, Stylocheiron maximum et Nematoscelis atlantica*. Si l'on se réfère aux inventaires antérieurs relatifs aux pêches planctoniques (Bacescu et Mayer, 1961 ; Macquart-Moulin et Leveau, 1968 ; Casanova, 1968 et 1974 ; Wiebe et d'Abramo, 1972) on retrouve la même espèce dominante, *Nematoscelis megalops*, accompagnant les autres formes "tempérées" que sont *Euphausia krohni* et *Stylocheiron longicorne*. *Meganyctiphanes norvegica*, forme "boréale", est assez bien représentée en cette période estivale sur les stations les plus proches du chenal ligurien où elle abonde (Boucher et Thiriot, 1972) ; c'est d'ailleurs la forme majoritaire du macroplancton observée en soucoupe ou pêchée au chalut pélagique dans ce secteur (Franqueville, 1970, 1971) . On aurait pu s'attendre, vu la grande profondeur des prospections à trouver l'espèce tempérée *Stylocheiron maximum* en plus grand nombre, en raison de son alimentation zoophage et de son niveau trophique profond; il faut croire qu'elle reste relativement rare en Méditerranée. Malgré leur présence discrète, il existe quatre formes "subtropicales", *Euphausia hemigibba, Thysanopoda aequalis, Stylocheiron abbreviatum* et *Nematoscelis atlantica* qui deviennent plus abondantes dans les secteurs méridionaux des deux bassins méditerranéens (sud du secteur central, mer Tyrrhénienne, secteur siculo-libyen et sud du bassin oriental). Les deux autres espèces de cette catégorie vivant en Méditerranée : *Euphausia brevis* (Ruud, 1936; B.Casanova, 1974) et *Stylocheiron suhmi*, n'ont pas été trouvées dans ces récoltes. Il est vrai que la dernière cependant, est plus abondante en Méditerranée orientale. En revanche, l'absence de *Thysanoessa gregaria* et de *Nyctiphanes couchi* n'est nullement surprenante puisque la première se maintient dans la couche d'eau superficielle "d'influence atlantique", dans le sud et le centre du bassin occidental, et la seconde affectionne les secteurs néritiques plus septentrionaux, comme le golfe du Lion.

Quels enseignements peut-on tirer de l'étude de ce matériel ? Tout d'abord, pour toutes les espèces, les tailles, mesurées de la pointe du rostre à celle du telson, présentent surtout des valeurs maximales indiquant peut-être que les grands spécimens se tiennent préférentiellement au voisinage du fond. On notera que la sex-ratio est nettement en faveur des femelles chez *Meganyctiphanes norvegica Nematoscelis megalops* et *Euphausia krohni*, et qu 'en revanche les deux sexes sont plus équilibrés chez *Stylocheiron longicorne, S. abbreviatum et Euphausia hemigibba*. En ce qui concerne la reproduction, la présence de quelques post-larves chez *Euphausia krohni* et *Stylocheiron longicorne*, de quelques jeunes furcilia chez *Nematoscelis megalops* ainsi que d'une femelle ovigère chez celle-ci et chez *Stylocheiron maximum*, indique, pour cette période estivale, une activité reproductrice chez ces espèces . En revanche, l'absence de spermatophore chez *Meganyctiphanes norvegica* montre que cette espèce n'est pas en phase de reproduction. Ces différentes remarques sont la confirmation de ce que nous avions déjà observé antérieurement. Il est intéressant de mentionner que 8% de la population épibenthique de *M.norvegica* est parasitée par un Elliobiopsidae (*Thalassomyces fagei* Boschma ?) contre 2% seulement pour celle récoltée dans le plancton, dans cette même région. L'implantation du parasite se fait, le plus souvent, entre le céphalothorax et l'abdomen : de longs filaments trophomères, formant par endroits des masses noduleuses (gonomères ?), s'insinuent sous la carapace et en bordure de celle-ci, atteignant vers l'avant le premier thoracopode et vers l'arrière le deuxième pléopode. Cette extension latérale d'un seul côté du parasite, sur près de la moitié de la longueur du Crustacé, doit plus alourdir et entraver sa nage qu'influer sur sa reproduction (Einarsson, 1945) puisque le petasma des mâles est intact.

Quoiqu'il en soit, le peuplement épibenthique de ce secteur nord de la Méditerranée occidentale est constitué par un fonds d'espèces tempérées dominantes, avec une espèce boréale abondante et, en petit nombre, quatre formes subtropicales. La présence de ces Euphausiacés dans la couche d'eau précédant le fond, aussi bien de jour que de nuit, montre que même les espèces migratrices comme *Euphausia krohni* , *E. hemigibba* et *Meganyctiphanes norvegica* ne désertent pas totalement les grandes profondeurs. Cette zone épibenthique constitue donc en Méditerranée une région fréquentée par ces Crustacés, comme nous l'avions déjà constaté dans le golfe de Gascogne (Casanova, 1985). Ces deux études montrent l'intérêt qu'il y aurait à étudier la faune peuplant les quelques mètres au-dessus du fond en améliorant les engins de récolte car, ainsi que nous l'avons souvent constaté, les spécimens sont assez abîmés.

Références

BACESCU (M.) et MAYER (R.), 1961.- *Comm. int. Explor. sci. Mer Médit., Rapp. et P.V.*, 16 (2): 182-192.
BERNARD (F.), 1958.- *Ann. Inst. océanogr. Monaco*, 35 (4) : 287-326.
BOUCHER (J.) et THIRIOT (A.), 1972.- *Mar. Biol.* 15 : 47-56.
CASANOVA (B.), 1968.-*Comm. int. Explor. sci. Mer Médit.*, Congrès de Monaco,doc.polycopié : 62p
———— , 1974.- Thèse Doct. Etat Univ. Provence Marseille C.N.R.S. AO 9446 : 380 p.
———— ,1985.- In peuplements profonds du golfe de Gascogne, L. Laubier et Cl. Monniot, éd. IFREMER : 551-555.
EINARSSON (H.),1945.- *Dana Rep.*, 27 : 158-159.
FRANQUEVILLE (C.), 1970.- *Mar. Biol.* 5 : 172-179.
———— , 1971.- *Téthys* 3 (1) : 11-56.
HESSLER (R.R.) et SANDERS (H.L.), 1967.- Deep-sea Res., 14 : 67-78.
MACQUART-MOULIN (C.) et LEVEAU (M.), 1968.-*Comm. int. Explor. sci. Mer Médit., Rapp. et P.V.*, 19 (3) : 495-497.
PERES (J.M.), 1958.- *Ann. Inst. océanogr. Monaco*, 35 (2) : 260-285.
———— , 1960.- *Rec. Trav. St. mar. Endoume*, 20 : 17-24.
PERES (J.M.), PICARD (J.) et RUIVO (M.), 1957.- *Bull. Inst. océanog. Monaco*, 1092 : 1-29.
RUUD (J.T.), 1936.- *Rep. dan. oceanogr. Exped.*, 1908-1910, *Médit.*, 11 (6) : 1-86.
WIEBE (P.H.) et D'ABRAMO (L.), 1972.- *Mar. Biol.* 15 : 139-149.

P-IV1

Study of water turbidity in the Port of Pollença (Balearic Islands)

B. CABRER*, J.-L. FERRA**, V. FORTEZA**, G. MOYA**, M.-R. PICORNELL**, M.-M. RAMIS** and G. RAMON**

*Conselleria de Sanitat i Seguretat Social, Govern Balear (Espana)
**Departament de Biologia, Universitat de les Illes Balears, Palma de Mallorca (Espana)

The Bay of Pollença is in the north of Majorca, between the capes of Formentor and Pinar. The Port of Pollença is located to the north-west of the bay. It is 610 m long and 2700 m wide, with a maximundepth of 7 m.

The Port has in the last years suffered a problem of turbidity during the summer months. This was particularly serious and longlasting in 1987, and prompted an investigation into its causes which was initiated at the end of that year.

The present contribution shows the results from one year's (1988) monitoring of the following parameters: temperature, total suspended matter, dissolved oxygen, nitrates, nitrites, phosphates, silicates, pigments and phytoplankton according the most common methods (APHA, 1981; Strickland & Parsons, 1972). Water was sampled monthly, and weekly in the summer, at surface from six stations: five near the shore and one in the centre of the Port.

Minimum (Min.), maximum (Max.) and average (Med.) values for the three stations along the shore, with a maximum depth of 2 m (A), and for the other three stations, with a maximum depth between 2 and 7 m (B) are presented in table 1.

TABLE 1. Results of water analysis

	A			B		
	Min.	Max.	Med.	Min.	Max.	Med.
Susp. Matter (mg/l)	5.20	29.70	12.60	5.20	31.51	9.80
Temperature (°C)	12.50	28.30	21.80	12.30	27.30	21.25
Oxygen (mg/l)	3.86	8.85	5.96	3.75	8.72	5.81
Phosphates (µg at P/l)	0.10	3.04	0.45	0.14	2.91	0.43
Nitrates (µg at N/l)	0.09	8.36	1.86	0.06	4.85	1.59
Nitrites (µg at N/l)	0.03	1.74	0.29	0.03	0.60	0.22
Silicates (µg at Si/l)	0.80	14.70	2.56	0.70	5.00	1.59
Chlo. *a* (mg/m^3)	0.03	3.81	0.79	0.00	1.54	0.28

On one occasion, at the end of summer, sediments were sampled with a dredge sampler from 13 stations and analyzed for: Loss-on-ignition (LI), organic carbon (OC), total nitrogen (TN) and particle size: percentage of sand (Sa), silt (Si) and clay (Cl), according to the standarized methods (M.A.P.A., 1986).

Throughout the year, low dissolved oxygen content and very substancial nutrient and total suspended matter contents were the most significant features of the study area, and not very different from other western mediterranean areas (Rodriguez & Vives, 1984; Establier *et al.*, 1987).

Nutrient release into the water column from sediments is probably very important. Fine sediments with high organic matter levels are accumulated in the centre of the Port (Table 2: St. 1, 2, 3, 10, 11). Organic matter can have a autochthon origin or it may be allochthonous near the mouth of seasonal streams Table 2: St. 6, 13).

TABLE 2. Results of sediment analysis

		%LI	%OC	%TN	%Cl	%Si	%Sa
Station	**1**	15.8	6.0	0.2	18.0	21.0	50.2
	2	16.4	6.5	0.3	17.5	21.0	52.2
	3	16.6	4.9	0.3	15.0	22.0	57.0
	4	7.6	2.0	0.1	8.0	5.5	79.0
	5	5.4	1.7	0.1	5.0	2.0	91.2
	6	11.0	3.3	0.1	7.5	10.0	76.2
	7	5.6	1.4	0.2	2.7	5.3	86.2
	8	4.2	1.3	0.1	4.1	5.5	80.5
	9	6.8	2.0	0.1	4.5	6.5	70.2
	10	20.1	5.8	0.4	27.5	24.5	38.7
	12	7.5	2.0	0.2	6.5	9.5	74.0
	13	15.6	4.5	0.3	14.0	4.0	69.7

The nutrient content in the water column together with high summer temperatures and a low level of marine dynamics creates ideal conditions for a phytoplankton bloom. In August the most confined area of the Port (Table 1: A) showed maximum chlorophyll *a* values. Thus the phytoplankton density, normally between 2 and 6. 10^3 cells /ml, reached values between 43 and 47.10^3 cells/ml as a result of a massive development of nanoplankton and small dinoflagellates and diatoms.

The phytoplankton bloom is an important component of the total suspended matter and also of water turbidity in the summer. There is also an inorganic compoment, source of which is the sand derived from an artificial beach in the bay. The continuous input of allogenous matter prevents a correct sedimentation and turbulence favours a resuspension of sediments which contribute to the turbidity of water.

In the Port of Pollença, an enclosed coastal area exploited for various touristic uses (artificial beach, leisure harbour,...), seawater undergoes an increasing process of eutrophication, which prevails in the summer months, and is reflected by a high level of turbidity.

REFERENCES

- ESTABLIER, R; J. BLASCO & L.M. LUBIAN. 1987.- Fitoplancton e hidrografía de la Bahía de Cádiz. Enero de 1984 a Diciembre de 1985. *Inv. Pesq.*, 51: 501-515.
- M.A.P.A. 1986.- *Métodos oficiales de análisis.*.Dirección General de Política Alimentaria. Madrid. 530pp.
- RODRIGUEZ, V & F. VIVES. 1984.- Variables hidrográficas y biológicas de un sistema pelágico portuario. *Inv. Pesq.*,48: 207-222.
- STRICKLAND, J.D. & T.R. PARSONS. 1972.- A Practical Handbook of Seawater Analysis. *Bull. Fish. Res Board Can.* 167: 1-310
- APHA-AWWA-WPCF.1981. *Standard methods for the examination of water and wastewater.* American Public Health Association Washington. 1134pp.

P-IV2

Monitoring of the Blooms along the Bulgarian Black Sea Coast

V.-J. PETROVA-KARADJOVA

Institute of Fisheries, 9000 Varna (Bulgaria)

Abstract : Blooms are seasonal phenomena . They are coastal(local and offshore (regional) in the western part of the Black Sea. They reflect adequately the eutrophication and show cycling controlled by solar activity - a basis for bioprognosis.

Introduction. With progressive eutrophication and increasing sea pollution the blooms become very actual. The aim of the monitoring was to make ecological evaluations and prognosticate a protection of the sea from pollution by means of controlling the blooms.
Material and methods. The blooms in the Black Sea were studied annually (1954-1990) according to a standard expedition scheme of profiles and stations up to 55-90 km off the coastal line. Every season the monitoring included an area from 9-15 thousand square kilometers down to the sulphydric hydrogen layer. The volume of investigation amounted to more than 10 000 half a litre quantitative samples; the Utermöl method was used for cells counting (10^6/m3) by species level.
Results and discussion. The spatial structure of the phytoplankton along the Bulgarian coast has a seasonal nature. Several zones became prominent towards the shore : 3 miles-broad coastal zone under intensive anthropogenic and recreative influence with chronic blooms; a 10 to 20 miles-broad one under the influence of the Danube and the cyclonic sea currents directed southwards, with regional blooms; a 30 to 40 miles-broad open sea one, with 1-2 degrees lesser in quality and with an uniform content. The vertical structure has seasonal nature as well : at spring and summer temperature stratification, the blooms are at the surface, (above the 25 m) and during winter homothermy, they are distributed to the bottom. The combined influences of factors such as temperature, salinity and content of nutriments on the spring blooms are strongly showed (R= 0.9); simple correlative function between salinity and spring blooms is negative (r= -76)as they begin at low salinity and rapid increasing of water temperature.

By means of statistical and spectral analysis, the influence of the solar activity was proved upon the dynamics (1954-1987) of Black Sea plankton diatoms in Bulgarian open sea (PETROVA-KARADJOVA, APOSTOLOV, 1988). Dual maximum development in the three 11-year cycles of sun-spots (19-21 cycle by the Zürich numeration) was found out : the first maximum occurs 1 or 2 years after the maximum of the sun-spots cycle and the second one coincides with its minimum. Diatom cycles showed a period of approximately 5.5 years, which proved valid for other plankton species as well. The maxima and minima of the solar cycles were followed by or coincided with mass blooms of species belonging to different taxa, as follows :

Nitzschia seriata Cl. The bloom was discovered in February-March 1959 (on an average of 2367 x 10^6/ m3) from the Danube's mouth to the Bosphorus (PETROVA, SKOLKA, 1964) two years after the maximum of the 19th sun cycle (1957).

Cerataulina Bergonii Perag. A dominant diatom species in the 1964 spring bloom (on an average of 48 x 10^6/m3) which coincides with the minimum of the sun cycle (1964).

Prymnesium parvum Carter. The blooms of this toxical species of Chrysophyta appeared in coincidence with those of the diatoms : in September 1959 (maximum 150 x 10^9/ m3) with mass mortality for the fauna (PETROVA, 1962)and in March 1964 (on an average of 520 x 10^9 m3) in the Bourgas Lake, but as water temperature reached 10.4°C, no fish mortality occured (PETROVA, 1966; KOLAROV, 1965).

Detonula confervacea (Cl.) Gran. In 1969 the winter bloom of this diatom species at 20 miles off Varna (on an average of 2973 x 10^6/m3) was registered a year after the maximum of the 20th sun cycle (1968).

Sceletonema costatum (Grev.) Cl. the spring bloom at 30 miles off Varna (on an average of 6183 x 10^6/m3) perfectly coincided with the minimum of the 20th sun cycle in 1976. It was constant throughout the winter-spring months with very frequent local blooms in relation to human pollution along the shore.

Until 1970 the Diatoms predominated in the Black Sea. The progressive organic pollution and the increase of seasonal water temperatures during the period 1971-1980 changed the flora with a predominance of Dinoflagellates in the western half of the sea. The maximum of the 21st sun cycle was registered in 1979 and its minimum in 1986 and in the spring of these two years appeared regional, about one month long, blooms of the dinoflagellate Exuviaella cordata Ost. (PETROVA-KARADJOVA, 1979; SUKHANOVA et al., 1988), lately identified as Prorocentrum minimum (Pav.)Schil. (MARASOVICH, 1986). The concentrations of this species varied, but were the highest in bays (e.g. in the Varna Bay maximum 280 x 10^9 in 1979 and 220 x 10^9/m3 in 1986).

Phaeocystis pouchetii (Hariot) Lagerheim is a Haptophyceae we discovered for the first time along the Bulgarian Black Sea coast in August-September 1989 (only in the form of disintegrated jelly-like colonies) above the 25 m layer and up to 30 miles in the open sea between the Cape of Caliacra and the Cape of Emine at water temperature of 20-24°C. The species is known to be present in the North Sea (ZENKEVICH, 1956). Now it has appeared in front of Denmark and Ireland with unpleasant smell and foam on the beaches; fish migrate from blooms areas. The small colonies of Phaeocystis get swallowed by Noctiluca, which follows its blooms (KAT, 1982; REPORT ICES, 1989/:18). In the Bulgarian areas the species appears as whitish stripes and spots on the surface of the sea. The observations are continuing.

The monitoring proved the cycling of the regional blooms and the possibility for their prognosticati approximately every 5.5 years in dependence on the prognoses of the sun cycles with the annual, continual and gradual seasonal local blooms as a back ground.

References

KAT, M. (1982). The sequence of the principal phytoplankton blooms in the Dutch coastal area. ICES, C.M./L : 22.
KOLAROV, P. (1965). Über die Toxizität des Prymnesium parvum Car. unter den Bedingungen niedriger Temperaturen. Zeit. f. Fisch., 13, N.F. 3/4.
MARASOVIC, I. (1986). Occurence of Prorocentrum minimum in the Adriatic Sea. Rapp. et P.V. C.I.E.S.M., 30 (2).
PETROVA, V. (1962). Blossoming of Prymnesium parvum Car. in the Varna Lakes during the summer of 1950. Bull. Inst. Rech. sci. Pisc. et Pêch., 2.
PETROVA, V.J., SKOLKA, H. (1964). Massovoe rasvitie Nitzschia seriata Cl. v.vodah Cherno more V 1959. Rev. Roum. d. Biol. s. Bot.,9.
PETROVA, V.J. (1966). Verbreitung u. massenhafte Entwicklung d. giftigen Chrysomonade Prymnesium parvum Car. in d. Seen d. Bulgarischen Schwarzmeerküste. Zeit. f. Fisch., 14, NF 1/2.
PETROVA-KARADJOVA, V.J. (1979). Zafteji na phytoplanktona v Cherno more. Sb. dokl. II, SNRB.
PETROVA-KARADJOVA, V.J., E.M. APOSTOLOV (1988). Influence of solar activity upon the the diatoms of Black Sea plankton. Rpp. et P.V. C.I.E.S.M., 31 (2).
SUKHANOVA, I.N. et al. (1988). Exuviaella cordata red tide in Bulgarian coastal waters (May yo June 1986). Mar. Biol., 99, 1-8.
REPORT OF THE ICES, CM 1989/F:18, pp. 8, 26, 27, 33, 38.
ZENKEVICH, L. (1956). The Seas of USSR. Fauna and Flora. M.424.

P

L'eutrophisation et la production phytoplanctonique des eaux de la Mer Noire devant la Côte Roumaine

V.-H. SKOLKA et A.-S. BOLOGA

Institut Roumain de Recherches marines, Constantza (Roumanie)

Abstract : The consequences of the Black Sea waters eutrophisation on phytoplanktonic production in the Romanian waters are presented.

Les campagnes effectuées sur toute la surface de la mer Noire (SAMYCHEV, 1987), ainsi que les observations pluriannuelles devant la côte Roumaine (DOROGAN et al., 1985; PECHEANU et al., 1977) relèvent le fait que pendant les deux dernières décennies la biomasse du phytoplancton a été multipliée par trois fois grâce à l'eutrophisation. La cause principale du phénomène est l'augmentation incessante des apports de nutriments transportés par les fleuves. La position géographique de ceux-ci explique les différences régionales concernant le degré d'eutrophisation et la biomasse phytoplanctonique des parties Est et Nord-Ouest de la mer, jusqu'au niveau des embouchures du Danube.

Le Danube, principal tributaire de la mer Noire, apporte environ 77% du volume total d'eaux douces, c'est-à-dire quelque 200 km3/an. Le littoral Roumain situé au sud de ses embouchures subit la plus forte influence du processus d'eutrophisation. Dans cette zone, pendant la période 1960-1989, la concentration en nitrates a augmenté de 13 fois et celle des phosphates de 10 fois. Les silicates ont diminué en revanche de 3 fois.

La biomasse du phytoplancton a augmenté en même temps de 11 fois (BODEANU, 1984). La structure qualitative du phytoplancton s'est modifiée en faveur du développement des Dinoflagellés et des Coccolithophorides au détriment des Diatomées, conséquence de la diminution des quantités de silicates. Le taux des Dinoflagellés a augmenté de 14% en 1979 à 36% en 1980 et a diminué à 12% en 1989. Les Diatomées représentaient 86% en 1979, 26% en 1980 et 12% en 1989, et les Coccolithophorides sont passés de 0.4% en 1979 à 37% en 1980 et à 76% en 1989; les floraisons de l'espèce "Coccolithus huxleyi" ont affecté les eaux de la haute mer tant en 1980 qu'en 1989.

Si jusqu'en 1970 le développement plus abondant du phytoplancton a affecté seulement les eaux côtières peu profondes, il a gagné ensuite les eaux de la haute mer; la biomasse moyenne du phytoplancton de cette dernière zone, de 495 mg/m3 (1960-1966) (SKOLKA, 1967, 1969) jusqu'à 90 Km de distance du littoral, y a augmenté jusqu'à 1.065 mg en 1979, à 2.770 mg en 1980 et à 1.065 mg en 1989.

L'augmentation de la production phytoplanctonique est illustrée aussi par la concentration en chlorophylle a, comprise entre 0.15 - 5.6 mg/m3 jusqu'à 40 Km, entre 0.06 - 0.15 mg jusqu'à 90 Km (1963), entre 0.2 et 4.4 mgr dans les eaux peu profondes (1976-1977), entre 3 et 35 mg devant les embouchures du Danube, à 12 Km pendant une intense floraison de Skeletonema costatum (1982) et entre 0.04 et 4.2 mg/m3 aussi jusqu'à 90 Km (BOLOGA et al., 1981, 1985).

Pendant les trois expéditions effectuées au-dessus de la plate-forme continentale Roumaine en 1989, nous avons observé, en fonction des particularités physico-chimiques, des associations successives, caractéristiques de chaque masse d'eau.

En février, dans les eaux côtières dominaient Gymnodinium splendens, Gyrodinium fusiforme, G. lachryma, G. nasutum, Thalassiosira parva et Th. subsalina, dont les deux dernières furent autrefois caractéristiques de la saison froide. Plus au large, on a observé un mélange de Skeletonema costatum, Prorocentrum cordatum et Gymnodinium splendens, mélange jamais relevé en mer Noire depuis 1959, car P. cordatum produit de fortes floraisons pendant les mois les plus chauds.

En mai, dans les eaux moins salées dominèrent Thalassiosira parva, Gymnodinium agile, G. sphaericum, Protoperidinium globulus, Glenodinium paululum, etc. La zone de la haute mer était envahie par "Coccolithus huxleyi" et le mélange cité plus haut de Dinoflagellés.

En août, on a trouvé près de la côte l'association Goniaulax cochlea, Prorocentrum cordatum, Cerataulina pelagica et Rhizosolenia calcar-avis et en haute mer la floraison de "Coccolithus huxleyi" en mélange avec de rares Dinoflagellés.

Chaque mois, dans les différentes masses d'eaux se développèrent d'une saison à l'autre, des quantités phytoplanctoniques croissantes. Pour la couche de photosynthèse de 0-20 m, les moyennes générales de biomasse phytoplanctonique furent 559 mg/m3 en février, 4501 mg en mai et 8.049 en août.

Les résultats concernant la chlorophylle a dans la couche superficielle (0 m) furent de 0.2 à 2.16 mg/m3 et dans la couche de 5-50 m entre 0.04 et 4.15 mg/m3 en mai, et entre 0.07 et 3.30 mg/m3 dans la couche de 0-50 m en août. Les valeurs de la production primaire furent de 5.8 à 73.4 mg C/m3 (0 m), entre 1.2 et 124.6 mg C/m3 (5-50 m), soit entre 3.4 et 48.4 mg C/m2 (0-50 m) en mai. En août, ces valeurs furent de 3.2 à 99.1 mg C/m3 (0 m), 1.3 à 82.0 mg C/m3 (5-50 m), soit 6.6 à 19.7 mg C/m2 (0-50 m).

REFERENCES

BODEANU, N., 1984.- Trav. Mus. Hist. Nat. Gr. Antipa, 26, 70-83.
BOLOGA, A.S., 1981.- Rapp. Comm. int. Mer Médit., 27, 7, 77-78.
BOLOGA, A.S. et al., 1985.- Cercetări Marine, IRCM, Constantza, 18, 97-115.
DOROGAN, L. et al., 1985 .- Rapp. Comm. int. Mer Médit., 29, 7 : 57-59.
PECHEANU, I. et al., 1977 .- Cercetări Marine, IRCM, Constantza, 10, 67-75.
SAMYCHEV, E.Z., 1987.- Ryboe Hoziaistvo, 6, 40-43.
SKOLKA, V.H., 1967.- Ecologie Marină, 2, 193-293.
SKOLKA, V.H., 1969.- Ecologie Marină, 3, 149-226.

P

L'effet de la pollution du Golfe d'Izmir sur certains Dinoflagellés

N. OKTEM et D. ENGIN

Département de Biologie, Faculté des Sciences, Université d'Egée, Bornova-Izmir (Turquie)

Cette recherche constitue la suite de deux autres travaux réalisés en 1985 par ÖKTEM et SESEN et en 1987 par ÖKTEM et ENGIN.

Le genre Ceratium Schrank, avec son apparence caractéristique qui a toujours attiré l'attention des chercheurs, a été réétudié par SOURNIA (1984) du point de vue classification et nomenclature. Le travail de HALIM (1963) est important par les informations qu'il rassemble sur les Ceratiums de la Méditerranée orientale.

L'étude et les données sur les planctontes du golfe d'Izmir (ERGEN, 1967) et sur les Ceratiums (Öber, 1972) sont limitées à la partie interne du golfe. Les espèces du genre Ceratium ont été étudiées qualitativement et quantitativement par KORAY et GÖKPINAR (1983). Le golfe d'Izmir est soumis à des observations périodiques jusqu'au delta du Gediz.

Selon les chercheurs s'occupant de pollution, les déchets domestiques et industriels responsables de la pollution du golfe, influent considérablement sur l'activité biologique de ses eaux.

Les échantillons ont été récoltés près d'Urla et dans la partie interne du golfe au filet à plancton de 55 µm de vide de maille; ils ont été fixés par une solution de formol à 4%. Les prélèvements ont été effectués entre les mois d'Avril et d'Octobre 1989, une fois par mois. On a ainsi effectué l'étude de 50 échantillons par mois récoltés en milieux pollué et non pollué.

Le pH , la salinité, l'oxygène dissous, les nitrates et les phosphates ont été mesurés par les méthodes classiques (STRICKLAND et PARSONS, 1972).

Les résultats fournis par les mesures d'exemplaires de Ceratium fusus et de Ceratium macroceros montrent que la longueur et la largeur des protistes provenant des zones polluées sont plus petites que celles des individus des zones non polluées.

Les valeurs obtenues chez Ceratium fusus et Ceratium macroceros sont les suivantes :

	Ceratium fusus :		Ceratium macroceros :	
	Longueur totale	Largeur µm	Longueur totale	Largeur µm
Zone polluée	204 - 372 (289)	12 - 37 (16)	186 - 372 (279)	31 - 62 (46)
Zone non polluée	254 -1426 (475)	12 - 37 (19)	248 - 651 (349)	37 - 99 (57)

Les valeurs ainsi obtenues, projetées sur des histogrammes, montrent que les individus de la zone polluée n'atteignent pas les tailles limites de 378 et 1426 µm observées sur les Ceratium fusus provenant de la zone non polluée (Fig. 1).

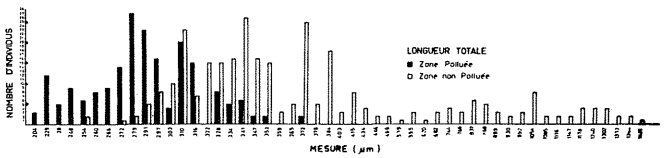


Figure 1 : La longueur cellulaire de Ceratium fusus en zone polluée et non polluée (en abscisses : nombre d'individus 0-28).

Autrement dit la grande taille est dominante en zone propre. Cette observation est valable également pour Ceratium macroceros. Les valeurs de 384 et 561 µm n'ont été relevées que sur des individus des zones non polluées (Figure 2).

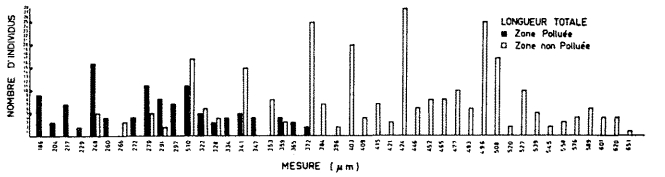


Figure 2 : La longueur cellulaire de Ceratium macroceros en zone polluée et non polluée (en abscisses, nombre d'individus 0-28).

Par l'analyse de variance à un facteur, nous avons comparé les longueurs et les largeurs des spécimens provenant des deux régions. Avec une probabilité de 0.05, la valeur critique de F est F 0.05 (n-2)= 4.04. Si F est inférieur à 4.04, cela signifie qu'il n'y a pas de différence importante entre les variantes et inversement on remarque, dans les tableaux suivants qu'il existe une différence entre les longueurs et les largeurs des protistes.

Analyse de variance à un facteur chez Ceratium fusus

Paramètres / mois	Longueur totale	Largeur	Décision
Mai	38.45	34.36	+
Juin	19.99	17.18	+
Septembre	14.00	26.99	+
Octobre	75.55	4.98	+

Analyse de variance à un facteur chez Ceratium macroceros

Paramètres / mois	Longueur totale	Largeur	Décision
Avril	143.72	4.79	+
Juin	155.58	436.31	+

Il en résulte qu'une diminution de la taille de Ceratium fusus et de Ceratium macroceros se manifeste bien sous l'influence de la pollution.

References

ERGEN, Z., 1967. The main planktonic organisms found in the Bay of Izmir. Sci. Rep. Fac. Sci. Ege University, n° 47.
HALIM, Y., 1963. Microplancton des eaux Egyptiennes : le genre Ceratium Schrank (Dinoflagellés). Rapp. Comm. Int. Mer Médit., 17 : 495-502.
ÖBER, A., 1972. Izmir Korfezinde Ceratium genusunun kalitatif ve kantitatif yönden arastirilmasi (Thèse).
ÖKTEM, N. et SESEN, H., 1985. Les effets de la pollution du golfe d'Izmir sur les Tintinnides (Ciliata). Rapp. Comm. Int. Mer Médit., 29 (9): 175-177.
ÖKTEM, N. et ENGIN, D., 1987. L'effet de la pollution sur certains Dinoflagellés du Golfe d'Izmir. Biologia Gallo-hellenica, 13.
STRICKLAND, J.D.H. and PARSONS, T.R., 1972. A practical handbook of seawater analysis. Fisheries Research Board of Canada, Bull. n° 167.

P-IV5

Consumption of nutrients from sewage effluents by the Green Alga *Enteromorpha prolifera* (Mull.) J. AG.

A.-A. SAMAAN, E.-A. IBRAHIM and M.-G. GHOBRIAL

National Institute of Oceanography & Fisheries, Alexandria (Egypt)

Introduction : Enteromorpha prolifera was selected in the present investigation for its ability to withstand wide salinity variations. Experiments were conducted to evaluate its quantitative role in the removal of inorganic nutrient salts (nitrogen and phosphorus) from diluted sewage effluents and production of protein rich algal biomass.

Materials and Methods : The alga was cultured outdoors in glass jars. A series of 15 liters culture media were prepared by mixing clear sewage effluents and seawater to obtain dilutions of 20,40 & 60% respectively. About 15 gm of fresh fronds of Enteromorpha were inoculated in each medium. The culture media with 20 & 40% sewage effluent were changed twice during three successive incubation periods of 13,12 & 7 days (in October-November, 1989), but with the same algal fronds. The 60% culture medium extended for 21 days with the original medium. Ammonia, nitrate, nitrite and phosphorus were determined at the beginning and by the end of the 3 periods. The increase in fresh and dry weights and protein content of the seaweeds were measured by the end of the each period as indices of growth.

Results and Discussion : The average water temperature of the culture media was 26.8°C and the day length was 11.5 hours. The water salinities were respectively 30.2‰, 23.4‰, and 16.6‰in cultures with 20,40 and 60% sewage effluents. The initial and final concentrations of the total inorganic nitrogen and phosphorus in the different culture media during the successive incubation periods are illustrated in table (1). Of all culture experiments performed, Enteromorpha showed better utilization of inorganic nutrients at 20% concentration. The rate of algal growth in 20% culture medium reached 1.85 gm freshweight/day and that of 40% sustained growth rate of about 1.2 times higher than that recorded for 20% during the first incubation period, but decreased again to lower values comparable to that obtained in the former dilution in the other 2 periods (table 2). The total nitrogen, built up through protein synthesis in Enteromorpha exceeded the total inorganic N present in the original media. Such high utilization rate can be sufficed by excess inorganic nitrogen, produced through bacterial breakdown of organic materials present in the effluents. Waite and Mitchell (1972a), found that the carbon assimilation by Ulva lactuca was inhibited by ammonia at concentrations higher than 60 uM. In the current study, the growth of Enteromorpha was maintained well with ammonia as high as 6.9 mg NH_3-N/liter.

The protein content in algal fonds increased by about 82% and 66% of the original values by the end of the 32 days in culture media with 20 and 40% sewage effluent respectively.

Results indicate that tertiary treatment of domestic wastes by photosynthetic algal growth appears to be successfully achieved at dilutions of about 20% sewage effluent. Concentrations higher than 40% appear to reduce algal growth as well as protein synthesis.

Table (1) : Initial & final concentrations of inorganic nitrogen & phosphorus in different culture media of 15 liters exposed in situ with 15 gm fresh wt. algal fronds.

%Sewage effluent	Duration (days)	Conc.	mg/15 liters				
			NH4-N	NO2-N	NO3-N	Total inorg.N	Total inorg. P
20%	13	Initial	40.50	0.24	5.10	45.84	31.40
		Final	0.01	0.00	0.00	0.01	3.60
	12	Initial	69.00	2.04	2.80	73.84	39.60
		Final	1.65	0.00	0.00	1.65	6.60
	7	Initial	61.95	0.17	1.70	63.82	30.10
		Final	12.30	0.00	0.00	12.30	11.30
40%	13	Initial	93.00	0.18	0.80	93.98	60.20
		Final	2.40	0.00	0.00	2.40	5.90
	12	Initial	108.00	1.53	2.10	111.63	60.90
		Final	43.50	0.00	0.00	43.50	11.10
	7	Initial	123.80	0.13	1.20	125.13	58.10
		Final	41.55	0.00	0.00	41.55	24.90
60%	21	Initial	117.20	0.12	1.40	118.72	91.10
		Final	39.90	0.00	0.00	39.90	23.70

Table (2) : Daily yield of 15 gm fresh algae (fresh and dry weights) grown in 15 liters culture media with 20,40 & 60% sewage effluents. The percentage of protein content in algal dry weights with initial concentration of 22.6% after the different exposure periods is also illustrated.

% Sewage	Duration in days	Fresh Wt mg	Dry Wt mg	% Protein
20%	13	1850	140	28.0
	12	580	30	33.8
	7	1430	80	41.3
40%	13	2310	160	28.0
	12	580	30	35.6
	7	1140	50	37.6
60%	21	860	50	24.4

Kererences

Waite, I. and Mitchell, R., 1972a. The effect of nutrient fertilization on the benthic Ulva lactuca. Bot. Mar., 15 (3), 151 : 167.

P-IV6

Temperature - Initiation factor of Red Tide Bloom in the Kastela Bay (Adriatic Sea, Yugoslavia)

Ivona MARASOVIC

Institute of Oceanography and Fisheries, 58000 Split, P.O. Box 114 (Yugoslavia)

Year-to-year recurrence of red tides by the Gonyaulax polyedra in the same area (eastern part of the Kaštela Bay) led us to suspect that cysts or "seed population" were involved. The fact that sea water samples from this area very often contain resting cysts of G.polyedra supports this hypothesis to a certain extent. Vegetative cells are typically present from April to November but not observed during the winter season when a massive diatom bloom often occurs. During April, and thereafter, dinoflagellates become more and more important within the phytoplankton community. During July, a monospecific bloom of G. polyedra extending through August and September vary in intensity over short time scales. In order to study mechanism initiating and supporting red tide occurrences in the Kaštela Bay a monitoring was undertaken during the summer 1988 and 1989. All standard oceanogrphic parameters (T, Sx10^{-3}, O_2, pH, transparency, nutrients, density of phytoplankton cells) were sampled on a weekly basis.

The analysis of temperature data pointed to the fact that red tide bloom in the Kaštela Bay is always associated with the increased sea water temperature exceeding 20°C. When surface temperature attains 20°C the bloom begins to develop reaching its peak intensity not earlier than when bottom layers attain the same temperature. The bloom persists until the surface temperature drops below 20°C (Table 1).

Table 1. Sea water temperature, existence of G.polyedra red tide and number of G. polyedra cells in the eastern part of the Kaštela Bay

Period		T(°C)	Existences of R.T. + or -	N_o of G. polyedra cells
July,	1983.	23,3	+	1,0 x 10^6
June,	1984.	21,2	+	1,2 x 10^6
July,	1984.	23,2	+	1,0 x 10^7
August,	1984.	22,1	+	1,1 x 10^7
May,	1985.	19,2	-	9,2 x 10^4
June,	1986.	20,7	+	1,3 x 10^6
April,	1988.	15,9	-	0
June,	1988.	24,1	+	3,5 x 10^6
July,	1988.	26,0	+	3,8 x 10^6
August,	1988.	26,9	+	4,0 x 10^6
September,	1988.	23,7	+	3,2 x 10^7
June,	1989.	19,7	-	6,0 x 10^4
July,	1989.	23.9	+	4,3 x 10^7

Even though the bloom of G.polyedra takes place in the surface layer, temperature of the bottom layer is also of importance for its development, that is the temperature which makes possible the excystment of G.polyedra. As shown by our results, temperature at which the excystment of G.polyedra starts at about 20°C. Upon excystment, vegetative cells of G. polyedra swim actively to the sea surface concentrating in large quantities. Red tide bloom terminates with the cooling of surface layer (temperature drops below 20°C). This is due to the fact that the bloom is limited to the surface layer since G.polyedra is markedly photophylous requiring high light intensity (ANDERSON et al., 1987).

Red tide spreading all over the bay (during September, 1988 and July, 1989) may also be related to the heating of deeper layers. Data on temperatures in summer 1988 and 1989 point to the fact that spreading of red tide all over the bay came as a consequence of thermocline descending between 10 and 20 m depth (Table 2). At that time the bottom layer of a large part of the bay attained 20°C temperature causing thus the excystment of a large number of G.polyedra cells.

Table 2. Sea water temperature (°C) in the deepest part of the Kaštela Bay during the period of investigation (1988 and 1989)

Depth(m)		V	VI	VII	VIII	IX	X
0		20,00	22,68	24,20	26,20	23,21	-
5		18,02	19,02	24,20	21,38	22,98	-
10	1988	15,32	18,40	17,32	19,04	22,00	-
20		14,70	17,12	15,30	15,54	16,49	-
35		13,99	14,90	14,18	14,06	14,78	-
0		14,69	19,60	24,64	22,23	-	16,80
5		14,70	18,80	24,56	22,18	19,85	16,80
10	1989	14,65	18,24	21,10	21,87	19,60	16,83
20		14,50	16,60	17,38	18,66	18,90	17,41
35		14,28	15,62	14,94	14,60	17,19	16,60

Our analyses indicate that the temperature determines initiation and termination of G.polyedra blooms in the Kaštela Bay. The limiting temperature is found to be around 20°C.

REFERENCES

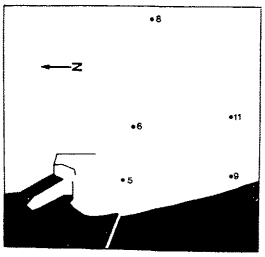
ANDERSON,D.M., C.D. TAYLOR and E.V.ARMBURST, 1987. The effects of darkness and anaerobiosis on dinoflagellate cyst germination. Limnol. Oceanogr., 32(2): 340-351.

P

Waste influence on Zooplankton Distribution in Valencia Coastal Waters (Spain)

C. BLANCO*, C. RIOS*, A. RADUAN*, E. SOLER** and J.-G. DEL RIO**

*Departamento de Biologia Animal, Universidad de Valencia, 4600 Burjassot (Spain)
**Departamento de Ingenieria Hidraulica y Medio Ambiente, Universidad Politecnica, Valencia (Spain)



The study zone corresponds to the mouth of a waste disposal channel from urban origin, mainly from the city of Valencia (Fig. 1). Twelve sets of samples were collected between May 1989 and January 1990 at six stations of different deep: 9(5m), 5(10m), 6 and 11(20m) and 8(40m). Salinity, dissolved inorganic nitrogen (nitrite, nitrate plus ammonium), dissolved phosphorous, total phosphorous, dissolved silica and chlorophyll *a* have been analized in each sample. The zooplankton studied, corresponds to vertical samples of water column, taken with a net 1m long and 53µm mesh.

Fig.1.- Localization of sampling points.

prm. / st.	SAL. (1) x̄	SAL. (1) sd	P.S.R. (2) x̄	P.S.R. (2) sd	P.T. (2) x̄	P.T. (2) sd	N.I.D. (2) x̄	N.I.D. (2) sd	$Si\,O_4$ (2) x̄	$Si\,O_4$ (2) sd	Cla (3) x̄	Cla (3) sd
5	36.72	1.13	0.27	0.22	1.72	0.66	11.99	22.25	2.02	1.78	11.12	13.42
6	37.14	0.44	0.22	0.28	1.35	0.76	8.47	9.84	1.62	1.48	4.24	3.69
8	37.53	0.30	0.09	0.05	0.74	0.23	3.14	1.79	0.94	0.52	0.86	0.91
9	36.92	0.66	0.31	0.28	1.81	1.17	9.77	6.93	1.85	1.54	8.47	11.61
11	37.27	0.43	0.18	0.09	1.20	0.55	7.08	6.22	1.38	0.89	3.58	5.45

Table 1.- Average values ($\bar{x}$) and standard deviations (sd) of physicochemical parameters at the stations. (1)‰, (2)µ at-gl^{-1}, (3) mg/m^3.

In table 1 the physicochemical data appear in the form of mean values and standard deviation in each one of the stations considered. St. 5 is the one showing the highest influence of waste disposal as it presents a lesser degree of salinity and a greater standard deviation. The contents of nutrients an silica are in general greater, showing a higher productivity in terms of chlorophyll *a*. We must underscore the increase in phosphorous due to the influence of continental waters used for agriculture purposes. Seasonal variability of these parameters as well as those referring to zooplankton composition differs according to the zones due to continental outflow irregularities and littoral dynamic factors.

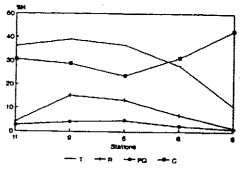
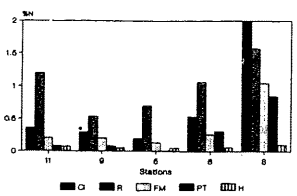


Fig.2 -Distribution of more abundant taxa in samples. T-Tintinnids, R-Rotifers, PQ-Polychaetes, C-Copepods.



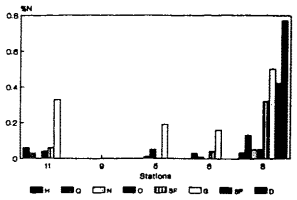


Fig. 3.- Percent abundance of different taxa. Positive gradient in open waters. 3A.- Cl-Cladocerans, R-Radiolarians, FM-Foraminipherans, PT-Pteropods, H-Hydromedusae. 3B.- H-Heliozoans, Q-Chaetognaths, N-Nemerteans, O-Ophiuroids, SF-Siphonophores, G-Gasteropods, SP-Salps, D-Doliolids.

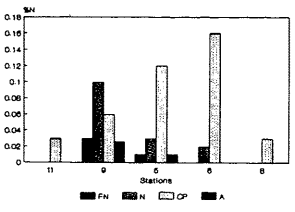


Fig.4.- Percent abundance of different taxa. Negative gradient in open waters. Fn-Phoronids, N-Nematods, Cp-Cirriped larvae, A-Ascidian larvae.

The zooplankton community is described by porcentual values of the commonest taxa. The most abundant taxa were copepods and tintinnids. The distribution of the zooplankton groupings presents a gradient that goes from 5 and 9 in the most eutrophic areas to 8 and 11 in the those of a lesser continental influence. Fourteen among the 24 taxa that were found reached their maximum values in these areas of less eutrophy (Fig. 2 and 3).

On the contrary 7 taxa present an opposite gradient showing minimum values and even disappearance in these areas (Fig. 2 and 4). Only in the case of the Appendicularians and bivalve and holoturian larval forms are particular preferences not found. The taxa belonging to more open waters correspond to heliozoans, siphonophors, salps, doliolids and chaetognaths. Nematods, phoronid and ascidian larvae might mean that their specific composition is better suited to the eutrophic conditions of the zone.

REFERENCES

- AMBLER, J.W., J.E. CLOERN and A. HUTCHINSON, 1985.- Seasonal cycles of zooplankton from San Francisco Bay. Hydrobiologia, 129: 177-197.
- MACKLAS, D.L., G.C. LOUTTIT and M.J. AUSTIN, 1980.- Spatial distribution of zooplankton and phytoplankton in British Columbian Coastal Waters. Can. J. Fish. Aquat. Sci., 37: 1476-1487.
- RADUAN, A., BLANCO, C., SOLER, E. and DEL RIO, J.G. 1990. Appendicularian dynamics and the influences of runoff on their distribution in the Bay of Cullera (Spanish Mediterranean). Scient. Mar., 53 (in press).

Planktonic Protista associated with "color-tides" in Izmir Bay (Aegean Sea)

Tufan KORAY

Ege Universitesi, Biyoloji Bölümü, Hidrobiyoloji Ana Bilim Dali, Bornova, Izmir (Turkey)

One of the most important factors affecting the seawater color is the quantity of organisms living within the body. Generally, during red tides, 10^6 - 10^8 cells /l densities of protists give their pigment colors to the seawater. However, this range may decrease to 10^5 - 10^5 cells /l when the cell sizes increase (JACQUES and SOURNIA, 1979; STEIDINGER and HADDAD, 1981; STEIDINGER, 1983).

In coastal seas and in the bays, the red-tides have been known as most important events changing the seawater color and sometimes causing PSP (paralytic shellfish poisoning) and NSP (neuro-toxic shellfish poisoning). Yet, though some species of diatoms, dinoflagellates and ciliates are not poisonous, they may excessively grow in convenient circumstances and may create green-, yellow-,etc. tides. This event may cause biological pollution especially in the bays where the nutrient budgets have been supported continuously with agricultural and domestic inputs. Furthermore, these protists whose high cell densities cause decrease of the depth of euphotic zone have negative effects on the biota indirectly by stimulating toxic extracellular nitrite production by phytoplankton living under low light intensities in the presence of adequate nitrate.

In the present study, the planktonic protists caused different type color-tides (toxic and non-toxic) of Izmir Bay were determined and their effects on the biota were summarized. The material has been collected with the project support of FAO-MAP (MED POL) TUR/24-H.

As could be seen from Table I, 4 species of diatoms (2 centric, 2 pennate), 11 species of dinoflagellates, 1 species of euglenoid flagellate and 1 species of photosynthetic symbiotic ciliate are responsible for color-tides and their excessive growth in the eutrophicated waters of Izmir Bay cause changes of seawater color.

Undoubtedly, A. minitum, G. polyedra and G. spinifera are the most important species among others because they have caused PSP sometimes. Although there exist some reports about the toxicity of P. micans and P. triestinum blooms, there are not clear evidences on the subject from Izmir Bay.

During the blooms of non-toxic color-tides the super increases of dissolved O_2 and CO_2 in seawater (produced by phytoplankton as a result of photosynthesis during the day and night) may cause gas bubbles and hypoxia illnesses respectively in many crustaceans and fishes. Especially hypoxia is the main reason of the mass emergences of the crab Carcinus mediterraneus Gerniausky, 1884 onto land on the nights during the blooms.

Table I:The planktonic protists responsible for color-tides in Izmir Bay.

Species	Blooming month	Color of the sea	Max.cells in a lt.	Tox.
BACILLARIOPHYCEAE				
Coscinodiscus granii Gough	1,2,6,7,10	Greenish -orange	$2\cdot10^3$	-
Nitzschia closterium(Ehrenberg) W.Smith	1,2,3	Pale olive -green	10^5	-
Phaeodactylum tricornutum Bohlin	6,7	Pale brown	10^7	-
Thalassiosira rotula Meunier	10,11,12	Greenish -brown	$2\cdot10^4$	-
PYRROPHYCEAE				
Alexandrium minitum Halim	3,4,5,6	Reddish -brown	10^7	PSP
Ceratium furca(Ehrenberg)Claparède et Lachmann	3,4	Brownish -orange	$4\cdot10^4$	-
Gonyaulax polyedra Stein	5,6	Reddish -brown	$5\cdot10^4$	PSP
Gonyaulax spinifera(Claparède et Lachmann)Diesing	5,6	Reddish -brown	$2\cdot10^4$	PSP
Noctiluca scintillans(Macartney) Ehrenberg	1,2,3	Pink -patches	$2\cdot10^4$	NH_3
Oxytoxum scolopax Stein	5,6,7	Pale -orange	$2\cdot10^4$	-
Prorocentrum micans Ehrenberg	1,2,5,6	Yellowish -orange	$9\cdot10^7$	?
Prorocentrum triestinum Schiller	6,7,8	Pale -orange	$6\cdot10^4$	?
Protoperidinium longipes Balech	4,5,8,9	Pale -orange	$2\cdot10^4$	-
Protoperidinium steini(Jörgensen) Balech	5,6,7,8	Pale -brown	$7\cdot10^4$	-
Protoperidinium trochoideum (Stein)Balech	5,6	Brownish -orange	$6\cdot10^6$	-
EUGLENOPHYCEAE				
Eutreptia sp.	7,8,9	Light -green	$7\cdot10^5$	-
CILIATA				
Mesodinium rubrum(Lohmann) Hamburger and Buddenbrock	1,2,3,9	Reddish -orange	$9\cdot10^4$	-

REFERENCES.

JACQUES, G. and SOURNIA, A. 1979. Les "eaux rouges" dues au phytoplancton en Méditerranée. Vie Milieu, 29(2):175-187.
STEIDINGER, K. A. and HADDAD, K. 1981. Biologic and hydrographic aspects of red tides. Bioscience 31:814-819.
STEIDINGER, K. A. 1983. A re-evaluation of toxic dinoflagellate biology and ecology. Progress in Phycological Research, 2:147-188.

P-IV9

Dynamique saisonnière pluriannuelle (1986-1989) du Zooplancton dans une aire fortement eutrophisée - les eaux côtières de Constantza (Mer Noire)

Adriana PETRAN et Maria RUSU

Institut Roumain de Recherches Marines, Constantza (Roumanie)

La zone peu profonde proche de Constantza est soumise à une intense influence anthropique liée au voisinage urbain, portuaire et industriel et représente maintenant une aire fortement eutrophisée. Cette zone a fait l'objet de nos observations mensuelles pendant la période 1975-1979, dès le début des phénomènes d'eutrophisation des eaux du littoral Roumain de la mer Noire (1,2). En 1986, nous avons repris ces recherches sur la même radiale, avec six stations réparties sur une distance de 1 à 30 miles de la côte, analysant plus de 600 prélèvements zooplanctoniques jusqu'à la fin de l'année 1989.

La période étudiée (1986-1989) est caractérisée par un renforcement de l'eutrophisation, avec de grandes quantités de nutriments dans la zone (les quantités de nitrates ont été 5 fois et celles des phosphates 25 fois plus grandes que celles de la période 1960-1970), et une croissance continue des quantités de phytoplancton (en 1986, les biomasses phytoplanctoniques ont été cinq fois plus grandes que celles observées entre 1960-1970), conséquence d'amples et fréquents phénomènes de floraisons de plus en plus intenses.

Le zooplancton des eaux côtières de Constantza a révélé pendant ces quatre années une forte tendance à l'accroissement des quantités globales, les valeurs moyennes de la densité et de la biomasse augmentant de 1986 jusqu'à 1989, à cause du développement exceptionnellement grand de l'espèce Noctiluca scintillans, qui s'est produit chaque année après les périodes de "floraison". Le déclenchement de ces poussées (même au printemps, quoique moins spectaculaires qu'en été) a déterminé pendant toutes ces années les abondances saisonnières du zooplancton total (Fig.1). Les populations les plus nombreuses de cette espèce particulièrement détritiphage, ont été trouvées dans les couches de surface, jusqu'à environ 15 miles de la côte, aux mois de juillet-août, coïncidant avec les pics de la biomasse du zooplancton total (en 1987, au mois d'août, le stock de Noctiluca atteignait les valeurs les plus élevées observées jusqu'à présent de 2048.10³ ind./m3 et 163.8 g/m3).

Pendant la période 1987-1989, en relation avec de grandes poussées phytoplanctoniques, on a enregistré des biomasses générales zooplanctoniques accrues : ainsi la valeur moyenne pour 1989 fut quatre fois plus grande que celle de 1986 (Fig.1).

L'analyse de l'évolution des principaux groupes du zooplancton consommés par les poissons (plancton trophique) a mis en évidence une tendance différente, c'est-à-dire une diminution importante de leurs quantités qui se traduisit en 1988 et 1989 par la situation précaire des communautés zooplanctoniques côtières avec de petites valeurs de biomasse (la moyenne annuelle de 1988, -10.14 mg/m3, a été plus de quatre fois inférieure à celle de 1986).

Le petit nombre de copépodes, de cladocères (en 1979 les cladocères représentent 22% de la biomasse générale et en 1989, seulement 1,8%) et de méroplanctontes a conduit, surtout pendant l'été, à des valeurs moyennes de densité et biomasse trophique inférieures à celles enregistrées dans cette zone pendant la période antérieure (2).

Parmi les espèces qui ont vu se réduire considérablement leurs populations par rapport à la décennie antérieure se trouvent le copépode Centropages ponticus, les cladocères Evadne tergestina, E. spinifera et Penilia avirostris, cette dernière ayant connu jusqu'aux années 1975-1976 un développement exceptionnel dans les eaux du littoral Roumain (1).

La dynamique des organismes méroplanctoniques a montré pendant ces mêmes années une diminution importante de leur apport pondéral à la biomasse trophique (entre 0.2 et 18/7%), à la suite de la mortalité affectant une grande partie des populations benthiques, conséquence des "floraisons".

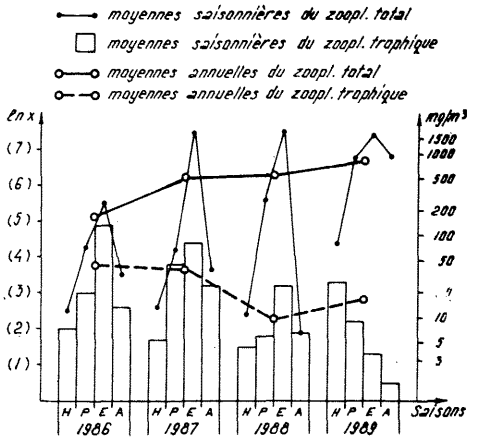


Figure 1 - Variations saisonnières et annuelles des biomasses zooplanctoniques en mg/m3 (valeurs moyennes pour la couche de 0 à 50 m)dans le secteur de Constantza.

Pendant la période considérée,nous avons observé des densités plus élevées par rapport aux années antérieures, des groupes microzooplanctoniques - tintinnides et rotifères - organismes nanophages qui pullulent au printemps et en été dans les eaux côtières (aux deux stations au voisinage de la côte, ils ont représenté jusqu' à 65% de la densité, mais seulement 16% de la biomasse zooplanctonique).

En ce qui concerne les copépodes, ils sont restés, surtout pendant l'été, le groupe dominant dans la biomasse trophique, avec Acartia clausi (3) l'espèce la plus caractéristique des milieux eutrophisés. Précisons cependant que les biomasses constituées par les copépodes ont diminué ces dernières années ainsi que pendant l'été 1989 où les moyennes des biomasses furent six fois plus basses que pendant l'été 1986 (Fig. 1).

En résumé, nos recherches ont mis en évidence l'influence saisonnière sur la structure des populations, avec en été une période de dominance d'une ou deux espèces caractéristiques des milieux fortement eutrophisés (Noctiluca, Ploopis polyphaemoides, Acartia clausi) qui ont déterminé, pour cette saison, les pics des biomasses (Fig.1).

La forte eutrophisation de la zone étudiée s'est traduite par un appauvrissement qualitatif et quantitatif des communautés zooplanctoniques, les années 1988 et 1989 se signalant par les valeurs les plus basses de biomasse et aussi par les captures moins abondantes de poissons planctonophages sur le littoral Roumain de la mer Noire.

Références bibliographiques

1. PETRAN A. et IALINA E., 1979 - Rapp. Comm. int. Mer Médit., 25/26, (8): 123-124.
2. PETRAN A. et IALINA E., 1981 - Rapp. Comm. int. Mer Médit., 27, (7) : 117-118.
3. PETRAN A., 1986 - Recherches Marines, 19 : 55-72.

P-IV10

Discrimination du Plancton influencé par la pollution au moyen des analyses multivariées

I. SIOKOU-FRANGOU, K. PAGOU et V. GIALAMAS

Centre National des Recherches Marines, 16604 Athènes (Grèce)

Dans le cadre programme MEDPOL, des échantillons de plancton ont été prélevés afin de surveiller l'impact de la pollution sur l'écosystème pélagique du golfe Saronikos. L'échantillonnage a été effectué en 11 stations dispersées dans le golfe Saronikos et la baie d' Elefsis en février et mai 1987. Les échantillons de phytoplancton ont été pris en surface et ceux du zooplancton du fond de la mer à la surface (filet WP-2). La classification hiérarchique et le quadrage multidimensionnel ont été utilisés (Clarke & Green,1988).

La densité du phytoplancton a varié fortement en février, présentant des valeurs très hautes dans la baie d' Elefsis (1477123 c/l) et des valeurs plus basses aux autres stations (min = 3300 c/l). Ce fait est lié à l' eutrophisation de la baie, due aux charges polluantes domestiques et industrielles et au caractère semi-fermé de la région. En mai, la densité phytoplanctonique a augmenté en general, variant entre 15300 c/l (st. 5) et 820000 c/l (st. 1). Au contraire le zooplancton n' a pas présenté de fluctuations importantes d'une station à l' autre (600 a 2100ind/m³). Les valeurs basses de densité dans la baie d'Elefsis, semblent être exceptionnelles pour l' année 1987, puisque de très hautes valeurs y ont été observées antérieurement (Moraitou-Apostolopoulou et Ignatiades, 1980). Cette diminution peut être liée à la présence précoce des méduses Aurelia aurita, prédateurs du plancton.

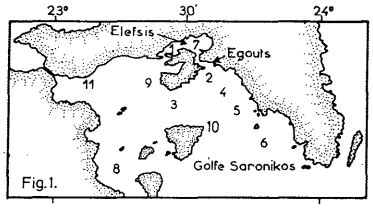
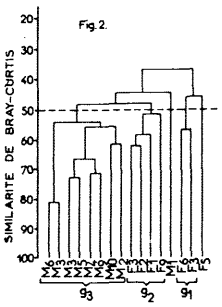


Fig.1.

En ce qui concerne la composition spécifique, les figures obtenues de la classification hiérarchique et du quadrage multidimensionnel (fig. 2 et 3) révèlent une distinction tant d'après la saison que selon la pollution: le quadrage positionne la station 1 en mai et en février d'un côté et les stations oligotrophes et riches en espèces (F5,F6, F3) de l'autre. Au niveau 50% de similarité, trois groupes sont à distinguer: a)le groupe g_1 des échantillons pris en février aux stations 1,2,8,9 et caractérisés par les espèces Gyrodinium glaucum, Cryptomonas sp., Chaetoceros affine, Thalassiosira rotula et Gymnodinium breve. b) Le groupe g_2 des échantillons pris en février aux stations 3 et 6, caractérisés par les espèces Rhizosolenia stolterfothii, Gyrodinium spirale, Nitzschia seriata, Thallassionema nitzschioides. c) le groupe g_3 des échantillons pris en mai à toutes les stations sauf celle de la baie d'Elefsis. Les stations du golfe sont caractérisées par une composition équilibrée des espèces Exuviaella baltica, Peridinium trochoideum, Cryptomonas sp., Nitzschia closterium. Au contraire, la station de la baie se distingue par la forte dominance de Peridinium trochoideum (75.9%) et la présence de Ochromonas sp., Eutreptia sp., Exuviaella marina. Ces résultats suggèrent une influence de la pollution plus sur la densité que sur la composition spécifique du phytoplancton. Toutefois, dans la baie d'Elefsis, des blooms phytoplanctoniques ont été observés, mais en périodes de calme les communautes présentent une diversité assez haute. Ce fait avait été déjà remarqué dans la région par Moraitou-Apostolopoulou & Ignatiades (1980).



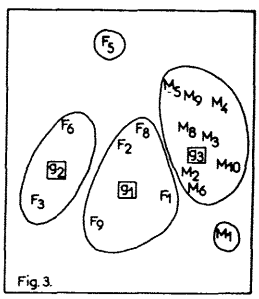
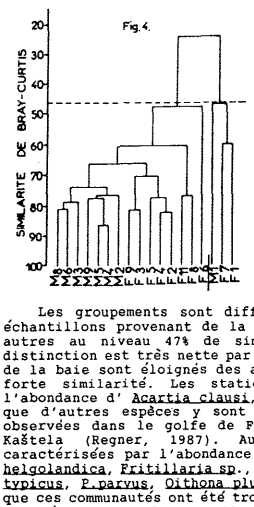


Fig.3.



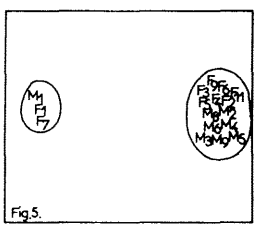


Fig.5.

Les groupements sont différents pour le zooplancton (fig. 4). Les échantillons provenant de la baie d'Elefsis se distinguent de tous les autres au niveau 47% de similarité, tant en février qu'en mai. La distinction est très nette par le quadrage (fig.5), comme les échantillons de la baie sont éloignés des autres, d'ailleurs superposés à cause d'une forte similarité. Les stations de la baie, sont caractérisées par l'abondance d' Acartia clausi, Podon polyphemoides, Oithona nana, tandis que d'autres espèces y sont rares. Des situations semblables ont été observées dans le golfe de Fos (Benon et al.1978) et dans la baie de Kaštela (Regner, 1987). Au contraire, les autres stations sont caractérisées par l'abondance en février de Ctenocalanus vanus, Oithona helgolandica, Fritillaria sp., Paracalanus parvus et en mai par Centropages typicus, P.parvus, Oithona plumifera, Evadne nordmanni. Il faut signaler que ces communautés ont été trouvées même à la station 2 qui se trouve près de l'égout central, mais il semble que la circulation des eaux dans le golfe dilue les effluents et diminue l'effet de la pollution sur le plancton.

BENON, P., B.BOURGADE, R.KANTIN (1977) These Doct.3e cycle, Aix-Marseille.
CLARKE, K.R.& R.H.GREEN (1988) Mar.Ecol.Progr.Ser.46:213-226.
3MORAITOU-APOSTOLOPOULOU, M.&L.IGNATIADES (1980) Hydrobiologia 75:259-266.
REGNER, D. (1987) FAO Fish.Rep. 352:201-215.

The recent study of the Copepod community from the Eastern Adriatic Coast caused by eutrophication

Dubravka REGNER

Institute of Oceanography and Fisheries P.O. Box 114, 58000 Split (Yugoslavia)

This paper presents some recent results about progressive changes of the copepod community from the eastern Adriatic coast caused by eutrophication. Previous long-term results in front of the most important harbours of the eastern Adriatic, showed some changes of copepod composition and biomass (REGNER,D., 1987). As summer was found the most threatened season throughout the year, investigations were continued with the special attention to this season.

The material for this study was taken by vertical hauls of the Hensen plankton net (73/100, silk N°3), from bottom to surface at the permanent stations in front of Zadar, Šibenik, Split, Kardeljevo and Dubrovnik (Gruž), and from two stations in the Bay of Kaštela, situated in the middle part of the bay, and at the eastern - the most threatened area under the influence of the industrial wastes (Fig. 1).

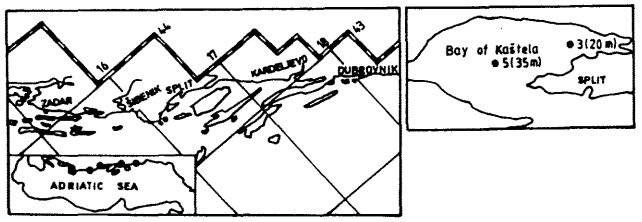


Fig. 1. The study area

In 1985-1988 period, about 40 species of copepods including two genera were found at the investigated stations in summer season.Neritic species that usually occur in higher density, dominated again at whole investigated area. Between all of them, Acartia clausi was markedly dominant, even with higher percentage than in the previous results (Fig. 2).

Furthermore, the long-term data on copepod biomass (expressed with number of copepods per m^3), showed the trend of the increasing, too. This phenomenon we can connect with the permanent increasing of phytoplankton density in the eastern Adriatic coast (PUCHER-PETKOVIĆ, 1989) in the same period.

Studies on some hydrographic and chemical parameters in 1984-1988 period have shown some oscillations, too. According Morović (in DUJMOV et al.,1988)sea-water

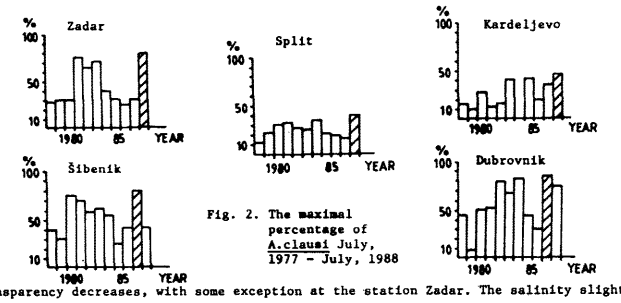


Fig. 2. The maximal percentage of A.clausi July, 1977 - July, 1988

transparency decreases, with some exception at the station Zadar. The salinity slightly increases in front of Zadar and Šibenik, while nitrate and phosphate levels slightly increase at all investigated stations (Stojanoski, Vukadin and Zvonarić in DUJMOV et al., 1988).

Besides, more interesting results were found at the Kaštela Bay during Red tide event. The percentage of Acartia clausi increased in summer from ten percents in the eastern part of the bay, to almost twice in the middle of the bay in three - years period (Tab. 1).

Tab. 1. The percentage of Acartia clausi at the Kaštela Bay

	Station 3	Station 5
July 1982-1985	60 %	35 %
July 1988	70 %	65 %

The biomass expressed by density showed the trend of the increasing from 1970. to 1988, too (Tab.2), even in the middle part of the bay, where the influence of the coast was not so strong as in the coastal part (before Red tide phenomena became rather frequent).

Tab. 2. The biomass of copepods (number/m^3) at the station 5

July 1970-74	188
July 1982-83	350
July 1988	484

So, the markedly increased percentage of Acartia clausi,as the increasing of copepod density, we can clearly connect with the progressive eutrophication of the eastern Adriatic coastal waters, and the increasing phytoplankton density especially in summer.

References

DUJMOV et al.,1988.Kontrola kvalitete priobalnog mora.Studije i elaborati 86,IOR,Split, 200 p.

PUCHER-PETKOVIĆ,T.,1989. Etude des fluctuations pluriannuelles du phytoplancton dans les eaux de l'Adriatique moyenne.XXI Congresso Società Italiana di Biologia Marina - sous presse.

REGNER, D.,1987. The impact of pollution on the copepod community from the eastern Adriatic coast.Chemosphere, 16, 2/3, p.p. 369-379.

Accumulation of Mercury in a marine food web of the Mediterranean

V. MINGANTI, R. CAPELLI and R. DE PELLEGRINI

Istituto di Analisi e Tecnologie Farmaceutiche ed Alimentari, Università di Genova, Via Brigata Salerno, 16147 Genova (Italia)

High levels of mercury in some marine organisms from the Mediterranean have been explained by accumulation processes in the food chain (Buffoni at al., 1982).

Aim of this research is to investigate the mechanism of bioamplification of mercury in a marine food chain. This is a crucial step towards understanding the biogeochemical cycle of mercury in the marine ecosystem.

The characterization of a food chain in the Mediterranean is a difficult task due to the great number of species and to the lack of specialization in predation. The food web of the Red Shrimp has been studied in detail (Relini Orsi and Wurtz, 1977) and several species of this food chain (*Meganycthiphanes norvegica, Gennadas elegans, Pasiphaea sivado, Pasiphaea multidentata, Aristeus antennatus*) have been chosen as representing increasing trophic levels even if a strict distinction is not possible.

The presence in the environment of different chemical forms of mercury with different chemical behavior makes necessary to examine the distribution of the different chemical species separately. All samples have been thus analyzed for the total mercury content and for organic mercury content. Inorganic mercury is obtained as difference between total mercury and organic mercury.

Sampling and classification of specimens have been realized with the help of Prof. L. Relini Orsi and Prof. G. Relini of the Department of Zoology (university of Genova). All samples have been stored deep-frozen until the analysis was performed.

Samples have been freeze-dried before analysis to calculate the fresh weight/dry weight ratio without any loss of sample and to help its homogeneisation.

Organic mercury determination was carried out on an aliquot of the dried samples by graphite furnace atomic absorption spectrometry (GFAAS) after extraction in toluene and back-extraction in 0.01M sodium thiosulfate solution. The sensitivity of the method was 0.007 µg/g dry weight.

Total mercury was determined on the residual sample, after mineralization by nitric acid, by cold vapor atomic absorption spectrometry with gold amalgamation preconcentration (Au-CVAAS). The sensitivity of the method was 0.003 µg/g dry weight.

Accuracy of the whole procedure was tested as follows: (a) no loss of mercury occurs during freeze-drying process (personal communication), (b) organic mercury determination has been compared to other laboratories, and (c) total mercury determination has been checked with standard reference materials.

Results obtained are summarized in Figure 1, where the distributions of the logarithms of the concentrations found for inorganic and organic mercury are compared. Even if the distributions in the various species are overlapping, a noticeable increase in mercury (both inorganic and organic) can be detected. Along the trophic chain the accumulation of organic mercury is more marked than those of inorganic mercury.

The trophic chain proposed is a rough simplification of the natural processes, however the accumulation of mercury can be clearly seen.

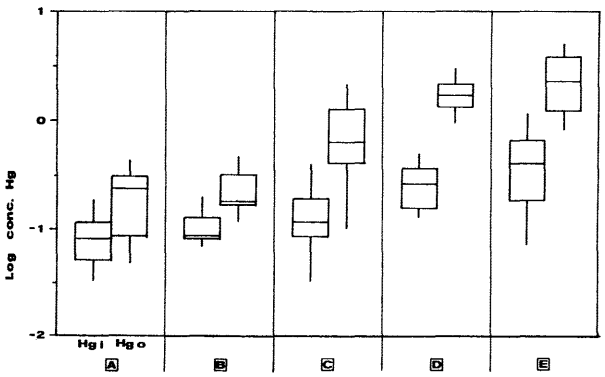


Figure 1. Box and whiskers plots of the concentrations of inorganic and organic mercury (as µg/g dry weight) of the selected species. On the vertical axis is reported the common logarithm of the concentrations. [A] *Meganycthiphanes norvegica*, [B] *Gennadas elegans*, [C] *Pasiphaea sivado*, [D] *Pasiphaea multidentata*, [E] *Aristeus antennatus*.

REFERENCES

Buffoni G., Bernhard M. and A. Renzoni, 1982. Thalassia Jugosl., 18: 231-243.

Relini Orsi L. and M. Wurtz, 1977. IX Congresso Soc. Ital. Biologia Marina, Lacco Ameno d'Ischia, 19-22 Maggio 1977: 389-398.

P-V1

Phytoplankton and Zooplankton relationships in several coastal areas of Palma Bay (Baleares Islands) 1988-1989

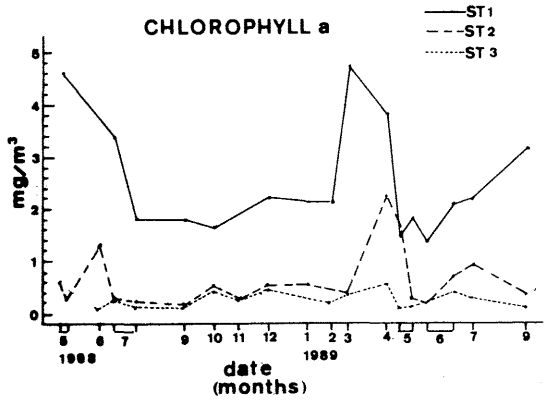
M.-L. FERNANDEZ DE PUELLES and J. JANSA

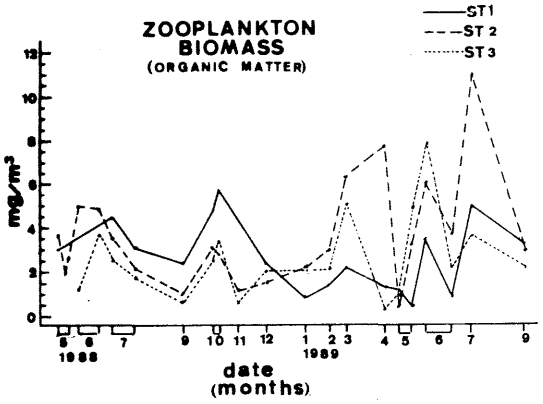
Centro Costero de Baleares. Apdo. 291. Palma de Mallorca (Spain)

In order to define the temporal coastal variations of the planktonic communities in relation to the pelagic environments, physical, chemical and biological(phyto-plankton and zooplankton) marine samples were collected from May 1988 to September 1989. Three different areas of Palma Bay (Mallorca Island) were sampled, at least monthly : Station 1 : Port area, 20 m depth. Station 2 : nearby a sewage effluent, 30 m depth and Station 3 : a cleaner area in the middle of the bay, 30 m depth.

Zooplankton samples were taken with a 20 Ø cm Bongo plankton net 250 µm mesh, equipped with an oceanic 2030 flowmeter, to know the volume of the water filtered in each tow (Steedman, 1974).

Data were analyzed and compared. Annual temperatures varied from 27.7° C in July to 14.4°C in January. The lowest value observed during the studied year was 1°C higher than in previous years (Navarro, 1931, 1932; Lopez-Jurado, 1989). In all areas, a cold homothermy developed in winter, but in summer, a hot homothermy was only observed inshore and a clear thermocline was found offshore.





The euphotic layer, estimated 30 m deep, was close to the bottom at stations 2 and 3, while at station 1, it was only 10 m deep in an average.

All the nutrients values obtained are not considered limiting factors especially inshore, where from July to next February an increase of nitrate and phosphate could be observed (2.5 µg at N/l and 0.5 µg at P/l in September), with mean values of 0.70 µg at N/l and 0.26 µg at P/l, and offshore values 0.20 µg at N/l and 0.18 µg at P/l.

Chlorophyll "a", as an index of phytoplankton biomass, presented a clear gradient between the three areas : in port area, the mean value (2.7 mg/m3) was 10 times higher than at station 3 (0.29 mg/m3), and at station 2 (0.5 mg/m3) twice higher than at the latter. At the same time the zooplankton biomasses obtained were 4.3, 4.9 and 3.7 mg of dry weight/m3 and 2.9, 3.6 and 2.8 mg organic matter/m3, at stations 1, 2 and 3 respectively.

The similarity of organic matter values at stations 1 and 3 can indicate that the inshore phytoplankton is not utilized by the zooplankton grazers (> 250 µm), especially in spring, although at offshore stations, that can be finished.

In the middle of the bay (station 3), the nutrients and the chlorophyll were poorly represented, but several zooplankton maxima values were observed, in spring, early summer and autumn, higher than expected in this oligotrophic area (Margalef, 1989). At station 2, similar variation as in the former area was seen, but particularly in summer, greater values of biomass were appreciated.

REFERENCES

López-Jurado, J.L., 1989. Bol. I.E.O. (en prensa)
Margalef, R., 1989. Ed. Omega, Barcelona.
Navarro, F., 1931. Notas y resumenes I.E.O., n° 47.
Navarro, F., 1932. Registros y Notas I.E.O., n° 63.
Steedman, H.F., 1974. J. Conseil Int. Explor. Mer 35 (3), 351-358

P-V2

Brachiomonas sp. and *Eunotia* sp. two new Microalgae favourable for mariculture cultivation

B. SKARAMUCA , J. SANKO-NJIRE , M. CARIC and D. VILICIC

Biological Institute, P.O. Box 39, Dubrovnik (Yugoslavia)

The unicellular algae have been used in aquaculture as food for zooplankton and some other herbivorous organisms, e. g. larval bivalves .One of the main conditions has been the fastest possible growth of populations and adequateness of the species's size and quality as food for the organisms they have been grown for. Although the concentrated algae (either frozen or dessicated in capsulae) have been used lately as a food for zooplankton, live unicellular algae have remained a basic food in mariculture. Consequently, new phytoplankton species are still being isolated and the investigations on their ecology and nutritional quality carried on.

This paper presents the results of the research work on two microalgae (Brachiomonas sp. and Eunotia sp.) isolated at the Biological Institute, Dubrovnik, where they were used for the first time as food for rotifers. This work is a part of a larger programme "Influence of the different algae on the growth and nutrient quality of the rotifer Brachionus plicatilis for better survival and growth conditions of the rotifer-fed sea bass larvae and the post-larvae".

The two algae were isolated in supralittoral rock pools in Dubrovnik, by the standard method of dilution and micropippeting (Knight-Jones, 1951). The algae were cultured in pasteurized nutrients enriched sea water (Guillard and Ryther, 1962) in aerated 50 l plastic bags, at 22°C and 12 hL: 12 hD cycle and the light level of 480 lux. The culture density was determined daily by microscopic counts in Burker-Turk chamber. The rotifer Brachionus plicatilis was inoculated (ca 10 ind/ml) when the algae population density reached over 3 x 10^5 cells/ml). The growth of rotifer population was observed daily, until the density was sufficient for larvae's food. Rotifer's chemical composition was also analysed (Carić et al, 1989).

Both phytoplankton species achieved high population densities on the fifth day of the trial (Fig 1). The green algae Brachiomonas sp. was observed to retain the highest density somewhat longer than the other species. Moreover, rotifer Brachionus plicatilis fed on Brachiomonas sp. reached higher density values than when fed on the diatom Eunotia sp. (Fig 2).

Water, ash, lipids and proteins contents of the rotifer fed on these two microalgae differed from those of the rotifer fed on Chlorella sp. and Phaeodactylum tricornutum (Caric et al, 1989). Highest protein levels were found in Eunotia sp. - fed rotifer, whereas lipids were observed to achieve the highest values in rotifer fed on Chlorella sp. Because of a relatively fast population growth which saves both time and energy and thus reduces production costs, optimal cell size (15 - 90 µm) and high protein levels, we recommend the use of both microalgae for rotifers rearing.

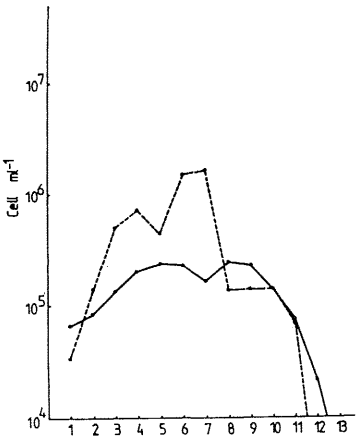


Figure 1. Population growth of microalgae Eunotia sp. (----) and Brachiomonas sp. (——)

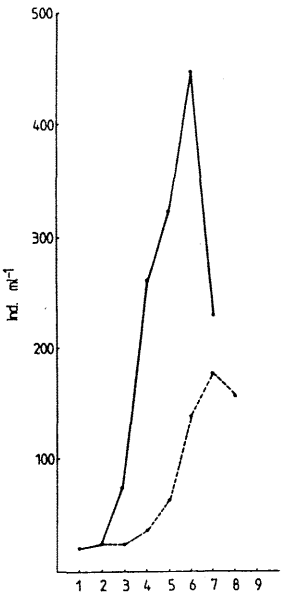


Figure 2. Population growth of the rotifer Brachionus plicatilis fed on Brachiomonas sp. (——) and Eunotia sp. (---)

REFERENCES.

CARIC, M., SKARAMUCA, B. and SANKO, J., 1989. Nutritional effect on the biochemical composition of the rotifer (Brachionus plicatilis Muller). Period. biol., 91: 128-129.

GUILLARD, P.R.L. and RYTHER, J.H., 1962. Studies on marine planktonic diatoms I Cyclotella nana Hustedt and Detonula confervacea (Cleve.) Gran. Can. J. Microbiol., 8: 229-239.

KNIGHT-JONES, E.W., 1951. Preliminary studies of nannoplankton and ultraplankton systematics and abundance by a quantitative culture method. J. Cons., 17: 140-155.

P

P-V3

Chemical composition of the Rotifer (*Brachionus plicatilis*, Muller) fed on *Brachiomonas* sp. and *Eunotia* sp.

M. CARIC, B. SKARAMUCA and J. SANKO-NIJRE

Biological Institute, P.O. Box 39, Dubrovnik (Yugoslavia)

As a live food, rotifer (Brachionus plicatilis Muller) is well-suited to the purpose of rearing the larvae of most marine fish, due to its appropriate size, rapid production rate and capability to be fed on a variety of live unicellular algae or baker's yeast. Nutritional quality of the rotifer is very important in the survival of fish larvae (Howell, 1977). This study aims at investigating the nutritional effects of phytoplankton monocultures Brachiomonas sp. and Eunotia sp., which were isolated in Biological Institute in Dubrovnik, on the chemical composition of the rotifer. The rotifer's samples were taken at exponential, stationary and death phases in order to determine water, ash, total lipids, proteins and carbohydrates contents.

Algae were cultured in the pasteurized natural sea-water enriched with nutrient and in their late exponential phase of growth, the rotifer was added. The rotifers were separated on 53 µm aperture naylon mesh. In the samples the moisture were determined by drying at 60° C and ash content by ashing at 800° C (Lovergrove,1966). Lipids were extracted with a chloroform-methanol mixture and estimated by the sulphophospho-vanillin method (Barnes and Blackstock,1973). To the lipid free pellets TCA was added. In supernatant total carbohydrates determinations were done using a phenol sulfuric acid method reported by Kochert (1978). In precipitate protein was assayed as described by Bradford (1976). Three experimental series were performed.

Table I shows the values of water, ash, lipids, carbohydrates and proteins content in rotifers fed on the green algae Brachiomonas sp. and the diatoms Eunotia sp. at exponential, stationary and death phases. In the both samples water content reached its lowest value at the stationary phase of growth. Ash levels were highest at the death phase, probably due to a decline in organic matter. Its highest value was found in Eunotia sp.-fed rotifer and probably was consistent with siliceous nature of cell walls of diatoms. Lipids and carbohydrates were observed to decline from the exponential to the death phases. Protein levels increased at the stationary phase and reached the highest value in Eunotia sp.-fed rotifers. At the last growth phase a marked and fast decline in lipids, carbohydrates and proteins was observed along with an increase in ash and water contents. The above results indicate that the rotifer should be maintained at the late exponential phase when it was observed to be most suitable to the feeding purposes.

In our further research rotifers at the late exponential phase of growth fed on Brachiomonas sp. and Eunotia sp. should be used as a diet for fish larvae. The chemical composition and the survival rate of fish larvae would be observed.

TABLE I: Moisture (%wet weight), ash, lipid, carbohydrat, protein (%dry weight).
Growthcycle: I-exponential, II-stationary and III-death phases.
Means at the same phase of growth followed by different superscripts are significantly different (P<0,05, Student's t-test)
Inoculum on Day 0 contained 89,7% moisture, 6,9% ash, 12,4% lipid, 2,1% carbohydrat and 38,4% protein.

		ROTIFERS FED ON				
	PHASES OF GROWTH	BRACHIOMONAS sp.	EUNOTIA sp.	BRACHIOMONAS sp.	EUNOTIA sp.	PHASES OF GROWTH
LIPID	I	13,9[a]	14,5[a]	87,5[a]	89,7[b]	I
	II	11,5[a]	13,3[a]	86,9[a]	88,3[a]	II MOISTURE
	III	10,3[a]	12,2[a]	90,0[a]	91,7[a]	III
CARBO-HYDRAT	I	3,5[a]	4,1[a]	6,1[a]	10,2[b]	I
	II	2,9[a]	3,8[a]	7,9[a]	12,7[b]	II ASH
	III	2,2[a]	2,8[a]	13,2[a]	17,0[b]	III
PROTEIN	I	28,7[a]	42,3[b]			
	II	45,1[a]	54,6[b]			
	III	34,2[a]	38,5[b]			

REFERENCES.

BARNES, H. and BLACKSTOCK, J., 1973. Estimation of lipids in marine animals and tissues: detailed investigation of the sulphophospho-vanillin method for total lipids. J. Exp. mar. Biol. Ecol., 12: 103-118.

BRADFORD, M. M., 1976. A rapid and sensitive method for the quantitation of micrgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem., 72. 248-254.

HOWELL, B. R., 1977. Aspects of the development of cultivation techniques for flatfish, Ph. D. Thesis, M.A.F.F., Fisheries Laboratory, Lowestoft U.K., 53: 833-838.

KOCHERT, G., 1978. Carbohydrate determination by the phenol-sulfuric acid method. In: Handbook of phycological methods: physiological and biochemical methods. Ed. by J. A. Hellebust and J.S. Craigie. London: Cambrige University Press: 95-97.

LOVERGROVE, T., 1966. The determination of the dry weight of plankton and the effect of various factors on the values obtained. In: Some contemporary studies in marine science. Ed. by H. Barnes, London: 429-467.

P-V4

Heterotrophic Plankton dynamics in the stratified water column in the Gulf of Trieste (Northern Adriatic)

Valentina TURK, Lovrenc LIPEJ and Alenka MALEJ

Marine Biological Station, Institute of Biology, JLA 65, 66330 Piran (Yugoslavia)

The classical view of planktonic food chain changed with the realization that bacterioplankton is a major pathway in the flux of organic material and energy in pelagic marine ecosystems. Nanoflagellates are important bacterivores, and appear to be regulated through predation by larger protozoa (Wikner & Hagström, 1988). Rapid remineralization of organic matter channeled through bacterioplankton and the prozoan predator-prey chain can cause the release of nutrients.

The field population dynamics based on abundances of bacterioplankton and those organisms presumed to be their predators was followed in the coastal waters of the Gulf of Trieste during summer in 1988 and 1989. Standard methods were used for collection of the samples. Epifluorescence microscopy was used to count bacteria and nanoflagellates in formalin preserved and stained samples, and live cyanobacteria in green excitation light. Bacterial production was measured by the incorporation of ^{3}H-thymidine (Fuhrman & Azam,1982). Microzooplankton (< 200 µm) was enumerated in formalin preserved samples, using a Wild inverted microscope. The quantitative counts of net zooplankton (10 Standard net, 200 µm mesh size) were made on aliquots of the formalin sample.

A seasonal study showed the dominance of autotrophic cyanobacteria, and an increase of heterotrophic bacterial biomass and production during the period of stratification (Fig.1-A,B). The biomasses of heterotrophic bacteria and cyanobacteria were high in July and August, with abundances of 9.1-14.0*10^8 cells $l^{-1}$and 2.6-5.6*10^7 cells l^{-1}, respectively. A peak of bacterial production up to 5.4*10^4 cells l^{-1} h^{-1} was observed in August.

A bloom of nanoplankton and picoplankton developed in late July-August presumably due to low abundance of main predators, and direct microbial utilization of the fraction ungrazed by higher levels. The seasonal dynamics of protozoa and metazoa (Fig.1-C,D) support this presumption. After a peak of 1.4 *10^6 cells l^{-1}, flagellate number decreased through the summer, while abundance of ciliates increased at the end of August, which coincided with bacterioplankton sharp decrease. Total microzooplankton abundance varied from 56 to 669 ind./l, with the dominance of oligotrichous ciliates such as Aloricates (*Strombidium* and *Tontonia*) and the tintinnid *Helicostomela subulata*. Other tintinnids (*Eutintinnus* spp., *Tintinnopsis* spp., *Dictyocysta* sp., *Favella ehrenbergi*, *Stenosemella* spp., and *Steenstrupiella*) were encountered rarely with low abundance.

Copepods with dominant neritic species (*Acartia clausi*, *Clausocalanus* spp., *Ctenocalanus vanus*, *Paracalanus* sp., *Temora longicornis*, *Centropages typicus*, *Oithona* spp., *Oncaea* spp.) were not important in the stratified pelagic system and showed clear peaks of abundance in May and October. On the contrary, cladocerans (dominant species *Penilia avirostris*) showed a large pulse of abundance in August, and similar seasonal pattern has been observed also for Appendicularia (dominant species *Oikopleura dioica* and *O. longicauda*).

Bacteria and cyanobacteria are actively consumed and metabolized by a variety of micrograzers depending on individual feeding capability and efficiency. Similar trophic interaction and the role of predators in regeneration of nutrients in the pelagic food web have been observed also in other environments (Rassoulzadegan & Sheldon, 1986; Wikner & Hagström, 1988).

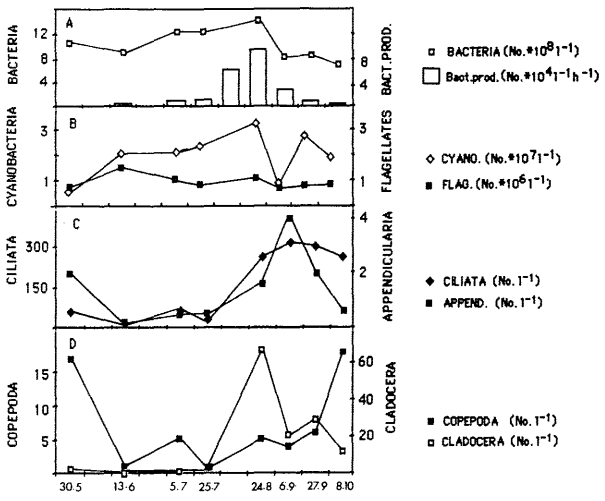


Fig. 1. Seasonal dynamics of bacterioplankton (A,B), microzooplankton and net zooplankton (C,D)in the Gulf of Trieste in the stratified water column during summer 1989.

Fuhrman, J.A. and F. Azam. 1982. Thymidine incorporation as a measure of heterotrophic bacterioplankton production in marine surface waters: evaluation and field results. Mar. Biol. 66: 109-120.

Wikner, J. and Hagström Å. 1988. Evidence for a tightly coupled nanoplanktonic predator-prey link regulating the bacterivores in the marine environment. Mar. Ecol. Prog. Ser. 50:137-145.

Rassoulzadegan, F. and R.W. Sheldon. 1986. Predator-prey interactions of nano-zooplankton and bacteria in an oligotrophic marine environment. Limnol. Oceanogr. 31(5): 1010-1021.

P-V5

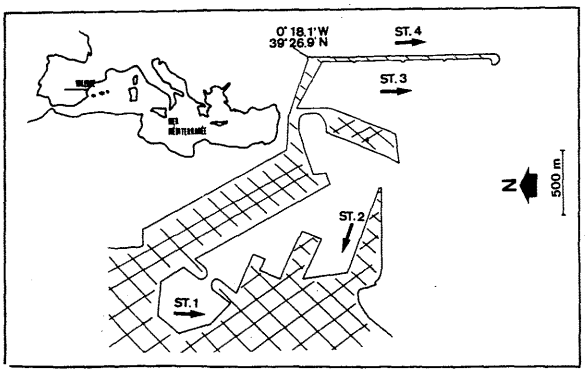
Etude de la communauté zooplanctonique dans un environnement portuaire (Port de Valence, Espagne, Méditerranée Occidentale) I. Holoplancton non Arthropode

David GRAS et Celso RODRIGUEZ BABIO

Departamento de Biologia Animal, Universitat de Valencia, C/ Dr Moliner, 50. 46100 Burjassot (Espana)

Les ports, étant donné les conditions hydrographiques qu'ils réunissent et leur facilité d'accès, constituent des endroits idéaux pour essayer d'évaluer l'effet du confinement et de la contamination sur le zooplancton. Les travaux les plus remarquables qui ont été effectués sur le zooplancton des ports de la Méditerranée espagnole se limitent à quelques localités: Mahón (MASSUTI, 1948; JANSA, 1985), Málaga (RODRIGUEZ et VIVES, 1984), Castellón (SAN FELIU et MUÑOZ, 1962) et Valencia (RADUAN, 1987). Comme suite à ces travaux, la présente étude prétend contribuer à une meilleure connaissance de la communauté zooplanctonique en milieu portuaire.

Les échantillons ont été obtenus par pêche horizontale et superficielle (- 3 m) grâce à un filet Juday-Bogorov dont l'ouverture de maille est de 125 µm. Dans chacun des trois bassins du port ainsi que dans une station-témoin extra-portuaire, des prélèvements d'une durée de dix minutes ont été réalisés, au cours desquels 65 m^3 d'eau furent filtrés. Ces prélèvements ont été effectués chaque mois pendant un cycle annuel (de mars 1987 à février 1988).



Le tableau suivant présente les résultats:

TAXONS	DISTRIBUTION SPATIALE 1	2	3	4	DISTRIBUTION SAISONNIERE P	E	A	H	ABONDANCE* 1	2	3	4
FORAMINIFERES												
Globigerina spp.			x	x	x	x	x	x			x	
TINTINNIDES												
Favella spp.	x	x	x	x	x	x	x	x				x
Codonellopsis spp.	x	x	x	x	x	x	x	x			x	
Helicostomella subulata (MÖBIUS, 1833)	x	x	x	x	x	x	x	x			x	
ACANTHAIRES			x	x	x			x			x	
RADIOLAIRES	x	x	x	x	x	x	x	x				x
SIPHONOPHORES												
Muggiaea kochi (WILL, 1844)		x	x	x	x	x	x	x				x
Muggiaea atlantica CUNNINGHAM, 1892			x	x	x		x			x		
CTENOPHORES												
Pleurobrachia rhodopis CHUN, 1880				x				x	x			
MOLLUSQUES												
Creseis acicula f. virgula (RANG, 1828				x		x	x				x	
CHETOGNATHES												
Sagitta setosa GUOY et GAIMARD, 1827		x	x	x	x		x	x			x	
TUNICIERS												
Oikopleura dioica FOL, 1872	x	x	x	x	x	x	x	x				x
Fritillaria pellucida (BUSCH, 1851)				x				x		x		
Doliolum nationalis (BORGERT, 1894)				x		x	x			x		

* Classes d'abondance: 1, de 1 à 10 individus/échantillon; 2, de 10 à 100 ind./échant.; 3, de 100 à 1.000 ind./échant.; 4, plus de 1.000 ind./échant.

A partir de ces résultats, on peut tirer les conclusions suivantes sur la composition de la communauté portuaire holoplanctonique non arthropode et distinguer:

- un holoplancton autochtone (Protozoaires sauf les Acanthaires, Muggiaea Kochi et Oikopleura dioica), permanent et bien représenté quantitativement dans tous les échantillons qui proviennent aussi bien de l'intérieur que de l'extérieur du port, étant donné le caractère néritique de ses composants.
- un holoplancton saisonnier dont la distribution est réglée par les différentes conditions hydrographiques: températures modérées (Muggiaea atlantica), températures élevées (Creseis acicula, Doliolum nationalis), ou salinités basses (Sagitta setosa).
- enfin, un holoplancton allochtone (Acanthaires, Pleurobrachia rhodopis et Fritillaria pellucida), occasionnel, généralement peu abondant, caractéristique de la mer ouverte et entraîné vers les côtes lors des tempêtes, si fréquentes en hiver.

REFERENCES.

JANSA, J., 1985. Nota sobre el zooplancton de las principales bahías y puertos de las Baleares. Bol. Inst. Esp. Oceanogr., 2(1): 132-154.

MASSUTI, M., 1948. Estudio del plancton del puerto de Mahón en el curso de un año (1946). Bol. Inst. Esp. Oceanogr., 2: 29.

RADUAN, M.A., 1987. Población de Apendicularias en el litoral valenciano. Tesis doctoral. Universitat de València. 236 pp.

RODRIGUEZ, V.; VIVES, F., 1984. Variables hidrográficas y biológicas de un sistema pelágico portuario. Inv. Pesq., 48(2): 207-222.

SAN FELIU, J.M.; MUÑOZ, F., 1962. Consideraciones sobre la hidrografía y el zooplancton del puerto de Castellón. Inv. Pesq., 21: 3-27.

P-V6

Etude de la communauté zooplanctonique dans un environnement portuaire (Port de Valence, Espagne, Méditerranée Occidentale) II. Holoplancton Arthropode

David GRAS

Departamento de Biologia Animal, Universitat de Valencia, C/ Dr Moliner, 50. 46100 Burjassot (Espana)

La représentation des crustacés holoplanctoniques, considérable tant aux points de vue qualitatif que quantitatif ainsi que le rôle écologique capital qu'ils jouent dans l'océan -particulièrement les Copépodes, considérés comme les métazoaires les plus abondants en haute mer (EHRHARDT et SEGUIN, 1978)-, justifient une étude monographique.

Dans le présent travail, qui a été réalisé en milieu portuaire, ont été inventoriées et dénombrées les différentes espèces de crustacés holoplanctoniques qui ont été observées et qui se limitent en fait à 3 groupes (Copépodes, Cladocères et Mysidacés). L'effet des conditions hydrographiques particulières régnant dans ce genre de milieu sur la distribution de la faune et de la flore permettra de reconnaître les indicateurs biologiques de ces conditions et, par suite, de relier l'état de la communauté zooplanctonique avec les caractéristiques de l'environnement.

Pour ce qui concerne la méthode d'échantillonnage et la description de la zone d'investigation, on se reportera à la note précédente (voir GRAS et RODRIGUEZ BABIO, 1990).

Sur base des résultats obtenus, on peut constater l'apport considérable, y compris dans ces zones confinées, que constituent les Copépodes et les Cladocères représentant ensemble 52.3% du total du zooplancton (fig. 1). Quant aux Mysidacés, ils n'offrent qu'un simple intérêt écologique vu leur participation réduite dans les échantillons.

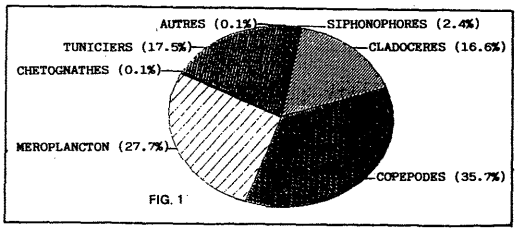


FIG. 1

Le tableau suivant résume les distributions spatio-temporelles et les abondances des diverses espèces inventoriées, à la suite de quoi nous ferons un bref commentaire sur les espèces caractérisant les milieux portuaires et pouvant par là être considérées comme indicatrices.

TAXONS	DISTRIBUTION SPATIALE 1	2	3	4	DISTRIBUTION SAISONNIERE P	E	A	H	ABONDANCE* 1	2	3	4
CLADOCERES												
Penilia avirostris DANA, 1849		x	x	x		x	x					x
Podon polyphemoides (LEUCKART, 1850)	x	x	x			x	x					x
Podon intermedius LILLJEBORG, 1901	x	x	x				x	x				x
Evadne spinifera MULLER, 1868			x	x	x	x	x					x
Evadne tergestina (CLAUS, 1862)			x	x		x	x				x	
Evadne nordmanni LOVEN, 1835			x	x			x	x			x	
COPEPODES												
Calanus helgolandicus (1863)			x	x				x		x		
Paracalanus parvus (CLAUS, 1863)	x	x	x	x	x	x	x	x				x
Calocalanus pavo DANA, 1849				x				x	x			
Clausocalanus spp.	x	x	x	x			x	x				x
Temora stylifera (DANA, 1848)			x	x		x	x				x	
Centropages typicus KROYER, 1849			x	x			x	x			x	
Isias clavipes BOECK, 1864	x	x	x	x			x	x				x
Anomalocera patersoni TEMPLETON, 1837			x					x	x			
Labidocera wollastoni (LUBBOCK, 1857)				x				x	x			
Acartia clausi GIESBRECHT, 1889	x	x	x	x	x	x	x	x				x
Acartia discaudata STEUER, 1929	x	x	x	x	x		x	x			x	
Acartia latisetosa KRICZAGUIN, 1873	x	x	x				x	x				x
Acartia grani SARS, 1904	x	x	x				x	x				x
Oithona helgolandica (CLAUS, 1863)	x	x	x	x	x		x	x			x	
Oithona plumifera BAIRD, 1843				x			x			x		
Oithona nana GIESBRECHT, 1892	x	x	x	x	x	x	x	x				x
Euterpina acutifrons (DANA, 1852)	x	x	x	x	x	x	x	x				x
Clytemnestra rostrata (BRADY, 1883)				x				x	x			
Sapphirina nigromaculata CLAUS, 1863				x		x			x			
Corycaeus spp.			x	x			x			x		
Oncaea spp.	x	x	x	x	x	x	x	x				x
MYSIDACES												
Mesopodopsis slabberi (BENEDEN, 1861)			x	x				x		x		

* Classes d'abondance: 1, de 1 à 10 individus/échantillon; 2, de 10 à 100 ind./échant.; 3, de 100 à 1.000 ind./échant.; 4, plus de 1.000 ind./échant.

D'après ces résultats, les différentes espèces de crustacés holoplanctoniques observées peuvent se répartir en 3 groupes:

- espèces exclusivement portuaires, indicatrices hydrographiques de confinement: Podon polyphemoides (estival), et Podon intermedius, Acartia latisetosa et Acartia grani (hivernales).
- espèces exclusivement extra-portuaires, indicatrices hydrographiques de mer ouverte. Elles peuvent être d'origine néritique (espèces du genre Evadne, Temora stylifera, Centropages typicus et Corycaeus spp.) ou être d'origine océanique, et dans ce cas, entraînées vers la côte lors des tempêtes d'automne et d'hiver (Calanus helgolandicus et Oithona plumifera).
- espèces à localisation indistinctement portuaire et extra-portuaire, permanentes (Paracalanus parvus, Clausocalanus spp., Isias clavipes, Acartia clausi, Acartia discaudata, Oithona helgolandica, Oithona nana, Euterpina acutifrons et Oncaea spp.) ou temporaires, la distribution de ces dernières étant déterminée par les températures élevées et les salinités basses, bien plus que par le confinement des eaux (Penilia avirostris et Mesopodopsis slabberi), comme quoi elles ne peuvent pas toutes être considérées comme indicatrices du confinement. On inclut également dans cette section des espèces que l'on ne peut attribuer à aucun rang spatio-temporel vu leur faible nombre (Calocalanus pavo, Anomalocera patersoni, Labidocera wollastoni, Clytemnestra rostrata et Sapphirina nigromaculata).

REFERENCES

EHRHARDT, J.P.; SEGUIN, G., 1978. Le plancton. Composition, écologie, pollution. Gauthier-Villars ed. Paris. 210 pp.

GRAS, D.; RODRIGUEZ BABIO, C., 1990. Etude de la communauté zooplanctonique dans un environnement portuaire (port de Valence, Espagne, Méditerranée occidentale). I. Holoplancton non Arthropode. Rapp. Comm. int. Mer Médit., 32(2)

P

Etude de la communauté zooplanctonique dans un environnement portuaire (Port de Valence, Espagne, Méditerranée Occidentale) III. Méroplancton

Celso RODRIGUEZ BABIO et David GRAS

Departamento de Biologia Animal, Universitat de Valencia, C/ Dr Moliner, 50. 46100 Burjassot (Espana)

Les données sur la composition spécifique du méroplancton sont beaucoup moins précises que celles concernant l'holoplancton. Toutefois, on ne peut négliger son étude malgré sa difficulté parce que l'importance de ce contingent est considerable. Parmi les travaux les plus notables consacrés au zooplancton portuaire de la Méditerranée, avec des déterminations à différents niveaux taxonomiques d'organismes méroplanctoniques, citons: celui de PATRITI et al. (1979) sur le port de Marseille, celui de DELLA CROCE et al. (1973) sur le port de Gênes et celui de VIVES et al. (1986) sur le port de Castellón.

La récente publication de monographies concernant les Phoronidiens (EMIG, 1982) et les larves de Polychètes (BHAUD et CAZAUX, 1987) nous a permis de caractériser taxonomiquement une partie des individus larvaires appartenant à ces groupes.

En ce qui concerne l'échantillonnage voir la note de GRAS et RODRIGUEZ BABIO (1990).

Les organismes méroplanctoniques observés dans les échantillons ont été identifiés à différents niveaux taxonomiques et l'établissement de la liste des espèces se poursuit:

- Hydroméduses
- Larves de Turbellariés Polyclades Leptoplanidae (fig. 2, A)
- Larves nectochètes de Polychètes
  - Glycera tridactyla SCHMARDA, 1861 (fig. 2, B)
  - Nephtys sp. (fig. 2, C)
  - Sigalionidae (fig. 2, D)
  - Sabellaria alveolata LINNAEUS, 1767 (fig. 2, E)
- Larves nauplius, métanauplius et cypris de Cirrhipèdes
  - Balanus amphitrite DARWIN, 1854
  - Lepas spp.
- Larves zoés et mégalopes de Décapodes
- Larves véligères de Gastéropodes et Bivalves
- Larves actinotroques de Phoronis psammophila CORI, 1889 (Actinotrocha sabatieri) (fig. 2, F)
- Larves ophiopluteus d'Ophiurides
- Larves d'Ascidies

Le méroplancton représente une fraction importante du zooplancton portuaire, avec 27.72% de l'ensemble zooplanctonique (fig. 1, A). Son abondance dans les échantillons s'explique par le caractère éminemment néritique que possède et le grand contingent des larves d'organismes incrustants présents dans les aires portuaires.

Le méroplancton (fig. 1, B), est remarquable par l'énorme proportion des larves de Cirrhipèdes (82.84%), appartenant presque exclusivement à l'espèce Balanus amphitrite, sauf quelques nauplius de Lepas spp. En seconde position se situent les larves de Mollusques (8.53%), celles des Polychètes (4.90%) et celles des Décapodes (1.02%). Les 2.7% restants se composent d'hydroméduses, de certains stades larvaires de Turbellariés Polyclades Leptoplanidae, de larves ophiopluteus, de larves actinotroques de Phoronis psammophila ainsi que de larves d'Ascidies.

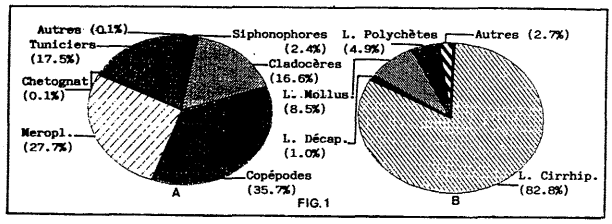


FIG.1

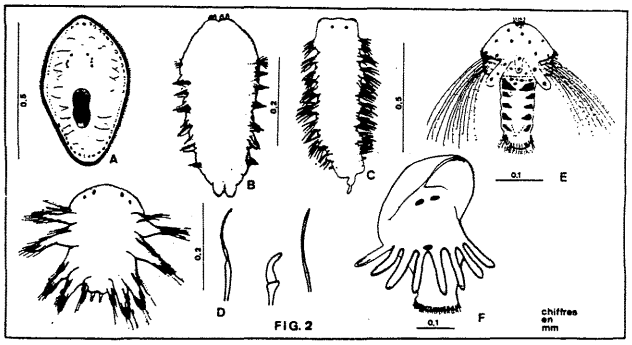


FIG.2

REFERENCES

BHAUD, M.; CAZAUX, C., 1987. Description et identification des larves de Polychètes; leurs implications dans les problemes biologiques actuels. Oceanis, 13(6): 596-753.

DELLA CROCE, N.; DRAGO, N.; SALMENI, P.; ZUNINI, T., 1973. Caratteristiche ecologiche e popolamento zooplanctonico del porto di Genova. 2. Popolamento zooplanctonico. Catt. Idrog. Pesc. Univ. Genova, 3: 1-34.

EMIG, C.C., 1982. The biology of Phoronida. Adv. Mar. Biol., 19: 1-89.

GRAS, D.; RODRIGUEZ BABIO, C., 1990. Etude de la communauté zooplanctonique dans un environnement portuaire (port de Valence, Espagne, Méditerranée occidentale. I. Holoplancton non Arthropoda. Rapp. Comm. int. Mer Médit., 32(2)

PATRITI, G.; BLANC, F.; CUBIZOLLES-BASTIANI, F., 1979. Système planctonique en milieu portuaire (port de Marseille). Structure et fonctionnement-étude chronologique. Téthys, 9(2): 137-148

VIVES, F.; MORALES, E.; ARÍAS, E.; SUAU, P.; SOUSA, J.M., 1986. Estudio ecológico de una estación de ensayos de pinturas antiincrustantes. II. Fitoplancton y zooplancton. Rev. Iber. Corros. y Prot., 17(2): 119-131.

Evolution mensuelle des Tintinnides (Tintinnina) de 1986 à 1988 en deux stations de la Baie de Jounieh (Liban)

Marie ABBOUD-ABI SAAB et Marie-Thérèse KASSAB

Centre de Recherches Marines, CNRSL-UL, B.P. 123, Jounieh (Liban)

Les Ciliés loriqués (Tintinnina), collectés par un filet fin (52 µm), ont fait l'objet d'une étude détaillée (ABBOUD-ABI SAAB, 1989). Ils sont présents toute l'année dans le milieu avec un maximum printanier en surface, conséquence d'une importante poussée de phytoplancton, leur principale source de nourriture (ABBOUD-ABI SAAB, 1986).

L'analyse des échantillons collectés par différentes méthodes, a permis de constater que les techniques d'échantillonnage influent beaucoup sur l'effectif des Tintinnides, surestimant ou sousestimant certaines espèces. Le filet fin laisse passer certaines formes inférieures au vide de maille utilisé; quant au petit volume d'eau destiné à l'étude du phytoplancton, il n'est pas suffisant pour fournir un effectif utilisable statistiquement, surtout durant la période de pauvreté.

Pour pallier ces lacunes, les Ciliés loriqués ont été dénombrés mensuellement, en surface, durant deux années (nov. 1986 à oct. 1988) dans des échantillons d'eau d'un litre, en deux stations situées dans la baie de Jounieh :J0 (à environ 40 m du rivage par 5 m de fond) et J1 au centre de la baie (à 2 km du rivage par 150 m du fond). Les échantillons d'eau destinés à cette étude ont été fixés au Lugol dès leur récolte et le dénombrement des cellules effectué suivant la méthode d'Utermöhl (1958) après sédimentation de plusieurs jours.

Durant cette période, la température de l'eau suit le cycle normal connu dans la région et les salinités varient entre 35,6 (mars-avril) et 39.25% (octobre-novembre).

Les effectifs des Tintinnides varient entre 2 et 1388 ind./l (moyenne = 215) à J0 et entre 8 et 960 ind./l (moyenne = 145) à J1. Les maxima sont atteints suivant les années, en juin et en avril à J0 et en juin à J1. Les minima sont atteints en octobre et en mars à J0 et en avril, octobre et mars à J1 (Fig. 1).

Les espèces dominantes sont de petite taille et appartiennent au genre Tintinnopsis : T. beroidea, T. compressa, T. campanula. Notons également la présence de Metacylis jorgensenii, Stenosemella ventricosa, Dadayiella ganymedes, Helicostomella sp., Favella ehrenbergi, Eutintinnus lusus, ... qui dominent aussi durant les différents mois de l'année.

La comparaison des résultats obtenus à partir de ces échantillons d'eau et d'échantillons collectés au filet aux mêmes stations et dénombrés par la méthode d'Utermöhl, montre certaines différences :

- Le nombre d'espèces récoltées par le filet est plus élevé et atteint parfois le double.
- Les espèces dominantes,lors d'une sortie, ne sont pas toujours les mêmes et si elles sont pareilles, leur pourcentage par rapport au total des effectifs varie.
- Les dates des maxima et des minima diffèrent entre les deux types d'échantillons; par exemple, en 1987, le maximum "au filet" se situa en mai au lieu de juin et était dû à Favella ehrenbergi au lieu de T. beroidea. De tels exemples sont nombreux
- Les résultats publiés antérieurement (ABBOUD-ABI SAAB, 1989) et fondés sur des échantillons "au filet" montrent que le maximum principal se situe en juin ou en mai suivant les années, donc en bonne concordance avec les résultats actuels; par contre, le maximum secondaire en décembre et janvier , n'est pas évident ici.

On déduit de ces résultats et d'autres non encore publiés, qu'il est primordial de fixer au préalable la méthode d'échantillonnage qui paraît la plus satisfaisante. De plus, les Tintinnides, se nourrissant de microzooplancton et surtout de phytoplancton, se multiplient suivant un rythme calqué sur celui du phytoplancton printanier : rapide et important. Il est évident que dans de tels cas, la fréquence d'échantillonnage doit nécessairement augmenter pour capter au maximum toutes les variations possibles et procurer les résultats les plus fiables.

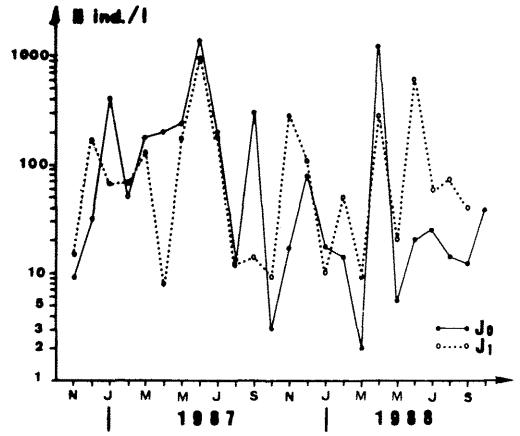


Fig. 1. Variations saisonnières des densités de Tintinnides entre nov. 1986 et oct. 1988 en deux stations situées au centre de la côte libanaise (d'après des échantillons d'eau).

REFERENCES

ABBOUD-ABI SAAB, M. 1986. Contribution à l'étude de la poussée phytoplanctonique printanière dans les eaux côtières Libanaises. Lebanese Science Bulletin, 2 (1) : 29-51.

ABBOUD-ABI SAAB, M. 1989. Distribution and ecology of Tintinnids in the plankton of Lebanese coastal waters (eastern Mediterranean). J. Plankton Res., 11 (2) : 203-222.

UTERMÖHL, H. 1958. Zur Vervollkommnung der quantitativen Phytoplankton Methodik. Mitt. Int. Ver. Limnol., 9 : 1-38.

P-V9

Calcul et mesure de la diversité chez quelques groupes planctoniques des Eaux Côtières Libanaises (Méditerranée Orientale)

Sami LAKKIS et Raymonde ZEIDANE

Centre de Recherches Marines, CNRSL-UL, B.P. 123, Jounieh (Liban)

Pour étudier la structure et l'organisation d'une communauté planctonique,il est indispensable de connaître la diversité spécifique.Plusieurs critères et modèles ont été proposés pour le calcul de la diversité spécifique(Whittaker,1972;Pielou,1975;Grassle et al.,1979). Plusieurs méthodes de calcul ont été réalisées sur la diversité spécifique (Giller,1984). Margalef(1957),considère que dans un échantillon à composition donnée,l'attribution d'un individu à une espèce comme étant un signal élémentaire d'information.Ainsi l'information moyenne par individu donnée par Margalef:I=1/Qlog2 Q/q1!q2!...qN! tend vers l'information donnée par la formule de Shannon: I=-pi log2 pi. Toutes les analyses de la diversité qui sont basées sur la théorie de l'information,prennent en considération la fonction de Reyni(1961) qui généralise l'entropie de Shannon et celle de Patil et Taillie(1976) qui généralise l'indice de dominance de Simpson.D'autres indices sont encore utilisés:l'indice d'uniformité ou entropie relative"eveness" et l'indice "richness" de Margalef. Ces indices ont servi de base à l'élaboration de quelques programmes d'analyse de la diversité élaborés par Scimone et al.(1987) que nous avons utilisés pour les calculs de la diversité chez trois groupes planctoniques importants des eaux Libanaises:les Copépodes,les Tintinnides et les Dinoflagellés.Les matrices des densités ont été élaborées à partir d'analyses d'échantillons planctoniques effectués tous les mois en plusieurs stations de la côte libanaise(Méditerranée orientale) entre 1985 et 1988(Lakkis et Zeidane,1987).

1-Les COPEPODES. Le programme DIV utilisé,élabore une matrice m x n contenant huit indices différents de diversité.Les variations mensuelles de la diversité chez les copépodes ont le même aspect pour les huit indices(Tab.1).En mai la diversité est la plus élevée(H'=2,87 bits/ind.) alors qu'elle est la plus faible en mars(H'=0,653). Un autre programme BETADIV, consiste à calculer 10 mesures de diversité pour chacun des vecteurs mois et donner les tracés correspondants(Fig.1a,1b).Ces calculs sont basés sur la fonction de Patil et Taillie: $H(beta) = (1-Sp(i)^{(beta+1)})/beta$ i=1,...,m où beta varie de -1 à 1 en augmentant chaque fois de 0,2.

2-Les TINTINNIDES. Les Tintinnides sont très abondants dans les eaux portuaires et semi-fermées(Lakkis et Lakkis,1985). Le programme PRODIV permet de tracer les profils de la diversité de Whittaker suivant les mois en se basant sur l'entropie de Shannon ou de l'indice de Gini-Simpson:D=Sp(i)^2 i=1,...,m . La figure 2 montre la courbe de la diversité totale des Tintinnides(44 espèces) trouvés dans le port de Jounieh entre 1985 et 1986. La diversité est maximale en décembre(H'=2,311 bits/ind.) alors qu'elle est minimale en août et septembre (H'=0,005).

3-Les DINOFLAGELLES. Sur les 110 espèces identifiées sur les côtes du Liban(Lakkis et Lakkis,1981), 50 dont la fréquence de présence est supérieure à 10% ont été retenues pour cette analyse. Le programme INFORMA nous permet de calculer les indices de similitude ou les distances entre les mois de la matrice. Les résultats sont donnés sous forme de matrice triangulaire(Tab.2) de 12 éléments(mois) comprenant les indices de similitudes de Rajski. Par ailleurs les différentes composantes de l'entropie générale sont aussi calculées:information entre les lignes(espèces),entre colonnes(mois),information conjointe,information mutuelle,équivocation,indice de Rajski et indice de cohérence. La diversité la plus élevée tombe en février(H'=2,59),la plus faible en octobre(H'=1,20).

Malgré une pauvreté marquée en biomasse, le plancton des eaux libanaises est caractérisé par une diversité spécifique assez élevée.

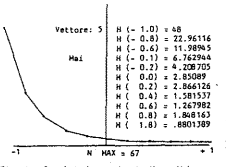


Fig. 1a. Tracé de la courbe de diversité chez les Copépodes des eaux Libanaises (Station J),Mai 1987. Prog.BETADIV

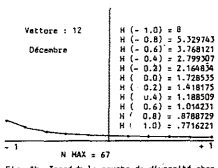


Fig. 1b. Tracé de la courbe de diversité chez les Copépodes du Liban (Station J) en Décembre 1987. Programme BETADIV

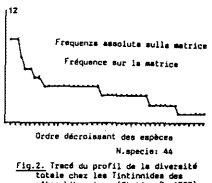


Fig.2. Tracé du profil de la diversité totale chez les Tintinnides des côtes Libanaises (Station P, 1987). Programme PRC

Componenti dell'entropia generale
Informazione di riga 5593.985
Informazione di colonna... 4786.606
Informazione congionia.... 3946.312
Mutua informazione..... 1434.379
Equivocazione..... 7511.833
Indice de Rajski ..... .8396664
Coerenza ..... .5431026

Tableau 2. Matrice des indices de similitude et de distance entre les mois chez les Dinoflagellés du Liban, basée sur la théorie de l'Information (Station J, 1987),calculés en utilisant Progr. INFORMA.

Matrice di simmetrica fra i vetteri colonna per:indice di somiglianza di Rajski

1.000	0.879	0.873	0.868	0.857	0.868	0.847	0.881	0.844	0.826	0.874	0.856
1.000	0.959	0.956	0.895	0.896	0.863	0.880	0.823	0.882	0.878	0.911	
1.000	0.955	0.939	0.947	0.927	0.915	0.833	0.789	0.849	0.927		
1.000	0.925	0.918	0.893	0.876	0.845	0.856	0.852	0.920			
1.000	0.961	0.961	0.933	0.813	0.903	0.913	0.894				
1.000	0.942	0.956	0.835	0.925	0.925	0.912					
1.000	0.920	0.795	0.904	0.916	0.879						
1.000	0.838	0.892	0.914	0.894							
1.000	0.956	0.901	0.903								
1.000	0.901	0.934									
1.000	0.932										
1.000											

Rilievo	S/R	R/T	H MAX	H.MAXT	SP	H'	EVEN	RICH
1	24	0.358	3.178	0.756	0.481	1.221	0.394	3.474
2	24	0.358	3.178	0.756	0.120	2.477	0.780	4.865
3	33	0.567	3.638	0.865	0.775	0.654	0.180	4.791
4	35	0.522	3.555	0.846	0.464	1.442	0.406	5.563
5	49	0.731	3.892	0.926	0.112	2.847	0.732	8.961
6	23	0.343	3.135	0.746	0.082	2.823	0.900	5.814
7	46	0.687	3.829	0.911	0.243	1.967	0.514	7.026
8	42	0.627	3.738	0.889	0.247	1.831	0.490	6.123
9	34	0.507	3.526	0.839	0.137	2.350	0.666	5.622
10	23	0.343	3.135	0.746	0.397	1.414	0.451	3.030
11	24	0.358	3.178	0.756	0.342	1.576	0.496	3.656
12	9	0.134	2.197	0.523	0.228	1.729	0.787	1.689

S/R= N. specie /Rilievo — N.Totale specie = 67
R/T = N.specie per Rilievo/N.Totale specie — N. Rilievi = 12
H'MAX = Diversita' massima per Rilievo (log N.Specie) — H MAX totale = 4.204693
H'MAXT =H MAX per Rilievo/H MAX totale
SP = Indice di Dominanza Simpson
H' = Indice di Diversita'di Shannon
Even = Indice di Uniformita'(entropia relativa)
Rich = Indice di Ricchezza di Margalef

Tableau 1. Matrice des 8 mesures d'indice de diversité mensuelle chez les Copépodes du Liban (Station J, 1987),calculée à l'aide du programme DIV (Scimone et al., 1987).

Remerciements. Les analyses ont été effectées au Département de Biologie de l'Université de Trieste,grâce à une subvention accordée par l'Académie des Sciences du Tiers Monde(TWAS) à S.Lakkis.

P-V10

Distribution of Macroplankton and marine circulation in the Ligurian Sea

Tecla ZUNINI SERTORIO, Ignazio DAGNINO and Claudia VACCAREZZA

Institute of Marine Environmental Science, University of Genoa, Corso Rainusso 14, 16038 Santa Margherita Ligure (Italy)

During two cruises conducted respectively in April and August 1986, by the GRO-G (Oceanological Research Group-Genoa) and the Institute of Marine Environmental Science of the University of Genoa, macroplankton samples were collected in the northeastern sector of the Ligurian Sea, over a grid of offshore stations; three stations (45, 46, 47), however, were located at the easternmost end of the basin, parallel to the coastline, near the edge of the continental shelf.

The sampling was carried out from April 24th to 27th and from August 25th to 27th, using a 1 mt ORI net of 1 mm mesh, equipped with a flowmeter and towed on the surface at 1,5 knot speed during day time. The average volume of filtered water was 1,444 cubic meters. In the laboratory the organisms were counted and sorted into the main taxa and the biomass of each taxon was evaluated (dry weight, 60°C).

Temperature and salinity recordings from 0 to 100 db were made at the same time using a Neil Brown CTD onboard the O/V "Minerva", the purpose being to acquire information on the physical and dynamic conditions of the water masses at the sampling time. In order to obtain a general view of the marine circulation pattern, the mean temperature and salinity of the layer comprised between 0 and 100 db were calculated, and the average isotherms and isohalines were plotted.

A cyclonic circulation is a permanent feature of the Ligurian Sea, flowing along the coast at variable speed in relation to the stresses brought about by atmospheric circulation. Deep masses show an upwelling tendency at the centre of the circuit (central divergence), as against the downwelling tendency of surface masses at its periphery (convergence). The divergence axis, therefore, is identified by minimal mean temperatures, as well as by highest mean salinities (HELA 1963, ASTRALDI & GASPARINI 1986, HECQ et al. 1987).

a) Dynamic conditions of water masses. APRIL 24-27, 1986. The isothermal pattern showed an absolute temperature minimum (13.13°C) in the central and deepest area of the basin (St. 27): the central divergence appeared to follow two directions, corresponding to stations 25, 31 and 27, 34, 40. The main displacement of surface masses was at the periphery of this area.

AUGUST 25-27, 1986. The pattern of mean isotherms and isohalines pointed to the presence of a divergence area at stations 34 and 41; stations 32, 33, 34, 40 and 41 were all within an area characterized by prevailing vertical motions. The cyclonic motion at the periphery of this area was almost parallel to the coastline.

b) Composition and distribution of macroplankton. APRIL 24-27, 1986. Gelatinous specimens were prevailing in most of the samples. On the average 74% of the plankton biomass (dry weight) were Siphonophora, the other taxa in the examined area being : Tunicata (9%), Pteropoda (7%), Crustacea (6%), Polychaeta (2%) and Medusae (1%). The average proportion of Chaetognatha and Pisces larvae in the whole biomass was less than 1% dry weight.

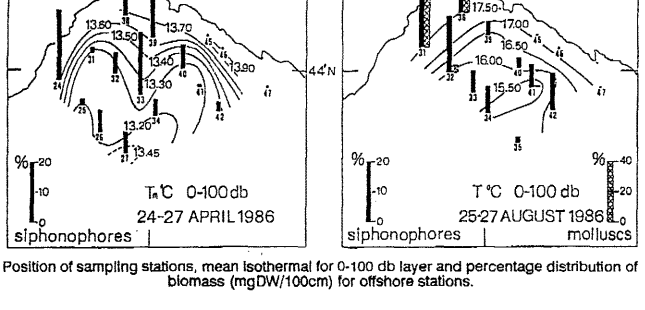
Zooplankton density was highest into inshore stations (46, 47). In offshore waters Siphonophora showed a very heterogeneous distribution, concentrating at three stations (24, 33, 39) located outside the central divergence zone, mainly in station 24 which was characterized by particularly intense temperature and salinity gradients. In the said three stations, moreover, there were specimens of all the taxa inhabiting the surface waters at the time of sampling. On the other hand, stations 25, 26, 27, 31 and 34, located in the area of greatest divergence, were characterized by a less diversified population and a general impoverishment of the whole biomass. However, in some of these stations, the concentration of Copepoda (*E.rostrata, A.patersonii*) and Euphausids larvae appeared to be rather high.

AUGUST 25-27, 1986. Mollusca or Siphonophora were dominant by weight in individual samples. On the average Mollusca were prevailing contributing to 54% of dry biomass, followed by Siphonophora (25%), Chaetognatha (11%), Crustacea (5%) and Medusae (4%). The Tunicata and Pisces larvae were less than 1%.

The divergence area at the center of the basin (33, 34, 35, 39, 40) was very poorly populated, Siphonophora being almost the exclusive presence. In offshore waters the biomass was mainly concentrated in two stations (31, 38) along the cyclonic circuit, where Mollusca, Chaetognatha (31, 38), Siphonophora, Medusae (31), *Doliolum*, Stomatopods larvae, Pisces larvae (38) were present in highest density.

Concluding remarks. The large-scale macroplankton sampling carried out in a large area of the Ligurian Sea in the shortest possible time, and the contemporary observation of the physical and dynamic conditions of the waters, enabled us to evidence the influence exerted by the basin dynamic conditions on the macroplankton distribution.

The data show that in the basin area characterized by vertically moving components of water masses, the macroplankton biomass is subject to an overall decrease and the macroplanktonic population is poorly diversified. Altogether, the macroplankton appears to be richer along the cyclonic circuit flowing by the Ligurian coast, and to concentrate mostly in the peripheral areas where temperature and salinity gradients are highest. Major biomass densities are due mainly to Siphonophora and Mollusca, i.e. to the largest populations encountered in the diurnal surface macroplankton at the time of the surveys. Taxa other than Copepods contribute in a lesser amount to the highest biomass concentrations in these areas. Hydrodynamical conditions coupled with behavioral patterns (vertical migration, reproduction) may aggregate zooplankton. The predominant role of biological factors in the small-scale spatial distribution of Copepods was shown by Boucher (1984) in the Ligurian front facing the French coast.



Position of sampling stations, mean isothermal for 0-100 db layer and percentage distribution of biomass (mgDW/100cm) for offshore stations.

References:

ASTRALDI M., GASPARINI G.P., 1986. La circolazione costiera nel Mar Ligure orientale. Bull. Mus. Ist. Biol. Univ. Genova, 52 suppl: 317-331.

BOUCHER, J., 1984. Localization of zooplankton populations in the Ligurian marine front: role of ontogenic migration. Deep-Sea Res., 31(5): 469-484.

HECQ J.H., BOUQUEGNEAU J.M., DJENIDI S., FRANKIGNOULLE M., GOFFART A., LICOT M., 1987. Some Aspects of the Liguro-provençal Frontal Ecohydrodynamics. Marine Interfaces Ecohydrodynamics. Ed. J.C.J. Nihoul. Elsevier Oceanogr.: 257-271.

HELA, I., 1963. Surface Currents of the Ligurian Sea. Bull. Inst. océanogr. Monaco, 60 (N° 1268), 15pp.

Distribution of the Zooplankton in Mediterranean Sea along the River Nile Delta Region

Mohamed M. EL-KOMI

National Institute of Oceanography and Fisheries, Alexandria, Kayet Bay, Alexandria (Egypt)

During the period from 20 to 26 December, 1988 the R/V "Akademik M.A. Laverentyev" Soviet Cruise in the frame work of an agreement between the Pacific Oceanological Institute of the Far Eastern Branch of the USSR Academy of Sciences and the National Institute of Oceanography and Fisheries, Egypt this work was carried out to study the influence of natural processes on pollutant migration (oil hydrocarbons and heavy metals) in the River Nile Delta Region. Vertical zooplankton hauls were collected by means of the closing Juday net (mesh aperture 168 µm) from seven sectors perpendicular to the Egyptian Coast from Alexandria to Port Said. The biomass of the whole zooplankton haul was conducted on board the ship by Mrs. Tamara A. Zadonskay research worker of the Biology laboratory (microvolume Yashnov meter).

The zooplankton population shows a considerable variation in its density and constituents within different sectors (Fig. 1) as well as between the three different zones of inshore neritic zone (< 50 meters depth), offshore neritic zone (50-200 meters depth) and the oceanic zone (> 200 meters depth). The inshore neritic waters off Abu Kir (A) and Rossetta (B) were more productive areas with a relatively high density in both zooplankton population and the plankton biomass (wet weight, mg/m 3) yielded an average 1980 org/ m^3 113 mg/ m^3 and 2943 org/ m^3 282 mg/ m^3, respectively (Table 1). The number of zooplankton and their biomass greatly reduced away from inshore waters of A sector at depths 72, 256, 335 and 780 meters deep to 536, 420, 410 and 517 org/ m^3, respectively. At B sector they decreased to 463 org/ m^3 at 235 m and 715 org/ m^3 at 668 meters deep. The zooplankton biomass in the offshore and oceanic zones decreased to 27-70 mg/ m^3 as the total zooplankton number does. At Manzalah (F) sector the density of zooplankton crop is high productive amounted 1207 org/ m^3 in the inshore neritic region, where the zooplankton biomass is maximum weighing 333 mg/ m^3. They decreased rapidly from the shore to 616 org/ m^3 and 102 mg/ m^3 as regards to increasing depth at the offshore neritic zone (74 meters deep) and the oceanic zone at depths 229, 1090 and 1300 meters deep amounted 486 org/ m^3 (82 mg/ m^3), 383 org/ m^3 (40 mg/ m^3) and 571 org/ m^3 (58 mg/ m^3), respectively. Generally, zooplankton crop was higher in the inshore neritic region than offshore neritic region and the lowest in the oceanic region (Fig.1). Similarly, the zooplankton community was less productive at Borollus (C&D), Domiatta (E) and Port Said (G) sectors than in the previous sectors of A, B and F. The zooplankton population in plankton samples sustained a low values with an average ranging from 936 to 827 org/ m^3 and a total biomass weighing 115-94 mg/ m^3 in the inshore neritic zone. It decreased rapidly in the offshore neritic zone to 466 org/ m^3 and 38 mg/ m^3 at Port Said sector and to the lowest amount 124 org/ m^3 and 45 mg/ m^3 at Borollus section of 1740 meters depth.

The number of copepoda and copepod nauplii was dominating among the zooplankton population in the different stations and it is represented with an average ranging from 70 % to 92 % of the total zooplankton count. Nauplii larvae of cirriped were numerically high, yielded 420 org/ m^3 at Abu Kir and 537 org/ m^3 at Rossetta sectors in the inshore neritic zone. Whereas, Appendicularia, Chaetognatha, copepod nauplii and Gastropod larvae were common among the zooplankton population and a high number recorded was 50 org/ m^3 or less in the three different regions in the different sectors. The rest groups of zooplankton were less important and represented with a relatively very small number of organisms per cubic meter ranging from 2 to 33. These groups were Siphonophores, Leptomedusae, Ostracoda, Protozoa, Heteropoda, Pteropoda, Mysidaceae, Polychaeta larvae, Thaliacea , Decapod larvae, Lamellibranch veligers, Bryozoa larvae, Echinoderm larvae, fish eggs and fish larvae.

In this study the zooplankton crop through a total of 31 samples collected from 31 stations covering a wide area in the Mediteranean Sea (ca 4000 Km^2) appears that it reduced greatly in the number of organisms per cubic meter and in the biomass of the total zooplankton in comparison to the previous results by the earlier investigators (El-Maghraby and Halim,1965 and Hussein, 1977). The environmental conditions of this area subjected to great changes due to the construction of the High Dam and the complete cessation of the Nile flood.

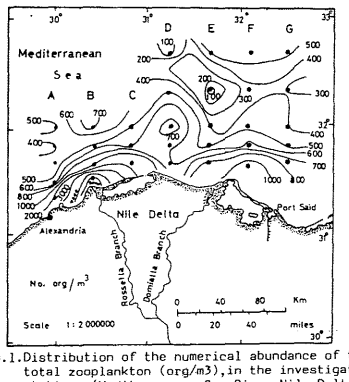


Fig.1.Distribution of the numerical abundance of the total zooplankton (org/m3),in the investigated stations (Mediterranean Sea,River Nile Delta region).

Sector	Depth m	Total zoopl.	Biomass mg/m³
Abu Kir A	35	1980	113
	72	536	103
	256	420	30
	335	410	31
	780	517	27
Rossetta B	18	4825	525
	28	1060	38
	235	463	42
	668	715	70
Borollus C&D	16	1861	147
	43	524	54
	124	504	70
	18	589	141
	56	624	117
	96	752	75
	1740	124	45
Domiatta E	29	827	89
	66	455	81
	111	404	40
	1112	90	12
	1400	515	27
Manzalah F	18	1207	333
	74	616	102
	229	486	82
	1090	382	40
	1300	517	58
Port Said G	35	742	94
	182	466	38
	509	414	37
	930	307	104
	1260	520	49

Table 1.The biomass (mg/m3) and the total zooplankton crop (org/m3)in the study area.

REFERENCES

El-Maghraby, A.M. and Halim,Y. 1965. A quantitative and qualitative study of the plankton of Alexandria waters. Hydrobiologia, 25(1-2):221-238.

Hussein, M.M., 1977. A study of the zooplankton in the Mediterranean waters in the Egyptian coast during 1970-1971 with special reference to copepods. M.Sc. Thesis, Alexandria University, pp. 228.

Les Scyphoméduses du Bassin Levantin (Beyrouth) et de l'Adriatique du Nord (Golfe de Trieste) : comparaison faunistique et écologique

Sami LAKKIS* , Massimo AVIAN** , Paola DEL NEGRO*** et Laura ROTTINI-SANDRINI**

*Centre de Recherches Marines (CNRSL-UL) B.P. 123, Jounieh (Liban)
**Dipartimento di Biologia, Università di Trieste, Via Valerio 32, 34127 Trieste (Italia)
***Laboratorio di Biologia Marina, CIMAM, Trieste (Italia)

Les différences hydrologiques entre la Méditerranée orientale (Bassin Levantin) et l'Adriatique septentrionale, impliquent des différences dans la composition et la distribution des groupes planctoniques, surtout lorsqu'il s'agit des scyphoméduses. Nous avons trouvé intéressant de faire une comparaison faunistique et écologique des espèces de ce groupe dans ces deux régions méditerranéennes : cette étude contribuera à combler des lacunes qui, malheureusement existent encore dans nos connaissances de plusieurs zones de la Méditerranée.

Si l'Adriatique a fait l'objet depuis longtemps de travaux sur les scyphoméduses (I-II Workshop on jellyfish, 1983-1987), par contre les travaux relatifs à ce groupe sont encore très rares dans le Bassin levantin (Lakkis, 1987; Dowidar, 1983).

La distribution des scyphoméduses dans l'océan mondial est liée, comme chez la plupart des groupes planctoniques, aux facteurs hydrologiques, notamment, température et salinité. Si plusieurs scyphoméduses montrent une distribution cosmopolite, par contre, d'autres restent cantonnées dans les eaux tropicales et subtropicales (Mayer, 1910; Kramp, 1961; Russell, 1970). Si le Bassin levantin était considéré comme un bassin tempéré chaud à affinité subtropicale, par contre l'Adriatique du nord serait une mer tempérée froide. Un simple examen du Tableau 2 permet de constater les différences hydrologiques existant entre ces deux bassins méditerranéens, du moins en ce qui concerne la température et la salinité.

Si les eaux Libanaises sont caractérisées par une température élevée durant la saison estivale, longue et sèche (T = 30°C en août) et une salinité annuelle moyenne au-dessus de 39‰ par contre la température en Adriatique ne dépasse pas 24°C en été et chute à 8°C en hiver, faisant ainsi de cette mer un bassin tempéré froid.

Ces différences hydrologiques retentissent sur la composition de la faune des scyphoméduses : deux espèces seulement sont communes aux deux mers (Tableau 2):

- Rhizostoma pulmo (Macri): espèce d'eaux tempérées et subtropicales, est la plus abondante sur les côtes du Liban, surtout entre mai et juillet. Elle est aussi commune dans le Golfe de Trieste au printemps et en automne, formant parfois des agrégations.
- Cotylorhiza tuberculata (Macri) : espèce méditerranéenne profonde (Mayer, 1910), observée en Adriatique d'octobre à mai, parfois en accumulations exceptionnelles (Avian, 1986). Dans les eaux Libanaises, on l'observe entre juin et novembre en nombre limité.
- Cassiopea andromeda (Forsskal) : espèce de mer tropicale, signalée en 1988 pour la première fois en Méditerranée orientale, en nombre limité (Goy et al.). Il s'agit d'une espèce de la mer Rouge migratrice vers la Méditerranée orientale.
- Rhopilema sp. : cette espèce tropicale non signalée encore en méditerranée, serait aussi une forme migratrice à travers le canal de Suez. Elle a été observée pour la première fois sur les côtes du Liban en grand nombre entre août et novembre 1989. Elle atteint parfois un diamètre de 40-50 cm. B. Galil (com. pers.) en a fait une nouvelle espèce : R. nomadica.

Quatre autres scyphoméduses, non signalées des eaux orientales, sont présentes dans l'Adriatique septentrionale :

- Chrysaora hysoscella (L.) : méduse côtière, commune dans les mers tempérées froides (Russell, 1970). Plus fréquente au printemps, elle a été observée aussi en automne à Trieste. Elle est présente sur toutes les côtes adriatiques de juin à août selon Riedl (1983).
- Pelagia noctiluca (Forsskal) : scyphoméduse de mer tempérée, totalement absente sur les côtes Libanaises; elle forme parfois des agrégations très denses sur les côtes adriatiques, causant des blessures aux baigneurs et des dommages aux pêcheurs

Tableau 1. Moyennes mensuelles de la température et de la salinité de surface au large de la côte Libanaise et dans le Golfe de Trieste. Les moyennes représentent les observations sur dix années consécutives : 1976-1986.

		J	F	M	A	M	J	J	A	S	O	N	D	X
T°C	B.L.*	19,96	18,80	19,53	20,75	23,85	26,98	28,07	29,46	30,01	26,45	24,55	20,26	23,02
	TS**	8,81	8,08	8,81	11,61	16,45	20,69	23,00	23,69	21,69	18,49	14,59	11,08	15,85
S ‰	B.L.*	39,10	38,85	38,65	38,89	38,98	39,15	39,20	39,60	39,50	39,17	39,15	39,12	39,25
	TS**	37,00	36,90	36,33	36,87	35,57	31,27	34,70	37,13	36,43	36,80	37,83	37,90	36,23

* Bassin Levantin; ** Golfe de Trieste

Tableau 2. Composition des populations et distribution des scyphoméduses au large de la côte Libanaise et dans le Golfe de Trieste entre 1976 et 1989.

REGIONS	Méd. Orient. (Côtes Lib.)				Adriatique (G. de Trieste)			
Espèces/Saisons	H	P	E	A	H	P	E	A
Chrysaora hysoscella (L.)	-	-	-	-	-	XX	X	X
Pelagia noctiluca (Forsskål)	-	-	-	-	X	XX	X	XXX
Aurelia aurita (L.)	-	-	-	-	X	XX	X	X
Discomedusa lobata Claus	-	-	-	-	XX	X	X	-
Cotylorhiza tuberculata (Macri)	-	X	XX	XX	X	X	X	X
Rhizostoma pulmo (Macri)	-	X	XXX	XX	X	XX	X	XXX
Cassiopea andromeda (Forsskål)	-	-	XX	XX	-	-	-	-
Rhopilema sp.	-	-	XXX	XX	-	-	-	-

——— = absent; X = rare; XX = commun; XXX = abondant

(Rottini Sandrini & Avian,1983).

-Aurelia aurita (L.):forme cosmopolite des mers tempérées froides(Russell,1970)présente toute l'année dans le Golfe de Trieste,principalement entre septembre et avril.

-Discomedusa lobata Claus: espèce rare dans l'Adriatique;signalée de décembre à mars dans le Golfe de Trieste (Avian,com.pers.).

Les scyphoméduses semblent être des organismes dont la distribution est fortement liée aux conditions hydrologiques du milieu.Aussi,quelques-unes pourraient être considérées comme indicatrices écologiques. Les deux espèces migrantes de la mer Rouge vers la Méditerranée orientale ne sont pas encore des formes endémiques,mais les changements écologiques qui sont survenus ces dernières années dans le Bassin levantin pourraient faciliter le phénomène d'implantation de ces deux espèces comme c'est déjà le cas de plusieurs autres espèces planctoniques indo-pacifiques.

Remerciements. Cette étude a été subventionnée en partie par l'Académie des Sciences du Tiers Monde(TWAS)grâce à une bourse de recherche offerte à S. Lakkis au Département de Biologie,Université de Trieste.

References

AVIAN,M., 1986,Nova Thalassia,8(2):47-58.

DOWIDAR,N.,1983,Workshop on jellyfish blooms in the Mediter.,UNEP Rep.:9-16.

GOY,J., LAKKIS,S.,ZEIDANE,R.,1988.Rapp.Comm.int.Mer Médit.,31(2):299 .

KRAMP,P.L.,1961,J.mar.biol.Ass.U.K.,40,pp.469.

LAKKIS,S.,1987.IInd Workshop on jellyfish in the Mediterranean Sea,MAP.Technical Reports Ser. ,in press.

MAYER,A.G.,1910.Carnegie inst.,Washington:499-735.

RIEDL,R., 1983.Paul Parey Verlag, Berlin,pp.836.

ROTTINI SANDRINI,L.,Avian,M.,1983. Mar. Biol.,74:169-174.

P-V13

The Scyphomedusae off the Mediterranean Coast of Israel

Bella S. GALIL* and Ehud SPANIER**

*Center for Nature Conservation Research, George S. Wise Faculty of Life Sciences, Tel Aviv University, Tel Aviv 69978 and Israel Oceanographic & Limnological Research, Haifa 31080 (Israel)
**Center for Maritime Studies and Department of Maritime Civilizations, University of Haifa, Haifa 31999 (Israel)

The Scyphomedusae of the Mediterranean were the subject of some of the earliest marine research and are well known, but studies of the Levant basin fauna are scarce. The records of Scyphomedusae from the Israeli coasts are by Bodenheimer (1935): *Aurelia aurita* (L., 1758) and *Rhizostoma pulmo* (Macri, 1758), Fishelson (1983): *Pelagia noctiluca* (Forsskal, 1775) and *Cotylorhiza tuberculata* (Macri, 1778), and Spanier (1989): *Cassiopea andromeda* (Forsskal, 1775). On the Egyptian coasts one can find *Pelagia* and *Aurelia* (Dowidar, 1983), and on the Lebanese coasts *Cotylorhiza, Cassiopea* and *Rhizostoma* (Lakkis, 1971, 1974; Lakkis and Kouyoumjian, 1974; Lakkis and Zeidane, 1985; Goy et al., 1988). We can add *Phyllorhiza punctata* von Lendenfeld, 1884, new for the Mediterranean Sea, and *Rhopilema nomadica* n.sp., new for science, first found in the Indian Ocean and Red Sea and, like *Cassiopea*, a Lessepsian migrant medusa. *Cassiopea andromeda* is the first known Lessepsian Scyphomedusa. It was first recorded by Keller (1888) in the Suez Canal, again observed by Krukenberg (1888) (Lake Timsah) and more recently by Browne (1926) and Fox (1926) (Great Bitter Lake and Lake Timsah). The first record of *C. andromeda* in the Mediterranean was obtained from Cyprus by Maas (1903). Schafer (1955) reported the occurrence of very young specimens (2-30 mm) on a volcanic island near Thira in the southern Aegean, where the medusae flourished in rocky pools where water temperature reached 36°C due to volcanic activity. *C. andromeda* was recently reported from Lebanon (Goy et al., 1988) and Israel (Spanier, 1989).

Phyllorhiza punctata von Lendenfeld, 1884, was known previously only from Australia, the Philippines and Japan. The single specimen from Israel constitutes the first and only record from the Mediterranean. *Rhopilema nomadica* appeared off the Israeli Mediterranean coast in the mid-seventies. It has become fairly common in the past decade, appearing in ever larger numbers each year. *R. nomadica* has a nearly hemispherical umbrella. Exumbrella minutely granulate, granules fewer and blunter near margin. Margin of umbrella divided into 64 rounded vellar lappets. Ocular lappets small, lanceolate, one third as wide as vellar lappets. Arm disc prismatic. Distal corners of oral pillars tuberculate. Subgenital ostium kidney-shaped. A pear-shaped, tuberculate papilla, interradially on subumbrella, opposite ostial opening. Eight pairs of large scapulets, their upper sides bearing frilled mouths and numerous filaments. Mouth arms divided distally into two triangular lobes, bearing ventrally numerous frilled mouths and long filaments. Lowermost end bearing a vermicular appendage, terminating in a thin filament.

Stiasny (1938) reported the presence of *R. hispidum* (Vanhoffen, 1888) from the Red Sea. That medusa differs from *R. nomadica* in having sharp conical warts on the exumbrella and swollen "club" appendages at the ends of the mouth arms as compared with blunt tuberculation and vermicular filaments of the latter. On examination, all of Stiasny's specimens from the Red Sea proved to be identical with our Mediterranean material. It is of interest that the juveniles of *Alepes djedaba* (Forsskal, 1775), a Lessepsian migrant carangid fish, are commonly found in association with *R. nomadica*, taking shelter under its umbrella and among the filamentous mouth arms.

The mass appearance of a previously unknown Lessepsian migrant medusa off the Israeli coast is, unlike the seasonal proliferation or cyclical fluctuation of other Mediterranean medusae, the exponential phase of an intruder - a pattern recognized in other Lessepsian migrants.

References

Bodenheimer, F.S. 1935. Animal life in Palestine, an introduction to the problems of animal ecology and zoogeography. L. Mayer, Ed. Jerusalem, 506 pp.

Browne, E.T. 1926. Report on the medusae. Zoological results of the Cambridge Expedition to the Suez Canal, 1924. Trans. Zool. Soc. Lond. 22: 105-115.

Dowidar, N.M. 1983. Medusae of the Egyptian Mediterranean waters. Workshop on jellyfish blooms in the Mediterranean, Athens, 1983: 9-16.

Fishelson, L. 1983. Aquatic life. In: A. Alon (Ed.), Plants and animals of the land of Israel - an illustrated encyclopedia. Israel Ministry of Defence, Tel Aviv, 324 pp. (in Hebrew).

Fox, H.M. 1926. Summary of results. Zoological results of the Cambridge Expedition to the Suez Canal, 1924. Trans. Zool. Soc. Lond. 22: 843-863.

Goy, J., Lakkis, S. and Zeidane, R. 1988. Les Meduses de la Mediterranee orientale. Rapp. P.-V. Reun. CIESM 31(2): 299.

Keller, C. 1888. Die Wanderung der marinen Thierwelt im Suezcanal. Zool. Anz. 11: 359-364, 389-395.

Krukenberg, C.F.W. 1888. Die Durchfluthung des Isthmus von Suez in chronologischer, hydrographischer und historischer Beziehung. Wissenschaftliche Ergebnisse meiner Reise vom Etang de Berre uber Marseille und Triest nach Suakim und Massaua. Vergleichend Physiologische Studien Experimentelle Untersuchungen 5: 1-156.

Lakkis, S. 1971. Contribution a l'etude du zooplancton des eaux libanaises. Mar. Biol. 11(2): 138-148.

Lakkis, S. 1974. Distributions saisonnieres du zooplancton dans les eaux libanaises. Rapp. P.-V. Reun. CIESM 22(9): 117-118.

Lakkis, S. and Kouyoumjian, H. 1974. Observations sur la composition et l'abondance du zooplancton aux embouchures d'effluents urbains des eaux de Beyrouth. Rapp. P.-V. Reun. CIESM 22(9): 107-108.

Lakkis, S. and Zeidane, R. 1985. Les hydromeduses des eaux neritiques libanaises. Rapp. P.-V. Reun. CIESM 29(9): 179-180.

Maas, O. 1903. Die Scyphomedusen der Siboga Expedition. Siboga Expeditie Monograph 11(9): 1-91, 12 pls.

Schafer, W. 1955. Eine Qualle aus dem Indischen Ozean in der Agais. Natur und Volk 85: 241-245.

Spanier, E. 1989. Swarming of jellyfish along the Mediterranean coast of Israel. Israel J. Zool. 36(1): 55-56.

Stiasny, G. 1938. Die Scyphomedusen des Roten Meeres. Verhandl. Koninglijke Akad. Wetenschappen, Amsterdam, sect. 2, 37(2): 1-35, pls. 1-2.

P-V14

Etude de la Répartition du Zooplancton dans les Mers Egée et Ionienne

I. SIOKOU-FRANGOU, M.-A. PANCUCCI-PAPADOPOULOU et P. KOUYOUFAS

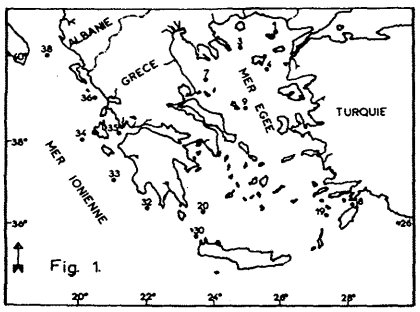
Centre National de Recherches Marines, 16604 Athènes (Grèce)

Dans le cadre du projet "Etude océanographique des mers Egee et Ionienne", nous avons réalisé une étude comparative de la répartition du zooplancton de la couche superficielle de ces deux mers. En août et septembre 1987, des échantillons ont été pris en 17 stations (fig. 1), par traits verticaux au filet WP-2, dans la couche au-dessus de la thermocline et/ou de l'halocline. Les données ont été analysées par les méthodes de la classification hiérarchique et du quadrage multidimensionnel, en utilisant l'indice de similarité de Bray-Curtis (Clarke & Green, 1988).

Les résultats des analyses (fig. 2 et 3) ont révélé une différence marquée entre la partie Nord-orientale de la mer Egée (groupe g1) et les autres stations tant de la mer Egée que de la mer Ionienne. Cette différence est due à l'abondance du cladocère Penilia avirostris, de copépodites de Temora, de dolioles, d'appendiculaires et du copépode Paracalanus parvus. En outre, on note la discrimination des couches 0-5 m et 5-25 m devant le détroit des Dardanelles. La couche superficielle (0-5 m), à la salinité très basse (29.59 °/oo), est caractérisée par l'extrême abondance de P. avirostris (4444 ind/ m3) et par la présence de P. parvus, des cladocères Evadne tergestina et E. spinifera et de copépodites de Temora. La couche sous-jacente est beaucoup moins riche en zooplancton (343 ind/m3) et les adultes de Temora stylifera y sont abondants. Ce fait est à relier à l'hydrologie complexe de la région :

- D'une part, les eaux moins salées et eutrophes de la mer Noire franchissent en surface le détroit des Dardanelles et voient leur salinité augmenter vers le Nord et ensuite vers l'ouest, par mélange avec les eaux de la mer Egée (Theocharis et Georgopoulos, 1989).
- D'autre part, des eaux très salées en provenance de la mer du Levant entrent en mer Egée-Sud et s'avancent en profondeur jusque devant le détroit des Dardanelles. La différence de qualité des masses d'eaux en ce point se traduit par la composition différente du zooplancton.

Les stations de la partie Nord-occidentale de la mer Egée sont groupées (groupe g2) au niveau 45% de similarité (fig. 2) avec les stations de la mer Egée-Sud et de la mer Ionienne. Leur similarité est due à la dominance de Clausocalanus furcatus et de copépodites de Oithona plumifera.



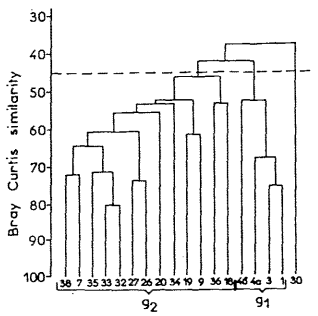


Fig. 2 : Analyse hiérarchique

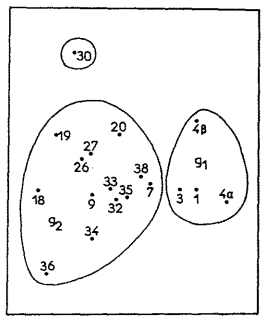


Fig. 3 : Quadrage multidimensionnel

Sur la figure 3, issue du quadrage multidimensionnel, on peut remarquer que la st. 7 du groupe g2 se trouve près des stations du groupe g1, voisines géographiquement, et ont même certaines espèces communes. D'autre part, la st. 18 (détroit de Rhodes), bien que réunie à la st. 36 (mer Ionienne) sur la figure 2, en est bien distincte sur la figure 3, cette position étant liée à certaines différences dans la composition spécifique. La st. 18 y est positionnée plus près des st. 19, 26 et 27 qui entourent l'île de Rhodes et ceci est peut-être dû à la présence des copépodes Corycaeus giesbrechti, C. latus, C. typicus, Corycella rostrata et Calocalanus pavoninus. En mer Ionienne du Nord, la st. 38 est groupée tant avec les autres stations de cette mer qu'avec la st. 7 de la mer Egée Nord-occidentale. En effet, les st. 7 et 38, bien qu'éloignées géographiquement ont en commun certaines espèces abondantes : C. furcatus, O. plumifera, P. parvus, copépodites de Clausocalanus, Paracalanus et Temora, P. avirostris. Cette composition est probablement liée à la salinité plus basse qu'aux autres stations plus méridionales. D'ailleurs, il paraît exister une influence de la mer Adriatique sur la st. 38, fait remarqué déjà par Greze (1963) et due à sa position au débouché de celle-ci sur la mer Ionienne. Les études antérieures en mer Egée (Moraitou-Apostolopoulou, 1972; Kiortsis, 1974) ont distingué le bassin nord du bassin sud, tandis que Pavlova (1966) a signalé les particularités de la région Nord-orientale.

Bibliographie

CLARKE, K.R. & R.H. GREEN (1988). Mar. Ecol. Progr., Ser., 46 : 213-226.
GREZE, V.N. (1963). Okeanologischeskiye Issled, 9 : 42-59.
KIORTSIS, V. (1974). Rapp. Comm. int. mer Médit., 22 (9) : 139-141.
MORAITOU-APOSTOLOPOULOU, M. (1972). Hell.Ocean. Limn., 11 : 325-404.
PAVLOVA, E. (1966). Investigation of plankton in South Seas, 7 : 38-61.
THEOCHARIS, A. & D. GEORGOPOULOS (1989). Pollution Research and monitoring programme in the Aegean and Ionian Seas. Report II, NCMR, Athens : 9-76.

The Cladocera of the Inner Bay of Izmir

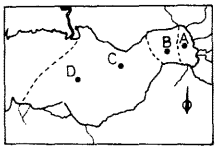
Ismet OZEL and Süleyman MAVILI

Department of Hydrobiology, Ege University, Science Faculty, 35100 Bornova, Izmir (Turkey)

The Gulf of İzmir can be divided into two parts topographically and hydrographically: an inner bay and an outer bay. The inner bay is situated in the eastern part of the Gulf of İzmir around the city and is connected with the outer bay through a channel (580 m wide and 18.6 m deep). This lagoon-like bay is shallow and the depth reaches 5 m to about 20 m.; the area is 65.5 km². Large quantities of organic matter and industrial wastes of this densely populated settlement are transported by several outfalls and small rivers. So, inner bay waters are less transparent and the quantities of seston and nutrients are very high.

A WP-2 nylon net with a mesh size of 200 µm was used. Zooplankton samples were collected by means of surface hauls for 5 min, at an approximate speed of 1.5-2 knots/h. 4 stations were investigated (Fig. 1).

The eutrophicated and very polluted inner bay may be divided into three parts: very polluted area (A), polluted area (B) and semipolluted area (C, D) (Kocataş, 1980). All six mediterranean Cladoceran species: **Penilia avirostris** Dana, **Evadne spinifera** P.E. Müller, **Evadne tergestina** Claus, **E. nordmanni** Lovén, **Podon intermedius** Lilljeborg and **P. polyphemoides** Leuckart have been found. Distribution and abundance of these species show conformity to the dividing mentioned above and vary significantly in the investigated stations, and also depend on the various environmental factors (Tab. 1).



Stations	Temp. (°C)		Sal.(0/00)		Sec.disc.(m)	
	Min.	Max.	Min.	Max.	Min.	Max.
A	11.5 -	26.0	34.9-	37.6	0.80 -	1.75
B	10.0 -	25.5	35.2-	37.9	1.00 -	3.20
C	9.8 -	26.5	35.2-	38.0	1.30 -	4.00
D	9.5 -	27.0	35.1-	38.6	1.50 -	4.70

Penilia avirostris is an euryhaline and neritic species. It is found most abundantly in July and November. Its quantity increases from the inner part to the channel. The presence of this species in the inner bay may be explained by the existence of detritus.

Evadne spinifera is a thermophilic species. It is found during the warm period, maximum in July and disappears in winter. It prefers clear waters, so it is absent in the inner parts (A, B), in relation with the decreasing of water transparency.

Evadne tergestina is also a thermophilic species and is found in all stations in the warm period, from June to December, maximum in July.

Evadne nordmanni is found occasionally in all stations, only in March and April (only in May in the outer bay).

Podon intermedius is a typically psychrophilic species and is encountered in the whole inner bay (except in its innermost part) during the cold period, maximum in January.

Podon polyphemoides is the indicator of both diluted waters and pollution. It is the most common and abundant Cladoceran species of the inner bay. Although a thermophilic species (Patriti, 1973), it is found in great numbers in the whole inner bay in all months, maximum in May (Fig. 2).

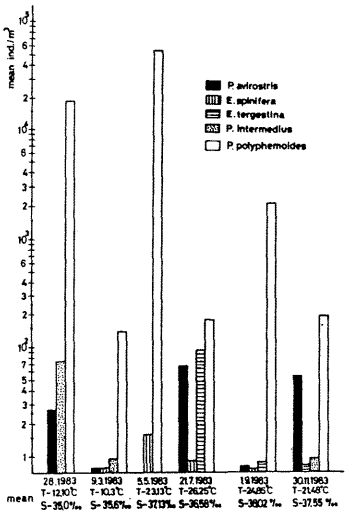


Fig.2.- Quantitative variations of Cladocera in the Inner Bay of İzmir.

REFERENCES

KOCATAŞ- A., 1980. Effects of domestic pollution in İzmir Bay (Turkey). Helgol. Meeresunters., 33: 393-400.

PATRITI, G., 1973. Les cladocères des milieux portuaires de Marseille. Mar. Biol. 20: 50-57.

Surface dynamics of *Cypridina multipilosa* (Ostracoda; Crustacea) in the Gulf of Aqaba (Eilat), Red Sea

T. ECHELMAN* and L. FISHELSON**

*Marine Science Research Center, State University of New York-Stony Brook, Stony Brook, NY 11794-5000 (U.S.A.)

**Department of Zoology, Tel Aviv University, Ramat Aviv 69978 (Israel)

Numerous taxonomic studies of zooplankton have been conducted in the Gulf of Aqaba, but few ostracod species have been reported (Echelman, 1989) and less is known of ostracod seasonal population dynamics.

Ostracods were usually more abundant 2 km offshore than near the reef. They were quite rare in mid-day surface zooplankton collections (Echelman, 1989), and in seasonal night collections most abundant during February and March. The Ostracod collections included six species: Asterope sp., Conchoecia sp., Cypridina multipilosa, Cypridinodes sp., Philomedes sp., and Synasterope sp., of which only C. multipilosa was numerous. Maximum C. multipilosa abundances (419 m^{-3}) were observed during a relatively full moon (March 1, 1988), at this time comprising 47.2 % of the total zooplankton ind. and a significant portion of the total biomass (86.1 g wet weight m^{-3}). Horizontally this high concentration was quite patchy, where at a distance of less than 600 m concentrations as low as 61 ind. or a total biomass of 8.3 g wet weight m^{-3} were observed. With the exception of these March abundances, maxima never exceeded 27 m^{-3} and were generally much lower.

Ostracod maxima have been observed in the same season (February to April), in the Atlantic Ocean (Deevey, 1982) and Andaman Sea (Boonruang, 1985), but reported maxima were much lower (24-46 ind. m^{-3}). To our knowledge only one other seasonal ostracod maximum has been reported, of similar magnitude to our findings during March 1988, and according to Paulinose and Aravindakshan (1977), this phenomena had previously been unreported from any region of the world oceans. There in the northern Arabian Sea Cypridina dentata was observed at concentrations of ca 179 ind. m^{-3}, which set record zooplankton displacement volumes for the upper 200 m of the Indian Ocean, and appeared associated with swarming for planktonic mating and bioluminescence (Daniel and Jothinayagam, 1977; Paulinose and Aravindakshan, 1977). Like Cypridina multipilosa, C. dentata was observed in dense vertically migrating patches (Daniel and Jothinayagam, 1977; Paulinose and Aravindakshan, 1977).

The assemblage of ostracod species from the Gulf of Aqaba appears similar to that of the Gulf of Suez, where seven species are known (Halim, 1969). However, four of the six species from the Gulf of Aqaba, including: Conchoecia sp., Cypridina multipilosa, Cypridinodes sp., and Synasterope sp. have not been reported from the Gulf of Suez or the Red Sea proper. For most planktonic taxa, more species are known from the Red Sea proper than either of the two northern Gulfs; however, ostracods appear to be an exception to this trend (Halim, 1969; Echelman, 1989).

Acknowledgments: The authors wish to express their sincerest thanks to Dr. R. Lerner-Seggev for her help in identifications, A. Cushnier and others for their help in collections, and the H. Steinitz Marine Biological Laboratory for providing facilities and equipment.

Literature

Boonruang, P. (1985). The community structure and distribution of zooplankton at the East Coast of Phuket Island, Southern Thailand, Andaman Sea. Phuket Mar. Biol. Center, No. 39.

Daniel, A. and J. Jothinayagam. (1977). Neuston biomass and variations in abundance of its major zooconstituents in the northern Arabian Sea during the oceanographic expedition on Ins Darshak. pp. 264-273. in: Proceedings of The Symposium on Warm Water Zooplankton. National Institute of Oceanography, India.

Deevey, G. (1982). Planktonic ostracods of the north Atlantic off Barbados. Bull. of Mar. Sci., 32(2): 467-488.

Echelman, T. and L. Fishelson. (1988). The seasonal surface zooplankton dynamics near Eilat, Gulf of Aqaba, Red Sea. Rapp. Rapp. P.-v. Reun Comm. int. Mer. Mediterr., 31: 304

Echelman, T. (1989). The seasonal surface near-reef and offshore zooplankton dynamics near Eilat, Gulf of Aqaba, Red Sea. Tel-Aviv University (M.Sc. thesis).

Halim, Y. (1969). Plankton of The Red Sea. Oceanogr. Mar. Biol. Ann. Rev., Vol. 7: 231-275.

Paulinose, V. and P. Aravindakshan. (1977). zooplankton biomass and abundance in the northeastern Arabian Sea. pp. 132-145. in: Proceedings of The Symposium on Warm Water Zooplankton. National Institute of Oceanography, India.

P-V17

Associations congénériques d'*Acartia* (Copepoda Calanoida) dans les Eaux Côtières Libanaises : Calcul des indices d' "Overlap" et de "Niche hypervolume"

Sami LAKKIS et Raymonde ZEIDANE

Centre de Recherches Marines, CNRSL-UL, B.P. 123, Jounieh (Liban)

Parmi les neuf espèces d'Acartia trouvées dans les eaux côtières Libanaises (Bassin levantin), six forment des niches écologiques, notamment dans les baies semi-fermées et les ports. Les populations de ces congénères montrent au cours de leurs successions annuelles une coexistence et un phénomène d'overlap (Lakkis et Zeidane,1987). La coexistence de ces espèces en essaims et en densité très élevée, indique qu'elles ont les mêmes exigences de facteurs écologiques (ressources naturelles), mais une certaine compétition entre elles montre que l'équilibre écologique n'est jamais atteint(Hamner et Carleton, 1979; Alcazar, 1983). Le concept de niche comprend deux éléments complémentaires : le premier est l'Hypervolume occupé par une espèce donnée dans un espace écologique défini (Feoli et al., 1988) et l'autre est l'Overlap qui concerne les ressources naturelles exploitées par les associés ainsi que leur compétition (Hulbert, 1978; Giller, 1984). Plusieurs indices de calcul de l'overlap ont été utilisés, soit comme coefficient de compétition, soit en tant que mesure de distance ou comme coefficient de corrélation (Holt, 1987). Dans cet article, nous présentons les résultats des calculs des indices d'overlap et d'hypervolume chez les congénères d'Acartia en utilisant des programmes appropriés (Ganis, 1989).

Les données sont basées sur des matrices de densité des espèces comptées dans les échantillons planctoniques effectués tous les mois entre 1986 et 1988 dans deux stations côtières : station J,située à l'entrée de la baie de Jounieh (35°33'E;34°N) par 75 m de fond et la station P située à l'intérieur du port. Si la température de surface montre les mêmes variations saisonnières en P et J (T°min.=17°C; T°max.= 31°C), par contre la salinité qui fluctue faiblement autour de 39,30‰ en mer ouverte, subit des fluctuations importantes dans les eaux du port (S ‰= 32,38-38,70) en raison des déversements d'eaux usées de la ville et d'autres sources. Par ailleurs, plusieurs sources de pollution affectent l'eau portuaire, notamment les émissaires urbains et les dérivés d'hydrocarbure. Ce milieu portuaire semble constituer un biotope favorable aux espèces d'Acartia, où la densité est beaucoup plus élevée qu'à l'extérieur du port; les variations saisonnières montrent que la densité des populations est limitée entre février et octobre avec des overlap entre les congénères (Tab.1). Parmi les neuf espèces présentes, six ont été sélectionnées pour calculer les indices d'overlap et d'hypervolume (Fig. 1).

1) Programme SPRANG. Ce programme sert à préparer les matrices des valeurs minima et maxima pour chaque espèce et pour chacun des facteurs écologiques considérés (T°, S‰, Phytoplancton).
2) Programme HYPERVOLUME. Il permet de calculer l'Hypervolume des niches des congénères suivant la formule : HV=Pi(max-min) où P est le produits des intervalles pour tous les facteurs et i le facteur ith, ainsi que la matrice des overlaps entre les niches suivant la formule : HV(a,b)=Pi(min des max-max des mini) i, a et b étant deux espèces le long des axes facteurs. Les résultats sont présentés tableau 2. Les indices Hypervolume overlap sont calculés à partir des 2 formules :
HVr (a,b)=(HV(a,b)/HV(a) + HV(a,b)/HV(b)/2 où HV(a) et HV(b) sont les hypervolumes des niches d'espèces a et b, puis D(a,b)=Dab/Da + Dab/Db/2 où D représente les diagonales des hypervolumes entre les deux espèces a et b. Tableau 3A, nous avons les indices HV entre les 6 congénères, on note qu'entre A. italica (n°4) et A.josephinae (n°5), HV est le plus élevé (0,989), cet indice d'hypervolume est par contre faible entre les autres espèces. Tableau 3B, nous avons la matrice des indices Distance D entre congénères, D esttrès grand entre A. discaudata et A. grani (D=0,987,donc très éloignés ,et très faible entre A. grani, A. italica et A. josephinae (D=0,763),donc congénères plus proches.
3) Programme OVERLAP. En plus des min et max pour chaque facteur et les intervalles pour chacune des espèces, ce programme calcule l'information mutuelle MI et l'index d'intersection relative: RI=1-MI/logN x T(N= nombre d'espèces; T= grand total). RI prend en considération l'overlap des intervalles, l'équitabilité et la richesse en espèces. Si RI=1, cela veut dire qu'ily a overlap complet, s'il est égal à 0, il n'y a pas d'overlap entre les congénères; Tableau 4, l'analyse de l'overlap pour facteur de salinité montre 0,99571, donc overlap très élevé entre les congénères pour facteur S‰. La figure 2 montre le dendogramme d'association entre les six congénères,effectués par analyse cluster sur base des matrices d'overlap et d'hypervolume. Deux groupes d'espèces montrent nettement l'association entre les espèces 1, 2,3 d'une part et entre 4, 5, 6 de l'autre.

Remerciements. Ce travail a été réalisé grâce à une subvention de l'Académie des Sciences du Tiers Monde (TWAS) offerte à S. LAKKIS.

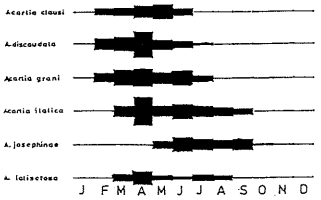


Fig. 1 - Distribution saisonnière d'abondance des congénères d'Acartia dans les eaux Libanaises en 1987.

CODE	ESPECES	STATION (P) N/m3	Rang	%D	STATION (J) N/m3	Rang	%D
1	Acartia-clausi	33	5e	5%	26	1er	62%
2	A.discaudata var-mediterranea	111	3	10	6	3	14
3	A.grani	205	2	33	8	2	5
4	A.italica	211	1	34	2	5	3
5	A.josephinae	38	4	6	2	4	4
6	A.latisetosa	20	6	3	1	6	2
-	A.fossae	1	8	0,5	1	8	0,5
-	A.longiremis	x	9	0,2	1	8	1
-	A.negligens	1	7	1	1	7	0,5

Tableau 1-Liste et abondance des espèces du genre Acartia aux deux stations P et J des eaux libanaises entre 1986-1988.

```
Variable N°2  Salinité S‰
Min val.:32,260    Max val.: 38,670 Range:6,410

        1       2       3       4
Interval bounds:
     32,260  34,240  38,340  38,670
Int.ranges: 1,980   2,100   0,330
Number of Overlaps for each interval:2  6  5
Graphic related to each Niche in one Dimension:

OVERLAP MATRIX

ROW/COL    1       2       3       4       5       6
      1  3.42500 3.42500 3.42500 3.42500 3.42500 3.42500
      2  3.42500 4.41900 4.41900 3.81600 3.81600 3.81600
      3  3.42500 4.41900 4.41900 3.81600 3.81600 3.81600
      4  3.42500 3.81600 3.81600 3.81600 3.81600 3.81600
      5  3.42500 3.81600 3.81600 3.81600 3.81600 3.81600
      6  3.42500 3.81600 3.81600 3.81600 3.81600 3.81600

Mutual Information = 1,12241
Overlap Index      = 0,99571
```

Tableau 4 - Graphique des niches de chacun des six congénères d'Acartia relatif au facteur salinité. La matrice d'Overlap entre congénères est donnée.

OVERLAP HYPERVOLUMES MATRIX ACCORDING TO FORMULA(HVab/HVa+HVab/HVb)/2

	1	2	3	4	5	6
1	1,00					
2	0,50	1,00				
3	0,50	0,754	1,00			
4	0,48E-01	0,337	0,220	1,00		
5	0,47E-01	0,330	0,216	0,989	1,00	
6	0,65E-01	0,323	0,388	0,731	0,742	1,00

A

DISTANCE MATRIX ACCORDING TO FORMULA: (Dab/Da + Dab/Db)/2;négative val.=overlap

	1	2	3	4	5	6
1	-1,00					
2	-0,84	-1,00				
3	-0,84	-0,98	-1,00			
4	-0,81	-0,78	-0,76	-1,00		
5	-0,81	-0,77	-0,76	-1,00	-1,00	
6	-0,84	-0,76	-0,78	-0,97	-0,97	-1,00

B

Tableau 3- 3A :Matrice des indices Hypervolumes overlap; en 3B:Matrice des indices Distance entre les six congénères. Les valeurs négatives indiquent l'Overlap.

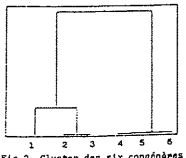


Fig.2- Cluster des six congénères d'Acartia effectué sur base des Distances d'Hypervolumes Niche

		SORTED HYPERVOLUMES	DIAGONAL
1	6	2155,87	9,31900
2	1	2295,73	10,57590
3	4	4369,68	9,79699
4	5	4461,08	0,80061
5	3	0,259E+07	15,51720
6	2	0,392E+07	15,60150

Tableau 2- Matrice des Hypervolumes et de leurs Diagonales,pour les 6 espèces et des 3 facteurs hydrologiques

P-V18

Reproductive patterns of *Pasiphaea sivado* in the Ligurian Sea

Lidia ORSI RELINI and Silvia PINCA

Istituto di Zoologia, Laboratori di Biologia Marina ed Ecologia Animale, Via Balbi 5, 16126 Genova (Italia)

Pasiphaea sivado occupies a key position in the food chains of the Ligurian Sea, where it forms part of the diets of pelagic and benthic predators in a vertical space of at least 700 m . Details of its distribution are given by FRANQUEVILLE (1971) and SARDOU and ETIENNE (1988) and of its trophic role by ORSI RELINI and RELINI 1989. Preliminary observations have been carried out on the reproduction with the aim of assessing its life cycle in the Ligurian Sea.

About 2000 specimens were obtained by means of 52 hours of pelagic trawling (Isaacs Kidd Midwater Trawl 15 feet; R/V Minerva, C.N.R.; cruises in August 1987, July 1988, August 1989, December 1989, February 1990) mainly in the bathymetric ranges 300-400 and 600-700 m. About 1000 additional specimens were fished by commercial otter trawls on fishing grounds at 500-700 m depth off Ventimiglia, where glass shrimps represent a by-catch of *Aristeus antennatus*.

The shrimps were isolated, sexed and measured in terms of carapace length by calipers. Females were identified from 10 mm c.l. upwards by looking for the ovary under or through the thin and transparent carapace wall. The smallest males with an easily distinguishable appendix masculina were 10 mm c.l. The specimens under these sizes were classified as juveniles. The largest size was 22 mm c.l. for both sexes.

In the females the following reproductive patterns were recorded a) with ovarian eggs in advanced maturation; b) with embryos; c) with egg remnants represented by fixing stalks on pleopods. The "reproducing females" are the sum of a+b+c. The embryos were classified in the following stages:

1) unsegmented egg i.e. whose tracks of segmentation are not visible under the stereo-microscope.
2) embryonic tissues extended to a third part of the egg contour line.
3) embryonic tissues which cover half (or a little more) of the egg contour; eye pigments appearing as a very small spot.
4) embryonic tissues about 3/4 of egg volume: eyes and limbs evident.
5) reserves consumed except the oil droplet; egg envelope easily broken.

Sex ratio and minimum reproductive size

In pelagic catches the sex ratio is in favour of females (overall ratio 1.5:1), with negligible differences between the upper and the lower sampled levels. In demersal catches we have observed both sex ratio in favour of females and instances of sex-ratio near to 1:1. The minimum reproductive size for the female was established as the minimum carapace length when bearing embryos. This size was 15 mm in summer 1987, 16 mm in summer 1988 and 1989 and 14 mm in December 1989.

Reproductive stages

The reproductive structure of the female population was studied in pelagic (fig. 1) and demersal catches (fig. 2). Both included females with ovarian eggs in early and advanced maturation and bearing embryos of the stages 1-4. However recently delivered females are present only near the bottom (fig. 2). Supposing that after hatching eggs the female moults and mates - as is common in many Decapods - it is probable that the partners meet and copulate in this bottom environment.

During the winter we observed the same series of reproductive stages as in the summer. Moreover only in the winter samples were recordered some females with embryos of stage 5, i.e. hatching.

Presence of parasites

In the period of this study we observed increasing examples of the presence of a parasite of the genus *Amallocystis* (Protozoa, Ellobiopsidae) in both sexes of *P. sivado* (total incidence in the examined material 4.3%). Females affected by parasites were never seen reproducing.

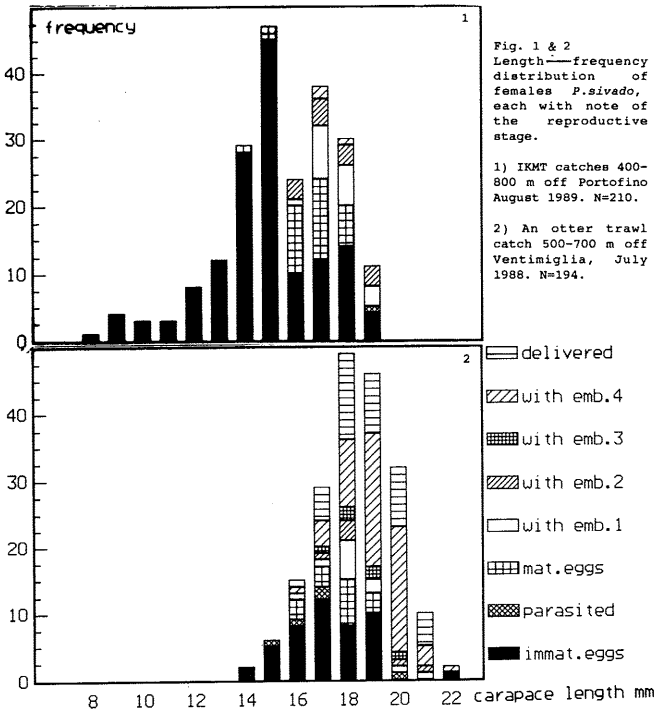


Fig. 1 & 2 Length—frequency distribution of females *P.sivado*, each with note of the reproductive stage.

1) IKMT catches 400-800 m off Portofino August 1989. N=210.

2) An otter trawl catch 500-700 m off Ventimiglia, July 1988. N=194.

Références

FRANQUEVILLE C., 1971 - Tethys, 3: 11-55.

ORSI RELINI L. and RELINI G., 1990 - in Trophic Relationship in the Marine Environment. Proc. 24th Europ. Mar. Biol. Symp.: 334-346.

SARDOU J. and ETIENNE M., 1988 - Rapp. Comm. int. Mer Médit., 31,2.

Distribution of the Zoea larvae of *Ethusa mascarone* (Herbst, 1782) (Brachyura, Decapoda) in the Aegean Sea

Ismet OZEL and Süleyman MAVILI

Department of Hydrobiology, Ege University, Science Faculty, 35100 Bornova, Izmir (Turkey)

The family Dorripidae is represented in the Aegean Sea by Medorippe lanata (Linné, 1766) and Ethusa mascarone (Herbst, 1782), (Kocataş, 1981). The zoea larvae of them are similar, but they are easily distinguishable from one another by the dorsal spine-rostrum length and the presence or absence of a pair of spines on carapace. Descriptions of the larval stages of E. mascarone have been made by Kurian (1956), Bourdillon-Casanova (1960) and Heegaard (1963). However, the zoea larvae of only E. mascarone have been found in the plankton samples collected in the Aegean Sea. These larvae have also, previously been reported from several localities in the Mediterranean Sea: abundantly from the SW coast of Portuguese between June and September (Paula, 1987); from the Catalonia coast of Spain, only in June (Fuste, 1987); in the bay of Algeria, rarely in June-July (Seridji, 1970); in the Gulf of Marseille, from the begining of summer to the end of autumn (Bourdillon-Casanova, 1960) and in the vicinity of Mljet in the Adriatic Sea, common from May to November with maximum in May (Kurian, 1956).

This study has been based on the zooplankton samples, collected with two conical nets, mesh size 0.569 mm and 0.330 mm by surface and vertical hauls in the Aegean Sea in April and June, 1977 and in the Gulf of İzmir in 1987.

Totally, 287 specimens have been found in the samples which were hauled generally in surface waters from April to November. Mean Total lengths of the specimens are in accordance with Bourdillon-Casanova's (1960) measurements, except that in our material, Rostrum lengths are nearly equal to or longer than Dorsal spine lengths. And also, the average lengths at the stage IV are greater than her values (Tab. 1).

Table 1.- Mean values (mm) of Dorsal Spine (DS), Rostrum (R) and Total Lengths (TL).

		Aegean Sea			Marseille (B.C., 1960)		
		DS	R	TL	DS	R	TL
Zoea	I	2.060	2.104	4.758	2.15	2.00	4.80
Zoea	II	2.933	3.147	6.808	3.50	2.50-2.75	6-8.00
Zoea	III	3.792	4.054	8.787	4.00	3.00	8.50
Zoea	IV	4.960	5.108	11.275	4.00	3.60	9.20

Table 2.- Distribution of E. mascarone larvae and investigated parameters of the research stations (The last five stations are situated in the Gulf of İzmir).

Geographic location	Stages	N.Ind.	Depths	Temp.°C	Sal.‰	Date
39°34'00" N	Zoea I	1	24m	21.3	38.05	13.6.1977
26°54'30" E						
39°30'30" N	Zoea I	2	66m	21.3	37.95	13.6.1977
26°36'00" E	Zoea III	1				
	Zoea IV	1				
39°27'00" N	Zoea I	13	110m	22.3	37.92	12.6.1977
26°25'00" E	Zoea II	11				
	Zoea III	1				
39°02'30" N	Zoea I	187	40m	21.5	37.85	11.6.1977
26°46'00" E	Zoea II	42				
	Zoea III	13				
	Zoea IV	1				
38°44'00" N	Zoea I	1	70m	19.4	38.70	11.6.1977
26°40'30" E						
38°43'00" N	Zoea II	1	110m	15.0	38.72	19.4.1977
26°29'00" E						
30°40'00" N	Zoea I	1	70m	21.0	38.70	28.6.1987
26°37'00" E	Zoea III	3				
	Zoea IV	2				
38°28'30" N	Zoea I	1	38m	22.8	37.88	27.7.1987
26°51'30" E						
38°27'30" N	Zoea I	1	47m	20.1	37.60	10.10.1987
26°47'30" E	Zoea II	1	47m	23.5	38.40	7.7.1987
38°25'30" N	Zoea I	1	29m	21.5	38.70	28.6.1987
26°39'00" E	Zoea II	1	29m	24.0	38.74	27.7.1987
	Zoea I	1	29m	23.5	38.76	25.8.1987
38°25'30" N	Zoea I	1	29	22.6	37.64	27.7.1987
26°48'30" E						

BOURDILLON-CASANOVA, L., 1960. Rec. Trav. Sta. mar. Endoume, Fasc. 30, Bull. 18, 286p.
FUSTE, X., 1987. Inv. Pesq. 51 (Supl. 1): 277-284.
HEEGAARD, P.E., 1963. Vidensk. Medd. fra Danks naturh. Foren., bd.125: 450-493.
KOCATAŞ, A., 1981. Rapp. Comm. int. Mer Médit., 27, 2: 161-162.
KURIAN, C.V., 1956. Inst. Ocenogr. Riborstvo, Split VI(3): 1-106.
PAULA, J., 1987. Inv. Pesq. 51 (Supl. 1): 267-275.
SARIDJI, R., 1970. Fac. Sci. L. Univ. Alger (Ph Thesis): 1-131.

Taux de filtration de l'Appendiculaire *Oikopleura dioica* Fol 1872

R. FENAUX et G. MALARA

URA. 716 Station zoologique, Observatoire océanologique, 06230 Villefranche-sur-Mer (France)

Abstract.

A method is described to determine the filtration rate of the appendicularian *Oikopleura dioica* and the variations of the rate with the animal size are given at 18° C.

Méthodes.

Des individus de *Oikopleura dioica* sont placés dans de l'eau de mer filtrée sur 0.45 µm. On les force, au moyen d'une aiguille, à quitter leur logette. Aprés qu'ils en aient reformé une nouvelle, ils sont transférés dans des flacons de 50 ml contenant de l'eau de mer filtrée sur 0.45 µm à laquelle une culture monospécifique du flagellé *Isochrisis galbana* (4 µm de diamètre) est ajouté. La concentration des flagellés est mesurée au compteur de particules HIAC équipé d'une sonde de 60 µm (échantillon de 10 ml ; canal de mesure calibré pour compter les particules de 3 à 6 µm).

Les flacons fermés, sans air à l'intérieur, sont fixés suivant les rayons d'un disque de plastique vertical de 50 cm de diamètre, tournant à la vitesse de 4 tours / minute afin d'assurer une homogenéisation permanente du milieu. Deux flacons contenant la même concentration de flagellés, mais sans appendiculaires, servent de témoins. Le nombre de flagellés est compris , pour toutes les expériences, entre 3000 et 4000 / ml et le nombre d'appendiculaires par flacon a varié de 1 à 5 suivant la taille des individus. Les individus d'un même flacon sont choisis dans une même classe de taille de 100 µm et la moyenne est utilisée.

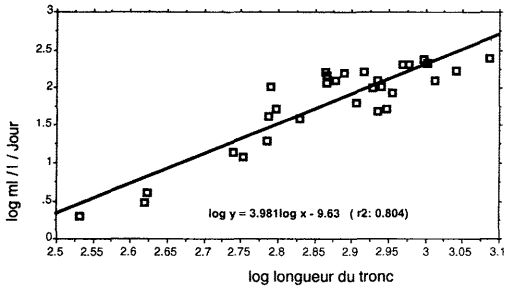
La concentration des flagellés (cell/ml^{-1}) est mesurée au début et à la fin de l'expérience pour les flacons témoins. La moyenne de ces deux mesures (**A**) sert de référence pour les flacons contenant les appendiculaires dont on mesure la concentration cellulaire (**B**) en fin d'expérimentation. La durée des expériences est limitée à deux heures pour éviter les changements de logette pouvant amener des perturbations par la remise en circulation d'une certaine quantité de particules déjà filtrées mais non ingérées et pour être certain de la durée effective de la filtration. C'est pourquoi, seuls les flacons contenant des individus dans leur logette et sans logettes vides sont pris en considération.

Le nombre de cellules filtrées par animal dans les 50 ml du flacon et par heure est calculé par la formule : $C = [(A-B) / x) * 50] / H$, où x = nbre d'appendiculaires et H = tn - to (exprimé en heures).
Le volume filtré par individu et par jour est donné par $V = (C / M) * 24$ avec $M = (A+B) / 2$ représentant la concentration moyenne entre to et tn .

Résultats.

Nous avons obtenu, dans 30 expériences, les résultats suivants donnés en fonction de la longueur du tronc T.L. :

L.T.	930	1007	610	675	860	847	1030	805	419	565
ml / J-1	202	209	20	39	49	101	127	64	4	12
L.T.	417	340	755	870	860	884	548	900	1220	1100
ml / J-1	3	2	127	102	127	53	14	86	247	167
L.T.	611	995	950	616	625	730	735	825	776	735
ml / J-1	42	238	206	103	52	164	117	162	160	144



Conclusions.

Les appendiculaires ayant un tronc inférieur à 400 µm, ont un taux de filtration très faible. Rappelons que *O. dioica* commence à filtrer après la bascule de la queue qui se produit lorsque le tronc atteint environ 300 µm à 18°C (calcul d'après les données de R. Fenaux, 1976). Les adultes proches de la maturité filtrent plus d'un litre par jour. Les différentes valeurs que nous avons trouvées sont plus élevées que celles données par King (1981), pour la même espèce et la même alimentation, ces différences sont liées à la température plus basse (13.5°C) utilisée pour l'expérimentation. Nos valeurs sont proches de celles calculées par Gorsky (1987) pour *O.dioica* et Alldredge (1977) pour *O. longicauda* et O. *fusiformis*, mais, comme on pouvait s'y attendre, trés différentes des volumes calculés par ce dernier auteur pour les grandes espèces, en particulier *Stegosoma magnum* (plus de 35 litres par jour).

Références.

Alldredge A.L. 1977. House morphology and mechanisms of feeding in the Oikopleuridae (Tunicata, Appendicularia). Journal of zoology, London, **181**, 2, pp. 175-188, 3 fig., 2 pl., 2 tabl.

Fenaux R. 1976. Cycle vital d'un Appendiculaire : *Oikopleura dioica* Fol, 1872. Description et chronologie. Annales de l'Institut océanographique, Paris, **52**, 1, pp. 89-101, 5 fig, 4 pl., 1 tabl.

Gorsky G. 1987. Aspects de l'écophysiologie de l'Appendiculaire *Oikopleura dioica* Fol, 1872 (Chordata : Tunicata). Thèse sciences, Université P. et M. Curie, Paris VI, 102 p., 3 pl., 15 tabl.

King K.R. 1981. The quantitative natural history of *Oikopleura dioica* (Urochordata: Larvacea) in the laboratory and in enclosed water columns. Ph. D. thesis, University of Washington, Seattle, VIII + 153 p., 30 fig., 19 tabl. (University microfilms international, Ann Arbor, Michigan, USA. n° 82-12564).

P-V21

Distribution du Tunicier pélagique *Salpa fusiformis* Cuvier à Villefranche : 13 années d'observations

J.-C. BRACONNOT, M. ETIENNE et M. MOITIE

CNRS,UA. 716 Station Zoologique, Observatoire océanologique, 06230 Villefranche-sur-Mer (France)

En 1968 nous avons publié cinq années d'observations des fréquences de distribution des blastozoïdes de *Salpa fusiformis*. Cette espèce est présente en hiver et au printemps dans les eaux de Villefranche (Méditerranée occidentale) (BRACONNOT 1968).

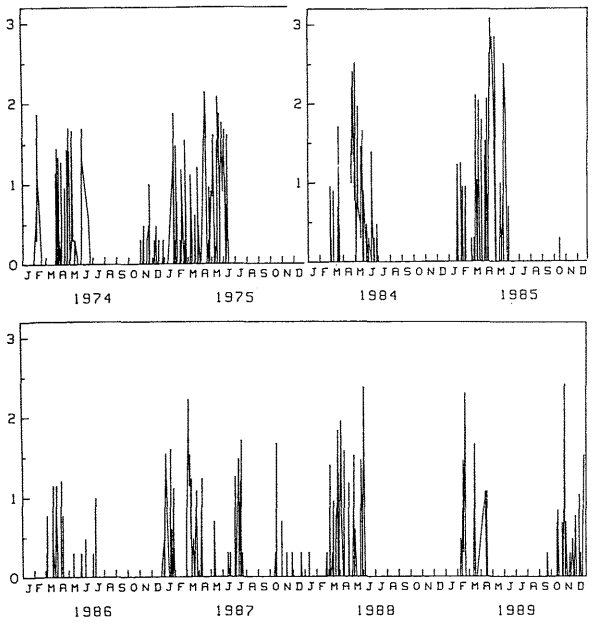
De 1984 à 1989 des observations semblables ont été reprises dans le cadre des travaux sur le rôle des herbivores du macroplancton gélatineux dans l'écosystème pélagique superficiel. Des pêches verticales quotidiennes de 75m à 0m sont effectuées en un point B situé à la sortie de la rade de Villefranche avec un filet de soie de 1m de diamètre d'ouverture et 700µm de vide de maille. Chaque pêche filtre ainsi approximativement 60 m³ d'eau. Les résultats (figure) sont les logarithmes décimaux des effectifs de blastozoïdes récoltés dans chaque pêche. Toutes les pêches sont prises en compte, quand l'effectif est nul le point représentatif de la courbe de fréquence est sur l'axe des abcisses. Nous avons pu ajouter des résultats comparables au même point pour les années 1974 et 1975.

La comparaison de ces années avec celles de la décennie 60 permet de dégager quelques caractères généraux des populations de l'espèce dans nos eaux. On sait que l'efficacité du mode de reproduction des Salpes permet des pullulations qui s'établissent en peu de temps (BRACONNOT et al. 1988), cependant ces grandes populations ne se produisent que si les conditions du milieu le permettent et ainsi toutes les années ne sont pas semblables.

On peut décrire plusieurs types de développement des populations de *Salpa fusiformis* au cours des périodes favorables:

- Le plus fréquent est celui qui donne les populations les plus abondantes avec une invasion du milieu telle que les autres espèces du plancton sont pratiquement éliminées au moment du maximum de population. Cela s'est produit pendant les années 1960, 1963, 1966, 1975, 1984, 1985 et 89-90. La saison débute par une présence irrégulière de l'espèce, de faibles effectifs, pendant les mois d'hiver (janvier à mars), puis la pullulation se produit avec une présence constante d'individus en très grands nombres dans toutes les pêches (100 à 1000 individus par pêche ou de 1,5 à 20 individus par m³) pendant un à deux mois (avril, début-mai) et disparition brusque et totale en mai-juin. **Ce sont les années normales.**
- D'autres années se caractérisent par une population faible pendant toute la saison, aucune pullulation ne se produit. C'est le cas de 1964, 1974, 1988 et 1989: présence aléatoire, toujours en faibles effectifs (<1 ind/m³). **Ce sont les années faibles.**
- Un troisième type d'années, représenté par 1965 et 1987, montre bien la première phase des années normales, ne possède pas de grand développement comme en année faible, mais montre une troisième phase de moyennes abondances qui s'étend jusqu'en juin et juillet. **Ce sont les années spéciales-faibles.**
- En 1986 nous avons dû considérer un nouveau type que nous ne pensions pas possible à Villefranche: **année nulle** où aucune population, même faible, ne s'installe, seuls quelques individus épars étant récoltés pendant la saison.

Une recherche des causes de ces différences entre années permettra d'amorcer une étude à long terme des populations superficielles locales et donc de celles du bassin Ligure qui suivent de près celles de la côte comme nous avons pu le vérifier de nombreuses fois (en année nulle, 1986, la totalité du bassin Nord-Ligure était exempte de *Salpa fusiformis*, pendant les campagnes TROPHOS II et MIGRAGEL I; en année d'abondance, le bassin est totalement envahi, cas des échouages simultanés à Villefranche, à Antibes et à St Tropez en 1979).



Au cours des campagnes de plongées avec CYANA, nous avons décrit une population de *Salpa fusiformis* persistante en toutes saisons vers 400-600m, probablement détritivore (LAVAL et al. 1989). En surface la population disparaît pendant les mois sans conditions favorables du milieu; la population de la saison suivante serait produite par des individus migrant depuis la population de profondeur vers la surface et se développant dès que les conditions sont bonnes (nourriture suffisante, températures convenables...). Dans cette hypothèse, un très petit nombre d'individus, injectés ainsi dans les couches de surface de janvier à mars, suffirait à produire en avril-mai une invasion du milieu. Ce processus fonctionnerait plus ou moins bien selon les années comme nous l'avons vu.

REFERENCES:

BRACONNOT, J.C. 1968. Distribution du Tunicier pélagique *Salpa fusiformis* à Villefranche/mer. *Rapp. Comm. int. Mer Médit.*,19 (3) pp. 481-482, 1 fig.

BRACONNOT, J.C., CHOE, S.K., NIVAL, P., 1988. La croissance et le développement de *Salpa fusiformis*. *Ann. Inst. océanogr.*, 64 (2) pp. 101-114, 2pl.

LAVAL, Ph., BRACONNOT, J.C., GORSKY, G., 1989. Organismes pélagiques profonds. *Congrès commun Limnol. Océanogr. Marseille-Luminy. Résumés.* pp. 195-196.

P-V22

Etude ultrastructurale de la morphogénèse et des remaniements du revêtement tunical au cours du développement et de la métamorphose de la Larve de l'Ascidie *Ascidiella aspersa* (Tunicata, Ascidiacea)

B. LUBBERING, G. GOFFINET et J. GODEAUX

Laboratoire de Biologie générale et de Morphologie ultrastructurale, Université de Liège, 22, quai Van Beneden, B 4020 Liège (Belgique)

Abstract : Tunic morphogenesis in Ascidiella aspersa was studied ultrastructurally from the very beginning up to the young ascidian. Tunic development starts during the tail-bud stage. In the trunk, the larval cuticle and three tunic layers arise successively; in the tail just the larval cuticle and a single tunic layer are formed. Shortly before metamorphosis, a new very thin layer appears that limits the tail tunic interiorly. The tunic is composed of granular and fibrillar material embedded in an electron transparent ground substance. In the course of metamorphosis the tail is retracted. The larval cuticle and the first tunic layer are discharged. Then the young ascidian is just surrounded by a cuticle and one tunic layer.

La structure de la tunique chez les larves d'Ascidies n'a fait l'objet que de quelques recherches (*Ciona intestinalis*, Gianguzza et Dolcemascolo, 1980; *Corella inflata* et *Ascidia paratropa*, Cloney et Cavey, 1982; *Distaplia occidentalis*, Cavey et Cloney, 1984).

Des embryons de *Ascidiella aspersa* ont été obtenus sous le contrôle de conditions expérimentales rigoureuses après insémination artificielle des ovocytes. La segmentation de l'oeuf, du type bilatéral et déterminé, est classiquement suivie des stades blastula, gastrula, neurula et bourgeon caudal. L'éclosion des larves a lieu environ 14 heures après fécondation. La période du stade têtard libre, capitale pour le choix du substrat de fixation, ne dure que quelques heures. Aussitôt fixées, les larves subissent une profonde métamorphose.

Les premiers éléments structuraux de la tunique font leur apparition au stade bourgeon caudal (embryons âgés de 11 h 15) sous la forme d'un ruban discontinu de matériaux fibreux couvrant la membrane apicale de l'épiderme. Ce dépôt constitue la cuticule larvaire et est immédiatement suivi de celui d'une première couche tunicale mince. Par la suite, deux couches supplémentaires de substances tunicales sont mises en place dans la seule région correspondant au futur tronc de la larve.

C'est ainsi que dans les embryons âgés de 13 h, alors que l'épiderme de la région caudale n'est toujours limité que par la cuticule et une seule couche tunicale, la tunique du tronc présente une organisation plus complexe. La cuticule s'y présente comme une condensation de matériaux fibrillaires et granulaires disposés en 3 feuillets de densités électroniques différentes. En dessous, la première couche tunicale se compose de matériaux granulaires relativement denses mais sans organisation particulière. La troisième couche se caractérise par la présence de fibrilles dont l'orientation est généralement parallèle à la surface de l'épiderme. Ces deux couches sont séparées par une mince strate fibreuse plus ou moins compacte, la deuxième couche tunicale.

Cette organisation se retrouve dans la cuticule des larves au moment de leur éclosion, à l'exception de la cuticule qui apparaît épaissie et dépourvue de son organisation tripartite inititiale.

Durant le stade nageur de l'organisme, l'organisation de la tunique subit des modifications importantes. Au niveau de la cuticule et de la première couche tunicale du tronc, on assiste à une disparition progressive des matériaux se traduisant par une diminution accusée du contraste électronique alors que la troisième couche s'épaissit considérablement et que la deuxième couche apparaît mince et contrastée.

L'épaisseur de la tunique de la région caudale ne varie pas, mais une perte des éléments fibrillaires y est également évidente. De plus, lors du stade précédant la fixation de la larve, une lacune préparant probablement la rétraction de cette région apparaît entre la masse tunicale et la membrane apicale de l'épiderme.

La métamorphose s'accompagne d'une résorption de la région caudale et du rejet de sa tunique. La tunique de la jeune ascidie se présente comme une simple couche tunicale limitée extérieurement par une cuticule. Les observations suggèrent que la cuticule et la première couche tunicale larvaires sont abandonnées et que la deuxième et la troisième couches tunicales larvaires deviennent respectivement la cuticule et la couche fondamentale de la tunique de la jeune ascidie.

BIBLIOGRAPHIE

CAVEY, M.J. et CLONEY, R.A. (1984). Development of the larval tunic in a compound ascidian : Morphogenetic events in embryos of *Distaplia occidentalis*. Can. J. Zool., **62**, 2392-2400.

CLONEY, R.A. et CAVEY, M.J. (1982). Ascidian larval tunic : Extraembryonic structures influence morphogenesis. Cell Tiss. Res., **222**, 547-562.

GIANGUZZA, M. et DOLCEMASCOLO, G. (1980). Morphological and cytochemical investigations on the formation of the test during the embryonic development of *Ciona intestinalis*. Acta Embryol. Morphol. Exper., ns **1**, 225-239.

P

R-I1

IAEA - 307 : A New Biological Reference Material for Marine Environmental Radioactivity Studies

A. VEGLIA*, S. BALLESTRA** and D. VAS**

*Centre Scientifique de Monaco, 16 boulevard de Suisse (Monaco)
**International Atomic Energy Agency, International Laboratory of Marine Radioactivity, 19 avenue des Castellans (Monaco)

A laboratory intercomparison exercise to determine the levels of natural and artificial radionuclides in a homogenized sample of sea plant (Posidonia oceanica) was organized by the International Laboratory of Marine Radioactivity (IAEA) in 1988-1989. The sea plants were collected along the shore from the vicinity of Monaco in October 1986 and were assumed to be contaminated by both global and close-in radioactive fallout from the accident of Chernobyl (26 April 1986).

TABLE 1

Reference activity values :

Radionuclide	Recommended value[1] Bq kg^{-1}	Confidence interval Bq kg^{-1} (α=0.05)
Potassium-40	150	141-161
Ruthenium-106	33.5	30.0-36.5
Silver-110m	5.1	4.8-5.5
Caesium-134	1.6	1.5-1.9
Caesium-137	4.9	4.5-5.2
Radium-226	3.1	2.1-4.4
Plutonium-238	0.025	0.022-0.028
Plutonium-239,240	0.72	0.66-0.79
Americium-241[2]	0.036	0.030-0.050

1. Activities are expressed on dry-weight basis (constant weight at 80°C) for the reference date : 1 January 1988.

2. Recommended value for reference date only. Ingrowth from any ^{241}Pu present will alter value if ^{241}Am is measured in the sample during some subsequent year.

Sixty-six laboratories from 31 member state countries reported results for 34 natural and man-made radionuclides in this reference material (IAEA-307). The large participation made it possible to generate statistically valid recommended values for the activities of 9 radionuclides in this material (Table 1). Non-certified information values were generated for 4 radionuclides (Table 2). This reference material IAEA-307 was certified as a reference material from this exercise and made available for distribution in 1990.

TABLE 2

Non-certified activity values :

Radionuclide	Activity[1] Bq kg^{-1}	Confidence interval Bq kg^{-1} (α=0.05)
Strontium-90	0.72	0.28-1.6
Lead-210	58.5	40-91
Thorium-228	3.2	1.5-4.2
Uranium-238	14	2.5-21

1. Activities are expressed on dry-weight basis for the reference date : 1 January 1988.

Recommended concentrations represent overall median values calculated from the results that passed a non-parametric test that identified outliers (1) and which satisfied a number of other selected quality criteria (2). Confidence intervals were calculated from statistical tables and correspond to a significance level of 0.05.

The total number of outliers from the 415 reported results was small (about 8% of all results) and varied between 0 and 3 per laboratory. Twenty laboratories submitted results that included at least one outlying value.

The reference material IAEA-307 is certified for use to evaluate the accuracy of radioanalytical procedures for biological materials, and when checking precision among analysts in a laboratory.

REFERENCES

1) A. Veglia : International Atomic Energy Agency, Report No. IAEA/RL/84 (August 1981)

2) A. Veglia, S. Ballestra, D. Vas : Report on the Intercomparison of IAEA-307, Radionuclides in Sea Plant, Report No. IAEA/AL/014 (October 1989)

R-I2

Gamma Emitters in IAEA's SD-A-1 Marine Sediment Intercomparison Sample

Iolanda OSVATH

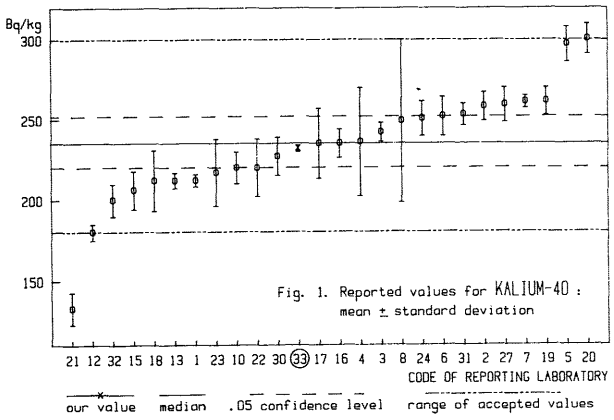
Environmental Radioactivity Research Laboratory, Institute of Meteorology and Hydrology, Bucharest (Romania)

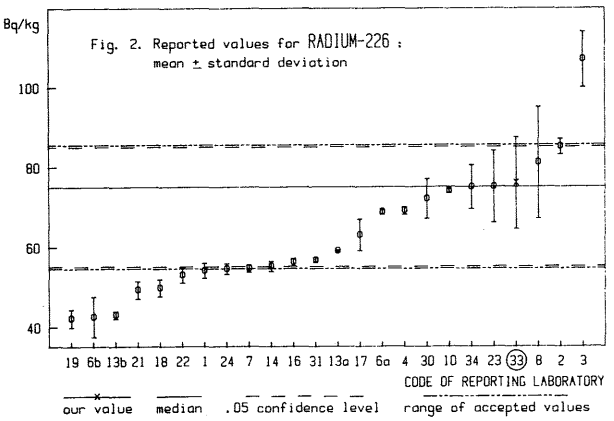
SD-A-1 is a deep-sea sediment sample, collected in 1985 from the Atlantic floor (between 46° - 48°30′ N and 18° - 22° E, depth greater than 4000 m), (IAEA, 1988). A box corer was used for sampling. The top 15 cm of the resulting sample having been removed, the remaining material was assumed to have artificial radionuclide concentrations at or below detection limits. The intercomparison run, organized by the International Laboratory of Marine Radioactivity during 1986-1987, certified the values of some natural radionuclide concentrations in the sample, which thus became reference material, also recommended as a blank for artificial radionuclides. Results for K-40 and Ra-226 are synthesized in Fig. 1, respectively Fig. 2.

In our laboratory, we have analysed an aliquot of 100g of the sample, using high resolution, low-background gamma spectrometrical equipment. Three measurements were performed, with the counting time ranging between 30 and 61 hours. Data were processed according to ILMR requests.

Two problems regarding data interpretation ask for attention, leading to conclusions of interest for the gamma spectrometrical analysis of sediment samples.

1. Among the Ra-226 concentration values reported by the participants, the ones obtained through gamma spectrometrical analyses were assesed by two methods:
a. directly, from the 186 keV photopeak, and
b. indirectly, from Pb-214 - Bi-214, assuming them to be at equilibrium with Ra-226.
Under normal sealing conditions (sample in closed plexiglass beaker), even at times much longer than needed for equilibrium to be attained among Ra-226 daughters, a disequilibrium factor of 1.3-4 persists. It is due to the great diffusivity of Ra-222,





part of which can consequently leave the sample. This is not the case with the thorium series, due to the relatively short half-life of Ra-220, the Ra-228(Ac-228)/Pb-212 activity ratio being very close to unity. These statements are based on a large amount of measurement data resulting from marine as well as river and lake sediments.

The conclusion can be drawn that the activity concentration of the Ra-226 in the sample cannot be assimilated to the Pb-214 - Bi-214 activity concentration.

2. Activity concentrations are reported for Tl-208, which appear to be calculated using different values for the yield of its gamma line at 583.1 keV. According to the disintegration schema of the thorium series (GUSEV and DMITRIEV, 1978), when equilibrium is reached in a closed sample, as pointed out in pp. 1, the Pb-212 - Bi-212/Tl-208 activity ratio approximates the branching ratio (BR=0.36).

This BR has to be considered when calculating the Tl-208 activity concentration from its 583.1 keV line.

The same explanation also accounts for the large scatter in Tl-208 data reported in the IAEA-306 Baltic Sea sediment intercomparison run (IAEA, 1989): they obviously group around two values, which differ from one another by a factor which closely approximates the BR.

Regarding U-235, although itself was one order of magnitude below our detection limit, the sample spectra showed clearly the presence of its gamma emiting daughters, like Th-227, Ra-223 and Bi-211. Most of the important gamma lines of the daughters are usually shielded by those of radionuclides in the U-238 and Th-232 series.

REFERENCES

IAEA, 1988. Report on the Intercomparison Run SD-A-1: Radionuclides in Marine Sediment. IAEA/AL/012

IAEA, 1988. Report on the Intercomparison Run IAEA - 306: Radionuclides in Baltic Sea Sediment, IAEA/AL/013

GUSEV I.G., DMITRIEV P.P., 1978. Radioactive Series. A guide.

Stable Element Variation in Sediments and Macrophytes from Rumanian Black Sea Coast the Last Decade

Ana PANTELICA*, Maria SALAGEAN* and Iulia I. GEORGESCU**

*Institute for Physics and Nuclear Engineering, Bucharest (Rumania)
**Polytechnical Institute, Faculty of Chemical Technology, Bucharest (Rumania)

Bottom sediments on the Rumanian Black Sea coast as well as the algae Enteromorpha linza and Ceramium rubrum sampled during 1989 from the sea beach were analysed by INAA for determining certain selected stable elements. During the last ten years an increasing concentration in Zn, Cr, As, Sb, Se and Hg was observed. Co was found decreasing in sediments and Enteromorpha linza but increasing in Ceramium rubrum. Sc was found decreasing in sediments but slightly increasing in algae.

Sediment samples from the bottom of the Rumanian Black Sea (45°08'N, 29°57'E, to 44°08'N, 28°57'E, 12-17 nautical miles offshore and 29-43 m depth were collected together with E. linza and C. rubrum on the sea side beach during March-June 1989. After rinsing the algae the samples were dried. The samples were analysed by INAA. About 100 mg of each sample were irradiated along with an equal quantity of standards under same conditions in the VVRS-2 reactor in Bucharest (flux 10^{12-13} n/cm²sec). Counting has been performed by using a Ge(Li) detector (2.8) keV resolution coupled with a pulse height analyser.

The results obtained in this work concerning As, Co, Cr, Cs, Hg, Sb, Sc, Se, Th, U and Zn are given in Table 1. In a previous paper it has been outlined that the content of the selected stable elements was increasing in E. linza and C. rubrum during 1986 (SALAGEAN et al., 1988). Nowadays, four years later, the concentration of As, Co, Sb, Hg and Zn was found increased. Also Sc was found increased in C. rubrum while in E. linza was decreased at S. Eforie but increased at Mangalia. The mean value as a whole of Sc in E. linza is about the same as before. Uranium is almost constant in both algae while Th is slightly increased in C. rubrum. In the bottom sediments at Portitza sampling site at the south of Danube river, higher concentration of the elements was observed than at the other sampling sites: Zn (615 ppm), Cr (130 ppm), As (8.4 ppm) (SALAGEAN et al. 1988). The Cs value (8.9 ppm) related to illite presence explains the highest accumulation of Cs-137 at Portitza site.

Table 1. Stable element content (ppm dry matter) in sediments and algae sampled from the Rumanian Black Sea coast during 1989

ELEMENT	SEDIMENTS				Enteromorpha linza		Ceramium rubrum	
	Sulina	Sf.Gheorghe	Portitza	Constantza	South Eforie	Mangalia	South Eforie	Mangalia
As	6.2±1.7	11.2±2.7	18.4±4.4	5.7±1.4	<5	<4	<7	<4
Co	7.3±0.2	7.5±0.2	15.5±0.4	5.2±0.1	1.7±0.1	2.8±0.2	5.1±0.3	4.4±0.2
Cr	75 ± 3	50 ± 2	130 ± 5	27 ± 1	5.2±0.7	16 ± 1	31 ± 1	24 ± 1
Cs	2.9±0.1	3.0±0.2	8.9±0.4	1.9±0.1	0.54±0.12	0.81±0.10	2.3±0.2	1.6±0.2
Hg	<1.8	<2.1	<2.0	<1.9	<2.1	<1.5	2.6±0.9	<1.7
Sb	0.9±0.1	0.94±0.09	2.2±0.1	0.56±0.06	0.4±0.1	0.48±0.07	1.4±0.1	0.75±0.09
Sc	6.5±0.2	5.9±0.2	15.4±0.5	3.5±0.1	0.06±0.02	1.52±0.04	4.6±0.1	3.1±0.1
Se	<1.3	1.2±0.6	<3	<1.5	<2.5	<1.6	<3.3	1.3±0.5
Th	4.8±0.1	4.5±0.1	11.5±0.3	2.9±0.1	0.52±0.06	1.6±0.07	3.6±0.1	2.5±0.1
U	1.1±0.2	1.7±0.2	2.8±0.4	0.9±0.2	<1	1.1±0.4	1.4±0.6	1.5±0.5
Zn	296±18	133±21	615±43	155±15	150±9	230±14	298±30	310±23

REFERENCES

SALAGEAN, M., PANTELICA, A. and GEORGESCU, I.I., 1988. Instrumental neutron activation analysis of two macrophytes from the Rumanian Black Sea beach. Rapp. Comm. int. Mer. Medit. 31 (2) :326.

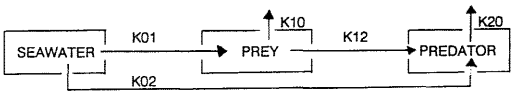
Modelling Cesium, Cobalt & Strontium Accumulation in Painted Comber, *Serranus scriba*

C.-V. NOLAN*, S.-W. FOWLER*, J.-L. TEYSSIE*, M. BULUT** and O. de la CRUZ-RODRIGUEZ***

*I.A.E.A., International Laboratory of Marine Radioactivity, 19, Av. des Castellans (Monaco)
**C.N.A.E.M. Radyobiyoloji Bl., Pk. 1, Havaalani, Istanbul (Turkey)
***Secretaria Ejecutiva Asuntos Nucleares, P.O. Box 6689, Havana (Cuba)

Radionuclides of cesium, cobalt and strontium may be introduced into the marine environment in global fallout and in civil nuclear discharges. Since they may be accumulated by biota and transferred through marine food chains, it is important to quantify relevant transport processes in order to predict any risks to consumers which may be associated with such transfers. This involves identifying pathways as well as determining the extent of accumulation at different trophic levels. One approach used in assessing the accumulation of radioactivity involves the use of concentration factors (CF) - defined as the radioactivity per unit wet mass of an organism divided by the concentration of radioactivity in the water. CFs have been determined for radionuclides in many species both *in situ* and in laboratory experiments. Generally, laboratory exposures tend to lead to underestimates of CFs measured *in situ* - perhaps because of too-short exposure periods in laboratory aquaria or because of non-representative diets of the test animals or of the physicochemical speciation of the radionuclides in the test system (1). In this presentation we report the application of a three-compartment model which allows the CF of a radionuclide to be predicted in fish predator species. The model also allows estimates to be made of the time required to reach steady-state conditions and differentiates between the contributions of food and of water vectors to total uptake. Here it is used to predict the accumulation of 134-Cs, 60-Co and 85-Sr in the painted comber, *Serranus scriba*, using laboratory-determined accumulation and excretion rate data as well as the assimilation efficiency for these radionuclides after ingestion of a radiolabelled prey organism - juvenile flathead grey mullet, *Mugil cephalus*.

Description of Model: The model is a slight modification of that described by Aoyoma & Inoue (2). From water, of radionuclide concentration W, both predator and prey accumulate radioactivity at the rate K20 and K10 respectively. Both species also excrete accumulated radioactivity at the rates K20 and K10. In addition the predator accumulates radioactivity at the rate K12 through consumption of the prey organism. The parameter K12 is equivalent to the product of the assimilation efficiency and the feeding rate (expressed as the daily ration as percent of the total body weight). The radioactivity in the predator at any time (t) is equivalent to the sum of water (WATER) and food (FOOD) vectors.



WATER = W*K02/K20 * (1-EXP(-K20*t))
FOOD = W*K01*K12*{[1/(K10*K20)] + [EXP(-K10*t)/(K10*(K10-K20))] + [EXP(-K20*t)/(K20*(K20-K10))]}
Since the uptake and loss rates in the prey can be expressed in terms of those of the predator then the expression describing uptake from food can be reduced to:
FOOD = 2.09*W*K02*K12*[1.8 + EXP(-2.8*K20*t)-2.8*EXP(-K20*t)]/[5.04*K20*K20]

Estimation of parameters: *Serranus scriba* (28±4 g) captured near Monaco were used. (i) Accumulation from water: Four fish were exposed to 60-Co (450 Bq/l), 134-Cs (450 Bq/l) and 85-Sr (7500 Bq/l) for 30 days in individual 20-litre aquaria containing 10μm-filtered seawater. The water was changed and the radionuclide concentration re-established every second day. The animals were routinely wholebody-counted under anaesthesia in a calibrated 2"x3"NaI well-type detector and the radionuclide content determined by comparison with known standards. The accumulation rates, normalised to unit radionuclide concentrations in the water, were calculated by linear regression of radionuclide content *vs.* time (Table 1); (ii) Excretion: Four fish were fed a single ration of grey mullet containing 92.5 kBq 60-Co, 18.5 kBq 134-Cs and 18.5 kBq 85-Sr. The animals were maintained for 37 days in aquaria with constantly flowing seawater and were fed daily with non-contaminated mullet. They were regularly wholebody-counted as described above and the loss rates were determined by fitting a double-exponential decay curve to the data (Table 1); (iii) Assimilation efficiency for a single feeding could be estimated from the equation of the excretion curve. A second estimate was made using linear regression of wholebody-counting data for four fish which were fed daily for 75 days with radiolabelled mullet (20% of the radioactivity used for the single feeding) *vs.* time (Table 1).

Table 1. Laboratory values for the parameters used and the consequent predictions.

	^{60}Cobalt	^{134}Cesium	^{85}Strontium
Uptake	0.087*t - 0.024	0.201*t - 0.036	0.024*t + 0.014
K02	0.087	0.201	0.024
Loss (Fast Pool)	0.91*EXP(-2.1*t)	0.53*EXP(-12*t)	0.98*EXP(-2.6*t)
Loss (Slow Pool)	0.09*EXP(-0.015*t)	0.46*EXP(-0.018*t)	0.02*EXP(-0.026*t)
K20	0.032	0.0175	0.0256
Assim. Eff. (loss)	9.5%	46%	2.0%
Assim. Eff. (uptake)	9.3%	35%	3.8%
K12	0.0942	0.4410	0.0292
CF (from Water)	5.7	11.5	0.93
CF (Food & Water)	32.0	33	1.02
Cont. of Water	18%	35%	91%
90% St.-State at	170 days	150 days	90 days

Assumptions made in model: It was assumed that (a) in an exposure situation the radionuclide concentration in the water would remain constant with time (this is considered to be valid for global fallout and for routine civil nuclear discharges but is not necessarily so for accidents *etc.*); (b) the excretion rate is independent of the route of uptake of the radionuclide; (c) in the natural environment the predator consumes a daily ration equivalent to 10% of its body weight in four separate feeds (each feed equivalent to 2.5% of the body weight of the predator); (d) the accumulation and excretion processes in the prey organism are functionally identical to those of the predator and are proportional to a power function of body weight i.e. Accumulation Á Weight$^{0.80}$ and Excretion Á Weight$^{0.72}$ (3). Thus the accumulation rate from water in the prey would be 2.09 times that of the predator and the excretion rate would be 2.8 times that of the predator (4).

Simulations and Predictions of Model: Accumulation of the radionuclides by *Serranus scriba* during 300 days of exposure was simulated using this model with initial conditions of zero radioactivity in predator and prey at time zero and assuming that the concentration of each radionuclide in the water remained constant at unity (W = 1) during the exposure. The predictions of the model are presented in Table 1. Accumulation is given in terms of CF. No accumulation of strontium beyond the levels in the water is seen (CF = 1) and more than 90% of the strontium uptake in the animals is from the water. Both cesium and cobalt are accumulated predominantly from the diet (CF = 33 and 32 respectively) although water is a more important vector for the former during accumulation (35% *vs.* 18% of total uptake). In all three cases more than 90 days are required to reach CF values equivalent to 90% of the steady-state values. The predicted CF values are in excellent agreement with field-measured CF values for these radionuclides in fish (1, 5) and both the time required to reach steady-state values and the significant contribution of diet to total uptake of cesium and cobalt may explain why laboratory-determined CF values tend to underestimate those measured *in situ*. This work demonstrates the value of simple laboratory studies and their application in relatively unsophisticated models in the prediction of pathways of accumulation and the importance of trophic transfer in the movement of radionuclides through marine food chains.

References:
1. Harrison, F.L., 1986, EPA Report 520/1-85-015, Washington
2. Aoyoma, I. and Inoue, Y. 1973, J. Radiat. Res., *14*, 375-381
3. Jorgensen, S.E., 1986, Fundamentals of Ecological Modelling, Elsevier, Amsterdam, 391pp.
4. Evans, S., 1988, J. Exp. Mar. Biol. Ecol., *120*, 57-80
5. Noshkin, V., 1985, EPA Report 520/1-84-028, Washington

R-I5

Distribution of Technetium in *Mytilus edulis*

G.-Y. QIU*, M. COGNEAU**, F. REGOLI***, G. NUYTS****, A. BOSSUS****, J.-M. BOUQUEGNEAU*****, D. Van der BEN****** and S. BONOTTO****

*Department of Virology and Molecular Biology, Wuhan University, Wuhan, Hubei (P.R. China)
**Laboratoire de Chimie Inorganique et Nucléaire, Université Catholique, Louvain-la-Neuve (Belgique)
***Dipartimento di Biomedicina Sperimentale, Infettiva e Publica, Sezione di Biologia e Genetica, Università di Pisa, Pisa (Italia)
****Department of Radioprotection, C.E.N./S.C.K., Mol (Belgium)
*****Laboratoire d'Océanologie, Institut de Chimie, Université de Liége, Sart Tilman, Liège (Belgium)
******Institut Royal des Sciences Naturelles de Belgique, Bruxelles (Belgique)

The artificial element 43, technetium, is a metal which was virtually absent from the natural environment prior to the nuclear age. The most important isotope, from the radioprotection point of view is Tc-99, which decays to stable Ru-99 with a half-life of 2.1 x 10^5 years. Once in the aquatic environment, Tc-99, which is highly soluble and mobile, would probably remain available for quite a long time.
It was, thus, of interest to improve our knowledge on the biological behaviour of technetium in aquatic organisms. The mussel, Mytilus edulis, is a choice organism for investigating not only the uptake and loss processes, but also the tranfer along the food chain.
In previous studies, we have shown that technetium was accumulated mostly in the hepatopancreas (Verthé et al., 1984 ; Bouquegneau et al., 1985). On the other hand, it is well known from the literature that mussels are capable of synthesizing metal-binding proteins when they are exposed to heavy metals such as cadmium, copper and mercury (Noël-Lambot, 1976 ; Frazier, 1986 ; Viarengo et al., 1980 ; Roesijadi, 1982).
In our recent investigations we have observed that in mussels exposed to technetium (Tc-95m) for about three weeks, an important accumulation occurred in the hepatopancreas, where more than 50% was present in the cytosol compartment. However, analysis of cytosol fractions by column chromatography and by the Cd-109 saturation method (Nolan and Shaikh, 1986) did not reveal the presence of metallothioneins in animals supplied for about two weeks with 200 µg l^{-1} Tc-99. By contrast, cadmium, at the same concentration (200 µg l^{-1}), showed a good inductive capacity of the synthesis of metallothioneins (both Cd-BP20 and Cd-BP10 ; Frazier, 1986).

Our results suggest that, in contrast to cadmium, technetium is incapable of inducing the synthesis of metallothioneins, at the concentration of 200 µg l^{-1}. It would be of interest to investigate whether at higher concentrations, technetium has an inductive capacity and whether this element can bind to metallothioneins previously induced by other metals present in the marine environment. Another important question to be resolved is whether technetium can be sequestered in intracellular granules, as shown for other metals (Fowler, 1987 ; Chassard-Bouchaud et al., 1989).

References

BOUQUEGNEAU, J.-M., VERTHÉ, C., MOUREAU, Z., MANIA, B., VAN BAELEN, J., van der BEN, D., COGNEAU, M., VANDECASTEELE, C.M., MYTTENAERE, C. and BONOTTO, S. (1985) Accumulation of technetium by four marine molluscs and transfer to a predatory fish. In : Progress in Belgian oceanographic Research (Van Grieken, R. and Wollast, R., Eds.), pp. 380-392. University of Brussels (VUB).

CHASSARD-BOUCHAUD, C., BOUTIN, J.F., HALLEGOT, P. and GALLE, P. (1989) Chromium uptake, distribution and loss in the mussel Mytilus edulis : a structural, ultrastructural and microanalytical study. Dis. aquat. Org., 7, 117-136.

FOWLER, B.A. (1987) Intracellular compartmentation of metals in aquatic organisms : roles in mechanisms of cell injury. Environ. Health Perspect., 71, 121-128.

FRAZIER, J.M. (1986) Cadmium-binding proteins in the mussel, Mytilus edulis. Environ. Health Perspect., 65, 39-43.

NOËL-LAMBOT, F. (1976) Distribution of cadmium, zinc and copper in the mussel Mytilus edulis. Existence of cadmium-binding proteins similar to metallothioneins. Experientia, 32, 324-325.

NOLAN, C.V. and SHAIKH, Z.A. (1986) Determination of metallothionein in tissues by radioimmunoassay and by cadmium saturation method. Anal. Biochem., 154, 213-223.

ROESIJADI, G. (1982) Uptake and incorporation of mercury into mercury-binding proteins of gills of Mytilus edulis as a function of time. Mar. Biol., 66, 151-157.

VERTHÉ, C., MAQUET, M.N., MOUREAU, Z., MANIA, B., VAN BAELEN, J., van der BEN, D., COGNEAU, M., VANDECASTEELE, C.M., BOUQUEGNEAU, J.-M., MYTTENAERE, C. and BONOTTO, S. (1984) Transfer of technetium in an experimental marine food chain. In : Radiation Protection (Cigna, A. and Myttenaere, C., Eds.), pp. 397-415. EUR9214 EN, CEC, Luxembourg.

VIARENGO, A., PERTICA, M., MANCINELLI, G., PALMERO, S. and ORUNESU, M. (1980) Rapid induction of copper-binding proteins in the gills of metal-exposed mussels. Comp. Biochem. Physiol., 67C, 215-218.

Acknowledgements

Prof. G.Y. Qiu was recipient of a short term fellowship from the International Union of Radioecologists.
Part of this work was supported by contract CCE B-16-0049-B.

R-I6

Chromate Bioavailability in Two Benthic Invertebrates

Maria STAMOULI and Catherine PAPADOPOULOU

"DEMOKRITOS" National Research Center, Institute of Physical Chemistry, 153 10 Aghia Paraskevi, Attiki (Greece)

The accumulation and elimination of hexavalent Cr-51 in the molluscs Venerupis aureus and Mytilus galloprovincialis was studied. The uptake experiments lasted 27 days and the concentration factors found were 4.3 for Venerupis sp. and 6.1 for Mytilus sp. while the biological half lives were 96.8 and 51.1 days, respectively. The distribution of Cr-51 in the body of both species was also determined.

Chromium is released into the atmosphere because of ferrochrome production, ore refining, combustion of coal, etc., and eventually finds its way into the sea. Moreover the discharge of effluents by the plating, tanning and textile industries is another source of chromium into the marine environment. The presence of radioactive Cr-51 in the marine environment has been pointed out by several investigators (POLIKARPOV, 1966). Cr-51 is derived from nuclear tests and from the disposal of liquid radioactive waste of atomic plants and is also a corrosion product of nuclear power ships. It has been reported that certain marine organisms are able to concentrate Cr-51 in the trivalent or hexavalent state (CHIPMAN, 1966, PAPADOPOULOU et al. 1986, PAPADOPOULOU and STAMOULI, 1989). In order to extend our knowledge on the accummulation of Cr-51 by various edible mollusc species we studied the bioavailability of hexavalent Cr-51 in Venerupis aureus and Mytilus galloprovincialis. The uptake of trivalent Cr-51 in the same mollusc species has been investigated in a previous paper (STAMOULI and PAPADOPOULOU, 1988).

Several individuals of Venerupis aureus and Mytilus galloprovincialis were sampled from Salamis Island in Saronikos Gulf (Greece). Sea water was also taken from the same area. Two uptake experiments were performed for each species (n=10) at a temperature ≈20°C and salinity 38‰ using the gamma emitting radioisotope Cr-51 (H.L. 27.8 d) as sodium chromate (40 µCi/18 l sea water). The experiments lasted 27 days. In order to determine the distribution of Cr-51 in the body of the molluscs certain individuals from each species (n=4) were dissected at the end of the uptake experiments and the Cr-51 activity in the different parts of their body was counted. In the remaining animals of each species (n=6) the elimination of Cr-51 was studied in order to determine the biological half life. Moreover leaching experiments were performed by placing the shells in 0.5N HCL.

In the first days of the uptake experiments the rate of accumulation was rather fast but gradually it became slower for both mollusc species. The concentration factors after 27 days reached the values K=4.3 in Venerupis sp. and K=6.1 in Mytilus sp. The distribution of Cr-51 in the whole body of both molluscs is given in Table 1.

TABLE 1. Distribution pattern of Cr-51 radioactivity (%) in the whole body of the two molluscs after 27 d exposure

Organism	Shell	Soft parts	Byssus	Body fluid
Mytilus sp.	33.8	36.8	22.6	6.8
Venerupis sp.	12.3	48.3	-	39.4

In the soft tissues of the species studied the distribution pattern of Cr-51 was found to be as follows: Mytilus sp.: Visceral mass 53.5%, muscle 7.4%, foot 0.9%, gills 28.8% and mantle 9.4%. Venerupis sp. : Visceral mass 34.2% muscle 15.4%, foot 1.7%, gills 17.2%, mantle 16.3%, ventral siphon 7.4% and dorsal siphon 7.8%. The biological half life in Mytilus sp. was found to be 51.1d and in Venerupis sp. 96.8d.

Low concentration factors were found for both mollusc species. It should be noted that in our previous paper concerning the uptake of trivalent Cr-51 by the same species (STAMOULI and PAPADOPOULOU, 1988) medium concentration factors were found (K=55 for Mytilus sp. and K=47 for Venerupis sp.) These results are comparable to those obtained in another mollusc species, Venus verrucosa, where also low concentration factors were found for the uptake of hexavalent Cr-51 (K≈2) but medium for the uptake of trivalent Cr-51 (K≈65) (PAPADOPOULOU et al., 1986, PAPADOPOULOU and STAMOULI, 1989). In Venerupis sp. only a small part of the accumulated whole body radioactivity is found in the shell (12.3%), in contrast to the results concerning the trivalent Cr-51 (STAMOULI and PAPADOPOULOU, 1988) where the larger part of the radioactivity (58.9%) was detected in the shell; in Mytilus sp. the fraction of hexavalent Cr-51 found in the shell (33.8%) is comparable to that of trivalent Cr-51 (35.2%). Among the soft tissues of both mollusc species viscera displays the greater ability to accumulate the hexavalent Cr-51.

REFERENCES.

POLICARPOV, G.G., 1966. Radioecology of aquatic organisms. North Holland Publ. Co., Amsterdam : 27-60.

CHIPMAN, W.A., 1966. Uptake and accumulation of Cr-51 by the clam Tapes decussatus in relation to the physical and chemical form. Proc. Symp. Vienna, IAEA, SM-72/35 : 571-582.

PAPADOPOULOU, C. et al., 1986. Ag-110m and Cr-51 uptake by the mollusc Venus verrucosa. XXXth Congress and Plenary Assembly of I.C.S.E.M. Palma, Majorca, Spain 20-25 Oct. 1986. Publ. Rapp. et Proc. Verbaux des Reunions, 30(2), R-114 : 216.

PAPADOPOULOU, C. and STAMOULI, M., 1989. Chromate bioavailability to the mollusc Venus verrucosa. Toxicological and Environmental Chemistry 20 : 249-254.

STAMOULI, M. and PAPADOPOULOU, C., 1988. Trivalent Cr-51 Bioaccumulation Study in two mollusc species. XXXIth Congress and Plenary Assembly of I.C.S.E.M., Athens, Greece, 17-22 Oct 1988. Publ. Rapp. et Proces Verbaux des Reunions, 31(2) 249.

Selenium Assimilation in a Marine Copepod

Nicholas S. FISHER* and John R. REINFELDER*

*Marine Sciences Research Center, State University of New York, Stony Brook, NY 11794-5000 (USA)

A new method was developed for determining the assimilation efficiency of Selenium in marine animals feeding on Selenium-containing food. The experiments, which employed two gamma-emitting radiotracers--^{75}Se and ^{241}Am-- to study the assimilation of Selenium ingested by the marine Copepod Acartia tonsa, indicated that 97% of the ingested Selenium was retained by this animal after gut evacuation. Selenium showed a higher assimilation efficiency in Copepods than any other element, including Sulfur and Carbon.

The assimilation of an element ingested by marine Zooplankton will determine the extent to which that element is biologically usable or toxic and well as the residence time of that element in surface waters. Those elements which show negligible assimilation by marine Zooplankton (e.g., the Lanthanides and Actinides) would not accumulate in biological tissue, the oceanic food web, or the organic cycle in general. They would be efficiently "packaged" by the zooplankton into rapidly sinking materials, generally in fecal pellets or exoskeletons which are periodically released during molting, and the Zooplankton would therefore serve to depurate the surface waters of these elements (FOWLER and KNAUER, 1986; FISHER and FOWLER, 1987). The oceanic residence times for these elements is characteristically short (WHITFIELD and TURNER, 1987). In contrast, elements which show pronounced assimilation in the Zooplankton would enter into the organic cycle in surface waters and have much longer oceanic residence times than the unassimilated elements. These elements would therefore have lower concentrations in fecal pellets or exoskeletons than in body tissue or in the food upon which the animals had fed. Polonium has been well studied in this regard and has been shown to assimilate in the hepatopancreas of marine crustaceans (CHERRY *et al.*, 1983) and to associate in general with proteins in marine organisms (FISHER *et al.*, 1983b; HEYRAUD *et al.*, 1987). We have examined the assimilation of another group VIA element, Selenium, which may act as a Sulfur analog in aquatic organisms and which associates with seleno-amino acids in Algae and higher plants (BROWN and SHRIFT, 1982).

In a series of experiments, the small centric diatom Thalassiosira pseudonana was labeled with two gamma-emitting radiotracers, ^{75}Se, added as selenite (37-660 kBq l^{-1}, 0.136-2.42 nM)) and ^{241}Am (18.5-37.0 kBq l^{-1}, 0.6-1.2 nM), cells were harvested from their radioactive medium and resuspended into 200 ml unlabeled seawater to give cell densities of 1.3 to 2.1 x 10^5 ml^{-1}. These feeding suspensions then received 20 individuals of the adult copepod Acartia tonsa and the animals were allowed to feed for 6 hours. During the feeding, the radioactivity of the cells, the ambient water (ie., in the dissolved phase), and the fecal pellets and eggs produced by the animals was monitored using a gamma counter with a NaI (Tl) crystal as described in FISHER *et al.* (1983a).

The assimilation efficiency of the Selenium was determined by relating the radioactivity in the food and fecal pellets as described by the equation :

$$\text{Assimilation efficiency} = \frac{^{75}Se/^{241}Am\ (\text{food}) - ^{75}Se/^{241}Am\ (\text{feces})}{^{75}Se/^{241}Am\ (\text{food})}$$

The results indicated that the concentration of ^{75}Se in the fecal pellets was always reduced by over an order of magnitude in the fecal pellets relative to the levels in the food. The mean assimilation efficiency from four different experiments, conducted months apart from each other with different batches of phytoplankton and animals, was 97.1± 1.5% (Table 1). Mass balance assessments of Se assimilation efficiency gave comparable values. Further mass balance calculations indicated that only about 1% of the ingested ^{241}Am was assimilated.

The results suggest that Se should readily enter the organic cycle in the ocean, perhaps acting as a S analog in marine organisms. The high assimilation in animals and association with amino acids in Algae are consistent with the observation that most of the Selenium in surface waters is in organic form (CUTTER and BRULAND, 1984). Its biogeochemical behavior is therefore similar to that of Po.The organic cycling of Se is probably responsible for its relatively long residence time --2.6 x 10^4 years--in the oceans (BROECKER and PENG, 1982).

Table 1. Radioactivity of ingested and excreted material and assimilation efficiencies of Se calculated using the ratio method.

Experiment	Radioactivity (Bq µg^{-1} dry wt) Food			Feces			Assimilation efficiency
	Se	Am	Se/Am	Se	Am	Se/Am	
1	2.99	1.53	1.95	0.11	2.63	0.04	98%
2	2.74	1.19	2.30	0.05	0.55	0.09	96.1%
3	12.65	1.44	8.79	0.33	0.84	0.39	95.5%
4	6.14	0.65	9.45	0.26	2.12	0.12	98.7%
						mean :	97.1+1.5%

R

REFERENCES

BROECKER (W.S.) & PENG (T.-H), 1982.- Tracers in the Sea. *Eldigio*, New York, 690p.

BROWN (T.A.) & SHRIFT (A.), 1982.- Selenium: toxicity and tolerance in higher plants. *Biol. Rev.* 57, 59-84.

CHERRY (R.D.), HEYRAUD (M.) & HIGGO (J.J.W.), 1983.- Polonium-210: its relative enrichment in the hepatopancreas of marine invertebrates. *Mar. Ecol. Prog.* Ser. 13, 229-236.

CUTTER (G.A.) & BRULAND (K.W.), 1984.- The Marine biogeochemistry of Selenium: a reevaluation. *Limnol. Oceanogr.* 29, 1179-1192.

FISHER (N.S.) & FOWLER (S.W.), 1987.- The role of biogenic debris in the vertical transport of transuranic wastes in the sea. In *Oceanic Processes in Marine Pollution*, Vol. 2, T.P. O'CONNOR, W.V. BURT, & I.W. DUEDALL eds., Krieger Press, Malabar: 197-207.

FISHER (N.S.), BJERREGAARD (P.) & FOWLER (S.W.), 1983a.- Interactions of marine plankton with transuranic elements. 3. Biokinetics of americium in euphausiids. *Mar. Biol.* 75, 261-268.

FISHER (N.S.), BURNS (K.A.), CHERRY (R.D.) & HEYRAUD (M.), 1983b.- Accumulation and cellular distribution of ^{241}Am, ^{210}Po, and ^{210}Plo in two marine algae. *Mar. Ecol. Prog.* Ser. 11, 233-237.

FOWLER (S.W.), KNAUER (G.A.), 1986.- Role of large particles in the transport of elements and organic compounds through the oceanic water column. *Prog. Oceanogr.* 16, 43-67.

HEYRAUD (M.), CHERRY (R.D.) & DOWDLE (E.B.), 1987.- The subcellular localization of natural ^{210}Po in the hepatopancreas of the rock lobster (Jasus lalandii). *J. Environ. Rad.* 5, 249-260.

WHITFIELD (M.) & TURNER (D.R.) 1987.- The role of particles in regulating the composition of seawater. In : *Aquatic Surface Chemistry* : Chemical Processes at the Particle-Water Interface, W. Stumm ed., Wiley, New York: 457-493.

Radium and its Daughters in *Bryopsis plumosa*

Constantine DOVLETE

Environmental Radioactivity Research Laboratory, Institute of Meteorology and Hydrology, Bucharest (Rumania)

Among the species of marine biota from the Rumanian sector of the Black Sea, the radioactivity of which has been systematically monitored since 1984 (DOVLETE 1984, 1985, 1986 and OSVATH 1987, 1988, 1989), the Bryopsis plumosa green alga stands out due to the great values of its alfa and beta radioactivity. High resolution gamma spectrometrical analysis shows that these are to be attributed to Ra-226, Ra-228 (radionuclides belonging to the uranium-radium, respectively thorium radioactive series) and their daughters (GUSEV and DIMITRIEV, 1978). An average radionuclidic composision of Bryopsis plumosa is presented in Table 1 (natural radionuclides only).

Table 1. Natural gamma emmitting radionuclide concentrations (Bq kg^{-1} fresh weight) at 320 days after sampling

Ra-226	Pb-214	Bi-214	Pb-210	Ac-228	Pb-212	Tl-208	K-40
642±6	437±2	400±2	9±2	250±3	67±1	24±4	75±3

Regarding the members of natural radioactive series identified in Bryopsis plumosa, the following relevant activity ratios were studied: Ra-226/Pb-214, Pb-214/Pb-210 for the U-Ra series and Ac-228/Pb-212 for thorium series. The activity of the i-th radionuclide in a radioactive series at time t is given by:

$$A_i(t) = \lambda_i N_0 \sum_{J=i}^{1} e^{-\lambda j t} \prod_{K=1}^{i-1} \lambda_K \Big/ \prod_{K=1,K\neq J}^{1} (\lambda_K - \lambda_J) \qquad \text{Eq. (1)}$$

where: λ_i = decay constant coresponding to i-th nuclide
N_o = number of parent nuclei at t=0

Values of the Pb-214/Pb-210 and Ac-228/Pb-212 activity ratios, computed using Eq. (1) and from radionuclide concentration data obtained directly by gamma spectrometrical analysis of the samples are presented in Tables 2 & 3 for various values of time T elapsed after sampling. In computing ratio values by applying Eq. (1) the hypothesis was made that Ra-226 and Ra-228 were the parent radionuclides of the series in the sample, which indicates that Bryopsis plumosa assimilates only the radium isotopes from its environment. The good agreement between calculated and measurement derived values (Table 2, for higher values of T, and Table 3) confirms the hypothesis, leading to the conclusion that the alga does not concentrate uranium or thorium isotopes but only radium isotopes from the environment. This conclusion is validated by the discrepancy between experimental values of the Ac-228/Pb-212 activity ratio and the theoretical ones according to which Th-232 is assimilated by the alga (Table 3). The discrepancy between theoretical and measurement-derived Pb-214/Pb-210 ratio values given in Table 2 is due to the difficulties for measuring Pb-210 by applying gamma spectrometry because its concentration is near the detection limit for lower values of T. The discrepancy obviously decreases with time, as Pb-210 concentration increases through the usual ingrowth process characterising radionuclides in a radioactive series. From this it can also be concluded that the alga does not assimilate Pb-210 from its environment, but all the Pb-210 in the sample are the decay products of Ra-226 assimilated by the living plant.

Table 2. Pb-214/Pb-210 activity ratio

T (days)	240	320	1000
experimental	81	48.7	13.5
theoretical parent Ra-226	45	34.0	11.0

Table 3. Ac-228/Pb-212 activity ratio

T (days)	240	320	1000
experimental	5	3.7	1.3
theoretical parent Ra-226	4.6	3.6	1.4
theoretical parent Th-232	9.4	7.1	2.6

The measurement-derived value of the Ra-226/Ra-228 ratio ranges between 2 and 3 in Bryopsis plumosa and between 1.5 and 3 in marine sediment (OSVATH, 1989), hence in sea water. This confirms that the alga conserves the environmental relative abundance of radium isotopes. It can be concluded that Ra-223 is also assimilated in much lower quantities, according to its relative abundance, but due to their short half-lives, its descendents cannot be identified in samples.

Radioactive equilibrium is achieved between Rn-220 and Po-216, Rn-220 exhalation from the sample being negligible. The situation is different for Rn-222, where a disequilibrium factor of 1.4 exists between Rn-222 and Po-218 (assessed through the Ra-226/Pb-214 ratio). The value of the radium concentration factor (CF) for Bryopsis plumosa calculated using the typical value of Ra-226 concentration in sea water given in (PENTREATH, 1988), is of the order of 10^5, three orders of magnitude above the average value recomended in IAEA, 1985. The computation of CFs for members of radioactive series (e.g Pb-210) is a delicate problem, and often requires supplementary measurements.

REFERENCES

DOVLETE, C., 1984, 1985, 1986. Annual Report on The Radioactivity of Marine Sediment, Water and Biota. Research Contract with the Rumanian Marine Research Institute.

OSVATH, I., 1987, 1988, 1989. Annual Report on The Radioactivity of Marine Sediment, Water and Biota. Research Contract with the Rumanian Marine Research Institute.

PENTREATH, R.J., 1988. Radionuclides in the Aquatic Environment, in Radionuclides in the Food Chain. Editor J.H. Harley et al.

IAEA, 1985. Technical Reports Series No. 247

Radioecologically Important Stable Element Concentration in two Mollusc and one Polychaete Species

Maria SALAGEAN*, Ana PANTELICA* and Iulia I. GEORGESCU**

*Institute for Physics and Nuclear Engineering, Bucharest (Rumania)
**Polytechnical Institute, Faculty of Chemical Technology, Bucharest (Rumania)

The content of certain stable elements in the molluscs Mytilus galloprovincialis, Mya arenaria as well in the polychaete Melina palmata sampled at different depths from the Rumanian Black Sea bottom was studied by instrumental neutron activation analysis.

The increase of chemical industry and the intensive use of certain pollutant elements can exceed their normal concentration in sea water which may have toxic effects to biological systems in the sea. From the radioecological point of view the study of stable elements in natural systems, such as the marine environment, is important since radionuclides introduced into the sea follow similar pathway to the stable elements already present. During June 1989 mussels M. galloprovincialis, M. arenaria and M. palmata polychaete were sampled from the bottom of the Black Sea at a depth 29-40 m. and analysed for certain radioecologically important stable elements.

After rinsing,with distilled water and removal of the shells, the soft tissues and byssus were separated. M. palmata samples were only rinsed. All saples were dried, grounded to a fine powder and irradiated along with an equal quantity of the IAEA reference material MA-M2/TM in the VVR-S2 nuclear reactor of Bucharest (thermal neutron flux 10^{12-13} n/cm²sec). All measurements were carried out by using a high resolution Ge(Li) detector coupled with a multichannel analyser.

Data for the 12 selected stable elements (As, Co, Cr, Cs, Hg, Rb, Sb, Sc, Se, Th, U and Zn) in the species mentioned above are given in Table 1. As it can be seen the Se content (<0.7 ppm) is lower in M. palmata polychaete, while all the other elements in the same species were found to present the highest values at Portitza site. At Sulina in total tissue of M. galloprovincialis 513 ppm Zn and 11 Cr were found while at Portitza in M. palmata the values were 1230 ppm for Zn and 117 for Cr. The concentration levels of the elements are higher in soft tissues of M. galloprovincialis than in byssus. By comparing the results obtained with those reported for M. galloprovincialis sampled during 1987 at about the same sites, (SALAGEAN et al., 1988) a decrease in Zn and Sc content is observed while an increase in the elements As, Co, Cr, Cs and Th is presented.

Table 1. Stable element concentration (ppm dry matter) in two mollusc and one polychaete species sampled from the Rumanian Black Sea coast during 1989

ELEMENT	SULINA			SFINTUL GHEORGHE		PORTITZA	CONSTANZA	
	M. galloprovincialis	M. arenaria	M. galloprovincialis	M. palmata	M. galloprovincialis			
	Soft tissue	Byssus	Total tissue	Soft tissue	Byssus	Total tissue	Soft tissue	Byssus
As	8.8±2.1	8.4±2.3	8.4±3.1	14.3±3.4	5.9±2.5	27.0±6.0	15.7±3.6	5.0±2.0
Co	2.7±0.1	1.4±0.1	1.8±0.1	2.0±0.1	1.0±0.05	13.6±0.4	2.1±0.1	1.4±0.1
Cr	10.8±0.6	3.1±0.3	8.6±0.5	5.8±0.5	2.6±0.3	117±5	10.0±0.5	2.6±0.3
Cs	0.6±0.1	0.26±0.06	0.56±0.08	0.47±0.08	0.21±0.05	8.2±0.3	0.7±0.1	0.20±0.05
Hg	1.1±0.5	1.5±0.5	<2	0.7±0.4	0.8±0.4	<1.8	<0.8	1.1±0.4
Rb	6.9±1.4	4.4±1.1	15.4±1.5	11.9±1.4	3.6±1.3	122±5	10.8±1.2	4.9±1.4
Sb	0.20±0.04	0.08±0.03	0.21±0.06	0.11±0.04	0.09±0.04	1.9±0.1	0.22±0.04	<0.1
Sc	1.21±0.04	0.34±0.01	1.00±0.03	0.70±0.02	0.30±0.01	13.7±0.4	1.15±0.04	0.032±0.01
Se	4.3±0.09	3.9±0.5	4.9±1.0	5.2±1.0	3.6±0.8	<0.7	5.4±1.0	4.2±0.9
Th	0.88±0.04	0.24±0.03	0.78±0.05	0.70±0.04	0.30±0.04	10.6±0.3	0.9±0.04	0.21±0.03
U	0.31±0.15	0.30±0.15	0.62±0.2	0.62±0.2	<0.4	2.8±0.6	<0.3	<0.4
Zn	513±26	386±20	453±24	234±20	186±10	1230±15	235±12	201±11

EFERENCES.

ALAGEAN, M., PANTELICA, A. and GEORGESCU, I.I., 1988. Instrumental eutron activation analysis of M. galloprovincialis from the Rumanian hore. Rapp. Comm. int. Mer. Medit., 31 (2).

V-I1

Some data on Biometry and Stomach Content of a Meditterranean Monk Seal found in Santorini Island (Greece)

D. CEBRIAN* , H. FATSEA** and Ch. MYTILINEOU***

*Estacion Biologica de Donana, P.O.Box 1056, 41080 Sevilla (Esapana) Actual address : Research Station of Alonnisos, University of Thessalia, Volos (Greece)
**University of Athens, department of Biology, Division of Ecology-Taxonomy, Ilisia, Athens (Greece)
***National Center for Marine Research, Hellinikon, Athens (Greece)

ABSTRACT

A Meditterranean Monk seal strangled by a fishing net,was dissected. The content of the stomach and measurements of the digestive system are reported.From these measurements no conclusion was made about this Monk's eating habits.

Materials and Methods

A male *Monachus monachus*, was strangled by a tramel net and was found in Santorini island, south of the village Acrotiri, on March 13,1990. The Monk was 239cm long, measured from the tip of the snout to the tip of the flippers and 218cm long from the tip of the snout to the tip of the tail. The perimeter at the level of the navel was 121cm.

The Monk seal was transported and dissected in Athens about 65 hours after its death. The stomach was immersed and filled as well as,with 37% formaline.

Results

A. Measurements of the digestive system:
Length of esophagus: 0.25m.
Length of the stomach: 0.50m.
Length of the small intestine: 16.66m.
External diameter of the small intestine: 31.00mm.
Length of the large intestine: 1.36m.

B. Stomach content:
The stomach was almost full and its content weighted 5.5kg. From all this mass we separated 22 fish speciments (53% of the total weight). We have identified eleven fish individuals (39% of the total weight) which belong to nine different species. (see table 1). We have also found a small piece of fishing net (39mm net's eye opening).

Table 1. Species of fish and squid which were identified in the stomach of the seal which was found in Santorini island.

Species	Length(cm)	Weight(g)
Boops boops	23	148
Boops boops	19	100
Boops boops	16.5	58
Oblada melanura	25	218
Diplodus vulgaris	21	218
Lophius sp.(piece)	39	517
Lophius sp.(piece)	-	223
Serranus sp.	21	88
Scomber scombrus	17	120
Mullus sp.(piece)	80	32
Triglidae (piece)	210	264
Sepia officinalis	-	163

Discussion

The fishing net where the animal was trapped presented many holes, some of them typically made by the seals. This fact along with the presence of a piece of the same fishing net inside the stomach indicate that, at least the last amount of the digested fish (53% of the total food mass), were catched by the seal from the fishing net. Therefore, from these data, we cannot obtain a definite answer on the seal's diet in the wild environment.However, we found out that the animal did not eviscerated the preys taken from the net.

Acknowledgements

We appreciate and thank the Hellenic Society for the study and protection of the Monk seal,which has provided the financial and materialistic support to our work.

V-I2

Investigation on Mediterranean Monk Seals, *Monachus monachus*, (Hermann, 1779) in the caves along the Coastline of Western Black Sea, Marmara and Aegean Seas

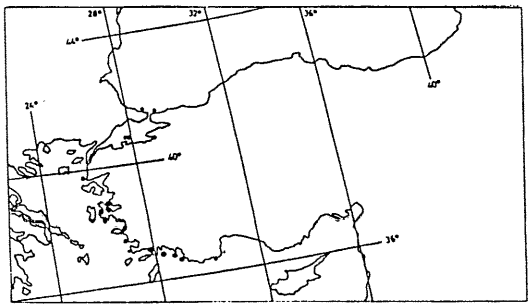
Bayram OZTURK , Han ERIM , Adem COLAK and Ufuk TALU

School of Aquatic Products, Beykoz, Istanbul (Turkey)

ABSTRACT:
This research has been done in a nearly three months period, from 20 th of June to 10 th Septembe in 1989, with the aim of finding out the number of monk seals inhabiting Turkish Coasts. All observatisons were recorded by film at the same time, to get more information about the environment they live in the caves, and how they behave in water.
During the reserach, two in the western Black Sea, two in the Marmara Sea and twelve in the Aegean sea , totaly 16 caves, an islet were closly observed while observing the caves dives also have been done in to caves, however no monk seals were seen and all were abandoned.
The only place where we could have the chance to observe an adult monk seal was a isolated islet in the Aegean Sea, near Çeşme. This observed, indivudual monk seal was taken in to a film under broadcoast standarts. Oceanographic measurement around the islet revealed the water temperature on surfece as 22 °C in agust and the current speed as 2 miles per hour. Chronoatric measurements revealed that she was spending different periods of time under the water, varying from 1' 49" to 4' 56" minutes.

INTRODUCTION:
Mediterranean Monk Seal, Monachus monachus, which, considering the enormous reduction in their number, is now forming endangered species in habits these caves, breeds and grows the pups. These monk seals habitats are usually located on isolated islands or shores and known by local fishermen.
The purpose behind this research is to find out the present conditions of the caves where monk seals used to inhabit and investigate the pattern of their behavior with observations and films both on surface and underwater. Our other important aim is, by showing the film to masses, to focus Turkish People's attention on the subject and provide their support. An additional target was to get more information about the physico-cheaical proporties and meteorological parameters of the water where monk seals prefer living.

MATERIAL AND METHOD:
During the whole research period a 25 meter long fishermen boat has been used, which had a speed 15 miles per hour and a capacity of 20 people. The research has begun in the western Black Sea. Night and day observations and scuba dives have been done to on islet near Çeşme and totaly 16 caves which, with the order of our proceeding direction, were as follows: Two in Igneada and Şile, two is Ekinlik and Marmara Island is the Marmara Sea, 12 in the Aegean Sea (Foça, Hayırsız Island, Eşendere, Ildır, Süngükaya Island, Alaçatı, Dilek, Kiremit Island, Nar Island, Toprak Island, Sulu Island, üç Islands).



Map 1 : Mentioned caves is the research and localisation of the islet the monk seal inhabited. All these previously datermined caves have been observed and dived having the aim of coming across with monk seals or their traces.

RESULTS AND DISCUSSION:
It was only five years ago that these caves were famous and known as "Monk Seal Caves". However during our 80 day-research program neither monk seals nor their traces were come across. This made us to reduce that the monk seals have migrated from the shores to desolate islands. We think that the monk seal we observed in Süngükaya, the desolate islet near Çeşme, is actualy one of the monk seals which abandoned Alaçatı Coasts. Because the caves is Alaçatı, Çeşme and the Süngükaya Island are only two miles apart from each other.
As a conclusion, the Süngükaya Island shoud be preserved as a National Park. All necessray precautions should be taken to keep the fishermen away from all monk seal habitats. It is a must and the crux of our message that all these islands and coasts serving as monk seal habitats should be turned in to preserved National Parks. In addition against all disturbances and conciousless or ignorant touristical settlements or urbanization must be ensured. It is also extremely important to emphasize the need of more detailed research opportunities.

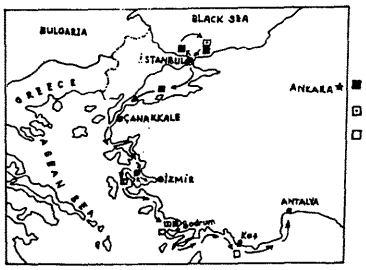
REFERENCES:
BERKES, F., ANAT, H., ESENEL, M., and KIŞLALIOGLU, M. (1979). Distribution and Ecology of Monachus monachus of Turkish Coast, in the Mediterrnean Monk Seal (Ronald, K. and Duguy, R. 1979 : 113 - 127).
MURSALIOGLU, B. (1982) Pup mother environmental relation in the the Mediterrenean Monk Seal, Monachus monachus, (Hermann 1779) on Turkish coast. p. 167 in symposium Int. Therilogical Congr. Abs. Helsinki
MURSALIOGLU, B. (1984) The survival of Mediterrenean Monk Seal Monachus monachus, (Hermann 1779) pup on the Turkish coast. A.U.Fen Fak. Turkey
MURSALIOGLU, B. (1984) Monk seal conservation in Turkey.W.W.F Monthly Report 98-100
RONALD, K. and DUGUY R., 1979 The Mediterrenean monk seal U.N.E.P. Ser 1 Pergamon Press, Oxford. 1883 p.

Species of Dolphins that occurs in the Western Black Sea, the Sea of Marmara and the Aegean Sea

Bülent TOPALOGLU, Bayram OZTURK and Adem COLAK

School of Aquatic Products, Beykoz Istanbul University (Turkey)

Abstract :
We observed, photographed and filmed the dolphins that we came across in the waters of Western Black Sea, The Sea of Marmara and The Agean Sea, in a series of research sails that took place from June 20, 1989 to September 10, 1989. A team of 20 people aboard a 15 mile per hour research vessel was employed in the observation and count of the dolphins. Although the observation and the count were made directly most of the time, we also took advantage of binoculars in order to verify what we had observed with naked eye. We also evaluated the photographs and films of dolphins that we had taken, for the some reason I have just mentioned.



On the map you see the route that our research vessel took besides, the areas where different species of dolphins were spotted.

Of the total number of 63 dolphins observed, 9 Delphinus delphis (Linnaeus, 1758); 6 Tursiops truncatus (Montagu, 1821); 8 Delphinus delphis and, 26 Stenella coeruleoalba (Meyen, 1833); 6 Delphinus delphis, 8 Tursiops truncatus, from Odontoceti-Delphinidea were spotted respectively in The Western
Blacksea, The Sea of Marmara and The Aegean Sea. Among the dolphins were observed Stenella coeruleoalba (Striped Dolphins) make up the biggest group 26 dolphins, followed by Delphinus delphis (Seddleback Dolphins) with 23 dolphins and by Tursiops truncatus (Bottlenose Dolphins) with 14 dolphins.

According to our conclusion Stenella coeruleoalba was only observed in the Aegean Sea, mainly in the area between Kaş and Antalya. 6 young dolphins were spotted as well during the project.

However, we need more data and time to estimate the abundance and the frequency for the exact distribution of dolphin in Turkish coast.

REFERENCES :

- ARSINIOV, V. A. - ZOMSKY, V. A. - STUDERETSSKOYA, I.S. (1973) Morskie Mlekopiteyushckie (Marine Mamals) Moskova, Pisckevaja Pronisklennost.
- BERKES, F. (1977). Turkish Dolphin Fisheries Oryx, 14 (2): 163-167
- ÇELİKKALE, S-KARAÇAM, H-DÜZGÜNEŞ, E-ÜNSAL, S-DURUKANOĞLU, F. (1989) Size and Distribution of Dolphin Population in the Blacksea, Doğa, Tu.j. Zoology 13-3, 1989 ANKARA
- DANILAVSKY, N. M-TUVUTYUNNİKOV, V.P. (1968) Present State of Blakc Sea Dolphings Described Dybn. Khoz. Mosk. 11,25-7-1968
- KARAÇAM, H-DÜZGÜNEŞ, E-DURUKANOĞLU, F. (1990) Karadenizde Yaşayan Yunuslarda Yaş-Ağirlık, Yaş-Uzunluk Kompozisyonu Üzerine Bir Araştirma. K.T.Ü. Sürmene Deniz Bilimleri ve Teknolojisi Yüksekokulu (Baskıda)
- MARCHESSAUX, D. (1980) A Review of Current Knowledge of The Cetaceans in The Eastern Medditteranean Sea, Vie Marine Volume: 2. Page 59 a 66
- SLASTENENKO, E. (1953) Karadeniz Yunus Balıkları, Hidrobiyoloji Mecmuası, İ.Ü.F.F. Hidrobiyoloji Araştirma Enstitüsü Yayını, 3,2,69-90-1955

Stomach Content Analysis of a Stranded Specimen of *Tursiops truncatus*

A. VOLIANI and C. VOLPI

Consorzio Regionale di Idrobiologia e Pesca, Livorno (Italia)

Abstract - A total of 145 individuals belonging to at least 9 species were found in the analysis of a bottle-nosed dolphin stomach content; fishes represented approximately 90% and the remaining 10% were cephalopods. Most of the preys found have demersal habits.

On the 15th of February 1990 a stranded male bottle-nosed dolphin (Tursiops truncatus) was found on the beach of Marina di Donoratico, Livorno, Italia. 1-2 days before the dolphin was found, when the stranding is supposed to have taken place, winds blew from S-SW, with a strength of 30-75 km/h and the sea was very rough (6-7 degrees Beaufort).
The specimen, 2.15 m long, bore no outward signs of the possible cause of the death. A superficial necropsy, carried out on the field, revealed no useful hints as to assess why the animal died. The complete skeleton is deposited at the Natural History Museum of Livorno.
The stomach contained approximately 2 kg (total weight) and 1.3 kg (dripped weight) of food at various stages of digestion. The analysis of the gastric contents revealed rests of fishes and molluscs, some of which at the initial stage of digestion, thus indicating that the dolphin had ingested food almost until its death. The remains of the food were analysed in order to determine which species were present. The following table is a detailed list of the body parts used for the identification and of the number of individuals found for each species.

SPECIES	OTHOLITS R.	OTHOLITS L.	OTHER BODY PARTS	BEAKS	SPECIMENS
FISHES					
Merluccius merluccius	62	62	yes		62
Spicara smaris	30	30	yes		30
Trisopterus minutus	22	22	yes		22
Argentina sphyraena	-	-	yes		2
Conger conger	1	1	yes		1
Scomber sp.	2	2	yes		2
Clupeidae	1	2	yes		7
unidentified fishes	5	7	-		7
CEPHALOPODS					
Eledone cirrhosa			yes	11	11
Illex coindetii			yes	1	1

The identification of the species through otholits and cephalopod beaks was carried out by comparison with those available in the Institute study collections and by using reference books (Clarke 1986). Where it has been possible, other identification keys were used: jaws, vertebrae, etc..
Clupeidae have very small and fragile otholits and reassembled vertebral columns were used to determine the number of specimens. A.sphiraena was identified through its peculiar swimming bladder.
The size and weight of the preys can be approximately inferred from the body parts which have been found. The otholits length / total length ratio has been estimated and used for M.merluccius (N=34 a=-1.91 b=2.16 r=.995 p<.001); figure 1 shows the distribution by size obtained by means of this ratio.
Weights varying from 15 to 380 g were estimated by using the L/W relationship (Auteri et al.1987). The size and weight of E.cirrhosa was determined through the beak length / mantle length and beak length / weight ratios indicated by Clarke (1986). The specimens have thus resulted to have mantle sizes that varied from 70 to 95 mm and weights from 50 to 150 g.
For little sized species, with a very reduced size range, single values were given for length and weight. A weight of 25 g per individual was attributed to T.minutus and S.smaris, usually shorter than 15 cm, and 15 g to A.sphyraena and Clupeidae. An evaluation of the weight of the few items of Scomber sp., C.conger and I.coindetii, thanks to their almost integral conditions, was possible: 250, 150 and 25 g respectively.
Figure 2 shows the diagrams of presence respectively by items' numbers and weights per species.

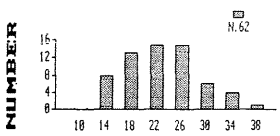


Fig.1

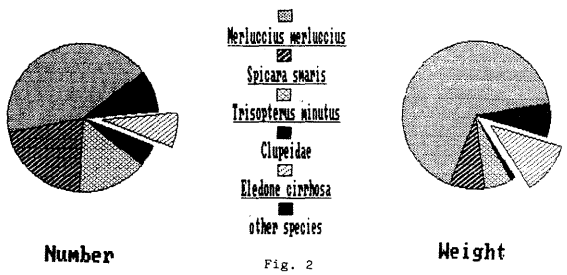


Fig. 2

The preys found totalled 145 individuals and about 9.5 kg; fishes represented approximately 90% in number as well as in weight. Most of the preys are demersal species (M.merluccius, T.minutus, C.conger, S.smaris) and even benthic ones (E.cirrhosa) confirming that this dolphin is adapted to a catholic diet (Evans, 1987).
The total length of most of the preyed fishes is less than 20 cm, probably because these are the most common sizes in the environment; however M.merluccius close to 40 cm long and 400 g weight have been reported.

REFERENCES

CLARKE M.R., 1986. A Handbook for the Identification of Cephalopod Beaks. Clarendon press, Oxford 1-XIII+1-273 pp.
EVANS P.G.H., 1987. The Natural History of Whales & Dolphins. Helm press, London 136-142 pp.
AUTERI R., BAINO R., SERENA F., RIGHINI P., REALE B., VOLIANI A., MANNINI P., VOLPI C., PIRAS A., SILVESTRI R., 1988. Valutazione delle risorse demersali; risultati del presurvey 1985 dalla foce del Magra all'Isola d'Elba. Atti Sem. UU.OO. Min. Marina Mercantile: 1105-1165.

V-I5

Indice d'Abondance de la Megafaune en Méditerranée. Campagne TRANSMEDICET du *"Jean Charcot"* (IFREMER) du 20/10/89 au 26/10/89

D. VIALE et N. TERRIS

C.N.R.S., Laboratoire d'Ecologie des Cétacés, n°034915, CEVAREN, Université de Corse, B.P. 52, 20250 Corte (France)

Un transit du navire "JEAN CHARCOT"entre la Coruna et Toulon, est utilisé pour faire des relevés de cétacés et autres grands organismes de surface.

Ces relevés nous permettent de calculer des indices d'abondance grâce auxquels nous comparons diverses microrégions de Méditerranée (VIALE, 1990).

Lors de cette mission nous avons pu étendre également notre comparaison à l'Atlantique (côtes espagnoles).

METHODE

Une vigie de jour est assurée en continu.

Parallèlement sont étudiés les paramètres hydrologiques par enregistrement thermique en continu et par repérage des fronts par satellite.

Les paramètres biotiques étudiés sont les biomasses sous-jacentes détectées par échosondeur 12 kHz.

Etant donné la diversité des organismes rencontrés, dont la biomasse varie de 10 kg (thons) à 60 tonnes (Baleinoptère), la comparaison par simple comptage des individus se révèle inappropriée.

Aussi VIALE 1989 propose d'utiliser un poids moyen défini arbitrairement et conventionnellement pour chaque espèce. Ce poids moyen est déduit des courbes taille/poids issues de la littérature.

Tableau I

Balaenoptera physalus	60	tonnes
Physeter macrocephalus	40	tonnes
Globicephala melaena	1,5	tonne
Tursiops truncatus	0,3	tonne
Delphinus delphis	0,25	tonne
Stenella coeruleoalba	0,15	tonne

RESULTATS

Pas d'observations en Atlantique vu les mauvaises conditions météorologiques et l'état de la mer (force 6 à 10).

En Méditerranée, les observations ont été essentiellement des cétacés. Pour la zone parcourue de jour entre Gibraltar et le Cap de Gata, nous avons observé quatre troupeaux de *Stenella coeruleoalba*, soit un nombre total de 16 à 25 cétacés.

La troisième zone décrite est située entre le Cap de Creux et Toulon, au large du Golfe du Lion. Là, nous avons pu répertorier 6 espèces de cétacés (*Delphinus delphis, Stenella coeruleoalba, Tursiops truncatus, Globicephala melaena, Balaenoptera physalus* et une espèce non identifiée. Le nombre total d'individus observés dans cette zone est : 85 à 92.

DISCUSSION

Pour les deux premiers tronçons : Gibraltar-Cap de Gata et Cap de Palos - Majorque, le nombre d'individus observés est le même (16 à 25).

Ceci correspond à une biomasse totale rapportée au mille parcouru en vigie de 0,028 tonne pour Gibraltar-Cap de Gata et de 0,026 tonne pour la région Cap de Palos-Majorque.

La région Nord Baléares-Toulon nous a révélé une faune très importante et diversifiée (5 espèces et 85 à 92 individus), soit une biomasse moyenne de 3,13 tonnes/mille parcouru en vigie.

Cette biomasse est une indication d'une forte production secondaire de la région correspondante. Celle-ci peut être reliée à des phénomènes hydrologiques variés (tourbillons, front des Baléares, front liguro-provençal) comme ceux que nous avons identifiés à 75 milles au nord de Minorque.

D'autres phénomènes hydrologiques étaient visibles à l'oeil nu : plaques de convergence et de divergence, cellules de Langmuir.

Si nous comparons ces données aux indices d'abondance établis préalablement pour le bassin occidental de la Méditerranée (de 0,4 à 1,6 tonne par mille parcouru en vigie), nous constatons une fois de plus que la zone située entre les Baléares et la Provence est une région riche en espèces et en biomasse.

CONCLUSION

Ces résultats confortent nos précédents travaux, liant les cétacés aux phénomènes hydrologiques productifs tels que les fronts, les tourbillons, etc. (Campagne Western Mediterranean Circulation Experiment) (VIALE et al., sous presse et VIALE 1990).

En revanche, ils s'opposent à l'affirmation de DUGUY 1990 : "La zone la plus fréquentée est la mer Ligurienne ainsi que les eaux du Sud de l'Italie. Par contre, le Golfe du Lion paraît relativement pauvre".

Nos observations fournissent un moyen objectif et comparatif d'évaluation des stocks de cétacés dans les zones échantillonnées

BIBLIOGRAPHIE

DUGUY : "Les Mammifères marins de la Méditerranée occidentale". Bull. Soc. Zool. de France. 114(3) : 89-96.

VIALE et PISTECK 1988 : "Correspondance between Surface Macrofauna and deep scattering Layers related with Western Mediterranean Circulation Experiment : Mission NORDA 706-86". Communication W.M.C.E. Symposium 15-20 mars 88. Bay St Louis - Mississipi USA.

VIALE et al : "Consortium of W.M.C.E. Investigator : a preliminary Revue of Results". *E.O.S. Trans-Americ-Geophys.Union.*

VIALE 1990 : "Une méthode synoptique de recherche des zones productives en mer. Détection des cétacés, des fronts thermiques et des biomasses sous-jacentes". Bull. Instit. Oceanograph. Paris (sous presse).

V-II1

On a Specimen of the Leatherback Turtle, *Dermochelys coriacea* (Linnaeus, 1766), stranded at Mazara del Vallo (South-West Sicily)

Patrizia JEREB and Sergio RAGONESE

I.T.P.P., C.N.R., Via L. Vaccara 61, 91026 Mazara del Vallo (Italia)

The leatherback Turtle, *Dermochelys coriacea*, an Atlantic species with wide geographical distribution, though repeatedly found in Mediterranean waters (Crespo et al., 1988 ; Hachaichi & Rais, 1985 ; Maigret, 1986 ; Oliver, 1986) and occasionally in Italian waters (Bruno,1970, 1978 ; Capocaccia, 1967; Di Palma, 1978), is still however a species whose capture constitute an uncommon event so that Petit's comment (1951) : "... en raison de la rareté ... toute capture avec au minimum l'indication de date, des dimensions de l'animal et du sexe, mérite d'être signalée" is still valid.

As far as the southern coast of Sicily is concerned, records of this species are very sporadic and relative to the more eastern side (Bruno, 1970 ; Capra, 1949 ; Carfì Pavia, in Di Palma, 1978) ; this which follows is the first documented sighting of a specimen of the leatherback Turtle on the western side of Sicily. The specimen, a male, was stranded probably because of a violent sea-storm on the coast of Mazara del Vallo on 5th April, 1989. It was found dead on the beach, although external examination revealed no wounds or particular signs of damage. It was measured (fig.1), transported to the Institute and kept frozen.

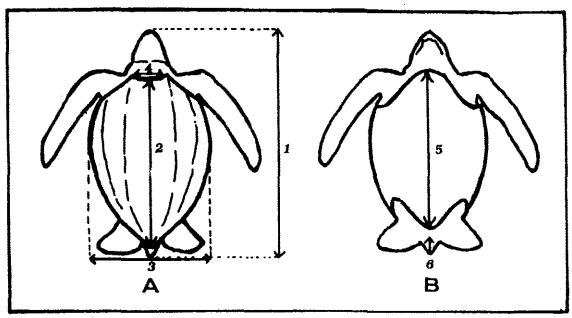


Fig. 1 - Measurements taken on the specimen of the loggerhead, *Dermochelys coriacea* (Linnaeus, 1766), following Duron-Dufrenne, 1978, modified as in Oliver, 1986. A : dorsal view; B : ventral view. 1 : Total length = 202 cm; 2 : Carapace length = 145 cm; 3% : Carapace width = 70 cm; 4% : Length between the foremost lateral keels = 28 cm; 5% : Plastron length = 95 cm; 6 : Tail length = 24 cm. (% = measurements taken on the embalmed specimen).

The post-mortem examination revealed a digestive system completely "clogged up" with residues of various sorts of plastic, the probable cause of death. Because of the scientific interest of the find in itself and of the stir created locally by the stranding of this Turtle, the specimen was embalmed by a French taxidermist and is at present preserved at the I.T.P.P. Considering the known presence, even if occasional, of this species in the Tunisian waters (Hachaichi and Rais, 1985) and the absence of documented sightings in the Sicilian Channel "sensu latu", an area widely swept by southern sicilian trawlers, this record constitutes an event of particular interest which tends to confirm the migratory scheme proposed by Crespo et al. (1988). Entering the Mediterranean through the Straits of Gibralter, the leatherback Turtle would follow the currents of warm water, spreading over in the Western and Central Mediterranean : on reaching the entrance of the Sicilian Channel, the Skerki Bank could form the point where the route divides, on one way to the north (Italian and Corsican waters) and on the other to the south (Tunisian waters).

The results of the post-mortem examination are also very interesting, tending to confirm what has often been referred to as one of the probable assumption on the ever more frequent cases of death of sea turtles : the ingestion of plastic. The carnivorous feeding of these animals, also including large zooplanktonic organisms such as jellyfish (e.g. *Rhizostoma pulmo*) and the continuous increase of the quantities of plastic waste in the water, which could be confused with the former, especially when the water is turbolent or turbid, are obviously closely related factors, as this case seems to prove.

REFERENCES

BRUNO, S., 1970. Anfibi e rettili di Sicilia (Studi sulla fauna erpetologica italiana.XI). Atti Accad.Gioenia Sci.Nat., Catania, vol.II: 1-144.

BRUNO, S., 1978. Le tartarughe nei mari italiani e nel Mediterraneo. Natura Montagna 25(3):5-17.

CAPOCACCIA, L., 1967. La *Dermochelys coriacea* nel Mediterraneo. Atti Acad. Ligure 24:318-327.

CAPRA, F., 1949. La *Dermochelys coriacea* (L.) nel Golfo di Genova e nel Mediterraneo. Ann.Mus.Civ.St.Nat., Genova, 63:270-282.

CRESPO, J., CAMINAS, J.A. and REY, J.C., 1988. Considerations sur la présence de Tortues Luth, *Dermochelys coriacea* (Linnaeus 1758), dans la Méditerranée occidentale. Rapp.Comm.int. Mer Médit. 31(2):284.

DI PALMA, M.G., 1978. Notizie sulle tartarughe marine in Sicilia. (Reptilia, Testudines). Il Naturalista Siciliano, S.IV,II(1-2):1-6.

HACHAICHI, M. and RAIS, C., 1985. Captures de tortues luth (*Dermochelys coriacea*) dans les eaux tunisiennes. Bull.Inst.Oceanogr. Pêche Salammbo 12:77-85.

MAIGRET, J., 1986. Statut actuel des Tortues de mer en Méditerranée. Rapp.Comm.Int.Mer Médit. 30(2):243.

OLIVER, G., 1986. Captures et observations des Tortues luth, *Dermochelys coriacea* (Linnaeus, 1766), sur les côtes françaises de la Méditerranée. Vie et Milieu 36(2):145-149.

PETIT, G., 1951. Capture d'une Tortue luth à la Nouvelle (Aude). Vie et Milieu 2(1):154-155.

Rapp. Comm. int. Mer Médit., **32,** 1 (1990).

L'origine des Tortues Caouannes, *Caretta caretta* (Linnaeus, 1758) de Méditerranée Occidentale

Luc LAURENT

Laboratoire Reptiles et Amphibiens, Muséum National d'Histoire Naturelle, Paris (France)

L'origine des très nombreuses Caouannes capturees ou observées dans le bassin occidental (CAMINAS, 1988 ; LAURENT, 1988, 1989a) pose les problèmes de la nidification dans cette zone marine et de l'apport de population depuis l'Atlantique ou la Méditerranée orientale. Ce sont trois hypothèses liées à des phénomènes biologiques dont les déterminismes conditionnent une grande partie de la compréhension du fonctionnement du peuplement de cette espèce en Méditerranée. Des études récentes en Afrique du Nord (LAURENT, 1989a) permettent de discuter de l'importance de chacune de ces hypothèses.

Existence de nidification dans le bassin occidental

La nidification de la Caouanne a été évoquée de nombreuses fois aux Baléares et en Corse mais les travaux de MAYOL (1985) et de DELAUGERRE (1987) ont confirmé l'absence de ponte sur ces îles. En Italie péninsulaire et en Sardaigne (côtes occidentales), BRUNO (1969,1973) et ARGANO (1979) ont mentionné l'existence de sites de ponte sans en apporter de preuve. Pour la Sardaigne orientale VOESONEK et VAN ROY (1984) évoquent une nidification possible bien que les prospections aient été infructueuses durant l'été 1984. Une mission de prospection et d'enquêtes réalisée sur toutes les côtes d'Algérie et du Maroc méditerranéen (LAURENT, 1989a), permet d'affirmer que ces littoraux n'abritent pas de plages de ponte.
Malgré le manque de données précises pour la Sardaigne, il semble maintenant évident que contrairement au bassin oriental, la Méditerranée occidentale ne soit pas une zone de nidification. L'absence de ce phénomène sur les côtes d'Algérie et du Maroc dont la latitude est comprise entre celle des sites de ponte de Grèce ou de Turquie et celle des sites connus en Tunisie et en Libye est intéressante. Il faut en chercher la cause probablement dans les conditions hydrologiques propres à cette partie de la Méditerranée.

Les apports depuis l'Atlantique

Les origines de ces tortues migrantes seraient les grands sites de ponte de la côte sud-est des Etats-Unis et les côtes d'Afrique situées à la même latitude : le littoral du Maroc. Mais les eaux baignant ces côtes orientales de l'Atlantique sont plus froides et aucune zone de nidification n'a été mentionnée. SCHOUTEN et THEVENOT (1988) signalent l'absence de nidification sur les plages de la région de Tarfaya au Maroc. Finalement les sites de ponte les plus proches actuellement connus sont situés au Sénégal (MAIGRET, 1983) et les courants atlantiques (courant des Canaries) de direction sud, longent ces côtes d'Afrique occidentale la majeure partie de l'année. Seule une origine américaine via le Golf Stream pourrait expliquer une entrée pour Gibraltar. Mais quelle est l'importance de cette migration par ce détroit dont la largeur est de 8 milles (15 km). CARR (1987) sur la base d'une comparaison des histogrammes de taille de Caretta caretta capturées aux Açores et aux Baléares considère que les tortues de Méditerranée occidentale proviennent des Etats-Unis via les Açores. Cette assertion est discutable sur de nombreux points en particulier sur le fait que des jeunes tortues de longueur droite de carapace inférieure à 0,20 m ont été observées dans ce bassin (LAURENT, 1988, 1989a) alors que selon CARR (1987) ils devraient se trouver aux Açores. Actuellement la seule preuve est la reprise en Adriatique d'une tortue marquée au Texas (MANZELLA et FONTAINE, 1988).

Les apports depuis la Méditerranée orientale

Le principal élément en faveur de cette hypothèse est la méconnaissance actuelle de la taille de la population reproductrice de Méditerranée orientale. Celle-ci pourrait être en fait très importante. Des prospections récentes sur les côtes nord de Chypre révèlent l'existence de nombreux sites de ponte (TILLEY and KECO, 1990) et les grands littoraux non prospectés de Lybie et d'Egypte doivent abriter en toute logique de grands sites de nidification.
D'autre part, le peuplement du bassin oriental semble être caractérisé par une prédominance des jeunes et des subadultes (LAURENT, 1989b) ce qui contraste avec la Méditerranée orientale et plus particulièrement les côtes de Turquie où les données d'échouages montrent une très faible représentation des immatures (BARAN and KASPAREK, 1989). Cette hypothèse du déplacement d'une partie des jeunes vers le bassin occidental (des adultes marqués à l'est ont déjà été retrouvés à l'ouest) avec retour vers l'est pour la reproduction entraîne des points de critique : le passage du canal sicilo-tunisien dont les courants portent à l'est et le déterminisme d'un tel déplacement. Mais les données satellitaires montrent que ces courants ne sont pas réguliers (TAUPIER-LETAGE, 1988) et les capacités natatoires des nouveaux-nés et des jeunes peuvent être très importantes (STONEBURNER and RICHARDSON, 1982 ; DAVENPORT and CLOUGH, 1986). Le bassin occidental a une productivité plus grande et pourrait servir de zone d'alimentation pélagique. Pourquoi les tortues se dirigeraient-elles vers l'ouest ? On peut évoquer le gradient thermique ouest-est qui les guiderait dans la recherche des zones d'alimentation.

Conclusion

Seule l'utilisation de méthodes génétiques de discrimination permettant de rattacher un individu à sa population clarifiera l'origine des Caouannes du bassin occidental et par là même le fonctionnement du peuplement de cette espèce en Méditerranée.

REFERENCES

ARGANO, R., 1979. Report W.W.F. Project 1474. Switzerland. 19p.

BARAN I. et KASPAREK, M., 1989. Zoology in the Middle East, 3 : 31-36.

BRUNO, S., 1969. W.W.F. Roma, 4 : 12-13.

BRUNO, S., 1973. Atti. 3e Simp. Naz. Cons. Nat., Bari, 2 : 117-126.

CAMINAS, J.A., 1988. Rapp. C.I.E.S.M., Monaco, 31 (2) : 285.

CARR, A., 1987. Conserv. Biol., 1 (2) : 103-121.

DAVENPORT J. et CLOUGH W., 1986. Copeia, 1 : 53-57.

DELAUGERRE, M., 1987. Vie et Milieu, 37 (3/4) : 243-264.

LAURENT, L., 1988. Bull.Soc. Herp. Fr., 45 (1) : 9-16.

LAURENT, L., 1989a. Rapport RAC/SPA, Greenpeace Méditerranée. 48p.

LAURENT, L., 1989b. Communication au Colloque de Carry Le Rouet (France).

MAIGRET, J., 1983. Bull.Soc. Herp. Fr., 28 : 22-34.

MANZELLA, S.A. et FONTAINE, C.T., 1988. Marine Turtles Newsletter, 42 : 7.

MAYOL, J., 1985. Reptils i Amfibis de les Balears. Ed. Moll. 263p.

SCHOUTEN J.R. et THEVENOT, M., 1988. Trav. Inst. Sci. Rabat, mém. h.S. : 105-113.

STONEBURNER, D.L. et RICHARDSON, J.I., 1982. Copeia, 4 : 963-965.

TAUPIER-LETAGE, I., 1988. Thèse d'Océanographie Aix Marseille II, 119p.

TILLEY, R., and KECO, K., 1990. Sea Frontiers, March April 1990 : 54-55.

VOESENEK, L. et VAN ROY, P., 1984. Report to the Council of Europe, SEH.73p.

Tortues Marines dans la Zone Levantine de la Péninsule Ibérique

J. MAS* et P. GARCIA**

*Instituto Espanol de Oceanografia, Centro Oceanografico del Mar Menor, San Pedro del Pinatar, Murcia (Espana)

**ANSE. c/ Rosario Larga, 37. 30205, Cartagena, Murcia (Espana)

En Espagne, les tortues marines se partagent le paradoxe d'être protégées par la législation nationale (Real Decreto 3181/1980, du 30 décembre, 1980) et d'être objet en même temps d'une importante capture accidentelle par les bateaux de pêche nationaux (entre 15.000 et 20.000 individus/an, selon les différents auteurs: MAYOL, 1986; CAMIÑAS, 1988). D'autre part, il existe une profonde méconnaissance de l'importance réelle des populations des différentes espèces, des migrations, de la survie des individus capturés, et d'autres aspects de leur biologie.

Les palangres dérivants utilisés par la flotte maritime sont réglementés par la législation de la pêche, qui limite a 2.000, selon l'espèce-cible, le nombre d'hameçons maximum et la longueur du palangre à 60.000 mètres. Le nombre d'embarcations utilisant cette technique varie, même si une petite partie la practique durant toute l'année. Cependant, les pêcheurs qui travaillent habituellement au chalut ou avec d'autres types d'engins utilisent les palangres, durant l'été. Ceci provoque une concentration importante de ce système de pêche durant les mois d'été, spécialement dans la zône comprise entre le Cap Gata et le Cap San Antonio, ainsi qu'autour de l'archipél des Baléares.

Simultanément on a transformé ou même détruit des zones traditionnelles de ponte sur toute la méditerrannée. Au sud-est de la Péninsule Ibérique et plus concrètement à la Manga del Mar Menor, les tortues de mer auraient pu se reproduire dans le passé. Au musée de Sciences Naturelles de Madrid, on conserve un jeune spécimen de Chelonia mydas originaire de "El Estacio" et recueilli en 1914. (MAS, 1986).

La conjonction de ces deux problêmes met en péril la survie des tortues marines dans la Méditerrannée. Pour cette raison, on a décidé de développer au Centre Océanographique de Mar Menor, un programme de surveillance en captivité des tortues marines, qui avait avalé un ou plusieurs hameçons de palangres.

Une fois transférées depuis les palangriers, les tortues ont été installées dans des bassins de 7.000 l. avec de l'eau prélevée de la lagune côtière de la Mar Menor (Salinité entre 43,056‰ et 48,070‰ , et température entre 9,60ºC et 27,62ºC, pendant la durée de l'expérience). Les tortues étaient soumises à des observations radiologiques afin de suivre la progression interne des hameçons. Une fois par jour, au moins, on nettoyait les bassins des déchèts et restes alimentaires, en notant le taux d'ingestion et l'apparition de hameçons sur le fond; la photopériode naturelle a eté respectée et on a maintenu un système de circuit ouvert, avec un taux journalier de renouvellement d'eau compris entre six et sept fois le volume du bassin.

Ces expériences ont débuté en 1986 sur Caretta caretta, avec les résultats suivants:

Année	Tortues(Nb)	Mortes(Nb)	Hamecon expulsés	Durée de l'expulsion (jours)
1986	5	1	4	53 à 123
1987	3	2	1	285
1988	5	1	1	55
1989	7	2	0	En observation 6 individus
1990	8	2	0	En observation 6 individus

Dans le cas extrême d'une durée d'expulsion de 285 jours, l'animal n'a ingéré aucun aliment pendant les neuf mois qu'il a retenu le corps étranger.

De ces expériences on peût conclure que les individus qui avaient les hameçons logés dans le palais ou dans le premier tronçon du larynx, ont des indices de survie supérieurs à ceux qui l'avaient dans l'oesophage. Le niveau de déglutition de l'hameçon avant la levée des lignes est sûrement très important, de même que la taille de celui-ci. C'est-à-dire que les hameçons qui ont pénétré profondément dans le tube digestif, produisent plus de mortalité. Lors de l'autopsie des tortues mortes, on notait des déchirures et des hémmoragies localisées tout autour des blessures, et, en fonction du temps écoulé, des septicémies généralisées. Durant la surveillance on pût remarquer que ces animaux étaient capables d'attaquer et de casser l'hameçon tout au long du tractus digestif. Les hameçons rejetés etaient intacts.

Les individus présentaient parfois d'autres types de blessures: déplacements des plaques du plastron et de la dossiére, amputation de membres, présence d'un crabe parasite...etc. D'autres avaient des poches d'air ou de gaz accumulé à l'intérieur du corps, ce qui empêchait leur plongée. On a également observé des tortues qui avaient avalé deux hameçons.

Cette étude a permis d'identifier les espéces apercues en mer, attrapées par les lignes de pêches ou échouées sur les plages; dans certains cas il s'agissait de Dermochelys coariacea. Pour 1990 on a projeté un programme de marquage dans le but d'obtenir des données sur le nombre réel de tortues capturées, les aires d'hibernation et les routes de migrations, etc.

BIBLIOGRAPHIE

CAMIÑAS, J.A., 1988. Incidental captures of Caretta caretta (L.) with long-lines in the Western Mediterranean. Rapp. Comm. int. Mer. Médit.; 31.2.

MAYOL, J., 1986. Incidencia de la pesca accidental sobre las tortugas marinas en el Mediterráneo español. Publ. Téc. SECONA. (en prensa).

MAS, J., 1986. Fauna Marina. In J. Mas (Ed.). Sureste Ibérico. El Medio Natural. Eds. Mediterráneo, (59); 139 pp.

V

V-II4

Sur la présence de la Tortue Verte, *Chelonia Mydas* (L., 1758) en Méditerranée Occidentale

J.-A. RAFA et J. SALINAS

Departamanto de Biologia Animal (Zoologia), Facultad de Ciencias Biologicas, Universidad de Valencia, Burjasot, Valencia (Espana)

Depuis 1989 nous avons entrepris, avec la collaboration de la Generalitat Valenciana, une étude des tortues marines échouées ou capturées dans la région de Valence (Méditerranée espagnole).

Nous avons surtout observé des *Caretta caretta* (L., 1758) et, occasionnellement des *Dermochelys coriacea* (Vandelli, 1761). Toutes les tortues capturées, mortes ou vivantes, ont été prises accidentellement par des filets ou des palangres. Notre programme de recherches comprend la récupération des animaux capturés, tant blessés que sains, qui sont éventuellement relâchés après marquage.

Le 25 avril 1990, une tortue verte (*Chelonia mydas*, L., 1758) a été prise par un filet trémail. La capture s'est produite à 100 m de la côte, au niveau du village de El Perellonet (province de Valence), à une profondeur de 8-10 m. L'exemplaire avait une longueur totale de 51,5 cm, sa carapace mesurait 36 cm de large sur 39 cm de long. Le poids de l'animal était de 6750 g.

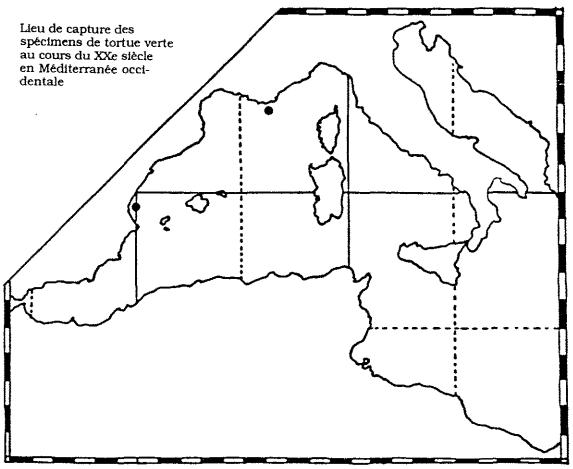
La tortue verte est une espèce rare en Méditerranée occidentale. Sa présence est confirmée au XIXè siècle aux Iles Baléares et Columbretes (BOSCA, 1916; MAYOL, 1985). Dans les révisions réalisées par PASCUAL (1985) pour les eaux espagnoles et par DELAUGERRE (1987) pour le bassin occidental de la Méditerranée cette espèce n'est pas mentionnée. Néanmoins, la capture d'une tortue verte a été signalée au Grau du Roi (Gard, France) en août 1989 (MAIGRET, comm. pers.).

Les zones de reproduction actuelles de la tortue verte sont principalement situées en Méditerranée orientale : côtes de la Turquie, de Chypre et d'Israël (DELAUGERRE, 1987).

HADJICHRISTOPHOROU et GROVE (1983) donnent un poids de 500-900 g pour les spécimens méditerranéens âgés d'un an. BALAZS (1982) signale, aux îles Hawaii, la recapture d'une tortue verte de 38 cm de longueur à une distance de 1900 km six mois après son marquage. En Méditerranée, MARGARITOULIS (1988) rapporte des déplacements d'individus de *C. caretta* marqués en Grèce et capturés deux mois après dans les eaux de Sardaigne à 1500 km du point de remise à l'eau.

La présence d'une tortue verte dans les eaux de Valence résulte vraisemblablement d'un long déplacement de l'espèce en Méditerranée.

Au cours de ce siècle, *C. mydas* a donc été capturée deux fois seulement dans la Méditerranée occidentale.



REFERENCES

BALAZAS, C.R., 1982 - Status of sea turtles in the Central Pacific Ocean. In: K.A. Bjorndal (Ed.) *Biology and conservation of sea turtles*, Smithosonian Institution Press: 243-252.

BOSCA, A., 1916 - *Fauna Valenciana*. Ed. A. Martin, Barcelona, 131 pp.

DELAUGERRE, M., 1987 - Statut des tortues marines de la Corse (et de la Méditerranée). *Vie et Milieu*, 37 (3/4): 243-264.

HADJICHRISTOPHOROU, M. et GROVE, D.J., 1983 - A study of appetite, digestion and growth in juvenile green turtle (*Chelonia myda* L.) fed on artificial diets. *Aquaculture*, 30: 191-201.

MARGARITOULIS, D., 1988 - Post-nesting movements of loggerhead sea turtles tagged in Greece. *Rapp. Comm. int. Mer Médit.*, 31 (2): 284.

MAYOL, J., 1985 - *Reptils i Amfibis de les Balears*. Ed. Moll, Palma de Mallorca, 236 pp.

PASCUAL, X., 1985 - Contribucion al estudio de las Tortugas marinas en las costas espanolas. I. Distribucion. *Misc. Zool.*, 9: 287-294.

V-III1

Analysis of the Sexual Development of *Eledone cirrhosa* (Cephalopoda, Octopoda) in the Northern Tyrrhenian Sea through two maturity indices

Paola BELCARI, Elisabetta FEDI and Paolo SARTOR

Dipartimento di Scienze Ambiente e Territorio, Via A. Volta 6, 56100 Pisa (Italia)

An analysis of the monthly development of two maturity indices was carried out as a preliminary phase of a study on the sexual maturity of Eledone cirrhosa (Lam., 1798). Through the assessment of the relative weights of the components of the reproductive system it has been possible to utilize the gonadosomatic index (MORIYASU, 1988) and the Hayashi index (HAYASHI, 1970) modified for octopuses according to GUERRA (1975) (Table 1). Eleven monthly samplings were carried out from March 1989 to February 1990, collecting 762 specimens (313 males, 379 females and 70 undetermined specimens). Samples were collected using a trawl-net in the Northern Tyrrhenian Sea, between the Isles of Elba and Giannutri at depths ranging between 92 and 350 m, with highest frequencies between 100 and 130 m. Through the size-frequency distribution analysis (BHATTACHARYA, 1967), it was possible to single out a cohort to be followed every month. First the maturation stages were determined through the macroscopic analysis of the gonads (MANGOLD-WIRZ, 1963; MORIYASU, 1988) and then they were compared with the two indices. Table 2 shows the existence of a good correlation, since a well defined mean value index corresponds to each maturation stage.

Table 1

	Gonadosomatic index (GSI)	Hayashi index (HI)
♂♂	((tW + NW)/W) 100	NW/(NW + tW)
♀♀	(oW/W) 100	odW/(odW + oW)

W = specimen weight; tW = testis weight;
oW = ovary weight; NW = Needham sac mass weight;
odW = oviducts and annex glands weight.

Table 2

	♂♂				♀♀			
	$\overline{GSI}$	SD	$\overline{HI}$	SD	$\overline{GSI}$	SD	$\overline{HI}$	SD
Immature specimens	2.130	2.017	0.132	0.045	0.277	0.138	0.135	0.037
Maturing specimens	8.061	1.727	0.206	0.096	2.331	1.851	0.101	0.035
Mature specimens	7.386	1.203	0.654	0.163	8.885	4.017	0.057	0.011

The GSI enables only two phases to be distinguished in the maturation process of the males, as previously reported by MORIYASU (1988). Fig. 1 shows the monthly variation of the maturity indices. The graphics refer to two different cohorts, as the cohort singled out in the previous period of investigation disappears from the fishery area after reaching the reproductive period (BOYLE, 1983). For the males, during the months of June, July and August, the HI exceeds the value of 0.5, above which the

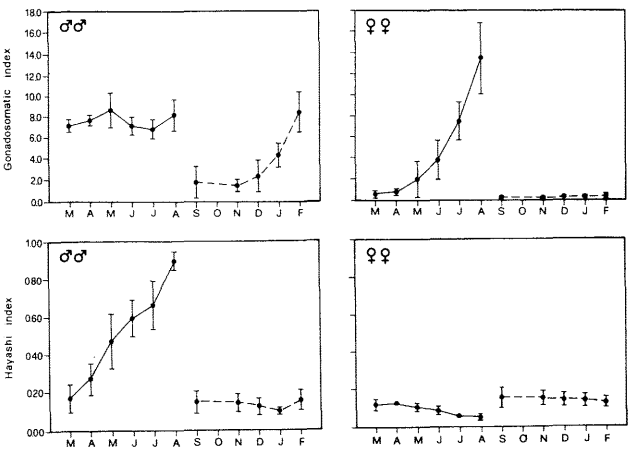


FIG. 1

males are supposed to be mature (MORIYASU, 1988). Mature females are found in a shorter period with respect to the males, the peak of maturity is shown in August (GSI= 13.45, HI= 0.052). From September to February the analyzed data refer to a new cohort, the individuals are at the beginning of the maturation stages. By observing the global variation of the indices, it is possible to point out that the maturation process starts previously in the males with respect to the females. Essentially our results are in agreement with those reported by PALUMBO & WURTZ (1983-'84) in the Ligurian Sea and by MORIYASU (1988) in the Gulf of Lions, even if some differences have been found relative to the period of maturity: in the Gulf of Lions the maturation process starts earlier in both sexes and mature females are found for a longer period.

REFERENCES

BHATTACHARYA C.G. (1967) Biometrics, 23: 115-131.

BOYLE P.R. (1983) In: Cephalopod life cycles (P.R. Boyle ed.), 1: 365-386.

GUERRA A. (1975) Inv. Pesq., 39: 397-416.

HAYASHI Y. (1970) Bull. Jap. Soc. Sci. Fish., 36(10): 995-999.

MANGOLD-WIRZ K. (1963) Vie et Milieu, suppl. 13, 273 pp.

MORIYASU M. (1988) Aquat. Living Resour., 1: 59-65.

PALUMBO F., WURTZ M. (1983-'84) Nova Thalassia, 6 (suppl): 721-723.

Cephalopod remains from Blue Sharks, *Prionace glauca*, Caught in the Gulf of Taranto

Giambattista BELLO

Istituto Arion, Mola di Bari (Italia)

The blue shark, Prionace glauca (L., 1758) (Selachii: Carcharhinidae), is an opportunistic predator, which feeds heavily on relatively small prey, especially bony fishes and squids; much of its prey is pelagic (COMPAGNO, 1984). Blue sharks are a quantitatively important by-catch in drifting longline fishery for swordfish, Xiphias gladius, in the Ionian and Adriatic Seas.

An examination was made of the gastric content of five specimens of P. glauca captured by drifting longline at night in the Gulf of Taranto, inlet of the Ionian Sea. The first two of them (specimens nos. 1 and 2) were caught on May 26th 1985 at about 16 nautical miles off Porto Cesareo (Lecce); their size and sex are unknown. The other three sharks (nos. 3 to 5) were hooked on May 28th 1985 at about 30 nautical miles SW of Porto Cesareo. The bottom depth in the fishing zone is between 500 and 1,700 m.

The author received the whole stomach content from blue sharks nos. 3 to 5 and only the cephalopod remains from specimens nos. 1 and 2. Each of the specimens nos. 3 to 5 contained cephalopod parts and one bait-mackerel. The cephalopod remains from all stomachs consisted only of loose beaks and lenses. Thanks to the low number of beaks involved, it was possible to match each upper mandibule with a lower one. Blue shark no. 1 contained just one unpaired upper beak while no. 2 contained three pairs, no. 3 two pairs and nos. 4 and 5 one pair.

The beaks were identified according to MANGOLD & FIORONI (1966) and CLARKE (1962 and 1986), and by comparing them with "vouchers" (cf. CLARKE, 1986). The size of beaks was described by the rostral length, as suggested by CLARKE (1986). Mantle lengths were estimated from the beaks. The mantle length estimation for H. bonnelli and T. sagittatus was done by the regression equations reported by CLARKE (1986) and for H. reversa by simple proportion with beaks extracted from specimens of known mantle length.

The ommastrephid beaks from blue shark no. 2 were tentatively ascribed to T. sagittatus because of the complete lack of darkening of the upper walls and crest and lower wings, which rules out Illex coindetii (cf. CLARKE, 1962); the shape of the upper rostrum, whose ventral side is almost straight, making a downward curve only at the tip (cf. MANGOLD & FIORONI, 1966); the narrowness of the lower rostrum, which rules out Ommastrephes bartramii (cf. CLARKE, 1986).

The table reports the size and sex of P. glauca specimens, the list of the cephalopods found with their beak size and their estimated mantle length.

		Prionace glauca specimens				
Cephalopoda		1	2	3 119 - F	4 143 - M	5 163 - M
Histioteuthis bonnellii	URL	11.9		3.5		7.5
(FERUSSAC, 1834)	LRL	-		3.2		6.5
	EML	11		4.5		7.5
Histioteuthis reversa	URL			2.0	3.6	
(VERRILL, 1880)	LRL			2.0	3.7	
	EML			4.5	8	
Ommastrephid sp. juv.	URL	2.1	2.2	2.4		
cf. Todarodes sagittatus	LRL	2.5	2.5	2.7		
(LAMARCK, 1798)	EML	9	9	10		

List of cephalopods found in the gastric content of Prionace glauca. Total length (cm) and sex of blue shark specimens nos. 3 to 5 are reported below the corresponding number. URL = upper rostral length (mm); LRL = lower rostral lenght (mm); EML = estimated mantle length (cm).

The gastric content of the examined blue sharks appeared to be rather poor and not very diverse; they had fed upon typically pelagic species. A cautious comparison between the present results -caution is due to the small number of P. glauca specimens examined- and the analysis of the stomach content of X. gladius from the same area (BELLO, 1985 and in preparation) shows a possible competition for food. Swordfish mostly prey upon T. sagittatus; they also occasionally ingest histioteuthids. Besides it is well known that P. glauca and X. gladius compete for longline hooks. For instance DE METRIO et al. (1983) report that in a two year period 2025 swordfish and 1035 blue sharks were caught by drifting longline in the Gulf of Taranto.

As to the cephalopods found in the shark stomach, T. sagittatus is abundant in the Gulf of Taranto (BELLO, 1985), whereas the occurrence of H. bonnellii and H. reversa has been rarely recorded (BELLO, 1987; D'ONGHIA et al., in press). However the analysis of predator stomach content (present results; personal observations on swordfish and cetaceans) suggests that they are not as rare as was thought. Thus, these observations can contribute to a better understanding of the teuthofauna structure of the Gulf of Taranto.

REFERENCES

BELLO G., 1985. Rapp. Comm. int. Mer Médit., 29, 8: 231-232.
BELLO G., 1987. Atti Soc. ital. Sci. nat. Mus. civ. St. nat. Milano, 128: 173-179.
CLARKE M.R., 1962. Bull. British Mus. (Nat. Hist.) Zool., 8: 419-480; 10 plts.
CLARKE M.R. (Ed.), 1986. Clarendon Press, Oxford: xiii + 273 pp.
COMPAGNO L.J.V., 1984. FAO Fish. Synop., 125, vol. 4: 655 pp.
DE METRIO G., M. LENTI & G. TRAINA, 1983. Accad. Pugliese Sci., parte II, 41: 3-7.
D'ONGHIA G., P. PANETTA, A. MATARRESE & A. TURSI, in press. Atti XXI Congr. Soc. Ital. Biol. Mar.
MANGOLD K. & P. FIORONI, 1966. Vie Milieu, sér. A, 17: 1139-1196.

Note préliminaire sur les Céphalopodes des Eaux Turques

T. KATAGAN et A. KOCATAS

Ege University, Department of Biology, Section of Hydrobiology, Bornova-Izmir (Turkey)

La Méditerranée est habitée par environ 59 espèces de Céphalopodes dont 46 vivent en Méditerranée orientale (MANGOLD et BOLETZKY, 1988). Malgré l'abondance de certaines espèces comme **Sepia officinalis**, **Loligo vulgaris**, **Octopus vulgaris** et **Eledone moschata** sur le marché en Turquie, aucun travail n'a jamais été tenté sur les Céphalopodes de cette région.

Les recherches scientifiques menées à partir du bateau de "K. Piri Reis" entre 1987 et 1989, nous ont permis de faire une douzaine de prélèvements benthiques et pélagiques en Mer Egée. Les prélèvements ont été faits essentiellement dans le Golfe de Saros (GS), dans le Golfe d'Edremit (GE), dans le Golfe d'Izmir (GI), dans le Golfe de Güllük (GGU) et dans le Golfe de Gökova (GG). Les espèces ont été identifiées selon FISHER et al. (1987).

Les positions géographiques et les caractéristiques des stations de prélèvement sont présentés dans le tableau ci-dessous.

Stations	Profondeur	Positions	Prélèvement	Date
GS 1	680 m	40° 27' N, 26° 24' E	benthique	12.09.1988
GS 2	600 m	40° 23' N, 26° 16' E	pélagique	13.12.1988
GE	311 m	39° 26' N, 25° 59' E	benthique	23.06.1988
GI 1	35 m	38° 24' N, 26° 56' E	benthique	21.12.1988
GI 2	20 m	38° 25' N, 26° 59' E	benthique	30.03.1988
GI 3	40 m	38° 31' N, 26° 38' E	pélagique	25.09.1989
GGU	10 m	37° 14' N, 27° 35' E	pélagique	15.11.1988
GG 1	80 m	36° 57' N, 27° 23' E	benthique	30.08.1988
GG 2	290 m	36° 59' N, 27° 50' E	benthique	22.08.1987
GG 3	320 m	36° 59' N, 25° 51' E	benthique	31.08.1988
GG 4	430 m	36° 53' N, 27° 44' E	benthique	22.08.1988
GG 5	500 m	36° 57' N, 27° 32' E	pélagique	13.11.1988

Nous présentons, ci-après, une liste des espèces de Céphalopodes rencontrées en Mer Egée. Les espèces marquées d'un astérisque sont assez répandues dans les eaux égéenne et méditerranéenne de la Turquie.

SEPIOIDEA

Sepiidae

Sepia officinalis Linnaeus, 1758*

Sepia orbignyana Ferrussac, 1826

Matériel: GG 2, 1 ♀ de 31 mm.

Sepia elegans Blainville, 1827

Matériel: GG 1, 2 ♀ de 30 à 40 mm et 1 ♂ de 50 mm.

Sepiolidae

Heteroteuthis dispar (Rüppel, 1845)

Matériel: GS 1, 1 juv. de 0.7 mm.

Sepiola sp.

Matériel: GI 1, 1 ♂ de 15 mm.

Sepietta oweniana (Pfeffer, 1908)

Matériel: GE, 1 ♀ et 1 ♂ de 24 mm.

Sepietta spp.

Matériel: GG 1, 1 ♀ de 16 mm; GG 3, 1 ♀ de 19 mm; GG 4, 1 ♀ de 20 mm.

Rondeletiola minor Naef, 1912

Matériel: GE, 1 ♀ de 20 mm et 1 ♂ de 15 mm; GG 3, 1 ♂ de 15 mm.

TEUTHOIDEA

Loliginidae

Loligo vulgaris Lamarck, 1798*

Alloteuthis media (Linnaeus, 1758)

Matériel: GI 2, 1 ♀ de 63 mm; GGU, 1 ♀ de 63 mm; GG 1, 2 ♀ de 40 à 53 mm et 1 ♂ de 40 mm.

Ommastrephidae

Todarodes sagittatus (Lamarck, 1798)

Matériel: GS 2, 1 ♀ de 90 mm; GG 5, 2 ♀ de 150 à 220 mm.

OCTOPODA

Octopodidae

Octopus vulgaris Cuvier, 1797*

Eledone moschata (Lamarck, 1799)*

Ocythoidae

Ocythoe tuberculata Rafinesque, 1814

Matériel: GI 3, 1 ♀ de 170 mm.

REFERENCES

FISCHER, W., BAUCHOT, M.L., et SCHNEIDER, M. (1987). Fisches FAO d'identification des espèces pour les besoins de la pêche. Vol. 1: 760 p.
MANGOLD, K., et BOLETZKY, S.V. (1988). Mediterranean Cephalopod Fauna. The Mollusca, Vol. 12: 315-330.

V-III4

Field Observations of Young *Ommastrephes bartrami* in Offshore Waters in the Ligurian Sea

Lidia ORSI RELINI

Laboratori di Biologia Marina ed Ecologia Animale, Istituto di Zoologia, Università degli Studi, Genova (Italia)

Given the relevant presence of teuthofagous mammals such as *Globicephala melaena, Grampus griseus, Ziphius cavirostris* (Viale 1985, Notarbartolo di Sciara *et al.* 1990), the Ligurian Sea is supposed to be rich in cephalopods, probably of species which at present do not constitute fishery resources. However, the distribution - if not the identity - of such pelagic species is unknown.
Taking Clarke's interesting notes (1966) on oceanic squids of genus *Ommastrephes* as a starting-point, I wondered if it might also be possible in the Mediterranean to see these animals in offshore waters at night. Some cruises on the R/V Minerva (CNR August 1987, July 1988, August 1989, December 1989, February 1990) gave me the opportunity to answer this question. It is a well-know fact that during the night, especially when the sea is very calm, a light put on the surface attracts squids which can then be easily fished with shrimplike artificial lures. In the inshore waters of the Ligurian Riviera I have observed that such catches are composed mainly of *Loligo vulgaris* and to a smaller extent of *Illex coindetii*. The same fishing technique was used in offshore waters.
During the first two cruises on calm nights in which the ship was adrift in proximity to the bottoms of the Ligurian slope where *Aristeus antennatus* is the target species of the trawl-fishery (500-700 m depth), several sightings of young ommastrephid were registered. Optimal conditions were reached a few hours after the ship's engines had stopped and a light which had been put over the side of the boat started collecting small fish and shrimps (Myctophidae, *Pasiphaea sivado, Meganyctiphanes norvegica* etc.) which became food for the cephalopods. However, every caught specimen proved to be *Todarodes sagittatus*. Indeed, this squid is sporadically associated to the trawl mesobathyal catches.
During the 1989-90 cruises the ship reached deeper waters (more than 1000 m depth) up to a maximum of 40 miles from the Ligurian coastline. In the same conditions as described above, finally several specimens of the genus *Ommastrephes* were observed and caught.
In August the squids appeared in small groups (up to six individuals), passing rapidly under the light. They maintained a distance of about 1 m from each other and were seen repeatedly seizing the fish. Five of them were fished both with artificial bait and with a landing-net and preserved in formalin solution.
The second observation took place in December: they appeared in the same circumstances as before, but were less numerous and larger. On board, two large tanks filled with sea water were used to keep the freshly caught specimens. They showed astonishing changes of colour from dark red-brown, when the squid was lifted into the air, to a white and blue colour when it was put in the tank (the latter had white walls and was floodlit in the laboratory). This last coloration was very similar to that of pelagic fish, the dorsum being blue and the ventral surface white with silver hues. However, this colour was seen when there were single specimens in the tank, but on adding a second specimen a furious reaction was observed, with colour changes and emissions of jets of water and clouds of ink. Four specimens were fixed in formalin solution. The post mortem coloration is also very characteristic. A black colour appears on the dorsal surfaces which is sharply delimited laterally; the borderline runs through the middle of the second pair of arms.
On the final occasion in February, watching the sea surface in the above-mentioned conditions I was not able to see any of them, but a member of the crew fished a specimen, together with two *Todarodes sagittatus*, in the last hour of the night.

Examined materials:
14.08.89 Minerva st. 43°49' 09°07'
five specimens: M.L. 11; 14.5; 15.5; 15.5; 17.5 sex undetermined (no signs of hectocotylization on ventral arms).
09.12.89 Minerva st. 43°43' 09°09'
four specimens: males (initial hectocot.) M.L. 19.5; 19.5; 21.3; female M.L. 25.5
05.02.90 Minerva st. 44°08' 09°07'
one female specimen M.L. 27.5
All these fit the description of *Ommastrephes bartrami* given by Young (1972), with the exclusion of details regarding the dentition of suckers.

Discussion: a) Species identity
In the opinion of Nesis (1982/1987), the genus *Ommastrephes* includes only one species, *O. bartrami*, with three formally undescribed subspecies: a North Atlantic (M.L. to 86 cm); a North Pacific (M.L. to 53 cm) and a southern subspecies (M.L. to 65 cm). In particular, the North Pacific subspecies is probably the best known (Araya 1983), as it sustains a fishery yield of 150,000 t/year. In the past, three species have been recognized.
For the Mediterranean records, which have generally been sporadic, the authors concerned have used the name *O. bartrami* (Naef 1923; Issel 1925; Torchio 1967, 1971). However, recently Roper et al. (1984) assigned the Mediterranean forms to *O. caroli* . As a consequence, for the most recent specimens found in the Mediterranean both the terms *O. caroli* (Guescini and Manfrin 1986) and *O. bartrami* (Ragonese and Jereb in press) have been used for what is probably the same form. Following the remarks of Bello (1986) and while waiting for a revision of the genus, I prefer to mantain the name *O. bartrami* for these Ligurian specimens.
b) Significance of Ligurian records.
This species is poorly represented in the Ligurian and Mediterranean collections as generally only very rare big specimens are preserved; in these cases the doubt remains that they are exceptional finds. I am of the opinion that to have found young specimens on three occasions in the same area - in spite of the limited search allowed by the ship timetable i.e. a total of few hours - is indicative of their regular presence. The sizes of the examined specimens suggest that they belong to the same cohort, which has been monitored over a period of six months, precisely as is the case - although with an enormous difference in numbers - in the north Pacific at approximately the same latitude (Araya, 1983).
During the cruises of the Minerva I was not able to see large specimens, neither in the summer nor in the winter,but their presence in the area is testified by two specimens stranded at Santa Margherita Ligure (Museum of Natural History of Genoa; a female 59 cm ML studied by Issel, 1925) and from recent observations during offshore sport fishing (Orsi and Fida in preparation).

References

ARAYA H. - 1983 - Mem. Nat. Mus. Victoria, 44: 269-283.
BELLO G. - 1986 - Boll. Malacologico, 22: 197-214.
CLARKE M.R. - 1966 - Adv. Mar. Biol., 4: 91-300.
GUESCINI A. and MANFRIN G. - 1986 - Nova Thalassia, 8, suppl. 3: 519-521.
ISSEL R. - 1925 - Ann. Mus. Civ. St. Nat. Genova 52: 5-8.
NAEF A. - 1923 - Die Cephalopoden. Fauna Flora Golf. Neapel, 35: 863 p.
NESIS K.N. - 1982 - Cephalopods of the world. Engl. tr. by B. Levitov 1987 T.F.H. publ.
NOTARBARTOLO di SCIARA G., AIROLDI S., BEARZI G., BORSANI F., CAVALLONI B., CUSSINO E., JAHODA M., VENTURINO M.C., ZANARDELLI M. - 1990 - European Cetacean Society 4° Congr., Palma de Majorca.
TORCHIO M. - 1967 - Thalassia Salentina 2: 1-7.
TORCHIO M. - 1971 - Natura (Soc. It. Sci. Nat. Milano) 62: 5-64.
ROPER C.F.E., SWEENEY S.J., NAUEN C.E., - 1984 - FAO Fish Synop. 125, vol.3: 1-277.
RAGONESE and JEREB - 1988/90 - Oebalia (in press)
VIALE D. - 1985 - Oceanogr. Mar. Biol. Ann. Rev., 23: 491-571.
YOUNG R.E. - 1972 - Smithsonian Contr. Zool. 97 : 1-159.

V-III5

Etude comparative de la relation taille-poids de *Eledone cirrhosa* des Mers Catalane et Tyrrhenienne Septentrionnale

P. SANCHEZ* et E. FEDI**

*Instituto de Ciencias del Mar, Paseo Nacional s/n, 08003 Barcelona (Espana)
**Dipartimento di Scienze dell'Ambiente e del Territorio, Università di Pisa, Via A. Volta 6, 56100 Pisa (Italia)

Eledone cirrhosa (Lamarck, 1798) est un octopode commun en Méditerranée occidentale. Diverses études sur quelques uns des aspects de sa biologie ont été réalisées dans ce secteur (Mangold-Wirz, 1963; Sánchez 1979; Moriyasu, 1983; Fedi 1988, parmi tant d'autres). Etant donné que c'est également une espèce commune et bien connue de l'Atlantique Nord, un travail de comparaison entre les peuplements atlantiques et méditerranéen a été mené à bien (Boyle et al., 1988). On y a remarqué quelques différences entre les deux peuplements: dans la morphométrie et dans le cycle de vie. Malgré ces nombreuses études, aucune n'a jamais effectué de travail comparatif entre les divers peuplements méditerranéens.
A partir d'information recueillie, d'une part par l'Institut des Sciences de la Mer de Barcelone au cours de l'année 1989 sur des pêches commerciales au chalut réalisées entre 72 et 630 m; d'autre part L'Universite de Pise sur des pêches au chalut effectuées en 1986 et 1987 entre 5 et 600 m de profondeur, on a procédé à une comparaison des rapports taille-poids pour les mois où l'on avait des échantillons des deux provenances. Nous sommes bien conscients que pour mener à bien une comparaison correcte, il faut disposer de données relevant de la même méthodologie, sur un même laps de temps. Cependant, nous pensons qu'une première approche du problème peut nous donner un point de départ pour analyser et connaître les peuplements d'Eledone cirrhosa en Méditerranée. Pour comparer les deux peuplements, on a pris en compte la relation entre la longueur du manteau (LDM) et le poids total (W), et on a comparé les données des deux peuplements (que nous appellerons catalan et tyrrhénien) sur un même mois; puis les échantillonnages réalisés en mer Tyrrhénienne en 1986 et 1987 entre eux. Les paramètres de la courbe de régression LDM/W ont été calculés avec l'équation: W= a*LDM**b.

MALES

Année/mois	R	A	B	VB	N
86/Mars	0.963	0.459	2.627	0.002	275
87/Mars	0.954	0.364	2.742	0.007	102
89/Mars	0.901	0.501	2.630	0.061	17
86/Avril	0.808	1.561	2.105	0.087	29
87/Avril	0.980	0.449	2.608	0.003	81
89/Avril	0.928	1.235	2.218	0.079	21
86/Septembre	0.927	0.717	2.334	0.002	524
87/Septembre	0.925	0.452	2.536	0.006	198
89/Septembre	0.951	0.999	2.338	0.018	35
86/Novembre	0.933	0.369	2.650	0.005	227
89/Novembre	0.907	0.831	2.535	0.034	43
FEMELLES					
86/Mars	0.931	0.438	2.686	0.004	289
87/Mars	0.964	0.264	2.886	0.007	96
89/Mars	0.901	0.828	2.556	0.039	41
86/Avril	0.940	1.276	2.221	0.025	28
87/Avril	0.967	0.316	2.780	0.004	146
89/Avril	0.957	1.989	2.120	0.022	30
86/Septembre	0.929	0.630	2.416	0.002	489
87/Septembre	0.947	0.397	2.614	0.003	242
89/Septembre	0.954	0.780	2.634	0.020	37
86/Novembre	0.929	0.518	2.482	0.004	230
89/Novembre	0.948	0.565	2.928	0.018	56

R=Coefficient de la corrélation, A,B=paramètres de la régression; VB=variance de la pente de la courbe; N=nombre d'individus.
Les deux courbes ainsi obtenues ont été comparées au moyen du test de Student.

MALES				FEMELLES			
t	gl	mois	années	t	gl	mois	années
1.181	373	Mars	86/87	1.941	381	Mars	86/89
0.426	115	Mars	87/89	1.548	133	Mars	87/89
0.011	288	Mars	86/89	0.631	326	Mars	86/89
1.668	106	Avril	86/87	3.292	170	Avril	86/87
1.362	98	Avril	87/89	4.156	172	Avril	87/89
0.275	46	Avril	86/89	0.466	54	Avril	86/89
2.258	718	Septembre	86/87	2.755	727	Septembre	86/87
1.400	229	Septembre	87/89	0.132	275	Septembre	87/89
0.034	555	Septembre	86/89	1.489	522	Septembre	86/89
0.585	266	Novembre	86/89	2.989	282	Novembre	86/89

t=t de Student; gl=degrés de liberté (pour un niveau de signification de 0.05 la valeur de t est de 1.96).

Nous pouvons observer, dans les mâles, que le t de Student n'est différent de façon significative que dans un cas dans les deux échantillonnages du mois de septembre recueillis en mer tyrrhénienne. Les comparaison effectuées sur les échantillonnages réalisés en mer tyrrhénienne et en mer catalane, ne comportent en aucun cas de différence significative. Dans les cas des femelles, 4 comparaisons apparaissent différentes: de façon significative: celle du mois d'avril entre les deux échantillonnages tyrrhéniens , celle de l'échantillonnage tyrrhénien de 1987 avec le catalan de 1989, celle des deux échantillonnages tyrrhéniens du mois de septembre, enfin, celle qui a été réalisée sur les échantillonnages catalan et tyrrhénien du mois de novembre présente de différence significative également. Le fait que peu de différences apparaissent entre les divers échantillonnages (5 sur 20) et qu'elles surviennent pour la plupart dans des échantillonnages réalisés sur la même zone, nous amène à penser que le rythme de croissance en taille et poids est vraisemblablement similaire pour les peuplements des mers Catalane et Tyrrhénienne Septentrionale. Une légère variation d'une année sur l'autre pourrait éventuellement être dûe à des conditions d'environnement différentes.

BOYLE,P.R., MANGOLD,K. & NGOILE,M.-1988. Malacologia 29(1):77-87.
FEDI, E.-1988.Tesi di Laurea, Università degli Studi di Pisa.
MANGOLD-WIRTZ, K.-1963. Vie et Milieu suppl.13:285 pp.
MORIYASU, M.-1983. Oceanologica Acta, 6(1):35-41.
SANCHEZ, P.-1979. Rapp.Comm. int. Mer Medit. 25/26: 185-187.

Distribution and Reproduction of *Sepia elegans* in the North Tyrrhenian Sea

C. VOLPI*, R. AUTERI*, M. BORRI** and P. MANNINI*

*Consorzio Regionale di Idrobiologia e Pesca, Via dell'Ambrogiana, 2, Livorno (Italia)
**Museo Zoologico "La Specola", Università degli Studi, Via Romana, 17, Firenze (Italia)

Abstract - Sepia elegans is relatively abundant south of Livorno between depths of 25 and 285m. During the sampling period about 50% of the specimens were mature, indicating an extended reproductive period.

The population of Sepia elegans was sampled over a total of 8475 km2 between a depth of 12 and 700 m along the Tuscan coast, from the outlet of the Magra River to the northern coast of Elba Island up to the limits of the Corsican territorial waters. Four trawl surveys, each consisting of 30 one-hour daytime hauls, were made in the spring (late March-early May) and summer (late August-early September) between 1985 and 1986, using a drag net with a 20 mm mesh bag. The area was subdivided into homogenous blocks according to the type of bottom and bathymetric range, and the hauls were distributed between the blocks proportionally to the respective areas and positioned randomly. Sepia elegans was captured between 25 and 285 m and most frequently between 60 and 120 m. It was most abundant south of Livorno - on sandy muddy bottoms in the circalitoral level related with the VTC biocenosis and with the DL biocenosis (Peres & Piccard, 1964) bathyal layers - and least abundant north of Livorno. This may have been due to the outlets of the Magra, Serchio and Arno rivers which modify the substrate and degree of salinity.

The hauls brought up 991 specimens weighing a total of 8.38 kg. The mantel length (M.L.) of the largest male was 52 mm, that of the largest female 65 mm. Males and females with an M.L. greater than 45 mm and 52 mm, respectively, were collected in the summer when the species was most abundant - about 350 specimens per trawl as compared to about 100 in the spring. Despite the notable difference between the two seasons, the bathymetric preferences of the species can nonetheless be compared. In the spring the cuttlefish were mainly found between 100 and 200 m, while their preference was not so obvious in the summer; in 1985 they were found predominantly between 50 and 100 m and in 1986 between 100-200 m (the springtime depths). In the summer most of the larger cuttlefish preferred the limits of their specific bathymetric range.

The sex and degree of maturity was determined from a subsample equally distributed by size and bathymetric layers. A total of 166 males and 231 females were checked, grading the degree of maturity according to Mangold's (1963) scale. The percentage of immature (stage 1) males and females was highest in the summer. In both seasons about 50% of the population was ready to spawn, but the greater percentage of mature males occurs in the spring and the females in the summer. The Table shows the maturity stages (in %) of individuals divided by length classes and season.

PERCENTAGES OF SEXUAL MATURITY STAGES

ML	MALES						FEMALES											
	SPRING			SUMMER			SPRING						SUMMER					
mm	1	2	3	1	2	3	1	2	3	4	5	6	1	2	3	4	5	6
20	70	20	10	86.7	10	3.3	79.7	2.1	3.8	3.1	11.3		100					
30	17.2	10.3	72.5	24.4	46.3	29.3	36.4	4	8	15.6	28	8	59.1	4.1	18.4	8.2	8.2	2
40	7.1	18.6	74.3	2.4	21.4	76.2	4.2		4.1	16.7	54.2	20.8			3.4	10.3	46.6	39.7
50						100					66.7	33.3			3.2	9.7	35.5	51.6
60																	33.3	66.7

The maturity of both sexes is linked more to size than to season, despite the fact that equally mature specimens can differ greatly in size and that beyond a certain size all cuttlefish are mature.

A comparison of equally long small and medium-sized specimens collected in the spring and summer revealed a precocity in the spring specimens. Richard (1966, 1971) observed in reared Sepia officinalis that low light intensity and short photoperiod, i.e. a winter-like situation, stimulates sexual maturity, while high temperature, i.e. a summer-like situation, stimulates somatic growth. Our observations may reflect the antagonistic roles of light and temperature as pointed out by Richard.

The degree of maturity of the females was calculated from the size of their largest eggs. Using this method the intermediate stages (2-3-4) of maturity are poorly represented, which could be due to the rapidity with which the eggs develop to their maximum size.

Though our data refer only to the spring and summer, these allow us to conclude that Sepia elegans reproduces all year long as Mangold (1963) suggests. They also do not seem to migrate in order to reproduce.

REFERENCES.

MANGOLD-WIRZ, K., 1963. Biologie des céphalopodes benthiques et nectonique de la Mer Catalane. Vie et Milieu, 13 (suppl.): 1-285.

PERES, J.M. & PICCARD, J., 1964. Nouveau manuel de bionomie benthique de la mer Méditerranée. Rec. Trav. Stat. Endoume, 31 (47): 137pp.

RICHARD,A., 1966. La température, facteur externe essentiel de croissance pour le céphalopode Sepia officinalis L.. C.R. Acad. Sci. Paris 263 (D): 1138-1141.

RICHARD,A., 1971. Contribution à l'étude expérimentale de la coissace et de la maturation sexuelle de Sepia officinalis L. (Mollusque, Céphalopode). Thèse de Doctorat d'Etat, Université de Lille (No.243), 264 pp.

V

Trace metals in three species of Fish of the Mullidae Family from the Mediterranean Coast, Israel

Hava HORNUNG and Nurit KRESS

National Institute of Oceanography, Israel Oceanographic and Limnological Research Tel-Shikmona, P.O.B. 8030, Haifa 31080 (Israel)

The Mullidae family is common throughout the Mediterranean. *Mullus barbatus* and *Mullus surmuletus* are Atlantic-Mediterranean species, and *Upeneus moluccensis* is of Red Sea origin (BEN-TUVIA, 1971). These fish inhabit sandy and muddy sea beds, and their prey's habitat is benthic.

To establish a baseline of the existing levels of trace elements (Hg, Cd, Pb, Cu, Zn, Fe) in these commercially important species, their muscle tissue and inner organs were analyzed. Specimens were obtained from trawl catches along the coastline at depths between 10-100 m. Specimens of *Mullus barbatus* (484 specimens; 40 composite samples included 318 fish and 166 individuals), 222 specimens of *Upeneus moluccensis* (18 composite samples included 136 and 56 individuals) and 70 individual specimens of *Mullus surmuletus* were used in this study.

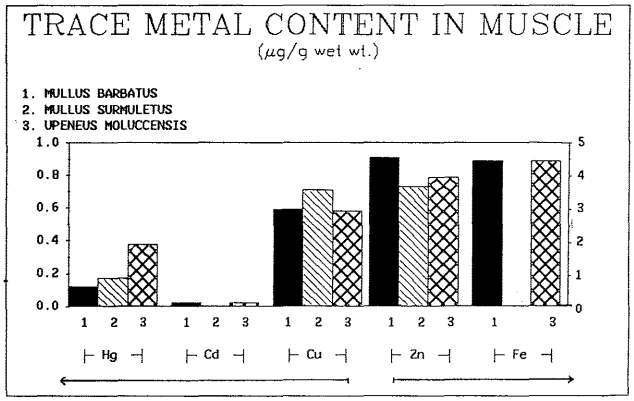
The highest values of total mercury were recorded for *U. moluccensis*, which is known to accumulate higher mercury levels in its muscle than the other Mullidae species, *M. barbatus* and *M. surmuletus*, even though they inhabit similar areas and feed on the same food items. However, levels were low in most cases (see table) and typical for these species, when compared to other areas in the Mediterranean (UNEP, 1986). Mercury content in the muscle correlated significantly with the weight of the fish for *U. moluccensis* ($r = 0.801$), but for *M. barbatus* and *M. surmuletus*, the relationship was poor ($r = 0.28$ and 0.27, respectively). The highest levels were detected in the liver (0.12-0.62 μg g^{-1}) followed by the kidneys (0.089-0.56 μg g^{-1}) and the heart (undetectable to 0.28 μg g^{-1}). Low, undetectable values of mercury were found in the gills, spine, gonads and intestines in all three mullets.

Cadmium levels in the muscle tissue were consistently low and ranged from undetectable to 0.11 μg g^{-1}, with most values below the approximate detection limit of 0.030 μg g^{-1} (see table).

Ranges, averages and standard deviation of trace metal concentrations (μg g-1 wet wt.) in muscle tissue of *Mullus barbatus*, *Mullus surmuletus* and *Upeneus moluccensis* (lead was undetectable).

Species	Year	Hg	Cd	Cu	Zn	Fe
Mullus barbatus	1975-1980[a]	0.035-0.475 0.122±0.08	0.007-0.114 0.026±0.02	0.18-1.29 0.60±0.32	1.94-10.0 4.41±1.8	--
	1984-1989[b]	0.008-0.313 0.108±0.06	BDL[c]-0.093 0.026±0.02	0.20-1.39 0.57±0.29	3.01-6.14 4.66±0.77	1.89-7.72 4.45±1.44
Mullus surmuletus	1975-1980[a]	0.069-0.316 0.170±0.05	0.005-0.026 0.016±0.01	0.35-0.66 0.50±0.22	2.90-3.76 3.33±0.61	--
	1984-1989[b]	0.092-0.164 0.135±0.02	BDL	0.71-1.12 0.88±0.15	3.07-4.98 4.04±0.59	--
Upeneus moluccensis	1975-1980[a]	0.095-1.02 0.412±0.18	0.002-0.08 0.04±0.02	0.10-1.34 0.52±0.36	2.14-7.60 3.86±1.07	--
	1984-1989[b]	0.005-1.12 0.240±0.18	BDL-0.048 0.006±0.01	0.20-1.35 0.64±0.30	2.75-5.96 4.04±0.68	2.48-7.01 4.43±1.03

a MED POL - Phase I.
b MED POL - Phase II.
c Below detection limit.



The levels of lead were generally below the detection limit of this element and therefore were not recorded.

Copper, zinc and iron are distributed uniformly in the muscle tissue in these species (Fig. 1). The highest values were recorded in the livers and in the food content associated with the feeding habits of these fish.

A comparison of the data for the years 1975-1980 and 1984-1989 shows no differences in the metal content of the muscle tissue in these species. Moreover, there are no significant differences in the values among the three species studied, even though they were collected from different locations along the coast.

This study is part of a comprehensive study on mercury in *M. barbatus* carried out within the framework of the MED POL Phase I and II program and was partly supported by the Mediterranean Trust Fund.

All given values are expressed as μg g^{-1} wet weight.

REFERENCES

BEN-TUVIA, A., 1971. Revised list of Mediterranean fishes of Israel. Israel J. Zool., 20 : 1-39.

UNEP. 1986. UNEP/FAO/UNESCO/WHO/WMO/IAEA/IOC. Coordinated Mediterranean pollution monitoring and research programme (MED POL - Phase I). Final Report 1975-1980. MAP Tech. Rep. Ser. (9). UNEP, Athens.

V-IV2

Levels of Heavy Metals in Two Demersal Fishes, *Arnoglossus laterna* (Risso, 1810) and *Buglossidium luteum* (Walbaum, 1792) in Izmir Bay

Hatice PARLAK* and Erkan DEMIRKURT**

*Ege University, Faculty of Science, Department of Biology, Hydrobiology Section, Izmir (Turkey)
**Dokuz Eylül University, Institute of Marine Sciences and Technology, Izmir (Turkey)

In this study, the quantity of data on the presence and content of heavy metals in two demersal fishes, (A. laterna and B. luteum) collected from Izmir Bay was accumulated between 1988-1989. The samples were chosen considering to their presence in every season and found them easily in the study area. The aim of this study was to determine the concentrations of Hg, Cd, Pb and Zn in the fillet of these fishes and compare the data of two years.

The analytical procedure applied involved a decomposition technique using HNO_3 - $HClO_4$ (5:1) acids in water bath with the temperature maximum 40°C under reflux system.

Determinations were carried out with Atomic Absorbtion spectrophotometer (Varian Techtron, Model 1250). Hg was determined by cold vapour technique using varian Model 65 vapour generation accessory and the other elements by flame (BERNHARD, 1976). The results have been calculated as µg/kg wet weight, medians and quartiles of data has been used for statistical evaluations (TUKEY, 1977; CLAUSSEN, 1988).

Concentrations of Hg in fillet of A. laterna didn't fluctuated much between 1988 and 1989 with lower quartile values of 9 and 13 µgHg/kg wet weight and with upper quatile 30-29 µgHg/kg respectively. Also, Hg concentrations of B. luteum in these two years ranged from 16 to 11 µgHg/kg as lower quartile and with the values 45-23 µgHg/kg upper quartile. It can be seen that Hg concentration has slightly decreased in 1989.

Cadmium concentrations of A. laterna ranged from 8 to 296 µgCd/kg as extreme values for 1988 while they varied from 72 to 334 µgCd/kg for 1989. Also, Cd concentrations of B. luteum ranged from 7 to 289 µgCd/kg in 1988 varied in between 56 to 175 µgCd/kg in 1989. So, Cd concentrations in B. luteum has increased in 1989 comparing to the data obtained 1988 (Table 1).

Lead concentrations of A. laterna was higher than of B. luteum generally. A. laterna has Pb concentrations between 127 to 4627 µgPb/kg as extreme values whereas accumulation in B. luteum varied between 94-3623 µgPb/kg in 1988. Also, Pb values obtained Pb from the samples collected in 1989 varied from 371 to 4138 µgPb/kg in A. laterna. It can be seen from the Table 1 that Pb concentrations in these organisms has decreased in 1989 comparing with these from 1988.

Zinc accumulations of A. laterna ranged from 3520-3863 µgZn/kg respectively as lower quartiles and 5669-5380 µgZn/kg as upper quartiles during 1988-1989. Also, Zn values of B. luteum ranged from 2680-2824 µgZn/kg as lower quartiles and 4325-3480 µgZn/kg as upper quartiles respectively during 1988-1989. The zinc values has decreased in 1989 in both fishs but Zn content of A. laterna was higher than of B. luteum (Table 1).

Table 1- Statistical values of trace metal concentrations in two demersal fishes (A. laterna and B. luteum) in Izmir Bay (µg/kg wet weight).

Species		Mercury 1988	Mercury 1989	Cadmium 1988	Cadmium 1989	Lead 1988	Lead 1989	Zinc 1988	Zinc 1989
A. laterna	Mimimum	5	5	8	72	127	371	2751	2749
	Lower Quartile	9	13	39	83	531	771	3520	3863
	Median	20	17	161	102	2363	946	3915	4577
	Upper Quartile	30	29	223	130	2671	1695	5669	5380
	Maximum	75	62	296	334	4627	4138	11296	6863
		n=20	n=19	n=16	n=9	n=19	n=14	n=20	n=20
B. luteum	Mimimum	4	7	7	56	94	639	2164	2395
	Lower Quartile	16	11	76	87	873	1077	2680	2824
	Median	26	22	106	100	1433	1156	3028	3288
	Upper Quartile	45	23	222	133	2045	1373	4325	3480
	Maximum	179	100	289	175	3623	1693	7990	3658
		n=23	n=13	n=17	n=8	n=20	n=9	n=23	n=14

A comparision of our data with those mentioned by other authors was not available because of lack of informations on this subject using these fishes on Turkish coasts. But, comparing with those reported from different areas of Mediterranean using similar kind of fishes, the heavy metal accumulations was not exeeded them (UYSAL, 1978; BARGAGLI at al. 1986).

However, the levels Pb indicated that we mustn't neglected it although the values are not high now.

REFERENCES

BERNHARD, M., 1976. Manual of metods in aquatic environment research: Part 3. Sampling and analyses of biological material. FAO Fish. Tech. Pap. 158: 124 p.

CLAUSSEN, T., 1988. Levels and spatial distribution of Trace metals in Dabs (Limanda limanda) of the Southern North Sea. Mitt. Geol.-Paläont. Inst. Univ. Hamburg Heft 65:467-496.

TUKEY, J.M., 1977. Exploratory data analysis - Reading, Mass, Addision- Wesley Publishing Co.: 473 p.

UYSAL, H. and TUNÇER, S. 1978.Accumulation and distribution of heavy metals in some marine organisms in the bay of Izmir and Aegean Coasts. IV^{es} Journées Etud. Poll. 213-217 Antalya, C.I.E.S.M.

BARGAGLI, R., BARGHIGIANI, C., GIOFFRE, D., PELLEGRINI, D. and TORTI, M., 1986. Preliminary results on total Mercury and Methylmercury content in different tissues of two benthic species collected in the Northern Tyrrherian Sea. Rapp. Comm. Int. Mer Médit., 30, 2: 109.

V-V1

Aquaculture Production in Greece, 1980-1988

I.-N. ARGYROU* and K.-I. STERGIOU**

*Institute of Technological Applications Hellenic Productivity Centre, Athens (Greece)
**National Centre for Marine Research, Agios Kosmas, Hellenikon, Athens 16604 (Greece)

ABSTRACT

Aquaculture production (excluding lagoons) in Greece increased from 2,000 t in 1980 to 3,900 t in 1988 with a mean production of 2,340 t representing 1-2 % of the mean annual fishery production in Greek waters. The mean 1986-1988 production was allocated as follows: 1983 t trout, 233 t carp, 132 t sea bream/sea bass, 570 t mussels, and 51 t other species (of which 7 t eels). The mean 1984-1986 production represented 0.4% of the mean (1984-1986) Mediterranean aquaculture production. A quadratic trend model explained 85% of the variability of aquaculture production in 1980-1988 and forecasts for 1992 amount to 7,900 t.

INTRODUCTION

Although aquaculture experience in Greece goes back to the 1950's, it is only since 1980 that aquaculture developed systematically; from 1981 to 1988 more than 12 million USD have been spent for the development plant of marine aquaculture (ANONYMOUS 1990) whereas more than 100 million USD were planned to be invested for aquaculture during 1987-1991 (KALLIFIDAS 1990). Here aquaculture production in Greece (excluding lagoons) is reviewed for 1980-1988. Yet, since forecasting of aquaculture production will be beneficial for the development of aquaculture infrastucture, forecasts are developed using decomposition (trend analysis) time-series techniques.

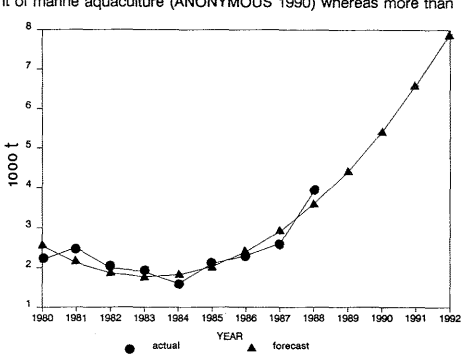


Fig. 1. Aquaculture production (excluding lagoons) in Greece, 1980-1988, and forecasts produced by the quadratic trend model (1980-1988: in-sample forecasts; 1989-1992: out -of-sample forecasts).

MATERIAL AND METHODS

Annual aquaculture production in Greece (excluding lagoons) for 1980-1988 and production per species (1986-1988) are taken from the Ministry of Agriculture, KALLIFIDAS (1990) and ARGYROU (1990). Trend analysis was used to model aquaculture production for 1980-1988 and, consequently, in-sample (1980-1988) and out-of-sample (1989-1992) forecasts were produced. The following measures of forecasting accuracy were computed: (1) Absolute Percentage Error, APE, (2) Mean Absolute Percentage Error MAPE, and (3) Mean Error (according to MAKRIDAKIS et al. 1983) and the coefficient of determination (according to SAILA et al. 1979).

RESULTS AND DISCUSSION

Aquaculture production (excluding lagoons) in Greece increased from 2,000 t in 1980 to 3,900 t in 1988 (Fig. 1) with a mean production of 2,340 t representing 1-2 % of the mean annual fishery production in Greek waters (STERGIOU 1990a). The mean 1986-1988 production was allocated as follows (Fig. 2): 1983 t trout, 233 t carp, 132 t sea bream/sea bass, 570 t mussels, and 51 t other species (of which 7 t eels). The mean (1984-1986) production amounted 2,000 t representing 0.4% of the mean (1984-1986) Mediterranean aquaculture production (= 496,000 t; GIRIN 1989). The mean (1984-1986) trout production ranked fourth in the Mediterranean salmonid production representing about 2 % of the mean (1984-1986) (= 66,000 t; France, Italy and Spain made up more than 90% of salmonid production during that period, GIRIN 1989).

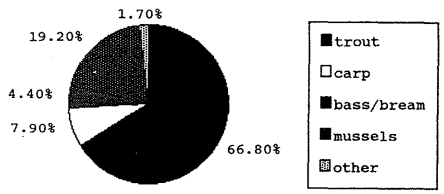


Fig. 2. Mean (1986-1988) aquaculture production per species (excluding lagoons) in Greece

Production per farm during 1986-1988 increased significantly for mussels (from 15 t/farm to 46 t/farm) and carp (from 5 t/farm to 14 t/plant) whereas it did not exhibit any significant increase for the remaining species (ARGYROU 1990).

Forecasting as applied to biological systems is mainly oriented towards modeling on the basis of: (a) explanatory, regression techniques (simple, multiple, categorical) which take into account other input variables, and (b) stochastic, time series techniques that treat the system as a black box (AutoRegressive Integrated Moving Average models, transfer function models, spectral analysis) (see STERGIOU 1989, 1990b). These techniques cannot be applied to our data because (a) the factors that mainly affect aquaculture production in Greece (e.g. such as technical and scientific expertise, management skills) cannot be parameterized, and (b) production time-series is short. Hence, a simple, decomposition method (trend analysis) was used to model and predict aquaculture production. Decomposition methods try to identify components of the basic underlying pattern and forecasting is based on extrapolation each of these component patterns separately and recombining them into a final forecast. The following quadratic trend curve was fitted to the 1980-1988 data: $X_t = 3.12 - 0.65\ T + 0.08\ T^2$, where X_t = production (in 1000 t) and T = time. ME and MAPE were estimated to be 0.0 and 9.5% respectively. APE ranged from 3.3 to 15.9%. The model explained 85% of the variability of aquaculture production in 1980-1988 and forecasts for 1992 amount 7,900 t (Fig. 1).

Forecasting plays a central role in managerial decisions: it preceeds planning which, in turn, preceeds decision making (MAKRIDAKIS et al. 1983). Forecasting of annual Greek aquaculture production within an APE ranging from 3.3 to 15.9% (MAPE = 9.5%) is an important goal. Aquaculture production in Greece is influenced by many factors and is confronted by all sorts of uncertainty (management skills, availability of fingerlings, availability of food, technical and scientific expertise). Yet accurate forecasts will be beneficial for the development of aquaculture infrastructure (fry and feed production both of which at present are mainly imported increasing the cost of products and render them not competitive for exportation), predict future prices, and planning exports and absorption by the local market.

REFERENCES

ANONYMOUS 1990. *Greek Fishing News* 103: 115-116 (in English)

ARGYROU, I.N. 1990. *Greek Fishing News* 103: 65-72 (in Greek)

GIRIN, M. 1989. *AquaReview* : 26: 31-34

KALLIFIDAS, G. 1990. *Greek Fishing News* 103: 52-56 (in Greek)

MAKRIDAKIS, S., S. WHEELWRIGHT & V. McGEE. 1983. Forecasting: methods and applications. John Wiley & Sons, N.Y., 926p.

SAILA, S.B., M. WIGBOUT & R.J. LERMIT. 1979. *J. Cons. int. Explor. Mer* 39: 44-52

STERGIOU, K.I. 1989. *J. Cons. int. Explor. Mer* 46: 16-23

STERGIOU, K.I. 1990a. *Greek Fishing News* 103: 31-38 (in Greek)

STERGIOU, K.I. 1990b. *Fish. Bull. U.S.* 88(2) (in press)

V

Development of Diets for Gilthead Bream *Sparus aurata* L. cultured in Egypt

Elham A. WASSEF(*)

Fish Nutrition Laboratory, National Institute of Oceanography and Fisheries, Alexandria (Egypt)

ABSTRACT

Two novel raw materials, dry germinated soyabean meal and fish silage, were used as the major protein sources in Sparus aurata feeds. Amino acid analyses of both materials, on one hand and the experimental fish on the other hand, proved that they meet or exceed the requirements of the species.

Three balanced diets were formulated on the basic idea of replacement of fish meal either partially, by defatted soyabean meal/dried germinated soyameal, or completely by a mixture of both soyabean meal and fish silage. Preliminary observations, under aquarium conditions, indicated that these artificial feeds are appropriate for the species.

Table 1. Composition (% Dry Weight) of raw materials.

Ingredients	Crude protein	Ether extract	Carbo-hydrates*	Metabolic energy	Calcium	Phosphorus
Fish silage	73.4	17.1	1.2	14.7**	1.0	1.5
Soyabean meal, defatted	44.0	1.0	39.3	9.4	0.3	0.6
Fish meal	65.0	4.0	5.0	11.8	6.0	3.0
Dried germinated soya	43.9	16.7	28.2	15.4**	0.2	0.6
Cod liver-oil	-	100	-	35.0	-	-
Soyabean oil	-	100	-	37.0	-	-
Wheat starch	-	-	100	13.0	-	-
Calcium carbonate	-	-	-	-	38.0	-

* Includes nitrogen free extract and crude fiber. ** Estimated.

Table 2. Amino acid profiles for soyabean meal, fish silage and sea bream muscles.

Amino acid	Dry germinated soyabeans (g/100g)	Fish silage	Sea bream muscles (g/100g protein)	requirements*
Arginine	5.59	4.97	4.14	1.7/34**
Histidine	4.30	3.24	1.97	-
Threonine	2.97	3.58	5.63	-
Isoleucine	3.64	3.65	2.18	-
Leucine	6.09	6.08	6.06	-
Valine	3.86	4.13	3.60	-
Lysine (LYS)	4.49	7.23	6.49	1.7/34
Methionine	1.25	2.48	1.88	1.4/34
Tryptophan	-	0.87	-	0.2/34
Phenyl alanine	4.30	3.24	1.75	-
Aspartic acid	15.20	8.19	8.85	-
Serine	4.15	3.60	6.63	-
Glutamic acid	13.03	12.09	11.54	-
Glycine	3.14	4.80	17.45	-
Alanine	3.54	5.13	14.57	-
Tyrosine	4.03	2.80	1.22	-
Proline	4.46	3.57	3.71	-
Cystine	1.13	0.67	-	-
Availability LYS	4.31	-	-	-
% availability	96%	100%	-	-
% recovery	83%	79%		-

* After Sabaut and Luquet, 1974 (Loc. cited Wilson, 1985).
** Percent of protein in the diet.

REFERENCES

DIVANACH, P., KENTOURI, M. AND DEWAVRIN, 1986. Sur le sevrage et l'evolution des Performances biologiques d'alevins de daurades, Sparus auratus, provenant d'elevage extensif, apres remplacement des nourrisseurs en continu par des distributeurs libre service. Aquaculture, 52 : 21-29.

EISAWY, A. AND WASSEF, E., 1984. Preliminary studies on rearing of the gilthead seabream, Sparus aurata, in brackish water ponds. Aquaculture,38: 255-260.

KRAIJEVIC, M., 1984. On the experimental feeding of sea bream (Sparus aurata L.) under aquarium conditions. Acta Adriat. 25 (1/2) : 183-204.

WILSON, R.P., 1985. Amino acid and protein requirements of fish. In : Nutrition and Feeding in Fish. Cowey, C.B., Mackie, A.M. and Bell, J.(eds), Academic Press London, 1-16.

(*) Present address, Girls College, Jeddah, Saudi Arabia.

Catch data from an artificial reef and a control site along the Central Adriatic Coast

Giovanni BOMBACE , Gianna FABI and Loris FIORENTINI

Istituto di Ricerche sulla Pesca Marittima, C.N.R., Molo Mandracchio, 60100 Ancona (Italia)

Artificial reefs are generally constructed in coastal waters around the world to enhance nearshore fisheries for their fish-attraction effect and increased production (BONSACK and SUTHERLAND, 1985). These effects should be particularly evident in areas far from natural reefs where the artificial substrates provide additional food, shelter from predation and greater habitat availability (BONSACK, 1989).

In order to evaluate the effectiveness of artificial reefs along the Adriatic coast and their influence on the fish assemblage and yield, 25 experimental fishing samplings were carried out from January 1988 to December 1989, both in a site sheltered with a concrete artificial reef and in an unprotected control site. Both the sites are situated along the central Adriatic coast, in front of Senigallia, on a sandy-muddy bottom (depth 10-11 m), at a distance of 2.5 miles from each other and 1.2 miles offshore. The artificial complex, completed in October 1987, consists of 29 pyramids, each made of five concrete cubic blocks, and 12 concrete cages for shellfish culture (FABI and FIORENTINI, in press).

The fishing samplings were carried out monthly with a trammel net (length 500 m; height 2 m; inner mesh size 70 mm; outer mesh size 340 mm), lowered into the water at sunset and pulled in at dawn, for an average of about 12 hours at sea.

A total of 41 species were recorded over the two sampling years: 32 were fishes, 4 crustaceans and 5 molluscs. Of these 40 species (31 fishes, 4 crustaceans and 5 molluscs) were reported from the artificial reef and 32 (27, 2 and 3 respectively) from the control site, corresponding to 98% and 78% of the total species composition. The average values of catch were 10.4 kg at the reef site for a total yield of 260.5 kg, (59% of the total catch) and 7.3 kg at the control site for a total of 182 kg (41%).

In both sites the catches consisted mainly of fish, other than an exceptional catch of *Squilla mantis* recorded in April 1989 at the control site (Table 1). Molluscs were mainly represented by *Sepia officinalis* (86%), a sandy-muddy bottom species which concentrates in spring to nearshore for spawning. Its bigger catch at the reef with respect to the control site might be related to a greater substrate availability for egg attachment as well as to the reef protection effect.

Over the two survey years, the fish reported from the reef exceeded 25% in number and 115% in weight those obtained from the control site. Benthic and pelagic species always constituted most of the fish catch (85-96%). They were mainly original sandy-muddy bottom species (*Trigla lucerna* and Soleidae: *Solea vulgaris, S. impar, Buglossidium luteum*) as well as transient, gregarious fishes (*Sardina pilchardus, Engraulis encrasicholus* and Mugilidae: *Mugil cephalus, Chelon labrosus, Liza ramada, L. aurata, L. saliens*). Their biomass was practically the same in the catches from both sites during the first sampling year (1988), while it increased at the artificial complex in 1989. This increment was particularly appreciable with respect to *S. vulgaris* and Mugilidae and it might be in relation to the reef protection effect against trawling for the first species and to the reef attraction and aggregation effect for the second.

The only reef-dwelling benthic species of commercial value, caught exclusively and constantly at the reef site, was *Scorpaena porcus*, which gradually increased in number during the whole sampling period (11 specimens in 1988 and 14 in 1989).

The man-made structures however noticeably influenced the catch of the nekto-benthic species immediately after deployment. This group of fish was always present in a low proportion in catches at both sites during the entire survey period, but the number and weight reported from the artificial reef exceeded 3 and 4 times respectively those from the control site, in both years.

Such a difference was mainly due to the constant presence and/or increase in catch of some species of high commercial value such as Sparidae and Sciaenidae, rare by found at the control site. For example, 15 specimens of *Lithognathus mormyrus*, 1 of *Umbrina cirrosa* and 1 of *Sciaena umbra* were reported at the control site against 29, 12 and 27 respectively at the reef during the whole survey period. In particular *S. umbra*, which is a typical reef-dwelling species, drastically increased in number at the artificial complex from 1988 to 1989 (1 and 26 specimens respectively).

Table 1 - Average number of specimens and average biomass per catch for pelagic, nekto-benthic and benthic fish, crustaceans and molluscs at reef and control sites.

	1988				1989				Average 1988-89			
	Control		Reef		Control		Reef		Control		Reef	
N. catch operations	12		12		13		13		25		25	
	n.	W(g)	n.	W(g)	n.	W(g)	n.	W(g)	n.	W(g)	n.	W(g)
PELAGIC FISH	46.8	2172	44.0	2131	32.3	2618	51.3	8940	39.3	2404	47.8	5672
NEKTO-BENTHIC FISH	1.0	152	3.6	576	1.1	158	3.1	730	1.1	155	3.4	656
BENTHIC FISH	16.3	1259	15.1	1206	10.0	725	16.1	1374	13.0	981	15.6	1293
CRUSTACEANS	6.1	300	24.9	1322	108.3	5376	28.6	1560	59.2	2939	26.8	1446
MOLLUSCS	3.4	942	5.2	1515	2.4	680	3.9	1207	2.9	806	4.5	1355
TOTAL	73.6	4825	92.8	6750	154.1	9557	103.0	13811	115.5	7285	98.1	10422

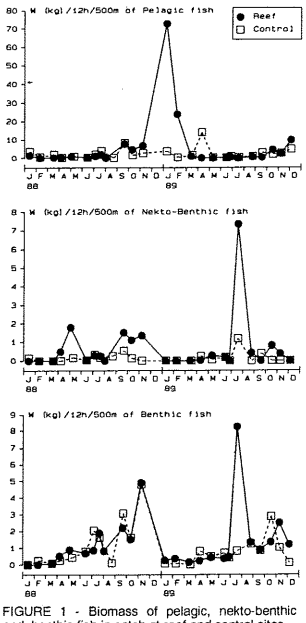


FIGURE 1 - Biomass of pelagic, nekto-benthic and benthic fish in catch at reef and control sites.

Moreover visual observations evidenced the occurrence at the reef of a higher number of reef-dwelling species as well as of individuals for each species in respect to the control site. They were nekto-benthic hard-substrate species such as *Dicentrarchus labrax, Diplodus sargus, Diplodus vulgaris*, living in shelters and/or around the lower layers of the artificial bodies, as well as pelagic reef-attracted species such as *Seriola dumerilii, Balistes carolinensis* and large schools (hundreds of individuals) of *Spicara flexuosa* and *Boops boops* swimming around the upper ends of the structures.

The influence of environmental conditions on reef effects was shown by seasonal fluctuations in fish catch recorded at both sites (Figure 1), with the lowest values for most of the species in winter, when they are assumed to migrate to deeper and warmer waters. The seasonal fish occurrence, also confirmed by visual observations, was particularly evident for the nekto-benthic fish, which appeared from spring to autumn and completely disappeared during the winter months.

Although the reef benefits seem to be reduced in winter, the higher catch values obtained from the sheltered site show that artificial reef deployment along the coast of the central Adriatic sea might be effectively useful to influence fish assemblage and to enhance nearshore fishing, with the occurrence and/or increase of selected species which are absent or rare in the original habitat (BOMBACE et al., in press).

REFERENCES

BOMBACE, G., FABI, G., and FIORENTINI, L. - *FAO Fisheries Report*, 428. (in press).

BONSACK, J.A., 1989 - *Bull.Mar.Sci.*, 44: 631-645.

BONSACK, J.A. and SUTHERLAND, D.L., 1985 - *Bull. Mar.Sci.*, 37: 11- 39.

FABI, G., and FIORENTINI, L. - *FAO Fisheries Report*, 428. (in press).

V-VI1

Catalogue Faunistique des espèces capturées par la flotille artisanale dans la Mer d'Alboran (SE de l'Espagne)

J.-A. CAMINAS , F. RAMOS , J.-C NUNEZ et J. BARO

Instituto Espanol de Oceanografia, Centro Oceanografico de Fuengirola, Apdo. 285, 29640-Fuengirola, Malaga (Espana)

Ce catalogue est le résultat de l'étude de la composition spécifique des prises qui, depuis 1987 ont été réalur le littoral sudméditerranéen espagnol, faisant partie du projet coopératif I.E.O./C.E.E. "Las Pesquerías Locales de la Región Surmediterránea Española (entre Punta Europa y Cabo de Gata)".

Une des principales caractéristiques de la flotille artisanale qui travaille dans le secteur d'etude est la multispécifité des prises.Ce phénomène est la conséquence d'une hétérogénéité importante de l'écosystéme littoral, cadre physique dans lequel la flotille opère. L'ensemble des caractéristiques océanographiques (plateau continental étroit, influence du courant méditerranéen et du courant atlantique, nature diverse du substrat, etc.), implique l'existence d'une grande diversité d'environnements, qui sont exploités depuis trés longtemps par une grande variété d'engins de pêche.

Le nombre d'espèces recensées, capturées par la flotille artisanale est de 224, appartenant à des groupes taxonomiques différents.

Dans le catalogue suivant, l'importance économique de chaque espèce ainsi que l'importance des prises ont été spécifiées par les symboles suivants: (+) espèce capturée abondemment; (*) espèce capturée frequemment; (-) espèce capturée occasionnellement; (x) espéce migratoire capturée saisonnièrement; (T) espèce trés commerciale; (C)espèce commerciale; (P) espèce peu commerciale; (J) espèce dans la quelle les petites tailles sont aussi commercialisées; (E) espèce toujours rejetée.

Cl. CHONDRICHTHYES
-C Alopias vulpinus
-E Cetorhinus maximus
-P Dasiatis pastinaca
-JC Galeorhinus galeus
-C Hexanchus griseus
-C Isurus oxyrynchus.
-JC Mustelus asterias
-JC Mustelus mustelus
-P Myliobatis aquila
-C Prionace glauca
*C Raja asterias
-C Raja brachyura
-C Raja clavata
-C Raja naevus
-C Raja undulata
*C Scyliorhinus canicula
-JC Scyliorhinus stellaris
-JC Squalus blainvillei
-JC Squalus megalops
*P Torpedo marmorata
-P Torpedo torpaedo

Cl. OSTEICHTHYES
-C Alosa alosa
-E Hippocampus spp.
xC Hirundichthys rondeletii
-E Labrus bergylta
-E Labrus merula
-E Labrus viridis
-P Lampris guttatus
-C Lepidopus caudatus
-JT Lepidorhombus boscii
-C Lichia amia
*T Lithognatus mormyrus
*P Liza aurata
*P Liza ramada
-T Lophius piscatorius
-E Macrorhamphosus scolopax
-T Merluccius merluccius
-JP Microchirus ocellatus
-C Micromesistius poutassou
-P Mola mola
-JP Monochirus hispidus
*P Mugil cephalus
+JT Mullus barbatus
+JT Mullus surmuletus
-E Muraena helena
-C Oblada melanura
-P Odeachilus labeo
-E Ophidion barbatum
-E Ophisurus serpens
+JT Pagellus acarne
-JT Pagellus bellottii
*JT Pagellus bogaraveo
+JT Pagellus erythrynus
+JT Pagrus pagrus
-P Peristedion cataphractum
*T Phycis blennioides
*T Phycis phycis
-P Plectorhinchus mediterraneus
*JC Pleuronectes platessa
-C Polyprion americanus
-P Pomadasys incisus
-P Pomatomus saltatrix
-JT Psetta maxima
xT Sarda sarda
+JT Sardina pilchardus
-JC Sardinella aurita
*P Sarpa salpa
-C Sciaena umbra
xT Scomber japonicus
xT Scomber scombrus
-E Scomberesox saurus
-JT Scophtalmus rhombus
-P Scorpaena notata
*P Scorpaena porcus
*P Scorpaena scrofa
-T Seriola dumerilii
+P Serranus cabrilla
-E Serranus hepatus
-C Alosa fallax
-E Anthias anthias
-T Aphia minuta
-E Apogon imberbis
*T Arnoglossus laterna
*T Arnoglossus thori
-P Aspitrigla cuculus
-C Atherina boyeri
-C Atherina presbyter
xT Auxis rochei
-E Balistes carolinensis
xP Belone belone
*E Blennius ocellaris
+C Boops boops
*JT Bothus podas
xC Brama brama
-C Buglossidium luteum
-E Callanthias ruber
-E Callionymus lyra
-E Capros apper
-C Caranx rhonchus
-E Cepola rubenscens
xC Cheilopogon heterurus
-P Chelon labrosus
-E Chromis chromis
*P Serranus scriba
*JT Solea lascaris
-JT Solea senegalensis
*JT Solea vulgaris
-T Sparus aurata
-E Sphoeroides cutaneus
-P Sphyraena sphyraena
-P Spicara flexuosa
*P Spicara maena
-P Spicara smaris
-T Spondyliosoma cantharus
-P Stromateus fiatola
-E Symphodus ocellatus
-E Symphodus melops
-E Symphodus tinca
-E Syngnathus acus
-E Syngnathus typhle
-E Synodus saurus
-E Thalassoma pavo
xT Thunnus alalunga
xT Thunnus thynnus
-C Trachinotus ovatus
-C Trachinus araneus
-C Trachinus draco
-C Trachinus radiatus
xJT Trachurus mediterraneus
xJT Trachurus picturatus
xJT Trachurus trachurus
-C Trigla lucerna
-C Trigla lyra
-C Trigloporus lastoviza
-P Trysopterus luscus
-P Trysopterus minutus
-T Umbrina cirrosa
-T Umbrina rhonchus
-C Uranoscopus scaber
xT Xyphias gladius
-E Xyrichthys novacula
-T Zeus faber

Cl. BIVALVIA
-E Acanthocardia aculeata
*C Acanthocardia tuberculata
+T Callista chione
-P Cerastoderma edule
+T Chamelea gallina
-E Circomphalus cassinus
*T Donax trunculus
-C Ensis siliqua
-E Glycymeris violacescens
-P Mactra corallina
*T Pecten jacobeus
-E Ruditapes decussatus
-P Venerupis pullastra
+T Venerupis rhomboides
*C Venus verrucosa
-C Citharus linguatula
*C Conger conger
-C Coriphaena hippurus
*E Coris julis
-T Cristallogobius linnearis
-E Dactylopterus volitans
-T Dentex dentex
-T Dentex gibbosus
-T Dicentrarchus labrax
-T Dicentrarchus punctatus
-C Dicologoglossa cuneata
*C Diplodus annularis
*C Diplodus cervinus
*C Diplodus puntazzo
*C Diplodus sargus
*C Diplodus vulgaris
*JT Engraulis encrasicolus
-T Epinephelus alexandrinus
-T Epinephelus guaza
xC Exocoetus volitans
-P Gaidropsarus mediterraneus
-P Gymnammodytes cicerellus
-C Halobatrachus didactylus
*C Helicolenus dactylopterus
-E Hippocampus guttulatus

Cl. GASTROPODA
-E Astraea rugosa
*C Bolinus brandaris
-E Charonia rubicunda
-E Cymatium corrugatum
-E Cymbium olla
-E Hinia reticulata
-E Phalium granulatum
*C Phyllonotus trunculus
-E Tonna galea

Cl. CEPHALOPODA
-C Eledone cirrhosa
*T Loligo vulgaris
+T Octopus vulgaris
-C Todarodes sagittatus
-P Todaropsis eblanae
+T Sepia officinalis
*T Sepia orbygniana

Cl. CRUSTACEA
-T Aristeus antennatus
-P Calappa granulata
-E Carcinus maenas
-E Dardanus arrosor
-T Homarus gammarus
*E Liocarcinus depurator
-E Macropodia longirostris
-T Maja squinado
-E Mesopodopsis slabberi
-E Pagurus prideauxi
-T Palinurus elephas
-T Penaeus kerathurus
-T Plesionika martia
-E Schistomistis ornata
-C Scyllarus arctus
-C Squilla mantis

Cl. ECHINOIDEA
-E Arbacia lixula
-E Paracentrotus lividus
-E Sphaerechinus granularis

Cl. ASTEROIDEA
-E Astropecten aranciacus
-E Chaetaster longipes
-E Marthasterias glacialis

Cl. OPHIUROIDEA
-E Astropartus mediterraneus
-E Ophioderma longicauda

Cl. HOLOTHURIOIDEA
-E Holoturia forskali
-E Stichopus regalis

V-VI2

Evolution de la moyenne vertébrale de la Sardine (*Sardina pilchardus*, Walbaum, 1792) le long du Littoral Algérien

F. DJABALI , B. BRAHMI et M. MAMMASSE

Institut des Sciences de la Mer et de l'Aménagement du Littoral, Alger (Algérie)

Introduction:
Les vertèbres de 130 sardines de la baie de Mostaganem (ouest algérien) et de 199 autres provenant de la région de Annaba (est algérien) ont été dénombrées (condyle occipital exclus à urostyle inclus), afin de situer l'évolution de la moyenne vertébrale le long du littoral algérien.Les résultats de Bouchereau (1981) à Oran et de Djabali et Mouhoub (1989) à Alger étant utilisés à cet effet.

Résultats:
Comme ce qui a été observé en région d'Alger, le nombre de vertèbres varie de 50 à 53 (Djabali et Mouhoub , 1989) pour les deux régions étudiées, la plus forte proportion revenant aux individus ayant 51 vertèbres (Tableau 1).

	50	51	52	53
Annaba	3.5	52.8	42.7	1
Mostaganem	4.6	63.8	30.8	0.8

Tableau 1: Pourcentage du nombre de vertèbres

Comparaison des résultats:
La comparaison des moyennes vertébrales de Annaba et de Mostaganem entre elles et avec la valeur obtenue pour la région d'Alger (Djabali et Mouhoub, 1989) par le test de l'écart-réduit, nous a conduit aux résultats ci-aprés :

Régions	Moyennes vertébrales	Ecart-réduit
Annaba Mostaganem	51.41 51.28	2.04 (**)
Annaba Alger	51.41 51.45	0.89 (*)
Mostaganem Alger	51.28 51.45	3.06 (**)

(**) Différence significative au risque de 5%
(*) Différence non significative au risque de 5%

De cette étude comparative et en reprenant les résultats obtenus par Djabali et Mouhoub (1989), le premier groupement défini par Kartas (1981) devrait s'étendre de Tanger à Mostaganem autour d'une moyenne de 51.29 .

Conclusions:
Cette étude a permis de préciser une des bornes est du premier groupement de sardines maghrébines, à savoir Mostaganem, la sardine de la région d'Oran avec une moyenne vertébrale de 51.29 (Bouchereau, 1981) s'intégrant parfaitement dans ce contexte.
D' autre part et bien qu ' une étude ultérieure de la région comprise entre Alger et Annaba s'avère nécessaire, il apparait, au vu de la différence non significative des moyennes vertébrales entre le centre algérien (51.43 à 51.51), la région de Annaba et le nord tunisien (51.41 - 51.42), que la suggestion de quatre groupements (Kartas,1981) de sardines maghrébines peut-être ramenée aux trois groupements suivants :
* Premier groupement: de Tanger(Maroc) à Mostaganem(Algérie) 51.29
* Deuxième groupement: de Cherchell(Algérie) à Kelibia(Tunisie) 51.46
* Troisième groupement: de Sousse(Tunisie) à Sfax(Tunisie) 51.57

****

Bibliographie sommaire: Bouchereau,J.L.,1981-Thèse Doct.3ème cycle, Univ.Aix-Marseille II / Djabali,F. et Mouhoub,R.1989-Pelagos-vol.III-Fasc.1 / Kartas,F.,1981-Thèse Doct.Etat, Fac.Sci.Tunis.

Sur quelques caractères biométriques de l'Aiguille *Tylosorus acus imperialis* (Rafinesque, 1810) (Belonidae) des Côtes Tunisiennes

Monia TRABELSI et Fredj KARTAS

Laboratoire de Biologie et d'Ecologie Littorale, Faculté des Sciences de Tunis, (Tunisie)

La famille des Belonidae est représentée dans les eaux côtières tunisiennes par trois espèces dont la diagnose a été mise au point par Collette et Parin (1970). Il s'agit de *Belone belone gracilis* Lowe, 1839, *Belone svetovidovi* Collette et Parin, 1970 et *Tylosorus acus imperialis* (Rafinesque, 1810). Les données concernant leurs caractéristiques morphologiques et biologiques sont inexistantes pour la Tunisie et très peu nombreuses pour les autres régions. Afin de combler partiellement cette lacune, nous nous proposons de rapporter dans la présente note les résultats relatifs à la biométrie de *T. a. imperialis*; les principaux caractères méristiques des populations tunisiennes des deux premières espèces ont déjà fait l'objet d'une communication (Kartas et Trabelsi, 1988).

	Nombre de rayons à la dorsale						
	23	24	25	26	N	moyenne	écart type
Tunisie	3	17	10	-	30	24,233	0,626
Méditerranée*	2	14	8	2	26	24,385	0,752

	Nombre de rayons à l'anale						
	20	21	22	23	N	moyenne	écart type
Tunisie	1	5	19	5	30	21,933	0,691
Méditerranée*	-	-	16	8	24	22,333	0,481

	Nombre de rayons aux pectorales					
	13	14	N	moyenne	écart type
Tunisie	24	6	30	13,201	0,407

	Nombre de vertèbres								
	91	92	93	94	95	96	N	moyenne	écart type
Tunisie	1	1	6	8	8	6	30	94,301	1,291
Méditerranée*	-	-	6	11	9	1	27	94,185	0,834

	Tunisie	Méditerranée*
Hauteur de la tête	0,0504X + 8,784	0,0677X - 2,696
Diamètre de l'oeil	0,0017X + 22,194	0,0433X - 0,762
Longueur des pectorales	0,0796X + 14,363	0,1163X - 5,436
Longueur du préopercule	0,0469X + 3,065	0,0436X + 0,462
Distance interorbitaire	0,0377X + 8,476	0,0538X - 2,753
Hauteur de la dorsale	0,0204X + 36,011	0,0836X - 0,757
Longueur des pelviennes	0,0794X + 4,430	0,0916X - 4,068
Distance postorbitaire	0,0845X + 7,017	0,1026X - 1,329
Largeur de la tête	0,0381X + 12,851	0,0714X - 3,833
Hauteur de l'anale	0,0886X + 5,208	0,0900X + 0,633

(Les données de Collette et Parin (1970) sont désignées par Méditerranée*)

Nos observations ont porté sur 30 individus (21 mâles et 9 femelles) provenant de divers lots pêchés en mai 1989 sur la côte sud-est tunisienne. Leur longueur du corps (du bord postérieur de l'opercule à la base de la nageoire caudale) mesurait entre 460 et 590 mm et ils pesaient entre 483 et 883 g. Quatre caractères méristiques et dix caractères métriques ont été analysés et comparés, à l'exception du nombre de rayons aux nageoires pectorales, aux résultats fournis par Collette et Parin (1970) d'après l'observation d'individus capturés au large du Liban.

Pour ce qui est des caractères méristiques, nous constatons que les moyennes obtenues sont statistiquement confondues pour le nombre de rayons à la nageoire dorsale et pour le nombre de vertèbres et très voisines pour le nombre de rayons à la nageoire anale. Cette grande homogénéité des moyennes traduit une stabilité particulièrement remarquable des caractères méristiques de *T. a. imperialis* dans les deux secteurs est et ouest du bassin oriental de la Méditerranée.

Quant aux caractères métriques, les équations linéaires établies par la méthode des moindres carrés décrivent la croissance relative de certains organes et proportions du corps en fonction de la longueur du corps prise comme longueur de référence. Leur comparaison avec celles calculées par Collette et Parin ne peut pas être rigoureuse étant donné que les spécimens étudiés par ces derniers auteurs sont trop petits (LC = 156-490 mm) par rapport aux nôtres.

Références

COLLETTE, B.B. & N.V. PARIN, 1970. - Needlefishes (Belonidae) of the Eastern Atlantic Ocean. *Atlantide Report* N°.11: 60pp.

KARTAS, F. & M. TRABELSI, 1988.- Données sur quelques caractères numériques des espèces du genre *Belone* (Poissons, Téléostéens) des côtes tunisiennes. *Rapp. Comm. int. Mer Médit.*, 31, 2: 258.

On the presence of *Pomatoschistus minutus* (Pallas) in a Southern Tyrrhenian Coastal Lagoon (Pisces, Gobiidae)

M. IANNIBELLI* and G. SPEZIE**

*Istituto di Tecnologia della Pesca e del Pescato, C.N.R., Mazara del Vallo (Italia)
**Istituto di Meteorologia e Oceanografia, I.U.N., Napoli (Italia)

Pomatoschistus minutus (Pallas, 1770) is a benthonic, euryaline species whose young specimens are also possible to be found in estuarial areas (Miller, 1973; Miller, 1986).

From a zoogeographical point of view P. minutus was always considered as a goby included in the Mediterranean ichthyofauna, but lately, by recent authors its presence was assured only for some northern parts of the Mediterranean sea, like the Gulf of Genoa or the Venetian lagoon (Tortonese, 1975; Miller, 1986).

Indications of the presence of this goby in more meridional Mediterranean areas, Morocco and the opposite coasts of Spain, were previously given by Wiktor (1962). Moreau too (1891) pointed out the presence of this goby on French and Algerian coasts.

In the course of a research for determining the effects of meteomarine conditions on the fish fry migration in coastal lagoons (Iannibelli et al., 1988, 1989) some specimens of P. minutus were captured.

Species identification of specimens was carried out following Tortonese (1975).

It can be easily evidenced that P. minutus was always captured in entering flow conditions, with a velocity of stream exceeding 7 cm/sec. (from 7 to 9 cm/sec.). The salinity, in sampling cases, was always exceeding 35.30‰ (range from 35.30 to 37.13‰), while the water temperature was always higher than 12.53° C (from 12.53 to 13.75° C).

According to the above data P. minutus can be considered a marine species entering brackish environments not only in young stages (Miller, 1988) but also in adult forms.

Concerning the distribution of the species, P. minutus is a goby very well represented in northern seas, certainly present in the Mediterranean as far as the Gulf of Naples (40° 50' lat.N) southward.

More investigations are required to precise if P. minutus is present also in more meridional Mediterranean stations as Carus indicated (1889), always considering that this goby has a quite spotted distribution, very probably, as Miller (1976,1986) suggested.

Common names of P. minutus in some Mediterranean countries (Bini, 1968): Bourgette (Fra.); Ghiozzetto minuto (Ita.); Glavočić pjeskuljaš (Yug.); Gobetu longu (Mon.); Cabuxino (Spa.); Hurma kaiassi (Tur.).

Literature cited

Bini G., 1968 - Atlante dei pesci delle coste italiane, Mondo sommerso, Roma, 7 : 199 pp.

Carus J.V., 1889 - 1893 - Prodromus Faunae Mediterraneae. Vertebrata, II. E. Schweizerbartsche Verlangshandlung (E.Koch), Stuttgart, 854 pp.

Iannibelli M., Levi D. and Spezie G., 1988 - Effects of meteomarine parameters on fish fry migration in the lake of Fusaro (Naples) : first results. Rapp. Comm. int. Mer Medit., 31, 2 : 275.

Iannibelli M., Levi D., Spezie G., 1989 - Osservazioni preliminari sulla rimonta del novellame nel lago Fusaro (Napoli) Atti XIX Congresso S.I.B.M. In Oebalia, 15-2 n.s.:803-805.

Miller P.J., 1973 - Gobiidae. In: Check-list of the fishes of the north-eastern Atlantic and of the Mediterranean. Hureau J.J.C. & Monod Th. (eds.), Unesco, Paris, 1 : 483-518.

Miller P.J., 1986 - Gobiidae. In: Fishes of the north-eastern Atlantic and the Mediterranean. Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E. (eds.). Unesco, Paris, 3 : 1019 - 1085.

Moreau E., 1891 - Histoire naturelle des poissons de la France. Tome 2. Masson G., Paris, 572 pp.

Tortonese E., 1975 - Osteichthyes, Fauna d'Italia, 11:636 pp.

Wiktor J., 1962 - Gobiidae. In: Klucze do oznaczania kręgowców Polski. Gąsowskiej M. (ed.). Państwowe Wydawnictwo Naukowe, Warszawa, Kraków, Część 1 : 183 - 193.

V-VI5

On the occurence of *Oedalechilus labeo* (Cuv.) in a Mediterranean Euhaline Lagoon (Pisces, Mugilidae)

M. IANNIBELLI* and G. SPEZIE**

*Istituto di Tecnologia della Pesca e del Pescato, C.N.R., Mazara del Vallo (Italia)
**Istituto di Meteorologia e Oceanografia, I.U.N., Napoli (Italia)

*Istituto di Tecnologia della Pesca e del Pescato, C.N.R., Mazara del Vallo (Italia)
**Istituto di Meteorologia e Oceanografia, I.U.N., Napoli (Italia)

Oedalechilus labeo (Cuvier, 1829) is a Mediterranean species commonly considered as a marine one (Bini, 1968; Trewavas, 1973; Tortonese, 1975; Ben Tuvia, 1986); as a consequence, it is extremely difficult to find this mullet in lagunar fish samples.

During the course of a research in lake Fusaro, for determining the influence of meteomarine conditions on fish fry displacements in coastal lagoons (Iannibelli et al., 1988, 1989) some specimens of O. labeo were captured in one of the channels connecting this lagoon, considered by Carrada (1973) as an euhaline one, with the sea.

Indications about the particular fishing-net used and the meteomarine parameters recording system were previously given (Iannibelli et al., 1988).

Species identification of specimens was carried out following Trewavas and Ingham (1972) and Tortonese (1975). However, morphological peculiarities of O. labeo make the diagnosis of this species quite unfailing.

The presence of O. labeo was noted on four of the six days of sampling, from January 17th to March 3rd, 1986.

It is interesting to note that, in all the cases of capture, the salinity of the water ranged from 37.15‰ to 37.30‰ and the T°C was exceeding the 13° C (from 13.24°C to 14.04°C).

Dissolved oxygen was always in oversaturation, exceeding the 8.1 mg/l and water flow has been observed in entering conditions (from 5 to 9 cm/sec.) in three cases, in stationary condition in the fourth.

It is necessary to consider that undoubtedly no displacements of O. labeo fry have been noted, being all specimens longer than 130 mm. (S.L.), while in the same station all the other Mugilidae species fry have been captured (Iannibelli et al.1988, 1989).

This preliminary data supports precise indication of the fact that O. labeo is surely a species with strong marine preferences, as environmental parameters (fig. 3) show and literature reports (Bini, 1968; Tortonese, 1975; Trewavas, 1976). It has to be evidenced instead that, in some particular conditions, this mullet can also be found in brackish environments as southern Mediterranean coastal lagoons, lake Fusaro for the Tyrrhenian site or the lake of Lesina for the Adriatic one (Villani, 1988).

Common names of O.labeo in some Mediterranean countries(Bini,1968):

Mulet labéon, mange-sabon, sabounié (Fra.); Kifon siftani (Isr.); Cefalo labrone (Ita.); Cipal supljak (Yug.); Kaplat buri (Mal.); Müsarú labrun (Mon.); Bouri (Mor.); Caluga (Spa.); Dudakli kefal (Tur.).

Literature cited

Ben Tuvia A., 1986 - Mugilidae. In:Fishes of the north-eastern Atlantic and the Mediterranean. Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E.(eds.). Unesco, Paris,3 : 1197 - 1204.

Bini G., 1968 - Atlante dei pesci delle coste italiane. Mondo sommerso, Roma, 4 : 163 pp.

Carrada G.C., 1973 - Profilo ecologico di una laguna salmastra flegrea : il lago Fusaro. Archo Oceanogr. Limnol., 18 suppl. : 145 - 164.

Iannibelli M., Levi D. and Spezie G., 1988 - Effects of meteomarine parameters on fish fry migration in the lake of Fusaro (Naples) : first results. Rapp. Comm. int. Mer Medit.,31,2 : 275.

Iannibelli M., Levi D., Spezie G., 1989 - Osservazioni preliminari sulla rimonta del novellame nel lago Fusaro (Napoli). Atti XIX Congresso S.I.B.M. in Oebalia, 15 - 2 n.s.:803-805

Tortonese E., 1975 - Osteichthyes. Fauna d'Italia,11 : 636 pp.

Trewavas E., 1973 - Mugilidae. In:Check-list of the fishes of the north-eastern Atlantic and of the Mediterranean. Hureau J.J.C. & Monod Th. (eds.). Unesco, Paris,1 : 567 - 574.

Villani P., 1988 - The ascent of Mugilidae fry into a coastal lagoon of the Adriatic sea. F.A.O. Fish. Rep.,394 : 181-188.

V-VI6

Note Préliminaire sur la présence d'un Gobie (*Gobius vittatus* Vinciquerra, 1883) dans les Eaux Turques

M. KAYA*, H.-A. BENLI** et S. MATER*

*Ege University, Faculty of Sciences, Department of Hydrobiology/Biology, Bornova, Izmir (Turkey)
**Dokuz Eylül University, Institute of Marine Sciences and Technology, Konak, Izmir (Turkey)

Il y a peu de travaux sur les espèces de la famille des Gobiidae concernant les côtes de Turquie. Parmi ces travaux les plus importants sont: SÖZER (1941), MILLER (1982), MATER et KAYA (1986) et KAYA et MATER (1987).

En juillet 1989, nous avons trouvé l'occasion de faire un trait de chalut sur fonds algaux (Vidalia sp., et Codium bursa) de 30 a 40 m aux environs de Bodrum (Fig. 1).

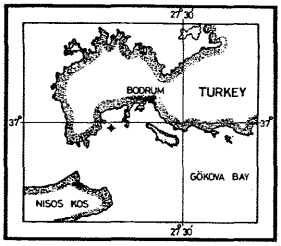


Figure 1. Station de prélèvement.

Parmi les poissons récoltés sur ce fond, l'un "Gobius vittatus" n'a jamais été signale des côtes de Turquie (Fig. 2). Les caractères morphométrique et méristique de cette espèce sont présentés dans le tableau (Tab. 1).

A l'exterieur des côtes de Turquie, cette espèce a été déjà signalée en Mer Egée par ONDRIAS (1971), TORTONESE (1975), MILLER in WHITEHEAD et al. (1986) et PAPACONSTANTINOU (1988).

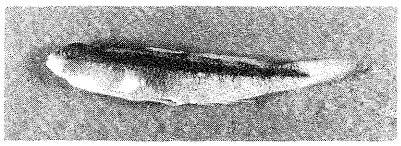


Figure 2. Gobius vittatus Vinciquera, 1883.

Table 1. Caractères morphométrique et méristique de G. vittatus

Longueur totale	44.70 mm	
Longueur standart	37.60 mm	
Hauteur maximum	6.50 mm	
Longueur de la tête	10.40 mm	
Longueur de museau	2.50 mm	
Diamètre horizontal de l'oeil	3.40 mm	
Longueur pré - dorsal	7.90 mm	
Longueur pré - anale	19.50 mm	
Nombre de rayons de la 1ère nageoire dorsale		VI
Nombre de rayons de la 2ème nageoire dorsale		I - 12
Nombre de rayons de la nageoire anale		I - 11
Nombre de rayons de la nageoire ventrale		I - 5
Nombre de rayons de la pectorale		17
Nombre d' écailles en ligne longitudinale		36 (+1)

REFERENCES

KAYA, M. and MATER, S.,1987. A new Gobiid genus and three Gobiid species (Pisces: Gobiidae)For Turkish Seas. "DOĞA" Turkish Jour. Zool., C:11, S:3, 122 - 127.

MATER, S. and KAYA, M., 1986. Recherche sur la Systematique et la morphologie des Gobiides (Osteichthyes,Perciformes) du Golfe d'İzmir. "DOĞA" Turkish Jour. Biol., C:10, S:2, 184 - 192.

MILLER,P.J., 1982. A new Pomatoschistus from the Mediterranean and redescription of P.tortenesei MILLER,1968.Senckesbergiana biol., 62 (1/3):5 - 19.

MILLER in WHITEHEAD at al ., 1986. Fishes of the North-eastern Atlantic and the Mediterranean. Vol III,p:1045-1046.

ONDRIAS, C,J., 1971.A list of the fresh and sea water fishes of Greece. Prac. of the Inst. of. Ocean and Fish Res. Period, Xa, p.37.

PAPACONSTANTINOU, C., 1988. Check-list of marine fishes of Grecee. In: Fauna Graeciae, 4:p.145, Athens.

SÖZER, F., 1941. Les Gobiides de la Turquie, Rev. Fac. Sci Univ. İstanbul, VI, 1, 128 - 169.

TORTONESE, E., 1975. Osteichthyes Pesci Ossei (Parte Seconda), Fauna d'Italia, XI, 308.

V

V-VI7

Utilisation du Locus Gapdh-1 comme marqueur génétique dans la différenciation de stocks de Merlu (*Merluccius merluccius*)

A. VILA , J.-L. GARCIA-MARIN , F. UTTER et G. PLA

Laboratori d'Ictiologia, Estudi General de Girona (U.A.B.), Plaça Hospital 6. 17071 Girona (Espana)

INTRODUCTION. L'identification des individus et populations est une nécessité très général dans la gestion piscicole et dans la recherche biologique. Cependant, cette identification nécessite des marqueurs adéquats. Généralement, les espèces peuvent être différenciées par des caractéristiques morphologiques, mais en ce qui concerne une espèce par ces méthodes, l'identification d'individus qui peuvent arriverà constituer des populations différenciées ou des stocks, est difficilement possible, en général, et quelquefois impossible. Précisément, la difficulté pour pouvoir identifier des stocks différents d'une espèce précise représente, actuellement, l'un des problemès les plus importants qu'affrontent les programmes de gestion piscicole (Allendorf et al. 1987).
La recherche de caractères génétiques qui puissent servir comme marqueurs pour des groupes génétiquement distincts et une connaissance adéquate de leur structure populatoire, représentent un exemple des données qui peuvent être utilisées pour les études différentielles de poissons. La plus grande partie de l'information génétique obtenue dans ce sens, a été fournie par l'analyse de la variation enzymatique détectée par electrophorèse (Utter 1987).
Ce travail présente les valeurs des fréquences géniques du locus GAPDH-1, obtenues à partir de l'analyse de la variabilité génétique étudiée dans diverses populations naturelles atlantiques et méditerranéennes de *Merluccius merluccius*, ainsi que son application en tant que marqueur génétique différentiel des dites espèces. *M.merluccius* se trouve dans l'Atlantique Nord et en Méditerranée. Cette espèce se distribue depuis les côtes de Norvège jusqu'à la côte Nord du Maroc et depuis la mer Noire jusqu'au détroit de Gibraltar. Il s'agit d'une des resources en pêche de grande valeur économique pour certains pays méditerranéens et il génère d'importantes zones de pêche aussi bien dans l'Atlantique qu'en Meéditerranée.

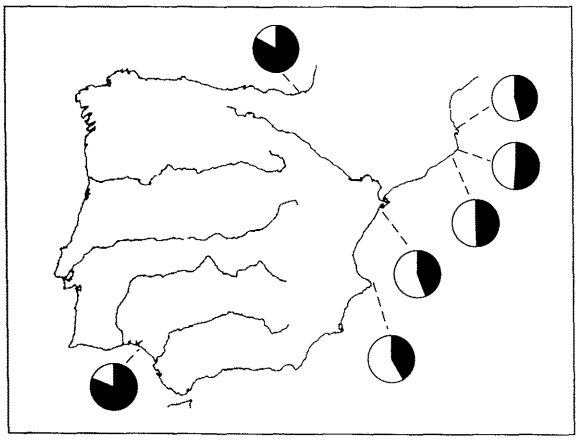


FIG. 1 : Proportions de chacun des deux allèles du locus GAPDH-1 dans les diverses localités échantillonnées

MÉTHODOLOGIE. Pour ce travail on a examiné 285 individus de cinq localités méditerranéennes et 123 de deux atlantiques. Les échantillons pris sur des merlu d'une longuer moyenne de 20 cm ont été conservés à -70ºC jusqu'à l'analyse électrophorétique.

RESULTATS. On a détecté 31 loci codifiants pour 17 enzymes. Dix de ces loci ont montré une variation génétique bien que seulement 5 de ceux-ci peuvent être considérés polymorphiques au niveau de 5%. On n'a pas observé d'hétérogénéité pour les fréquences alleliques entre les cinq populations de la Méditerranée ni entre les deux de l'Atlantique. Par contre le degré d'hétérogénéité entre les échantillons de l'Atlantique et de la Méditérranée est grand pour tous les loci sauf GPI-1 (GAPDH-1, χ^2=88.433, d.d.l.=1, p<0.05; G3PDH-1, χ^2=4.828, d.d.l.=1, p<0.05; GPI-1, χ^2=1.363, d.d.l.=2, p>0.05; GPI-2, χ^2=12.481, d.d.l.=3, p<0.05; SOD, χ^2=11.342, d.d.l.=2, p<0.05). Le locus GAPDH-1 a montré une variation génétique pour deux formes alléliques et les valeurs des fréquences alléliques trouvées pour les populations atlantiques présentent un comportement différent de celui des populations méditerraneénnes. Sur la Figure 1 on montre ces valeurs représentées sous forme de diagramme circulaire sur lequelle sont indiquées les proportions de chaque allèle pour les diverses localités échantillonnées.

DISCUSSION. Des travaux réalisés sur diverses espèces de *Merluccius* ont montré une grande uniformité entre les divers échantillonages analysés dans une même zone (Mangaly et Jamieson, 1978; Grant et al., 1988). Cependant, Pla et al. (1990) on trouvé une grande différentiation génétique entre les populations méditerranéennes et atlantiques, supérieure à n'importe quelle autre décrite pour cette espèce, provoquée par la fréquence du locus GAPDH-1. Ce qui nous a mené donc à confirmer dans ce cas, l'existence de deux populations bien différenciées quant au merlu du Nord de l'Atlantique: l'Atlantique même et la Méditerranéenne. Le comportement du locus GAPDH-1, est donc intéressant et important par sa fréquence qui ne varie pas de manière significative entre les 2 populations si éloignées de l'Atlantique, ni parmi les 5 populations méditerranéennes, mais si que cette fréquence serait caractéristique et trés différente entre ces 2 zones. Ces résultats sont en accord avec la différentiation morphologique décrite précédemment entre espèces de ces deux zones (Cadenat 1952). Ce comportement clair que présente le locus GAPDH-1 nous a amené à en déduire que nous pouvons prendre ce comportement comme un type de marqueur génétique pour différencier les populations de ces deux zones.

V

RÉFÉRENCES.

ALLENDORF, F.; RYMAN, N. et UTTER, F., 1987. Genetics and Fishery Management: Past, Present, and Future. In: **Population Genetics and Fishery Management,** N. Ryman and F. Utter (eds.), University of WashingtonPress, Seattle and London: 1-19.
CADENAT, J., 1952. Note au sujet des Merlus de la region de Dakar. Jour. Cons. Inter. Expl. du la Mer **28**: 2-15.
GRANT, S.W., BECKER, I.I. et LESLIE, R.W., 1988. Evolutionary divergence between sympatric species of southern African hakes, Merluccius capensis and merluccius paradoxus. I. Electrophoretic analysis of proteins. Heredity **61**: 13-20.
MANGALY, G. et JAMIESON, A., 1978. Genetics tags applied to the European hake, Merluccius merluccius (L.). Anim. Blood Grps biochem. Genet. 9: 39-48.
PLA, C.; GARCIA-MARIN, J.L. et VILA, A., 1990. Utilisation des méthodes génétiques comme instrument de gestion piscicole. Bull. Soc. Zoo. de France, **114**(3).
UTTER, F., 1987. Protein electrophoresis and stock identification in fishes. In: **Proceedings Stock Identification Workshop**, H.E. Kumpf, F.N. Vaught, C.B. Grimes, A.G. Johnson and E.L. Nakamura (eds.), U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-SEFC-199: 62-103.

V-VII1

The induction of maturation of female Grey Mullet (*Mugil capito* Cuv.)

E.-M. AMIN and Kh.-A. HUSSEIN

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

ABSTRACT. This work is a report of the results obtained from a series of laboratory experiments on induced spawning of the grey mullet (*Mugil capito* Cuv.). Migrating females were collected from lake Edku (40 km to the east of Alexandria) during their exodus to the Mediterranean Sea for spawning (October to December 1989).

Females were injected by carp pituitary and Synahorin. Histological studies were carried out to examine egg maturation before stimulation.

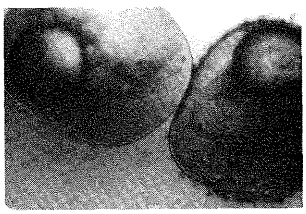


Fig.1. Ripe egg with a single oil droplet.

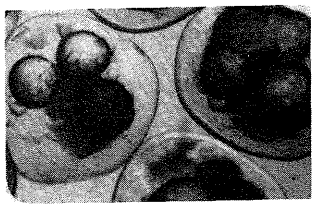


Fig.2. Ripe egg with two or more oil droplets.

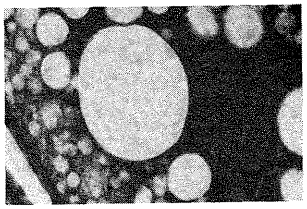


Fig.3. Unripe egg with oil droplets around nucleus.

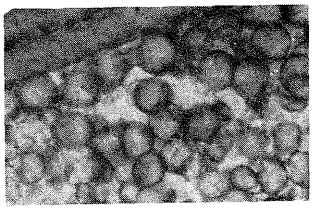


Fig.4. Maturing egg, cytoplasm filled with yolk granules.

Three times injected females gave ripe eggs (Fig. 1) when gently pressed on the belly. Ripe eggs were spherical and transparent. The egg surface smooth and unsculptured. Average egg diameter measured 0.83 mm. A centrally positioned large oil globule measured about 0.33 mm. Most ripe eggs appeared with one prominant large oil globule making them extremely buoyant.

Before release in Petri dish containing sea water many eggs appeared with two or more oil globules (Fig. 2). During examination in sea water, diffusion of oil globules took place. The number of oil globules of mugilids was shown to increase with the manual pressure of artificial stripping (Kuo et al., 1973a). The normal eggs frequently appeared with a single oil droplet (Nash et al., 1974).

The success of the often used induction techniques was extremely connected with the degree of gonad maturation (Hussein, 1982). Not all of the induced females gave positive results when treated with CP and Synahorin. Response to hormonal stimulation was noticed when the histologically examined eggs contained comparatively large oil globules around the nucleus which lost its circularity and began to migrate towards the animal pole. Zona radiata, very thin and externally followed by the epithelial follicle. Connective tissue layer was too thin to observe (Fig. 3).

Negative results were obtained when the eggs contained spherical and centrally positioned nucleus. Cytoplasm filled with yolk granules and surrounded by still thick zona radiata (Fig. 4).

References :

Hussein, Kh.A. & Aiass, A.A., 1982. Bull. Inst. Ocea. and Fish. ARE, 8 (1): 69–79.
Kuo, C.M., Shehadeh, Z.H. & Milisen, K.K., 1973a. J. Fish. Biol., 5: 459–470.
Nash, C.E., Kuo, C.M. & McConnel, S.C., 1974. Aquaculture, 3: 15–24.

V-VII2

The Ripeness of Eggs of Induced European Eel (*Anguilla anguilla*), with notes on the changes of oil globules

E.-M. AMIN

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

ABSTRACT. Results of this work were obtained from the comprehensive studies carried out on the European eel (Anguilla anguilla L.) inhabiting the Egyptian delta lakes between 1974 and to day. The used material was collected from lake Edku during the spawning migration in 1988-1989. Females of migrating silver eel were injected by carp pituitary (CP) and HCG. On reaching stage IV of maturation, the ovaries occupied the entire body cavity, oocytes enlarged in size (0.60 mm), nucleus was centrally positioned, nucleoli adherent to the nuclear membrane, and dense deposition of yolk granules.

Fig. 1

Fig. 2

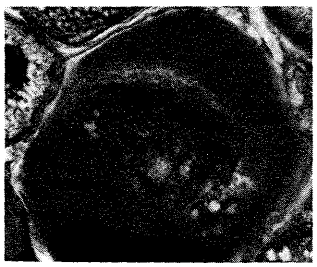


Fig. 3

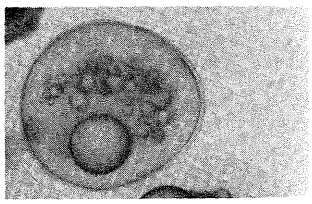


Fig. 4

After completion of trophoplasmic growth (stage IV of maturation), the directly following process of ripening occured in 2-4 days, this period was classified into four distinguished phases. Each phase developed within a period of time from 15 to 24 hours. **First phase**: Egg diameter about 0.69 mm, nucleus started its migration toward the animal pole and began to lose its circularity. Yolk granules appeared in groups and began to diffuse thence homogenize in the periphery of oocyte (Fig. 1). **Second phase**: egg diameter about 0.80 mm, nucleus with disintegrated membrane appeared near the egg cover. Homogeneity of yolk granules increased, small granules appeared in red-orange stained (Fig. 2). **Third phase**: a characteristic increase in number and size of oil globules (more than 10), oocytes were more transparent, karyoplasm in the state of prophase and about full homogeneity of yolk (Fig. 3). **Fourth phase**: Ripening condition, variable numbers of oil globules, mostly less than ten, and counted from four to six in some oocytes. Other oocytes appeared with one prominant oil globule (Fig. 4).

Such artificial maturation brought about by the effect of hypophysial and hormonal injections reveals that CP and HCG could stimulate the gonadotropin secretion in female silver eel to develop its sexual cells in successive developmental stages. This result suggests that the amount of gonadotropin releasing hormone is one of the main factors which regulate the speed of gonadal development.

V-VII3

Effect of induced gonodal development and starvation on blood contents of *Anguilla anguilla* L.

E.-M. AMIN

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

Fishes of migrating silver Eel *Anguilla anguilla* were kept in special tanks under certain environmental conditions. Hormonal induction was carried out for gonadal development, experiments extented to 40-70 days without any food supply. Other fishes were starved for 330 days. Hemoglobin content, hematocrit value, red blood cell count and leukocytes contents were examined. Hematological studies were done to determine the alterations which occured in the blood during induced gonadal development and starvation.

Blood was obtained by transection of the caudal area for all the previous examinations. A drop of blood was used to make the smear and stained with a May-GreenWeld (M-G) giemsa.

In female silver Eel treated with a combination of carp pituitary (CP) and human chorionic gonadotropin (HCG) to ovulation hemoglobin, hematocrit and red blood cells count were sharply decreased in samples taken from injected fishes (ripe stage). In male silver Eel treated with (HCG), hemoglobin and hematocrit continuously decreased with gonadal development from immature (control) to ripe conditions (spermiation), but there was no change in erythrocyte count (Table 1).

Leukocytes counts (white blood cells) did not vary during consecutive gonadal development in both sexes, this virtually reflected that there was no pathological state of the blood.

During starvation, the loss of body weight of males from 150g to 60g and females 700g to 250g was more severe followed by a marked decrease of lipid and protein contents in the whole body (Amin, 1988). Such reductions in body weight, lipid and protein contents were accompanied by significant decrease in all hematological contents of male and more significant in female silver Eels (Table 1).

Table 1 : Hematological changes on fish

	sex	control	ripe fish	starved fish
Hemoglobin concentration (g/100ml)	♂	11.9±0.51* (30)**	9.9±0.92 (20)	6.9 ±0.41 (10)
	♀	10.1±0.91 (30)	4.2±0.19 (6)	2.0±0.21 (4)
Hematocrit (%)	♂	34.1±2.9 (30)	27.1±1.91 (20)	21.9±1.53 (10)
	♀	30.1±2.9 (30)	24.6±2.01 (6)	20.1±1.67 (4)
Red blood cell count erythrocytes (mm^3)x10^6	♂	2.61±0.19 (30)	2.63±0.29 (20)	0.88±0.28 (10)
	♀	2.47±0.15 (30)	0.90±0.12 (6)	0.67±0.25 (4)

* = mean ± standard deviation
** = number of fish

In conclusion, the experimented silver Eels during their gonadal development and complete starvation were anemic. The abnormality in the formation of hemoglobin which depend mainly on the amino acid and iron percentages lead to the formation of cell anemia. Such condition may further expressed by the extremely low values of hemoglobin, hematocrit and loss in red blood cells.

The behaviour of migratory Eels (*Anguilla anguilla* L.) in response to lunar period, winds and rainfall

Kh.-A. HUSSEIN and E.-M. AMIN

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

The Egyptian brackish delta Lakes (Edku, Burollos and Manzalah) constitute important resources for Eels fishery. Fyke nets are the main used gear.

Changes which take place in the morphological characters before spawning migration, behaviour and size of catch with relation to the moon phase, winds and rainfall were studied during the period from October 1985 to September 1986 in Lake Burollos.

Certain morphological changes took place before the onset of seaward spawning migration (October-February). Yellow Eels which were residents of the lake changed into silver sea-going Eels. The head became narrow, snout acute and eye diameter enlarged as shown in the following Table and Fig.1.

A Table showing the morphological measurements of silver and yellow Eels.

Characteristics	Silver Eel (narrow head)	Yellow Eel (wide head)
Head length (% of total length)	10.0	12.6
Head width (% of head length)	25.1	26.9
Snout width	11.9	15.9
Eye diameter	11.7	9.3

Such changes undoubtedly facilitate swimming and vision to evade predators during the very long spawning migration.

The Eels catch extremely increased in periods coincided with the waining of the moon. Rainfall played the same role of increasing the catch of fyke nets distributed in four different areas inside the lake, especially in nights of full moon as shown in Fig. 2 which represented the catch of an area located near the lake-sea opening.

Fig.1 : Migrating silver Eels with narrow heads and pointed snout

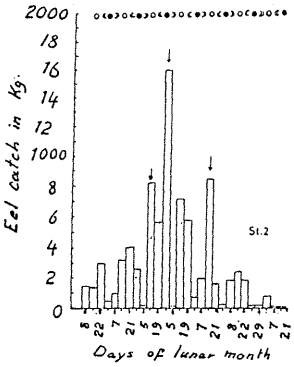


Fig.2 : Eel catch with relation to the moon cycle. Arrows indicate to time of rainfall

Apart from the influence of moon phase on the orientation of Eel and consequently on the size of catch, the influence of wind was significant. Since, during the lake-sea migration, the Northern, North Western, and Western winds were frequently prevailing. Such winds affected water circulation in Lake Burollos, and furthermore affected the locomotor activity of Eels. Locomotor activity in Lake Burollos is directed towards the North-East, where the inflow of sea water to the lake through lake-sea opening.

Knowledge of previously stated influences which affect Eels behaviour, virtually facilitates the determination of suitable time for intensive migration and consequently for the prediction of the size of Eels catch.

V

Etude de quelques modalités de l'absorption de la Glucosamine par l'intestin de l'Anguille (*Anguilla anguilla* Linné 1758)

B. TRITAR*, S. CHABCHOUB-ELLOUZ* et G. PERES**

*Laboratoire de Physiologie Animale, Faculté des Sciences, Campus Universitaire, 1060 Tunis (Tunisie)
**Laboratoire Maritime de Physiologie, Institut Michel Pacha, 83000 Tamaris-sur-Mer (France)

Dans le cadre des études entreprises sur l'absorption digestive chez l'Anguille (TRITAR et coll., 1986, 1988.), il nous a paru opportun d'étudier l'action de quelques facteurs chimiques sur le déroulement de l'absorption de la D- glucosamine afin de préciser les mécanismes mis en jeu.

Les expériences sont effectuées in-vivo à 20° C selon le protocole qui a été décrit par PERES et coll., 1973 et qui consiste en une perfusion continue de l'intestin du poisson. La solution physiologique de la D- glucosamine à 0,5 mM en présence d'un marqueur radio-isotopique (Glucosamine ^{14}C) permet la détermination des quantités de glucosamine absorbées par l'intestin pendant 30 minutes.

Nos expériences portent sur l'étude des facteurs suivants: l'ion sodium et l'ouabaïne.

L'absorption d'une solution de Ringer à différentes concentrations en sodium (9‰, 6‰ , 3‰ et 0‰) contenant de la glucosamine à 0,5 mM est envisagée.

Le manque de sodium est compensé par du potassium, qui ne provoque aucune altération de la fonction absorbante de l'intestin d'aprés les travaux de PONZ et LLUNCH, 1971.

Les résultats sont exprimés en µM de glucosamine disparues du liquide de perfusion par gramme de tissu intestinal frais et rassemblés dans le tableau 1.

Concentration en Nacl	0‰	3‰	6‰	9‰
Quantité de glucosamine absorbée en µM/gramme de tissu intestinal frais	0,367 +-0,026	0,488 +-0,049	0,725 +-0,042	1,071 +-0,046

Tableau 1.

Nous constatons que la quantité de glucosamine absorbée augmente avec l'élévation de la concentration en sodium dans le perfusat.

L'analyse statistique des résultats montre que le déficit en sodium provoque des inhibitions hautement significatives. Ceci nous permet de penser que l'absorption de la glucosamine par l'intestin de l'Anguille présente une composante dépendante de sodium.

L'absence totale de sodium provoque une inhibition de l'absorption de la glucosamine de 65,73%, alors qu'elle n'est que de 46% seulement pour le glucose chez le même animal et dans les mêmes conditions expérimentales (TRITAR et coll. ,1986).

L'absorption d'une solution de Ringer à 9‰ de Nacl contenant de la glucosamine à 0,5 mM est envisagée en présence d'ouabaïne à la concentration 10^{-4} M.

Les résultats obtenus sont groupés dans le tableau 2.

Concentration en ouabaïne	Témoin	ouabaïne 10-4M
Quantité de glucosamine en µM/gramme de tissu intestinal frais	1,071 +- 0,046	0,747 +- 0,068

Tableau 2.

Nous remarquons qu'en présence d'ouabaïne l'absorption de la glucosamine est inhibée de 30,19% par rapport au témoin. Cette inhibition est de 45% pour le glucose chez le même animal et dans les mêmes conditions expérimentales (TRITAR et coll. 1986).

L'analyse statistique des résultats montre que l'inhibition provoquée par l'ouabaïne est hautement significative

L'ouabaïne étant connue comme inhibiteur spécifique de l'ATPase Na^+-K^+ dépendante, il est permis de penser que l'absorption de la glucosamine présenterait une composante sensible au métabolisme énergétique pour maintenir le gradient sodium (KIMMICH et RANDLES, 1972).

REFERENCES:

KIMMICH G.A. et RANDLES J. (1972): J. Membrane Biol., 12, 23-46.

PONZ F. et LLUNCH M. (1971): Rev. Esp. Fisiol, 27, 369-374.

PERES G., RIGAL A. et BOGE G. (1973): Ann. Inst. Michel Pacha, 6, 18-25.

TRITAR B., CHABCHOUB-ELLOUZ S. et PERES G. (1988): Rapp. Comm. Inter. Mer Médit., 31, 2.

TRITAR B., SAID K., BOGE G. et PERES G. (1986): Rapp. Comm. Inter. Mer Médit., 30, 2.

V-VII6

Déplacements des pièces osseuses composant les mâchoires pharyngiennes supérieures de *Serranus scriba* (Poissons, Serranidae) lors de la prise de nourriture. Première analyse

P. VANDEWALLE et M. HAVARD

Université de Liège, Institut de Zoologie, 22, quai Van Beneden, 4020 Liège (Belgique)

SUMMARY - The three osseus components of the upper pharyngeal jaws of Serranus scriba are able to move with some freedom.

INTRODUCTION - Chez les Perciformes, ce sont généralement les mâchoires ou os pharyngiens qui traitent la nourriture et la mène à l'oesophage (LIEM, 1978; LAUDER, 1983). Les deux os pharyngiens inférieurs sont parfois soudés pour ne former qu'une seule mâchoire (LIEM et SANDERSON, 1986) tandis que les os pharyngiens supérieurs en constituent toujours deux. Ces derniers sont chacun composé de pharyngo-branchiaux exceptionnellement soudés entre eux, et recouverts de plaque dentée. Toutes les études considèrent les mouvements des mâchoires pharyngiennes supérieures lors du traitement de la nourriture comme s'il s'agissait de ceux d'une pièce unique (par exemple AERTS et al., 1986; CLAES et DE VREE, 1989) même si ses composants apparaissent assez libres les uns des autres. Chez Serranus scriba, chaque mâchoire pharyngienne supérieure est composée des deuxième et troisième pharyngo-branchiaux couverts de dents et d'une plaque dentée postérieure (BENMOUNA et al., 1984). Les trois éléments sont unis par du tissu conjonctif mais semblent posséder cependant des possibilités de mouvements autonomes. C'est ce que nous voulons mettre en évidence en observant les déplacements d'une mâchoire pharyngienne supérieure pendant différentes prise de nourriture.

MATERIEL ET METHODES - Une marque de plomb a été placée sur les deuxième et troisième pharyngo-branchiaux ainsi que sur la plaque dentée postérieure de trois Serranus scriba. Les déplacements de ces marques lors de la prise de nourriture ont été observés en cinéradiographie (film tourné à 50 images/sec).

RESULTATS - Lors de toutes les scènes de prises de nourritures examinées, les marques de plomb décrivent des déplacements qui peuvent être assimilés à des cycles même si les marques ne reviennent pas exactement à leur point de départ (fig. 1). L'amplitude des cycles de chaque marque varie et au moment où débute un cycle, la distance entre deux marques voisines peut avoir augmenté ou diminué et l'angle qu'elles forment entre elles peut changer (fig. 1).
La variation de distances entre les marques 1 et 2 (fig. 1) ne peut être interprétée que comme un déplacement plus important vers l'avant du 2ème pharyngo-branchial et/ou vers l'arrière du 3ème pharyngo-branchial (fig. 2 B et 2 C). Les muscles élévateurs branchiaux 1 et 2 et rétracteur dorsal peuvent être à la base de ces déplacements.
L'augmentation ou la diminution de la distance entre les marques 2 et 3 ne peuvent être comprises que comme le résultat d'une rotation vers le bas (fig. 2 F) ou vers le haut (fig. 2 E) de la plaque dentée postérieure sur laquelle aucun muscle n'est inséré. La contraction du sphincter de l'oesophage qui entoure la plaque dentée peut abaisser cette dernière tandis que le recul du 3ème pharyngo-branchial peut l'élever. Le changement d'angle entre les trois marques peut être dû au changement de position de la plaque dentée, à l'élévation d'un pharyngo-branchial plus important que celle de l'autre, à une rotation des pièces pharyngiennes autour d'un axe antéro-postérieur ou à une combinaison des causes citées précédemment.

CONCLUSIONS - Les différents constituants de la mâchoire pharyngienne supérieure de Serranus scriba sont animés de mouvements simultanés mais pas identiques, ce qui est certainement à mettre en rapport avec la forme des proies capturées. Certains des résultats des études réalisées ces dernières années devraient donc être revus en tenant compte du degré de liberté des différents constituants des mâchoires pharyngiennes supérieures des Perciformes.

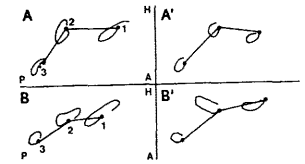


Fig. 1. Les points 1, 2 et 3 symbolisent la position d'avant (A) en arrière (P) des 3 marques de plomb placées dans les trois pièces de la mâchoire pharyngienne supérieure gauche; deux cycles des marques lors de la prise en A et A' d'une crevette sans carapace et en B et B' d'une crevette avec carapace sont représentés. (H : Haut).

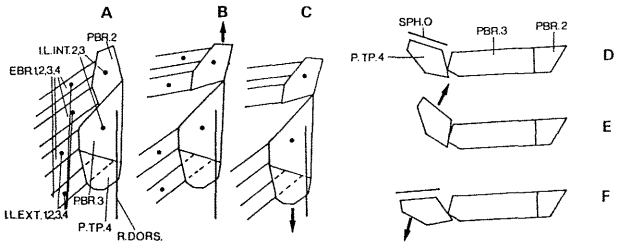


Fig. 2. Schémas qui illustrent les déplacements des composants de la mâchoire pharyngienne supérieure gauche. En A, vue dorsale et en D, vue latérale des pièces concernées; en B et C, et E et F leurs différents déplacements symbolisés par les flèches (EBR 1,2,3,4 : épibranchiaux; I.L.EXT.1,2,3,4 : insertions des muscles élévateurs branchiaux externes; I.L. INT.2,3 : insertions des muscles élévateurs branchiaux internes; PBR.2.3 : 2ème et 3ème pharyngo-branchiaux; P.TP.4 : plaques dentées postérieures; R. DORS. : muscle rétracteur dorsal; SPH.O : muscle du sphincter de l'oesophage).

REFERENCES

AERTS,P., F. DE VREE et VANDEWALLE, P. (1986). Ann. Soc. r. zool. Belg., 116,75-82.
BENMOUNA, H., I. TRABERT, P. VANDEWALLE et CHARDON,M. (1984). Cybium, 8, 71-93.
CLAES, G. et DE VREE, F. (1989). Ann. Mus. Roy. Afr. Centr., Sc. Zool., 257, 69-72.
LAUDER, G.V. (1983). J. Morphol., 178, 1-21.
LIEM, K.F. (1978). J. Morphol., 158,363-360.
LIEM, K.F. et SANDERSON, S.L. (1986). J. Morphol., 187, 143-158.

REMERCIEMENTS

Ce travail a été subsidié par un crédit n° 2.9005.84 du F.N.R.S. Les auteurs remercient le Dr. D. BAY et le personnel de STARESO (Calvi ,France) pour la fourniture des poissons vivants et le Prof. F. DE VREE dans le laboratoire duquel les films radiographiques ont été réalisés. P.V. est chercheur qualifié au FNRS (Belgique).

V-VIII1

An essay on the Coastal Fisheries of North and South Sicily

M. ARCULEO* , G. D'ANNA** and S. RIGGIO***

*Istituto di Zootecnica, Università di Reggio Calabria, Gallina (Italia)
**Istituto di Tecnologia della Pesca e del Pescato, CNR, Mazara del Vallo (Italia)
***Istituto di Zoologia dell'Università di Palermo, Palermo (Italia)

Coastal small scale fishery is a prominent activity in Sicily, now under thorough reconsideration due to its relatively low impact on the marine environment and of its favourable economic potentialities which are even more relevant when compared with the high cost/benefits ratio of trawling. Investigation on artisanal fisheries is moreover a well suited means for the assessment of exploitable biological reosurces. Information on the state of the coastal fisheries is provided by critical examination of as many as **242** fishing samples collected in the course of the past eight years from sites on the N and S coasts of the Island. As many as **206** samples were collected from the following stations: Cefalù, S. Nicola l'Arena, Vergine Maria (Palermo), Bay of Carini, Trappeto, all on the Tyrrhenian coast **(Fig. 1, a-e)**. Fine sands make up the seabeds off Cefalù and Carini; the other stations are mixed seagrounds of calcareous rocks and sand. **Thirtysix** samples were obtained from Sciacca, Porto Empedocle and Licata **(Fig. 1, f-g)** along the southern coast, all on a flat uniform layer of soft muddy sediments..

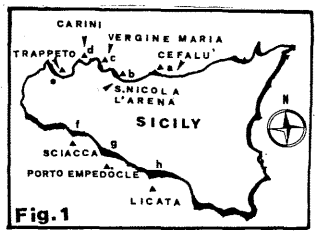


Fig.1

MATERIALS AND METHODS. A trammel net with an inner **40mm** mesh size was employed: Fishing was performed from sunset to sunrise with a mean submergence of **12 hours** at a depth of 18m. Monthly samplings were made. Data of catch were standardized to a **100m** long fishnet for a total duration of survey equal to **12 months.**

RESULTS. A mean yield as high as **376g per 100m** net was recorded. Average yields (in **g/100m** net) in the Tyrrhenian **(386g)** were slightly higher in comparison with the southern coast **(330g)**. Maximum yields were recorded in January (due to the cephalopod catch) and June for the south; in spring- and autumn months for the Tyrrhenian coast. In all samples the **fish** biomass was as much as **64%** of catch composition whereas the **cephalopods** were **33%** and the **crustacea** a mere **3%.** The cephalopod biomass rose however to **42%** in the easternost stations of the Tyrrhenian coast and even more in the South. ***Penaeus kerathurus*** and ***Squilla mantis*** were the only crustacea recorded in appreciable amounts in the Tyrrhenian stations and were related to restricted estuarine areas. The number of species was higher in the rocky stations of the Tyrrhenian and decreased sensibly in the southern coast **(ARCULEO et al., 1989; ARCULEO and RIGGIO, 1989).**
The cuttlefish, ***Sepia officinalis,*** was by far the most common prey. Flatfish such as the **Pleuronectiformes** prevailed in the Bay of Carini; they were replaced by species of the **Rajiformes *(R. miraletus, R. clavata)*** in the southern coast. The most common fish on rocky grounds were the sparidae with ***Diplodus*** spp., ***Pagellus*** spp., ***Lithognathus mormyrus;*** the scorpaenids and the labrids came next. The **Triglidae** were very frequent in the south and increased Eastwards; they were nearly absent from the Tyrrhenian samples. Maximum intersimilarity values were recorded between the rocky stations of Vergine Maria and S. Nicola l'Arena. A similar structure in catch composition appeared between the station in the Bay of Carini and the sites in the south.
DISCUSSION AND CONCLUSIONS. The yields are very low, either in comparison to the average values in the Mediterranean, or to the mean values reported by **Andaloro e Cavallaro (1982)** for the Strait of Messina. The apparent low productivity is very likely consequent to the illegal nearshore trawling as well as to the competitive interactions with the numerous sportfishermen. The lower species richness of the southern stations is merely due to the gently sloping seabeds as well to the environmental uniformity. The greater diversity recorded for the Tyrrhenian grounds is further enhanced by the rocky habitats and by the presence of luxuriant ***Posidonia oceanica*** seagrass beds which are instead missing from off the southern coast. The nature of the bottom accounts for the high similarity of catch composition observed between the Bay of Carini and the fishing grounds in the south. Flatfish such as the Pleuronectids and the Rajids are ecologically equivalent, and their different abundances in the North or in the South should be referred to as biogeographic. As a conclusion, coastal fisheries in Sicily differ sensibily from even nearby sites in relation to the nature of the bottom and to the geographic situation: the W Tyrrhenian coast shows markedly subtropical characters, a greater biotic diversity and a prevalence of highly prized fish; the southern coast is cold, with marked "oceanic" characteristics which are reflected on the fishing yields, the simpler catch composition and the lower prize of species.

REFERENCES

ANDALORO F. e G. CAVALLARO, 1982. Test di resa su rete a tremaglio nell'area dello stretto di Messina. ***Naturalista sicil., S IV, VI (suppl.)***, 2: 421-428.

ARCULEO et al., 1989. Dati sulla pesca e sulle faune ittiche dei fondi costieri da Sciacca a Licata (Sicilia meridionale). ***Ibid. , XIII:*** 1-2: 61-73.

ARCULEO M. e S. RIGGIO, 1989 . Artisanal fishery in an area of Palermo Bay subjected to heavy environmental disturbance. ***Quad. IRPEM, CNR.,*** 5 (1) : 61-75.

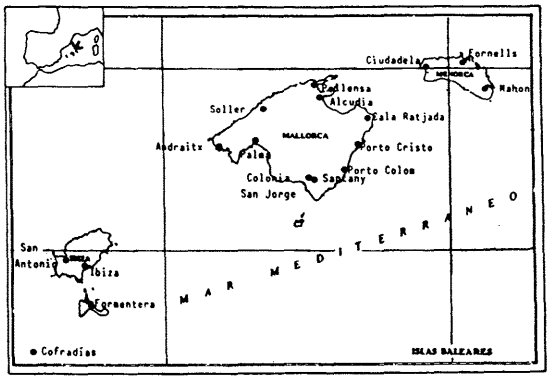
La Pêche Artisanale dans la Région Baléare

Magdalena IGLESIAS et José M. MARTORELL

Instituto Espanol de Oceanografia, Centro Oceanografico de Baleares, Palma de Mallorca (Espana)

La présente étude fait partie du programme "La pesquería litoral de las Islas Baleares", subventionné par la Direction Générale XIV de la Communauté Economique Européenne.

La pêche littorale dans les Iles Baléares est considérée comme une importante alternative aux autres modalités de la pêche traditionnelle, étant donné qu'elle est représentée par presque 90% des bateaux de la flottille, controlés et enregistrés dans cette région à la différence d'autres régions espagnoles.



Le caractère insulaire des Baléares et leur éloignement relatif de la Peninsule Iberique fait que l'étude de leurs pêcheries littorales est très simple du fait de l'inexistence dinterférences avec les flottilles de pêche littorale d'autres communautés ou régions. Les secteurs d'activité de cette flottille sont, en général, inaccesibles aux autres types de pêche.

Voici les facteurs qui définissent la pêcherie:

* embarcations type "llaud" avec une longueur qui ne dépasse pas les 11 mètres.
* tonnage (TJB) inférieur à 10 tonneaux de jauge brute.
* puissance maximum 100 CV, la moyenne se situant autour de 20-40 CV.
* l'effectif embarqué par bateau varie de 1 à 2 hommes.
* multiplicité d'engins de pêche et d'espèces capturées, avec une rotation au long de l'année.
* les secteurs de pêche traditionels se trouvent sur des fonds dont la profondeur n'est pas supérieure à 200 mètres.
* marées d'un jour.
* entreprise à caractère familiale: le patron est aussi l'armateur et le reste de l'équipage est, en général, de la même famille. Toujours originaires du même port et souvent avec une ocupation alternative à terre.
* on ne se déplace pas entre îles, mais seulement entre les ports d'une même île.
* la vente de la capture est souvent réalisée sur le lieu de débarquement.

Flottille littorale aux Iles Baléares (1988)

	MALLORCA	MENORCA	IBIZA-FORMENTERA	TOTAL
Nº BATEAUX	383	119	168	670
TONNAGE TOTAL (TJB)	1.398	349	360	2.107
PUISSANCE TOTALE(CV)	15.282	4.728	3.551	23.561
LONGUEUR MOYENNE (m)	7	6,4	5,8	6,4
EQUIPAGE MOYEN	1,7	2	1,5	1,7

On a réalisé un suivi et un contrôle des captures débarquées par cette flottille dans la Lonja de Palma (Mallorca), qui atteignent environ les 300-350 tonnes par an. Ce chiffre serait certainement très supérieur si on pouvait y ajouter les captures débarquées par la flottille et qui sont vendues directement aux restaurants, et sur lesquelles il n'y a aucun contrôle.

Le facteur touristique, si important dans les îles, et le caractère de luxe du poisson font que sa valeur marchande est toujours plus élevée.

Dans l'activité de pêche littorale il faut remarquer pour son importance aux Baléares, la pêche du "jonquillo" (Aphia minuta), péché uniquement à Majorque, ainsi que les pêcheries de langouste rouge et rose (Palinurus elephas et P. mauritanicus), la première de grande tradition dans tout l'archipel et l'autre d'introduction plus récente; la pêche de "llampuga" (Coryphaena hippurus) à l'île de Majorque; la pêche de "gerret" ou "caramel" (Spicara spp.) à Eivisse et la pêche de la seiche (Sepia officinalis), qui sont toutes très importantes du point de vue économique.

Some Factors Affecting the Fisheries in Lake Mariut (South of Alexandria)

W.-F. WADIE and G.-H. THOMAS

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

In developing counteries, different animal protein sources cannot be able to sustain the additional protein requirements. So, it is necessary to develop fishery resources either by exploiting less conventional fish species or maintaining satisfactory rate of fish production through fisheries improvement.

During the last twenty years and due to the continuous decrease in marine catch, lake fisheries represent about 60% of the total in Egypt.

The present work aimed to discuss several factors that affect fish production in lake Mariut as it plays an important role to the Egyptian fisheries. Lake Mariut is one of the four Delta lakes occupying a portion of the Mediterranean foreshore plain in a depression ranging between -4.0 & -3.4 meters below sea level with mean depth of about one meter. It has no connection with the sea and can be considered as an almost closed basin. To keep the lake water level lower than that of the adjacent cultivated lands, powerful pumps were established to pump water from the lake up into the sea.

During the period 1965-1986, the catch in lake Mariut decreased from 7261 tons in 1965 to its minimal value in 1968 (1289 ton), then gradually increased to 10668 tons in 1973 reaching maximum production of about 17500 tons in 1975. The catch is dropped to 5800 tons in 1986. Our study revealed that continuous decrease in lake Mariut fisheries during the last years is caused by various factors.

- As the other Delta lakes, lake Mariut has been subjected to noticeable shrinkage in its total area due to land reclamation programme, the area is reduced from 25000 acres in 1965 to 14000 acres in 1984. The reduced area is greatly connected with reduction in the length of shoreline, reduction in the total volume of water leading to overfishing, competition for food and space between different fish species and also competition between different units of gears.

- The lake has no direct connection with the Mediterranean, so its water level depends on the volume of water discharged into it from the adjacent cultivated lands and water pumped into the sea. Lowering the lake water level reduces the catch by diminishing the area, the water volume and by decreasing the effeciency of fishing gears used. The lake water level has an effective relationship with the net as an active fishing gear than with the passive as traps.

- Catch per unit effort is an index of abundance and level of exploitation of fishing resources. In closed water system there is an inverse relationship between fishing effort and fish catch per unit effort. However in lakeMariut during the period 1965-1972, it was observed that the small number of trips is accompanied by low catch per unit effort while the second period 1973-1982 is characterized by big number of trips and high catch per unit effort. Variation in catch per unit effort is caused by the change in fish stock induced by different environmental conditions taking place in the lake. In the period 1983-1986, fishing effort is slightly reduced, but catch per unit effort is decreased to half, its value during the period 1973-1982. The unfavorable environmental conditions caused by reduction of the area, water level of the lake, pollution as well as overfishing activity took place in the second period (1973-1982) directly affect the fish stock during the third period (1983-1986).

- Fishing gears used in Lake Mariut are classified into two groups, the first is the legal mehthods including trammel; cast; gill nets and traps. The second group is the illegal ones represented by surrounding nets, small enclosures and dams.1984 illegal gears contributed about 63% of the total catch compared with 37% by legal. Englosures and nets with small mesh catch small and big fish. Big catch and the rapid increase of fish prices promote the use of illegal methods.

Also the increase in the number of fisherman and fishing boats leads to overfishing.

- Pollution is caused by large amounts of sewage and industrial waters discharged to the lake through some drains. Organic pollutants adversely affect fish and other aquatic life through oxygen depletion. Other studies revealed that lake Mariut is suffered such pollution as manifested by acute oxygen deficiency, high ammonia and hydrogen sulphide content resulting from the decomposition of organic effluents from municipal sewage and many industries, particularly wood fiber sludge from pulp mills.

V-VIII4

Fluctuations of Fisheries from the South-Eastern Mediterranean Sea

W.-F. WADIE and G.-H. THOMAS

National Institute of Oceanography and Fisheries, Alexandria (Egypt)

Since 1962, the Mediterranean fisheries are one of the most important sources of fish production in Egypt contributing about 40% of the total . However, twenty years ago the catch curve showed a continuous decline from 38000 tons in 1962 to 12000 in 1967, then fluctuated around an annual average of 8000 tons in the period from 1968 - 1977 followed by an increase to annual average of 14000 tons during the period 1978-1985.

The present work aimed to study different factors responsible for such fluctuations in catch of sardine, shrimp and other species as well as number of fishing trips of both motorised and non-motorised boats.

Catch from the south-eastern Mediterranean during the period 1962-1985 is closely affected by catch of sardine and shrimp and these two species are greatly affected by the environmental changes took place aftr damming of the River Nile in 1966, The trend of variation obtained for the total catch of fish landing centres along the Egyptian Mediterranean coast agree with the trend of such fluctuations in the intervals 1962-1972 & 1973-1985 for sardine and shrimp as well as total catch without them.

Before 1965 sardine catch represented about 40% of the total Mediterranean catch, but now it contributes about 8%. Although its catch shows sharp drop, it still plays the first role.There is a positive relationship between monthly Nile water outflow and sardine catch, the correlation coefficient r values were 0.547 after one month and 0.895 after two months and after three months r became insignificant.

Damming in 1966 resulted in sharp deterioration of nutritive base of pelagic fish especially sardine. The catch curve of sardine production could be divided into three periods, the fist before damming (1962-1966) with maximum annual average of 9500 tons, the second after complete damming (1967-1976) with annual average of 830 tons, the third period (1977-1985) is characterized by increase to annual average of 3800 tons which could be attributed to general decline in fish catch from the Mediterranean and introduction of purse seine nets in early seventies..Our study revealed a close relation between sardie catch and number of fishing trips due to the presence of sardine in large shoals in first period, so it is significantly correlated with non-motorized boats especially sardine gill net. In the third period, the relation becomes more significant because the catch of sardine is mainly caught by motorized boats especially purse seine net boats in which they are increased from 17 x 10^3 trips to 23 x 10^3 in first and third periods respectively.

The trend of shrimp catch variation during two periods 1962-1972 and 1973-1985 shows an observed decrease in its catch during the first that could be considered as an important factor responsible for the observed decrease in the total Mediterranean catch. In the second period, the trend shows slight increase explained by increasing role of motorized fishing boats especially trawlers during the last ten years.

The drastic changes took place after damming and pollutants discharged under the recent hydrological conditions exerted marked influence on shallow water characteritics and habitat of different aquatic organisms.

Recently, certain processes have been developed to compensate the decrease in fresh water, such as the role of convection intermixing has increased and the inflow of diluted waters into the sea from coastal lakes has grown and introduction of purse seine nets. By comparing the trend of catch of some fish species, we could conclude that the rate of increase in sardine and shrimp not at any level compensates the rate of decrease in catch of the most important dominant species which reduced, diminished or disappeared from the Egyptian Mediterranean waters. So, the observed decrease in total catch in due to the reduction in catch of sardine, shrimp and other species, while the observed slight increase in the total in due to the increase in sardine and shrimp landings.

There is strong relationship between catch of different species and number of fishing trips exerted by motorized boats recently, this is explained by increased number of purse seine boats and modern motorization of non-motorized ones. However, the sharp increase in number of fishing trips is not followed by significant increase in the catch.

V-VIII5

La Pêche Artisanale dans la Mer d'Alboran : contribution à l'étude de la taille des Poissons capturés par différents engins

J. BARO , J.-C. NUNEZ , F. RAMOS et J.-A. CAMINAS

Instituto Espanol de Oceanografia, Centro Oceanografico de Fuengirola, Apartado 285, 29640-Fuengirola, Malaga (Espana)

Suite à l'étude intitulée "Las Pesquerías locales de la Región Surmediterránea Española", initiée en 1987 en coopération entre l'IEO et la D.G. XIV de la CEE, on a recueilli des données de fréquence des tailles des principales espèces de poissons au cours de l'année 1989. Actuellement ce type d'échantillonage se poursuit.

Parmi les espèces cibles pour chaque engin (CAMIÑAS et al., 1988) on a selectioné celles qui sont indiquées sur le tableau. Elles représentent 45% de la capture totale de poissons estimée pour la période de mars à août 1989 (CAMIÑAS et al., 1989).

Les engins qui capturent ces espèces sont: filets maillants fixe à une nappe et fixe à trois nappes, filets dérivants, palangres et lignes.

Les échantillonages des tailles ont été realisés sur les lieux de débarquement et en mer, en utilisant un ichthyomètre et en mesurant au demi-centimètre prés. Pour l'analyse des données par espèce et type d'engin on a utilisé les mesures suivants: a) Taille minimale(Min) et taille maximale (Max) capturées par chaque type d'engin, b) rang de taille le plus courant (Rang), reconnaisant comme tel celui qui est compris entre 25 et 75% des fréquences cumulées de la distribution des tailles, c) fluctuation modale au long de la période d'échantillonage (Mode), et d) nombre d'individus échantillonées (n).

FILETS A MAILLANTS

	FIXES A TROIS NAPPES					FIXES A UNE NAPPE				
	Min	Max	Rang	Mode	n	Min	Max	Rang	Mode	n
Pagellus acarne	9	30	15-25	16-24	1045	15	29	20-26	22-25	2079
Pagellus erythrinus	14	44	18-27	19-26	217	18	42	21-28	21-28	499
Pagrus pagrus	15	60	20-27	21-22	205	19	48	19-21	20	17
Phycis phycis	15	61	33-41	34-37	135					
Mullus barbatus	11	22	14-18	15-17	288	11	32	14-29	15-29	254
Mullus surmuletus	8	42	14-35	15-31	928	14	34	15-30	17-30	255
Trachurus muediterraneus	-					24	41	28-39	29-39	163
Trachurus trachurus						18	39	24-34	25-33	733

FILETS DERIVANTS

	Min	Max	Rang	Mode	n
Cheilopogon heterurus	32	42	36-38	37	146

HAMEÇONS

	PALANGRE					LIGNE				
	Min	Max	Rang	Mode	n	Min	Max	Rang	Mode	n
Pagellus acarne	15	30	20-27	21-26	556					
Pagellus bogaraveo	17	29	21-25	22-23	210					
Pagrus pagrus	20	62	22-37	24-35	198					
Phycis phycis	15	65	34-55	36-54	337					
Thunnus thynnus						118	235	136-155	*	338

Dans le cadre de la pêche artisanale l'utilisation d'engins pour capturer une espèce donnée (espèce cible) est fréquente. Cependant tous les engins n'ont pas la même incidence sur la fraction exploitable de la population. Par conséquent l'analyse des rangs des tailles les plus fréquents qui sont apparus dans chaque combinaison espèce-engin, représente l'aspect le plus important de notre étude.

Aprés observation des données présentées dans le tableau on peut déduire que les filets maillants fixes à une nappe capturent une fraction de la population avec une amplitude du rang de tailles plus stricte (cas de Pagellus acarne, P. erythrinus et Pagrus pagrus) que celle des filets maillants fixes à trois nappes. Dans le cas des Mullidés ce rapport est inversé, cela est peut-être dû au fait que les filets maillants fixes à trois nappes sont plus sélectifs pour ces espèces (Mullus barbatus et M. surmuletus) que les precedents avec lesquels on obtient une dispersion des valeurs modales plus importante.

Le Trachurus mediterraneus comme le T. trachurus sont capturés presque exclusivement avec des filets maillants fixes à une nappe. La taille minimale de T. trachurus est inférieure à celle de T. mediterraneus et la taille maximale capturée de T. mediterraneus est supérieure à celle de T. trachurus.

En conclusion, les filets maillants fixes à trois nappes exploitent une fraction de la population composée de tailles inférieures à celles de la fraction qui est exploitée par les filets fixes à une nappe.

D'autre part la limite supérieure du rang de tailles capturées est généralement plus important dans les cas des palangres que dans celui des filets à maillants. Cela n'est pas valable pour toutes les espèces si on compare les deux types de filets maillants considérés. De plus les tailles minimales capturées par la palangre de fond sont englobées dans le rang de tailles que capturent les filets maillants.

Avec des filets dérivants la seule espèce sélectionnée, le Cheilopogon heterurus, est capturée par une pêcherie saisonnière, qui exploite un rang de tailles trés étroit de la population reproductrice de cette espèce migratoire.

Parmi les engins à hameçon on a la ligne qui capture une large gamme de tailles de l'espèce Thunnus thynnus. Pour cette espèce on n'observe pas une mode net (signalée sur le tableau avec *).

BIBLIOGRAPHIE

CAMIÑAS, J.A.; J. BARO; J.A. REINA, 1988.- Espèces cibles dans les petits mètiers de la mer d'Alboran. Rapp. Comm. int. Mer Médit., 31, 2 (1988).

CAMIÑAS, J.A.; J.C. NUÑEZ; F. RAMOS; J. BARO, 1989.- Las Pesquerías Locales de la Región Surmediterránea Española. (Segundo año). Proyecto Cooperativo IEO/CEE XIV-B-1-88/IX/2871.

Concentrations de *Capros aper* dans la Mer d'Alboran (Méditerranée Espagnole)

R. ABAD et A. GIRALDEZ

I.E.O. Centro Costero de Fuengirola, Apdo 285, Fuengirola, Malaga (Espana)

Les campagnes d'evaluation acoustique Ecomed-87 et Ecomed-88 furent realisées pendant les mois de juillet et juin de 1987 et 88 respectivement; on a evalué les especes pélagiques presentes sur le plateau de la Méditerranée espagnole, entre les 20 et 200 m de profondeur.

Au cours des deux campagnes on a obtenu des résultats trés similaires pour les zones de concentration maximum de Capros aper; ces hautes densités ont été trouvées dans la partie la plus occidentale de la Mer d'Alboran, au niveau de deux zones: la prémiere (zone 1), est située entre le Détroit de Gibraltar et Málaga et la deuxiéme (zone 2), autour de Motril (fig. 1).

La biomasse pour cette espéce a été estimée à 48131 et à 40721 Tm respectivement, dans ces deux zones elle représente le 28 et 38% du total evalué dans la Mer d'Alborán espagnole.

Dans les autres aires prospectées il n'a pas ete detecté de concentrations appréciables.

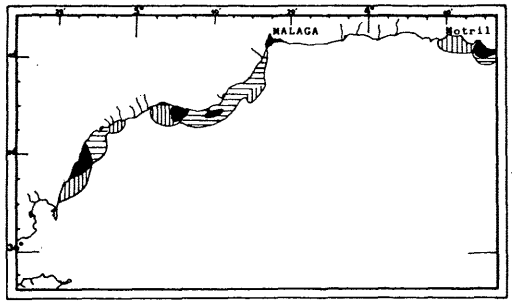
Les tailles des C. aper étaient comprises entre les 5 et 10 cm, avec un mode à 6 cm.

Les rendements obtenus pendant les opérations de pêche réalisées avec engin pelagique furent.

Année	ZONE 1		ZONE 2	
1987	Rendement	Profondeur	Rendement	Profondeur
	2140 Kg/16 min	100 m	35 Kg/46 min	70 m
	1748 Kg/15 min	70 m	122 Kg/15 min	150 m
	122 Kg/15 min	170 m		
1988				
	1370 Kg/40 min	100 m	432 Kg/36 min	70 m

Ces résultats concordent avec ceux obtenus pendant la campagne d'évaluation acoustique réalisée en mai 1982, durant laquelle la concentration de C. aper trouvée dans la zone 1, était de 19.003 Tm (Oliver et al, 1982).

Les abondances detectées pendant les mois de juin et juillet sont confirmées par les résultats de la campagne de chalutage "Málaga 775" (juillet 1975). Pendant cette campagne les fonds entre 300 et 800 m profondeur ont été explorés; les plus hautes densités ont été trouvées dans la zone 1, avec une capture maximum à 300 m, l'espéce en étant présente dans les pêches jusqu'à 420 m (Crespo et al., 1976).
Par contre, pendant les campagnes acoustiques realisées en septembre 1983 et octobre 1984 et 85 cette espéce ne se trouvait pas en quantités significatives; seuls quelques exemplaires ayant été capturés dans les pêches (Alvarez et al., 1990). Pendant ces mois on a detécté sa presénce à de fortes concentrations au cours de la campagne de chalutage realisée dans la Méditerranée marocaine au mois de septembre 1985. Les résultats donnent une grande abondance dans les zones proches du détroit de Gibraltar, 0 et 100 m, avec un rendement par peche de 4020 kg/h (Lazar et al., 1985).



Aires d abondance maximale de C. aper

Campagne 1987

Campagne 1988

Toutes les deux campagnes

BIBLIOGRAPHIE

Alvarez, F. et al., 1990. Resultados de las campañas de evaluación acústica Mediterráneo 83, 84, 85. Inf. Téc. I.E.O. (En prensa).

Crespo, J., J. C. Rey y J. A. Camiñas, 1976. Trachyrhynchus trachyrhynchus (Risso, 1810) del Mar Alborán (Región Surmediterranée). Bol. I.E.O. n 218. Madrid.

Lazar, N., K. Benbouchaib, M. M. Zouiri et A. Idelhaj, 1985. Resultat de la campagne exploratoire du plateau continental de la Méditerranée marocaine. F.A.O. Rapport sur les pêches n 277.

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). F.A.O. Fish Rep. n 277.

Biology and fishing of *Aphia minuta* (Risso, 1810) in the S.E. of Iberian Peninsula

P. MARTINEZ BANO*, F. VIZUETE*, J. MAS** and F. FARACO*

*Consejeria de Agricultura, Ganaderia y Pesca de la Region de Murcia, Servicio de Pesca y Acuicultura, Cartagena, Murcia (Espana)

**Instituto Espanol de Oceanografia, San Pedro del Pinatar, Murcia (Espana)

Among the small-scale fisheries on the coast of the Region of Murcia, we must point out the one aimed to catch transparent goby - - Aphia minuta (Risso, 1810). This small goby usually comes up together - with other species, such as Pseudaphia ferreri (O. de Buen & Fage, 1908) Crystallogobius linearis (von Duber, 1845) and young individuals of - - Atherina sp and Pagellus sp. In waters of the Spanish South-east both - Aphia minuta and Pseudaphia and Crystallogobius form shoals which are - detected by the echo-sounder of the fishing boats in very definite areas: the capture fluctuates between 6-30 mts in depth,in clear waters among - prairie of Posidonia oceanica, sheltered places and also in particular - bays usually those of soft substratum.

The study includes the months in which the fishery takes place (December, January and - - February) corresponding to two fishing periods: - - 1988-89 and 1898-90. Weekly biologic samplings have/ been carried out on the whole of the capture, noting down the following parameters:

- Total length (LT). From the beginning of the head to the end of the caudal fin, with the accuracy of 1 mm.

- Wet weight (P). Accuracy of 0,001 gr.

In the same way we made the sex differentation and gonad - development with the help of a magnifying glass based on external morpho logical characters and the presence of eggs in female gonads.

The obtained results for the period 1988-89, show that the evolution of the average total length and weights fluctuate between the/ ranks of 28-33 mm. and 0,114-0,193 gr. respectively, noticing that these parameters keep practically steady during December and January, arising/ a strong increase in both of them from February, in which they start the prelaying period.

In relation to the gonad development, an increase of egged-females is noticed, at the end of January, when it reaches a maximum - - (57%) to low down until the first half of February (37%). A strong increa se arises later, reaching 73% of the whole egged-females. Between 7-11%/ of these are about to spawn.

During 1989-90, both the size and the weight experimented/ a gradual increase from the beginning of the fishery (December) to half/ of January, to low down suddenly. The founded values are: in December - 40,4%, in January 49,8% and in February 42,4%. We can notice that the - maximum correspond to January in contrast to the previous period when - February was the month with a higher percentage of egged-females and - - females near to egglaying. This last fact has not been noticed in the - last period.

REFERENCES.

CAMIÑAS, J.A.; BARO, J.; REINA, J.A., 1987. Pesquerías artesanales del - Mar de Alboran. Informe final del proyecto Estudio de las pesquerías artesanales de la región surmediterránea española comprendida entre Punta - Europa y Cabo de Gata. (Primer año). Proyecto cooperativo IEO/CEE XIV-B-I-86/XII/3857.

DE BUEN, F., 1931. Notas a la familia Gobiidae. Observaciones sobre algunos géneros y sinopsis de las especies Ibéricas. Not. Resm. Ins. Esp. - - Oceanograf.; Serie II (54, 76 pp.).

IGLESIAS, M. Y MARTORELL, J.M., 1987. La pesquería litoral de las Islas - Baleares. Proyecto cooperativo IEO/CAIB/CEE XIV-B-1/87/8/2840.

Informe de la mesa de trabajo sobre la problemática de la explotación pes quera de góbidos y afines en el litoral mediterráneo español. Palma de - Mallorca, 7-8 de junio de 1.988. No publicado.

LOZANO y REY, L., 1960. Peces Fisoclistos, 3ª parte. Subserie Torácicos/ (Ordenes Esqueneiformes y Gobiformes), Pediculados y Asimétricos. M. R. - Acad. Cienc. Exact. Fis. Nat. Madrid; Ser.:Cienc. Nat.; 14: 613 p.

TORTONESE, E., 1965. Fauna d'Italia. Ostheichthyes. Pesci ossei. Edizioni Calderini. Bologna, XI: 290-340.

V-VIII8

The Transparent Goby Fishery in the Northern Tyrrhenian Sea

F. SERENA, R. AUTERI, A. ABELLA and R. BAINO

Consorzio Regionale di Idrobiologia e Pesca, Livorno (Italia)

RESUME.

Ce travail aborde l'exploitation des stocks du "rossetto" Aphia minuta dans le Thyrrenien septentrional. La pêche au rossetto est effectuée seulement de jour avec un type particulier de senne très selectif. La presence de espèces accessoires est toujours négligeable.

On decrit les characteristiques de la flotille et modalité de pêche. Donées concernant statistiques de pêche et sur la reproduction et recrutement de l'espèce sont adjointes.

The fishery of the transparent goby Aphia minuta takes place in the Northern Thyrrenian Sea from October to April with a maximum effort between December and February. This fishery was studied by analysing the activity of the 30 vessels which operates in the coastal waters off Livorno and the northern portion of the Grosseto provinces throughout the fishing seasons 1988-89 and 1989-90. These vessels have been considered as representative of the whole tuscanian Aphia fishery.

Fig.1 shows the main fishing grounds in the considered area. The fishing vessels are quite small (from 20 to 100 HP and 5-10 GRT) and furnished of acoustic equipment for the localization of schools and mechanized devices for the recovery of the net.

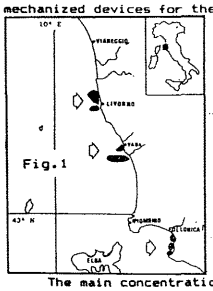


Fig.1

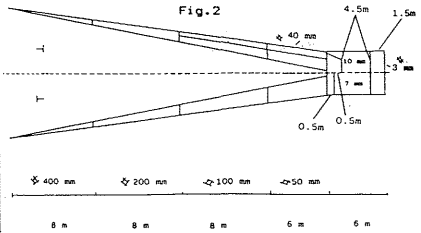


Fig.2

The main concentrations of Aphia are located at depths between 5 and 40m on muddy-sandy bottoms close to the mouth of the rivers or at the edge of the Posidonia beds. The fishing operations take place only during the light hours because at night, the fish schools are not vulnerable, being disposed in scattered layers.

The annual total landings of the goby were estimated from data supplied by the Livorno fishermen's cooperative society: during the last 10 years the number of fishing boats remained constant and the catch was very fluctuating (range from 4.7 to 22.4 tons/year, with a maximum in the seasons 1981-82 and 1982-83). Considering the species very short lifespan, those important fluctuations in catch can be related with different amounts of the annual recruitment.

The only gear utilized by the Aphia fishery in the area is a special seine net called "sciabichella" (fig.2). It has 30 m long wings composed by several pieces of different mesh sizes which diminish from the extremes of the wing in direction to the "tulle" codend (3mm stretched mesh size).

As soon as the school has been localized with the echosounder, the extreme of one wing is fixed to a buoy and the net is set with its mouth opening in the direction of the current. The seine retains the fish that swims actively against the current. Because of the very particular characteristics and use of the net and of the very easily recognizable fish schools normally located very close to the bottom, this fishery is highly selective and the catch is practically monospecific. Occasionaly, have been found in the catch some isolated individuals of Coris julis, Serranus cabrilla, Engraulis encrasicholus, Diplodus annularis, Mullus surmuletus, Gobius sp., Labrus sp., Palaemon serratus, Pisa spp., Amphipods, Alloteuthis media, Spatangus sp., as well as of marine vegetation: Posidonia oceanica, Cymodocea nodosa, Acrothamnion preissii, Udotea petiolata, Caulerpa prolifera. In no case the presences are of some quantitative significance.

At the beginning of the fishing season, the Aphia catch is composed exclusively by females because of the smaller size of males which will recruit to the fishery only in January. In the Thyrrenian Sea, according with the results of the biological samples, spawning apparently begins earlier than in the Adriatic Sea. In fact, a conspicuous number of mature females were found in April-May instead of in June-July as are normally found in the Adriatic Sea.

For Aphia minuta the Pauly's nomogram has been utilized to estimate the length at first capture. It expresses the selection factor (SF) as a function of the fish depth ratio (standard length/maximum body depth) or the girth factor (maximum girth/total length) and of the mesh size of the codend (fig.3)

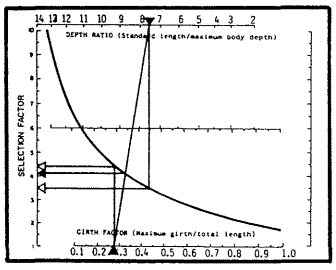


Fig.3

By means of this method, a SF value between 3.5 and 4.4 was calculated for the species. For a mesh size of 3mm these values correspond to a Lc = 10.5 and 13.2 respectively. The selection curve derived from the length-converted catch curve gave a bigger Lc (25.3mm). This discrepancy suggests that the absence in the catch of more important quantitatives of fish smaller than 25mm is not due to mesh selection but related with the species life history. In fact, the individuals of Aphia minuta of lengths up to 25mm are mainly pelagic and not vulnerable with this fishing technique. In this way, a conspicuous proportion of the individuals of lengths from 10 to 25mm that should be potentially retained by the net are not caught because they are not really recruited to the fishery.

V-VIII9

Brief Note on Catch and Biology of Blue Withing *Micromesistius poutassou*, Risso (Pisces, Gadidae) in the Northern Tyrrhenian Sea

B. REALE and P. RIGHINI

C.R.I.P., Livorno (Italia)

Introduction

The blue whiting is a demersal fish commonly found along the slope of the continental shelf. In the local market, it has not relevant commercial value because of its not very appreciated taste. The species is normally caught as a by-catch in the hake fishery. Generally, the blue whiting is rejected but sometimes, if the amount of the catch of the other species is scarce, it is possible that small quantitatives are kept and landed.

Material and methods

The data arise from surveys that took place in the Northern Tyrrhenian Sea in September and December 1987, February and June 1988. These surveys were part of a wider 3 years Marine Marchant Ministery Research Program (Demersal Resources Stock Assessment).

The fishing vessel utilized was a traditional trawler operating off Livorno whose main characteristics are 81 GRT and 420 HP, with a bottom trawl net with a 40 mm stretched mesh size at the codend, and about 10 m horizontal opening. The tows were performed with a speed of 3 knots for a regular time of one hour.

The surveyed area has been selected previously because the presence in the ground of very important commercial species: red mullet, hake, Norwegian lobster, was known. These species usually represent the target of the survey, but conspicuous quantitatives of blue whiting have been caught, specially in the subareas called: Corsica, Capraia, Pollice and Elba (Fig. 1)

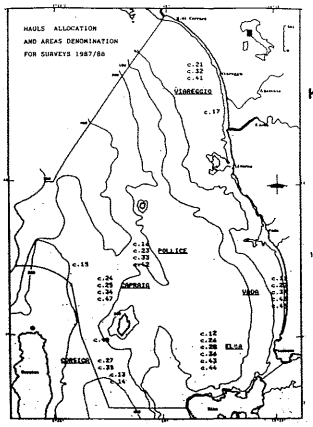


Fig. 1

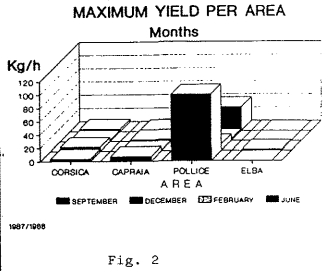


Fig. 2

In fig. 2 are reported the yields by fishing area in kg/hour. The area with the highest catch is locally called "Pollice" but this is only regarding Summer (June and September). During the whole survey there were caught 11317 individuals for a total weight of 350 kg. A sample of 1200 individuals was selected for biological measurements (total length, sex and sexual maturity).

Results

The species is caught in a depth range from 150 to 430 m and the best yields within the 250-400 depth interval.

The smallest individuals (juveniles) of TL = 8 cm have been caught in June at a depth of 270 m. This is in agreement with the findings of Froglia and Gramitto, 1981 and Lucena et Crespo, 1981. Probably, these juveniles were born during the spawning period in winter in January and February (Lucena et Crespo, 1981). During the other sampling periods, the minimum length caught was of 13 cm in September, 15.5 in December and 17.5 in February. The biggest length found was of 36 cm for a female caught at a depth of 420 m in December.

In February there were observed mature individuals. The minimum length found for mature males was 21 cm and 21.5 cm for the females. These observations are in agreement with those reported by Froglia and Gramitto, 1981.

The totality of the mature individuals were caught at depths from 250 to 400 m particularly in the area called "Pollice".

Considering 21 cm as a first maturity length, being the individuals bigger than 21 cm only the 14 % of the total, in consequence, the 86 % of the blue whiting catch during the survey was constituted by juveniles which have not reached the first maturity length.

Other than the blue whiting, during the surveys, there were caught several other species. The most important species in the catch ordered by importance in number were Gadiculus argenteus, Merluccius merluccius, Chlorophtalmus agassizzi, Capros aper, Argentina sphyraena, Scyliorhinus canicula, Trisopterus minutus capelanus and Sepietta oweniana.

Bibliography

FROGLIA C. and GRAMITTO M.E. (1981) -Observations on growth of Micromesistius poutassou (Risso)(Pisces, Gadidae) in the Central Adriatic Sea. Rapp. Comm. int. Mer Medit. 27,5.

FROGLIA C. and GRAMITTO M.E. (1981) - Summary of biological parameters on Micromesitius poutassou (Risso) in the Adriatic. F.A.O. - Fisheries Report n. 253.

LUCENA J. et CRESPO J. (1981) - Quelques donnees sur la biologie du Merlan Blue "Micromesistius poutassou" de la Mediterranee Occidental. Rapp. Comm. int. Mer Medit. 25,5.

V

La Pêcherie de Pélamide (*Sarda sarda*) du Littoral Catalan (Catalogne, Espagne)

Laura RECASENS

Institut de Ciències del Mar, Passeig Nacional, s/n, 08039 Barcelona (Espana)

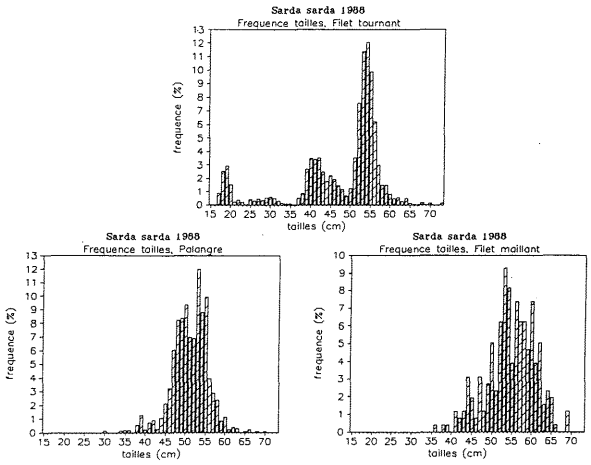
La présente étude fait partie du programme "La pesca en Cataluña" subventionné par la Direction Générale XIV de la Communauté Economique Européene.

La Pélamide, Sarda sarda (Bloch, 1793) est l'espèce de poisson pélagique de taille moyenne la plus capturée en Catalogne. En 1988 la production le long du littoral catalan s'est élevée à 377 tonnes, les poissons de grande taille étant ceux ayant la plus grande valeur marchande. Cependant, l'intérêt de cette espèce n'est pas dû à l'abondance des captures mais au fait qu'elle est pêchée avec trois engins très différents: l'"art clar", qui est une espèce de filet tournant avec une maille plus grande que celle qui s'utilise pour les petits pélagiques, la sardine (Sardina pilchardus) et l'anchois (Engraulis encrasicolus); la palangre, qui pour cette espèce est de surface, comme celle que l'on utilise pour l'Espadon (Xiphias gladius) mais avec des hameçons plus petits; et finalment, les "Redes Boniteras", qui sont des filets maillants à une seule nappe, un peu plus grands que les filets maillants utilisés pour d'autres espèces.

Pendant l'année 1988 on a réalisé un échantillonage des fréquences de tailles pour chaque engin, à partir d'exemplaires mesurés en criée. La mesure adoptée est la longueur à la fourche avec une précision au centimètre.

Pour le filet tournant qui représente 59% de la pêcherie, on a fait des échantillonages mensuels avec un total de 1880 poissons mesurés. Pour la palangre (20.9% de la pêcherie), on a pris des mesures pendant la période de pêche (d'août à décembre) avec une périodicité bimensuelle et un total de 873 poissons mesurés. Pour les filets maillants, qui representent 17.1% de la pêcherie, les données ont été recueillies de juin à décembre avec une périodicité mensuelle et un total de 258 poissons mesurés. Le fait que cette espèce n'est pas une espèce cible importante pour le pêcheur, mais un complément quand d'autres espèces diminuent, a créé des difficultés lors de l'échantillonage, surtout pour les filets maillants dont l'utilisation par les pêcheurs aux pétits métiers est très aléatoire et occasionnelle au cours de la période de pêche.

D'après nos résultats, le filet tournant est l'engin qui recueille le plus grand nombre de classes de tailles (de 15 à 73 cm), et, comme c'est l'engin qui réalise les plus fortes captures c'est celui qui représente le mieux les classes des tailles exploitées. La taille moyenne de capture est de 47.25 cm., tandis que la taille la plus capturée est celle de 54 cm. La palangre capture les tailles comprises entre 30 et 70 cm avec une taille moyenne de 51 cm. La taille la plus pêchée est celle de 53 cm.,et le maximum des captures se situe entre 47 et 55 cm. Pour les filets maillants, les tailles capturées vont de 36 à 69 cm., la taille moyenne est de 55 cm., et la taille la plus capturée qui est la même que pour la Palangre, est de 53 cm.



Frequence des tailles selon les differents engins de pêche

Comme on peut le voir sur les graphiques, les tailles capturées par les trois engins sont différentes. On peut dire que le filet tournant est le moins sélectif des trois engins, parcequ'il capture le plus grand nombre de classes de tailles et parce que la taille moyenne de capture présente des valeurs nettement inférieures à celles des autres engins. D'autre part, les filets maillants capturent beaucoup de grands individus de 50 à 62 cm. de longueur.

V

Données préliminaires sur la Pêcherie et le Cycle de Reproduction de *Lepidopus caudatus* en Mer Catalane (N.O. Méditerranée)

Laura RECASENS et Montserrat DEMESTRE

Institut de Ciències del Mar, Passeig Nacional, s/n, 08039 Barcelona (Espana)

Lepidopus caudatus (Euphrase, 1788), nomme "Sabre", est une espèce dont la pêche s'est développée durant les cinq dernières années. Cette espèce se capture toute l'année au chalut et au palangre. Pendant les années 1988 et 1989 on en a capturé à peu près 300 tonnes en Catalogne, contre seulement 180 tonnes en 1987. Les données des captures mensuelles que nous avons (provenant des Associations de Pêcheurs) ne permettent pas de différencier les débarquements du chalut du ceux du palangre.

Jusqu'à présent il n'existe pas d'étude concernant la pêche et la biologie de cette espèce en Méditerranée occidentale. Seule la distribution des oeufs et des larves dans l'Adriatique (Karlovac et Karlovac, 1976) et la mer Catalane (Sabatés, 1988) et celles des adultes dans l'Adriatique ont été abordées. Le présent travail fait partie d'une étude plus vaste subventionnée par la Direction générale XIV de la CEE sur la pêcherie catalane au cours de laquelle on abordera aussi la croissance et l'alimentation de L. caudatus.

On a fait 38 échantillonages biologiques avec une périodicité mensuelle, de mars 1988 à setembre 1989 compris. Un total de 506 poissons a été examiné provenant du chalut et du palangre. Les tailles observées sont comprises entre 68 et 118 cm de longueur total pour les femelles et entre 71 et 176 cm pour les mâles. Entre 26 et 100 cm on n'a pas pu déterminer le sexe de quelques exemplaires.

L'observation macroscopique des gonades a permis de distinguer six stades de maturation sexuelle:

1-Immature
2-Repos
3-En maturation
4-Préponte
5-Ponte
6-Postponte

Le tableau 1 donne le détail de la proportion, au cours de l'année, des differents états de maturation sexuelle. On observe une période de reproduction qui couvre presque toute l'année, d'avril à décembre, mais il y a des individues qui commencent leur maturation dès février. Etant donné l'amplitude de la période de frai, on peut supposer une ponte en série, avec un maximum en mai et un autre en août. En plus, pendant presque toute l'année on trouve des exemplaires immatures. Les larves sont présentes dans le plancton au printemps et en été (Sabatès, 1988) et le recrutement des individus de petite taille se fait principalement entre les mois de février et d'avril.

Tableau 1. Distribution en pourcentage des différents stades sexuels selon les mois.

	MOIS											
E.S.	1	2	3	4	5	6	7	8	9	10	11	12
6	67	21			20	26	33	35	73	29	42	40
5				12	32	27	49	42	23	38	10	3
4			13	22	24	12	14	7	2	3	3	
3		10	26	19	12	27	5	5		9	13	
2	28	18	8	9	4	2			2	12	26	31
1	6	51	53	38	8	6		12		9	6	26
N	18	39	76	67	25	51	43	43	44	34	31	35

E.S. = Stades sexuels, N = Nombre d'exemplaires

Pour étudier la taille à la première maturité, on a considéré les tailles échantillonées avec des intervalles de 3 cm. On n'a pas observé de différences significatives entre mâles et femelles, dans l'amplitude des tailles recensées. Pour les mâles, la taille de la première maturité est à peu près de 107 cm et pour les femelles cette taille est de 110 cm, la différence est uniquement d'une classe de taille. Pour préciser cet aspect une analyse histologique est actuelment en cours de réalisation.

BIBLIOGRAFIA

Karlovac, J. et O. Karlovac (1976). Apparition du Lepidopus caudatus (Euphr.) dans toutes les phases de sa vie en Adriatique. Rapp.Comm.int.Mer Médit., 23(8):67-68.

Sabatès, A. (1988). Sistemática y Distribución espacio-temporal del ictioplancton en la costa catalana. Tesis Doctoral, Univ. Barcelona, 558 pp.

Evaluation Hydroacoustique des Poissons Pélagiques sur le Littoral Méditerranéen Espagnol et le Golfe du Lion (Mai-Juin, 1988)

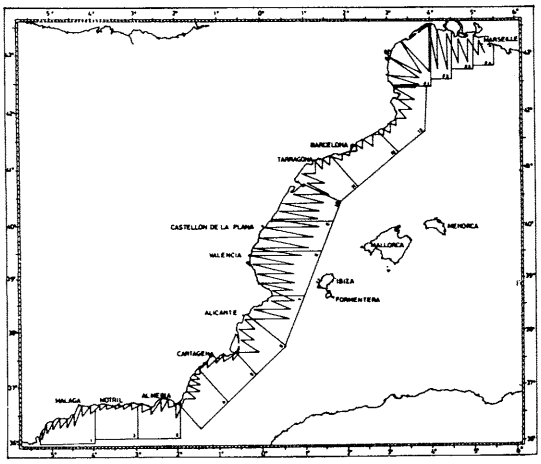
J. MIGUEL et F. ALVAREZ

Instituto Espanol de Oceanografia, Centro Oceanografico de Baleares, Palma de Mallorca (Espana)

RESUME. Depuis 1983, l'IEO réalise des campagnes d'évaluation hydroacoustique des populations de poissons pélagiques sur le littòral méditerranéen de la péninsule espagnole. La surface prospectée a été agrandie jusqu'au golfe du Lion. La campagne ECOMED-88 s'est déroulée entre le 25 mai et 24 juin, entre Punta Europa et Cap Croisset. Nous avons obtenu des estimations de l'abondance de Sardina pilchardus par classe d'âge, d'Engraulis encrasicholus et d'autres poissons pélagiques.

1.MATERIEL ET METHODE. La campagne s'est déroulée dans le B/O "Cornide de Saavedra" à une vitesse de 11 noeuds. L'équipement acoustique SIMRAD se compose de plusieurs écosondateurs de 38 et 120 KHz, d'un écointégrateur digital QD et d'une sonde FR-500 munie d'un câble, calibré avec une sphère de cuivre de 60 mm de diamétre (FROTE et al., 1982). Nous avons utilisé un chalut pélagique de 10 m d'ouverture verticale avec lequel nous avons fait 39 pêches au chalut pour l'identification des échos. Nous avons traîné la plataforme en zig-zag jusqu'aux 200 m, laissant une distance de 10 milles entre les radiales perpendiculaires à la côte. La surface a été divisée en secteurs et en strates (< 30 m, 30-100 m, 100-200 m). Trois groupes d'espèces ont été distingués à partir de la lecture des êchogrammes: pélagiques 1 (sardine et anchois), Capros aper et le reste des pélagiques (Trachurus ssp., Scomber scombrus, Boops boops, etc.). Pour calculer la constante de conversion des deux derniers groupes d'espèces nous avons utilisé l'expression TS/Kg = - 10 log L - 22dB, dont il resulte la valeur c = 0.1733 L ton/mn2/mm. Pour le premier groupe nous avons utilisé un TS (individuel) = 20 log L - 71.2 dB (ANON, 1983), ce qui donne un résultat de c=10.88E6/L^2ind/mn2/mm. La relation taille/poid utilisée pour la sardine est W=0.0023xL^3.4298 et pour l'anchois W=0.0127xL^2.7016 obtenues à partir des échantillonnages de la campagne, dont on a extrait 528 otolithes de sardine pour déterminer les clés taille-âge. Les biomasses ont été calculées par la méthode DOMMASNES et NAKKEN (1975). Le parcours et les pêches sont représentés sur la figure.

2.RESULTATS. Le degré de couverture (AGLEN, 1983) a été de 28.3, ce qui supose une variance espérée dans les estimations des index d'abondance relative inférieure à 20% . La biomasse de sardine a été estimée à 209 492 Tm et 59.6% de celle-ci ont été localisés dans le golfe de Valencia. Par classe d'âge (table ci-dessous), 66% des individus correspondaient à la classe d'âge 0, qui etait la plus abondante dans les régions d'Alborán et de Catalogne. La biomasse d'anchois a été estimée à 60 756 Tm dont 54.1% se trouve dans le golfe de Lion et 26.9% dans le golfe de Valence. La biomasse de C.aper a été estimée à 40 721 Tm seulement aux alentours de Gibraltar où l'ont a pas détecté d'autres espèces. Il semble y avoir une relation entre l'entrée d'eau atlantique et la distribution de C.aper. Cette espèce exclut les autres à l'époque oú elle apparaît ce phénomène a coincidé avec la présente campagne et les précedéntes. Nous avons estimé à 222 072 Tm le reste des pélagiques.



CLASS D'AGE	ALBORAN	G.VERA	ALICANTE	VALENCIA	CATALUÑA	TOTAL
0	63670	3778	23292	18723	37571	147034
I	183		3901	52131	9928	66143
II	381		466	7504		8351
III	213		13	1020		1246
IV	301		13	496		810
V	23			379		402
TOTAL	64771	3778	27685	80253	47499	223986

3.REFERENCES.

AGLEN, A., 1983. Ramdom errors of acoustic fish abundance estimates in relation to the survey grid density applied. FAO Fish. Rep. (300): 293-298.

ANON, 1983. Report of the Planning Group on ICES coordinated herring and sprat acoustic surveys. ICES C.M 1983/H: 12.

DOMMASNES, A. and NAKKEN, 1975. The application of an echo-integration system in stock abundance estimation of the Barents sea capelin. Coun. Meet. Int. Coun. Explo. sea.

FOOTE, K., KNUDSEN, H. and VESTNES, G., 1982. Standard calibration of echo-sounders and integrators with optimal copper spheres. Symposium on Fisheries Acoustics. Bergen, june 1982. Contribution No 40.

Estimation of mortality rates Z and M of Hake *Merluccius merluccius* (Linnaeus, 1758), Blue Whiting *Micromesistius poutassou* (Risso, 1826) and Striped Mullet *Mullus barbatus* Linnaeus, 1758

Paloma MARTIN

Instituto de Ciencias del Mar (CSIC), Paseo Nacional s/n., 08003 Barcelona (Espana)

Hake, blue whiting and striped mullet are species traditionally exploited in the Catalan coast.

Hake and blue whiting catches are similar, about 2000 annual tones, while striped mullet catches are smaller, given that combined annual catch of striped and red mullet is about 700 tones. With respect to economic yield from these species, at present, annual income from hake is about 2.000 million pesetas, and those of blue whiting and mullet (striped and red mullet) are similar, of about 500 million pesetas.

Hake is mainly exploited by trawling, but locally long line catches can be as important as those of trawling. This is the case of the hake fishery in Port de la Selva. Blue whiting and striped mulled are fished by trawling.

We present estimations of natural mortality rate M ant total mortality rate Z obtained by means of different methods, of hake, blue whiting and striped mullet.

Methods that have been used are as follows:

1) Taylor (1959), based on the parameters of the Von Bertalanfy growth equation Linf, k and to.

$$M = \frac{2.996\ k}{2.996 + k\ to}$$

p= arbitrary fraction of Linf

2.996= -ln (1-p)

2) Pauly (1980), where Linf, k and temperature are used.

$$\log M = -0.0066 - 0.279 \log Linf + 0.6543 \log k + 0.4634 \log T$$

3) Beverton and Holt (1956), from Linf, k, l' (smallest length fully recruited) and lm (mean length estimated from l').

$$(F+M) = Z = k\ \frac{(Linf - lm)}{(lm - l')}$$

4) Jones (1984), from Linf, k, lt (length at age t) and Nt (cumulated frequency of specimen until age t).

$$\ln (Nt) = a + b\ (Linf - lt);\ b = Z/k$$

DATA:

- annual exploited lenght composition of: hake exploited by trawling (June 1982-May 1983); hake exploited simultaneously by trawling and long line (data from Port de la Selva, December 1987- November 1988); and blue whiting (June 1981-May 1982) and striped mullet (June 1982- May 1983), exploited by trawling.

- parameters of the Von Bertalanfy growth equation:

	Linf	k	to	
hake	103.0	0.0495		Charbonier, 1986
blue whiting	40.3	0.22	-1.29	Verón, 1986
striped mullet	29.72	0.0891	-4.4207	Sánchez et al., 1983

- selectivity of gear:

	l'	lm	lmin	lmax
trawling hake	21	27.6	8	69
long line hake	49	58.3	33	85
blue whiting	21	23.2	9	37
striped mullet	13	14.5	6	22

RESULTS:

		traw. hake	long l. hake	blue whiting	striped mullet
1)Taylor, 1959	M	0.050	0.050	0.243	0.103
2)Pauly, 1980	M	0.124	0.124	0.428	0.258
3)Bev.&Holt, 1956	Z	0.566	0.238	1.71	0.904
4)Jones, 1984	Z/k	8.304	4.808	4.829	6.889
	Z	0.411	0.238	1.062	0.614

REFERENCES

BEVERTON, R.J.H. and HOLT, S.J., 1956. Rapp. Conseil Explor. Mer, 140 (1): 67-83.

CHARBONIER, D. (Ed), 1986. FAO Rapp. Pêches, (347): 231 pp.

JONES, R., 1984. FAO Fish. Tech. Pap., (256): 118 pp.

PAULY, D., 1980. J. Cons. int. Explor. Mer, 39 (2): 175-192.

SANCHEZ, P., MORALES, B. AND MARTIN P., 1983. ICES C.M. 1983/G:27. 19 pp. Mimeo.

TAYLOR, C., 1959. J. Cons. XXV: 93-101.

VERON, S., 1986. Morfología, estructura del otolito y crecimiento de la bacaladilla (Micromesistius poutassou Risso 1826). Tesis de licenciatura. Facultad de Biología. Universidad de Barcelona.

V

A Method for the Assessment of the Fish Abundance

S. MAZZOLA, D. LEVI, M. LUPOLI MAZZOLA and L. CANNIZZARO

Istituto di Tecnologia della Pesca e del Pescato, CNR, Via Luigi Vaccara N. 61, 91026 - Mazara del Vallo (Italia)

The aim of this paper is to illustrate a first application of a method based on K-nearest neighbour theory in order to assess the density of fish populations.

The assessment of the abundance of the marine Resourches, in the last years, is becaming every more important and pressing either for the management of fisheries activities or for environmental reasons (LEVI AND ANDREOLI, 1989).

The examined geographic area is considered as digital image in which high intensity zones (i.e. high measures of biomass realized by means of elettroacustic methods or by means of trawl surveys) correspond to high density zones in the binary image.

In the following, binary image are considered and the pixels with value equal to 1 are named "on" pixels; these pixels represent both structures background and "signal". Such images are referred as sparse images (DI GESU' , 1987); their analysis mainly deals with the densities of the "on" pixels instead of their intensities. Sparse images are kind of data often detected and analysed in biomedicine, high energy physics, X- γ -Astronomy.

Our method is directly comparable to the classical formulation of the deconvolution problem in the instance of discrete image, without noise background, v; namely it may be stated as follows: "given an image, M, detected by an instrument with response function, R, recover the true one, T".

Formally, the problem corresponds to finding the solutions of the vector equation:

$$M = R (*) T + v$$

where the operator (*) is the convolution product. Often its exact analytical solution is difficult or impossible (TIKHNOV and AESENINE, 1974) because only statistical hypothesis may be done on the noise part, the response function is not well known and the linearity assumption is far from reality.

The proposed adaptive convolution technique uses the local density information to compute the parameters of the convolution Kernel. At the present three convolution kernels have been considered. The gaussian (G), the uniform (U) and the Triangular (T). Their statistical parameters (bariances, width, ...) are determined by considering the K-nearest neighbours of each on-pixel.

There are several methods for the computation of the response function, R, and its shape parameters. The problem of computing the local density has no exact solution and anly heuristic methods have been proposed in the literature (TOUSSAINT, 1982, FRIEDMAN ET AL., 1981). Two major problems must be addressed: the choise of the best number of sample points and the evaluation of the "real" area in which they are contained.

The method has been tested on simulated data in order to control the results. The simulation technique generates a binary image, the density of which is proportional to the intensities of input image. The experimental results point out that the method restores the form of original images with good approximation.

THe method will be applied an real data collected during eight trawl-surveys in the sicilian channel and by employing a stratified random sampling design.

REFERENCES.

LEVI, D., ANDREOLI, M.G., 1989. Terzo contributo al dibattito sulla ricerca orientato alla gestione delle risorse pescabili. Paper presented at XXI Symposium of the SIBM, Fano (Italy).

TIKHONOV, A., AESENINE, V., 1974. Methodes de Resolution de problemes mal poses. Editions MIR, Moscow.

DI GESU', V., 1987. Problems and possible solutions in the analysis of sparse images. In: P.A. Devijver and J. Kittler, Eds., Pattern Recognition Theory and Applications, NATO ASI Series, Springer Verlag.

FRIEDMAN, J.H., STUETZLE, W., SCHROEDER, A., 1981. Projection Pursuit Density Estimation, ORION 002, Dep. of Statistics, Stanford University.

TOUSSAINT, G.T., 1982. Summary of decision theoretic methods. In: J. Kittel, K.S. Fu, L.F. Pau, Eds., Pattern Recognition Theory and Applications 73-91.

V

Période de ponte et taille à la première maturité sexuelle de *Boops boops* (Linné, 1758) des Côtes Oranaises (Algérie)

A. BENSAHLA TALET, D. BELAOUDA et L. MATOUB

Laboratoire de Biologie Marine, Université d'Oran, B.P. 16, Es-senia/W-Oran (Algérie)

De décembre 1986 à novembre 1987, 1774 femelles, de longueur à la fourche (LF) comprise entre 11,0 et 22,4 cm ont été échantillonnées. Sur chaque individu, nous avons relevé la longueur totale (LT) et la longueur à la fourche (LF) au mm près, la masse pleine (M) au 1/10 g près et celle des gonades (Mg) au mg près. Les rapports gonado-somatiques mensuels moyens de la population de femelles ont été calculés, toutes tailles confondues, à partir des valeurs individuelles (RGS = 100. Mg / M). La taille à la première maturité sexuelle (LF_{50}) que nous avons établie, correspond à la longueur à laquelle 50% des femelles sont mûres (CONAND, 1977). Le stade de maturité des gonades a été déterminé par observation macroscopique de ces dernières.

Le RGS moyen augmente à partir du mois de janvier, atteint un maximum en mars-avril,avec des valeurs de 3,5 % environ, puis diminue jusqu'en septembre (Tabl. 1). Les RGS individuels maximums sont de l'ordre de 6,5 à 7%. La pleine période de ponte se situe de la fin février jusqu'en mai, mais dés le mois de janvier nous avons noté la présence dans nos échantillons de femelles ayant pondu, et on peut considérer qu'elle est pratiquement achevée en juillet.

MOIS	Déc	Jan	Fév	Mar	Avr	Mai	Jui	Jll	Aoû	Sep	Oct	Nov
Effectifs	17	74	344	235	205	168	164	101	-	208	138	120
RGS moyen	0,92	1,06	2,67	3,66	3,49	2,38	1,19	0,39	-	0,37	0	0

Tabl.1 .- Variations mensuelles du RGS des femelles de *Boops boops*

AUTEURS	REGIONS	J	F	M	A	M	J	J
LO BIANCO, 1909	NAPLES							
BINI, 1968	ITALIE							
VIDALIS, 1951	MONACO							
GIRARDIN, 1981	G. LION							
ZUNIGA, 1967	ESPAGNE							
LAMRINI, 1988	MAROC Atl.							
DIEUZEDE *et al.*,1955	ALGERIE							
CHALI-CHABANE, 1988	BOU-ISMAIL							
ANATO et KTARI, 1983	G. TUNIS							
MOUNEIMNE, 1978	LIBAN							
Présent travail	ORAN							

Tabl. 2 .- Périodes de ponte de *Boops boops* en Méditerranée et en Atlantique.

Comparée à d'autres secteurs méditerranéens ou atlantiques limitrophes, la ponte de *Boops boops* sur les côtes oranaises se caractérise par sa précocité (Tabl. 2). En Italie (BINI,1968), à Monaco (VIDALIS, 1951), en Espagne (ZUNIGA, 1967) et au Maroc atlantique (LAMRINI,1988), elle débute en avril. Dans le golfe du Lion (GIRARDIN, 1981)et dans le golfe de Tunis (ANATU et KTARI,1983), elle commence en Mars. Il n'y a que sur les côtes du Liban (MOUNEIMNE, 1978) qu'elle a lieu dès février, mais elle prend fin en avril.

La taille à la première maturité sexuelle des femelles de *Boops boops* sur la côte oranaise, estimée à 11,7 cm, est légèrement inférieure à celle signalée en Méditerranée par divers auteurs qui l'évaluent à 13,0 - 13,5 cm (Tabl. 3) Dans ce cas, également, la population de bogues de notre région est comparable à celle des côtes libanaises où, selon MOUNEIMNE (1978), la taille à la première maturité sexuelle est de 12,0 cm.

AUTEURS	REGIONS	LF_{50}
GIRARDIN, 1981	G. LION	13,0 cm
MATTA, 1958	Arch. Toscan	13,5 cm
MOUNEIMNE, 1978	LIBAN	12,0 cm
BOUNHIOL et PRON,1916	ALGERIE	13,3 cm
CHALI-CHABANE, 1988	BOU-ISMAIL	13,5 cm
Présent travail	ORAN	11,7 cm

Tabl. 3 .- Taille à la première maturité sexuelle(LF_{50}) de *Boops boops*.

REFERENCES

ANATO C.B.et M.M. KTARI, 1983 ._ Reproduction de *Boops boops* (L. 1758) et de *Sarpa salpa*, Poissons Téléostéens,Sparidés du golfe de Tunis. **Bull. Inst. Nat. Scient. Tech. Océanog. Pêche Salambo**, 10 : 49 - 53

BINI P., 1968 ._ Atlante dei pesci delle coste Italiani. Edit. Mondo Sommerso,vol. IV, ROMA: 63 p.

BOUNHIOL J.P. et L. PRON, 1916 ._ La précocité sexuelle et les conditions thermiques de la maturation génitale et de la ponte chez quelques Sparidés communs d'Algérie : *P. erythrinus*, *P. acarne*, *P. centridontus*, *P. vulgaris*, *B. vulgaris*, *D. melanura*, *D. macrophtalmus*. **C.R. Soc. Biol.**, XXIX : 140.

CHALI-CHABANE F.,1988 ._ Contribution à l'étude biologique et dynamique de la population de bogues, *Boops boops*, de la baie de Bou-ismaïl. Thèse ISMAL, ALGER : 111p.

CONAND C., 1977 ._ Contribution à l'étude du cycle sexuel et de la fécondité de la sardinelle ronde, *Sardinella aurita* : pêche sardinière dakaroise en 1975 et premier semestre 1976. **Cah. ORSTOM, sér. Océanogr.**, 15 (4) : 301 - 312

DIEUZEDE R , NOVELLA M. et J. ROLAND, 1955 ._ Catalogue des poissons des côtes algériennes- III. Ostéoptérygiens (suite et fin). **Bull. Stat. Aquic. Pêches de Castiglione,** 6 : 384 p.

GIRARDIN M., 1981 ._ *Pagellus erythrinus* (L. 1758) et *Boops boops* (L. 1758) (Pisces, Sparidae) du golfe du Lion. Ecobiologie. Prises commerciales et modèles de gestion. Thèse Doct. 3ème cycle, USTL, Montpellier : 295 p.

LAMRINI A., 1988 ._ Les Sparidés de la côte atlantique marocaine. Reproduction, croissance et exploitation de cinq espèces. Thèse Doct. Etat, Univ. Bretagne Occidentale : 382 p.

LO BIANCO S.,1909 ._ Notizie biologiche riguardanti specialmente il periodo di maturita sessuale degli animali del golfo di Napoli. **Mitt. Zool. Stat. Napl.**, Vol. XIX : 513 - 576

MATTA F., 1958 ._ La pesca a strascio nell'archipellago Toscano. **Boll. di Pesca, Pisc. Idro.**, XXXIV, vol. XIII, fasc. 1 -2 : 23 - 365

MOUNEIMNE N.,1978 ._ Poissons de côtes du Liban. Thèse Doct. Etat, Univ. Pierre et Marie Curie, Paris VI : 490 p.

VIDALIS E., 1951 ._ Contribution à la biologie de *Boops boops* dans la région de Monaco - Nice. **Bull. Inst. Océanog.**, 988 : 18 p.

ZUNIGA L.R., 1967 ._ Estudio del crecimiento de *Boops boops* del levante espanol. **Inv.** Pesq., 31 : 383 - 481

V-IX2

Size and age at first maturity in Horse Mackerel (*Trachurus trachurus* L.) from the Adriatic Sea

Veronica ALEGRIA

Institute of Oceanography and Fisheries, P.O. Box 114, Split (Yugoslavia)

Size and age at first maturity are important characteristics for the assessment of a species under exploitation. The knowledge of these parameters makes possible a rather real evaluation of spawning biomass since they directly affect its reproductive potencial, defining the reproductive life span of individuals.

This paper present the result of studies of variations in mean length and mean age at first maturity in horse mackerel from the Adriatic Sea. This species make up a considerable part of the trawl catch at the eastern Adriatic coast.

The data used cover the 1986-1988 period. Total length (L,cm), weight and sex were recorded. Gonad maturity was determined by macroscopic examination using Macer scale of specific maturation (MACER, 1974). Age was estimated by otoliths reading. Mean age (A_o) and mean length (L_o) at onset of maturity and the reproductive life span (RLS) were calculated by the Lysack formula (TRIPPEL and HARVEY,1987). Length (L_{50}) and age (A_{50}) for 50 % maturity as well as length (L_{95}) and age (A_{95}) at 95 % maturity were taken directly from the maturation curves.

Variation in mean length and mean age (years) at first maturity of horse mackerel for the period 1986-1988 are as follow:

Year	Sex	N	L_o	L_{50}	L_{95}	N	A_o	A_{95}	A_{catch}	RSL
1986	Males	150	19.70	20.84	26.34	61	2.56	5.70	3.44	0.88
	Females	154	19.28	20.22	25.88	72	2.13	5.10	3.23	1.10
1987	Males	155	19.57	21.65	26.50	98	2.82	6.08	4.11	1.29
	Females	134	19.41	21.60	27.15	85	2.68	6.15	3.57	1.08
1988	Males	180	20.60	23.15	27.12	103	2.70	5.88	4.00	1.30
	Females	201	20.66	22.42	26.90	111	2.54	5.05	3.98	1.44

Onset of maturity in males tended to occur at larger sizes and older ages than in females. However, it may be stated that both males and females mature during the third year of age. The complete population reaches maturity not earlier than at five year of age. The transition from all inmature to 100 % mature condition occurred over a 10 cm interval of length and 3 to 4 years of age, for both males and females. The intervals tended also to increase.

When mean length at onset of maturity in males and females is compared to asymptotic length of this species, which was estimated to be 37.55 cm, for 1980-1981 period (ALEGRIA, 1984), it may be concluded that in both sexes the onset of maturity takes place when the specimens attain 52 % of the total length. This suggests that the reproduction strategy is rather late, probably due to the fact that most of energy is expended on the process of fast growth of adolescents.

The values obtained for each separate year of our study show a tendency to slight increase of mean length at first maturity, particularly in females. In relation to the age, however, the variations show no defined trend. The changes observed are probably related to changes of sea water temperature and favourable environmental conditions, which affect genetically defined length and age at onset of maturity. It is known that the increase in length and age at first maturity normally corresponds to years classes hatched at higher population biomass, since under those conditions reaching first maturity takes more time. This can mean that the horse mackerel stock is subexploited in the Adriatic Sea. However, it is uncertain if these were actual trends or due to sampling variability.

In the catch of horse mackerel in the eastern Adriatic, the adolescents up to 2.5 years of age make up 38 %, 41 % are individuals of 3-5 years and the rest are older individuals. On this basis the mean age of catches was estimated. If first maturity occurs when females attain, on average for 1986-1988 period, 2.45 years of age their reproductive life span lasts 1.25 spawning periods. Similar may be stated for males.

In summary, this study has indicated that there has been a trend of slight increase in mean length and age at first maturity of horse mackerel of the Adriatic Sea, resulting in a shorter reproductive life span. However, further data are necessary to determine if this will be continued.

REFERENCES

ALEGRIA, V., 1984. Observations on the age and growth of Trachurus trachurus (L.) in the central Adriatic. Bilj.Inst.Oceanogr.rib., Split, 58: 6 p.

MACER, C.T., 1974. The reproductive biology of the horse mackerel Trachurus trachurus (L.) in the North Sea and English Channel. J.Fish.Biol. 6: 415-438.

TRIPPEL, E.A., and H.H. HARVEY, 1987. Reproductive responses of five white sucker (Catostomus commersoni) populations in relation to lake acidity Can.J.Fish.Aquat. Sci., 44: 1018-1023.

V-IX3

Oogenesis of *Saurida undosquamis* (Richardson) from the South-Eastern Mediterranean

Th.-S. SHENOUDA and W.-F. WADIE

Faculty of Education, Tnanta University, National Institute of Oceanography and Fisheries, Alexandria (Egypt)

The present work deals with egg development in Saurida undosquamis as an example of Indo-Pacific species appeared in the Mediterranean on the fifteens of this century from the Red Sea crossing the Suez Canal and became one of the most important fisheries items. For histological analysis, one hundred ovaries collected during different periods of the year and egg diameter measured. Morphological study of oocytes in the fresh ovaries and relation between them at different phases of development is based on egg diameter measurements.

I was observed that process of oogenesis is divided into two phases, the first is the period of small growth (Protoplasmic) which could be subdivided into a Juvenile phase in which the ovules are represented by small oocytes with diameter 14.0 to 34.0 micron. The membrane is thin, cytoplasm is finely granulated, nucleus is relatively large occupying 60-80% of the egg cell. Eggs are transparent, chromosomes are not clear (phase B). b phase of egg cell with layered follicle in which the diameter of sexual cells ranges from 42-84 micron. The ovule consists of egg membrane and follicular membrane. The first is thin, while the second is double layered. Nucleus occupies about half the ovule diameter (Phase C).

The second period is that of intensive growth (Trophoplasmic), also this period can be subgrouped into three phases : a phase of primary yolk accumulation which is considered as the beginning of vitellogenesis and diameter of the egg cell fluctuates between 84 and 176 micron, yolk granules begin to appear at the periphery of the oocyte in vacuoles and gradually occupy its central part, they are of differnet sizes and have globe shaped form. The nucleus has nearly ovalshape, nucleoli are bigger than in the previous phase. The egg cell is not transparent having light yellow colour (Phase D). b phase of ovules filled with yolk. Diameter of the egg-cell ranges between 179 and 280 micron. The cell membrane is thicked (20-22 micron), cytoplasm is nearly full of yolk granules, nucleus is nearly oval occupying relatively smaller area. Micropyle begins formation at the end of this phase, the nucleus migrates to the animal pole at which there is a unique micropyle, chromosomes are not distinguished. Fresh ovule has bright yellow to orange colour (Phase E). c. Phase of ripe egg, diameter of eggs ranges from 280 to 360 micron, cell membrane becomes more thicker (28 micron). The micropyle is clear and a layer of fibers which may be produced by the follicular cells is found above zona radiate. In this stage, the deposition of yolk is accompanied by its hydration resulting in an increase in size of oocytes and eggs become transparent again. Nucleus is not distinguished. Based on diameter measurements, there are four peaks of diameter oocytes (Phase F). The smallest oocytes with diameter 50-200 micron, transparent and considered as reserve group. Second group of oocytes having diameter 200-450 micron, they are not transparent The third group of oocytes which are in the period of trophoplasmic growth with diameter 450-700 micron, oocytes are light yellow to orange. The fourth group is that of mature and ripe oocytes in which the yolk deposition takes place, having diameter 700-1300 micron, this group is divided into two subgroups, the first comprises eggs at the beginning of yolk deposition (diameter 700-1500 micron). As a result of this process, the eggs become semitransparent. The second subgroup has eggs with diameter 1100-1300 micron. This subgroup is characterized by the end of yolk deposition process and eggs are transparent.

Based on results obtained from histological and morphological studies of gonads and oocytes, the maturity scale for Sauride undosquamis is as follows :

Stage I : Ovaries and oocytes are thin and transparent, sexual cells cannot be visually differentiated, the oldest oocytes are in phase (B).

Stage II : Ovaries are slightly increased but still are colourless and transparent occupying about half the body cavity. The oldest generation of oocytes are in phase (C).

Stage III: Ovaries occupy more than half the body cavity. Oocytes are in the period of trophoplasmic growth having light-yellow to orange colour. The oldest oocytes belong to phases (D and E).

Stage IV : Ovaries occupy about two thirds of the body cavity cloudy translucent eggs of comparatively big diameters appeared. The oldest generations of oocytes are in phase (F).

Stage V : This characterizes the spawning fish in which ovaries attain the maximum size and occupy nearly all the body cavity. Ovaries contain perfectly transparent eggs discharged from follicles.

Stage VI : Fishes discharge eggs. Saurida undosquamis is a partial spawning, therefore the oocytes which will be discharged in the recurrent spawning season grow at different times.

The present study reveals that arsynchronous development of oocytes appears in stage III. After the discharge of the first egg portion, the ovary does not pass to stage VI as in the monocyclic spawning fisk but passes to a stage in which the oocytes are found in a stage similar to stage III, however, this special case of maturity differs from stage III in that the next egg portion has empty follicles and so this stage is considered as VI-III_2. If the fish discharges a second egg portion, so it will pass to stage VI-III_3 and then VI-IV_3. When the fish discharges all portions of eggs, the ovary enters into stage III

V

Etude Histo-Cytologique de la structure sexuelle d'une population de *Lithognathus mormyrus* (L.) (Teléosteen, Sparidé)

Laurence BESSEAU

Laboratoire de Biologie Marine, Université de Perpignan, Avenue de Villeneuve, 66025 Perpignan (France)

Le marbré, *Lithognathus mormyrus*, est un Sparidé méditerranéen côtier, défini comme hermaphrodite protandre par D'ANCONA (1950), puis par REINBOTH (1962). Ultérieurement, LISSIA-FRAU (1968) a remis en question l'application de ce caractère protandrique à tous les marbrés, dans la mesure où l'auteur a pu identifier des femelles primaires.

Une analyse de la structure sexuelle de *L. mormyrus* du Roussillon a été effectuée par des observations macroscopiques et microscopiques (histologie - cytologie) des gonades de 497 individus.

Macroscopiquement, quatre groupes sexuels ont été définis :
- immature (0)
- mâle fonctionnel (1)
- en inversion (3) : specimens dont l'ovotestis présente un développement du testicule et de l'ovaire sensiblement équivalent.
- femelle fonctionnelle (5).

Les mâles dominent dans les petites classes de taille. A partir de 25 cm, la tendance s'inverse en faveur des femelles. Au-delà de 32 cm, tous les individus sont des femelles. Ces résultats confirment la protandrie chez *L. mormyrus*. Les individus en inversion, difficiles à caractériser macroscopiquement, sont de surcroît peu nombreux (3,5 % ± 1,5) et largement distribués dans les différentes classes de taille : l'inversion sexuelle semble donc être un phénomène labile dans la vie du marbré. Par ailleurs, nos observations ont révélé la présence de femelles fonctionnelles dans les petites classes de taille : il s'agit donc de femelles primaires, représentées par un pourcentage relativement élevé (42 % ± 8).

L'examen histo-cytologique des gonades a permis de caractériser 7 groupes sexuels :

0 : gonade immature

1 : le testicule développé, est fonctionnel :

- 1+ : la partie femelle, de petite taille, présente des ovogonies alignées le long de la paroi délimitant la cavité ovarienne ; des ébauches de lamelles ovariques, avec quelques ovocytes prévitellogénétiques.
- 1- : dans la partie ovarienne des signes de dégénérescence sont observés sous la forme de lyses ovogoniales et ovocytaires, les cellules immunitaires étant nombreuses.

2 : testicule fonctionnel et dans le secteur femelle plus développé qu'en 1+, les ovocytes prévitellogénétiques nombreux sont situés dans des lamelles ovariques constituées.

3 : Ovotestis dans lequel les deux territoires ont un développement sensiblement équivalent.

4 : Ovaire fonctionnel et partie testiculaire en régression présentant toutefois une structure lobulaire normale.

5 : Ovaire fonctionnel et partie mâle très régressée, sous l'aspect d'une fine crête où ne subsistent que quelques rares spermatogonies.

Si l'examen histo-cytologique des gonades révèle encore un petit nombre d'animaux en inversion (6,1 % ± 2,7), il permet cependant de reconnaître deux étapes intermédiaires au cours desquelles l'ovaire se développe (stade 2) et le testicule régresse (stade 4). Ces deux stades transitoires signent le phénomène de l'inversion et compte-tenu de leurs pourcentages respectifs (12,2 % ± 3,7 et 6,1 % ± 2,7), mettent plus clairement en évidence l'ensemble des individus intéressés par le changement de sexe. Par ailleurs, à côté des marbrés classiquement protandres et des femelles primaires, ces observations histologiques ont permis de déceler parmi les mâles fonctionnels, certains dont la partie ovarienne de l'ovotestis présente des critères cytologiques de dégénérescence notable. Ces individus ne sont pas rares (10 % ± 3), et correspondent donc à des mâles qui ne subiront pas d'inversion sexuelle.

Nos résultats d'observations macroscopiques, complétés par des investigations histo-cytologiques confirment donc un hermaphrodisme protandre chez *L. mormyrus*. Le processus de l'inversion sexuelle apparaît comme un phénomène labile dont les modalités concernant le développement de l'ovaire et la régression complète du testicule paraissent étalées dans le temps. Cependant ce caractère protandrique ne peut s'appliquer à l'ensemble de la population. En effet, nos résultats montrent un nombre relativement important d'une part de femelles primaires et d'autre part de mâles qui ne subiront pas d'inversion sexuelle .

D'ANCONA U., 1950, Il differenziamento della la gonade e l'inverzione sessuale degli Sparidi. Arch. Ocean. Limnol., 6, 2-3, 97-163.

LISSIA-FRAU A.M., 1968, Le manifestazioni della sessualità negli Sparidi. (Teleostei, Perciformes). Studi Sassaresi, 2, 1-19.

REINBOTH R., 1962, Morphologische und funktionelle Zweigeschlechtlichkeit bie marinen Teleostiern (Serranidae, Sparidae, Centracanthidae, Labridae). Zool. Jb. Physiol. Bd., 69, S., 405-480

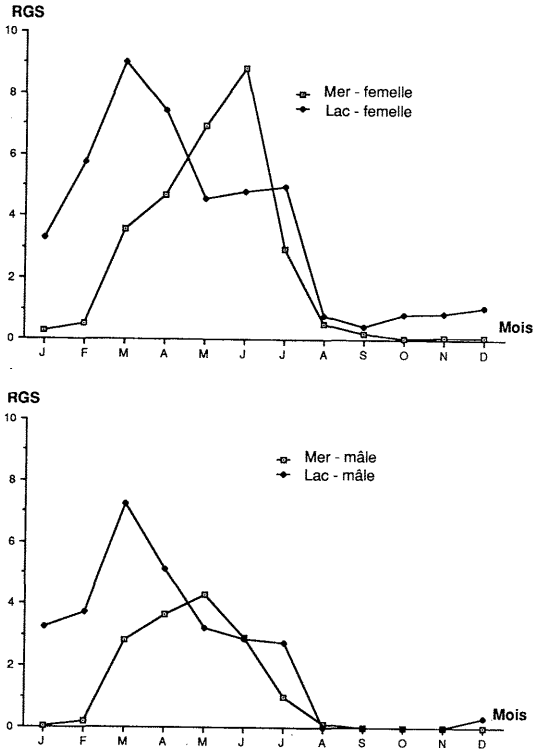
Sur la reproduction de l'Athérine *Atherina boyeri* Risso, 1810 du Littoral Marin et Lagunaire Tunisien

Monia TRABELSI et Fredj KARTAS

Laboratoire de Biologie et d'Ecologie Littorale, Faculté des Sciences de Tunis, (Tunisie)

La reproduction de l'athérine Atherina boyeri est étudiée chez deux populations, l'une marine inféodée au secteur de Monastir (Est tunisien) et l'autre lagunaire vivant dans le lac Ichkeul (Tunisie septentrionale). Les trois principales phases du cycle reproducteur, à savoir, la préponte, la ponte et la postponte, sont décrites et analysées grâce à l'observation macroscopique des gonades et au suivi des variations mensuelles du rapport gonadosomatique (RGS) effectués durant l'année 1984-85. (Figure ci-dessous).

Chez les femelles de la population marine, la période de maturation des gonades dure quatre mois (mars-juin) et se caractérise par un important et régulier accroissement du RGS. La ponte s'étale sur trois mois au plus; elle se déclenche en juin et pourrait se poursuivre jusqu'à août. La plus forte intensité d'émission des ovocytes a lieu en juillet. La phase de restauration de la gonade et de repos sexuel s'étend sur une longue période allant d'août à février.



Les mâles suivent une évolution cyclique analogue à celle des femelles. Le plein accroissement du testicule précède toutefois d'un mois environ celui de l'ovaire et la période de maturation se trouve ainsi limitée à trois mois (mars-mai). Le maximum d'émission des produits sexuels mâles est plus précoce que celui des oeufs et se produit en juin. Tandis qu'on enregistre la même période de repos sexuel qui couvre plus de la moitié de l'année. Du point de vue développement relatif des gonades, le RGS maximum est deux fois plus important chez les femelles que chez les mâles (8,8 contre 4,3), alors que les RGS minimums correspondant à la période de repos sont très faibles et voisins chez les deux sexes.

En milieu lagunaire, la maturation des glandes génitales s'effectue d'une façon synchrone chez les femelles et les mâles; elle débute en janvier et s'achève en mars et est donc plus précoce de deux mois et plus rapide que celle qu'on observe en milieu marin. On constate que là aussi, le RGS maximum est plus élevé chez la femelle (9,0) que chez le mâle (7,2), mais l'écart n'atteint pas les proportions de 2 contre 1 relevées en milieu marin. Cette différence est due notamment au fait que le RGS maximum des mâles lagunaires présente des valeurs plus fortes que celles des mâles d'origine marine. L'époque de ponte est plus longue que celle observée en mer et s'étale sur cinq mois (mars-juillet). Le RGS chute considérablement en avril et mai et il se stabilise chez les femelles ou régresse faiblement chez les mâles entre mai et juillet pour subir finalement une diminution spectaculaire en août. Cette stabilité plus ou moins nette en mai-juin-juillet suppose une reprise ou une continuation de l'activité gonadique qui se traduit par le développement d'ovocytes à mesure que ceux plus mûrs sont expulsés. La période de repos sexuel (août-décembre), quoique plus courte de deux mois environ, est superposable à celle observée en milieu marin.

V-IX6

Reproductive Biology of the common Guitarfish, *Rhinobatos rhinobatos* (Linneaus, 1758), in the South-Eastern Mediterranean

S.-H. ABDEL-AZIZ and S.-A. ABDEL-MAGUID

Oceanography Department, Faculty of Science, Alexandria University, Alexandria (Egypt)

The common guitarfish, *Rhinobatos rhinobatos*, are ovoviviparous fish which are abundant in the Egyptian Mediterranean waters. The present study indicated that *R. rhinobatos* reached maturity at 70 and 85 cm TL for males and females respectively. This finding is in full agreement with the results of Capape and Zaouali (1981) on the same species along the Tunisian coasts. The maximum sizes recorded in the present study were 172 cm for males and 181 cm TL for females. Mating occurs during the period from July to September. Two ovulation periods exist, one in spring and the other in autumn; two broods are born year. Ova were observed in the uteri of all examined females shortly after parturition, which means that two broods are born each year. Active vitellogenesis observed in the ovary of pregnant females have been mentioned before by various authors. McEachran and Capape (1984) mentioned that *R. rhinobatos* are ovoviviparous fishes with one or two litters per year, of 4-10 embryos. Capape (1985) mentioned that Rhinobatidae are among the Selachians that reproduce several times per year. The species studied have a gestation period extending for 6-9 months. Active vitellogenesis in the ovaries was observed during the first gestation period (March-August), while in the second gestation period (August-October), vitellogenesis stopped. During the present study the largest embryo recorded was 30.2 cm, while the smallest one was 24.5 cm TL at birth. This means that size of the new born varies between 24 to 31 cm TL. Capape et al. (1976) reported that the size at birth for *R. rhinobatos* was about 29 cm TL. The average ovarian fecundity for *R. rhinobatos* according to the present analysis was 17.6 eggs, while the uterine fecundity was 11.8 (based an calculations from the two ovaries and the two uteri). Along the Tunisian coasts, Capape (1985) reported that the ovarian fecundity reached 6 eggs for *R. rhinobatos* and 6-9 for *R. cemiculus* while the uterine fecundity was 4-6 eggs for *R. rhinobatos* and 5-8 for *R. cemiculus*. However, this author did not explain whether his calculation were based on two or one ovary or uterus. Several authors have reported relationships between number of embryos and mother size suggesting that the bigger individuals produce more litters . The present study reveals the presence of a linear correlation between ovarian fecundity and mother size.

References :

Capapé C., 1985. Archs. Inst. Pasteur, Tunis, 62 (3): 305-328 et 62 (4): 429-464.

Capapé C. et al., 1976. Archs. Inst. Pasteur, Tunis, 53 (1-2): 47-60.

Capapé C. et al., 1981. Bull. Off. natn. Pêches de Tunisie, 5 (1): 1-27.

McEachran J.D. and C. Capapé, 1984. in FNAM. Edit. UNESCO, Paris I: 156-158.

V-IX7

Observations sur la biologie de la reproduction de *Dasyatis marmorata* (Steindachner, 1892)(Pisces, Dasyatidae) de la Mer des Bibans (Tunisie Méridionale)

C. CAPAPE

Laboratoire d'Ichthyologie et de Parasitologie Générale, Université de Montpellier II, Sciences et Techniques du Languedoc, 34095 Montpellier (France)

Au long des côtes tunisiennes, cinq Dasyatidae ont été recensés(Capapé, 1989). Parmi ces espèces on cite, *Dasyatis marmorata* (Steindachner, 1892) considérée autrefois comme une variété de *D. pastinaca* (Linné, 1758) mais dont la position taxonomique n'est plus mise en doute (Fredj et Maurin, 1987). En Tunisie, et comme dans tout le reste de la Méditerranée, *D marmorata* est seulement capturée dans une lagune hyperhaline, la mer des Bibans, communiquant avec le golfe de Gabès. L'observation de 677 individus (329 mâles et 348 femelles) nous a permis de cerner certains aspects de la biologie de la reproduction de l'espèce. La taille de première maturité sexuelle des mâles a été mise en évidence par le biais de la croissance relative des ptérygopodes en fonction de largeur discale (ID) ; celle des femelles par l'observation de l'activité vitellogénétique des ovaires et l'examen des contenus utérins. Le premier mâle et la première femelle adultes ont respectivement 28 cm et 32 cm de ID. Les femelles atteignent une plus grande taille (56 cm de ID) que les mâles (40 cm de ID). *D. marmorata* est une espèce vivipare aplacentaire avec un seul utérus fonctionnel, le gauche. Des femelles avec des oeufs encapsulés ou des foetus à terme *in utero* sont capturées régulièrement en janvier, en avril en août et en septembre. La gestation pourrait durer 4 mois mais il est difficile de préciser par individu le nombre de portées annuelles, 1, 2, 3, ... La formation des ovocytes est synchrone de celle des foetus. Leur diamètre augmente au fur et à mesure de la croissance de ces derniers, mais leur taille maximum, 2 cm, ne serait pas atteinte lors de la parturition. Les embryons se développent essentiellement au cours des troisième et quatrième mois de la vie *in utero*. Le rôle de la femelle est fondamental, le poids d'un oeuf étant en moyenne de 3,2 g; celui du foetus à terme est de 98,5 g (Capapé *et al.*, 1988). Les baisses concomitantes du rapport hépato-somatique et du coefficient de condition au cours de la gestation nous amènent à penser que certaines substances sont prélevées dans le foie et dans la musculature et vont servir à l'élaboration des sécrétions utérines. La déplétion des réserves huileuses des hépatocytes a été clairement mise en évidence par Ranzi et Zezza, 1936 ; Mellinger, 1973 et Capapé, 1978 chez les Dasyatidae ; le phénomène se retrouve chez *D. marmorata*. La fécondité ovarienne est de 2 à 5 ovocytes. La fécondité utérine est de 2 à 4 oeufs encapsulés ou de 2 à 3 embryons par portée.

REFERENCES

CAPAPE, C., 1978. Contribution à la biologie des Dasyatidae des côtes tunisiennes. III. *Dasyatis tortonesei* Capape, 1975. Répartition géographique et bathymétrique, sexualité, reproduction, fécondité. *Bull. Inst. natn. scient. tech. Océanogr. Pêche, Salammbô*, 5 (1-4) : 97-110.

CAPAPE, C., 1989. Les Sélaciens des côtes méditerranéennes : aspects généraux de leur écologie et exemples de peuplements. *Océanis*, 15 (3) : 309-331.

CAPAPE, C., QUIGNARD, J.-P., MELLINGER, J., BEN BRAHIM, R., 1988. Les relations de nutrition entre femelles et embryons au cours de la gestation des Sélaciens vivipares. *Rapp. Comm. int. Mer Médit.*, 31 (2) : 274.

FREDJ, G., MAURIN, C., 1987. Les poissons dans la banque de données Médifaune. Application à l'étude des caractéristiques de la faune ichthyologique méditerranéenne. *Cybium*, 11 (3) : 217-298.

MELLINGER, J., 1973. Croissance et reproduction de la torpille (*Torpedo marmorata*). II. Croissance et variations pondérales de l'appareil digestif, particulièrement du foie. *Bull. biol. Fr. Belg.*, 107: 213-230.

RANZI, S., ZEZZA, P., 1936. Fegato, maturita sexuale e gestazione in *Trygon violacea*. *Publ. Staz. Zool. Napoli*, 13 : 331-347.

V

Egg-Case of the Dogfish *Scyliorhinus canicula* (L., 1758) from Sicilian Channel (Mediterranean Sea). I.- Test of the intraspecimen size diversity

Sergio RAGONESE and Patrizia JEREB

I.T.P.P., C.N.R., Via L. Vaccara 61, 91026 Mazara del Vallo (Italia)

The smallspotted catshark, *Scyliorhinus canicula*, has a widespread distribution in the Sicilian Channel, where it constitutes an important by-catch species for local fisheries (probably most of the 1833 t catch of *Scyliorhinus spp.* landed in 1982; Cingolani et al. 1986) and is commonly commercialized fresh and peeled (actual price ca. 4$/Kg). Neverthless, no information is available on the situation of this resource in the area of the Sicilian Channel investigated by the I.T.P.P.-C.N.R. of Mazara during two years (May. 85-Feb. 87) of experimental trawl surveys (Levi, 1988).

Using data collected in this occasion and during an "ad hoc" elaborated research program (SCYCAN), a random stratified sample (see the companion paper, Ragonese & Jereb, 1990) of 147 females of *S. canicula* with egg-cases in the oviducts was selected. For each specimen intra-oviducal egg-cases differences in length (median length = ML ; 0.1 mm), width (maximum width = MW ; 0.1 mm) and "virtual surface" (Sf = ML*MW ; mm^2 ; Fig.1) were tested by using a paired t-test (Sokal & Rohlf, 1969).

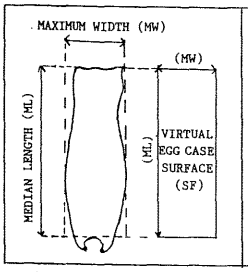


FIG.1 - Egg-case dimensions (ML and MW, 0.1 mm - measured by using a calliper; SF, mm^2): Tendrils are not reported in the drawing.

The null hypothesis (no difference) was always not disproved (Tab.1) but the test on the virtual surface fitted better the assumption "... left and rigth egg-cases are equivalent...", containing more information than the other two variables. Further, the basic assumption of the paired t-test (normal distribution of paired differences) was met for SFdif (p= 0.256) and not for MLdif (p= 0.015) neither for MWdif (p=0.010) according to the Kolmogorov-Smirnov one sample test using standard normal distribution (Lilliefors, 1967). The correspondence of rectangular approximation (virtual surface, fig.1) with the actual surface (computed by using a digital planimeter PLANIX 7, TAMAYA) covered by egg-case was evaluated on 18 egg-cases (3 for 6 dimensional classes); virtual surfaces are high significantly correlated to the actual ones (Pearson correlation coefficient = 0.975; p<0.01), the sligth overestimation (virtual/actual>1) being compensated by the easier computation.

	ML dif	MW dif	SF dif
MINIMUM	-1.9	-0.9	-40.1
MAXIMUM	2.1	1.1	45.2
MEAN	0.061	-0.008	0.638
STANDARD ERROR	0.054	0.025	1.252
t	1.20	0.32	0.51
H_o	ND	ND	ND

TAB.1 - Paired t-test on left-right differences (dif): degree of freedom = 146; level of confidence = 0.05 (two sided); critical t value = 1.97; H_o: μ dif = 0; ND = not disproved.

These results confirm, also on statistical bases, for *S. canicula* trawled in the Sicilan waters the "twin" nature of egg-cases (i.e. they are practically equivalent ; Mellinger, 1983) but indicate in the virtual surface a more useful statistic than length or width individually considered.

REFERENCES

CINGOLANI, N., COPPOLA, S.R. & MORTERA, J., 1986. Studio di fattibilità per un sistema di rilevazione campionaria delle statistiche della pesca (PESTAT). Parte II : Statistiche sulle Catture e sullo Sforzo di Pesca. Quad. Ist.Ric. Pesca Marittima, 5 (1 suppl.: 2° parte) : 754 pp.

LEVI, D., 1988. Relazione sull'attività svolta dall'unità operativa Istituto di Tecnologia della Pesca e del Pescato - Mazara del Vallo. *In* : Atti dei seminari delle unità operative responsabili dei progetti di ricerca promossi nell'ambito dello schema preliminare di piano per la pesca e l'acquacoltura. M.M.M. - C.N.R. III : 1561-1767, Roma, Italy.

LILLIEFORS, H.W., 1967. On the Kolmogorov-Smirnov test for normality with mean and variance unknown. J.Am.Stat.Ass. 64:399-402.

MELLINGER, J., 1983. Egg-case diversity among dogfish, *Scyliorhinus canicula* (L.) : a study of egg laying rate and nidamental gland secretory activity. J.Fish.Biol. 22:83-90.

RAGONESE, S. & JEREB, P., 1990. Egg-case of the dogfish *Scyliorhinus canicula* (L., 1758) from the Sicilian Channel (Mediterranean Sea). Part II : Morphometric relationships. C.I.E.S.M. XXXIInd Congress, Perpignan, October 1990.

SOKAL,R. & ROHLF, F.J., 1969. Biometry. Freeman, W.H. and Company, San Francisco, 776 pp.

V

Egg-Case of the Dogfish *Scyliorhinus canicula* (L., 1758) from the Sicilian Channel (Mediterranean Sea). II.- Morphometric relationships

Sergio RAGONESE and Patrizia JEREB

I.T.P.P., C.N.R., Via L. Vaccara 61, 91026 Mazara del Vallo (Italia)

Looking at the geographical variation in the egg-cases dimensions of different populations of *Scyliorhinus canicula*, a positive relationship between egg-case size and total length of specimens has been pointed out (Capapé, 1977). Within a wider research program on the smallspotted catshark of the Sicilian Channel (see the companion paper, Ragonese & Jereb, 1990), relationships between median length (ML ; 0.1 mm), maximum width (MW ; 0.1 mm) and virtual surface (SF = ML*MW ; mm^2) of the egg-cases and total length (TL ; 0.5 cm ; fig.1) gonadic weight (GW ; 0.1 gr) and somatic weight (SW ; 0.1 gr) of specimens were studied. Length index (LI = ML/TL %), surface index (SI=SF/TL %) and gonadic index (GI=GW/SW %) were also analysed. A set of 156 egg-cases (one for each specimen) constituded the data-base.

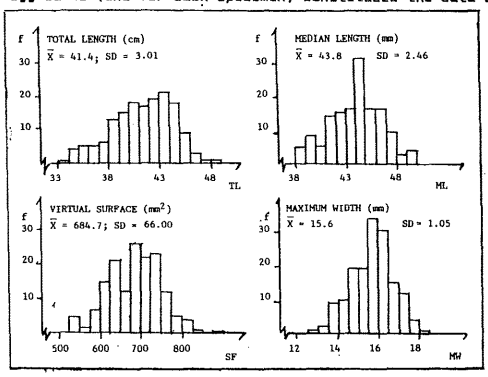


FIG.1 - Frequency distribution and descriptive statistics (X mean; SD = standard deviation) of egg-cases (ML, MW and SF) and specimens (TL) dimensions; f = absolute frequencies.

Median length and maximum width ranges observed (ML : 3.8 - 4.9 cm ; MW : 1.3 - 1.8 cm) correspond to those reported for the tunisian waters (Capapé, 1977), are lower but still comparable to those from the Adriatic Sea (Jardas, 1979) and the french Mediterranean (Mellinger et al., 1984), but, as expected, are different from those reported for the Atlantic (Mellinger et al., 1984). Total length, median length, maximum width and virtual surface frequency distributions are reported in fig.1 . With only one exception (TL ; p=0.023), all frequency distributions (variables reported in tab.1) were significantly comparable to the normal one (Kolmogorov-Smirnov one sample test using standard normal distribution; Lilliefors, 1967), even thought that of the maximum width in a marginal way (p=0.058).

	ML	MW	SF	TL	GW	SW	LI	SI
MW	.234	-						
SF	.739!	.827!	-					
TL	.399	.526	.591	-				
GW	.324	.572	.587	.530	-			
SW	.385	.574	.617	.922	.626	-		
LI	.352!	-.370	*.051!	-.714!	-.307	-.641	-	
SI	.531!	.525!	.673!	*.196!	.216	-.094	.594!	-
GI	*.005	*.177	*.134	*.192	.665!	*.138!	*.181	.326

TAB.1- Correlation matrix: ! = Autocorrelated variables (e.g. SF = ML*MW); * = H_o: $\rho_{12} = 0$ not rejected at $\alpha = 0.01$ (2 sided).

Qualitative analysis of the scatter-plots generally indicated a wide-spread distribution of points, suggesting the use of no particular regression model than the linear one. Pearson correlation matrix (tab. 1) shows that egg-case dimensions (ML, MW and SF) are, all together, more correlated to the somatic weight (SW) and highly significantly independent (p<0.01) of the gonado-somatic index (GI). Considering also the autocorrelation problem when using indexes, the individual parameter more correlated to size variations (total length and somatic weight) seems to be the maximum width, as pointed out for the french Mediterranean by Mellinger (1983); nevertheless, the virtual surface, as derived by the two variables median length and maximum width, constitutes a more useful variable. Anyway, only a small portion (less than 40-50 %) of the observed variability is explained by these correlation coefficients. Thus, other physiological and/or environmental factors beyond those strictly related to geographical different areas, seem to affect the kind of relationship existing between egg-case dimensions and size of the specimen.

REFERENCES

CAPAPE', C., 1977. Bull.Off.natn.Pêch. Tunisie 1(1):83-101.

JARDAS,I.,1979. Izv-Rep.Inst.Oceanogr.Ribar.Split Vol.IV(2-3):104 pp.

LILLIEFORS,H.W., 1967. J.Am.Stat.Ass. 64:399-402.

MELLINGER,J., WRIBEZ,F. & ALLUCHON-GERARD,M.-J., 1984. Cah.Biol.Mar. 25:305-317.

RAGONESE,S. & JEREB,P.,1990. C.I.E.S.M., XXXII Congress, Perpignan, October 1990.

V-IX10

Données sur la reproduction de *Scorpaena porcus* du Golfe de Gabès

Med Nejmeddine BRADAI* et Abderrahmen BOUAIN**

*Institut National Scientifique et Technique d'Océanographie et de Pêche 3029 Sfax (Tunisie)
**Faculté des Sciences, 3029 Sfax (Tunisie)

Nous rapportons ci-dessous quelques observations concernant la reproduction de la rascasse brune S. porcus, vivant dans le golfe de Gabès. Ce Scorpaenidé est abondant particulièrement dans les apports de la pêche côtière.

SEX-RATIO : 78,95 % des 684 individus examinés sont des femelles, celles-ci présentent une dominance statistiquement significative (X^2= 229). Cette dominance des femelles est constatée pratiquement tout au long de l'année.
L'étude du sex-ratio par classe de taille (Fig.1) montre que le pourcentage des femelles augmente avec la taille. Ce résultat peut être biaisé par le faible nombre d'individus dans les dernières classes.

TAILLE ET AGE DE 1ère MATURITE SEXUELLE : Les tailles de première maturité sexuelle ont été déterminées en pleine période de reproduction des poissons.
Les plus petites femelles matures mesurent 100 mm de Lst et les plus grandes femelles immatures mesurent 140 mm (Tabl. 1). La taille pour laquelle 50 % des femelles sont matures est de 108 mm soit à un age de 3ans (BRADAI et BOUAIN, 1988). A partir de 150 mm, la totalité des femelles sont matures. Ces résultats soulignent la grande variabilité de la taille de première maturité sexuelle.
Le plus petit mâle observé microscopiquement, susceptible d'émettre de la laitance, mesure 85 mm et est âgé de 2 ans.

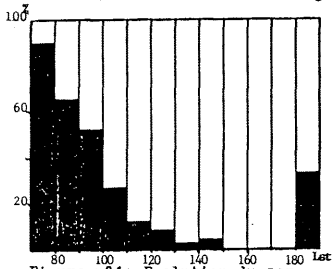


Figure n°1: Evolution du sex-ratio de S. porcus (% des mâles) par classe de taille.

Taille	Matures	Immatures	% matures
90	0	11	0
100	9	16	36,00
110	20	17	54,05
120	33	13	71,74
130	37	2	94,87
140	29	2	93,54
150	21	0	100
160	8	0	100
170	2	0	100
180	3	0	100

Tableau n°1 : Pourcentage des femelles matures en fonction de la taille chez S. porcus.

PERIODE DE PONTE : Le rapport gonado-somatique (R.G.S.) atteint son maximum, chez les femelles, au mois de Juin. Le développement des ovaires se situe essentiellement entre Avril et Juin. Le R.G.S. chute par la suite jusqu'au mois d'Août (Fig.2).
Chez les mâles la phase de maturation des gamètes parait se situer entre le mois de Mars et le mois de Mai. Le frai pourrait s'étaler de Mai à Septembre (Fig.2).
Nous devons souligner que le R.G.S. est nettement plus élevé chez les femelles que chez les mâles. Les testicules sont d'ailleurs le plus souvent filiformes, les plus développés sont blancs et n'occupent cependant qu'une partie infime de la cavité abdominale.

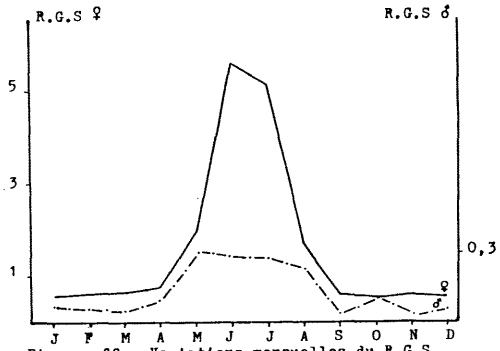


Figure n°2 : Variations mensuelles du R.G.S. chez S. porcus.

FECONDITE : L'étude de la fécondité totale a été réalisée sur 10 femelles de Lst comprise entre 105 et 163 mm et de masse comprise entre 49 et 181 g pêchées au mois de juin.
Les équations reliant la fécondité (F) à la taille (Lst), à la masse corporelle (Me) et à la masse des gonades (Mg) ont été établies :

$F = 3,23\ 10^{-2}\ Lst^{2,62}$ (r = 0,849)
$F = 214,22\ Me^{0,87}$ (r = 0,838)
$F = 3536,88\ Mg^{0,68}$ (r = 0,603)

Pour les tailles comprises entre 105 et 163 mm, la fécondité totale calculée varie de 6341 à 20.062 ovocytes. La fécondité relative est en moyenne de 2300 ovocytes par gramme d'ovaire et de 113 ovocytes par gramme de masse corporelle.

REFERENCE :

BRADAI M.N. et BOUAIN A., 1988 - Age et croissance de S. porcus et S. scrofa du golfe de Gabès. Bull.Inst.Natn.Scient.Tech.Océanogr. Pêche Salammbô, 15-88 : 13-37.

V-X1

Some aspects of biology and population dynamics of the Hake (*Merluccius merluccius*) from the Adriatic Sea

Veronica ALEGRIA and Stjepan JUKIC

Institute of Oceanography and Fisheries, P.O. Box 114, Split (Yugoslavia)

Among the heavily exploited demersal stock in the middle and northern part of the Adriatic, the population of the european hake from the Jabuka Pit (open middle Adriatic) has been an important target of the commercial trawl fishery. Annual fluctuations of the juvenile and the spawning stock for the period 1960-1986, point to similar, although opposite trend in abundance indices, the annual fluctuations of spawning stock however, lagging behind those of juveniles for two or three years. Calculations suggest that a density dependent relationship exists between the stock recruit strength and the adult stock.

On the basis of monthly fluctuations of indices of relative abundance of juvenile hake it may be stated that juvenile stock reaches a significant maximum in spring (May) and another, lower, in autumn (ALEGRIA and JUKIC, 1988). All evidences show that the reproductive cycle of this species extends almost all year round. The earlier spawning begins in winter, in deeper sea water layers (about 200 m). In spring-summer hake spawn in shallower waters (ZUPANOVIC and JARDAS, 1986). As to the life cycle of the Adriatic hake it was found that the smallest mature male in samples from 1988-1989 measured 23 cm and female 28 cm in total length. According to ZUPANOVIC (1968), males mature at 20-28 cm and females at 23-33 cm total length. It was confirmed that individuals attaining first maturity leave the channel regions of the eastern Adriatic coast, i.e. their feeding grounds, and migrate towards the open and deeper waters of the Jabuka Pit. This area is held to be the main hake spawning ground in the Adriatic. The larger number of eggs and larvae were found in this area during autumn-spring, with maximum in January and February (KARLOVAC, 1965). Juvenile individuals remain in this area by the end of the first year and the beginning of the second year, changing food and feeding habits (JUKIC, 1972).

All these changes are reflected upon the hake otoliths. During the first year of life period two to four not clearly distinct hyaline zones are formed round the otolith primordius. The last one is best developed and may be easily distinguished as a complete hyaline zone and is very likely indicative of the habitat change.

The following growth parameters were calculated: L_∞ = 92.83 cm total length, K = 0.097 and t_o = -0.692. Obtained values are slightly higher than those obtained earlier by ALEGRIA et al. (1982), but smaller than those calculated using the length at age data of ZUPANOVIC (1968). However, growth pattern was observed to differ between males and females coinciding with the different minimum body length at the onset of first maturity.

It was found that otolith length of males of 12-38 cm exceeded that of the females of 14-55 cm. However, if only juvenile and adolescent individuals are considered, the intervals of slow growth coincide to a certain extent. A possible explanation of these differences is that males grow slowly in comparison to females and that they have bigger otoliths than the same size females.

On the other hand, if the onset of first maturity of females occurs at older age than in the case or males, than the reproductive life of females is shorter. This problem should be accounted for by further and more detailed studies, especially the influence and relationship of the reproductive potential of spawning stock on recruit stock strength.

REFERENCES

ALEGRIA, V. and S. JUKIC, 1988. Stock-recruitment relationship of the hake (*Merluccius merluccius*) in the open middle Adriatic. (Jabuka Pit). FAO Fish. Rep., (394): 137-141.

ALEGRIA, V., B. GRANIC and S. JUKIC, 1982. The protection of the hake (*Merluccius merluccius* L.) in the Adriatic Sea by regulation of the level of exploitation. Acta Adriat., 23 (1/2): 431-440.

JUKIC, S., 1972. Nutrition of the hake (*Merluccius merluccius*), bogue (*Boops boops*), striped mullet (*Mullus barbatus*) and pandora (*Pagellus erythrinus*) in the Bay of Kastela. Acta Adriat., 14 (4): 3-45.

KARLOVAC, J., 1965. Contribution à la connaissance de l'écologie du merlu *Merluccius merluccius* dans le stade planctonique de sa vie en Adriatique. Rapp. Comm. int. Mer Médit., 18 (2): 461-464.

ZUPANOVIC, S., 1968. Study of hake (*Merluccius merluccius* L.) biology and population dynamics in the central Adriatic. Stud. Rev., 32: 1-24.

ZUPANOVIC, S. and I. JARDAS, 1986. A contributio to the study of biology and population dynamics of the Adriatic hake *Merluccius merluccius* (L.). Acta Adriat., 27 (1-2): 97-146.

V

Biology and population dynamics of Picarel (*Maena smaris* L), Family Centracanthidae, in the waters of Cyprus

R.-J. LIVADAS

Department of Fisheries, Nicosia (Cyprus)

Introduction

Maena smaris L, is one of four species of the family Centracanthidae inhabiting the seas of Cyprus. It is one of the most important commercially species landed by the fishery in Cyprus. The study of this species was undertaken for the purpose of obtaining its biological parameters and other data necessary for the rational exploitation and management if its stocks.

Materials and Methods

A total of 46678 fish were measured for length distribution on board commercial trawlers and inshore fishing boats during 1966-1984. A further lot of 1530 specimens were examined for population analysis in the laboratory. Total length (LT) was taken to the 1/2 or 1-cm below. Age determination was done from otolith and partly from scale readings. For determination of maturity stages, the 8-stage Classification scale by Maier was used. (Laevastu 1965).

Age designation: This is shown below:

Age-group	0	I	II	III
Months old	0-9	10-22	23-35	35-47
Year-rings	0	1	2	3

The above designation agrees with the age-designation by Chugunova (1959) and Williams & Bedford (1973).

Results

Length-weight relation. M+F $W = 1.45715 \times 10^{-2} \times L^{2.85}$

V.Bertalanffy's Growth Formula parameters.
M+F L_{∞}= 22.2cm K = 0.24 t_o = -1.0 W_{∞}=100g

Maximum age: 3.2 years

Sexual inversion: In Maena smaris appears the phenomenon of sexual dimorphism (proterogynous hermaphroditism) at the age of 2 years old. Maena smaris matures genetically at a length of about 10cm in its first year of life (11-12th month). Spawning starts at the end of March and is completed by the end of May. Female fish precedes male in the spawning process by 3 weeks at least. The catch of the trawl fishery consists of 4 age-groups, 0-III, of which age-groups I and II are the most important, providing the bulk of the trawlers' landings. The catch of the inshore fishery consists mainly of age-groups II and III, the most important being age-group II.
Age and length of recruitment to the trawl fishery:

t_c= 6-7 months old l_c = 6-7 cm

and for the inshore fishery t_c = 2 years old l_c=12-13 cm

Total mortality (Z) and Fishing mortality (F) for the period 1966-1984, fluctuate for the trawl fishery between:

Z= 0.37-0.70 F= 0.07-0.40

and for the inshore fishery:

Z= 0.58-0.99 F= 0.28-0.69

References.

CHUGUNOVA N.I. (1959). Age and Growth studies in Fish Trans. from Russian. Publ. by Israel Program for Scientific Translations Ltd. p:132

LAEVASTU T.(1965). Manual of Methods in Fisheries Biology FAO Man. Fish. Sci. No. 1

WILLIAMS T& B.G.BEDFORD (1973). The use of otoliths for age determination.
Int. Symposium of the ageing of fish.
p: 114-123
Ed. T. B. Bagenal F.B.A. Publishers: Unwin Bros.

V

Natural History of Sole (*Solea vulgaris* L. 1758) in the Amvrakikos Gulf (Greece)

C. PAPACONSTANTINOU, G. PETRAKIS and E. CARAGITSOU

National Centre for Marine Research, Hellenikon, Athens (Greece)

INTRODUCTION

Sole, Solea vulgaris L., is an important commercial species of flatfish, which contributes to the fisheries in estuaries, backwaters and inshore areas. It ranges from Senegal to Norway, along the eastern coast of the Atlantic Ocean, the Mediterranean Sea and the southwestern Black Sea (Whitehead et al.,1986). The species is very common in Greek seas, living on soft bottom at depths ranging from 5 to 80m, and it is actively exploited, mainly by coastal fisheries. Several authors have summarized and discussed the occurrence and life history of the species in the Mediterranean Sea, but no relative information is available of Greek seas. The purpose of this work was to investigate certain aspects of the life history of sole in the Amvrakikos gulf (Greece).

MATERIAL AND METHODS

Between December 1986 and March 1987, monthly samples of sole, amounting to 237 speciemns, were obtained from trammel net catches. All nets were 1.2m deep by 200-250m long and had 3 panels of mesh 40-(16-17)-40mm from knot to knot. The duration of fishing varied between 10 and 14 h. Total length (TL) to the nearest mm, weight to the nearest g, sex and gonad maturity, when possible, were recorded. Age was determined by otolith reading. Mortality estimates were calculated by the catch curve method of Pauly (1983).

RESULTS

A length-frequency distribution of 237 soles based on the total length at capture, over the study period, is illustrated in Fig.1. Since the size of the sample and the sampling period were small, all data were combined. Both sexes were combined, since no difference in length was found between them.The TL distribution ranged from 9.0 to 35.0cm, whilst the major peak of abundance was in the length range 21.0-31.0 cm. The

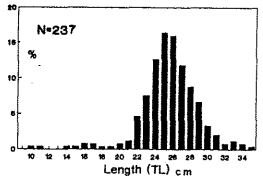


Fig.1. Length frequency distribution of sole (1986-1987)

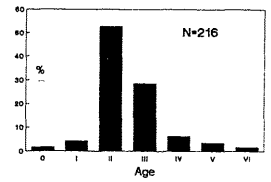


Fig.2. Age distribution of sole in the Amvrakikos Gulf (1986-1987)

presence of young sole, 9.0-21.0cm, representing age group 0+ and I+, was very low, not exceeding 13%.

The age distribution of sole, presented in Fig.2, shows that the longest size grouping included fish with ages ranging from 0 to VI years, whilst the age groups II and III were represented by over 80%. The scarcity of <II+ can be attributed to the selective action of the trammel nets used and to the dispersal of fish according to maturity or their ecology in different parts of the gulf.

The relationship between total length (TL) in mm and otolith radius (R), obtained with 211 individuals, was: TL=66.2+3.66XR (correlation coefficient 0.954).

TABLE I. Back-calculated TL in mm of sole from the Amvrakikos Gulf

Age group	Number of individuals	Length at capture	Calculated length at end of year I	II	III	IV	V	VI
I	10	180.9	164.3					
II	113	241.6	171.7	221.5				
III	62	266.1	170.4	223.2	250.9			
IV	14	283.9	168.8	219.2	250.8	296.6		
V	7	299.9	172.9	227.3	258.6	282.2	296.3	
VI	5	330.0	173.1	228.0	262.4	291.7	312.2	326.8
Average length			170.8	222.2	252.1	277.2	302.9	326.9
Number of individuals			211	201	88	26	12	5

The growth parameters were obtained from the length at time of capture for all fish aged 0-VI (sexes combined) and used to calculate the von Bertalanffy equation. The asymptotic length was found 348.8 mm, the growth coefficient (K) was 0.38, and the ''age'' at which the fish would have length zero if they always grew according to the equation (t_0) was equal to -0.41.

The length-weight relationship was developed using the general equation W=aL^b, where W weight in g. and L length in mm. No significant differences was found between sexes (analysis of covariance test).During the course of the survey, a total of 237 fish was weighed and the computed length-weight relationship (sex combined) was a=0.000003 and b=3.172.

As sampling was not representative over the whole year, the estimated mortality refers to the winter months, which are also those of the reproduction.A length converted catch curve based on the total catch was used to calculate total mortality (Z)= 0.769 (Pauly, 1983). An empirical estimate of the natural mortality (M)=0.26 was obtained using Pauly's equation (1983).Thus, the exploitation ratio was computed,E=0.75, indicating that the fishing pressure on the sole stock in the area was rather high. The reproduction in the Amvrakikos Gulf takes place between December and March. Some immature individuals were caught in summer.

REFERENCES

PAULY, D., 1983. FAO, Fish.Tech.Paper, No 234.
WHITEHEAD,P.J.P., BAUCHOT,M.-L, HUREAU,J.-C, NIELSEN,J & E.TORTONESE, 1984-1986. UNESCO ed., vol.I,II,III, 1473p.

V-X4

Quelques aspects de la Biologie de *Bothus podas* (Delaroche, 1809) (Osteichthyes, Bothidae) dans la Région du Golfe de Valence (Méditerranée Occidentale)

Antonio SANZ BRAU

Departamento de Ecologia (Biol. Marina), Facultat de Ciencies Biologiques, Universitat de Valencia, Burjasot (Espana)

Le rombou podas Bothus podas est une espèce benthique commune dans toute la Méditeranée et l'Atlantique oriental, depuis les côtes du golfe de Cadiz jusqu'à l'Angola (TORTONESE, 1975; NIELSEN, 1986). Poisson côtier, dans la region du golfe de Valencia c'est un habitant commun des fonds de sable de faible profondeur. La biologie de B. podas dans cette region est inconnue. Nous apportons dans ce travail les premieres données sur ce poisson.

Nous avons étudié 831 individus de Bothus podas provenant des chalutages effectués par les bateaux de la pêche industrielle du port de Valencia (golfe de Valencia) pendant les mois de décembre 1988 et de mars, septembre, octobre et novembre 1989. Cette espéce ne fait pas l'objet d'une pêche importante, car elles n'est présente que pendant quelques mois.

La figure 1 présente globalement les résultats de la structure de la population d'apres les histogrammes de fréquences des longueurs totales (classes de 1 cm) pendant les cinq mois étudiés. Les mâles ont une taille plus grande que les femelles, mais cette différence est seulement significative pour les prélèvements réalisés en décembre et en mars (tableau I).

Les mâles sont plus nombreux que les femelles. Le sex-ratio est 4:3 (X^2_1 = 0.1299, n.s.) sans variation selon les échantillons (X^2_4 = 6.5824, n.s.).

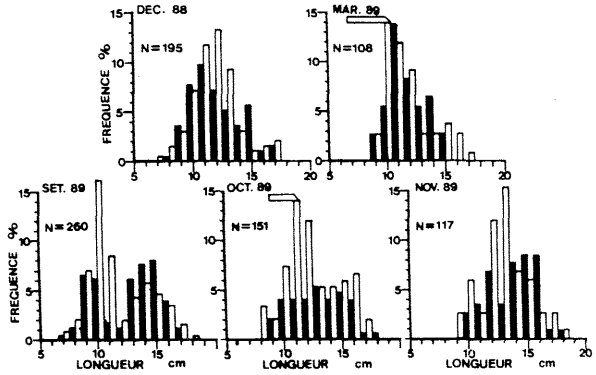


Fig. 1.- Histogrammes des fréquences des tailles.

	MALES		FEMELLES		t	SIGNIFICATION
	N	Taille (cm)	N	Taille (cm)		
Dec. 88	106	12.05 ± 0.18	89	11.34 ± 0.22	2.422	0.05
Mar. 89	60	11.90 ± 0.25	48	11.01 ± 0.22	2.531	0.05
Sep. 89	146	11.90 ± 0.20	114	11.89 ± 0.24	0.032	n.s.
Oct. 89	101	12.55 ± 0.22	50	12.27 ± 0.32	0.727	n.s.
Nov. 89	67	13.20 ± 0.24	50	13.09 ± 0.27	0.321	n.s.

Tab. I.- Tailles moyennes des mâles et des femelles.

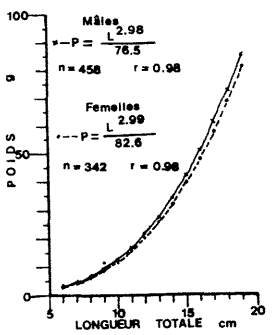


Fig. 2.- Rélations taille/poids.

Une caractéristique de cette espéce est son dimorphisme sexuel, notamment apparent au niveau de la distante interorbitaire. Chez les mâles l'éloignement des yeux est plus grand que chez les femelles; mais cette différence n'est seulement appréciable que chez les individus de taille superieure à 8 cm de longueur totale.

Le graphique de la figure 2 représente la relation taille/poids des mâles et des femelles. On voit que les poids des mâles sont superieurs ceux des femelles pour une même taille. Il existe donc encore à ce niveau un certain dimorphisme sexuel.

REFERENCES

NIELSEN, J.G., 1986.- Bothidae, in "Fishes of the North eastern Atlantic and the Mediterranean". vol III. UNESCO. pp: 1294-1298.

TORTONESE, E., 1975.- Osteichthyes (Pesci ossei). Fauna d'Italia. Ed. Calderini. Bologna. 636 pp.

V-X5

Approche de la croissance de l'Espadon *Xiphias gladius* en Méditerranée Algérienne

A. CHALABI, H. DIB, A. OURDANI et S.-M. KAHMOUN

Institut des Sciences de la Mer et de l'Aménagement du Littoral, I.S.M.A.L., B.P. 90, Alger 1er Novembre, Alger (Algérie)

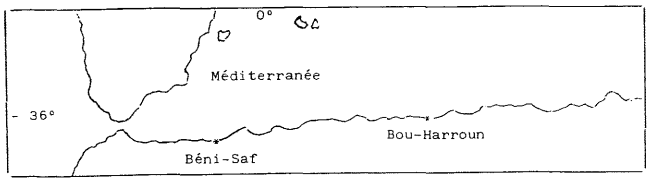
Les stocks de grands pélagiques constituent une ressource mal connue en Algérie. Leur pêche, considérée comme marginale, saisonnière, est pratiquée par des petits-métiers, palangre de surface pour les espadons et ligne morte pour les thons rouges.

L'amélioration de la pêche de ces espèces à haute valeur commerciale nécessite une modernisation technologique possible grâce à une connaissance approfondie de leur écologie, de leur biologie et de leur dynamique. A ce titre, un axe de recherche a été initié à l'ISMAL en 1989. Les premiers résultats concernent la croissance de l'espadon capturé en deux régions d'Algérie. Béni-Saf à l'Ouest et Bou Haroun au centre.

On a échantillonné respectivement 141 et 197 individus aux ports de Béni-Saf et de Bou Haroun de mai à août 1989. L'approche de la croissance a été abordée par l'analyse des fréquences de tailles (PETERSEN, 1892) pour les deux régions. Une méthode directe a été utilisée d'autre part pour les individus capturés à Béni-Saf ; elle consiste à déterminer les marques chronologiques observées sur les deux premiers rayons de la nageoire dorsale (R.E.N.D.). Pour cela des coupes sur lames minces (40 à 100 µm) ont été réalisées.

Les tailles modales correspondent à des longueurs sans rostre (LSR), mesurées à la fourche, exprimées en cm.

La relation d'allométrie entre la taille et le poids a été établie pour les captures de Béni-Saf. Le poids utilisé concerne le poids éviscéré (WE). La relation a été établie pour la longueur à la fourche, rostre compris (LF) et sans rostre (LSR).



La détermination des modes obtenus par les deux méthodes est présentée dans le tableau suivant :

Région	Méthode de PETERSEN					Lecture directe	
Béni-Saf	84,6	103,6	119,6			86	107
Bou Haroun	87,6	102,4	117,6	130	142,4		

Les trois premiers modes obtenus sont sensiblement égaux pour les échantillons des deux régions. Toutefois, les quatrième et cinquième modes n'apparaissent pas dans les captures de Béni-Saf, en raison semble-t-il d'un effectif très réduit dans les grandes tailles qui sont d'ailleurs inférieures à celles de l'échantillon de Bou Haroun.

La méthode directe à partir de l'observation du R.E.N.D. a montré deux modes pour des individus dont la longueur sans rostre varie entre 80 et 110 cm. Les tailles moyennes sont comparables à celles obtenues par la méthode de PETERSEN dans les deux régions.

Le taux de croissance entre deux modes successifs pour l'échantillon de Bou Haroun varie mais ne diminue pas avec l'âge. Cette observation indiquerait une croissance différentielle intra-spécifique due peut-être aux facteurs trophiques qui fluctuent avec les conditions de l'environnement. Pour les individus pêchés à Béni-Saf, le taux de croissance semble diminuer avec l'âge mais ceci n'est pas évident en raison de l'absence des quatrième et cinquième modes.

La relation taille-poids de l'espadon pour la région de Béni-Saf est la suivante :

$$WE = 5{,}188\ 10^{-6}\ LSR^{3{,}168} \quad \text{avec} \quad r = 0{,}957$$

$$WE = 7{,}018\ 10^{-6}\ LF^{2{,}869} \quad \text{avec} \quad r = 0{,}923$$

Le poids est exprimé en kg et les longueurs en cm. D'après le coefficient de corrélation, la relation est plus précise lorsque la longueur ne tient pas compte du rostre. Un test statistique (SCHWARTZ, 1963) indique qu'au seuil de confiance α = 5 %, la croissance de l'espadon peut être considérée comme étant isométrique.

Ces résultats préliminaires ne permettent pas d'établir une clé âge-longueur de l'espadon pêché près des côtes algériennes, bien que certains auteurs (BERKELEY et HOUDE, 1983 ; WILSON et DEAN, 1983) modélisent sa croissance selon l'équation de VON BERTALANFFY pour des spécimens capturés en Atlantique. Les méthodes statistiques qui nécessitent des effectifs élevés sont difficilement applicables sur une telle espèce de taille importante, dont les captures sont faibles en l'état actuel de la pêcherie. En conséquence, l'étude se poursuit en utilisant le second rayon de la nageoire anale pour la lecture de l'âge (BERKELEY et HOUDE, 1983). L'étude de la croissance de l'espadon est menée simultanément avec celle du régime alimentaire qui pourrait indiquer l'impact d'éventuelles périodes de disette sur le taux de croissance.

La structure démographique des poissons échantillonnés indique que seuls les juvéniles sont actuellement accessibles. Il reste à localiser les grands individus du stock ce qui est programmé dans le cadre de la campagne de recherche prévue pour l'été 1990.

BERKELEY S.A. et HOUDE E.O., 1983. U.S. Dept Commer. NOAA Tech. Rep. NMFS, 8 : 137-143.

WILSON C.A., et DEAN J.M., 1983. U.S. Dept Commer. NOAA Tech. Rep. NMFS, 8 : 151-156.

V

Croissance linéaire du Pageot Commun (*Pagellus erythrinus*) du Golfe de Gabès

Mohamed GHORBEL* et Abderrahman BOUAIN**

*Institut National Scientifique et technique d'Océanographie et de Pêche, 3029 Sfax (Tunisie)
**Faculté des Sciences de Sfax, 3038 Sfax (Tunisie)

ABSTRACT : The age and growth of common pandora (Pagellus erythrinus) living in the gulf of Gabès have been studied by scalimetric method and the theorical growth equations calculated. The results are compared with those obtained in other parts of the Mediterranean Sea.

RESUME : Nous avons étudié par scalimétrie la croissance linéaire du pageot commun (Pagellus erythrinus) du golfe de Gabès. Les résultats sont comparés avec ceux obtenus dans d'autres régions de la Méditerranée.

ESTIMATION DE L'AGE : L'observation des écailles du Pageot Commun (Pagellus erythrinus) montre que les stries d'arrêt de croissance apparaissent principalement au mois de Mai ; la ponte a lieu entre Mai et Juillet. Ce qui nous a permis de déterminer l'âge approximatif de ces poissons (tabl. 1).

Age en mois		10-12	22-24	34-36	46-48	58-60	70-72	82-84
Mâles	A	8,62	11,16	13,03	14,36	15,37	16,70	19,10
	B	8,61	10,92	12,91	14,61	16,07	17,32	18,40
	n	195	174	127	70	24	8	2
Femelles	A	8,54	11,15	12,85	14,22	16,16	18,35	20,75
	B	8,70	11,10	13,20	15,04	16,64	18,04	19,26
	n	282	202	77	32	10	4	2
Mâles + Femelles	A	8,58	11,16	12,94	14,31	15,58	17,25	19,93
	B	8,39	10,86	13,02	14,90	16,54	17,97	19,22
	n	483	380	208	104	35	12	4

Tableau 1 : Age approximatif et taille (Lst en cm) déterminée par scalimétrie (A) et par le modèle de Von BERTALANFFY (B) chez P. erythrinus du golfe de Gabès ; n : effectif.

CROISSANCE LINEAIRE : Les équations de regression reliant la longueur standard du poisson (Lst en cm) au rayon total de l'écaille (R en mm) figurent dans le tabl.2.

A partir de ces équations, nous avons calculé la taille des poissons à l'apparition de chaque anneau d'arrêt de croissance (tabl. 1).

	Equations	r	n
Mâles	$Lst = 5,335\ R^{0,850}$	0,901	203
Femelles	$Lst = 5,054\ R^{0,883}$	0,904	317
Mâles + femelles	$Lst = 4,988\ R^{0,901}$	0,920	527

Tableau 2 : Relation entre la taille (Lst en cm) et le rayon de l'écaille (R en mm) chez P. erythrinus du golfe de Gabès, n : effectif, r : coefficient de corrélation

MODELE THEORIQUE DE LA CROISSANCE : Pour déterminer les paramètres de l'équation théorique de Von BERTALANFFY, nous avons pris en considération l'âge maximum (tab.1) estimé à l'apparition de chaque anneau d'arrêt de croissance. Ces paramètres sont consignés dans le tableau suivant (Tabl. 3).

	Lst ∞ (cm)	K	t_0(ans)
Mâles	24,900	0,153	- 1,774
Femelles	27,781	0,135	- 1,791
Mâles + Femelles	27,714	0,137	- 1,631

Tableau 3 : Paramètres de l'équation de Von BERTALANFFY

DISCUSSION : Les valeurs des longueurs standards estimées à partir de l'équation de Von BERTALANFFY (B) sont très proches de celles déterminées par le calcul retrospectif (A) (tabl. 1). Ce modèle s'applique donc à la croissance des pageots.

Dans le golfe de Gabès les femelles de Pagellus erythrinus ont une croissance légèrement plus rapide que celle des mâles (tabl. 1).

La croissance linéaire de Pagellus erythrinus dans le golfe de Gabès est comparable à celle dans le canal de Sicile (ANDALORO et PRESTIPINO - GIARRITA, 1985) et à Chypre (LIVADAS, 1988) ; alors qu'elle est meilleure dans le golfe du Lion (GIRARDIN et QUIGNARD, 1985) (Fig. 1).

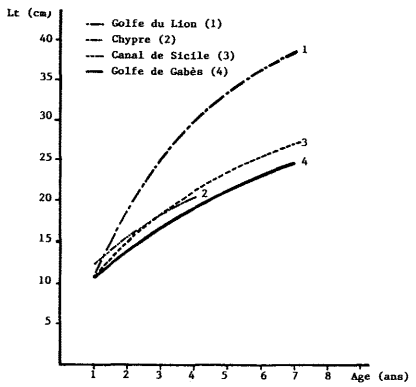


Figure 1 : Longueur totale (Lt) en fonction de l'âge chez P. erythrinus dans divers secteurs de la Méditerranée.

BIBLIOGRAPHIE

- ANDALORO, F. et PRESTIPINO-GIARRITA, S. - 1985 : Contribution to the age, growth and feeding of pandora Pagellus erythrinus (L. 1758) in the Sicilian Chanel. F.A.O. Fish. Rep., 336 : 85-87.
- GIRARDIN, M. et QUIGNARD, J. P. - 1985 : Croissance de Pagellus erythrinus (Pisces : Teleostean, Sparidae) dans le Golfe du Lion. Cybium, 9(4) : 359 - 374.
- LIVADAS, R. J. - 1988 : A Study of the Biology and Population Dynamics of Pandora (Pagellus erythrinus L. 1758), Family Sparidae, in the seas of Cyprus. F.A.O. Fish. Rep., 412 : 58 - 76.

First Age Estimates of Albacore, *Thunnus alalunga* Bonn., in the Aegean Sea using scales

Persefoni MEGALOFONOU

Dipartimento di Produzione Animale, Università di Bari, Bari (Italia)

INTRODUCTION Albacore distribution in the Aegean sea is discontinuous with a higher concentration mainly in the north between the Sporads islands and the penisula of Chalkidiki where the most important Greek fishery fleet for albacore operates since several years.

Preliminary data on fishing grounds, fishing period, total catch and size distribution are reported by DE METRIO G. et al.(1988) but there is no certain data about the age structure of the stock in this area. Age estimates have been made for albacore in the Central Mediterranean using the scales (CEFALI A. et al., 1982). Some other estimates were perfomed in the Atlantic using different methods (BEARDSLEY G.L.,1971; BARD F.X., 1974; GONZALEZ-GARCES A. and A.C.FARINA-PEREZ, 1983). This study is a first approach to evaluating the age and the growth of albacore caught in the Aegean sea using the scales.

MATERIALS AND METHODS The fork length and the weight of 868 fish in 1986 and 379 in 1987 was measured at Alonisos port. Scales were collected from 219 fish during the autumn of the same years. Date of capture and fork length (FL) were recorded for each specimen. For the age estimation, reading of the scales was performed under an optical microscope. The average lengths (FL) at age were calculated.

RESULTS AND DISCUSSION The fork length (FL) of the albacores ranged from 54.8 to 82 cm and the age estimated were from 1+ to 6+ years. The smallest specimen of the sample was 1+ year old while the largest was 4+ years old. A size-age key for 219 albacores grouped in size classes of 2 cm is given in Table I.

Table I. Size-age (estimated) key of the 219 albacores studied. The fork length (FL) is regrouped in classes of 2 cm.

FL (cm)	Estimated age							
	0+	1+	2+	3+	4+	5+	6+	TOT
54-56		1	1					2
56-58		3						3
58-60			2					2
60-62			8	1				9
62-64			20		1			21
64-66			31	10				41
66-68			16	23	1			40
68-70			5	32	1			38
70-72				15	11			26
72-74				4	12			16
74-76				1	10	2		13
76-78					1	1		2
78-80				1	1	2	1	5
80-82					1			1

The age classes most present in the sample were classes II, III and IV with a percentage of 37.9%, 39.7% and 17.8% respectively. Very few individuals, practically 4.6% of the sample, were estimated as belonging to the age classes I, V, and VI.

Size distribution of the catch in 1986 and 1987 is reported in the Fig.1. The average fork length of the albacore was 68 cm in 1986 and 67.6 cm in 1987 where the average weigth was 5.8 kg and 5.7 kg respectively. Most of the caught fish lengths (FL) ranged between 60 and 74 cm correspond to individuals of the second, third and fourth age classes, 39.3% - 41.8% - 12.8% in 1986 and 37.5% - 39.9% -12.2% in 1987 respectively, according the estimated size-age key. In the table II, the average values of length (FL) at age classes are reported.

Table II. Average fork length at age classes and standard deviation estimated.

AGE CLASSES	n	FL (cm)	st.deviation
I	4	56.5	0.8
II	83	64.5	2.5
III	87	68.8	2.6
IV	39	73.0	2.9
V	5	77.0	1.5
VI	1	79.0	-

Taking into account the very limited number of the individuals in the sample, smaller than 60 cm and bigger than 76 cm, we do not consider the estimates of the length at age for the classes I, V and VI as representatives. It is obvious that a sample including more individuals of the extreme length classes should be studied. Furthermore results obtained by various authors using the same or different methods differ; so given the importance of a correct age estimation for the stock assessment, a validation of the used method must be performed.

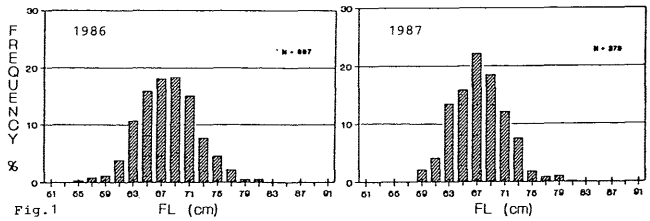


Fig.1

REFERENCES

BARD F.X. (1974) Etude sur le germon (Thunnus alalunga, Bonnaterre 1788) de l'Atlantic Nord. Elements de dynamique de population. ICCAT Collect.Vol.Sci.Pap., Madrid 2:198-224

BEARDSLEY G.L. (1971) Contribution to the population dynamics of Atlantic albacore with comments on potential yields. Fish.Bull. U.S.69

CEFALI A., A.POTOSCHI, G.DEMETRIO, G.PETROSINO (1986) Biology and fishing of germon, Thunnus alalunga (Bonn 1788) observed for a four-year period in the gulf of Taranto. OEBALIA 1986, vol.XIII, N.S.

DE METRIO G., P.MEGALOFONOU, S.TSELAS, N.TSIMENIDES (1988) Fisheries for Large Scombroids in Greek waters:Catches of Thunnus alalunga (Bonn. 1788) FAO Fisheries Report No 412

GONZALEZ-GARCES and A.C.FARINA-PEREZ (1983) Determining age of young albacore, Thunnus alalunga, using dorsal spines. U.S.Dep.Commer., NOAA Tech.Rep.NMFS 8

V-X8

Age and Growth of *Lepidopus caudatus* on the Northwestern Mediterranean Sea

B. MOLI* , A. LOMBARTE* and B. MORALES-NIN**

*Instituto de Ciencias del Mar, Paseo Nacional s/n, 08003 Barcelona (Espana)
**Institut d'Estudis Avançats de les Illes Balears, Campus Universitario, Palma de Mallorca (Espana)

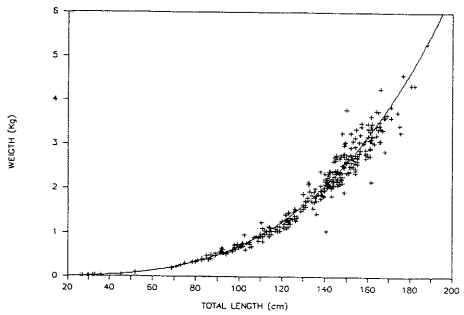
L.caudatus is captured off the Catalan coast by means of long-lines and trawls. Its importance in the catches has arisen recently, making necessary to conduct biological studies of this species to allow sounded management policies. This is the first study of the length-weigth relationship, age and growth of the species in the Mediterranean.

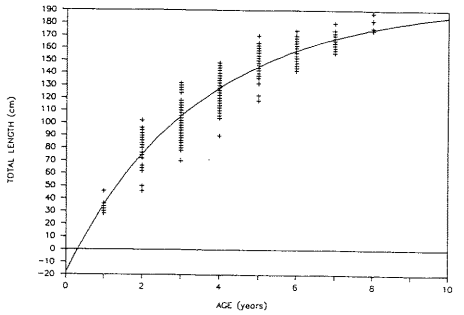
The fish were collected from trawl catches and from hook and line captures made off the Northwestern Spanish Coast from 1988 to 1989. The fish were transported to the laboratory where the total length, weight, and sex were determined.

The males were more abundant (52.16 %) than females (39.77 %), while 8.07 % of the fish couldn't be sexed. The weight-length relationship (fig.1) obtained from 533 measurements, was not signifficantly different for males and females and showed a positive allometry for the length (b=3.21).

A total of 492 otoliths were collected and after cleansing were stored dry in paper envelopes with a code number. These sagittal otoliths were read whole, against a black background and immersed in glycerol, using a compound microscope. As a rule each otolith was read twice by different readers and only coincident interpretations were accepted. The agreement between readers was high reaching 86 % of the interpretations.

The annual nature of the rings present in the otoliths was determined through marginal increment analysis, i.e. the percentage of otoliths having opaque margins was plotted for each month sampled. The thinnes of the otolith margin made very difficult to assess the presence of the opaque ring in the edge, because only almost complete rings could be identiffied. However, it seems that the hyaline rings are formed annually with a peack in October.





Once the annual nature of the rings was establised, the 1th January was used as arbitrary birth date to transform the coincident otolith interpretations into age-length relationships. The age-length matrix thus obtained was employed to fit the von Bertalanffy growth curve to females, males and to all the population (fig.2). The fish ranged from 1 to 8 years of age corresponding to the following mean lengths:

age yr	1	2	3	4	5	6	7	8
num. ex.	13	33	105	111	133	73	19	5
length cm	32.	81.3	101.8	128.8	146.8	155.9	166.2	179.2

The growth parameters obtained showed a lower growth index (K^{-1}) for females:

	L cm	K^{-1} yr	t_0 yr
males+females	198.2	0.298	0.4561
males	185.2	0.333	0.3438
females	195.4	0.297	0.3174

The otoliths of *L.caudatus* in the Northwestern Mediterranean showed rings that proved to be valid of age determination.

V-X9

Croissance de *Merluccius merluccius* L. des Iles Baléares par lecture de l'âge des Otolithes

P. OLIVER, M. GAZA et A. MORILLAS

Instituto Espanol de Oceanografia, Centro Oceanografico de Baleares, Palma de Mallorca (Espana)

1.MATERIEL ET METHODE. A partir de la lecture des otolithes de merlus des Iles Baléares, nous avons construit une série de données de tailles totales rétrocalculées sur chaque otolithe de 1838 merlus échantillonnés trimestriellement de mai 1980 à novembre 1986. On a réalisé le rétrocalcul en utilisant la relation rayon de l'otolithe - taille du poison obtenue pour chaque année et on a ajusté une droite de regression aux couples de valeurs correspondant aux otolithes échantillonnés. De cette façon nous avons obtenu une estimation de la taille moyenne correspondant à chaque bande de croissance pour chaque trimestre et à partir de ces tailles on à obtenu une taille moyenne pour les sept années échantillonnés. Pour réaliser la lecture des otolithes nous nous sommes appuyés sur des critères adoptés lors du Workshop tenu à Palma de Majorque en avril 1989 (Oliver, P. et al., 1989). A partir de ces tailles moyennes assignées à chaque bande de croissance nous avons estimé les paramètres de l'équation de von Bertalanffy. Ainsi, à partir des lectures de l'âge correspondant à chaque individu, on a construit des clés taille - âge qui, appliquées aux distributions de fréquences de tailles des débarquements, nous ont permis de calculer la taille moyenne annuelle des différentes classes d'âge et une valeur moyenne pour la période 1980-1986.

BANDE	L MOYENNE
B1	8,6
B2	17,3
B3	24,5
B4	31,6
B5	36,0
B6	38,7
B7	41,3
B8	43,6
B9	46,0
B10	48,3
B11	51,0
B12	53,5
B13	56,2
B14	57,7
B15	60,1
B16	63,1
B17	65,6
B18	68,1

Tableau 1

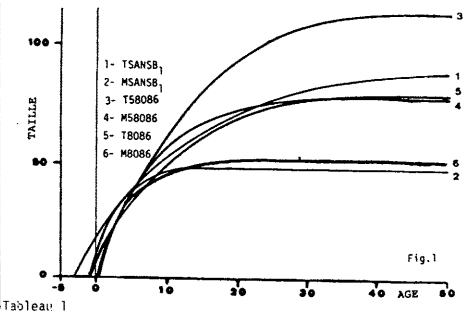


Fig.1

ANNEES	0	I	II	III	IV	V	VI	VII	VIII	IX+
1980	11,0	16,7	22,5	29,4	34,9	38,0	40,8	44,4	47,4	49,0
1981	11,0	15,4	22,4	29,1	35,3	38,5	41,0	43,4	45,9	48,9
1982	11,0	15,7	21,7	26,2	35,2	37,7	40,8	43,2	45,7	48,4
1983	11,0	17,1	22,7	27,8	34,4	37,9	41,3	43,7	45,9	49,0
1984	11,0	16,9	21,7	29,2	35,2	39,1	41,0	43,0	45,1	48,4
1985	12,2	16,3	20,9	29,6	34,4	38,1	41,0	43,8	45,5	48,3
1986		16,4	21,2	25,3	33,8	38,1	40,6	43,2	45,2	48,8
L MOYENNE	11,2	16,3	21,9	28,4	34,7	38,2	40,9	43,5	45,8	48,7

Tableau 3

PARAM.	T8086	T58086	TSANSB1
Loo	78,4	118,5	88,1
K	0,10	0,08	0,07
to	-0,70	-0,06	-2,74
r	0,987	0,999	0,988

Tableau 2.1

PARAM.	M8086	M58086	MSANSB1
Loo	50,8	78,0	50,4
K	0,25	0,14	0,26
to	0,28	0,16	-0,66
r	0,998	0,999	0,997

Tableau 2.2

PARAM.	F8086	F58086	FSANSB1
Loo	78,0	117,1	87,6
K	0,10	0,08	0,07
to	-0,66	-0,03	-2,69
r	0,987	0,999	0,988

Tableau 2.3

2.RESULTATS. Les tailles moyennes obtenues par rétrocalcul basées sur les 39 mois échantillonnés sont présentées dans le tableau 1. Les estimations des paramètres de VBGF obtenues pour les différentes hypothèses sont présentées dans le tableau 2 (8086 = total des sept années, SANSB1 = en rejetant la première bande, 58086 = en considérant la bande 5 comme correspondant à la première maturité et M : males, F: femelles et T : total). Les courbes correspondant aux données précédentes sont présentées sur la figure 1.Les tailles moyennes obtenues à partir des clés taille - âge sont inclues dans le tableau 3.

3.DISCUSSION. Une croissance différentielle entre males et femelles est mise en évidence. L'hypothèse TSANSB1, qui situe le premier hiver à une taille de 18,3 cm, doit être rejetée d'après les résultats de l'analyse de la progression modale, mais ce point de vue devra être confirmé dans le future après étude de la croissance journalière et du recrutement. Les hypothèses T8086 et T58086 doivent être retenues. Le suivi de la croissance de l'otolithe sur des échantillons mensuels n'à pas clarifié le problème mais les estimations des paramètres de l'équation de croissance dans chacun des cas sont parfaitement acceptables. De plus, le problème est que l'on travaille sur des points correspondant à un segment limité de la courbe de croissance. Les estimations des tailles moyennes obtenues à partir de la clé taille-âge correspondent aux estimations faites par rétrocalcul, étant donné qu'elles doivent être référées à la date du 1 juillet. D'aprés ces données on peut estimer qu'il n'existe pas de différence significative entre la croissance de Merluccius merluccius L. dans l'Atlantique et dans la Mer Mediterranée.

4.REFERENCES.

OLIVER, P., ALVAREZ, F. and MORALES-NIN, B., 1989. Report of the age-reading workshop on mediterranean hake and sardine. Palma de Mallorca, España, 10-15 April 1989. Inst.Esp.Oceanogr. (mimeo):102pp.

V

Croissance de *Merluccius merluccius* L. des Iles Baléares par analyse de la progression modale

P. OLIVER, A. MORILLAS et M. GAZA

Instituto Espanol de Oceanografia, Centro Oceanografico de Baleares, Palma de Mallorca (Espana)

1.MATERIEL ET METHODE. On assume qu'il est possible de suivre, moyennant des échantillons périodiques, les modes correspondant aux cohortes succesives créées par des pontes annuelles, limitées spatialement et temporellement. Les distributions de fréquences de tailles correspondant à la capture débarquée par la flottille de chalutiers du port de Palma de Majorque, obtenues à partir d'échantillons mensuels réalisés de janvier 1980 jusqu'à décembre 1986, ont été analysées pour étudier la progression modale des distributions normales successives qui apparaissent quand on utilise la "méthode de Bhattacharya". Ainsi, nous avons obtenu 84 séries de modes que nous avons attribuées aux 12 cohortes différentes qui nous ont permis d'obtenir une estimation de la taille moyenne mensuelle jusqu'à un âge de 6,5 ans. Avec ces estimations nous avons calculé les paramètres de l'équation de von Bertalanffy.

2.RESULTATS. Les modes adoptés dans les successives distributions de fréquences de tailles, présentés en ordre face à une échelle temporelle commune et référées à leurs années respectives de ponte (P) et recrutement au chalut (R) sont présentées dans le tableau 1. La représentation graphique des tailles moyennes, les estimations des paramètres de la VBGF et la représentation d'une série de résultats obtenues pour la même espèce par différents auteurs sont présentées dans le tableau 2 et sur la figure 1.

3.DISCUSSION. La progression modale démontre qu'il se produit un recrutement au chalut avec une maille de 40 mm entre les mois de fevrier et juillet, et que le mode de la distribution de fréquences de tailles totale correspondante, se situe entre 12.5 et 16.0 cm. L'apparition de ce recrutement, qui correspondrait à la classe I de la cohorte précédente de la ponte de l'année précédente, est constatée par la capture de merlus d'une taille moyenne de 9.5 cm dans les pêches au chalut avec une maille de 24 mm, réalisées pendant le mois de janvier 1977. Les estimations de Linf = 94.24 cm et la valeur de K = 0.086, valeurs similaires a celles obtenues anterieurement dans la même région par Bruno et al. (1979), impliquent une croissance comparable à la majorité des valeurs déterminées pour la Méditerranée ne sont pas très différentes de la gamme de valeurs estimée pour l'espèce dans l'Atlantique. Ce fait établit la possibilité qu'il n'existe pas de différences significatives entre la croissance de Merluccius merluccius L. dans l'Atlantique et dans la Mer Mediterranée. Il faut considérer aussi que la taille maximum des merlus enregistrée dans le Golfe de Lion a démontre l'existence d'individus de 87 cm ou 90 cm, ce qui nous fait supposer que des tailles similaires doivent exister dans nos îles et que l'estimation obtenue peut être parfaitement valable.

AGE	MOIS	ANNEES	P. 74 R. 75	P. 75 R. 76	P. 76 R. 77	P. 77 R. 78	P. 78 R. 79	P. 79 R. 80	P. 80 R. 81	P. 81 R. 82	P. 82 R. 83	P. 83 R. 84	P. 84 R. 85	P. 85 R. 86	L MOYENNE
	14	1,17								16,0					16,0
	15	1,25								16,6	16,0	12,5			15,0
	16	1,33								15,3	16,3	17,1	13,8		15,6
	17	1,42							12,3	15,1	14,9	16,9	16,9	15,7	15,3
	18	1,50							14,2	16,4		16,7	14,7	16,0	15,6
	19	1,58						14,5	13,7	16,4	16,9	14,7	14,3	16,0	15,2
	20	1,67						15,0	14,2	17,1	17,5	15,1			15,8
	21	1,75							18,8	17,1	16,3	16,1	16,7		17,0
	22	1,83						18,4	16,6	16,2	16,6	15,8	17,2		16,8
	23	1,92						16,5	17,8	20,2	16,5	18,8	15,4		17,5
2	24	2,00						16,5	17,8	18,1	19,3	18,7	16,1	17,7	17,8
	25	2,08					16,3	16,8	18,5	21,5	17,4	20,8	19,4		18,7
	26	2,17					18,7	16,8	22,5	21,6	18,6	19,7	19,3		19,6
	27	2,25					19,4	17,0	23,0	22,0	19,9	18,3	18,2		19,7
	28	2,33					19,0	19,6	19,8	22,7	20,9		22,2		20,7
	29	2,42					23,1	19,9	22,2	22,5	24,6	21,7	22,5		22,4
	30	2,50					22,7	21,9	22,5	23,1	22,5	19,1	22,2		22,0
	31	2,58					21,6	23,7	22,5	20,3		19,7	24,0		22,0
	32	2,67					23,0	21,5	24,2	23,5	21,2	21,7	22,2		22,5
	33	2,75					25,3	21,8	24,2	23,0			23,1		23,5
	34	2,83					24,3	24,0	21,5	22,2	20,5	24,6	23,9		23,0
	35	2,92					23,6	25,5	27,7	22,6	22,9		24,5		24,4
3	36	3,00					23,6	25,5	24,7	24,8	25,6		24,4		24,8
	37	3,08					25,9	24,9	26,8		24,7	23,3			25,1
	38	3,17				25,2	25,9	26,2	25,1	26,5	26,9	24,5			25,7
	39	3,25				27,0	25,4	28,0	26,9	26,3	24,3	26,8			26,4
	40	3,33				25,7	28,5	25,4	29,8	27,1					27,3
	41	3,42				30,2	28,1	28,8	27,2	29,1	28,0	26,8			28,3
	42	3,50				27,5	27,4	27,9	26,9			28,5			27,6
	43	3,58				28,1		27,9	27,2	30,1	29,4	29,5			28,7
	44	3,67				28,1		27,5	30,6		31,7	29,1			29,4
	45	3,75				29,7	30,1	27,5	29,6	28,5	31,5				29,5
	46	3,83				28,7	30,8	31,0		30,0					30,1
	47	3,92				28,9	31,0	31,0	29,4	28,0	30,7	30,9			30,0
4	48	4,00				28,9	31,0		28,9	31,0	31,0				30,2
	49	4,08				29,9	32,1			32,3	33,0				31,8
	50	4,17			30,6	29,9	31,7	31,7	32,1	34,5					31,7
	51	4,25					32,7	31,8	32,2		32,9				32,4
	52	4,33				33,2	32,7				32,5				32,8
	53	4,42					35,5	33,6							34,5
	54	4,50			33,0		34,5		32,5	34,4					33,6
	55	4,58			35,2		34,5		35,1	33,8					34,7
	56	4,67			32,8		36,7				34,6				34,7
	57	4,75			34,5	34,9	36,7		35,5	36,5	34,8				35,5
	58	4,83				38,1	36,8		35,0						36,6
	59	4,92			34,1				34,1		36,0				34,7
5	60	5,00			34,1				36,5						35,3
	61	5,08			37,7	37,1			38,5	38,5					37,9
	62	5,17		37,0	37,7	36,1	37,1								37,0
	63	5,25								39,7					39,7
	65	5,42					38,9			38,2					38,5
	66	5,50							37,4						37,4
	67	5,58							39,5						39,5
	68	5,67		39,5						41,5					40,5
	69	5,75						40,2							40,2
	70	5,83						40,2							40,2
	71	5,92						41,0							39,5
6	72	6,00		38,0											38,0
	73	6,08			41,7										41,7
	74	6,17	40,2												40,2
	78	6,50						42,2							42,2

Tableau 1

Données préliminaires sur la composition chimique des Otolithes d'Anguilles (*A. anguilla* L. 1758)

Raymonde LECOMTE-FINIGER

Laboratoire de Biologie Marine, Université de Perpignan (France)

La composition chimique et la structure cristallographique des otolithes d'anguilles jaunes *A. anguilla* ont été analysées à partir d'échantillons en provenance de milieux continentaux (Pyrénées Orientales), ainsi que de lagunes côtières méditerranéennes du Golfe du Lion. Différentes méthodes ont été utilisées :

- microscopie électronique et analytique à balayage
- diffractométrie en rayons -X.

Résultats

Ils portent sur la composition chimique élémentaire, l'organisation du réseau cristallin et la répartition du calcium dans l'otolithe. La microanalyse des otolithes révèle qu'ils sont constitués essentiellement de calcium (Ca) mais aussi d'éléments mineurs (Fe, Cu) et d'éléments traces (Na, Si, Mg, Cl). La diffractométrie montre que la structure minéralogique ($CaCo_3$) correspond à des cristaux d'aragonite ; elle ne présente aucune variabilité géographique ni saisonnière. Les variations spatio-temporelles de la quantité de Ca sont obtenues par balayage microdensitométrique, point par point, le long d'une droite traversant la surface poncée de l'otolithe par le nucléus. Cette quantité est nettement plus faible dans le nucléus que dans les zones concentriques à celui-ci. De plus, les zones hyalines sont plus fortement calcifiées que les zones opaques.

Discussion

Les otolithes d'anguilles sont peu différents des otolithes des autres téléostéens puisque composés essentiellement de $CaCO_3$ sous forme d'aragonite. Notons que l'aragonite "biologique" est un peu différente de l'aragonite "minérale" (les diffractogrammes présentent un décalage de 2 pics vers des angles supérieurs).

Leur originalité réside dans l'existence de variations du taux de Ca entre le nucleus et les zones adjacentes, traduisant une disponibilité en Ca différente dans les milieux environnementaux rencontrés au cours de leur cycle vital. En effet, la teneur en Ca en mer est plus faible que celle des eaux douces. Parallèlement, la proportion de Ca est plus faible (d'environ 20 %) dans le nucléus que dans les zones marginales.

Une autre singularité est la présence de fer. Déjà signalée par Hanson et al (1984) dans le squelette, ce fer peut jouer un rôle de magnéto-récepteur, l'anguille étant sensible aux variations du champ magnétique terrestre (Karlsson, 1985). Ces magnéto-récepteurs guideraient donc l'anguille argentée lors de sa migration transatlantique vers les Sargasses.

Références biliographiques

Hanson M., Karlsson L. et Westerberg H., 1984 - Magnetic material in European eel. Comp. Biochem. Physiol., 77 A : 221-224.

Karlsson L., 1985 - Behavioural responses of European silver eels to the geomagnetic field. Helgolander Meeresunters., 39 : 71-81.

V

V-X12

Age determination of Mediterranean Hake and Sardine : Recommendations of an International Workshop (Palma de Mallorca, Spain, 10-15 April 1989)

B. MORALES-NIN* , P. OLIVER** and F. ALVAREZ**

*Institut d'Estudis Avançats Illes Balears, Palma de Mallorca (Espana)
**Instituto Espanol de Oceanografia, Centro Oceanografico de Baleares, Palma de Mallorca (Espana)

The age Reading Workshop on Mediterranean Hake (Merluccius merluccius) and sardine (Sardina pilchardus) was held at the Centro Oceanográfico de Baleares del Instituto Español de Oceanografía on April 1989, sponsored by F.A.O. and with the participation of scientists of nine countries corresponding to west and east Mediterranean areas (Oliver, P. et al., 1989). The techniques used in the various laboratories, the relevant information on the species life cycles and other aspects of age determination were discussed. Practical otolith interpretation exercises were held and the interpretation criteria discussed.

HAKE

The main problem found in hake age determination is the attribution of the 1st annual ring. The capture of big hakes up to 87 cm length by long-lines and cast nets on Catalonia and Gulf of Lion and by trawling in Adriatic Sea rised the question of hake growth rates. The following hake otolith interpretation criteria were recommended:

1-The nuclear otolith zone previous to the first annual ring may be characterized by 2-3 pelagic rings and a demersal ring. Sometimes fishes born in summer might not laid down these false rings in their otoliths. The 1st annual ring might correspond to the hyaline ring laid down after the demersal ring when it corresponds to a fish of 12cm or more. this interpretation has to be supported by the length frequency distributions of the recruited fish and the spawning periods.

2-Annual rings are laid down at regularly decreasing intervals, generally annual rings are laid down in fishes over 35 cm length, while annual opaque zones and hyaline rings are laid down in younger fishes.

3-True winter annuli are identified by their good definition around the otolith. The winter ring could consist of a single hyaline band or a series of 2-3 clustered ones. In the last case measurements should be taken to the outermost ring in the series.

4-Hyaline rings are enumerated for age determination and are considered completely formed when the next opaque ring formation starts.

5-Taking 1st January as arbitrary birth date and winter as the period of hyaline ring formation, otoliths of fish caught between 1st july and 31st December with an hyaline ring in the edge are assigned to an age group by counting all the hyaline annulus except the last one. If the fishes are caught after 1st January all the hyaline annulus are counted.

SARDINE

The species behaviour and long spawning period and the fisheries characteristics highly conditioned the sardine available material. The sardine interpretation criteria were defined as follows:

1-The birth date is 1st January.

2-Each year an opaque and a hyaline ring are formed.

3-Annual growth rings are laid down at regularly decreasing intervals as the fish becomes older.

4-Otoliths with opaque edge during the first semester or hyaline edge during the second semester, are considered to belong to the previous age group.

RECOMMENDATIONS

From the above mentioned discussions and otolith readings the following recommendations were elaborated:

Mediterranean Hake

-The use of thin otolith cross-sections for age-reading of hake bigger than 20 cm in case than the annuli are not clear on whole otoliths.

-In order to make possible direct comparison between the studies conducted in various geographic zones the use of the standard terminology and notation for otolith interpretation of Jensen (1965) was recommended.

-To reduce the risk of errors of interpretations, the interpretation should be done independently following the same criteria by two persons trained in otolith reading, or more than once by the same reader with a time interval between readings. The coincident interpretations should be used for preparing the age-length keys.

-Due to the heterogeneity of data, and the necessity to clarify the 1st annual ring formation, regular sampling, determination of the annual cycle of reproduction and determination of the length distribution of the commercial catches are necessary. When possible, recruitment surveys should be held.

Mediterranean sardine

-Otolith lecture should be done unfixed without mounting the otoliths with Eukitt.

-Statistical procedures should be applied to study the errors on the estimations of growth parameters from the age-length key.

-Studies on daily growth ring in the otoliths could be implement ted to verify growth during the first year of life.

-In order to determine the precise spawning season ichthyoplacton surveys should be held.

-An interchange program on otoliths should be started between different countries to discuss material facing another international meeting.

REFERENCES

JENSEN, A.C., 1965. A standard terminology and notation for otolith readers. ICNAF Res. Bull., 2: 5-7.

OLIVER, P., ALVAREZ, F. and MORALES-NIN, B., 1989. Report of the age-reading workshop on mediterranean hake and sardine. Palma de Mallorca, España, 10-15 April 1989. Inst. Esp. Oceanogr. (mimeo): 102 pp.

V-X13

The Length-Weight Relationship and Condition Factor as Ageing Functions of Anchovy in the Middle Adriatic

G. SINOVCIC

Institute of Oceanography and Fisheries, P.O.Box 114, Split (Yugoslavia)

This paper is an account of the length-weight relationship and cubic condition factor variations as an ageing function as well as the conversion factor relationship between total and standard length of the juvenile and adult anchovy, Engraulis encrasicolus (L.) population from the coastal waters of the Middle Adriatic.

Anchovy specimens were randomly collected from commercial (purse-seining) pelagic catches during spawning season in Summer 1979. A total of 1,847 anchovy specimens were examined. Data on anchovy total and standard lengths are expressed in centimetres. The fishes were weighted to the nearest 0.01 g. Sex determination and state of gonads were by visual inspection. All of the adult anchovy specimens were at the most advanced state of maturity of gonads. The juvenile anchovy gonads were immature. The otoliths were used for aging the anchovy.

The length (L) weight (W) relationship for each age class was described by the equation: $W = a\ L^b$ (LE CREN, 1951). The cubic condition factor per each age class was estimated using equation proposed by HILE (1936) : $K = W \cdot 10^2 \cdot L^{-3}$.

The relationship between total length (L_t) and standard length (L_s) can be described by the following equation : $L_t = a + L_s b$.

The length-weight relationship

The mathematical relationship between the length and weight from all available data of anchovy can be described by the equation: $W = 0.018603\ L^{2.5801}$. Negative allometry is established. This is in agreement with the data of SINOVČIĆ (1978) who noted the negative allometry of anchovy in the Kaštela Bay in 1974.

The length weight relationship of each sex and age class is graphically presented in Fig.1. During the first and second years of life (0 and 1+) the growth of anchovy is isometric (b=3) or very nearly isometric (b=2.9). In the third (2+) and fourth (3+), negative allometry is established (b=2.61, b=2.40, respectively).

The value of the length-weight coefficient decreased as the anchovy increased in age.

Condition

The cubic condition factor varied between 0.497 and 0.653. The value of the cubic condition factor decreased in function of increased age of the anchovy with aberrance of 0 age class which show the lowest value of cubic condition factor. The cubic condition factor for males is larger then that of females probably because female anchovy might become more exhausted during spawning.

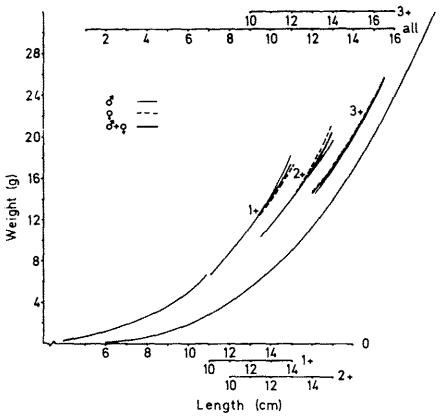


Fig.1. The length-weight relationship coefficient in relation to the anchovy age

Relationship between total length and standard length

Since many papers dealing with this fish species express the length measurements using total length (L_t) while others use standard length (L_s), a knowledge of the relationship between the two measurements is of practical value for comparative purposes.The relationship between total and standard length for small (L_t<8.5 cm), medium (L_t=8.6-13.0 cm), and large (L_t>13.1 cm) anchovy can be described by the following equations respectively:

$L_s = -0.4024 + 0.9021\ L_t$; $r^2 = 0.9988$

$L_s = -0.5750 + 0.9019\ L_t$; $r^2 = 0.9998$

$L_s = -0.8127 + 0.9164\ L_t$; $r^2 = 0.9998$

For all available data the equation is:

$L_t = 0.4179 + 1.1266\ L_s$

REFERENCES:

HILE, R., 1936. Age and growth of the cisco, Leucichthys artedi (LE SMEUR) in the lakes of the north-eastern highlands, Wisconsin.Bull.U.S.Bur.Fish., 48 : 211-317.

LE CREN, E.D., 1951.The length weight relationship and seasonal cycle in gonad weight and condition in the perch, Perca fluviatilis. J.Anim.ecolog., 20 (2): 201-219.

SINOVČIĆ, G., 1978. On the ecology of anchovy, Engraulis encrasicolus (L.) in the central Adriatic. Acta Adriat., 19 (2) : 32 p.

V

Preliminary Biological Data of Silvery Pout (*Gadiculus argenteus argenteus*) in the Northern Euboean Gulf (Greece)

Vassiliki VASSILOPOULOU

National Centre for Marine Research, Hellinikon (Greece)

INTRODUCTION

Gadiculus argenteus argenteus is a Gadidae species quite abundant in depths from 250 to 500m in Greek seas. Age and growth data of the species are not available. However, there are a few studies concerning ichthyoplankton (LANDINI & VAROLA, 1983; HALBEISEN, 1983; IZETA, 1985) and bathymetric distribution (MANCHLINE & GORDON, 1984).

MATERIAL and METHODS

Samples were collected seasonally between December 1986 and June 1987 in the northern Euboean Gulf. In each fish, total length and weight were recorded to the nearest respectively milimetre and gramme. Determination of age was based on otolith reading.

RESULTS

Total lengths ranged from 3.5 to 15cm and the main body of the stock was comprised between 8 and 11cm (Fig. 1a), corresponding to ages II and III (Fig. 1b).

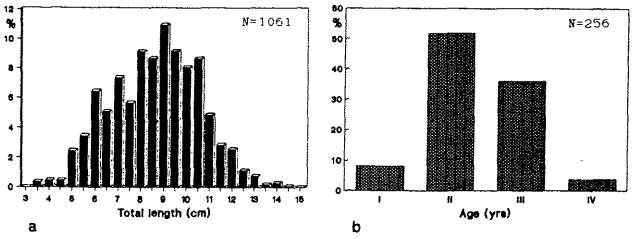


Figure 1. Length frequency polygons (a) and age composition (b) of silvery pout caught in the northern Euboean Gulf from December 1986 till June 1987.

The relationship between otolith radius (S) and total length (TL) was: TL=-0.39+1.38*S (r=0.89). On the basis of this formula Table 1 was calculated. The 49.8% of the maximal size of the silvery pout was attained during the first year of its life, while an abrupt reduction of growth rate occured during the second year and continued in a smoother way over the next two years. The parameters of von Bertalanffy's equation were calculated according Ford-Walford's method, yielding L_{∞}=19.72cm, k=0.19 and to=-0.94.

Table 1. Back calculated total lengths of silvery pout Gadiculus argenteus argenteus, in the northern Euboean Gulf (1986-1987).

Age	N	Mean Observed Length (TL)	Back calculated length I	II	III	IV
IV	10	12.56	5.60	8.39	10.44	12.04
III	92	11.00	6.00	8.45	10.38	
II	133	9.27	6.02	8.41		
I	21	6.82	6.06			
Mean TL			6.00	8.42	10.39	12.04
Mean annual increm.			6.00	2.42	1.97	1.65
" " " (%)			49.83	20.10	16.36	13.70
N			256	235	102	10

The computation of the total length (TL) - weight (W) relationship, based on 317 individuals, gave: $W=0.0000336*TL^{2.73}$ (r=0.87). The confidence interval of the exponent, being 2.73±0.17, had a statistically significant difference from the value 3 (P<0.05) implying an allometric growth of the species. The condition factor, estimated for the total sample was K=1.82±0.36 (mean ± confidence interval, P=0.05).

The 69% of the individuals caught in December were sexually mature; this proportion dropped to 21.9% in February and to 1.2% in June.

REFERENCES

IZETA, L. M., 1985. The larval development of the southern silvery pout, Gadiculus argenteus argenteus, (Guichenot,1850). J. Plankton Res., 7(6): 937-946.

HALBEISEN, H. W., 1983. Fish larvae communities west of Ireland in spring. Proc. ICES Council Meeting 1983, 24pp.

LANDINI, W. & VAROLA, A., 1983. Ichthyofauna of the lower pleistocene near Matera. Thalassia Salent. 12-13: 16-49.

MAUCHLINE, J. & GORDON, J. D. M., 1984. Feeding and bathymetric distribution of the gadoid and morid fish of the Rockall Trough. J. Mar. Biol., 64(3): 657-665.

V

Notes about *Schedophilus ovalis* (Osteichthyes, Centrolophidae) in the Ligurian Sea

Lidia ORSI RELINI, Bruno FIDA and Marco RELINI

Istituto di Zoologia, Laboratori di Biologia Marina ed Ecologia Animale, Via Balbi 5, 16126 Genova (Italia)

Schedophilus ovalis lives both in surface waters (juvenile phase associated with flotsam such as wreckage and jellyfish) and on slope bottoms in habitats which have not yet been defined. Many aspects of its biology remain obscure (Haedrich 1986), especially in the Mediterranean, where it has for a long time been supposed that this species is rare (Tortonese 1975).

The recent development of a specific sport fishery in the Ligurian Sea has given us the opportunity to make some preliminary observations about reproduction and growth. Other information derives from the underwater observation of young specimens in offshore surface waters and from the capture of some specimens by spearfishing.

A total of 31 fish, caught in the period July - March were examined; 29 of them were obtained by gear called "filaccioni", i.e. lines weighted at their ends, about 600 m long, with some 30 hooks, baited with clupeids, attached to the distal 60 m. Fishing took place on rocky bottoms about 30 miles from the coast. Fish were measured (total, standard and fork length), weighted and sexed by inspection of gonads. Gonads, sagittae, scales and gastric contents were preserved for further laboratory examinations.

Underwater observations. While scuba diving in a range 0-40 m one of us (M.Relini) observed several young specimens of 25-45 cm T.l., associated with an artificial structure, positionated about 35 miles offshore and moored on a bottom at 1100 m. The substratum was inspected in different seasons; the smaller fishes were observed in March - June and the larger ones in September - December. They displayed no fear of the observer and showed variable colour patterns with a uniformly dark grey or silvery colour or with black blotches or black stripes on a silvery backround. Two of them were caught in order to verify the meristic characters. On the basis of the Haedrich and Horn key (1972), they were definitely *S. ovalis*, also when the colour pattern was like that of *S. maculatus* (Gunther). In the killed specimens another kind of dark stripes appeared, which correspond to the zig-zag arrangement of the somites.

Reproduction. Among the fishes obtained by lines, males were 7 in number, ranging from 60.5 to 84 cm T.l. Females, 18 in number, ranged from 66 to 106 cm T.l.. Six specimens, from 43 to 61 cm T.l. remain undetermined

The examined materials include two females fished in August with almost mature ovaries. They weighed 11 and 13 kg (T.l. 93.5 and 103 cm) and had a gonadosomatic index of 8.04 and 8.92. Two spent / recovering females were obtained in August and February: the first, 100 cm T.l., 13.5 kg had a g.s. index of 1.03; the second 106 cm T.l., 12 kg had 1.29 of g.s.. It is interesting to note that seven other females of the size range 72 - 86 cm T.l., fished in summer, had immature ovaries. The minimum female reproductive size derived from the present material is therefore close to 90 cm T.l..

Fluent males were fished in July (1) and August (3): they were 75 - 84 cm T.l, with a weight of 5.5 - 6 kg and showed a g.i. of 1.13, 1.45, 0.36, 1.54.

Food items. Maul (1964) found in the intestine of *S. ovalis* several indigested *Pyrosoma* sp. We can add to this frequent prey also the pteropod *Cymbulia peroni* (to 8 in one stomach) and, in one case, the Euphausid shrimp *Meganychtiphanes norvegica*.

Morphology of sagitta and growth. The sagitta of the young fish living in surface waters is chalky white, with regular minute bands which apparently are uninfluenced by the seasons. The specimen fished on deep bottoms have an additional, almost hyaline contour, whose extension increases with the size of the fish. In the latter the tracks of periodic deposition are scarce and are difficult to interpret. The chalky area is therefore common to all fish and its maximum width corresponds to a growth of about 45 cm T.l., which is the largest size of the fish living in surface waters and the smallest size found in fish caught by lines. The latter were fished from September onwards.

Padoa (1956) reported a 44 mm long specimen caught in November 1914 at Messina. Maul (1964) observed a young 10 cm long specimen double its size in two months (May - June) in captivity. Considering our underwater observations in addition to these data, we suppose that growth to about 45 cm T.l. corresponds to the first year of life. The fish, born at the end of the summer would descend to its bathyal habitat the following autumn. Supposing that the chalky white area of sagitta corresponds to about one year of life, the reading of the remaining part suggests that our large mature females are four years old. Applying the same assumptions, males resulted mature when three years old.

Length - weight relationship. Using the Ricker method (1975) we have calculated the following fork length - weight relationship for both sexes: $P(kg) = 0.00477 * l(cm)^{3.3001}$.

References

HAEDRICH R.L., 1986. - Centrolophidae in *Fishes of North -eastern Atlantic and th Mediterranean* UNESCO. Paris

HAEDRICH R.L., HORN M.H., 1972. - A key to Stromateoid fishes. Woods Hole Oceanog. Instit., Techn. Rept.: 1 - 46 .

MAUL G.E., 1964. - Observation on young live *Mupus maculatus* (Günther) and *Mupus ovalis* (Valenciennes). Copeia 1964: 93-97.

PADOA E., 1956. - Stromateidae, Centrolophidae, Nomeidae, Tetragonuridae in *Fauna e Flora del golfo di Napoli*. 38 Monografia : Uova, larve e stadi giovanili di Teleostei

RICKER W.E., 1975. - Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191 : 1 - 382

TORTONESE E., 1975. - Osteichthyes. Parte seconda.*Fauna ital.*11, Calderini, Bologna

V-XI1

Régime alimentaire du Merlu (*Merluccius merluccius*, L., 1758) en Baie de Bou-Ismaïl

A. BOUAZIZ*, F. DJABALI* et C. MAURIN**

*I.S.M.A.L., B.P. 90, Alger 1er Novembre, 16003 Alger (Algérie)
**Professeur honoraire I.S.T.P.M. (France)

Introduction:

Nous avons entrepris d'observer et d'analyser les contenus stomacaux de merlus de la région de baie de Bou-Ismaïl, afin de connaitre son régime alimentaire et ses variations éventuelles en fonction de la taille des individus,de la profondeurs et des saisons.

Matériel et Méthodes :

De novembre 1987 à novembre 1988, 553 merlus pêchés au chalut de fond à deux face en baie de Bou-Ismaïl à des profondeurs comprises entre 50 et 400m environ ont été examinés et leurs estomacs conservés dans du formol à 5% . Les proies intactes ne présentant pas de diges--tion sont éliminées,les autres sont identifiées, comptées et pesées. Pour l'analyse quantitative nous avons utilisé l'indice de réplétion (Re) et le coefficient de vacuité (Ve), alors que pour l'étude quali--tative l'indice de fréquence d'une proie F, le pourcentage en nombre (Cn) et le nombre moyen de proies par estomac (Nm) ont été employés.

Résultats et discussion :

L'indice de réplétion chez les jeunes merlus de taille inférieu--re à 30 cm atteint son maximum en automne (Re = 5.63) et en hiver (Re = 4.60) et diminue au printemps (Re = 2.73) et en été (Re = 2.73) . Les individus les plus agés présentent également une activité trophique importante pendant les périodes automnales et hiver--nales (Re = 3.50) . L'alimentation de merlus est surtout composées de poissons téléostéens (F=66.99%, Cn=65.55%, Nm=1.01) et à degré moindre de crustacés natantia nectobenthiques (F=43.33%, Cn=32.87%, Nm=0.51). Cette dominance des poissons est constatée pour toutes les saisons sauf au printemps, période pendant laquelle, les crus--tacés occupent la première place dans le régime alimentaire (Nm poissons=0.56, Nm crustacés=0.74) . Cela montre que le merlu chasse plus prés du fond (Nm crustacés élevé) qu'en pleine eau en période printanière. Ces résultats divergent quelque peu de ceux obte--nus par Sorbe (1972) dans le golfe de Gascogne, probablement parce que cet auteur n'a pas fait d'observations en automne et au printemps Les céphalopodes dont nous ne retrouvons que des fragments ne repré--sentent qu'un pourcentage trés faible sur le plateau continental et relativement peu important sur le talus, le régime alimentaire est composé pour une bonne part et durant toute l'année par des crevettes natantia (F=75%, Cn=64.79%), alors que celle-ci sont moins représen--tées dans la nourriture des merlus vivant sur le plateau continental (F=37.94%, Cn=27.69%) . Ceci est dû à l'abondance de ces crustacés natantia sur le talus algérien où ils constituent une source impor--tante de nourriture pour l es merlus adultes que se tiennent à ce niveau.

L'ensemble de nos observations nous permet de confirmer que le merlu chasse principalement la nuit et peut se déplacer en pleine eau jusque dans des eaux superficielles (Maurin, 1955). En effet, d'une part le coefficient de vacuité (Ve = 53.17 % le jour et Ve = 35.02 % la nuit) et d'autre part nous avons trouvé dans les estomacs des adultes vivant au niveau du talus des poissons pélagi--ques fréquentant des eaux de surface comme Sphyraena sphyraena.

Conclusion:

Merluccius merluccius en baie de Bou-Ismaïl est un prédateur ichtyophage, relativement sténophage, chassant de préférence la nuit aussi bien prés du fond qu'en pleine eau avec toutefois une préféren--ce pour cette dernière.

Bibliographie sommaire:
Maurin,C., 1955-Bull.Inst.Pêches marit.Maroc,2,3-65.
Sorbe,J-C., 1972-Thèse 3ème cycle.Univ.Aix-Marseille.

V-XI2

Feeding of *Diplodus vulgaris* (E. Goeffr., 1817) (Pisces : Sparidae) in the Adriatic Sea

I. JARDAS and A. PALLAORO

Institute of Oceanography and Fisheries, Split (Yugoslavia)

Introduction:

Diplodus vulgaris is a very abundant fish species of Sparidae family in the Adriatic and Mediterranean Sea. They inhabit depth from 0-130 m, being more numerous down to 30 m, on markedly rocky bottoms, mixed rocky and sandy bottoms and rearly in laguns (Tortonese, 1975). Larger specimens occur in deeper waters while juveniles prefer closer shallow waters.

According to the available data on feeding of D. vulgaris it is preferentially carnivorous fish; feeding on smal crustaceans, worms and molluscs (Ara, 1937; Collignon & Aloncle, 1960; Onofri, 1986).

This paper deals with the quantitative and qualitative analysis of preadult and adult stages feeding habits, using the samples from the middle Adriatic, with special regard to selectivity, seasonal intensity and difference in diet between length groups.

Material and methods:

Guts of 103 specimens collected from April to November 1981-82 on 13 localities of the middle Adriatic were examined. Depth of the sampling localities ranged from 2-40 m. Total body length (Lt) of specimens varied from 13,9-33,4 cm. Guts of 84 specimens contained food, while 19 did not.

The relative importance of different components of the diet was assessed using three feeding indices: index of relative importance (IRI), main food item (MFI) and feeding coefficient (Q).

Results:

Prematurity stage and ripe D. vulgaris feed on a number of animal groups and species (Fig. 1). As to the global structure, importance and food coefficient, three species groups may be distinguished: Crustacea Decapoda (%IRI = 2430,9; %MFI = 31.9; %Q = 516.68), Echinoidea (%IRI = 1965.7; %MFI = 23.0; %Q = 467.75) and Bivalvia (%IRI = 1284.3; %MFI 23.9; %Q = 273.75), which, at the same time, are preferred food (%Q = > 200). Polychaeta, Gastropoda and Polyplacophora (%Q = 200-20) are food constituents of secondary importance, and all other animal group (Spongia, Anthozoa, Nematoda, Bryozoa, Enteropneusta, Ascidiacea, Pisces) are accidental food (%Q = < 20).

Food composition changes with fish growth (Fig. 1). Prematurity stage specimens (< 17 cm Lt) prefer Echinoidea (%Q = 585) and Polychaeta (%Q = 189) and Crustacea (%Q = 111) as secondari food. At first maturity and immediately following the first maturity (17-25 cm Lt) specimens prefer Echinoidea (%Q = 924) and Bivalvia (%Q = 571). Older specimens (> 25 cm Lt) show preference for Crustacea Decapoda (%Q = 1612),while their secondary prey are predominantly Bivalvia (%Q = 102) and Echinoidea (%Q = 40).

Seasonal aspect of feeding pattern show also changes in intensity: they feed most intensively at the end of spring and beginning of summer, and least intensively during spawning period (second half of autumn in the Adriatic Sea). However, in all analysed seasons (spring, summer, autumn) Crustacea Decapoda and Bivalvia dominated in the food.

As to the food composition D. vulgaris belong to carnivorous-omnivorous fish, the food of which is dominated by animal groups with firm body armour (Crustacea Decapoda, Bivalvia, Echinoidea).

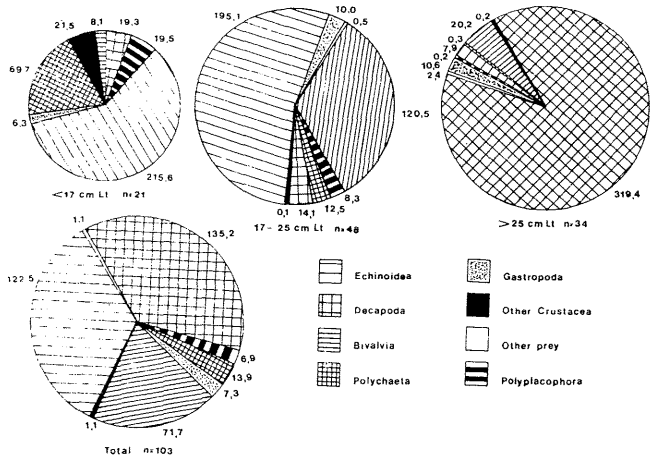


Fig. 1. Pray composition by size classes and total

References:

Ara, L., 1937. Contributio alla conoscenza dell álimentazione dei pesci. Sargus vulgaris Geoffr., Sargus annularis L., Sargus sargus L. Boll. Pesca Piscicul. Idrobiol., 13 (3): 371-381.

Collignon, J. & H. Aloncle, 1960. Le régime alimentaire de quelques poissons benthiques des côtes marocaines. Bull. Inst. Pêches Marit. Maroc, 5: 17-29.

Onofri, I., 1986. Morfološke prilagodbe zubala na način ishrane kod vrsta iz roda Diplodus, Puntazzo i Sarpa (Pisces, Sparidae) iz Jadranskog mora. Morsko ribarstvo, 4: 129-134.

Tortonese, E., 1975. Osteichthyes (Pesci ossei) Parte sec. Fauna d'Italia, XI, Ed. Calderini, Bologna.

V

Sur la Nourriture des Jeunes Thons Rouges *Thunnus thynnus* (L. 1758) des Côtes du Golfe de Valence

Antonio SANZ BRAU

Departamento de Ecologia (Biol. Marina), Facultat de Ciencies Biologiques, Universitat de Valencia, Burjasot (Espana)

Le Thon rouge Thunnus thynnus se reproduit aux mois de juin et juillet dans la Méditerranée (TORTONESE, 1975; COLLETTE, 1986). Les derniers jours de septembre, les jeunes Thons rouges sont abondants tout le long des côtes du golfe de Valencia, ils atteignent alors environ 30 cm. de longueur (RODRIGUEZ-RODA, 1969). Quoique capturés en grand nombre, les données sur leur biologie, sur cette côte, sont peu nombreuses. Dans ce travail nous apportons la première étude du régime alimentaire de cette espèce pour la région.

Nous avons étudié 82 jeunes individus de Thon rouge, provenant de captures effectuées par des bateaux de pêche industrielle à l'hameçon pendant les mois d'octobre et de novembre 1989. Ensuite, les jeunes Thons disparaissent des côtes du golfe de Valencia. Ces spécimens ont été mesurés (longueur totale) et pesés (poids total et éviscéré). La taille moyenne de ces poissons était de 34.2 ± 0.3 cm. de longueur totale avec une longueur minimum de 28.0 cm. et maximum de 41.5 cm., correspondant aux poids éviscérés de 663.0 ± 26.2 g., 319.2 g. et de 1263.0 g. respectivement.

Tab. I.- Degré de réplétion stomacal des jeunes thons rouges

REPLETION	$\frac{\text{Poids contenu stomacal}}{\text{Poids éviscéré}} \times 100$	N	%
Vide	0	14	17.07
Presque vide	0.1 - 1.0	9	10.97
Presque plein	1.0 - 2.5	17	20.73
Plein	2.5 - 5.0	24	29.76
Très plein	+ 5.0	18	21.95

Des 82 estomacs examinés, 68 contenaient des aliments (Tableau I), 14 étaient vides, ce qui donne un coefficient de vacuité de 17.07 %. Le poids moyen des contenus stomacaux était de 25.3 ± 2.4 g. avec un maximum de 97.8 g. (poids humides).

Tab. II. Composition du régime alimentaire des jeunes de T. thynnus.

PROIES	Nombre de Proies	Indice de Fréquence(f)	Indice Numérique(cn)
MOLLUSQUES	18	14.70	5.27
CEPHALOPODES			
Illex coindeti	6	8.82	1.75
Sepiola rondeleti	2	1.47	0.58
Indéterminés	10	5.88	2.62
CRUSTACES	79	14.70	23.16
COPEPODES			
Indéterminés	2	1.47	0.58
AMPHIPODES Hyperiidae			
Streetsia challengeri	1	1.47	0.29
Phoronisidae	1	1.47	0.29
Indéterminés	11	4.41	3.22
STOMATOPODES			
Larves Alima	16	2.94	4.69
EUPHAUSIACES			
Indéterminés	35	2.94	10.26
DECAPODES			
Pasiphaea sivado	5	4.41	1.46
Indéterminés	2	2.94	0.58
Larves de Décapodes			
Zoea de Albunea carabus	1	1.47	0.29
Zoea de Anomura	1	1.47	0.29
Megalopa de Anomura	1	1.47	0.29
Megalopa de Brachyura	1	1.47	0.29
Indéterminés	2	1.47	0.58
TELEOSTEENS	244	98.52	71.55
Sardina pilchardus	80	64.70	23.46
Engraulis encrasicholus	46	41.17	13.48
Cepola rubescens	3	2.94	0.87
Arnoglossus sp.	2	2.94	0.58
Holocentrus ruber	9	2.94	2.63
Spicara flexuosa	1	1.47	0.29
Trachurus trachurus	1	1.47	0.29
Mullus barbatus	2	1.47	0.58
Blennius ocellaris	1	1.47	0.29
Callionymus maculatus	9	1.47	2.63
Callionymus pusillus	1	1.47	0.29
Lesueurigobius friesi	3	1.47	0.87
Ophidion barbatum	1	1.47	0.29
Gobidae	1	1.47	0.29
Scorpaenidae	7	4.41	2.05
Photichtyidae	11	1.47	3.22
Paralepidae	1	1.47	0.29
Anguiliformes	6	1.47	1.75
Indéterminés	59	16.17	17.30

Dans le tableau II, nous signalons la composition du régime alimentaire des jeunes Thons rouges. De l'analyse des contenus stomacaux, nous concluons que la nourriture des jeunes Thunnus thynnus est constituée par les Téléostéens avec un indice de fréquence (f) de presque 100 %. Parmi ces Téléostéens, Sardina pilchardus et Engraulis encrasicholus sont les deux proies principales, avec le Céphalopode Illex coindeti. Quelques proies déterminées dans les contenus stomacaux sont probablement des appâts avalés par ces poissons.

REFERENCES

COLLETTE, B.B., 1986.- Scombridae, in "Fishes of the North eastern Atlantic and the Mediterranean". vol. II. UNESCO, pp.981-997.

RODRIGUEZ-RODA, J., 1969.- Los atunes jovenes y el problema de sus capturas masivas. Publ. Tec. Junta Est. Pesca., 8, pp.159-162.

TORTONESE, E., 1975.- Osteichthyes (Pesci ossei).- Fauna de Italia. Ed. Calderini. Bologna. 636 p.

The Nursery Function of Mediterranean Sand Bottoms for Gobiid Fish

C.-Dieter ZANDER

Zoologisches Institut, Zoologisches Museum, Martin-Luther-King-Platz 3, Universität, 2000 Hamburg 13 (F.R.G.)

The aim of this study was to demonstrate the importance of sand bottoms in the Mediteranean Sea as nurseries for typical benthic fish like gobies. Two of the chosen habitats were fine sand bottoms which lay in 12 m (C-2) and 15 m depth (C-3) at the Ile Grosse close to the Laboratoire Arago, Banyuls-sur-Mer (France). A coarse sand bottom in Peyrefite near Banyuls lying in a depth of 7 m was included in these studies.

The youngs of the gobies (Teleostei, Gobiidae) Gobius geniporus VAL. and Pomatoschistus bathi MILLER prevailed in these bottoms in summer 1987. Densities of the gobies were measured during SCUBA dives with means of a measuring rope by counting several areas of 0.25 m^2.

Densities of young gobies were changing in habitat C-3 and were c. 20 in regard to G. geniporus and c. 12 to P. bathi m^{-2}(Fig. 1). Even 27 G. geniporus and 31 P. bathi existed in habitat C-2 whereas in Peyrefite only 3 individuals of every species per square-meter were counted (Fig. 1). These results differ from former investigations (ZANDER & HAGEMANN 1990) in the C-2 and Peyrefite habitats and may depend on the respective seasons.

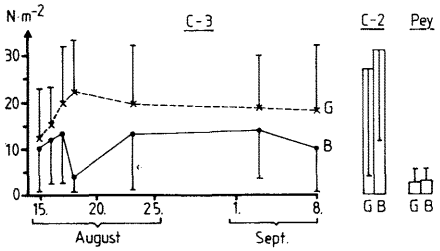


Fig. 1. Density counts (N m^{-2}) of two goby species in three habitats off Banyuls-sur-Mer/France. Vertical lines = standard deviation, B = Pomatoschistus bathi, G = Gobius geniporus.

Samples of fish were fixed in 4 % formalin and were treated for analyses of trophic relationships as was described by ZANDER (1982). The fullness index (the relation of ingested biomass of food to fish biomass) was compared in larger and smaller (less than 25 mm total length) G. geniporus as well as in P. bathi (Fig. 2). These values were similar at two dates in habitat C-3 with very high values of small G. geniporus, whereas the values of gobies from Peyrefite were lower (Fig. 2).

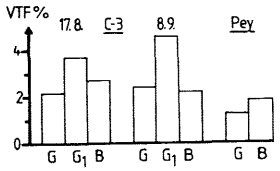


Fig. 2. Fullness index (VTF %) of three goby species or stages, respectively, from two habitats off Banyuls-sur-Mer/France. The C-3 habitat was studied in two dates. B = P. bathi, G = larger G. geniporus, G_1 = smaller G. geniporus (less than 25 mm total length).

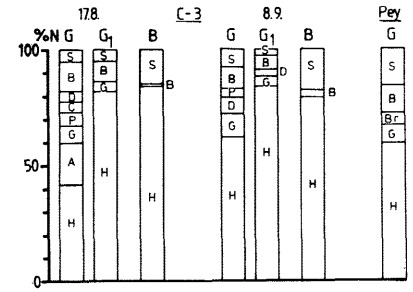


Fig. 3. Food spectra (% abundance) of three goby species or stages, respectively, from two habitats off Banyuls-sur-Mer/France. The C-3 habitat was studied in two dates. Symbols above columns mean B = P. bathi, G = larger G. geniporus, G1 = smaller G. geniporus (less than 25 mm total length). Symbols within columns: A = Anisopoda, B = other benthos, Br = Branchiostoma, C = Corophiidae, D = Decapoda, G = Gammaridae, H = Harpacticoidea, P = Polychaetes, S = Plankton/Suprabenthos.

The abundance of components was used for the analysis of food spectra (Fig. 3). Harpacticoids were the most important food of all gobies and prevailed in smaller G. geniporus and P. bathi. Larger G. geniporus completed their diets with several macrofauna organisms as diverse crustaceans, polychaetes or Branchiostoma (Fig. 3). These results are in accordance with former investigations (ZANDER 1982, ZANDER & BERG 1984, ZANDER & HAGEMANN 1990).

The supply of potentially available food organisms was richest in the C-2 habitat where also the fish biomass was highest (Table), obviously due to high densities (Fig. 1). In contrast, the Peyrefite habitat presented lowest fish biomass though the food supply was higher than in the C-3 habitat (Table). In other seasons and years the fish biomass was found to be lower in the C-2 and Peyrefite habitats (ZANDER & HAGEMANN 1990). Ingestion rates were highest in the September sample of the C-3 habitat, but lowest in Peyrefite (Table).

Table. Ecological data of three sand bottoms off Banyuls-sur-Mer/France.

Habitats	C-3 (Aug.)	C-3 (Sep.)	C-2	Peyrefite
Biomass supply (mg DW m^{-2}) excl. molluscs	566.9	1303.4	2265.3	2183.2
Mean weights (mg DW) G. geniporus	28.2	36.1		193.8
P. bathi	8.1	8.3		12.1
Fish biomass (mg DW m^{-2}) G. geniporus	550.6	656.7	761.4	581.4
P. bathi	105.9	83.1	251.1	37.7
total	666.5	739.8	1014.5	619.1
Ingestion (mg DW m^{-2}) = VTF x fish biomass				
G. geniporus	13.6	19.6		7.0
P. bathi	2.9	1.8		0.7
total	16.5	21.4		7.7

Therefore, high productivities of sand bottoms provide high densities of young fish. When they are growing up the relation of supplied biomass to fish biomass increases, but predators reduce densities and lesser feeding effectivity cause decreases of fullness indices.

References

ZANDER, C. D., 1982. Vie Milieu 32, 1-10.
ZANDER, C. D., & J. BERG, 1984. Vie Milieu 34, 149-157.
ZANDER, C. D., & T. HAGEMANN, 1990. Scient. Mar. 53, in press.

V-XII2

Adaptation of Red Sea Fish to the Eastern Mediterranean Environment

D. GOLANI and A. BARANES

Interuniversity Institute of Eilat and Department of Zoology, Hebrew University of Jerusalem (Israel)

The influx of Red Sea biota into the Mediterranean Sea via the Suez Canal (often termed Lessepsian migration) has fascinated scientists since the end of the last century. Until the last twenty years the study of Lessepsian fish was limited to monitoring and inventory. In order to reach a better understanding of the mechanism of the colonizers' adaptation to their new habitat, it was essential to conduct comparative research of the biology and morphology of the source population in the Red Sea and the colonizing population in the Mediterranean. The accumulation of such studies in the last two decades has enabled us to detect certain trends of Lessepsian fish adaptation.

In the present study we will summarize those characters in which recent research has revealed differences between the source and colonizing populations.

Feeding habits: Although, as expected, most colonizers retained their basic feeding habits, some differences were found that indicate adjustments of the colonizers to their new environment. The Mediterranean population of the two herbivore rabbitfish *Siganus rivulatus* and *S. luridus* show higher trophic selectivity than the source population in the Red Sea (Lundberg, 1980). Since selectivity generally increases with increased trophic abundance, it may be suggested that an "unsaturated niche" existed in the new habitat. A similar interpretation may be drawn from the case of the brownband goatfish *Upeneus pori* (known until recently as *U. asymmetricus* (Ben-Tuvia and Golani, 1989) who was found to prey upon larger-sized organisms in the Mediterranean.

Spawning season: Colonization of the Mediterranean resulted in temporal changes in the reproductive season of some species. In general those species, such as *Upeneus pori* (Golani, 1988), *Siganus rivulatus* and *S. luridus* (Popper, 1979), that live originally in shallower water and are therefore more prone to temperature fluctuation, retain their spawning season in the less stable environment of the Mediterranean. Those species inhabiting slightly deeper water (e.g., *Sargocentron rubrum* (Golani and Ben-Tuvia, 1985) and *Upeneus moluccensis*) shorten their reproductive period due to unsuitably cold temperatures prevailing in their new habitat throughout most of the year.

Morphomeristics: Comparison of the colonizers and the source populations revealed that in certain species, the counts of some morphomeristic elements have changed in the new environment. The most pronounced changes are the decrease in the number of lateral line scales and vertebrae in *Sargocentron rubrum* (Golani, 1987) and number of anal fin rays in *Pempheris vanicolensis*. It has been suggested that this reduction resulted from the higher temperatures prevailing in the Mediterranean than in the Red Sea during the respective spawning seasons of these species. Since the number of meristic elements are correlated to locomotory performance in various viscosities, which change with temperature, it can be postulated that alteration of meristic elements increases the adaptivity of the colonizer to its new environment.

References:

Ben-Tuvia, A. and D. Golani, 1989. A new species of goatfish (Mullidae) of the genus *Upeneus* from the Red Sea and the eastern Mediterranean. Isr. J. Zool. 36:103–112.

Golani, D., 1987. Comparison of morphomeristical variations of Mediterranean and Red Sea populations of the Suez Canal migrant *Sargocentron rubrum*. Centro. 3:25–31.

Golani, D., 1988. Aspects of colonization of two Red Sea species, the goldband goatfish *Upeneus moluccensis* and the brownband goatfish (*U. asymmetricus*), migrants in the Mediterranean Sea. Ph.D. thesis. The Hebrew University of Jerusalem, 124 + V pp. (in Hebrew with English summary).

Golani, D. and A. Ben-Tuvia, 1985. The biology of the Indo- Pacific squirrelfish, *Sargocentron rubrum* (Forsskal), a Suez Canal migrant to the eastern Mediterranean. J. Fish. Biol. 27:249–258.

Lundberg, B., 1980. Selectivity of food algae by the herbivorous fish *Siganus rivulatus* in the marine vegetation at Mikkmoret (the Mediterranean Coast of Israel). Ph.D. thesis. The Hebrew University of Jerusalem, 176 + 15 pp.

Popper, D.M., 1979. Comparative biology of species and populations of rabbit fishes (Siganidae) from the Red Sea, Mediterranean and Pacific Ocean (Applicative aspects). Ph.D. thesis. The Hebrew University of Jerusalem, 119 pp.

V

X-I1

Fluxes Across Continental Margins : Comparison of the SEEP and ECOMARGE Experiments

Pierre BISCAYE* and André MONACO**

*Lamont-Doherty Geological Observatory of Columbia University, Palisades New York 10964 (U.S.A.)
**Laboratoire de Sédimentologie et Géochimie Marines, Université de Perpignan, 66025 Perpignan (France)

The first comprehensive, multi-disciplinary, multi-institutional experiments to address the problem of fluxes across the marine boundaries of continental margins have been the SEEP program in the USA and the ECOMARGE program in France, both having begun in the early 1980s and continuing to the present. Major aspects of the first stages of both experiments have been published in dedicated volumes of *Continental Shelf Research* in both of which introductory papers give overviews and, to some degree, syntheses of the projects (Walsh et al., 1988; Monaco et al., 1990). SEEP (Shelf-Edge Exchange Processes) has been funded primarily by the US Dept. of Energy, and ECOMARGE (ECOsystemes de MARGEs continentales) by INSU of the French CNRS.

The scientific objectives of the two programs are very similar, as are some of the hypotheses on which the two experiments are based, as well as numerous aspects of the physical characteristics of the study areas yielding, therefore, some similarities in experimental design. Several other aspects of the study areas, however, are dissimilar, yielding differences in experimental strategy, and therefore in the results of the two experiments.

Both experiments have been sited on arcuate portions of continental margin on which the width of the continental shelf decreases in the downstream direction of the general advective drift of both shelf and slope waters (Figs. 1 & 2); exchange of water and suspended particulate matter (SPM) by "diffusive" processes across the shelf/slope break is relatively less than by advective transport toward and across the break at the downstream end of the system; "diffusive" exchange is related to meteorologic forcing with both seasonal and shorter-term components, and is strongly "event" driven.

Other aspects of the study areas and experiments differ strongly from each other. In the Middle Atlantic Bight of the SEEP experiment: there is a significant tidal dynamic component; riverine influx of SPM is low to possibly negative; primary productivity is reltively high; there is little storage of fine particles on the shelf; and the adjacent continental slope is incised by occasional submarine canyons. In the Gulf of Lions ECOMARGE experiment: there is no tidal mixing; riverine input of SPM is significant although seasonally variable; primary productivity is comparitively low; there are significant depositis of fine-grained sediments on the shelf; and more than 50% of the adjacent continental slope is incised by submarine canyons.

The effects of these and other similarities and differences on hypotheses, on experimental design and results, and conclusions will be analyzed as quantitatively as possible.

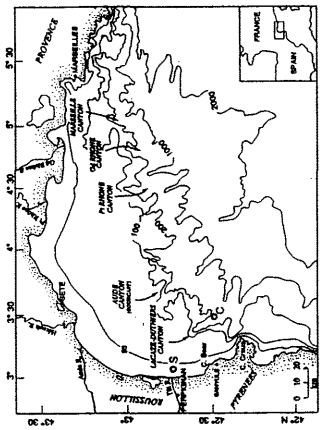
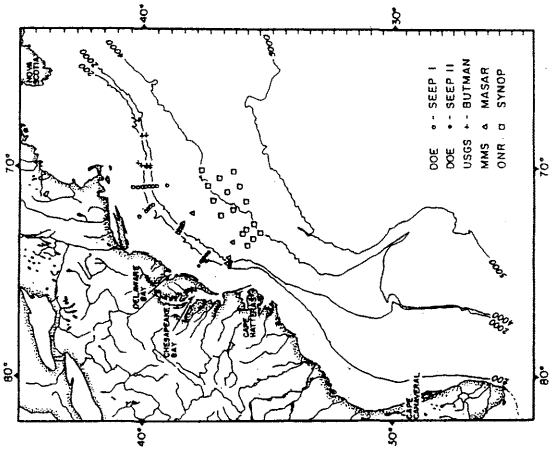


Fig. 1. (Left) The Middle Atlantic Bight (Cape Hatteras north to Cape Cod) of the USA east coast, showing the locations of the SEEP-I and -II experiments in the context of other US experiments during the 1980s.

Fig. 2 (Above) The Gulf of Lions (Cape Creus northeast to around Marseilles) of the French Mediterranean coast in which the first ECOMARGE experiment took place.



REFERENCES

Monaco, A., P. Biscaye, J. Soyer, R. Pocklington and S. Heussner, 1990, Particle fluxes and ecosystem response on a continental margin: the 1985-1988 Mediterranean ECOMARGE experiment. Cont. Shelf Res. (in press).

Walsh, J.J., P.E. Biscaye and G.T. Csanady, 1988, The 1983-1984 Shelf Edge Exchange Processes (SEEP)-I experiment: hypotheses and highlights. Cont. Shelf Res., 8, 435-456.

X-I2

Vertical Fluxes and Food Web Interactions

Rolf PEINERT

I.A.E.A., International Laboratory of Marine Radioactivity, 19, Av. des Castellans, MC 98000 (Monaco)

Although pelagic systems are potentially capable of retaining and recycling all autochtonous organic material, losses due to sinking particles inevitably do occur. The upper limit for the annual pelagic export in terms of essential biogenic elements is set by the availability of new nutrients and hence controlled by physical transport. The time pattern, composition and origin of settling particles, however, is under biological control by pelagic food web interactions. Sediment trap deployments revealed significant spatial and temporal variations of vertical fluxes that reflect imbalances of pelagic particle formation and degradation. Seasonal patterns, often consisting of flux maxima during spring and reduced losses thereafter during summer are the best documented ones. In the concept of new and regenerated production the spring vertical flux maximum is commonly regarded as characteristic for temperate to polar latitudes. Trap deployments have since shown, however, that seasonal patterns may substantially deviate from this paradigm and considerable interannual variations have come to light as well. This holds true in particular for different types of settling particles (various types of faeces, aggregates of varying origin, different organisms).

The presentation highlights the impact of selected planktonic organisms and their seasonal food web interactions on pelagic sedimentation. It concludes that further differentiations beyond the categories of new and regenerated production are needed for understanding observed vertical flux patterns. Herbivores with different feeding and life cycle strategies (including copepods, euphausiids, salps, pteropods) are grouped according to their role of either accelerating losses or counterworking sedimentation. The possible roles of copepods and pteropods are discussed in particular.

Based on sediment trap and water column data from the northern Northeast Atlantic, copepod grazing is proposed as a general retaining mechanism for suspended matter. For the spring period it is concluded that the timing between the onset of phytoplankton growth and copepod grazing controls the vertical flux. The coastal (fjords) and shelf systems (Norwegian Coastal Current, Barents Sea) as well as the marginal ice zones are characterized by spring blooms prior to the onset of intense copepod grazing. Thus, they have in common a spring sedimentation maximum of autotrophic origin that is triggered by the exhaustion of winter accumulated new nutrients. In the Norwegian Atlantic Current, however, that houses large overwintering copepod populations, a closer coupling of spring autotrophs and copepods is typical. The retention efficiency for essential elements in the pelagic food web therefore is more efficient and seems to be related to copepod population dynamics (with coprorhexy and coprophagy as important processes).

In the Norwegian Atlantic Current the seasonal vertical flux maximum accordingly is shifted towards late summer/autumn and consists of matter with heterotrophic origin. Omnivorous pteropods play a major role during this period and their abundance is highest after copepod hibernation has commenced. Their abandoned feeding webs and discharged pseudofaeces of pteropods scavenge smaller particles into aggregates. Discarded pteropod webs provide microhabitats and serve as transport vehicles accelerating the vertical export of particles. Their shells, in addition, contribute significantly to the carbonate flux during autumn in the Norwegian Sea. Little is known about the factors triggering pteropod mass sedimentation in autumn, be it may be starvation or old age mortality. The impact of the succession from copepods to pteropods as important grazers on the pelagic food web and on sedimentation can as yet only be speculated upon.

Other plankters such as salps and euphausiids can entirely dominate the vertical flux regionally and temporarily due to their rapidly sinking faeces. Krill faeces dominate trap collections during summer on the Norwegian Shelf and have been found of paramount importance in antarctic waters. Being rapidly exported from the layers of production, however, they are commonly not collected by deep moored traps, indicative of their easy fragmentation and, hence, deceleration. Salps, notoriously unpredictable in appearance and being patchily distributed, could contribute significantly to the interannual vertical flux variability at a given place.

Knowledge of the propagation, seasonal appearance and regulatory mechanisms of the biomass of all these plankters, as well as their specific functions in the pelagic food web, is of paramount importance in understanding the biological control of vertical fluxes in the oceans.

X

X-I3

Seasonal Changes in Mass Flux and Fecal Pellet Sedimentation at Monaco

J.-L. TEYSSIE , J.-C. MIQUEL and C.-V. NOLAN

I.A.E.A., International Laboratory of Marine Radioactivity, 19, Av. des Castellans, MC 98000 (Monaco)

Since January 1989 a sediment trap (0.125 m^2 aperture) has been deployed 3 nautical miles off Monaco at 80 m depth (120 m above the bottom). Mass and fecal pellet fluxes have been measured weekly and variations in the pellet composition determined (Fig 1). High mass fluxes are associated with rainfall and high wind speed from SE and NW rather than with phyto- and zooplankton abundance (meteorological data kindly provided by "Sémaphore de Ferrat"; plankton data provided by M. Boisson, CSM Monaco). The highest pellet fluxes, both in number and in mass, occurred in november-december where they accounted for a maximum of 51% of the total mass flux. At this time salp pellets (2-4 mm) dominantly contributed to the high mass flux of pellets whereas ovoid pellets (200-400 µm) were by far the most abundant by number. The latter presumably have been produced by amphipods since their exuviae were collected in the trap in great numbers as well during that time (Fig 1b). Cylindrical pellets of various sizes, as produced by copepods and euphausiids, were more consistently present throughout the year though they also showed a fall-winter maximum. Despite the relatively few samples obtained during the spring phytoplankton and zooplankton blooms it seems that few fecal pellets were in fact sinking out of the water column at those times. This surprisingly low contribution of the pellets to the vertical mass flux at the time of maximum zooplankton abundance supports the hypothesis that coprophagy and coprorhexy (Lampitt et al, 1990) indeed may play an important role in preventing losses from the pelagic zone. The possibility that the abundance of sinking pellets in winter is due to a fall-winter zooplankton bloom not previously recorded and/or to a resuspension of settled particles during stormy weather is being investigated.

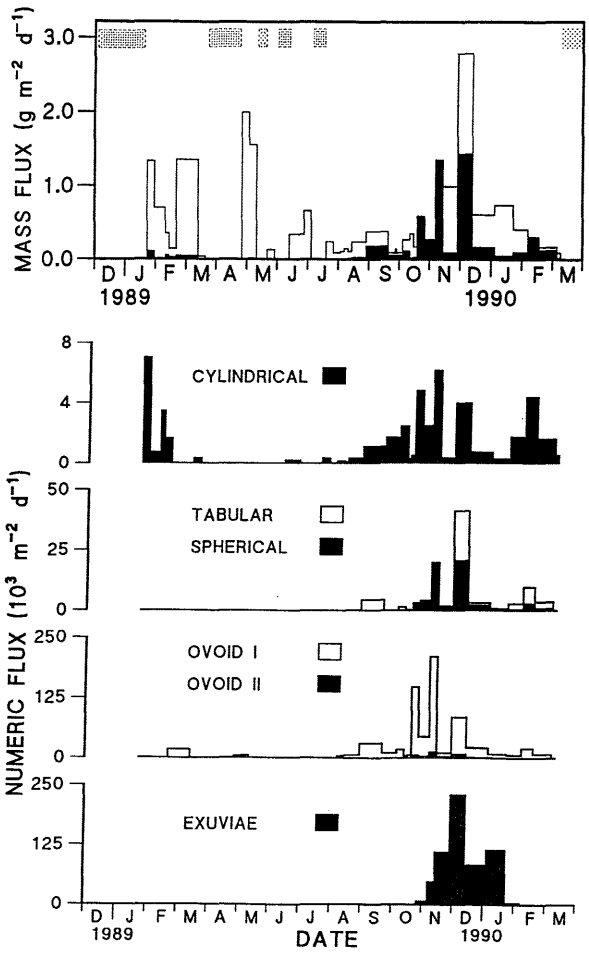


Figure 1. Vertical fluxes at a depth of 80m 3 NM south of Monaco during 1989. (a) Mass flux (excluding swimmers). The contribution of fecal pellets (solid areas) to total mass flux (open histograms) is estimated by the product of abundance of each pellet type and their respective mean dry weight. No data are available for those periods indicated by shading. (b) Flux of various types of fecal pellets (numbers) and of exuviae. Pellet types were determined by microscopy and are tentatively classed as cylindrical (copepods and euphausiids), tabular and spherical (salps), ovoid I (copepods and amphipods) and ovoid II (copepods and amphipods).

Reference:

Lampitt, RS, Noji, T & von Bodungen, B (1990). What happens to zooplankton faecal pellets? Implications for material flux. Mar.Biol. 104, 15-23.

X-I4

Vertical Fluxes of Particulate Material in a Frontal Zone off Corsica

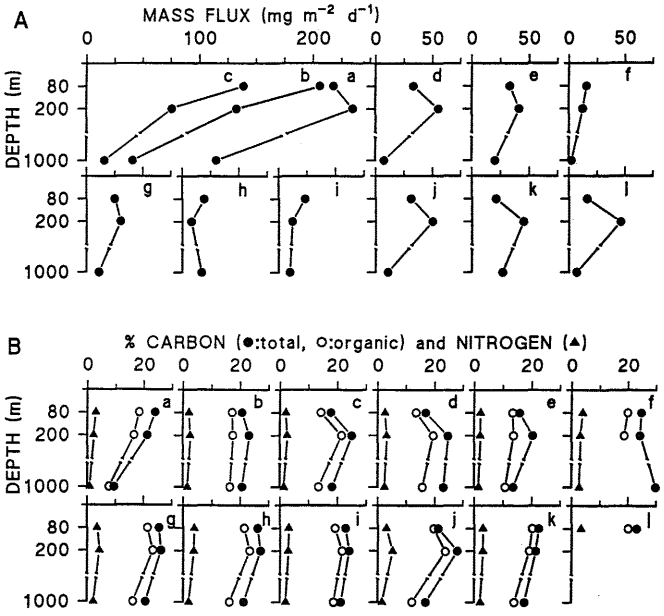
J.-C. MIQUEL , S.-W. FOWLER and J. LA ROSA

I.A.E.A., International Laboratory of Marine Radioactivity, 19, Av. des Castellans, MC 98000 (Monaco)

As part of the DYFAMED programme in the Ligurean Sea, cylindrical sediment traps (PPS3, Technicap) were moored 15 nautical miles off Calvi, Corsica, at 80, 200 and 1000 m depth in 2100 m of water from June to November 1987. The mooring site was situated in the Liguro-Provencal front which is persistent throughout summer and fall. At that time of year maximum chlorophyll a concentrations (ranging from 0.3 to 0.4 µg Chl a l^{-1}) are found at 60-80 m depth in June and 30 to 60 m depth in October (Hecq et al., 1986).

Mass flux integrated for 10 day collection periods and carbon and nitrogen composition were determined in the trap samples. In the upper 200 m, total mass flux was higher during June-July, exceeding 200 mg m^{-2} d^{-1}, and thereafter decreased to approximately 20-50 mg m^{-2} d^{-1} (Fig.1A). At 1000 m, the flux was generally lower than in the euphotic zone although it was relatively high (about 100 mg m^{-2} d^{-1}) at the beginning of the experiment. The pattern of carbon and nitrogen flux with depth closely followed that of mass flux except during the first period in which the increase in mass flux at 200 m was not associated with a concomitant increase in carbon and nitrogen fluxes.

Figure 1. Sediment trap observations at 3 depths, 15 NM off Calvi, Corsica.(A) vertical flux of particulate material for 10 day periods (a:22 June-2 July, b:2-12 July, c:12-22 July, d:22 July-1 August, e:1-11 August, f:11-21 August, g:11-21 September, h:21 September-1 October, i:1-11 October, j:11-21 October, k:21-31 October, l:31 October-10 November). (B) carbon and nitrogen composition in % dry weight of particles.



The carbon (total and organic) and nitrogen content of the particles was not correlated with total mass flux (Fig.1B); increases in mass flux were associated with either increases or decreases of C and N content. Mean values for total and organic carbon and nitrogen were consistently lower at 1000 m, although this relationship was not statistically significant. In the upper 200 m particles were normally less enriched in carbon and nitrogen at 80 m. Most of the carbon in the particles was of biological origin; the organic fraction accounted for an average of 84% of the total carbon at 80 m, 82% at 200 m, and decreased to 78% at 1000 m. Organic C/N weight ratios also show a continuous trend, increasing from an average of 6.2 at 80 m, 6.4 at 200 m, to 7.9 at 1000 m. This observation suggests that fresh biological material produced close to the surface degrades during its descent through the water column.

The higher flux of particles with lower carbon-nitrogen content noted during the period 22 June-2 July appeared to be due to a particle input associated with strong winds, exceeding 70 km h^{-1}, that were present for several days before the sampling started. On the other hand, the fluctuations in mass flux observed thereafter are most likely related to biological activity in the upper layers of the water column.

Reference:

Hecq, JH, Bouquegneau, JM, Djenidi, S, Frankignoulle, M, Goffart, A and Licot, M (1986). Some aspects of the Liguro-Provencal frontal ecohydrodynamics. In: Nihoul, JCJ (ed.), Marine Interfaces Ecohydrodynamics, Elsevier Oceanography Series 42, 257-271.

X

X-I5

Phénols et Sucres Marqueurs des Flux Sédimentaires sur la Marge Nord-Occidentale Méditerranéenne (Golfe du Lion)

F. GADEL*, C. GERMAIN*, B. CHARRIERE** et L. SERVE**

*Laboratoire de Sédimentologie et Géochimie Marines, Université de Perpignan (France)
**Laboratoire de Biologie Végétale, Université de Perpignan (France)

INTRODUCTION.

En domaine marin, la matière organique peut porter l'empreinte de sa double origine, terrestre et marine (DEGENS et MOPPER, 1976). Par ailleurs, la sensibilité de certains composés organiques aux processus biogéochimiques est telle que, par leur nature, ils peuvent apporter des informations précises sur les conditions de milieu.

Deux types de composés organiques ont été sélectionnés : les phénols qui, constituants majeurs de la lignine des végétaux supérieurs, sont de bons indicateurs des apports terrestres (POCKLINGTON et McGREGOR, 1973), même si certains peuvent avoir une origine marine (HEDGES *et al.*, 1988); les sucres qui, bien que provenant pour partie du complexe ligno-cellulosique terrestre, constituent de bons marqueurs des apports marins (ITTEKKOT *et al.*, 1984). S'ils peuvent perdre rapidement les informations sur leur origine, ils enregistrent mieux les effets des conditions de milieu.

A l'aide d' exemples choisis dans les zones épicontinentales (Rhône et Têt) et bathyales (canyon Lacaze-Duthiers) du Golfe du Lion, le fonctionnement de ces systèmes marins est précisé par l'analyse qualitative et quantitative de ces deux classes de composés organiques.

METHODES D'ETUDE.

L'analyse des phénols a été effectuée par chromatographie liquide haute performance après attaque nitrobenzène-soude (CHARRIERE *et al.*, 1986), méthode adaptée à de faibles quantités de matériel correspondant à une charge résultant de la filtration de 1 à 3 litres d'eau.

L'analyse des sucres a été réalisée en appliquant une méthode nouvelle de chromatographie liquide haute performance avec détection par ampérométrie pulsée mise au point aux Etats-Unis par Claire GERMAIN (MOPPER *et al.*, 1988; GERMAIN, 1989).

RESULTATS.

Les composés phénoliques représentatifs du matériel terrestre soulignent dans leur distribution et leur nature, la variabilité des apports et la diversité des conditions de milieu.

* Sur le delta du Rhône et sur la zone prodeltaïque de la Têt une forte accentuation des teneurs en phénols est enregistrée en période de crue, associée à une plus forte incidence des apports terrestres dans les eaux du large.

La distribution et la composition des phénols confirment bien l'existence d'un système multicouche plus ou moins individualisé au cours de l'année. Les eaux de surface sont généralement enrichies en acides-phénols, les couches profondes, moins oxygénées, en aldéhydes.

Issus de la dégradation de la matière organique déposée dans le lit du fleuve, les aldéhydes phénoliques sont, lors des crues, entraînés vers le large et, associés au complexe organo-minéral, rejoignent alors le néphéloïde benthique. A ce niveau, les teneurs en phénols rapportées à la matière organique sont plus élevées qu'en surface, traduisant un plus fort degré d'évolution.

En période d'étiage dans la zone deltaïque, les phénols, quoique moins abondants dans les suspensions, sont toutefois bien représentés vers le large (phénols de la série hydroxy-benzoyl) où ils semblent issus du matériel phytoplanctonique.

Au niveau des dépôts un certain enrichissement en phénols de la série gaïacyl, plus résistants, se manifeste comparativement aux suspensions plus riches en phénols de la série syringyl, comme l'ont montré HEDGES *et al.* (1988).

En domaine bathyal, une certaine richesse en phénols peut à la fois traduire une origine phytoplanctonique (tannins des algues), avec souvent une grande variété de composés dans la zone euphotique, ou une origine phanérogamique (débris de Posidonies - PIOVETTI *et al.*, 1984). Ce dernier apport, jusqu'à présent sous-estimée, confirme l'importance des transferts advectifs plateau-pente dans certains secteurs du Golfe du Lion.

* Malgré une certaine homogénéité de composition, les sucres dans le matériel en suspension présentent des différences suivant leur origine et leur aptitude à la dégradation. A ce titre, ils rendent compte de la variabilité des apports et des conditions de milieu.

En domaine deltaïque, des analogies se manifestent entre la Têt en période de crue et le Rhône dans son régime normal. Cette analogie se traduit par la prédominance de l'arabinose, du galactose et du mannose, représentatifs des apports terrestres. Par ailleurs, dans le delta du Rhône, l'absence de fructose pourrait indiquer un caractère plus évolué de la matière organique.

Dans les zones épicontinentales, la distribution et la nature des sucres présentent une certaine variabilité saisonnière. En juin, un faible rapport arabinose/fucose rend compte d'un bloom siliceux (Diatomées), au mois d'août, la richesse en arabinose témoigne au contraire d'un bloom carbonaté (Coccolithes). L'abondance dans les couches de fond du ribose, composé fragile traduit un transport rapide à partir de la surface. Durant l'automne, les forts apports en débris végétaux terrestres lors des crues rendent compte de la richesse relative en arabinose et en mannitol.

Dans le domaine bathyal, une baisse des flux de sucres se manifeste par rapport aux zones deltaïques. En période printanière, un bloom phytoplanctonique de diatomées amène un accroissement des sucres dans le matériel en suspension, à tous les niveaux de la colonne d'eau. En période estivale, l'abondance des pelotes fécales dans la zone euphotique se traduit par une certaine richesse en ribose et en sucres aminés. A 50 et 100 m, la composition voisine en sucres témoigne d'un transport vertical actif, mais l'existence de la thermocline en septembre réduit ces échanges verticaux. Les différences observées en automne entre les couches à 300 et 600 m rendent compte d'apports impulsionnels latéraux.

CONCLUSIONS.

L'utilisation de ces deux types de composés organiques comme marqueurs biogéochimiques sur la marge méditerranéenne nord-occidentale montre leurs caractères complémentaires comme sources d'informations sur l'origine et les conditions de milieu. Les phénols, composés relativement stables du fait d'une certaine toxicité vis-à-vis de l'activité bactérienne, permettent de mettre en évidence les flux d'origine terrestre. Les sucres, molécules plus fragiles et biosensibles, peuvent enregistrer les effets des conditions de milieu et, bien que pouvant perdre rapidement leurs caractères originels, rendre compte de la variabilité saisonnière des apports marins.

REFERENCES :

Charrière B., Sancho A., Serve L., Combaut G., Gadel F. & Piovetti L., 1986.- Les composés phénoliques dans un écosystème lagunaire méditerranéen : végétaux aquatiques, eaux, sédiments. *Journées Internationales d'Etudes, Groupe Polyphénols*, Montpellier, *VI* : 560-564.

Degens E.T. & Mopper K., 1976.- Factors controlling the distribution and early diagenesis of organic material in marine sediments. In Chemical Oceanography. J.P. Riley ed., 2nd ed. vol. 6 : 59-113.

Germain C., 1989.- Les sucres marqueurs de transfert de matières : application d'une nouvelle méthode chromatographique à l'étude de la marge nord-occidentale méditerranéenne. Thèse Doctorat Université de Perpignan : 230 p.

Hedges J.I., Clark W.A. & Cowie G.L., 1988 a.- Organic matter sources to the water column and surficial sediments of marine bay. *Limnol. Oceanogr.*, 33 (5) : 1116-1136.

Ittekkot V., Brockmann U., Michaelis W. & Degens E.T., 1981.- Dissolved free and combined carbohydrates during a phytoplancton bloom in the Northern North Sea. *Mar. Ecol. Prog. Ser.* 4 : 299-305.

Mopper K., Germain C. & Chevolot L., 1988.- Determination of sugars in sea water by direct injection of samples into a liquid chromatograph. *Trans. Amer. Geophys. Un.* Abstract, 42 B-12, 69 : 1130.

Pocklington R. & Mac Gregor C.D., 1973.- The determination of lignin in marine sediments and particulate form seawater. *Intern. J. Environ. Anal. Chem., 3* : 81-93.

Piovetti L., Serve L., Combaut G. & Gadel F., 1984.- Analyse des substances phénoliques des restes de *Posidonia oceanica* (L.) Delile provenant de sédiments holocènes et de dépôts actuels. International Workshop on *Posidonia oceanica* beds, Boudouresque C.F., Jeudy de Grissac A. & Olivier J. édit., GIS Posidonies, Publ. fr. 1 : 137-144.

X-I6

Utilisation de photoproduits du phytol dans les études de transfert surface-sédiments phyténals Z et E

Patrick J.-P. GIRAL

Observatoire des Sciences de l'Univers-Centre d'Océanologie de Marseille-URA 41-Faculté des Sciences de Luminy, route Léon Lachamp, 13299 Case 901-F, Marseille (France)

Aux moyens mis en oeuvre afin d'étudier les transferts de matière entre la surface et les sédiments, nous pouvons aujourd'hui ajouter l'utilisation de certains photoproduits du phytol *E* (tétraméthyl-3,7,11,15-hexadécène-2-ol-1). Cette molécule peut être liée à de multiples composés (cires, tocophérols,...) détectés dans le milieu, et constitue la chaîne latérale des chlorophylles *a* et *b*. Libérée par hydrolyse acide ou par l'action de la chlorophyllase, elle est rapidement photo-oxydée, pour conduire à divers composés isoprénoïdes, cétones, alcanes et aldéhydes (Rontani et Giusti, 1988). Ces derniers, les phyténals *Z* et *E* (tétraméthyl-3,7,11,15-hexadécènal-2), sont instables dans l'eau et vont pouvoir être utilisés dans les mesures de vitesse de sédimentation moyenne des particules. Leur quantification est faite en chromatographie en phase gazeuse, et leur identification formelle en comparant leurs spectres de masse contre ceux de témoins synthétisés. Cette méthode a été appliquée à divers échantillons provenant de Méditerranée Occidentale (Rontani et al, 1990).

Les phyténals *Z* et *E* sont produits dans la couche euphotique par photo-oxydation du phytol *E*. La présence de l'isomère *Z*, qui ne peut être produit biologiquement, en est la preuve. Après adsorption sur du matériel sestonique ou absorption, les phyténals vont sédimenter et évoluer au cours du temps, subissant des réactions d'oxydation et de rétroaldolisation. La première réaction est dépendante de la quantité d'oxygène dissous et conduit à la formation des acides isoprénoïdes *Z* et *E*, communément appelés acides phyténiques (tétraméthyl-3,7,11,14-héxadécénoïque-2 *Z* et *E*). Si ces acides peuvent être produits lors du métabolisme du phytol, la présence de l'isomère *Z* atteste une origine photochimique. La rétroaldolisation conduit à la formation de phytone (triméthyl-6,10,14-pentadécanone-2) par réaction des phyténals avec l'eau, et a lieu même en absence totale d'oxygène. Si ces trois produits d'évolution des phyténals ont été maintes fois trouvés dans les sédiments (Brooks et al, 1978), les phyténals sont par contre rarement détectés (Rowland, 1982). Des analyses effectuées sur du matériel particulaire en suivant deux protocoles différents nous ont permis de détecter à chaque fois les phyténals *Z* et *E* (Rontani et al, 1990).

Les utilisations de ces aldéhydes sont multiples du fait de leur instabilité dans l'eau et de l'ubiquité du phytol qui leur donne naissance. Leur présence dans les sédiments permet de définir un matériel 'frais', à haute valeur nutritive, et de rapides transferts entre la surface et les sédiments. Nous proposons donc d'utiliser ces photoproduits dans l'estimation des vitesses de sédimentation de la matière organique en déterminant les quantités (Cz1, Cz2, Czi) de phyténals aux profondeurs (z1, z2, zi) par analyse de matériel particulaire. Connaissant leur temps de demi-vie (T0) à la température θ, on peut estimer le temps de transit (St) entre chaque niveau. Les phyténals subissent simultanément un apport en provenance du haut et une évolution dans la trappe. Ces considérations nous conduisent aux expressions suivantes:

$$St=(Log(Cz1)-Log(Cz2))*T0/Log(2)$$

$$\lim_{n\to+\infty}(Cz)=\lim_{n\to+\infty}(Ci*\Sigma(1/2n))=Ci*\lim_{n\to+\infty}(\Sigma(1/2n))=Ci*2, \text{ donc } Ci=Cz/2$$

n = temps d'échantillonnage exprimé en périodes (T0).

$$vm/d=Log(2)*(z2-z1)/((Log(Cz1)-Log(Cz2))*T0)$$

Les échantillons de matériel particulaire prélevés à l'aide de trappes à sédiment du 7 au 25 Avril 1987 dans le canyon du Rhône (45°50'N, 4°48'E) au cours d'une campagne ECOMARGE (échantillons codés αIB5 et αID5) à 600 et 900 mètres de profondeur et à une température de 13°C ont été analysés et conduisent aux estimations suivantes:

Quantités de phyténals: 5,1 ppb à 600 m; 3,0 ppb à 900 m.
Flux de phyténals: 2,58 ppb/période à 600 m; 1,52 ppb/période à 900 m, où une période dure 4 jours.
Temps d'échantillonnage:4,5 périodes (18 jours).
Temps de transit entre 600 et 900 mètres:0,77 période soit 3 jours.
Vitesse de sédimentation des particules: 100 mètres par jour.

REFERENCES

BROOKS P. W., MAXWELL J. R. and PATIENCE R. L., 1978. Stereochemical relationships between phytol and phytanic acid, dihydrophytol and C18 ketones in recent sediments. Geochem. Cosmochim. Acta, 42 : 1175-1180.

RONTANI J.-F. et GIUSTI G., 1988. Photosensitized oxidation of phytol in seawater. Photochem. Photobiol., A:Chemistry, 42 : 347-355.

RONTANI J.-F., COMBES I., et GIRAL P. J.-P., 1990. Abiotic degradation of free phytol in the water column: A new pathway for acyclic isoprenoïd compounds formation in the marine environment. Geochim. Cosmochim. Acta, sous presse...

ROWLAND S.J., 1982. Origins and fate of sediment acyclic isoprenoids. Chapitre 3. Ph.D. Thesis, University of Bristol, U.K.

X

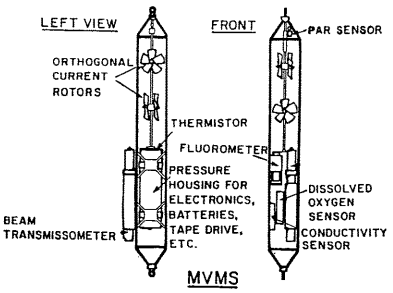
Recent Advances and Future Directions in concurrent Time Series Observations of Physical, Optical, Biological and Geochemical Processes

T.-D. DICKEY* and I. TAUPIER-LETAGE**

*Ocean Physics Group, Department of Geological Sciences, University of Southern California, Los Angeles, CA90089-0740 (U.S.A.)

**Centre d'Océanologie de Marseille, BP 330, 83507 La Seyne-sur-Mer (France)

New ideas concerning the sampling of the upper ocean ecosystem, on both spatial and temporal scales, have been driven in part by general concerns about the well being of the ocean environment and its role in climate change, particularly as influenced by anthropogenic activities. Remote sensing using satellite color imagery has been successfully applied to estimate regional near surface pigment concentrations, and, to some extent, primary productivity. Recently, advances in temporal sampling have been made as moored multi-disciplinary measurement systems have enabled the upper ocean ecosystem to be studied at time scales comparable to those previously limited to physical oceanographers (Dickey,1988). In fact, the present state of technology enables moored physical-biological-optical-geochemical measurements to be done every few minutes for periods up to 6 months. This is equivalent to a temporal resolution of ≈1/20,000th that possible using bi-weekly shipboard sampling.



As an example, during the Biowatt study in the Sargasso Sea (34N 70W), concurrent multi-disciplinary data were collected from moored instruments every 4 minutes during 3 consecutive deployments periods from February 28 through November 23, 1987 (Dickey *et al.*,1990a-b). These data sets were obtained from multi-variable moored systems (MVMS, Fig.) by collaborative groups led by Tom Dickey of University of Southern California and John Marra of Lamont-Doherty Geological Observatory. The MVMS instrument packages, located at 8 depths (10m through 160m), were used to measure horizontal currents, temperature, photosynthetically available radiation (PAR), beam attenuation coefficient, chlorophyll fluorescence, and dissolved oxygen. Diel variability was observed in the spectra of these variables throughout the euphotic layer, and a large (though short-lived: ≈2 days) springtime bloom event was evident in the beam attenuation and chlorophyll fluorescence time series. The bloom event was also evident in the concurrent bio-optical data (*e.g.* spectral diffuse attenuation coefficient) obtained from bio-optical moored systems (BOMS; Booth and Smith,1988; Smith *et al.*,1990). This springtime bloom coincided with a shoaling of the mixed layer depth from greater than ≈160m to ≈30m within about 2 days. It is apparent that the high degree of variability associated with processes such as diel particle production and transient blooms and their cessations cannot be observed using coarse (and highly aliased) temporal sampling (*e.g.* bi-weekly).

It is important to note that many of the observations described here (*e.g.* PAR, fluorescence, beam attenuation coefficient and dissolved oxygen) can be used to generate time series of biomass and/or primary productivity , system respiration and biological oxygen demand, carbon fluxes, and water turbidity (Kiefer and Mitchell, 1983; Brewer *et al.*,1986; Emerson,1987; Dickey,1988; Siegel *et al.*,1989; Dickey *et al.*,1990a-b). Concurrent temperature and current data are essential to determine relations between physical conditions (*e.g.* stratification, mixing time scales, advection and transport, etc...) and biological and geochemical processes.

Although our ability to sample the marine ecosystem has improved greatly, there remain several obvious high temporal resolution measurements which we would like to include in future systems. Among these are dissolved carbon dioxide and plant nutrients (nitrate, nitrite, silicate, and phosphate). Presently, it is possible to determine oxygen fluxes across the air-sea interface using mooring meteorological data and near surface dissolved oxygen concentration measurements. In addition, moored acoustical measurements are attractive. It is now possible to obtain relatively high vertical resolution acoustical measurements of currents and zooplankton distributions. Coupled with remote sensing satellite imageries and shipborne sampling, long-term high resolution multi-disciplinary monitoring using moored instruments allows a correct description of both open ocean and coastal areas, and can be used for model prediction of environmental changes.

Such a strategy is planned to be used in the Western Mediterranean in 1992-93, most probably in the Algerian Basin. Indeed, the instability of the Algerian Current generates mesoscale phenomena such as upwellings and eddies (Millot,1990). A multi-platform sampling approach which includes multi-disciplinary time series measurements from moorings can be used to obtain information on relationships between dynamical, biological, and geochemical phenomena, and to give a first assessment of the biogenic fluxes in this region.

Dickey T., 1988. Recent advances and future directions in multi-disciplinary *in situ* oceanographic measurements systems. In Toward a Theory on Biological and Physical Interactions in the World Ocean, B.J.Rothschild (ed.), Kluwer Academic, Dortrecht, The Netherlands, 555-598.

Dickey T., Granata T., Hamilton M., Wiggert J., Marra J., Langdon C., Siegel D., 1990a. Time series observations of bio-optical properties in the upper layer of the Sargasso Sea, *Ocean Optics*, in press.

Dickey T., Marra J., Langdon C., Granata T., Hamilton M., Siegel D., Wiggert J., 1990b. Bio-optical-physical time series observations in the Sargasso Sea during the spring of 1987, submitted to *J.Geophys.Res.*.

Booth C.R., Smith R.C., 1988. Moored spectroradiometers in the Biowatt experiment, *Ocean Optics IX*, 176-188.

Smith R.C., Waters K.J., Baker K.S., 1990. Pigment biomass and optical variability in the Sargasso Sea as determined using deep sea optical mooring data, submitted to *J.Geophys.Res.*

Emerson S., 1987. Seasonal oxygen cycles and new production in surface waters of the subarctic Pacific Ocean. *J.Geophys.Res.*, 92:6535-6544.

Kiefer D.A., Mitchell B.G., 1983. A simple, steady-state description of phytoplankton growth based on absorption cross section and quantum efficiency. *Limnol. et Oceanogr.*, 28:770-776.

Siegel D.A., Dickey T.D., Washburn L., Hamilton M.K., Mitchell B.G., 1989. Optical determination of particulate abundance and production variations in the oligotrophic ocean. *Deep Sea Res.* 36(2):211-222.

Brewer P.G., Bruland K.W., Eppley R.W., McCarthy J.J., 1986. The Global Ocean Flux Study (GOFS): status of the U.S. GOFS Program. *EOS*, 67:827-832, 835-837.

Millot C., 1985. Some features of the Algerian Current, *J.Geophys.Res.*, 90: 7169-7176.

Analyse d'Hydrocarbures Aliphatiques et Aromatiques Polycycliques dans les sédiments marins profonds des Marges Continentales Atlantique et Méditerranéenne (Programme ECOMARGE)

E. PARLANTI, P. GARRIGUES et M. EWALD

Laboratoire de Photophysique et Photochimie Moléculaire, UA 348 CNRS, Université de Bordeaux I, 33405 Talence (France)

INTRODUCTION

Les hydrocarbures sont universellement répandus dans l'environnement (atmosphère, lithosphère, hydrosphère et biosphère). Notre étude concerne plus particulièrement l'analyse des Hydrocarbures Saturés (n-alcanes) et des Hydrocarbures Aromatiques Polycycliques (HAP). Ces derniers sont principalement considérés comme des polluants d'origine anthropogénique (Neff 1979). Toutefois, s'ils sont en grande partie produits par l'activité industrielle, ces mêmes composés peuvent être issus d'une évolution diagénétique de la matière organique dans le milieu sédimentaire. Il apparait donc important de différencier les sources des HAP pour identifier l'origine et les modes de transport et de transformation de ces composés dans l'environnement. L'analyse complémentaire des n-alcanes nous permet de distinguer origines biogénique et pétrogénique de la matière organique dans les sédiments (Colombo *et al.*, 1989). Cette étude a été réalisée sur 60 échantillons de sédiment provenant des marges atlantique et méditerranéenne.

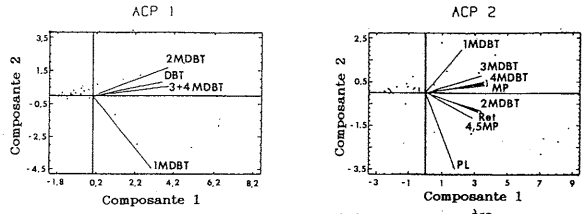
PARTIE EXPERIMENTALE

Les sédiments ont été prélevés à l'aide des carottiers Usnel et Flusha. Les échantillonages ont été réalisés au niveau de canyons sous-marins (tête de canyon et éventails sous-marins) pour chacune des marges. Les sédiments, gelés à bord, sont conservés congelés jusqu'à leur lyophilisation au laboratoire. L'extrait organique total est obtenu par extraction Soxhlet au dichlorométhane puis purifié sur micro-colonne de Florisil (Garrigues *et al.*, 1987). Une première étape de chromatographie liquide sur phase normale permet la séparation des hydrocarbures saturés et des différentes familles d'HAP (Garrigues *et al.*, 1988). Les différentes fractions sont collectées et analysées par chromatographie en phase gazeuse sur colonne capillaire (chromatographes Carlo Erba, FRACTOVAP 4160 et Shimadzu, GC-14A, equippés d'injecteurs splitless et de détecteurs FID, et couplés à un intégrateur Shimadzu CR4A). Les composés sont identifiés par comparaison avec un mélange étalon contenant les composés de référence et quantifiés par calibration avec un étalon interne.

RESULTATS

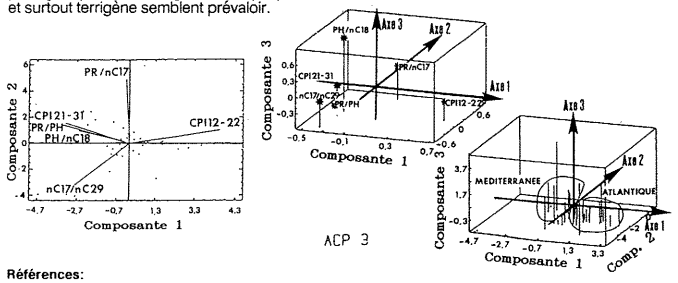
Les teneurs totales en HAP obtenues pour ces échantillons sont de l'ordre de plusieurs centaines de ng/g de sédiment sec (Parlanti *et al.*, 1989). Ce résultat peut paraître étonnant pour des échantillons non côtiers. Ces concentrations sont toutefois plus élevées en tête de canyon que pour les sédiments les plus profonds. Le méthylène 4,5-phénanthrène (composé typique d'une origine pyrolytique) a été détecté en faibles quantités au niveau des têtes de canyon, y suggérant une contamination de type pyrolytique. Il n'est pas présent dans les sédiments des éventails sous-marins où par contre le Rétène (caractéristique de la combustion de bois de conifères (Ramdahl 1983)) a été observé. Nous sommes donc certainement en présence d'une matière organique d'origine continentale apportée avant l'ère industrielle. L'analyse des homologues alkylés du phénanthrène a confirmé l'évolution diagénétique des sédiments les plus profonds ainsi que la contribution pyrolytique en têtes de canyon (Parlanti *et al.*, 1989).

Nous avons effectué sur l'ensemble de nos résultats une étude statistique multidimensionnelle (à l'aide des logiciels STAT-ITCF et STATGRAPHICS). Ainsi l'analyse en composantes principales (ACP) a été réalisée sur plusieurs matrices constituées de 60 observations (échantillons) et d'un nombre de variables allant de 5 à 20. Ces variables étant soit des teneurs, soit des rapports caractéristiques, les ACP ont été faites sur les données centrées réduites afin de se libérer du problème des unités. Ces analyses factorielles multiples nous ont permis de confirmer ou de mettre en évidence de nouvelles informations.



Il apparaît par exemple sur la figure précédente que la 1ère ACP, réalisée pour le Dibenzothiophène (DBT) et ses quatre homologues alkylés, individualise le 1-méthyldibenzothiophène (1MDBT), suggérant une origine différente de ce composé. La 2ème ACP présentée met en opposition le Pérylène (PL) et le 1MDBT. Le PL étant caractéristique d'une origine terrigène (Colombo et al., 1989), ce résultat conforte l'hypothèse que nous avancions, lors de précédents travaux, sur l'origine marine du 1MDBT.

Les variables choisies pour l'ACP illustrée sur la figure suivante, sont des rapports calculés pour la famille des alcanes normaux et spécifiques de diverses sources de la matière organique dans les sédiments. On peut noter ici l'opposition par l'axe 1 entre les rapports CPI12-22 (origine pétrogénique) d'une part, et CPI21-31 et nC17/nC29 d'autre part (caractéristiques respectivement d'une origine terrigène et d'une source marine). Ces deux derniers rapports sont d'ailleurs eux-même opposés par l'axe 2. L'axe 1 semble donc séparer origines pétrogénique et biogénique alors que l'axe 2 semblerait différencier les sources marine et terrigène. Si l'on s'intéresse maintenant à la distribution par rapport à ces mêmes axes de nos échantillons, nous constatons que pour les sédiments de la marge atlantique la prédominance d'une source pétrogénique est à souligner alors que pour les échantillons méditerranéens les caractères marin et surtout terrigène semblent prévaloir.



Références:

COLOMBO J. C., PELLETIER E., BROCHU C., KHALIL M. - 1989 - *Environmental Science & Technology*, 23, p 888-894.

GARRIGUES P., SOCLO H.H., MARNIESSE M-P., EWALD M. - 1987 - *International Journal of Environmental Analytical Chemistry*, 28, p 121-131.

GARRIGUES P., De SURY R., ANGELIN M-L., BELLOCQ J.,OUDIN J-L., EWALD M. - 1988 - *Geochimica et Cosmochimica Acta*, 52, p 375-384.

NEFF J. M. - 1979 - *In: Polycyclic aromatic hydrocarbons in the aquatic environment. 262 pp. - London: Applied Science Publishers.*

PARLANTI E., GARRIGUES P., BELLOCQ J., EWALD M. - 1989 - *Océanis*, 15, (4), p 615-622.

RAMDAHL T. - 1983 - *Nature*, 306, p 580-582.

X-I9

Flux de matière organique et réponse géochimique et biologique à l'interface sédimentaire sur la Marge de Méditerranée Occidentale

R. BUSCAIL* et L. GUIDI**

*Laboratoire de Sédimentologie et Géochimie Marines, Université de Perpignan (France)
**CEROV, Station Zoologique, 06230 Villefranche-sur-Mer (France)

L'étude des flux de matière organique et de leur bilan à l'interface sédimentaire doit être associée à celle du compartiment biologique benthique.

FLUX DE MATIERE ORGANIQUE PRES DU FOND

Sur la pente de Méditerranée occidentale, un gradient croissant d'Est en Ouest s'observe au niveau des flux de C org mesurés près du fond dans la zone des 1000m. Ils sont 6 fois plus élevés dans le canyon Lacaze-Duthiers que dans le canyon du Grand Rhône, avec respectivement 90 mg/m2/j et 16 mg/m2/j en moyenne sur un an. Sur l'interfluve entre les canyons du Grand Rhône et du Petit Rhône, le flux de C org (9,6 mg/m2/j) est 1,7 fois plus faible que dans l'axe du canyon du Grand Rhône. Dans ce canyon, la valeur obtenue près du fond, correspond à une décroissance exponentielle du flux de la surface vers le fond (profil de type océanique) alors que dans le canyon Lacaze-Duthiers, on assiste à un accroissement des flux près du fond dû à un apport latéral important (Monaco et al.,1990).

A l'entrée du système, la marge rhodanienne est de type océanique, alors que la marge pyrénéo-catalane, à la sortie, est de type continental.

Dans le Golfe du Lion, la circulation générale liguro-provençale induit le transfert Est-Ouest du matériel minéral et organique issu des apports produits sur le plateau continental ou remaniés sur le haut de la pente. A l'extrémité SW, dans le canyon Lacaze-Duthiers, le matériel en suspension se trouve concentré.

Les variations saisonnières des flux de matière organique ont une répercussion sur le comportement des organismes benthiques. Dans les canyons ces variations se traduisent notamment par des flux importants, au printemps. Dans le canyon Lacaze-Duthiers, ils sont de 200 mg de carbone et 16 mg d'azote/m2/j, soit respectivement 40 fois et 20 fois plus élevés qu'en été, période de flux minimum. Sur la marge rhodanienne les flux mesurés à proximité du fond sont 30 à 40 fois plus forts en avril qu'en automne.

La qualité des apports montre d'importantes variations au niveau de leur caractère labile ou réfractaire. En été, la matière organique qui alimente le fond à environ 1000 m sur la pente, est fortement dégradée (moins de 25% de composés labiles). Il semblerait qu'au cours de cette période, l'alimentation se fasse par reprise de matériel déjà déposé sur le plateau ou sur le haut de la pente. Par contre, en hiver et au printemps, le caractère labile résulte de l'augmentation de la proportion d'acides aminés. Si en décembre les fortes proportions d'acide aspartique (ASP) reflètent la présence d'organismes calcaires issus d'un bloom de coccolithophorides, au printemps une forte augmentation de la proportion de glycine (GLY) caractérise la préservation des membranes cellulaires de diatomées et le rapport ASP/GLY < 1 indique un transfert rapide de matériel frais.

RÉPONSE GÉOCHIMIQUE DE L'INTERFACE SÉDIMENTAIRE

Sur la pente du Golfe du Lion, les taux de C org dans les sédiments superficiels augmentent sur toute la zone comprise entre 200 et 1500 m. Cette partie de la marge est entaillée de nombreux canyons. Les plus forts taux de C org sont observés dans les vases accumulées dans les axes et sur les versants (0,6 à 0,9%). Les dépôts situés sur les interfluves entre deux canyons sont par contre appauvris en C org (0,5%). Un gradient décroissant du taux de C org dans les sédiments superficiels est observé d'est en ouest dans la zone des 1000 m, à l'inverse du gradient croissant des flux de C org (Buscail et al.,1990).

A l'interface eau-sédiment, il est possible de noter une réponse aux variations saisonnières des apports. Depuis l'été, et jusqu'au printemps, le taux de C org augmente progressivement de 7,7 à 8,7 mg/g de sédiment dans le canyon Lacaze-Duthiers. En parallèle, le caractère labile du matériel organique augmente, comme le montre la variation du rapport C/N, élevé en été (C/N=12,9), faible au printemps (C/N=4,4). Au printemps, le caractère azoté et labile est exprimé par un taux global de C org hydrolysable qui double, principalement à cause de la teneur en acides aminés 5 fois plus forte.

Le bilan du C org à l'interface sédimentaire a été effectué dans le canyon Lacaze-Duthiers. Il établit que 40 à 54% du C org atteignant l'interface s'accumulent alors que 46 à 60% sont consommés par les organismes benthiques. Deux types d'évaluation du taux de sédimentation (^{14}C et ^{210}Pb) sont à l'origine de ces valeurs extrêmes.

RÉPONSE DU COMPARTIMENT BENTHIQUE

Du point de vue de la biologie benthique, le fonctionnement de la marge du Golfe du Lion a été abordé par l'étude d'organismes susceptibles de répondre rapidement aux perturbations de l'environnement. Il s'agit de la méiofaune formée de métazoaires de taille inférieure au mm comprenant des groupes zoologiques variés représentés par de nombreuses espèces à développement relativement rapide (semaine, mois). Les apports organiques à l'interface eau-sédiment peuvent constituer des sources trophiques que ces organismes vont utiliser, transformer pour se développer et accroître leur densité et leur biomasse (De Bovée et al., 1990).

L'existence de relations entre les apports organiques et les réponses benthiques a été dans un premier temps étudiée en mesurant les concentrations de pigments chlorophylliens (spécifiques d'apports en provenance de la zone euphotique) à la fois dans la colonne d'eau et à l'interface eau-sédiment parallèlement aux densités en méiofaune.

Ainsi, dans le canyon Lacaze-Duthiers on mesure des flux advectifs rapides comportant des proportions importantes de matière organique en provenance du plateau continental. A la fin de l'hiver, environ 35% du carbone organique transporté à 600 m de fond se trouve sous la forme d'algues unicellulaires intactes (la chlorophylle-a représente alors 60% du flux total de pigments chlorophylliens). A l'interface eau-sédiment, on enregistre durant cette période une augmentation notable de la concentration en pigments chlorophylliens qui sont rapidement dégradés, en même temps qu'un accroissement des densités en organismes de la méiofaune.

A l'échelle du Golfe du Lion entre 600 et 2300 m, entre deux saisons (été et automne) il est possible de mesurer un phénomène similaire. Durant l'été, à des apports faibles ou nuls correspondent des densités en organismes de la méiofaune basses qui se trouvent multipliées par 2 en automne au moment où les apports en matière organique s'accroissent, quelle que soit la profondeur considérée.

La répartition spatiale des densités en organismes semble se calquer sur celle des apports. Il existe un gradient décroissant très net avec l'éloignement de la côte (et l'augmentation de la profondeur) : entre 600 et 2300 m les densités varient d'un facteur 10-15. Ce gradient bathymétrique se superpose à un gradient Est-Ouest (la partie occidentale du Golfe étant plus riche d'un facteur 2-3) en liaison avec la circulation générale qui influence la répartition des apports.

L'étude fine des processus se déroulant à l'interface eau-sédiment est en cours d'étude grâce à l'utilisation du submersible CYANA. Des carottiers à incubation permettant d'effectuer des expériences *in situ* ont été spécialement mis au point et sont utilisés de façon saisonnière afin d'aboutir à un bilan biologique et géochimique des transferts de matière organique (consommation, recyclage, enfouissement) à l'interface eau-sédiment.

RÉFÉRENCES

Buscail R., Pocklington R., Daumas R. and Guidi L. (1990) - Fluxes and budget of organic matter in the benthic boundary layer over the northwestern Mediterranean margin. Continental Shelf Research (in press)

De Bovée F., Guidi L. and Soyer J. (1990) - Quantitative distribution of dep-sea meiobenthos in the Northwestern Mediterranean (Gulf of Lions). Continental Shelf Research (in press)

Monaco A., Courp T., Heussner S., Carbonne J., Fowler S.W. and Deniaux B. (1990) - Seasonality and composition of particulate fluxes measured during ECOMARGE I on the western part of the Gulf of Lions. Continental Shelf Research (in press)

X-I10

Résultats préliminaires sur les Foraminifères Benthiques recueillis par pièges à particules dans le Canyon de Toulon (Programme ECOMARGE)

Laure BLANC-VERNET* et Joël LE CAMPION**

*Centre d'Océanologie de Marseille, O.S.U., Luminy, Marseille (France)
**Centre d'Océanologie de Marseille, O.S.U., Station marine d'Endoume, rue de la Batterie des Lions, Marseille (France)

Le matériel a été récolté dans le canyon de Toulon à la station 3 (43°00,53 N, 05°59',72 E ; profondeur -1 100m) entre le 11 mai et le 9 septembre 1989, lors de la mission GEOFLUX.

Trois type de pièges ont été immergés : un piège cylindrique à -350m, un conique à -360m et deux pièges séquentiels (PPS3) respectivement à -370m et -1 055m (fig.1).

Les pièges cylindrique et conique ont fonctionné pendant toute la période d'immersion et sont demeurés ouverts à la remontée. Les pièges séquentiels comprenaient chacun 6 godets dont l'ouverture et la fermeture étaient programmées pour 18 jours de collecte. Le flux de masse est, en moyenne de 315mg/m^2/j à -370m et de 961,2mg/m^2/j à -1 055m. Tous les contenus étaient formolés.

La ligne de mouillage comprenait en outre trois courantomètres.

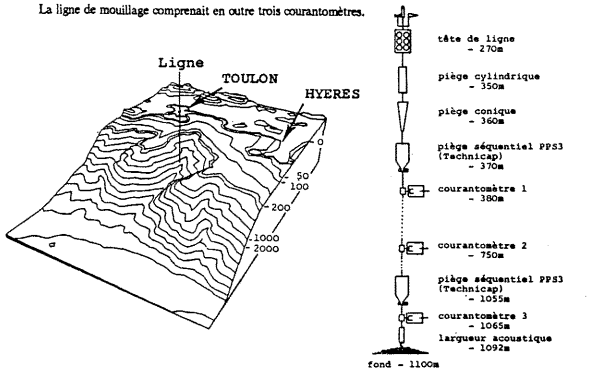


Figure 1 : Localisation de la station 3 et composition de la ligne de mouillage.

RESULTATS ET INTERPRETATION

Les effectifs totaux de foraminifères benthiques de taille supérieure à 63µm recueillis dans les trois types de pièges sont reportés dans le tableau 1.

On constate tout d'abord l'absence de foraminifères benthiques dans le contenu du piège cylindrique. On note cependant la présence de nombreuses formes planctoniques inférieures à 63µm et d'une *Hastigerinella digitata* de grande taille. A profondeur sensiblement égale, le piège séquentiel supérieur a récolté un nombre d'individus une fois et demi plus élevé que le piège conique. Le piège séquentiel profond en contenait très peu. Ces différences peuvent s'expliquer en partie par les surfaces de collecte et les formes des pièges.

Piège	Profondeur d'immersion	Temps de collecte	Surface de l'ouverture	Nombre total de tests récoltés
Cylindrique	-350m	123 jours	0,0315m^2	néant
Conique	-360m	123 jours	0,0707m^2	809
PPS3 (Technicap)	-370m	108 jours	0,1256m^2	1185
PPS3 (Technicap)	-1055m	108 jours	0,1256m^2	37

Tableau 1 : Profondeur d'immersion., temps de collecte, surface de l'ouverture des différents types de pièges utilisés et effectifs totaux de foraminifères benthiques recueillis.

Les tests vides recueillis à -360m et -370m sont de 7 à 10 fois moins abondants que ceux contenant du cytoplasme mais présentent le même aspect. Au contraire, à -1 055m, les deux catégories ont la même importance ; de plus, certains tests sont mal conservés, opacifiés, voire remplis de sédiment suggérant une remise en suspension de matériel antérieurement sédimenté.

La microfaune vivante présente des différences qualitatives suivant la profondeur et le type de piège. A -370m, on compte environ 10 individus originaires du plateau pour 1 de la pente ; les chiffres sont 1 à 3 à -1 055m. Dans le piège conique, les espèces dominantes sont *Rosalina vilardeboana*, *Miliolinella subrotunda*, *Allogromia* sp, *Cornuspira foliacea*. Dans le PPS3, ce sont *M. subrotunda*, divers autres *Miliolidae* et *Ophtalmidium* sp. On remarque (tableau 2) que *Rosalina* et *Cornuspira* atteignent de très grandes tailles dans le piège conique ce qui est d'ailleurs le cas de la majorité des espèces. On peut supposer qu'elles se sont installées sur les parois, s'y sont développées puis sont tombées dans le collecteur lors de la remontée de la ligne ; phénomène qui n'a pu se réaliser dans le cas du piège séquentiel. Effectivement on retrouve de gros individus sur les parois de la partie conique du PPS3 et même sur les dérives horizontales des courantomètres. En revanche, de petites *Allogromia*, en raison peut être d'un mode de vie plus mobile, se retrouvent dans les godets.

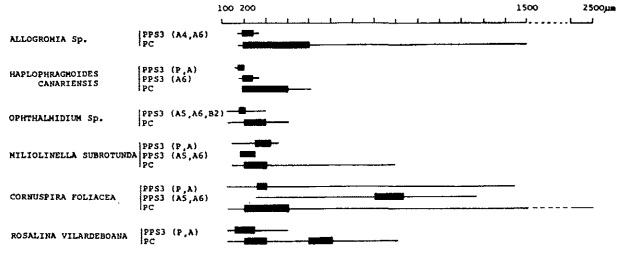


Tableau 2 : Taille minimale, classe modale et taille maximale pour quelques espèces de foraminifères benthiques récoltés à l'état vivant dans les différents pièges à particules. PC = piège à particules conique ; PPS3 = piège à particules séquentiel ; (P= paroi ; A= niveau -370m ; B= niveau -1 055m ; 2= Godet n°2; 5= Godet n°5 ; 6= Godet n°6).

CONCLUSION

La compositions des assemblages trouvés dans les pièges à -370m et -1 055m montre que les formes vivantes peuvent provenir soit du plateau, soit de divers horizons de la pente et que, sur la pente, une remise en suspension de matériel antérieurement sédimenté est possible.

Les stades juvéniles d'espèces benthiques (taille <100 mm) tels qu'on en trouve dans les filets à plancton sont donc capables de se fixer, de grandir (et peut être de se reproduire ?) dès qu'ils rencontrent en pleine eau un substrat adéquat, malgré des conditions de vie et de profondeur très éloignées de leur biotope habituel. Certaines espèces vivant en épifaune dans les pièges peuvent fausser les estimations des flux de carbonate (*Rosalina*, *Cornuspira*) et de matière organique (*Allogromia*). Il est donc indispensable de les éliminer en ôtant manuellement les individus d'une taille supérieure à ceux récoltés dans le plancton.

X

Source of Sedimentary Organic Matter in the Adriactic Sea

J. FAGANELI* , J. PEZDIC** , B. OGOLEREC*** and M. MISIC***

*Marine Biological Station, JLA 65, 66330 Piran (Yugoslavia)
**Jozef Stefan Institute, Jamova 39, 61000 Ljubljana (Yugoslavia)
***Geological Survey, Dimiceva 14, 61000 Ljubljana (Yugoslavia)

Organic C, N and P contents, and $^{13}C/^{12}C$ and C/N ratios of organic matter in surficial sediments of the Adriatic sea were used to study the distribution, origin and diagenetic transformations of sedimentary organic matter. Using the differences in $\delta^{13}C$ values and C/N ratios between autochtonous marine (planktonic) and allochtonous (riverine) organic matter in the Adriatic was possible to determine the origin of recent surficial sedimentary organic matter and that from the short cores indicating the past environmental conditions in the sea. Linear relationship between sedimentary organic C and $\delta^{13}C$ values demonstrated an important influence of terrestrial to surficial sedimentary organic C and an organic C content of purely planktonic origin

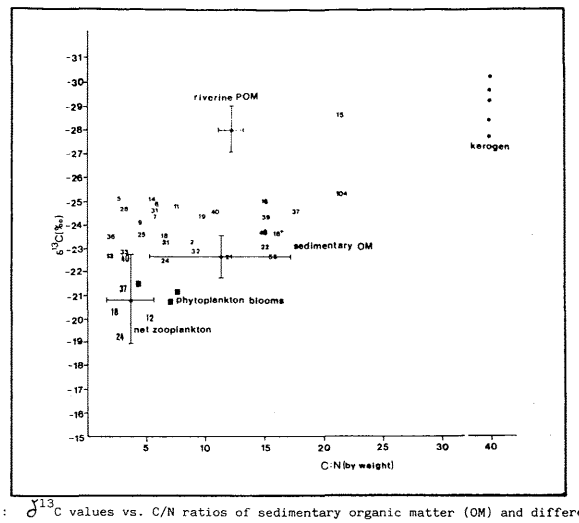


Fig. 1: $\delta^{13}C$ values vs. C/N ratios of sedimentary organic matter (OM) and different classes of organic matter (phyto- and zooplanktonic, allochtonous particulate organic matter - POM, middle Adriatic kerogen) in the Adriatic area. Mean values $\pm$ SD of $\delta^{13}C$ and C/N ratios are presented for organic matter from the Gulf of Trieste (N.Adriatic)

of about 0.15 %. Constructing the mixing model for determination of marine and terrestrial contributions to sedimentary organic matter we used the $\delta^{13}C$ values and C/N ratios of different end-members (Fig. 1), i.e. phytoplanktonic ($\delta^{13}C$ = -21.0 °/oo; C/N = 6) and riverine ($\delta^{13}C$ = -28.0 °/oo; C/N = 12) organic matter in the Adriatic area. We supposed the shift of $\delta^{13}C$ values of about 1.5 - 2 °/oo due to diagentic transformations of organic matter occuring in the water column and surficial sediments.

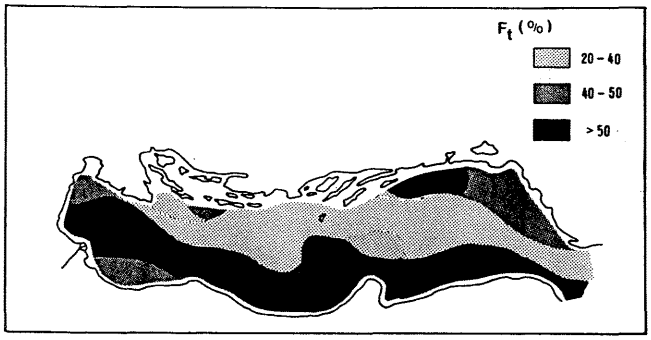


Fig. 2: Distribution of terrestrial organic carbon (F_t) in the Adriatic surficial sediments

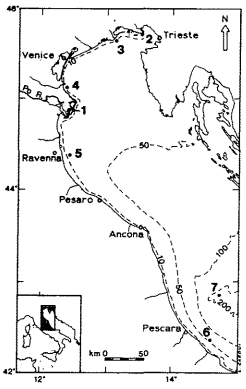
The geographycal distribution of higher terrestrial contribution to sedimentary organic matter (Fig. 2) also reflected in the higher organic C, N and P contents, is restricted to the western part of the Adriatic along the Italian coast strongly influenced by the river Po and other Italian river inflows and to southeastern part of the Adriatic affected by local (Albanian) riverine inputs. This areal distribution is a consequence of the general counterclockwise water circulation system and sedimentological properties of the Adriatic. The area of higher organic C content in the Jabuka Pit is, on the other hand, more direct consequence of higher biological production in this area. The distribution of organic C content and the $\delta^{13}C$ values within the short dated cores collected in the middle Adriatic suggested that the bioproductive conditions in the past were similar to those of the present day. The higher C content and lower $\delta^{13}C$ value observed in horizont from about 15 000 B.P., after the last glacial period, was attributed to a larger terrestrial contribution by increased river flow.

Sediment Fluxes on 100 YR Time Scale in Different Environments of the Adriatic Sea (Italy)

M. FRIGNANI , L. LANGONE , M. RAVAIOLI and A. CADONNA

Istituto per la Geologia Marina (CNR), Via Zamboni 65, 40127 Bologna (Italia)

Seven cores from different environments of the Adriatic sea were studied in order to calculate accumulation rates and provide a description of the principal factors affecting present sedimentation and sedimentary processes. The data were also used to test the models used to calculate sediment chronologies from ^{210}Pb and ^{137}Cs profiles.



Core locations are shown in the figure. The sites cover a wide range of environments. They include a lagoon of the Po delta with no input from land, coastal sites from the Northern Adriatic influenced by high sediment supply, and coastal sites from the Middle Adriatic.

Cores were sectioned in slices 1-3 cm thick with the greatest detail in the upper levels. ^{210}Pb, ^{137}Cs, grain size, mineralogical composition and loss on ignition at 375 C (as an indication of the organic matter content) were determined.

The core collected in the lagoon, by divers, shows no evident traces of bioturbation and the sediment is fine grained. The excess ^{210}Pb profile indicates a regular accumulation in recent times although some downcore irregularities are probably due to the period when the lagoon was directly connected to the river. The depth distribution of silt and clay fractions suggests a progressive decreasing of the energy of the environment toward present.

Cores 2, 3 and 4 represent different prodeltaic environments. The first, influenced by the material delivered by the Isonzo River,

sites	depth m	sup.act. dpm/g	acc.rate g/cm²/yr	invent. dpm/cm²	Pb flux dpm/cm²/yr	LOI %	OM flux mg/cm²/yr
1 lagoon	1.5	4.35	0.11	12.6	0.4	8.31	9
2 Isonzo	6.5	3.30	6.62	>170	>5	4.50	298
3 Tagliamento	10.0	2.47	nd	>8	>0.2	2.40	nd
4 Adige	20.0	4.39	0.77	79.9	2.5	6.67	51
5 Porto Corsini	14.0	2.42	0.40	39.0	1.2	3.49	14
6 Ortona	65.0	4.50	0.45	63.1	2.0	2.40	11
7 MAD	251.0	4.25	0.04	7.3	0.2	2.75	1

is characterized by a very high accumulation rate. In this case the core was not long enough to include the whole excess ^{210}Pb profile. An accumulation rate of 10 cm/yr was calculated by BALDI et al. (1990) on the basis of the peak activity of the ^{137}Cs from Chernobyl. A profile of the short lived ^{7}Be in the first 4 centimeters accounts for a rate of 8.2 cm/yr or 6.6 g/cm²/yr which substantially confirms the previous result. On the other hand, the excess ^{210}Pb activity at a depth of 100-105 cm (about 10 years) should be 28-30% lower than the superficial activity. Assuming a supported activity of 0.8 dpm/g, which is typical of these sediments, we can see that this prediction is confirmed. In this case the flux of organic matter is very high, due both to the high concentration in the sediment and to the high accumulation rate. Core 3, near the mouth of the Tagliamento River comes from a highly dynamic environment: the excess ^{210}Pb profile is very irregular and incomplete. It is interrupted, at a depth of 7-8 cm, perhaps due to an erosive event. In this case the ^{210}Pb data are not adequate for the calculation of the accumulation rate.

The site 4 is characterized by a fairly regular profile, although there are some fluctuations in activity above 22 cm depth. In this case both the CF-CS and the CRS models (ROBBINS, 1978; APPLEBY & OLDFIELD, 1978) give the same average accumulation rate.

The core taken offshore from Porto Corsini, south of the delta (site 5), represents a sediment strongly influenced by the water dynamics during the winter season. This creates an irregular, discontinuous ^{210}Pb profile. The mean accumulation rate calculated using the CRS model (Table) has a value similar to that determined for other cores in this area (FRIGNANI & LANGONE, 1989). The accumulation rate determined (using the CF-CS model) from the regression of the log-normal activities vs. depth gives a significantly higher value, and this is perhaps an effect of the mixing of the surficial sediments.

The ^{210}Pb activity profile of core 6, taken from a coastal zone of the Middle Adriatic, is fairly regular. Accumulation rates calculated with all the usual models give similar results. The same is true also for core 7, taken from the Meso Adriatic Depression. In this last case the profile has intervals with different slopes, which could be due to periods characterized by different accumulation rates.

Where available the ^{137}Cs data substantially confirm the rates obtained from the ^{210}Pb profiles as for core 1, 2 and 4.

Organic matter fluxes mainly depend on the accumulation rates: the minimum value is found for the Meso Adriatic depression, far offshore, which shows the lowest rate while the maximum occurs in the Isonzo prodelta where the accumulation rate is very high. At site 1 the organic matter content (estimated on the basis of the total organic carbon: 3.57%) is far higher than in the other cores, but the flux is not very high because of the low accumulation rate.

In conclusion the study sites show very different accumulation rates (from 0.04 to 6.62 g/cm²yr). In particular the prodelta areas are of the greatest interest for the establishment of the transport mechanisms and mass balances. Because of this it is needed to study the prodelta areas in greater detail.

REFERENCES

APPLEBY, P.G. & 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.

BALDI, A., DELFANTI, R., FIORE, V., GALLI, C., LAVARELLO, O., PAPUCCI, C., PENTASSUGLIA, C., VENTURA, G.C., GIACOMELLI, R., DE GUARRINI, F., & MATASSI, G., 1990. Distribution of artificial radionuclides in North Adriatic coastal sediments. Yugoslavian-Italian Symposium on Radiation Protection: Advance in Yugoslavia and Italy (Udine, 22-24 June 1988), in press.

FRIGNANI, M., & LANGONE, L., 1989. ^{137}Cs and ^{210}Pb geochronology of sediments off the Po River delta and the Emilia-Romagna coast (North-Western Adriatic sea, Italy). Proceedings of the 28th Int. Geol. Congress (Washington, D.C., July 9-19, 1989), 1, 513.

ROBBINS, J.A., 1978. Geochemical and geophysical applications of radioactive lead. In: Biogeochemistry of Lead in the Environment, J.O. NRIAGU ed., Elsevier, Amsterdam: A, 285-339.

X-I13

Keys for sedimentation in the Balearic Islands continental margin: benthic carbonate production vs. particle fluxes

M. CANALS*, A.-M. CALAFAT*, J.-L. CASAMOR*, J. SERRA*, E. BALLESTEROS** and M. ZABALA***

*Departament de Geologia Dinàmica, Universitat de Barcelona, 08071 Barcelona (Spain)
**Centre d'Estudis Avançats de Blanes, 17300 Blanes (Spain)
***Departament d'Ecologia, Universitat de Barcelona, 08071 Barcelona (Spain)

The "warm temperate" Balearic Shelf, which has been studied in the frame of several Spanish an European projects (namely EURECOMARGE), can be considered as a counterpart of the terrigenous-dominated margin of the Gulf of Lions (BROOKFIELD, 1988; LA VIOLETTE, 1990).

The biogenic-dominated continental shelf sedimentation is controlled by extreme water transparency, hydrodynamism, nutrients and particulate organic matter (POM) concentrations, type of substrate and microtopography (CANALS et al., 1990). Carbonate production rates by benthic communities are explicited in Table 1. Calculations based on biomass estimations and turnover rates give a mean carbonate annual production of 0.7 metric tones per hectare (BALLESTEROS, 1984). This significant amount of biogenic particles continuously contributes to sediment formation.

Benthic com.	Water depth range (m)	Mean annual production rate $gCaCO_3$ $m^{-2}y^{-1}$	Covered area		Total annual $CaCO_3$ production		
			Ha	%	Tm	%	Tm/Ha
A	0.5-5	200	280	5	541	13	1.9
B	0-6	5	640	11	32	0.8	0.05
C	5-35	100	2,655	45	2,656	66	1
D	35->50	5	1,565	26	78	2	0.05
E	37-50	90	800	13	721	18	0.9
F	>45	125	Small patches		Too low		
G	>50	350	Small patches		Too low		
			5,940	100	4,028	100	

Table1. Carbonate production by benthic communities in the Pollensa Shelf area (NE of Mallorca Is.). A: Photophilic algae; B: C.prolifera, C. nodosa; C: P. oceanica; D: sand com. w / Spatangus; E: Algal crusts, V. volubilis; F: Coralligenous; G: Maërl.

The coarse particles (sand and gravel sizes) of biogenic production are transported by traction processes (mainly longshore currents and their helical components) as proved by the existence of modern sand wave fields to 50m of water depth (CANALS et al., 1990). As it was expected, suspended particulate matter (SPM) in the water column over the shelfbreak is very low, specially if compared with values obtained in the Gulf of Lions (Table 2).

Although they are two different concepts, and even though it may be considered an oversimplification, comparison between measured gross particle fluxes from the Gulf of Lions and biogenic production from Balearic Shelf, both expressed in g m^{-2} y^{-1} , taking also into account the areas of the sediment-feeding zones (the river basins for the terrigenous input, and the productive zone over the shelf for the carbonate input), shows the main constrasting features between both depositional systems and eventually would allow an interesting discussion foreseen for the corresponding round table (Fig. 1).

		BALEARIC ISLANDS				GULF OF LIONS				
		N	M	SD	Max	Min	N	M	SD	Max	Min
SPM CONCENTRATION (mg/l)	TOTAL	44	0.23	0.157	0.8	0.04	24	0.86	0.504	2.3	0.23
	SURFACE	18	0.23	0.156	0.5	0.05	11	0.67	0.303	1.4	0.23
	BOTTOM	26	0.22	0.157	0.8	0.04	13	1.02	0.590	2.3	0.30

Table 2. Suspended particulate matter concentrations (mg/l) in surficial (less than 50m depth) and near bottom (more than 50m depth) waters in the shelfbreak areas of the Balearic Is. and Central Gulf of Lions. Data from water samples obtained during 1986 to 1989 EURECOMARGE cruises. N: set of samples; M: mean values; SD: standard deviations; Max: maximal values; Min: minimal values.

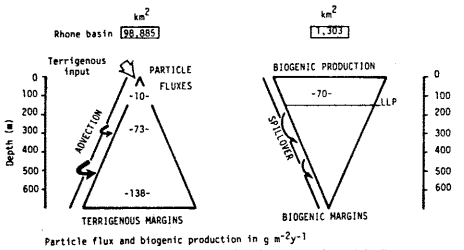


Fig. 1. Sketch showing the main contrasting features of particle fluxes vs. carbonate production in the Gulf of Lions and Balearic shelves. Gulf of Lions data are recalculated from MONACO et al (1987).

The production vs. transport/accumulation sediment regime dominating in the Balearic Islands continental margin during Pleistocene times has resulted in an important progradation of the outer shelf and upper slope, frequently associated with severe mass movememt processes. The overall benthic carbonate production rate reaches its maximum during sea-level highstands when, according to the physiography of the margin, the greatest sea-floor area under the photic zone is available for benthic community growth (present shelfbreak is at 115m depth). Carbonate maceration from ALEXANDERSSON (1979) and hemipelagic settling af planktonic and aeolian particles are necessary processes to explain the muddy , calcareous nature of the sediments in the outermost margin. In the light of the available data, which show the absence of mid-water and bottom nepheloid layers, vertical particle fluxes are irrelevant as a sediment contributor factor in the Balearic carbonate environment.

ALEXANDERSSON, T. (1979).- Sedimentology , 26: 845-852.
BALLESTEROS, E. (1984).- Ph .D. Thesis, Univ. of Barcelona (Spain); 587 p.
BROOKFIELD, ME. (1988).- Sed. Geol., 60: 137-153.
CANALS, M. et al. (1990).- Sed. Geol. (submitted).
LA VIOLETTE, P. et al. (1990).- Jour. Geoph. Res., 95 C2: 1559-1568.
MONACO,A. et al. (1987).- Mitt. Geol-Paläont. Inst. Univ. Hamburg SCOPE/UNEP, Sond. 62: 109-125.

X-I14

Prélèvement de M.E.S. dans le Néphéloïde Benthique profond par utilisation de ESAUP-6000

Jean-Michel FERNANDEZ* et André MONACO**

*Station Marine de Toulon, Service d'Etudes et de Recherches sur l'Environnement, DERS/IPSN/CEA, Base Ifremer BP 330, 83500 La Seyne-sur-Mer (France)
**Laboratoire de Sédimentologie et Géochimie Marines, Université de Perpignan, Avenue de Villeneuve, 66025 Perpignan (France)

RESUME.

Les campagnes antérieures (ECOMARGE et EPICEA-2) ont souligné la nécessité de réaliser des opérations d'échantillonnage avec la plus grande précision possible et visant à étudier le néphéloïde benthique.

La pompe immergeable ESAUP-6000, élaborée pour travailler sur la colonne d'eau depuis la surface, a également été conçue pour permettre d'effectuer des prélèvements au niveau de l'interface eau/sédiment, à partir d'un submersible habité.

Un premier essai de pompage à 10 cm au-dessus de l'interface eau/sédiment a été réalisé au cours de la campagne CYANECO (sept.1989) au large de Toulon par 1100 mètres de profondeur. Le volume filtré a été approximativement de 535 litres au terme de 1h 30 de travail et la masse particulaire récoltée est de 240 mg.

I - INTRODUCTION.

Pour étudier la matière en suspension compte tenu des faibles charges particulaires rencontrées dans le milieu marin, il est souvent nécessaire de travailler sur des volumes d'eau dépassant la centaine de litres. Dans ce but un appareillage autonome et immergeable capable d'effectuer des filtrations à été développé au cours de ces dernières années (ESAUP-6000).

En milieu profond, contrairement à l'ensemble de la colonne d'eau, les structures néphéloïdes benthiques, épaisses de quelques dizaines de mètres sont plus difficilement accessibles depuis la surface par les systèmes de prélèvement classiques. Or l'intérêt que suscite la connaissance de ce type de structure oblige à cibler l'échantillonnage au niveau même de l'interface eau/sédiment. On sait par, ailleurs, que les grosses particules sont peu représentées dans les captures par bouteille.

Dans ce but, la pompe immergeable ESAUP-6000 a été améliorée pour assurer sa mise en oeuvre à partir d'un submersible habité de façon à pouvoir prélever avec la plus grande précision géographique possible.

II - MOYENS ET METHODES.

Pour pouvoir envisager la mise en oeuvre de la pompe dans le but d'échantillonner à partir d'un submersible habité (CYANA ou NAUTILE), il a été nécessaire de procéder:

a/- à l'adjonction d'un boîtier de commande magnétique télémanipulable qui assure les fonctions de démarrage et d'arrêt des séquences de pompage,

b/- au montage de la pompe immergeable sur une ligne de mouillage dimensionnée spécifiquement pour provoquer un ralentissement progressif de sa vitesse descendante à l'approche du fond et stabiliser la pompe ESAUP-6000 à 2 mètres au dessus de l'interface eau/sédiments (figure).

La pompe a également été équipée d'une longueur de tuyau suffisante (10 m) et d'un collecteur positionnable à la hauteur désirée (10 cm).

Les opérations de mises à l'eau du matériel se sont déroulées en deux temps:

a/- mouillage de la ligne comprenant la pompe immergeable et le largueur pyrotechnique commandé par acoustique,

b/- plongée de la soucoupe CYANA.

Le déploiement du cône d'aspiration a été effectué en veillant à toujours effectuer les diverses opérations de télémanipulation en se positionnant en aval du courant. La mise en oeuvre de la pompe s'est opérée un quart d'heure après l'installation du collecteur, temps nécessaire à la dissipation d'une éventuelle remise en suspension des particules sédimentaires.

Au terme de l'expérimentation, l'ensemble a été largué et récupéré en surface. De nombreuses photographies ainsi qu'un film vidéo résumant toute l'opération ont été pris.

III - RESULTATS ET DISCUSSION.

La phase de pompage a comporté un prélèvement de suspension à 10 cm au-dessus de l'interface eau/sédiment. Cette séquence de travail a duré 1h30 et a permis de traîter un volume de 535 litres sur un filtre Millipore de 0,45 microns de porosité et de 293 mm de diamètre qui a été congelé dès la récupération de l'engin en surface.

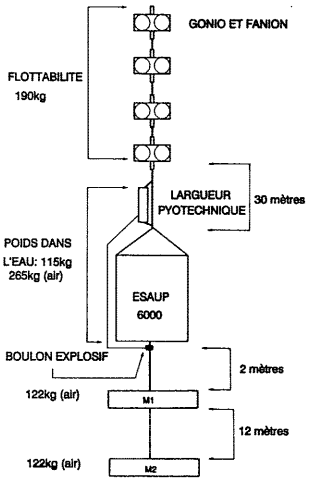
Au laboratoire, le filtre a été placé avec de l'eau distillée dans une cuve à ultra-sons pendant 10 minutes dans le but de récupérer les particules. Cette opération a permis de récolter la quasi totalisé de la matière dont la masse est de 240 mg, soit une charge particulaire de 0,45 mg/l.

Le travail effectué au MEB soulignent la présence de matériel frais d'origine phytoplanctonique (diatomées, coccolithes). La micro-analyse montrent l'abondance des alumino-silicates et silicates.

On note également la présence de débris de posidonies, abondantes à certains niveaux du sédiment. D'autres analyses sont en cours (CT, COP, minéralogie).

CONCLUSION

La technique de prélèvement employée s'est révélée être intéressante quant aux possibilités offertes pour l'echantillonnage controlé des eaux et des suspensions de toutes tailles (fines particules, neige marine, pelotes fécales) en milieu profond. Par ailleurs, un prélèvement analogue (2 m au dessus de l'interface) est envisageable sans l'intervention d'un submersible grâce aux possibilités de programmation de la pompe, gréée sur une ligne de mouillage. D'autre part, l'adjonction d'une vanne multivoies permettra à ESAUP-6000 d'effectuer des prélèvements séquentiels. Cependant si les masses et l'aspect qualitatif de la matière en suspension récoltées sont convenables l'analyse quantitative pose encore certains problèmes provoqués par l'emploi des filtres de grand diamètre difficilement exploitables.



PUBLICATION

FERNANDEZ JM, CALMET D, MONACO A, CHARMASSON S, 1989
ESAUP-6000; Un appareil de prélèvement de suspension et de percolation in-situ
Congrès de Limnologie-Océanographie, Marseille-Luminy, 26-30 Juin 1989.

X

X-I15

Synthèse d'une résine composite pour la fixation in situ du 137 Césium en milieu marin

G. GAROFALO*, J.-M. FERNANDEZ** et A. SEBAOUN*

*Université de Toulon et du Var, BP 152, 83130 La Valette-du-Var (France)
**CEA/DERS/SERE, Station marine de Toulon, BP 330, 83507 La Seyne-sur-Mer (France)

Résumé:
Le choix d'un matériau absorbant le césium et ses isotopes radioactifs en milieu marin est décrit. Les principales caractéristiques souhaitées sont d'ordre rhéologique et cinétique afin de permettre une utilisation en colonne de percolation in situ. Un bon compromis semble être réalisé par une résine composite de polystyrène-divinylbenzène dans laquelle est absorbé un complexe de ferrocyanure de cobalt potassium $K_xCo_{2-x}Fe(CN)_6.nH_2O$.

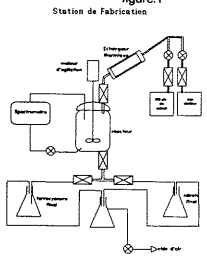
Introduction

Le suivi des concentrations de traceurs radioactifs artificiels comme le césium137 est devenu une pratique usuelle dans le domaine océanographique. L'évaluation de ces concentrations dans la phase dissoute a été réalisée jusqu'à présent par des techniques batch consistant à prélever de grandes quantités d'eau de mer (100 litres), volume nécessaire pour obtenir un précipité analysable par spectrométrie gamma.
Cependant cette technique présente deux inconvénients majeurs, le temps employé pour le piégeage du césium (12 h) et l'encombrement des bateaux lié au stockage de l'eau de mer.
Il a donc été envisagé de développer une technique de percolation in situ qui supprime en partie ces impératifs en employant une résine composite échangeuse d'ions capable de concentrer avec la meilleure efficacité le césium 137 contenu dans l'eau percolée.

Partie experimentale

La partie active de l'échangeur est constituée de sels de ferrocyanure de cobalt potassium adsorbés sur les sites de fixation d'une résine échangeuse d'ions anionique.
Les caractéristiques de fixation du césium par les résines composites sont fortement dépendantes de la composition du sel adsorbé (1) aussi nous avons procédé à l'installation d'une unité de fabrication automatisée (fig.1), afin de pouvoir étudier tous les paramètres influant sur la qualité de l'enrobage.

figure.1



Caractéristiques Rhéologiques

La première étape de notre étude nous a conduit à la sélection de la matrice organique anionique, hôte du complexe de ferrocyanure. Un tamisage par voie humide nous a permis de déduire la répartition granulométrique de plusieurs résines anioniques (fig.2).
Parmis ces divers supports on note une difference dans la répartition des populations avec en particulier la présence de billes de petite taille (entre 0,2 et 0,4 mm) qui occasionnent des pertes charges notables pour les débits que nous souhaitons utiliser.
Un essai de modélisation de ces pertes de charge a été effectué afin de pouvoir extrapoler nos résultats en colonne de laboratoire à une colonne de taille opérationnelle en mer. Le modèle testé est celui d'Ergun (2):

D'après nos résultats (fig.3) la résine la plus apte à subir une percolation à fort débit est celle qui sans tamisage présente des pertes de charge minimales :
A505 > MONO > IRA 900 = MSA > IRA 904 > IRA 958

figure.2

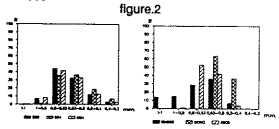
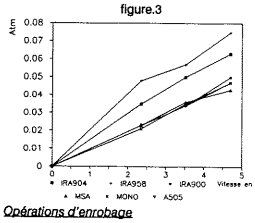


figure.3



Opérations d'enrobage

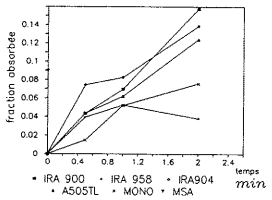
L'enrobage de chacun des supports organiques est réalisé à partir de solutions décimolaires de ferrocyanure de potassium et de nitrate de cobalt, selon un même protocole:
Lavage de la résine brute à l'eau distillée, thermostatisation des réactifs, puis ajout dans un premier temps du ferrocyanure de potassium. Le processus de diffusion des ions ferrocyanures $Fe(CN)_6^{4-}$ est suivi par spectrophotométrie ce qui nous permet d'apprécier la fin de la réaction d'échange.

Après un cycle de lavage de la résine imprégnée et suppression du ferrocyanure en excès la deuxième phase de l'enrobage fait intervenir le nitrate de cobalt opération également contrôlée par spectrophotométrie.
Un contrôle de la qualité est exercé par absorption atomique de flamme après dissolution d'une fraction de résine par HNO_3 concentré à chaud.
Les observations semblent montrer que la structure des résines composites n'est pas homogène selon le support utilisé seule l'IRA904-KCFC présente une bonne répartition en sel, les autres résines présentant une composition coquille.
Le rapport molaire relatif du Fer (5,82 %) au Cobalt (11,07 %) indique un composé dans la stoechiométrie $K_xCo_{2-x}Fe(CN)_6.nH_2O$, le potassium qui est l'ion échangeable n'est présent qu'à faible teneur (0,5 %).
Des travaux antérieurs (3) sur la forme minérale pure du ferrocyanure de cobalt potassium indique qu'un tel composé agit par échange de ces ions potassium contenu dans la maille du ferrocyanure (structure cfc) avec les alcalins de rayon ionique plus important qui sont pris au piège de cette maille.
Nous pouvons à ce niveau d'étude indiquer l'aptitude à la cristallisation du sel dans l'ordre des supports:
IRA904 > MSA > A505 > IRA900 > > IRA958 > > MONO
Les limitations à l'apparition du sel sont principalement induites par les différentes vitesses de diffusion du nitrate de cobalt qui sont maximales pour les résines de fortes porosité.

Cinétiques d'échange des résines avec le césium

La vitesse d'échange est déterminante pour l'efficacité d'une colonne.
C'est dans le but d'optimiser les temps de passage sur la colonne que nous avons décidé de comparer les vitesses d'échange relatives des différentes résines composites (fig.4).
L'étude comparative des cinétiques menée sur les diverses résines polymère-KCFC ont été effectuées sur un volume d'eau de mer filtrée à 0,45 micron. Le volume d'eau de mer naturelle est marqué par du césium 137 puis fractionné en volume de 50 cm3 pour évaluer les vitesses d'absorption du césium sur des échantillons de 150 mg de résine (fraction 0,5-0,63 mm).

figure.4



Résultats

Les résultats obtenus nous permettent de distinguer trois types de résine aux caractéristiques macroporeuses fortes, l'IRA900, IRA904 et MSA. Leur structure largement ouverte sur le fluide (ϕ pore > 500 nm) permet une diffusion plus rapide des alcalins vers les sites de fixation de l'échangeur qui se comporte comme un tamis moléculaire à l'image des zéolithes. La présence de canaux dans les résines macroréticulées favorise la cristallisation de sels avec une grande surface spécifique (30 m2/g), ce qui explique les cinétiques d'échange
la résine composite à base d'IRA 904 semble la plus adaptée à une technique de percolation d'eau de mer. Sa structure et en particulier son volume de pore supérieur aux autres résines anioniques lui permettent d'être plus facilement accessible à l'electrolyte et favorise la répartition des cristallites de ferrocyanure d'une façon homogène.
Les résines de type gel n'offrent pas de structure suffisamment poreuse pour que le complexe ferrocyanure puisse se former tandis qu'une résine de structure vinylique permet une cristallisation du ferrocyanure sur une partie limitée de la bille de résine.

Conclusion

La résine sélectionnée pour la concentration du césium137 en eau de mer est un composite d'IRA 904-KCFC.
Des essais en colonne expérimentale nous ont permis de fixer du césium à l'embouchure du Rhône à partir de 120 litres d'eau de mer.
Les rendements de fixation obtenu au bout d'une heure de percolation sont de 50% environ et nous développons actuellement des recherches pour améliorer ce rendement afin de pouvoir adapter des colonnes sur l'Engin Submersible AUtonome Polyvalent ESAUP 6000.

Bibliographie:
(1) Lee E.F.T ; Streat M., J.Chem.Tech.Biotechnol., 1983, 33A, 333-338.
(2) Ergun S., Chem.Eng.Prog., 1952, 48 (2), 89.
(3) Ganzerli Valentini ; Stella ; Cola., J.Radioanal.Nucl.Chem., 1986, 102 (1), 99-110

Nomenclature:
cfc: cubique face centrée
KCFC: Potassium Cobalt FerroCyanide.
IRA.. produits manufacturés par Rohm et Haas
A505 produits de la société Purolite
MSA, MONO produits de la société Dow Chemical/sp/

X-II1

Bioaccumulation de Métaux Polluants stables et radioactifs chez le Crabe *Liocarcinus puber* (Crustacé Décapode). Etude à l'échelle cellulaire et subcellulaire

C. CHASSARD-BOUCHAUD

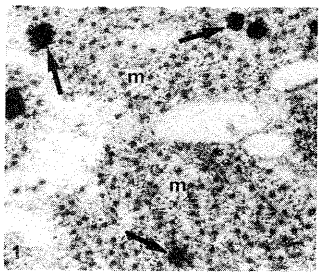
Laboratoire de Biologie et Physiologie des Organismes marins, Université P. et M. Curie, 4, Place Jussieu, 75252 Paris Cédex 05 (France)
Centre de Microanalyse appliquée à la Biologie, 6, rue du Général Sarrail, 94000 Créteil (France)

De nombreux métaux toxiques, présents en Méditerranée, sont susceptibles d'être concentrés par les organismes marins, et notamment par les crustacés, avec des stratégies physiologiques et biochimiques différentes selon les métaux et les organismes considérés. Pour tenter de comprendre les mécanismes d'absorption, d'excrétion et de détoxication éventuelle de ces polluants, les analyses qui permettent une microlocalisation de ces éléments à l'échelle cellulaire et subcellulaire sont nécessaires. Nous disposons actuellement de plusieurs types d'instruments de microanalyse, parmi lesquels il en est deux qui, par leurs performances complémentaires, sont bien adaptés aux études relatives à la pollution (CHASSARD-BOUCHAUD, 1987). Le premier est le microscope ionique (SIMS=Secondary Ion Mass Spectrometry) qui permet de localiser et de photographier les isotopes stables ou radioactifs présents dans une coupe histologique, avec une sensibilité d'environ 0,1 ppm et une résolution latérale de 0,5 µm (CHASSARD-BOUCHAUD, 1989). Cet appareil est associé à un système informatisé de traitement d'images. Le second est la microsonde de Castaing (EMP = Electron Microprobe) qui, avec une sensibilité moins élevée, peut par contre, grâce à son association avec un microscope électronique à transmission, localiser et déterminer la forme chimique des minéraux présents dans les organites.

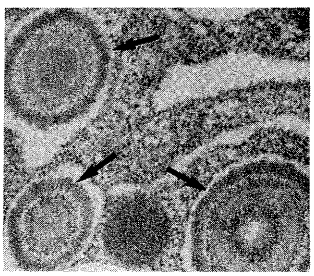
Notre objectif est d'exposer et de comparer les résultats relatifs à la bioaccumulation d'un élément stable, le chrome (^{52} Cr) et d'un élément radioactif, l'uranium (^{238}U), chez le crabe *Liocarcinus puber*. L'absorption de Cr et de U, par la voie branchiale est pratiquement nulle, alors qu'elle est importante par voie orale ; elle est suivie par une immobilisation importante de l'uranium dans la glande digestive qui apparaît comme l'organe principal de bioaccumulation du radionucléide mais qui, par contre, ne concentre pas du tout le chrome. Le tissu cible de bioaccumulation du chrome est le muscle où le métal se concentre en granules denses dans les myofibrilles (Fig. 1). L'exosquelette est aussi un site de stockage des deux métaux, ce qui permet au crabe de se détoxiquer périodiquement lors de ses exuviations.

A l'échelle subcellulaire, on montre que les deux organites cibles de bioaccumulation sont les lysosomes et les sphérocristaux (Fig. 2). Dans les lysosomes, Cr et U sont concentrés et précipités sous forme de phosphate (réaction enzymatique phosphatasique acide). Les lysosomes et les sphérocristaux, après piégeage des éléments toxiques, sont ensuite rejetés dans le milieu extérieur, ce qui assure une détoxication du crabe. Par contre, le chrome qui n'est pas séquestré par des organites spécialisés, reste libre dans le cytoplasme et risque d'engendrer des troubles cellulaires plus ou moins importants dans un tissu comme le muscle qui est dépourvu de toute fonction excrétrice.

En conclusion, des métaux tels que le chrome et l'uranium, dissous dans l'eau de mer, pénètrent dans les organismes par des voies diverses et viennent ensuite se fixer provisoirement ou définitivement dans des tissus ou organes cibles, variables selon les éléments, et où ils sont généralement transformés et insolubilisés sous forme de phosphate, en particulier dans les lysosomes. Ces isotopes stables ou radioactifs peuvent être ensuite, soit éliminés par différents processus, soit devenir permanents et susceptibles d'engendrer divers troubles du métabolisme cellulaire.



Muscle. On observe des granules (flèches) qui sont les sites de concentration de Cr, dans les myofibrilles (m). X 42000



Glande digestive. Les sphérocristaux (flèches) sont les sites de concentration de Cr et U. X 33000

Ce travail a été réalisé dans le cadre du Programme MED POL et a bénéficié d'un soutien financier du MED TRUST FUND en relation avec "the Food and Agriculture Organization of the United Nations". (contrats FRA 24/G et 39/G).

CHASSARD-BOUCHAUD C., 1987. Ion microscope and microprobes in marine pollution research. Analytica Chimica Acta, 195 ; 307-315.
CHASSARD-BOUCHAUD C., 1989. New developments in SIMS as applied to Medicine and Biology : a review. EMAG MICRO, 1989, London, Inst. Phys. Conf. Ser., 98, 19 ; 793-798.

X-II2

Lead compartmentation in Kidney Cell of *Murex trunculus* (Mollusca: Prosobranchia)

M. NIGRO, F. REGOLI and E. ORLANDO

Dipartimento di Biomedicina Sperimentale, Sezione di Biologia e Genetica, Università di Pisa, Via A. Volta 4 - 56100 Pisa (Italia)

The intracellular compartmentation of essential and xenobiotic metals is of great interest for improving our understanding of the normal metabolism of metals and of their mechanisms of cell injury (FOWLER, 1987). The role of a given compartment in the regulation of metal cations bioavailability depends on various factors such as cell type and species (FOWLER, 1987). The kidney of molluscs is a suitable material for studying the cellular mechanisms of metal homeostasis in non mammalian animals, due to its high capacity to concentrate metals (CARMICHAEL et al., 1980 ; GOLDBERG, 1986).

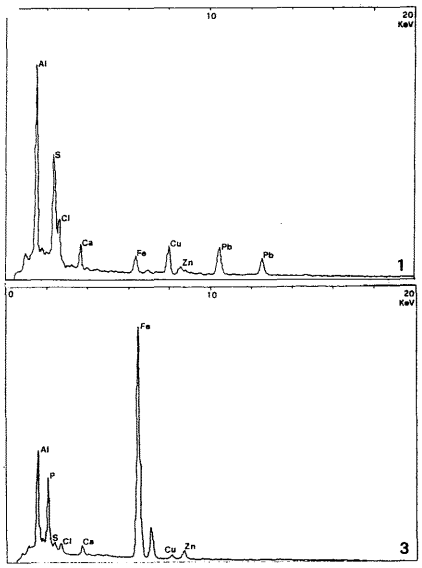
This paper reports preliminary data on Pb concentration and its intracellular localization in the kidney of *Murex trunculus* , a common predatory gastropod mollusc. The animals were collected in a heavily polluted marine area of the gulf of Follonica (North Tyrrhenian Sea). This area receives effluents from both industrial (production of TiO_2 and H_2SO_4) and domestic activities. Specimens of *Murex*, sampled in unpolluted waters of Sardinia (Porto Pozzo), were used for comparison. Metal concentration in the organ was measured by Atomic Absorption Spectrophotometry after wet digestion with HNO_3 in teflon vessels at 120°C. Accuracy of analytical procedures was checked with standard of *Homarus* (National Research Council Canada). Intracellular localization was revealed on chemically fixed material by Transmission Electron Microscopy and X-ray microprobe analysis.

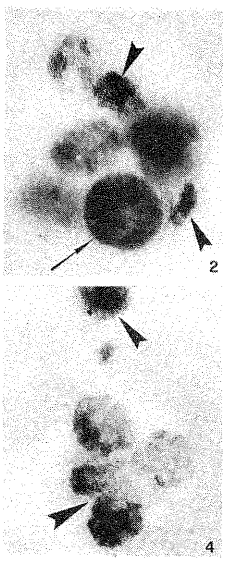
Renal concentrations higher than 700 ppm were measured in *Murex* from Follonica, whereas individuals from Porto Pozzo showed values lower than 1 ppm (dry weight). Kidney cells of *Murex* from Follonica showed a large number of lysosome-like inclusions (Fig. 2), containing an highly electrondense material and often homogeneous spherical bodies (0.4 - 0.6 µm in diameter) (Fig. 2 arrow). These inclusions contained also clusters of fine granules composed mainly by Fe (Fig. 2 arrow heads). X-ray microanalysis revealed that Pb was associated with the spherical bodies (Fig. 1).

Morphologically similar inclusions were seldom found in renal cells of *Murex* from Porto Pozzo (Fig. 4). However, these inclusions never contained lead (Fig. 3).

Cu and Zn were associated with the spherical bodies of *Murex* from both areas.

The values of Pb found in *Murex* from Follonica are remarkably higher in respect to literature data (DI CINTIO, 1986), indicating a very high lead pollution in this area. Our findings also confirm that this metal can be tolerated by molluscs in concentrations much higher than those found in normal tissues. This is probably due to the sequestration of lead within membrane bound lysosome-like bodies. This evidence supports previous data indicating these organelles as one of the major "sinks" for metal cations (FOWLER et al., 1975).





FOWLER B.A., WOLFE D.A. and HETTLER W.F., 1975. Mercury and iron uptake by cytosomes in mantle epithelial cells of Quahog clams (*Mercenaria mercenaria*). J. Fish. Res. Bd. Can, 32 ; 1767-1775.

CARMICHAEL N.G., SQUIBB K.S., ENGEL D.W. and FOWLER B.A., 1980. Metals in the molluscan kidney : uptake and subcellular distribution of ^{109}Cd, ^{54}Mn and ^{65}Zn by the clam *Mercenaria mercenaria*. Comp. Biochem. Physiol, 65A ; 203-206.

DI CINTIO R., 1986. Il piombo sotto forma inorganica e sotto forma organica nei mitili campionati lungo un tratto di costa ligure. Inquinamento, 7 ; 42-45.

GOLDBERG E.D., 1986. The mussel watch concept. Envir. Monitor. Assessm, 7 ; 97-103.

FOWLER B.A., 1987. Intracellular compartmentation of metals in aquatic organisms ; roles in mechanisms of cell injury. Environ. Health Perspect, 71 ; 121-128.

X-II3

Evaluation du contenu en Calcium intracellulaire et en Métaux Traces d'un organe (la branchie) chez le Poisson et la Moule

N. GNASSIA-BARELLI*, M. ROMEO*, A. MATHIEU**, D. RIBERA**, P. GARRIGUES** et M. LAFAURIE**

*INSERM, Unité 303 "Mer et Santé", B.P. 3, 06230 Villefranche-sur-Mer (France)
**G.I.C.B.E.M. Groupe Interface Chimie Biologie des Ecosytèmes Marins

Des prélèvements de moules et de poissons ont été effectués en Méditerranée nord-occidentale dans le cadre du G.I.C.B.E.M. (Groupe Interface Chimie Biologie Ecosystèmes Marins) regroupant plusieurs laboratoires européens.

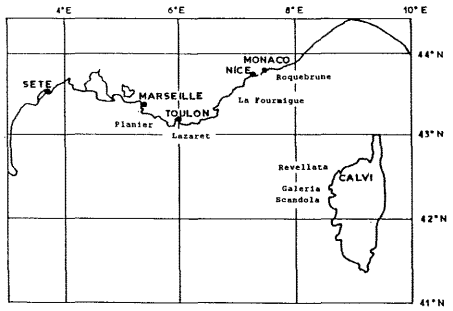
Les poissons récoltés (*Serranus scriba* et *Serranus cabrilla*) ont été choisis car ils présentent l'avantage de se capturer facilement et, aussi, d'être des hermaphrodites fonctionnels, ce qui élimine le facteur sexe. Les moules prélevées appartiennent à l'espèce *Mytilus galloprovincialis* , connue et très étudiée au point de vue des métaux traces.

A bord du bateau, les moules entières, les branchies de poissons et de moules séparées du reste du corps, sont soigneusement rincées par une solution isosmotique à l'eau de mer (Glycine 1M, TRIS-HCl 10 mM) et conservées dans l'azote liquide jusqu'au traitement des échantillons. Les échantillons sont ensuite lyophilisés et minéralisés par attaque acide (HNO_3 "suprapur"). Les analyses de calcium et de zinc ont été effectuées par spectrophotométrie d'absorption atomique à flamme, celles de cadmium par absorption atomique sans flamme.

En juillet 1989, les échantillons ont été prélevés au Planier, à Revellata, Galeria, Scandola, à l'embouchure du Golo, La Fourmigue, Roquebrune, au port de Gênes et à Portofino. En novembre 89, les prélèvements ont été effectués pour les branchies de poissons à Revellata, Galeria, Scandola et Roquebrune ; pour les branchies de moules au Lazaret, à Galeria, à La Fourmigue et à Roquebrune. Le tableau suivant donne les concentrations moyennes (± un écart-type) en métaux par rapport au poids sec suivant les espèces, toutes stations confondues.

	Ca(mg.g^{-1})	Cd(µg.g^{-1})	Zn(µg.g^{-1})
Juillet 89			
Serranus cabrilla (branchies, n = 20)	64 ± 15	1,43 ± 3,11	79 ± 20
Mytilus galloprovincialis (entières, n = 21)	1,1 ± 0,7	0,85 ± 0,53	156 ± 62
Novembre 89			
Serranus cabrilla (branchies, n = 16)	65 ± 39	5,16 ± 12,32	105 ± 65
Serranus scriba (branchies, n = 19)	80 ± 25	1,02 ± 1,75	123 ± 28
Mytilus galloprovincialis (branchies, n = 19)	2,9 ± 0,7	8,12 ± 14,22	82 ± 25

En juillet 89, pour *S. cabrilla*, seules les concentrations en cadmium des branchies sont significativement différentes selon les stations : pour Le Planier, elles sont de 5,05 ± 4,86 µgCd.g^{-1} (n = 5, avec une médiane de 5,05 µCd.g^{-1}), pour Roquebrune et Revellata, elles sont respectivement de 0,65 et 0,67 µCd.g^{-1} ; en revanche, aux autres stations (dont le port de Gênes) les valeurs trouvées sont en moyenne de 0,07 µg Cd.g^{-1}. Pour les moules entières, il n'y a pas de différences importantes pour les concentrations en calcium, cadmium et zinc suivant les stations.



En novembre 1989, les concentrations en calcium, en cadmium et en zinc des branchies de *S. cabrilla* varient en fonction du lieu de prélèvement : celles de Revellata sont significativement (test t) plus fortes (n = 5, 113 mg Ca.g^{-1}, 17,5 µg Cd.g^{-1} et 168 µg Zn.g^{-1}) que celles de Galeria, Scandola et Roquebrune (n = 11, 43 mg Ca.g^{-1}, 0,19 µg.Cd.g^{-1} et 81 µg Zn.g.$^{-1}$). Il faut noter les valeurs particulièrement faibles des concentrations en cadmium trouvées dans les branchies de Galeria (0,05 µg.Cd.g^{-1}) et de Scandola (0,03 µg.Cd.g^{-1}). Pour les branchies de *S.scriba*, les concentrations en calcium diffèrent suivant les zones de prélèvement : elles sont plus élevées à Revellata (test t significatif) (n = 5, 105 mg Ca.g^{-1}) qu'à Galeria, Scandola et Roquebrune (n = 14, 74 mg Ca.g^{-1}), les concentrations en cadmium sont plus élevées à Revellata et à Roquebrune (n = 9, 1,91 µg Cd.g^{-1}) qu'à Galeria et Scandola (n = 10, 3,21 µ Cd.g^{-1}). En ce qui concerne les branchies de moules, les concentrations en cadmium sont particulièrement élevées au Lazaret (n = 5, 33,9 ± 1,8 µg Cd.g^{-1}) par rapport à celles trouvées à Galeria, à La Fourmigue et à Roquebrune (n = 14, 0,49 ± 0,39 µg Cd.g^{-1}).

En conclusion, des valeurs particulièrement élevées ont été observées dans les concentrations en cadmium dans les branchies de poissons et de moules à certaines stations en juillet et en novembre . Dans certains cas, ces valeurs fortes sont liées à des concentrations élevées en calcium et en zinc. Des analyses supplémentaires sont nécessaires pour évaluer l'impact de la pollution métallique sur le contenu en calcium intracellulaire total des branchies de moules et de poissons. L'augmentation de ce contenu serait, selon VIARENGO et al. (1988), un indice de contamination du milieu.

VIARENGO A., MANCINELLI G., MARTINO G., PERTICA M., CANESI L. and MAZZUCOTELLI A., 1988. Mar. Ecol. Prog. Ser. 46 ; 65-70.

X

Essai d'utilisation des Eponges comme bioindicateurs des teneurs en métaux des eaux

E. RICHELLE*, H. NEYBERG**, E. ROYAUX**, G. VAN DE VYVER* et Z. MOUREAU***

*Laboratoire de Biologie animale et cellulaire, Université Libre de Bruxelles, Bruxelles (Belgique)
**Service Géologique de Belgique (Belgique)
***Institut Royal des Sciences Naturelles de Belgique (Belgique)

Dans ce travail, nous avons déterminé la teneur en brome, cerium, cuivre, chrome, fer, manganèse, rubidium, strontium, titane, zinc, zirconium et yttrium dans trois espèces d'éponges d'eau douce communes en Belgique, *Ephydatia mulleri*, *Eunapius fragilis* et *Spongilla lacustris*.

Les éponges sont des filtreurs très actifs, consommateurs de bactéries et de matière organique dissoute, colloïdale et particulaire. Les quelques études qui ont été effectuées en milieu marin ont révélé que les éponges sont accumulateurs d'éléments trace : métaux, organochlorés, etc... (ZAHN et al., 1981 ; PATEL et al., 1985). Dans cette optique, les éponges pourraient servir de modèle pour établir l'impact des hydrocarbures, des détergents et des déchets industriels sur le milieu aquatique ("Sponge Watch").

Aucune étude n'a porté sur les éponges d'eau douce qui pourtant pourraient se révéler très utiles pour la surveillance de la pollution dans les eaux douces. En effet, elles présentent l'avantage sur les autres organismes bioaccumulateurs de pouvoir être facilement transplantées dans divers milieux et de s'y développer massivement. Ceci est rendu possible grâce à la technique de culture *in vitro*.

La capacité des éponges à accumuler des métaux a été établie par dosage de la teneur de différents métaux dans les éponges et l'eau ambiante.

Nous avons dosé les éléments par fluorescence-X au moyen d'un spectromètre à vide Philips PW 1540. Les conditions d'analyse ont été : anode en Rhodium, 50 Kv 40 mA ; cristal analyseur LiF 200 ; temps de comptage, 100 secondes ; collimateurs en position fine et compteur à scintillation à 845 v pour Br, Cu, Fe, Rb, Sr, Zn, Zr, Y et collimateurs en position large et compteur à flux gazeux à 855 v pour Ce, Cr, Mn, Ti. La concentration finale de chaque élément est calculée par rapport à des standards internationaux (seuil de détection : 10 ppm).

Le choix des éléments à analyser a été établi au départ d'une dizaine de spectres réalisés à partir des trois espèces d'éponges d'eau douce, *E. mulleri*, *E. fragilis* et *S. lacustris*.

Ce screening a permis de déterminer que Br, Ce, Cr, Cu, Fe, Mn, Rb, Sr, Ti, Zn, Zr et Y étaient présents en quantité suffisante pour permettre une première évaluation de leur bioaccumulation par les éponges.

Les éponges ont été récoltées en Fagne et Ardenne occidentale (RICHELLE et al., 1989). Elles ont été rincées, égouttées, débarrassées de leurs épibiontes et conservées dans l'alcool.

La confection des pastilles pour la fluorescence-X s'effectue de la manière suivante : les échantillons d'éponges sont séchés pendant 48 heures à 60°C puis broyés finement ; la poudre ainsi obtenue est couverte d'acétone additionnée d'elvacite, séchée et comprimée à 5 tonnes pendant 10 minutes dans un moule cylindrique.

Les résultats de l'analyse de 19 échantillons, exprimés par rapport au poids sec, permettent de classer les métaux en 3 grandes catégories :

1 - Fe, Mn, Zn et Ti se distinguent des autres éléments par le niveau de leur accumulation chez les trois espèces. Les valeurs sont particulièrement élevées pour **Fe** (0,15% à 3,6%) et pour **Mn** (0,05% à 1,1%), soit plusieurs milliers de fois supérieures à celles du milieu environnant. Les teneurs en **Zn** varient de 51 ppm à 430 ppm et celles de **Ti** de 13 ppm à 1439 ppm.

2 - Br, Cu, Rb, Sr, Zr, Y sont accumulés par les trois espèces à un taux moindre, fort variable d'un échantillon à l'autre et souvent proche de la limite de détection.

3 - Ce et Cr ne sont décelés que dans certains échantillons et très rarement chez *Eunapius fragilis*.

Ces résultats préliminaires indiquent que les éponges d'eau douce sont capables d'accumuler, en quantité variable, des métaux présents à l'état de trace ou en faible quantité dans le milieu ambiant.

Ils ne nous permettent cependant pas d'établir, à ce stade, l'existence ou non d'une sélectivité spécifique et/ou d'une relation entre les teneurs métalliques des éponges et la contamination du milieu environnant.

Les teneurs en métaux dosées chez les éponges d'eau douce sont du même ordre de grandeur que celles observées chez les éponges marines à l'exception du manganèse (BOWEN et SUTTON, 1951 ; PATEL et al., 1985 ; VERDENAL, 1986). Les éponges d'eau douce étudiées en contiennent, en moyenne, 50 fois plus.

BOWEN V.T. and SUTTON D., 1951. Comparative studies of mineral constituents of marine sponges. J. Mar. Res., 10 ; 153-167.
ZAHN R.K., ZAHN G., MULLER W.E.G., KURELEC B., RIJAVEC M., BATEL R. and GIVEN R., 1981. Assessing consequences of marine pollution by hydrocarbons using sponges as model organisms. Sci. Total Environ., 20 ; 147-169.
PATEL B., BALANI M.C. and PATEL S., 1985. Sponge sentinel of heavy metals. Sci. Total Environ., 41 ; 143-152.
VERDENAL B., 1986. Spongiculture en Méditerranée nord-occidentale : aspects culturaux, molysmologiques et économiques. Thèse de doctorat.
RICHELLE E., MOUREAU Z., HUYSECOM J. et VAN DE VYVER G., 1989. Distribution des éponges d'eau douce dans la Fagne et l'Ardenne occidentale. Comptes Rendus du "Symposium Invertébrés de Belgique" ; 9-14.

Pathology of *Mytilus galloprovincialis* L. reproductive organs produced by Nitrogen-compounds

P.-E. MIHNEA

Romanian Marine Research Institute, Bd Lenin 300, 8700 Constanta (Romania)

Many of mineral and organic compounds or breakdown products may affect the natural environment; LC50, ET50 (LITCHFIELD & WILCOXON, 1949) as well as several methods of growth potential estimation or marine bioassay (BERLAND et al. 1972; MAESTRINI et al. 1984 a, b) were applied to get knowledge concerning their effects on marine living beings. There are only few data on their behaviour and pathways through the ecosystems. SOLBE (1988) defined "the study of the pathways, fate and effects of chemicals to and in environment: ECOTOXICOLOGY". And we emphasize: any physical or chemical parameter must be included as potential harmfull factors, when it reaches a critical size or concentration level. This is a new tool that helps us to understand biological effects of pollutant and learn how to protect our natural resources. Heavy eutrophicated environments present high levels of N-NH_4 and N-urea. N-NH_4 and N-urea reached into Romanian inshore area a significant increase as the process of eutrophication grown up in the last years. Ammonia reached in1989 maximum values of 240-1,417µg 1-1 and urea 201-2,200 µg 1-1 (PECHEANU, personal communication). Both N-compounds were found to be toxic - on Mytilus galloprovincialis in long term exposure - when they reach a high concentration level.

MATERIAL AND METHODS

Mussels were collected from an area less influenced by the outfalls, cleaned out of periphyton and acclimated at laboratory conditions for 30 days. They were experimented in static renewal, continuous air supply, 20 - 22°C, light/darks : 16/8 hrs., each vassel (10 l) containing 32 individuals (height 6-7 cm). There were used 8 experimental vassels representing duplicates for : control ; 1‰, 5‰, and 10‰ (in mg) N-NH_4 and N-urea. The sea water was changed every day and then contaminated with N-compounds up to experimental level. Mussels were fed with *Chloromonas* : 1.25×10^6 cel/mussel/8 times a day. Algae were separated from culture medium by centrifugation and rinsed with clean sea water. Mussels were sacrificed after 72 days of exposure. Gonad cycles was determined and numerical ranking of a sample was valued : O - resting ; 1 - immature ; 2 - developing ; 3A - ripe ; 3B - spawning ; 3C - redeveloping ; 3 D - spent. Both gonad squash observations and histological preparations were performed.

RESULTS

Ovula and sperm release was observed only in control, during August. The follicles size did not show great differences between controls and variants, except NO_3NH_4 exposures (Table 1).

Table 1 :
The size class frequency of follicles after 72 days of experimentation (N-compounds as mg ‰ and size in µ)

Analyzed sample		no. of samples	Follicles size X	SD	min.	max.	Follicles size class (%) 1-100	100-200	200-400	400-600
Control		32	225	127	71	550	9.37	46.87	28.12	15.63
Urea	1 ‰	32	204	107	57	471	15.15	45.45	33.33	6.06
Urea	5 ‰	32	152	152	71	385	21.87	62.50	15.62	0
Urea	10 ‰	32	304	128	143	607	0	25.00	59.37	15.63
NO_3NH_4	1 ‰	32	223	89	64	407	2.63	47.37	47.37	2.6
NO_3NH_4	10 ‰	32	265	79	164	499	0	25.00	71.87	3.13

The gonad stages (Table 2) proved that urea and NO_3NH_4 produced an interrupting of reproductive cycle, but what stage, it depended on the nitrogen species and their concentrations.

Table 2 :
The gonads stages

Analyzed sample		no.of samples	Frequency of each stage (%) 0	1	2	3A	3B	3C	3D	3E
Starting point of experiment		100	0	0	0	2	4	20	74	0
Control		32	0	100	0	0	0	0	0	0
Urea	1‰	32	0	0	0	0	0	28.89	71.11	0
Urea	5‰	32	0	0	0	0	0	16.67	83.33	0
Urea	10‰	32	0	0	0	0	0	0	3.12	90.62
NO_3NH_4	1‰	32	0	0	0	0	0	31.25	68.75	0
NO_3NH_4	10‰	32	0	0	0	0	0	5.77	94.28	0

At the end of experiment, 100% of the control individuals resumed the reproductive cycle as they were found to be immature : gonads presented islands of rudimentary reproductive tissue in the matrix. All variants showed in different percentages either 3C : developing (new oocystes being found at the margin of the follicle ; male follicles show a reformation of the lamellae of sperm), or 3D : spent (in females residual oocystes reabsorbed ; follicles in the males decrease in size and the remaining sperm are broken down by amoebocystes) stages.

When 10 mg‰ urea was used, a stage (3E) beyond the 3D was observed ; 90.62% of individuals presented follicles completely spent, and they looked like big and irregular holes with no tendency of recovering.

In conclusion, the increase of nitrogen compounds in an eutrophicated environment could produce a pathology of gonads.

LITCHFIELD J.T.Jr. and WILCOXON F., 1949 - A simplified method of evaluating dose-effect experiments. Journal of Pharmacology and Experimental Therapeutics, 96 ; 99-113.
BERLAND B.R., BONIN D.J., MAESTRINI S.Y. et POINCIER J.P., 1972 - Etude de la fertilité des eaux marines au moyen de tests biologiques effectués avec des cultures d'algues. I : Comparaison des méthodes d'estimation. Int. Revue ges. Hydrobiol., 57, 6 ; 933-944.
MAESTRINI S.Y., DROOP M.R. and BONIN D.J., 1984 a - Algae as ecological indicators. 4 : Phytoplankton as indicators of sea water quality : bioassay approaches and protocols. Acad. Press London, ed. L.Elliot Shubert ; 71-132.
MAESTRINI S.Y., DROOP M.R. and BONIN D.J., 1984 b - Algae as ecological indicators : Test algae as indicators of sea water quality : prospects. Acad. Press London, ed. L. Elliot Shubert ; 134-188.
SOLBE J., 1988 - Pre-marketing tests on chemicals and the protection of freshwater life. International Conference "Domestic and industrial wastes", Sherkin Island Marine Station ; 66-73.

X-II6

Effets de divers polluants sur les oeufs et les larves de Poissons: intérêt toxicologique et écotoxicologique et incidence de leur mortalité sur la dynamique des populations

J. BRUSLE

Laboratoire de Biologie Marine, Université de Perpignan, Avenue de Villeneuve, 66025 Perpignan (France)

Les effets de nombreux polluants sur la reproduction des organismes, et en particulier sur celle des poissons, ont donné lieu à un certain nombre de travaux. Ceux-ci considèrent la fonction reproductrice dans un sens large, incluant les effets sur les géniteurs (gamétogenèse, fécondité) et sur les gamètes (fécondabilité) et prenant en compte le succès de la reproduction c'est à dire l'impact sur la descendance (oeufs, larves, juvéniles), en terme de viabilité et de taux d'anomalies (tératogenèse).

Ces connaissances résultent, pour l'essentiel, de tests de toxicité réalisés en laboratoire, sur un certain nombre d'espèces d'eau douce et marines. Ils ont montré la grande sensibilité des phases précoces du développement vis à vis de divers agents toxiques (hydrocarbures, pesticides, métaux lourds, détergents ...). Les oeufs et larves apparaissent constituer des maillons particulièrement sensibles du cycle de vie des poissons et les divers effets embryotoxiques peuvent donc constituer de bons indicateurs de toxicité, susceptibles d'être utilisés avec profit pour l'établissement des normes de contrôle de qualité des eaux (Mc KIM, 1977).

Ces résultats expérimentaux sont toutefois difficilement transposables aux milieux naturels contaminés et leur validation écologique reste le plus souvent à faire, les effets négatifs des polluants sur les aires de ponte et les frayères, bien que dénoncés en Mer du Nord et en Baltique, demeurant délicats à démontrer en milieu naturel contaminé.

L'auteur se propose de dresser un bilan des connaissances actuelles et de s'interroger sur la signification des données, en insistant sur les espèces méditerranéennes à propos desquelles les travaux sont bien peu nombreux. Il a aussi pour ambition de montrer les multiples intérêts : théorique (mécanismes cellulaires en réponse à un stress environnemental et sensibilité différentielle en fonction des espèces et des stades de développement - oeuf, embryon, larve, postlarve -), méthodologique (tests rapides sur un matériel relativement aisé à contaminer) et pratique (tests de qualité des eaux et surtout menaces sur la reproduction des populations naturelles exploitables par la pêche). En effet, à la mortalité naturelle des oeufs et des larves de poissons marins, qui est généralement très élevée et qui dépend de facteurs intrinsèques (qualité des gamètes liée au génome, à l'âge et à la santé des géniteurs) et extrinsèques (température, salinité hydrodynamique, prédation ...), s'ajoute une mortalité plus ou moins considérable induite par des facteurs anthropiques tels que les chocs mécaniques, thermiques et chimiques subis dans les centrales électriques littorales et surtout par les intoxications par de nombreux polluants agissant le plus souvent en synergie. Enfin, il voudrait démontrer que des approches séquentielles, dans un cadre expérimental volontairement "réductionniste", pourraient être suffisamment représentatives pour être utiles à des fins de contrôle des niveaux de contamination des milieux marins et de prédiction des effets létaux et sublétaux de pollutions chroniques ou accidentelles. Il conclut sur la nécessité de promouvoir le développement de programmes nouveaux dans une voie jusqu'alors trop souvent négligée.

Mc KIM J.M., 1977 . Evaluation of tests with early life stages of fish for predicting long-term toxicity. J. Fish. Res. B. Canada, 34 ; 1148-1154.

X-II7

Effets des polluants sur la reproduction et le développement embryonnaire: une étude sur l'eau et les sédiments de la Rade de Toulon

G. PAGANO* , A. ESPOSITO* , L.-A. ROMANA** et N.-M. TRIEFF***

*Istituto Nazionale per lo Studio e la Cura dei Tumori, fondazione Pascale, 80131 Napoli (Italia)
**IFREMER, Centre de Toulon-La Seyne, 83507 La Seyne-sur Mer Cédex (France)
***UTMB, Department of Preventive Medicine and Community Health, Galveston, Texas 77550 (U.S.A.)

Les gamètes et les embryons des oursins de mer peuvent être utilisés comme des indicateurs biologiques appropriés pour contribuer aux études pluridisciplinaires sur les pollutions des eaux et des sédiments (PAGANO et al., 1986, 1988 ; DINNEL et al., 1981, 1988). Les tests biologiques effectués sur les échinoïdes permettent d'obtenir des informations concernant :

a) la toxicité sub-léthale à des niveaux réalistes d'agents contaminants ou de mélanges complexes;
b) une distinction possible entre les cibles cellulaires intéressées par l'action toxique, telles que la fécondation, l'activité mitotique ou la différenciation cellulaire/larvaire.

Des embryons ou du sperme d'oursin de mer ont été testés dans le cadre d'une étude pluridisciplinaire destinée à évaluer l'état de pollution des eaux et des sédiments dans la Rade de Toulon (France). La Fig. 1 indique l'aire d'échantillonnage centrée sur le rejet de l'émissaire de la station d'épuration de Toulon Est-La Garde. Les échantillons d'eau ou de sédiment ont été réfrigérés, puis testés en laboratoire. Nous avons appliqué les procédures suivantes :

a) eau de mer : collectée à des distances différentes du rejet de l'émissaire de la station d'épuration et utilisée directement, sans filtration ;
b) sédiments : dépôt d'une quantité connue (10 mg/ml) au fond des flacons de culture.

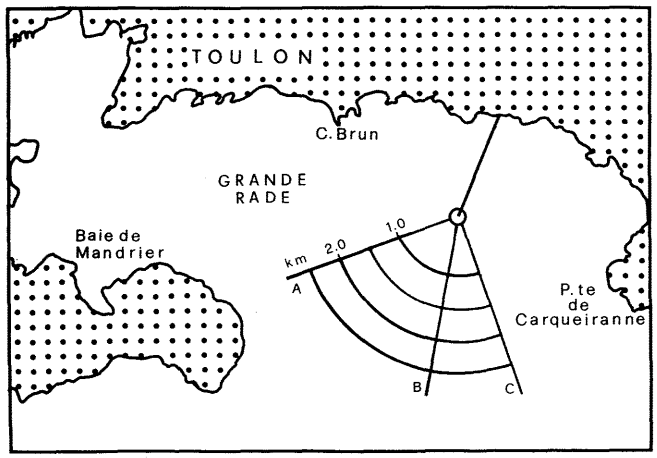
Les résultats ont porté sur :

1) les fréquences de malformations larvaires et d'arrêt de la différenciation larvaire ; ce test a été mené sur des échantillons de larves à la suite du traitement des embryons ainsi que sur les descendants du sperme prétraité (PAGANO et al., 1986) ;
2) l'altération des taux de fécondation à la suite de l'exposition du sperme à l'eau contaminée ou bien du sédiment.

L'eau de la Rade, collectée dans la zone d'influence de l'émissaire, a induit le maximum d'anomalies du développement des embryons en proximité du rejet. L'action de l'eau de la Rade sur le sperme a montré une augmentation de la capacité fécondante pour les échantillons d'eau plus pollués de l'émissaire, rapportée à la concentration d'ammonium.

Une tendance non-monotonique a été observée dans la répartition topographique des anomalies larvaires, à la suite de l'exposition des embryons aux échantillons de sédiment. On a observé une réponse décroissante en fonction de la distance du rejet dans les premiers 50 m ; puis, un nouveau maximum d'anomalies, avec une distribution annulaire à 500 m sur les radiales A et C et à 750 m sur la radiale B (voir figure). Aucun effet n'a pu être observé sur la capacité fécondante, ou sur la qualité des descendants, en exposant le sperme aux échantillons de sédiment de la Rade.

Sur la base des résultats obtenus et d'une étude parallèle conduite en Italie, on peut considérer que les essais sur les sédiments montrent une fiabilité supérieure par rapport aux essais sur l'eau. La sensibilité, apparemment meilleure pour les embryons que pour le sperme, peut être attribuée à l'exposition plus directe et prolongée des embryons jusqu'à l'éclosion.



PAGANO G., CIPOLLARO M., CORSALE G., ESPOSITO A., RAGUCCI E., GIORDANO G.G. and TRIEFF N.M., 1986. The sea urchin : Bioassay for the assessment of damage from environmental contaminants. In Community Toxicity Testing, J. CAIRNS Jr. ed., American Society for Standard Testing and Materials, Philadelphia ; 66-92.
DINNEL P.A., PAGANO G. and OSHIDA P.S., 1988. A sea urchin test system for marine environmental monitoring. In Echinoderm Biology, R.D. BURKE, P.V. MLADENOV, P. LAMBERT and R.L. PARSLEY eds., Balkema, Rotterdam ; 611-619.
PAGANO G., CORSALE G., ESPOSITO A., ROMANA L.A. and TRIEFF N.M., 1988. Increase of domestic sewage toxicity as a consequence of treatment by flocculating agents as determined by the sea urchin bioassay. Rapp. Comm. int. Mer Medit. 31 (2) ; 166.

X

Effects of an Organophosphorus Pesticide on the behaviour of *Monodonta turbinata* (Marine Gastropod, Trochid)

A. PIZZUTO and V. AXIAK

Department of Biology, University of Malta, Msida (Malta)

Organophosphorus pesticides have been increasingly used in agriculture because of their relative instability in the environment. These pesticides and potential marine contaminants interfere with neurophysiological activities and therefore it is possible that they also interfere with the normal behavioural and locomotory activities of exposed marine organisms. A series of investigations are being undertaken to study the effects of such contaminants on a range of marine invertebrates. In the present paper, some results are reported on the effects of Malathion at a relatively low concentration of 0.1 ppm, on the immersion-emersion activity of a locally abundant littoral trochid, *Monodonta turbinata*. This trochid, normally settles near the water surface, periodically moving up and down through this surface. This immersion-emersion activity is significant to the respiratory activities of *Monodonta* species and was found to be dependent on ambient temperature (MICALLEF, 1971).

This behavioural activity has been studied in the laboratory by means of an aktograph, first described by MICALLEF (1971). All experiments were carried out in a constant temperature room at constant temperatures ranging from 18 to 23 in different runs and with diffuse overhead artificial lighting switched on for 12 hours daily. Animals and sea water (salinity 34.4-36.8 ppt) were collected from unpolluted rocky shores on the northwest coast of Malta. Animals were acclimated to laboratory conditions for at least 24 hours and then each was introduced in an aktograph holding 100 ml of unfiltered seawater. This aktograph, which has been described elsewhere (SALIBA and VELLA, 1977 ; AXIAK and SALIBA, 1982) is capable of recording any immersion or emersion of an individual trochid, by a movement of a lever which leaves a 24 hour trace on a revolving drum. In the series of experiments here described, Malathion was first dissolved in acetone and then dosed in the exposed aktographs to obtain a nominal concentration of 0.1 ppm. Each exposure experiment lasted for 96 hours with test mixtures (unaerated) being renewed every 24 hours. Detailed chemical analysis of the test mixtures over the exposure period, will be reported elsewhere. Control aktograph were dosed with the same amount of acetone as exposure aktographs. A total of 21, 96-hour exposure experiments and 21 96-hour controls were carried out during the period January-April, 1990.

Table 1 shows the number of complete immersions and emersions, as well as the time spend immersed, emersed and at interphase for individual animals over a 24 hour period (activities during the light and dark periods being shown separately). Means and coefficient of variations (cv) for each parameter are included. 76, 24 hour traces and 64, 24 hour traces were analysed for exposed and control animals.

These results indicate that both the control and the exposed animals are more active across the water interphase during the day then during the night. During the day, the numbers are complete immersions and emersions are higher than during the night. Moreover, the animals spend more time immersed or in the water interphase.

Table 1

	Treatment : Day Period :	Control Light	Control Dark	Exposed Light	Exposed Dark
No of Immersions	means	5.0	1.8	1.6	0.4
	cv	6.44	5.16	3.69	2.42
No of Emersions	means	5.8	1.9	2.6	0.3
	cv	5.21	4.94	2.45	2.58
% time immersed	means	7.1	1.4	6.7	3.2
	cv	6.78	2.99	19.62	41.72
% time emersed	means	37.3	49.0	40.6	47.0
	cv	3.34	0.31	3.60	2.85
% time at interphase	means	4.6	0.7	1.3	0.5
	cv	11.22	3.55	4.03	8.10

These effects were found to be statistically significant ($P<0.01$) when means of the various parameters were compared by t-test as well as the Mann-Whitney U test (non-parametric test). Moreover, as is expected in such behavioural studies, a wide range of variability is exhibited by the various parameters monitoring both in the control and exposed animals. Animals exposed to a nominal concentration of 0.1ppm Malathion were more active across the water interphase and spent more time out of the water rather than at the interphase or immersed. These effects were statistically significant at the 0.05 P level as determined by t-tests on the respective means. This effect of Malathion at this low concentration may be considered as an adaptative change in the normal behaviour of this trochid which would enable it to come in contact with the contaminated water less frequently. This would presumably however affect the respiratory activities of the animal. Alternatively, this change behaviour could be interpreted as a manifestation of neurophysiological toxicity. Exposure to higher concentrations of Malathion (0.5 ppm) in fact induced the animals to enter into an inactive state and remain at the bottom of the aktograph throughout most of the exposure period. This activity of *Monodonata* is also known to be affected by other pollutants (SALIBA and VELLA, 1977 ; AXIAK and SALIBA, 1982).

MICALEFF H., 1971. A further study of the activity of *Monodonta lineata* (da Costa) by means of an aktograph. Rev. Roum. Biol. Zoologie, 16 ; 51-57.

SALIBA L.J. and VELLA M.G., 1977. Effects of mercury on the behaviour and oxygen consumption of *Monodonta articulata*. Mar. Biol., 43 ; 277-282.

AXIAK V. and SALIBA L.J., 1982. Effects of surface and sunken oil on the survival and behaviour of the marine gastropod, *Monodonta turbinata* Born. Vles Journées Etud. Poll., CIESM ; 749-754.

Diagnosis of factors influencing in vitro oil toxicity assessment

H. AWAD

Faculty of Science, Department of Oceanography, Alexandria University, Moharram Bek, Alexandria (Egypt)

Crude oils as all purely organic pollutants in the marine environment (as well as during *in vitro* bioassay experiments) are naturally subjected to many quantitative and qualitative modifications. By consequence, test organisms should have variable responses depending upon the instance composition and concentration of oil in their media.

From methodological point of view, the characteristics of the followed method for preparing the oily working medium play an essential part in the magnitude of constitutional variation of oil during the bioassay duration. In fact, any slight variation in the preparative steps of oily working medium (ratio of oil to water, mixing mean, power or duration, etc...) leads to significant variation in the potential of applied initial oil concentration and composition. Unsufficient attention is paid for this primordial aspect in the MAP technical report, devoted for oil ecotoxicological research (UNEP/FAO, 1987).

The factors and variables influencing the evaluation of oil toxicity on the marine organisms could be divides into four groups : form of oil in test medium, test medium preparative steps, water quality and test organism characteristics. Among these groups of factors, the present work includes results concerning the effect of variations in oily test medium preparation steps on the applied oil concentration in the bioassay experiments. Also, the relationship between initial preparated oil concentration in test medium, toxic effect (fish mortality) and instantaneous oil concentration in the medium (measured at the time of bioassay when a certain toxic effect is observed) is discussed.

The materials of this work are two types of arabian crude oils (light and heavy), 3 chemical dispersants (Finasol-2, -5 and -7) and one species of fish (*Lebistes reticulatus*) as test organisms for *in vitro* bioassay experiments. Throughout series of tests for preparing oily test media, ratios of oil : water or oil : dispersant : water, mechanically shaking power and duration and stabilization time of the produced mixtures are systematically varied. For each test, dissolved and dispersed oil residues are measured (IOC/WMO, 1976). In another series of bioassay experiments (Fig. 1), in which dispersed oil is used, lethal effect is followed for 5 days in comparison with the initial and instantaneous oil concentration in the medium.

From one side, the results showed the significant primordial role of any slight variation in the characteristics of even one of the preparative steps of used oily medium in bioassay tests. From the other side, effect of oil is related more to its instantaneous concentration in the medium than to the initial applied one. These results are supporting the necessity of the need of a standard method for *in vitro* oil ecotoxicological studies. Without such method, a convincing and precise overall picture for the real oil pollution effects in the marine environment could never be attained (PATIN, 1982).

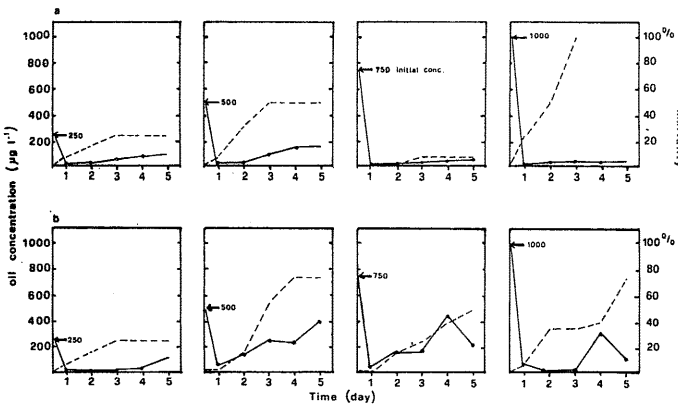


FIGURE 1 : Variations in fish-test mortality (—) in relation to variation in instantaneous dispersed light (a) and heavy arabian (b) oil concentration (- - -) with time using Finasol-7.

IOC/WMO, 1976. Guide to operational procedure for the IGOSS pilot project on marine pollution (petroleum) monitoring. UNESCO Manuals and Guides, n° 7.

PATIN S.A., 1982. Pollution and the biological resources of the oceans. Butterworth Scientific, London, 287 p.

UNEP/FAO, 1987. Research on the toxicity, persistence, bioaccumulation, carcinogenicity and mutagenicity of selected substances (Activity G). Final reports on projects dealing with toxicity (1983-85). MAP Technical Reports Series N° 10.
UNEP, Athens, 1987, 118 p.

X-II10

Etude de l'action conjuguée du Cadmium et du Benzo(a)Pyrène sur le foie de l'Anguille Européenne

S. LEMAIRE* , P. LEMAIRE** et A. MATHIEU**

*Laboratoire de Biologie Marine, Université de Perpignan, 66025 Perpignan Cédex (France)
**Laboratoire de Biotransformation et Cancérogénèse, Faculté de Médecine, 06034 Nice Cédex (France)

Malgré leur présence simultanée dans les zones polluées, l'action conjuguée des métaux lourds et des hydrocarbures sur les organismes aquatiques n'a été que rarement étudiée (FAIR, 1986). La plupart des études de contaminations multiples associent préférentiellement des polluants de même nature (métaux, hydrocarbures, pesticides ...) ayant souvent des voies de pénétration ou des effets similaires. Il nous a donc paru intéressant d'étudier l'action conjuguée de deux polluants de nature totalement différente ; d'une part, un métal hydrosoluble à pénétration transbranchiale, le cadmium dissous, et d'autre part, un hydrocarbure hydrophobe type, le benzo(a)pyrène (BaP), chez une espèce euryhaline, l'anguille européenne *Anguilla anguilla*. Nous nous sommes donc plus spécialement attachés à déterminer l'effet du cadmium sur le système de détoxication du BaP, au niveau du foie qui est le site d'une importante bioaccumulation du cadmium mais aussi d'une grande part de l'activité de détoxication des hydrocarbures par le système monooxygénase (MFO). En effet, dans l'optique d'une application directe à la surveillance biologique des milieux naturels, il est important de connaître les effets synergiques ou antagonistes de certains polluants, particulièrement au niveau des systèmes de détoxication souvent recommandés en tant qu'indicateurs biologiques.

MATERIEL ET METHODES :

Les anguilles, en provenance de l'étang de Bages-Sigean (Golfe du Lion), ont été acclimatées pendant trois semaines dans des bacs de 200 litres, en eau de mer artificielle (35°/oo, 18°C, photopériode de 12 heures).

La contamination expérimentale s'est déroulée dans des bacs de 25 l d'eau de mer artificielle, aérée, non recyclée mais renouvelée toutes les 48 heures. Les poissons ont été séparés en deux lots de 20 individus : un lot témoin et un lot contaminé par du nitrate de cadmium dissous dans l'eau à raison de 5 µg.-1. Après 24 jours d'expérience, chaque lot a été scindé en deux sous-lots, l'un témoin, l'autre recevant une injection intrapéritonéale de BaP, à raison de 20 mg/kg. Tous les poissons ont été sacrifiés et autopsiés 24 heures plus tard.

Les quatre lots suivants ont donc été étudiés :

Lot	A	B	C	D
BaP	-	-	+	+
Cd	-	+	-	+

(durées de contamination : cadmium : 35 jours ; BaP : 24 heures)

La quantité de cytochrome P-450 hépatique a été mesurée et différentes activités enzymatiques associées ont été analysées :

- trois activités de phase I : l'éthoxyrésorufine-O-déethylase (EROD), la benzo(a)pyrène monooxygénase (BaPMO) et la NADPH cytochrome c réductase (Cyt. Red.) ;
- une activité de phase II : la glutathion-S-transférase (GST).

RESULTATS

1) Induction des MFO par le BaP (lots A et C) : Parmi les activités de phase I, seules la BaPMO et l'EROD ont été induites respectivement d'un facteur 35 et 15. La quantité de cytochrome P-450 et l'activité Cyt Red ne sont pas modifiées après l'intoxication des poissons par le BaP. Au niveau de la phase II, il n'y a pas d'induction de la GST.

2) Effet du Cadmium sur les activités MFO de base (non induites) (lots A et B) : Les activités de base des phases I et II ne sont pas modifiées. Il faut cependant noter que la quantité de cytochrome P-450 et l'activité BaPMO montrent une légère augmentation (non significative) après contamination par le cadmium.

3) Effet du cadmium sur l'induction des MFO par le BaP (lots C et D) : Les augmentations de la quantité de cytochrome P-450 et des activités BaPMO et EROD ne sont pas significativement différentes entre les poissons cadmiés (lot D) et les poissons non cadmiés (lot C). L'activité Cyt Red, qui n'est pas induite, ne présente aucune variation. La GST, activité de phase II, ne semble pas modifiée par la contamination par le cadmium.

DISCUSSION ET CONCLUSION

L'existence d'un système MFO hépatique inductible par les hydrocarbures a été mis en évidence chez l'anguille américaine *Anguilla rostrata* (NAVA et ENGELHARDT, 1982). Il apparaît ici qu'un tel système existe également chez l'anguille européenne *Anguilla anguilla*. En particulier, les activités BaPMO et EROD répondent très fortement à l'induction par le BaP (inductions respectives de 35 et 15 fois) comparativement aux inductions observées chez d'autres poissons (LINDSTROM-SEPPA, 1988).

En ce qui concerne l'effet du cadmium, il est difficile de conclure : en effet, si certaines activités de phase I (EROD, BaPMO) et la quantité de cytochrome P-450 montrent une tendance à une augmentation, ces variations ne sont pas statistiquement significatives. Il faut toutefois noter que les activités de phase I induites par le BaP ne sont pas significativement différentes au risque d'erreur de 5%, mais elles le deviennent à partir de 10%. Le même type de résultat (augmentation non significative de l'activité BaPMO avec le cadmium) a été obtenu chez *Centropristis striata* après contamination au BaP et/ou au cadmium par voie trophique (FAIR et FORTNER, 1987).

NAVA, M.E. and ENGELHARDT, F.R. (1982). Arch. Environ. Contam. Toxicol., 11; 141-145.
FAIR, P.H. (1986). Arch. Environ. Contam. Toxicol., 15 ; 257-263.
FAIR, P.H. and FORTNER, A.R. (1987). Environ. Res., 42 ; 185-195.
LINDSTROM-SEPPA, P. (1988). Ecotoxicol. Environ. Safety, 15 (2) ; 162-171.

X-II11

Accumulation de contaminants et activité de biotransformation chez la Moule. Evolution au cours d'un épisode météorologique (coup de vent)

J.-F. NARBONNE* , D. RIBERA* , M. LAFAURIE** et A. ROMANA***

*Laboratoire de Toxicologie Alimentaire, Université de Bordeaux I, 33405 Talence Cédex (France)
**Laboratoire de Biotransformation et Cancérogenèse, Faculté de Médecine, 06034 Nice Cédex (France)
***IFREMER Toulon, B.P. 330, 83507 La Seyne-sur-Mer (France)

Les moules, organismes sédentaires possédant une large répartition géographique, servent d'organismes test dans de nombreux programmes internationaux (Earth Watch, Mussel Watch) visant à évaluer la contamination chimique dans le milieu marin, soit par mesure directe des composés bioaccumulés (GOLDBERG et al., 1975; PORTE et al., 1990), soit par mesure des activités des enzymes de biotransformation (SUTEAU et al., 1988; RIBERA et al., 1989).

La plupart des études de surveillance sont basées sur la comparaison des données obtenues entre différentes stations ou sur l'évolution des paramètres mesurés à des intervalles réguliers (annuels ou bi-annuels) dans le même site.

Afin d'évaluer l'influence d'un épisode météorologique sur la contamination et sur une activité enzymatique de biotransformation chez *Mytilus galloprovincialis*, nous avons suivi l'évolution de ces paramètres sur une courte période (8 jours) durant un coup de vent en Baie du Lazaret (Toulon, France).

Les hydrocarbures aromatiques polycycliques (HAP) ont été dosés dans le sédiment et dans les moules avant la tempête. Pendant le coup de vent, HAP, métaux et polychlorobiphényles (PCB) sont mesurés dans l'eau et dans les moules. Les activités benzo(a)pyrène monooxygénases B(a)PMO sont mesurées sur les microsomes des échantillons (composés de deux moules : un mâle et une femelle). L'ensemble des méthodes utilisées et des résultats obtenus sont détaillés dans le rapport IFREMER (1990) et dans le mémoire de D. RIBERA (1990).

Les mesures de turbidité montrent qu'il y a, lors d'un vent fort (4 à 8 beauforts), remise en suspension du sédiment de la baie.

D'après l'étude microgranulométrique, la mise en suspension des particules sédimentaires présente des cinétiques qui diffèrent en fonction de la taille de ces particules.

Avant le coup de vent, les HAP présents dans les moules et le sédiment ont des profils chromatographiques identiques. Pendant la perturbation, les empreintes des HAP dans l'eau et dans les moules sont identiques mais elles diffèrent de celles observées dans les conditions calmes . Ceci peut-être dû soit à une absorption différentielle selon la taille des particules sédimentaires (provenant de la baie et remises en suspension de façon séquentielle), soit à un apport d'un autre site par les courants induits par le vent.

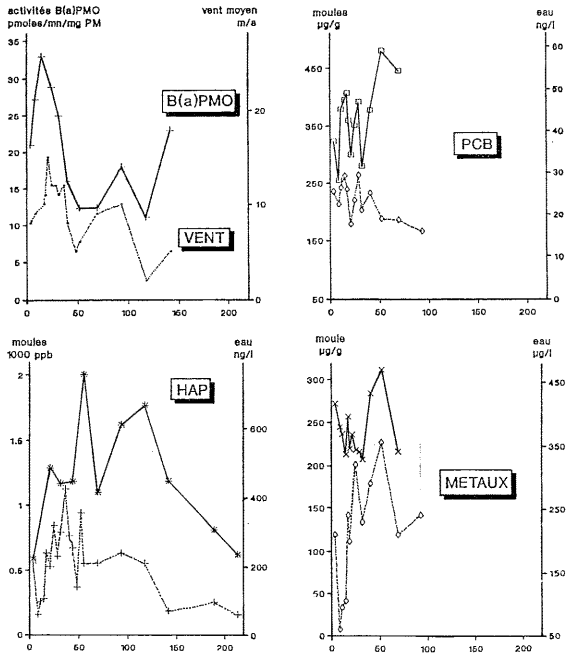
Les activités B(a)PMO fluctuent au cours de l'expérience. Leur évolution se décompose en trois phases : (1) jusqu'à 25 heures, en relation avec les maxima d'HAP et de PCB dans les moules, nous observons une augmentation importante ; (2) de 52 à 120 heures, nous mesurons de très faibles niveaux d'activité alors que les teneurs en contaminants sont élevées ; (3) après 120 heures, nous notons une restauration des activités contemporaines d'une diminution rapide des métaux et dans une moindre mesure des HAP.

Ces résultats montrent : (i) une induction des activités pendant la phase d'exposition aux contaminants ; (ii) un faible niveau d'activité pendant la phase d'accumulation pouvant traduire l'inactivité biologique des composés bioaccumulés ou un effet inhibiteur des métaux et (iii) une augmentation des activités correspondant à l'excrétion des contaminants.

Les phénomènes de bioaccumulation entraînent une forte contamination des moules trois jours après le coup de vent, le retour aux conditions initiales n'étant obtenu qu'après six jours.

L'ensemble de ces résultats montre l'importance de la fraction particulaire dans l'exposition des organismes marins aux contaminants.

De plus, des applications peuvent être envisagées dans les domaines de la mytiliculture et de la surveillance de l'environnement en permettant de sélectionner le moment de la collecte des organismes, les sites d'opération (par exemple, en fonction de la nature des fonds) et la durée éventuelle de dépuration.



Evolution de quelques paramètres météorologiques, biochimiques et chimiques au cours d'un épisode coup de vent (------ dans les moules, ... dans l'eau).

GOLDBERG E. D., BOWEN V.T., FARINGTON J.W, HARVEY G.R., MARTIN J.H., PARKER P.L., RISEBROUGH R.W., ROBERTSON W., SCHNEIDER F. and GAMBLE E., (1975). Mar. poll. Bull., 6, n° 7 ; 101-126.
SUTEAU P., DAUBEZE M., MIGAUD M.L. and NARBONNE J.F., (1988). Mar. Ecol. Prog. Ser., 46 ; 45-49.
RIBERA D., NARBONNE J.F., SUTEAU P., RAOUX C., GARRIGUES P. and LAFAURIE M., (1989). Océanis, 15 (4) ; 443-449.
PORTE C., BARCELO D., TAVARES T.M., ROCHA V.C. and ALBAIGES J., (1990). Arch. Environ. Cont. Tox., 19 (2) ; 263-274.
RIBERA D., (1990). Thèse doctorale n°444, Université de Bordeaux I, France.
IFREMER (1990). Rapport présenté au Conseil Régional PACA.

X

Activités de Monooxygénases à Cytochrome P-450 chez des Posidonies Prélevées dans différents sites du littoral méditerranéen

J.-P. SALAUN*, M.-P. HASENFRATZ*, F. DURST*, P. GARRIGUES**, J.-L. MONOD**, J.F. NARBONNE** et M. LAFAURIE**

*Laboratoire d'Enzymologie Cellulaire et Moléculaire, UA 1182 CNRS, Université Louis Pasteur, 28, rue Goethe, 67083 Strasbourg (France)
**G.I.C.B.E.M. Groupe Interface Chimie Biologie des Ecosystèmes Marins (France)

L'objectif des recherches est de corréler l'activité d'enzymes de biotransformation à la pollution chimique de l'eau ou des sédiments de différents sites méditerranéens. Ce test repose sur la capacité des organismes à induire l'activité des monooxygénases à cytochrome P-450 quand ils sont exposés à des polluants organiques ou métalliques. Dans le cadre du G.I.C.B.E.M., des missions océanographiques en Méditerranée ont été effectuées pour étudier *in situ* la validité de ce test en utilisant comme matériel expérimental les poissons (MATHIEU et al., 1988), les moules (NARBONNE et al., 1988) et les végétaux. Nous présentons ici les premiers résultats obtenus avec une plante supérieure subaquatique, la Posidonie *(Posidonia oceanica)*.

Trois activités enzymatiques dépendantes du cytochrome P-450 ont été mises en évidence dans la fraction microsomale des Posidonies (Tableau 1). La cinnamate 4-hydroxylase (CA4H), qui est une enzyme clef de la biosynthèse des lignines, et la laurate hydroxylase (LAH), dont le rôle physiologique est moins bien connu mais qui semble engagée dans la biosynthèse des cutines et subérines, avaient déjà été caractérisées chez les plantes terrestres (SALAUN et al., 1986 ; FONNE-PFISTER et al., 1988). Par contre, l'étoxycoumarine O-deethylase (ECOD), activité modèle des systèmes de détoxication chez les mammifères, n'avait jamais été mise en évidence chez les végétaux.

TABLEAU 1 : Activités de la cinnamate 4-hydroxylase (CA4H), de la laurate hydroxylase (LAH) et de l'étoxycoumarine O-déethylase (ECOD) et teneurs des cytochromes P-450 plus P-420 des microsomes de Posidonies prélevées dans différentes stations.

STATIONS	CA4H[1]	LAH[1]	ECOD[1]	P-450 + P-420
LE PLANIER	16,5	9,4	4,5	96,8
LE LAZARET	12,2	6,4	4,1	71,5
PORQUEROLLES	11,5	11,4	2,1	110,0
LA FOURMIGUE	9,5	19,5	3,1	133,1
ROQUEBRUNE	22,2	7,2	7,1	119,9

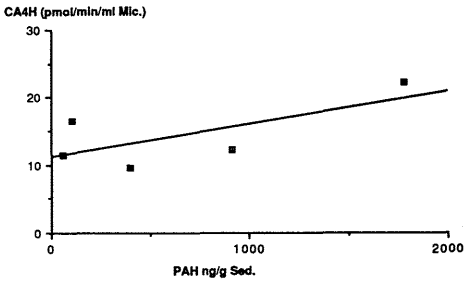
1) Les activités CA4H, LAH et ECOD sont exprimées en pmol./min/ml de microsomes.
2) Les taux de cytochromes P-450 + P-420 sont exprimés en pmol./ml de microsomes.

Le taux de cytochrome b5 présent dans les microsomes n'est pas différent de ceux des plantes terrestres et est identique dans tous les échantillons de Posidonies analysés. Par contre, de faibles quantités de cytochrome P-450 sont mesurées. Le cytochrome majeur est une forme dégradée du P-450, le cytochrome P-420 (60-80%).

Les activités CA4H et LAH des différents lots de Posidonies (Tableau 1) sont comparables à celles de nombreuses plantes déjà étudiées. L'activité CA4H varie au maximum de 2,3 selon les stations de prélèvement, celles de la LAH de 3,6 et de l'ECOD de 2,4 et les quantités additionnées de cytochrome P-450 plus P-420 de 1,9.

Comme le suggère la Figure 1, l'activité CA4H semble corrélée au taux d'hydrocarbures aromatiques polycycliques (PAH) mesuré dans les sédiments des différentes stations de prélèvement.

FIGURE 1 : Corrélations entre l'activité CA4H et les taux d'hydrocarbures aromatiques polycycliques des sédiments.



Préalablement à cette étude, nous avions testé *in vitro* la capacité d'induction du système hydroxylant des Posidonies en incubant les tissus dans de l'eau de mer contenant un inducteur modèle, le phénobarbital (PB). Les résultats obtenus ont montré une augmentation du taux global de P-450 (x 1,3) et des activités CA4H (x 2,2) et LAH (x2,1) qui lui sont associées. De plus, les ions manganèse (MnCl) induisent plus de 4 fois l'activité LAH alors que l'aminopyrine et le clofibrate semblent déprimer l'activité de cette monooxygénase. La mesure des activités CA4H et ECOD de ces fractions microsomales de Posidonie est en cours.

Ces expériences préliminaires montrent que le taux de P-450 (+P-420) et les activités qui lui sont associées, peuvent être augmentés quand les tissus, étiolés ou chlorophylliens, sont traités par des xénobiotiques ou des ions métalliques.

Pour résumer, des résultats majeurs fondamentaux ont été obtenus en étudiant le système d'oxydation microsomale des Posidonies. Une activité ECOD, représentative des systèmes de détoxification chez les animaux, a été mise en évidence chez les végétaux. La comparaison des activités CA4H, LAH et ECOD des tissus traités par différents xénobiotiques devrait nous renseigner sur la capacité et la sélectivité de l'induction des monooxygénases chez la Posidonie.

SALAUN J.P., SIMON A. and DURST F.,1986.
Specific induction of lauric acid w-hydroxylase by clofibrate, diethylhexyl-phtalate and 2,4-dichlorophenoxyacetic acid in higher plants. Lipids, 21; 776-779.
FONNE-PFISTER R., SIMON A., SALAUN J.P. and DURST F., 1988.
Xenobiotic metabolism in higher plants. Involvement of microsomal cytochrome P-450 in aminopyrine N-demethylation. Plant. Sci., 55 ; 9-20.
MATHIEU A., CARRIERE S., LEMAIRE P., GARRIGUES P., MONOD J.L. et LAFAURIE M., 1988.
Utilisation des enzymes hépatiques Cytochrome P-450 dépendantes, chez les poissons marins, dans la surveillance de l'environnement. Rapp. Comm. int. Médit., 31,2, Athènes, octobre 1988.
NARBONNE J.F., DAUBEZE M., RIBERA D. et SUTEAU P., 1988.
Les enzymes de détoxification de la moule utilisées comme tests biochimiques pour la surveillance des pollutions chimiques. Rapp. Comm. int. Médit., 31,2, Athènes, octobre 1988.

X

Suivi Radiologique du Littoral Méditerranéen Français (Continent et Corse)

Sabine CHARMASSON* et Michel CHARTIER**

*Commissariat à l'Energie Atomique, SERE/Station Marine de Toulon, c/o IFREMER, B.P. 330, La Seyne-sur-Mer (France)
**Commissariat à l'Energie Atomique, SEAPS/Laboratoire d'Etudes Sanitaires, B.P. 6, Fontenay-aux-Roses (France)

En France, parallèlement au développement du complexe nucléaire de la vallée du Rhône, les côtes continentales et insulaires du bassin nord-méditerranéen sont l'objet de nombreuses études de transferts de radioéléments au sein des différents compartiments de l'écosystème marin. Différents objectifs sont visés à travers ces programmes comme l'utilisation des radioéléments comme traceurs pour étudier les processus de dispersion/concentration à différentes échelles ainsi que l'établissement de bilans des niveaux de radioactivité des différents compartiments de l'environnement marin. Ce dernier aspect correspond tout à fait aux objectifs du programme GIRMED (Global Inventory of the Radioactivity in the Mediterranean sea).

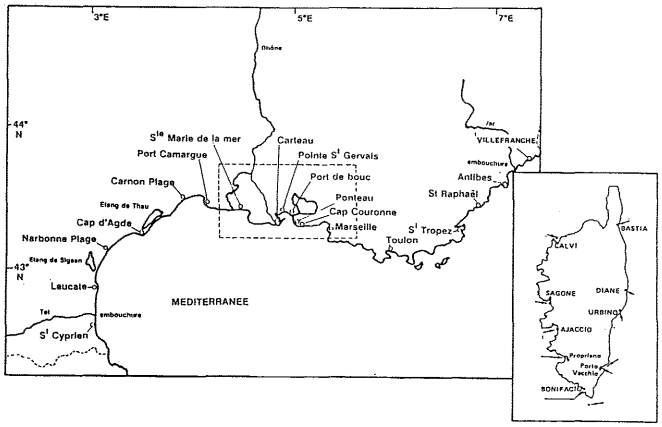


Figure 1: Principales stations du littoral français continental et corse échantillonnées dans le cadre de RADMED et du réseau d'observation de la radioactivité.

Le programme RADMED (Radioactivité de la mer Méditerranée) réalisé par la Station Marine de Toulon (Commissariat à l'Energie Atomique) étudie notamment la répartition spatiale et temporelle de la radioactivité de l'eau de mer, des sédiments et de divers bio-indicateurs le long des côtes françaises continentale et corse. Ce sont principalement les émetteurs gamma qui sont étudiés.

L'appréciation de l'impact radiologique sur les populations méditerranéennes est réalisé par le Service d'Etudes Appliquées en Protection Sanitaire. Des échantillons mensuels de végétaux, de mollusques et de poissons sont prélevés en différents points de la côte. Des mesures par spectrométrie gamma sont réalisées, associées à une recherche du 99Tc et des isotopes 239 et 240 du plutonium.

Dans le cadre du programme GIRMED qui concernera donc des mesures provenant de différents pays, il est nécessaire de décrire de façon très précise les méthodes de prélèvement et de conditionnement des échantillons, de manière à permettre des comparaisons entre laboratoires et l'établissement de bilans sur l'ensemble du bassin méditerranéen.

Les mêmes protocoles d'échantillonnage sont suivis dans le cadre des programmes cités précédemment. Ainsi, sur chaque site d'étude des échantillons de 100 litres d'eau de mer sont prélevés en surface et éventuellement à différentes profondeurs, dans les différentes masses d'eau. Afin de s'affranchir des variations des teneurs en matière en suspension, les échantillons sont systématiquement filtrés à 0,45 um avant traitement.

Trois milieux sont explorés lors de l'étude des niveaux de l'activité artificielle des sédiments de l'ensemble du bassin nord-occidental :

- le domaine lagunaire
- le domaine côtier jusqu'à une profondeur de 100m
- le domaine profond y compris les pentes du plateau continental

La stratégie d'échantillonnage s'appuie sur de nombreux levés sismiques réalisés au cours de travaux sédimentologiques antérieurs ainsi que par une reconnaissance préalable des sédiments au sondeur 3.5 kHz. A la suite des résultats des premières campagnes des stations clefs ont été retenues pour leur représentativité des domaines d'études et ont été suivies au cours du temps.
Dans l'ensemble les sédiments sont échantillonnés à des profondeurs comprises entre -10 et -2000m avec des carottiers boîtes dont la section varie de 625 à 700 cm2 pour une hauteur comprise entre 10 et 70cm. Les carottes subissent dès leur arrivée à bord, un découpage horizontal centimétrique permettant de caractériser la distribution verticale des radioéléments au sein de la colonne sédimentaire. Les échantillons sont ensuite congelés. Au laboratoire ils sont séchés à 40°C, puis broyés et tamisés à 1mm avant d'être conditionnés dans des conteneurs de comptage.

Différents bio-indicateurs, des algues (*Ulva sp., Corallina sp., Cystoseira sp.*), des phanérogames marines (*Posidonia oceanica, Zoostera marina*), des mollusques (*Mytilus sp., Ostrea edulis*) ainsi que des poissons plats (*Solea sp.*) ou des poissons de roche sont collectés dans la zone subtidale jusqu'à -20m par plongeurs ou dragages. Les échantillons sont séchés à 40°C, certains d'entre eux sont réduits en cendres et conditionnés dans des conteneurs de comptage.

Dans le cadre de GIRMED, certains bio-indicateurs peuvent être sélectionnés pour leur représentativité et leur intérêt dans l'établissement de bilans radiologiques en Méditerranée.

- La moule est reconnue comme un bon indicateur de divers types de pollution (Mussel watch). En outre elle présente une très bonne répartition spatiale et temporelle permettant un suivi régulier. Elle est de plus une composante classique des habitudes alimentaires des populations méditerranéennes.
- La phanérogame marine, *Posidonia oceanica*, espèce commune en Méditerranée, permet une étude du suivi chronologique de la contamination radioactive littorale. En effet, il a été montré que les feuilles sont représentatives des niveaux actuels de contamination alors que l'étude des écailles en place sur les rhizomes permet de retracer les évènements radiologiques passés.

X-III2

Recent Changes of the Mediterranean Environments - A Research Programme

Farid EL-DAOUSHY

Department of Physics, Uppsala University, Box 530, Uppsala (Sweden)

Energy consumption and land-use activities have created serious, if not catastrophic, environmental problems during the past century or so. Chemical and radioactive pollution are some examples of modern waste that have created increasing degradation of life qualities. Various degrees of environmental perturbations have been observed in the atmosphere, hydrosphere and the biosphere. The atmosphere is constantly contaminated by chemical waste with different damaging effects. Occasional atmospheric contamination by radioactivity, through failure of nuclear power plants and nuclear-weapon tests, have caused an increasing social and political fear. The greenhouse gases and possible impacts on climate change and landscape ecology have created intensive scientific and political debates. Lacustrine, riverine, estuarine and marine water-bodies suffer eutrophication as well as different forms of chemical pollution (e.g. acidification, heavy metal pollution, oil and organic waste). Soil erosion, dessication of vegetation, salinization, water scarcity and ground-water pollution have also been influenced by modern human activities.

Environmental and historical monitoring are thus important steps in evaluating the quality of present and past environments, and represent a basis for environmental protection policies. Such monitoring programmes would allow: 1) an early warning for environmental instabilities and catastrophic events; 2) global and regional chronological records on past environmental changes. Such knowledge is essential for assessing background values of unpolluted environments as well as for modelling sources, pathways and sinks of environmental pollutants and related interactions in space and time.

Routine and historical monitoring of recent environmental pollution/perturbation are now possible through a set of well-developed techniques covering reliable sampling of environmental materials, low-level counting of natural/artificial radioactivity and chemical/physical analyses of organic and metallic species as well as other palaeolimnological and palaeoecological interdisciplinary approaches. Intensive field studies, considerable international collaboration between specialists/ researchers from different sciences as well as solid social and political support are needed for such complicated and resource-demanding studies.

A research programme "The Mediterranean Pollution History: Radioactive and Chemical Mass-Balance Studies" focusing on modelling the history of modern pollution and its influence on the Mediterranean environments is proposed. This programme (MPH-RCM), however, aims at enriching and building up individual data banks on the history of radioactive and chemical pollution of the Mediterranean countries/regions. This programme would also allow exchanging and integrating scientific and intellectual efforts in environmental, earth-sciences, ecological and management (socio-economic) disciplines. These interactions would provide temporal and spatial correlations between chronologically and environmentally important radioactive nuclides, aquatic nutrients and toxic chemicals. A Mediterranean pollution model in space and time would be constructed. It is hoped that our refined techniques would allow us to evaluate available environmental hypotheses related to land-use and water resources and to understand the nature and dimensions of the confusing environmental issues.

The experimental work within MPH-RCM will primarily concentrate on ^{210}Pb, ^{226}Ra, ^{222}Rn, ^{137}Cs, ^{40}K, ^{90}Sr, $^{239,240,241}Pu$ and ^{241}Am. Nevertheless, some other radioactive nuclides such as ^{14}C, ^{10}Be and ^{32}Si may be considered in some cases. Toxic chemicals such as heavy metals, acid oxides, fluorocarbon, combustion-carbon (aromatic hydrocarbons and soots) and organic-gases, oil and refinery waste, phenols, cyanides, fluorides, synthetic organic chemicals, PCB's, DDT and soil remaining fertilizers have been atmospherically and non-atmospherically injected to the environments at increasing rates during the past century or so. Phosphorus and nitrogen are major nutrients of riverine, lacustrine and marine environments and their enhancement in these environments causes eutrophication, the history of such perturbation would be modelled.

Analyses of the mentioned radioactive and chemical species will be carried out on: 1) air, rain, water, food-stuffs and human organs; 2) depositional sequences with reliable/valuable chronological and environmental records (from undisturbed soils, accumulation bottoms of marine and lacustrine water-bodies as well as suitable wetlands and riverine systems) will be identified, sampled and analyzed. Statistical and modelling tools will be applied to find valid correlations and interactions as well as to construct regional biogeochemical cycles. The influence of climatic, meteorological, hydrological, geophysical and geochemical conditions on biogeochemical cycles will be investigated. The Mediterranean environments would be compared with the Scandinavian ones in order to monitor global trends and to assess the influence of pollution on these very different regions.

X-III3

137 Cs in Marine Organisms - Ten Year Studies in the Greek Marine Environment

H. FLOROU, P. KRITIDIS and M. PROBONAS

National Research Centre for Physical Sciences, Aghia Paraskevi, Athens (Greece)

The artificial as well as the natural radioactivity has been studied by radioanalytical methods and direct y-spectroscopy in marine organisms collected from an extended network of 30 stations around the Greek peninsula and the Greek Archipelagos of Aegean and Ionian sea.

The occurence of ^{137}Cs in the Greek marine environment was due to the world-wide fallout, the nuclear ships which were visiting Greece during the past years as well as to the indirect effects from the discharges of the nuclear power stations of the neighboring and Mediterranean countries, until 1986, while since April 1986 the Chernobyl nuclear reactor accident introduced a new load of ^{137}Cs to the marine environment verified by the peaks measured in the marine organisms, few days after the accident (Florou et al, 1987).

Tab. 1. Concentrations of ^{137}Cs (Bq.Kg^{-1}W) in marine organisms from the Aegean and Ionian sea (Greece), 1980-1990.

Algae		**Fish**	
Padina pavonica	0.0-0.4 (1.5)	Sardina pilchardus	0.8-1.4 (6)
Cystoseira	0.0-0.4 (2.0)	Spicara flexuosa	0.2-0.8 (5)
Acetabularia mediterranea	0.06	Boops boops	1.3-2.2 (16) (30)
Jania	0.05 (1.5)	Trachurus Trachurus	0.3-2.3 (2)
Caulerpa prolifera	- (20)	Pagellus erythrinus	0.2-0.5 (4)
Corallina mediterranea	N.D.-0.06(1.5)	Arnoglossus laterna	0.4 (2)
Distyota dichotoma	- (0.2)	Mullus barbatus	0.2-0.3 (5)
Hypnea musciformis	- (0.2)	Merlucius merlucius	0.2-0.4 (3)
Liagora viscida	- (0.5)	Diplodus annularis	- (6, 66)
Sargassum acinarium	0.0 (0.7)	Engraulis encrachicholus	- (5)
Sphaerococus coronopifolius	- (0.8)	Lithognathus mormyrus	- (6)
Codium bursa	- (0.5)	Sparus auratus	- (6)
Stypocaulon scoparium	0.0-0.3 -	Mugil cephalus	- (6,22)
		Micromesistus potassou	- (5)
		Aulopus filamentosus	0.6 -
		Mustelus sp.	1.3 -
Benthic organisms		**Seagrass**	
Mytilus galloprovincialis	0.3 (6, 33)	Posidonia oceanica	0.8-1.0 (2.4)
Paracentrotus lividus	4	Zostera marina	0.5-1.0
Nephrops norvegicus	0.3		
Macropipus depurator	N.D.	Plankton (total)	(2.0)

W : Wet mass
(x) : Values during the period May-October 1986
N.D. : Not Detected

From the overall view of the data one can note that, in general:

- Primary producers shows a low cesium bioaccumulation which is not affected by the species examined (Florou et al, 1985). The Chernobyl radioactive plume provoked an increase of one to two orders of magnitude in the measured values. Caulerpa prolifera is the alga with the greatest value during this time. (Florou et al, 1987). The adult leaves for Posidonia oceanica have been proved as the tissue of the plant, which shows the greatest values of cesium in comparison with the juvenile leaves, shoots and rhizomes (Florou,1989).
- The different feedings habits and habitatas of the measured fish do not seem to affect the bioaccumulation of cesium under the normal conditions, while for the short period after the Chernobyl accident the different ecological and biological parameters have affected the observed bioaccumulation. Boops boops, Diplodus annularis and Mugil cephalus have showd elevated values of cesium in some stations (Florou, 1987a). The values measured after the accident have increased up to one order of magnitude for a short period, while since 1987 they have been in the same range as before the accident (Florou et al, 1987b).
- Mytilus galloprovincialis, which is known as the mussel watch (Forstner and Wittman 1979), have showed an early response to the cesium impact which has varied according to the ecological parametrs of the sampling stations (Florou et al, 1987a).
- The different synthesis of plankton samples have showed various concentrations of cesium, with the great values in the samples with the phytoplankton as the major part (Florou,1989).
- From the different taxa examined, fish have showed the greatest values of cesium, espesially during the period of the radioactive plume influence.
- It could be necessary for the assessment of the cesium global inventory to the Mediterranean sea, in the framework of GIRMED, some organisms to be established as indicators for the cesium bioaccumulation. Nevertheless, the selected bioaccumulation of cesium among the different organisms should be the main parameter for the choice of the organism-indicators.

REFERENCES

-Florou et al, 1985. Rapp. Comm. int. Mer Medit. 29(7):199-201.
-Florou et al, 1987. Report, February 1987. National Centre for-Marine Research (in Greek). 80p.
-Florou H., Kritidis P., Synetos S. and Chaloulou Ch., 1987a. Congr. of the Intern. Radiat. Prot. assoc., Rome (Italy), 12-13 Oct. 1987.
-Florou H., Synetos s., Panayotidis P. and Chaloulou Ch., 1987b. Congr. of the Greek Atomic Energy Commission. 19-20 Nov., N.R.C.P.S., Athens.
-Florou H., 1989. Ph. D. Thesis. University of Athens.300p.
-Forstner U., Wittman G.T.W., 1979. Springer-Verlag, Berlin, Heidelberg,pp 486.

X

Evolution of 134Cs, 137Cs, 238U and 230Th on the Romanian Littoral of the Black Sea

Iulia I. GEORGESCU*, Constantin BONDAR**, Petre ROMAN* and Gheorghe BARAN*

*Polytechnical Institute of Bucharest (Romania)
**Institute of Meteorology and Hydrology, Bucharest (Romania)

ABSTRACT. Bottom sediments and biota (i.e. mussels *Myt.g.*) were sampled in view to explain the evolution of radionuclides from the North to the South on the romanian littoral, correlated with the liquid and solid discharge of the Danube river as well as with the marine currents.

INTRODUCTION. In view to explain the nuclear pollution of the romanian littoral, correlations are made between the liquid and solid discharge of the Danube river as well as the north to the south marine currents. The radioactivity of the man made radionuclides ^{134}Cs, ^{137}Cs, as well as of the U-Ra and Th natural families were correlated with the hydrological data. A global indicator for total radioactivity in a named cross section and its evolution between two cross sections is defined.

MATERIAL AND METHODS. Bottom sediments were sampled together with the mussels *Mytilus g.* The sediments and the mussels only the soft tissue were dryed at 105°C. The radioactive counting was carried out making use of a high resolution Ge(Li) detector coupled to a multichannel analyzer. The ^{134}Cs of 2.07 y and ^{137}Cs of 30 y were identified together with ^{238}U and ^{230}Th. The radionuclides flow can be defined by the eq. :

$$C = \sum c_{w_i c_{l_i}} \cdot Q_w + \sum c_{s_i} \cdot Q_s + \sum c_{b_i} \cdot Q_b + \sum c_{l_i} \cdot Q_l \qquad (1)$$

where c_{w_i}, c_{s_i}, c_{b_i}, c_{l_i} refer to the activities in $Bq \cdot m^{-3}$, or $Bq \cdot Kg^{-1}$ in water (w), suspended matter (s), bottom sediments (b) and biota (l) ; Q_w, Q_s, Q_b, Q_l are liquid discharge, suspended discharge, bed load discharge and biota discharge in $m^3 \cdot s^{-1}$, or in $Kg \cdot s^{-1}$. In function of geographical coordinates (of the cross section, the flow $C(Bq \cdot s^{-1})$ has the following equation:

$$C = C_c \quad \text{or} \quad C = C_c + C_D \qquad (2)$$

where C_c is due to marine currents, while C_D is due to the Danube river. Noting by j = I, II, ... the measurement cross-sections from the North to the South, we can define the nuclear coefficient pollution as follows:

$$K_{dilution} = (C_{j+1} - C_j)/\Delta L \quad Bq \cdot m^{-1} \cdot s^{-1} \qquad (3)$$, where ΔL is the distance between the two cross-sections. This coefficient $K_{dilution}$ is a global indicator of the nuclear pollution evolution. It must be outlined, $K_{dil.}$ is depending of physico-chemical parameters, current velocity, geological characteristics of bottom sea (mineralogical composition the grain size, etc.). Our measurements cross-sections are taking into account the marine currents in the littoral site (Fig.1) /1/.

Fig.1. Map of the cyclonic currents of the Black Sea (Knipovici)

The sampling and computing methods for evaluation the nuclear pollution is indicated in /2/.

RESULTS AND CONCLUSIONS. In Table 1 are presented only the radioactive measurements of the bottom sediments /3/.

Table 1. The radionuclides identified in the bottom sediments in 1989. $Bq.Kg^{-1}$ dry matter

Sample	^{134}Cs	^{137}Cs	^{238}U	^{232}Th
Sediment (Sulina)	1.9 ±0.5	33 ± 2	21 ± 2	22 ± 2
Sediment (Sf.Gheorghe)	4.8 ±0.5	39 ± 2	14 ± 2	16 ± 2
Sediment (Portitza)	0.8 ±0.5	119 ± 5	43 ± 3	58 ± 3
Sediment (Constantza)	5 ± 1	42 ± 2	18 ± 1	15 ± 2

REFERENCES

/1/ *** Black Sea of the Romanian Littoral. Hydrological Monographie. Ed. Inst. of Meteorology and Hydrology, Bucharest, 1973, p. 160,
/2/ Georgescu, I.I., Bondar, C., Roman, P., Baran Gh.: 1980 "On a monitoring Method for radioactive and chemical pollution in streams and rivers, in Management of Environment, Ed.B.Patel, Wiley East.Ltd.N.Delhi, p.302
/3/ Georgescu, I.I., Pantelica, A., Salagean, M., Radioactive contamination of the Romanian Black Sea Coast during 1989 (in press).

Zones humides protégées dans la Région du Friuli-Venezia Giulia (Italie)

L.-M. ROTTINI* et G.-A. AMIRANTE**

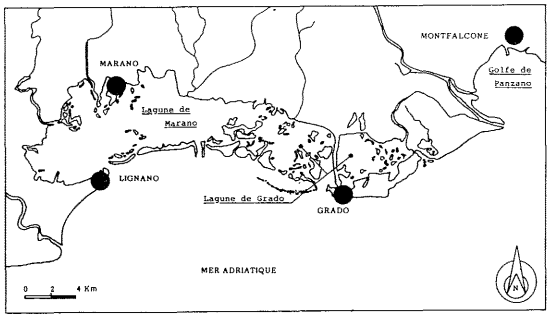
*Centro di Ecologia Teorica ed Applicata (C.E.T.A.), Gorizia (Italia)
**Dipartimento di Biologia, Università di Trieste, Trieste (Italia)

Les zones humides, telles que lagunes, marais, estuaires, lacs côtiers sont le resultat de l'evolution d'une plaine alluviale et representent des ressources naturelles tres importantes, car elles constituent un trait d'union et un filtre entre les ecosystemes terrestres et marins. Au début, la politique que les Etats ont suivi pour ces zones a été celle de l'assainissement, ensuite celle de la conservation. La dernière tendance, qui est toujours poursuivie, a été définie après avoir réalisé que ces zones sont une composante indispensable à l'équilibre hydraulique du territoire et que ce sont aussi des zones de reproduction et de fixation saisonnière pour certaines espèces animales.

Le Conseil de l'Europe, déjà en 1972, a crée la Charte de l'Eau dans laquelle fut proclamés les principes les plus importants pour la conservation et la gestion des zones humides. Le problème des zones côtières, où sont comprises aussi les zones humides, a suscité un grand intérêt auprès du PNUE qui en 1972, en établissant le programme des Mers Régionales, dont fait partie le Plan d'Action de la Mediterranee (PAM), reconnait la nécessité d'une protection contre la pollution d'origine marine et terrestre et tend à identifier l'environnement côtier comme le plus exposé à la dégradation. En même temps, les Etats-Unis ont prévu dans la loi pour la gestion des zones côtières (Coastal Zones Management Act) et dans la loi fédérale relative au contrôle de la pollution de l'eau (Ocean Dumping Act), l'identification, l'évaluation et aussi la restauration des zones humides.

En 1971 à Ramsar, au cours de la Conférence Internationale pour la Protection des Environnements Humides et des Oiseaux Aquatiques, a été élaboré le texte définitif d'une Convention pour la sauvegarde des zones humides d'interêt international surtout comme habitat des oiseaux aquatiques. Le texte de la Convention prévoit que les parties contractantes désignent les zones humides de leur territoire, qui devront être insérées dans une "liste de zones humides d'importance internationale" qui doit être conservée par le U.I.C.N. (Union International pour la Conservation de la Nature). Cette convention a été ratifiée par le Gouvernement italien en 1976 et est entrée en vigueur l'année suivante. Le considérable succès obtenu à l'échelle mondiale par la Convention a permis la déclaration de 2.789 zones humides qui representent une surface de 12.975.646 hectares dans lesquels 53.000 sont italiens.

Dans la région du Friuli-Venezia Giulia région à statut d'exception, le Plan Urbanisation Régional Général (P.U.R.G.) adopté en 1983 (L.R n. 11), donne une importance spéciale à la protection des milieux lagunaires, que ce soit pour l'importance du contenu naturel, ou pour la fragilité des équilibres qui composent l'écosystème lagunaire et enfin pour la tres grande extension que de tels milieux ont dans la Région du Friuli-Venezia Giulia. Le PURG, doit obtenir des municipalités la prise en compte de conseils et qu'elles définissent par le détail, la gestion et la réglementation des zones spécialement protégées. On a vu en application de la Convention de Ramsar et de la politique entreprise par le PURG que des mesures de sauvegarde doivent être prises pour la lagune de Marano et pour le marais de Cavanata - lagune de Grado. Cela fait longtemps en effet que la lagune et le marais sont dans la liste des zones humides d'importance internationale et que la Région du Friuli-Venezia Giulia les considère comme de possibles oasis faunistiques dans le plan triennal de développement. Après ces propositions les municipalités de Marano pour la lagune de Marano et de Grado pour le marais de Cavanata ont déclaré une partie de la première zone, de 820 hectares, et toute la deuxième, de 190 hectares, "oasis faunistique" selon les décrets de l'Assessorat Régional de l'Agriculture : n.594/C du 25 June 1976 pour la première et du 25 Juillet 1979 pour la deuxième. Ces résultats montrent qu'en l'absence d'une législation nationale unique, (loi n.979/1982), on peut protéger des zones côtières avec des lois régionales (D.R. n.598/C1976-D.R.1979 - L.R.n.11/1983). Il est cependant évident que pour avoir une unité de protection dans toute l'Italie, il ne sera pas possible, dans le futur, que chaque région applique individuellement ses propres normes.



Bibliographie

Amirante G.A. - Genetic and immunochemical studies on waterfowl population in the Cavanta Valley - in Evolutionary Ecology, London in press.

Guida agli ambiti di tutela ambientale - ed. Regione Friuli-Venezia Giulia, Trieste 1986.

Perco F., Musi F., Prodi R. - L'oasi avi-faunistica di Marano Lagunare - ed. W.W.F., Udine 1983.

Regione Autonoma del Friuli-Venezia Giulia - Le Lagune di Grado e di Marano - ed. Regione Autonoma Friuli-Venezia Giulia, Trieste 1979.

X-IV2

Aménagement de la Réserve Marine de l'Ile Plana ou Nueva Tabarca (Alicante, Espagne)

Alfonson A. RAMOS-ESPLA* , Jose L. SAN-LIZASO* et J.-T. BAYLE-SEMPERE**

*Institut d'Ecologia Litoral, Carretera de Benimagrell, s/n. 03560 El Campello, Alicante (Espana)
**Departamento de Ciencias Ambientales y Recursos Naturales, Division Biologia, Facultad de Ciencias, Universidad de Alicante, 0380 Alicante (Espana)

Cette Réserve fut crée à la demande de la municipalité d'Alicante selon les souhaits du Ministère de l'Agriculture et des Pêches de l'Etat espagnol et du Conseil d'Agriculture et Pêche du Gouvernement Régional de Valence, le 4 Avril 1986.

La Réserve a été crée pour être une aire de protection et de conservation des écosystèmes littoraux méditerranéens (particulièrement de l'herbier de *Posidonia oceanica* et du coralligène) ; et des populations d'espèces d'intérêt économique (*Epinephelus guaza*, *E. alexandrinus*, *Seriola dumerilii*, *Scyllarides latus*), où les juvéniles sont très fréquents. Elle a été considérée comme une réserve à multiples usages (selon la classification de la UICN), où la conservation du milieu peut être compatible avec les activités humaines. Aussi, les divisions furent elles faites en fonction des problèmes de conservation, de logistique et de développement d'une Réserve de la Biosphère comme le défini le project MAB (1987).

La Réserve de Tabarca (1.400 Ha) comprend trois sub-aires (Fig. 1) :

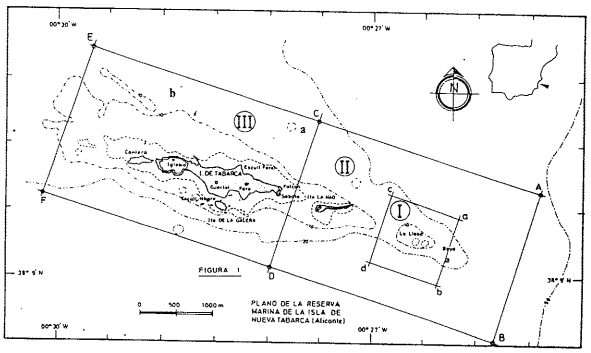


FIGURA 1

1) - Sub-aire de protection intégrale (100 Ha)
2) - Sub-aire d'amortissement ou zone tampon (630 Has.). La plongée en apnée ou en scaphandre autonome est permise ainsi que la pêche à la traîne dans la zone extérieure à l'est, et deux filets fixes à grandes mailles ("moruna grossa") d'avril à juin.
3) - Sub-aire d'accès libre ou zone périphérique (670 Has.), bain et plongée en apnée sont libres ; la plongée en scaphandre autonome avec autorisation. La pêche professionnelle avec filet fixe à petite maille ("moruna chirretera") d'octobre à décembre ; la pêche sportive à la canne depuis la côte.

Dans toute la réserve sont interdits la pêche sous-marine, l'extraction d'espèces marines (sauf la pêche permise), le motonautisme, le ski nautique, et le mouillage des bateaux en dehors des zones autorisées.

Après quatre années quelques objectifs sont atteints :

a) Protection et conservation : 1) surveillance par un gardien dépendant de l'autorité maritime ; 2) balisage, 3) information du public ; 4) récifs anti-chalutage, dans le secteur sud de la réserve ; 5) recouvrement des décombres et ordures avec les feuilles mortes de *Posidonia*.

Après quatre années quelques objectifs sont atteints :

a) Protection et conservation : 1) surveillance par un gardien dépendant de l'autorité maritime ; 2) balisage, 3) information du public ; 4) récifs anti-chalutage, dans le secteur sud de la réserve ; 5) recouvrement des décombres et ordures avec les feuilles mortes de *Posidonia*.

b) Recherche : 1) Poursuite et cartographie bionomique de la réserve ; 2) Etude de l'herbier de *Posidonia oceanica* ; 3) Etude des populations de poissons ; 4) Inventaire des macroalgues ; 5) Etude la pêche artisanale dans et hors de la réserve.

c) Pêche : 1) Le repeuplement en poissons (mérous, dentés) dans les zones entourant la réserve paraît important ; 2) La pêche autour de la réserve a augmenté (deux à trois fois selon les pêcheurs). 3) Les pêcheurs de Tabarca ont formé une coopérative pour les filets fixes.

d) Tourisme : 1) Contrôle du nombre (40) et des lieux de plongée ; 2) Zones de mouillage réservée.

e) Gestion : 1) Création d'une Commission de Gestion (15 Juin 1988) où sont représentées les administrations centrale (Ministère), régionale (Council) et locale (Municipalité d'Alicante). La Commission peut requérir la présence d'institutions et d'associations.

f) Education : Création d'une "Ecole de la Nature" sur le milieu marin.

X

Y-I1

Effets d'une crise dystrophique sur les Populations Laguno-Côtières Méditerranéennes de *Pomatoschistus microps* (Kröyer, 1838) et de *P. minutus* (Pallas, 1770), Poissons Gobiidés - Aspect du déterminisme du recrutement

J.-L. BOUCHEREAU , J.-C. JOYEUX , J.-A. TOMASINI et J.-P. QUIGNARD

Laboratoire d'Ichthyologie, Département d'Aquaculture et d'Halieutique, Université Montpellier II, Sciences et Techniques du Languedoc, Montpellier (France)

La lagune de Mauguio (Languedoc, France) a été, en août 1988, le siège d'une importante crise dystrophique (malaïgue). Il en est rapidement résulté une quasi disparition des populations résidantes de Poissons (QUIGNARD *et al*, 1989). Les Gobiidés ont été particulièrement affectés, notamment deux espèces annuelles sympatriques, l'une sédentaire *P. microps*, l'autre migratrice *P. minutus*. *P. microps* se reproduit de mars à juillet dans cette lagune et *P. minutus* effectue une migration génésique vers la mer où elle se reproduit de novembre à avril (BOUCHEREAU *et al*, 1989a,b,c; 1990).

1 - Après cette catastrophe, la reconquête du milieu lagunaire s'opère avec plus de rapidité pour *P. minutus* que pour *P. microps*. D'août 1988 à avril-mai 1989, seuls quelques rares individus de *P. minutus* et de *P. microps* ont été capturés. *P minutus*, 18 mois après la malaïgue, est numériquement et pondéralement dominant dans les débarquements. En effet, de novembre 1989 à février 1990, 20 kg de *P. minutus* par pêcheur étaient capturés quotidiennement, tandis que *P. microps* était pratiquement toujours absent des pêches, alors qu'entre 1985 et 1988 il en était débarqué journellement 3 kg par pêcheur pour la période considérée.

Le rétablissement de la population de *P. microps*, à partir des quelques survivants lagunaires ou d'éventuels apports extérieurs, provenant de biotopes non affectés par la malaïgue, se fait donc très lentement. Il y a là un blocage démographique momentané, plusieurs générations seront nécessaires pour retrouver l'équilibre initial.

Dans le cas de *P. minutus*, la mortalité subie en lagune a évidemment considérablement réduit l'importance de la ponte annuelle espérée en mer, mais n'a pas affecté l'importance numérique de la génération suivante 1988-1989 dans Mauguio. L'extrême rareté des pontes en mer des géniteurs de Mauguio a été compensée par un fort recrutement de larves issues de pontes provenant de géniteurs originaires d'autres lagunes. La ponte et la position des lieux de ponte en mer, ainsi que les systèmes de dispersion des néonates ont donc permis la recolonisation massive et rapide du milieu lagunaire de Mauguio. Cette reconquête a été très intense puisque durant l'hiver 1989/1990, on a pêché 5 fois plus de *P. minutus* que les années précédentes pour la même période.

L'absence de *P. microps* a eu pour conséquence de réduire la compétition territoriale et trophique entre ce poisson et *P. minutus*, ce qui a permis une forte implantation de ce dernier dans la lagune. A l'inverse, cette présence massive de *P. minutus*, avant la saison de ponte de *P. microps*, freine certainement les possibilités de réinstallation de celui-ci dans la lagune, ce qui explique la lenteur du processus de repeuplement de cette dernière espèce.

2 - Chez *P. minutus*, l'examen des valeurs extrêmes des tailles (longueur totale LT en mm) et des masses brutes (Mb en g) observées entre novembre 1989 et février 1990 sur les individus âgés de 8 à 12 mois indique que les minimums pour les deux sexes sont inférieurs (LT♂ et ♀ = 38; Mb♂ = 0,4; Mb♀ = 0,3) à ceux enregistrés pour la même période au cours des années 1985 à1988 (LT♂: 41-43; LT♀: 39-43 et Mb♂: 0,50-0,64; Mb♀: 0,60-0,64). Ceci s'explique par un recrutement des individus à un seuil de taille et de masse inférieur à celui observé durant ces années. Ce recrutement de petits individus est dû, plus au faible niveau de compétition intra et interspécifique qu'à un éventuel étalement de la ponte (hiver 1988/1989 très doux) ou qu'à une surcharge numérique. Les maximums de taille (LT = 89) et de masse (Mb = 7,2) des mâles sont supérieurs à ceux observés auparavant (LT: 83; Mb: 5,7), tandis que ceux des femelles (LT = 79; Mb = 4,4) sont inférieurs (LT: 81; Mb: 5,1).

Les maximums inhabituels de taille et de masse observés chez les mâles , en 1990, s'expliquent par l'absence de compétition trophique spécifique qui a largement favorisé la croissance somatique, alors que la croissance gonadique (rapport gonosomatique, RGS=100.Mg/Ms, avec Ms=Mb-Mg; Mg étant la masse gonadique), n'est pas plus élevée (0,4 %) que durant les autres années (1,1 %).

A l'inverse, la non augmentation des tailles des femelles, par rapport à celles enregistrées les autres années, indique que celles-ci ont plus investi, en 1989-90, dans la croissance gonadique que dans la croissance somatique. En effet, à intervalle de taille constant (55<LT<66), le RGS mensuel maximum est supérieur (22,6 %) à ceux calculés pour les autres années (19,2 à 21,1 %) durant la période considérée.

Des deux populations de *Pomatoschistus* présentes dans Mauguio, avant la malaïgue, c'est *P. minutus* qui a recolonisé la lagune dès la génération suivante, à partir des zones de reproduction marines, alors que *P. microps*, sédentaire, ne se rétablit que très lentement et n'a pas atteint, en février 1990, le niveau constaté les autres années. Le recrutement de *P. minutus* est d'autant plus important que l'effectif de géniteurs *P. microps* est très faible.

REFERENCES

BOUCHEREAU, J.-L., JOYEUX, J.-C.et QUIGNARD,J.-P., 1989a. Structure de la population de *Pomatoschistus microps* (Kröyer, 1838), Poissons, Gobiidés, lagune de Mauguio (France). *Vie Milieu*, 39 (1): 19-28.

BOUCHEREAU, J.-L., JOYEUX, J.-C.,TOMASINI,J.-A. et QUIGNARD,J.-P., 1989b. Cycle sexuel, fécondités et condition de *Pomatoschistus microps* (Kröyer, 1838) (Gobiidés) dans la lagune de Mauguio- France. *Bull. Ecol.*, t. 20, 3: 193-202.

BOUCHEREAU, J.-L., QUIGNARD, J.-P., TOMASINI, J.-A., JOYEUX, J.-C. et CAPAPE, C., 1989c. La population de *Pomatoschistus minutus* (Pallas, 1770), de la lagune de Mauguio, France. Paramètres démographiques et croissance individuelle. *Cah. Biol. Mar.*, 30.

BOUCHEREAU, J.-L., QUIGNARD, J.-P., TOMASINI, J.-A. et JOYEUX, J.-C., 1990. Cycle sexuel, condition, fécondité et ponte de *Pomatoschistus minutus* (Pallas, 1770), (Poissons, Gobiidés) du golfe du Lion, France. *Cybium* (sous presse).

QUIGNARD, J.-P., BOUCHEREAU, J.-L., CAPAPE, C., JOYEUX J.-C. et TOMASINI, J.-A., 1989. Les débarquements des pêches aux Cabanes de Pérols (lagune de Mauguio), Octobre 1985 - Décembre 1988. Rapport S.M.N.L.R., 84 p.

Y-I2

Les Poissons de la Lagune de Ghar El Melh (Tunisie) - Inventaire et Répartition

M.-S. ROMDHANE

Institut National Agronomique de Tunisie, Laboratoire de Milieux Aquacoles, 43 Av. Charles Nicolles, Tunis (Tunisie)

RESUME

La faune ichthyologique de la lagune de Ghar El Melh est representée par 49 especes appartenant à 26 familles.la repartition ,l'abondance et l'importance commerciale varie d'une espece à l'autre et en fonction des lieux et des saisons.

ABSTRACT

The ichthyofauna of Ghar El Melh lagoon is composed by 49 species from 26 family.Their repartition , abundance and commercial value , varried between species and with saisons and area.

La lagune de Ghar El melh situé au nord Est de la Tunisie,couvre une superficie de 3000 hectares,avec 25 km de cotes et une profondeur moyenne de 1 metre.Cette lagune presente 4 zones plus ou moins distinctes : la Bhira,El Hofra,El Ouafi et Les Khelij;elle communique avec la mer par des passes ou graus de nombre et de dimensions variables,les agitations marines et les crues sont les principaux facteurs de modification des graus dont les fonds sont toujours instables le plus souvent colmatés.

La lagune a ainsi acquiert un caractere euhalin sous l'effet des eaux marines du sud et continentales de l'ouest et du nord;le regime des vents frequents et dominants de nord ouest assure une bonne oxygenation de l'eau,les caracteres hydrobiologiques de la lagune sont assez stables ,avec une temperature d'eau toujours proche de celle de l'air variant de 16°C entre le mois le plus chaud (Juillet/Aout) et le plus froid (Fevrier),la salinité moyenne de la lagune est de 37,34 0/00 avec des extremes de 28 à 46 0/00 , le taux d'oxygene moyen est de 7,06 mg/l.Romdhane (1985).

L'inventaire specifique revele l'existance de 49 espece de poisson reparties sur 26 familles,nous avons reporté dans le tableau 1 la listez complete des especes avec mention du nom local ,nom statistique,lieu de peche privilegié et importance dans les captures.

La repartition des ces especes dans la lagune est regie par plusieurs facteurs liés aux especes elles memes,migration trophique et genetique,et aux conditions du milieu.

Comme Quignard et Zaouali(1980) nous avons distingué 3 groupes faunistiques :

Les especes sédentaires: Ce sont les especes qui passent la totalité de leur cycle vital dans la lagune; Nous avons, comme Mathias(1954),Paris et Quignard(1971),Casabianca(1974) et d'apres nos propres observations,rescensé 13 especes.

Les especes migratrices : C'est le groupe le plus important,23 especes, en ce sens qu'il rasssemble toutes les especes d'importance economique. on rencontre les especes communes ou permanentes,telles que les muges,loup,anguille et daurade,les especes assez communes dont les marbrés et les sparidés et les especes peu communes comme le pageot et la limande.

Les especes occasionnelles ou accidentelles : Ces especes ne penetrent dans la lagune que d'une façon hasardeuse soit à la poursuite des proies soit à la recherche d'abri.

L'etude de la faune ichthyologique de la lagune de Ghar El Melh à mis en evidence l'existance de 49 especes de poisson qui selon leurs exigences vis à vis du milieu se sont installées dans differentes zones : sous influence marine , continentale ou eryhaline , profondes ou peu profondes, agitées ou calmes.

Cet ensemble d'especes est reparti en trois groupes à caracteres ethologique differents : les especes sedentaires,les especes migratrices et les especes occasionnelles, relativement à la durée de leur sejour dans la lagune.

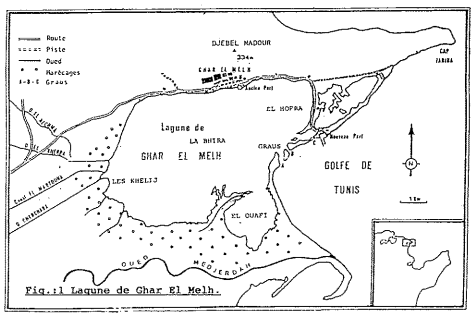


Fig.1 Lagune de Ghar El Melh.

CASABIANCA M.C.:1974 Dynamique et production d'une population de crustacés en milieu saumatre.These Doctorat d'Etat CNRS Marseille.200p.

MATHIAS.P.:1952 L'etang du Thau.Rapport.Comm.Inter.Expl.Medit. N.S.12 : 167-176.

PARIS J.QUIGNARD J.P.:1971 La faune ichthyologique des etangs Languedociens de Sete à Carnon. Vie et Milieu SuppL.22 :301-327.

QUIGNARD J.P.,ZAOULI J.:1980 Les lagunes perimediterraneennes Bibliographie ichthyologique annotée. Bull.Off.Nat.Peches Tunisie.IV(2): 293-360.

ROMDHANE M.S.:1985 La Lagune de Ghar El Melh Milieu,Peuplement Exploitation. These Doctorat de Specialité. Univ.de Tunis. 245p.

Y

Biology of *Acanthobrama mirabilis* Ladiges, 1960 in Lake Bafa (Turkey)

Süleyman BALIK and M.-Rusen USTAOGLU

Ege University, Faculty of Science, Department of Biology, Section of Hydrobiology, Bornova Izmir (Turkey)

Acanthobrama mirabilis, which is among economically important fish species of Lake Bafa, is one of the inland water fishes endemic in Lake Bafa and Büyük Menderes River. The present study deals with the age composition, growth equations for the length and weight, gonadosomatic indices, condition factors, fecundity of this species.

The present study was performed on 1812 specimens of A.mirabilis caught from different areas of Lake Bafa. The samplings took place each month during the period from September 1986 to August 1987, using different fishing nets of various mesh size (20, 25, 28, 32 mm). From each fish, data on total length, total weight and scale samples were collected. Length weight relationship was computed according to the cubic relation $W=c.L^n$. Length at age were computed from length distribution data (GULLAND, 1964). Condition factor and gonadosomatic indices were computed using the following equations: $k=(W. 100)/L^3$ and GSI=(Gonad weight. 100)/Total weight.

Lake Bafa is an alluvial dam lake with an area of 65 km^2, a maximum depth 19 m and salinity varies from 2.98‰ to 5.62‰ (YARAMAZ et al., 1988). The fish population of Lake Bafa is composed of 14 species (Mugil cephalus, Liza ramada, Chelon labrosus, Dicentrarchus labrax, Anguilla anguilla, Atherina boyeri, Pomatoschistus marmoratus, Lipophrys pavo, Gambusia affinis, Cyprinus carpio, Silurus glanis, Acanthobrama mirabilis, Chondrostoma nasus, Barbus capito)(BALIK and USTAOĞLU, 1988).

Age determination from scale readings revealed the presence of six age groups (II-VII) of A.mirabilis in Lake Bafa. The length frequency data on the collected 1812 specimens is converted into a length composition table from which the following mean lengths at ages were deducted: 11.50; 15.94; 18.18; 18.93; 20.67 and 23.85 cm, respective to age groups II to VII. The values are little higher than those of A.terraesanctae in Lake Tiberias (STEINITZ, 1959).

The percentage occurance of each group shows that among the six age groups represented in the catch, age group V constituted about 52.76%, followed by fishes of age group IV (24.45%) and age group VI (17.77%). The remaining age groups constituted 5.02% of the population.

Linear growth of A.mirabilis in Lake Bafa was found to be expressed mathematically by using the following equation $L_t = 28.10\ (1-e^{-0.26(t+0.0245)})$

The relation between total length (in mm) and total weight (in g) for 1812 specimens of A.mirabilis was found to be curvilinear and was expressed mathematically by the formula log W= 3.09 log L-5.09018 (r=0.964).

The theoretical equation expressing growth in weight could thus be written as: $W_t = 289.53\ (1-e^{-0.26(t+0.0245)})^{3.09}$

In Lake Bafa, the spawning period of A.mirabilis is between April-May, and during this period water temperature changes between 15.5-21.8°C. The average numbers and diameters of the eggs during the spawning period are respectively in April and May: 20129-1179.95 µ and 20271-1217.19 µ.

Gonadosomatic indices (GSI) during the same months are for the females 9.664 - 6.440 and for the males 5.344-1.655 respectively.

Maximum condition factor values of both males and females are observed during May (1.408; 1.524 respectively). It is possible that, this situation has a correlation with gonadal development during the spawning period. In the higher age groups, there are significant increases in the condition factors.

As a result of these investigations data have been gathered as, these are schooling fishes, feeding as omnivorous, having pelagical or semipelagical habits, easily adapting themselves up to 15‰ salinity, become mature in 2-3 years, immigrate to the small streams as big groups during spawning in April-May, having yellowish colored eggs and 1-1.2 mm in diameter, mature females produce about 20000 eggs, living about 7-8 years old and in these ages grow to 27 cm in length and 180 g in weight and Lake Bafa has a suitable habitat for developing of this species.

REFERENCES.

BALIK, S. et USTAOĞLU, M.R., 1988. Dans le lac de Bafa, une pêche intéressante grâce a une méthode originale. Rapp.Comm.int.Mer Médit.,31,2:69.

GULLAND, J.A., 1964. Manual of methods of fish population analysis.FAO Fish.tech.Pap., 40,61 p.

YARAMAZ, Ö., BALIK, S. et USTAOĞLU, M.R., 1988. Etude des paramétres physico-chimiques et des seis nutrifits dans le lac de Bafa (Aydın, Turquie). Rapp.Comm.int.Mer Médit., 31,2:76.

Plankton and Macrophyte Epibiota in the Fish Diet in a Brackish Lagoon near Alexandria

Sh.-K. GUERGUESS

National Institute of Oceanography and Fisheries, Kayet Bay, Alexandria (Egypt)

Earlier investigations have shown the important role of the epiflora and epifauna attached to macrophytes in the ecosystem of the Egyptian delta lakes (Guerguess, 1979). The aim of this work was to investigate the relative importance of the phyto- and zooplankton and of the epibiota in the fish diet in El-Khobeyza basin of Lake Edku, east of Alexandria.

Three positions located at an increasing distance from the feeding inlet of the basin were investigated for 12 months. Quantitative samples were taken from the macrophyte epibiota and the plankton. The chloride content, the pH, dissolved oxygen and phosphate were determined. The gut content of the four common species was sorted to species and their numerical frequency in the gut content determined.

The water characteristics of the basin show a sharp gradient from the feeding inlet (st.1) towards the inner basin (st. 2 and 3). The average chloride content rises from 0.6 to 1.19 g l^{-1}, dissolved oxygen (DO) from a low relative saturation of 34% to 102.1% and phosphate drops from 2.83 to 1.97 µ Ml^{-1}. The rise in DO and the decrease in phosphate are caused by the development of a luxuriant, macrophyte vegetation around the inlet (Potamogeton pectinatus). The phytoplankton standing crops also decrease along the same gradient respectively from an average 195 x 10^3 to 52 x 10^3 cells l^{-1} and from 71 x 10^3 to 38 x 10^3 organisms m^{-3}. The macrophytes grow in a massive belt around the inlet, becoming sparse in the inner basin. The potamegeton leaves are densely covered with pinnate diatoms and among them few cyanophytes and chlorophytes, 146x10^3 to 14x10^3 cell on each cm^2 : Mastogloia smithii is leading (70-90%) followed by Nitzschia minutissima, N. lanceolata, N. subcohaerens, Bacillaria paradoxa, Navicula spp. and Amphora sp.

The epizoa are more scattered 710 to 18 org. per 100 cm^2. The rotifer Rotaria sp. is leading (10-75%) followed by Brachionus angularis, B. urceolaris, Horaela brehmi, Lecane bulla and L. closterocerca, together with nematods, oligochaetes, and occasionally, mosquito larvae and cladocera (Moina micrura, Bosmina longirostris). Epiphyte browsers consist of gastropods : Melania tuberculata, Bulinus truncatus, Planorbis sp. and Lansites boltenianus. Of the four fish species in the basin two are browsers on the epibiota : Tilapia spp. and Mugil spp., the two others, Clarias lazera and Anguilla vulgaris are carnivorous predators. The gut content of Tilapia spp. consists mainly of epiphytic diatoms, Mastogloia smithii, but also epizoa : Brachionus calyciflorus and some cladocera. Mugil capito gut content consists also mainly of Mastogloia sp., Nitzschia spp., Navicula spp., but also of Euglenophytes and chlorophytes, nematoda and mosquito larvae. The exclusively planktonic species such as Cyclotella glomerata, Gymnodinium sp., Tholassiosira sp do not occur in the gut content of either species. The gut content of Clarias is mixed including small fish, shrimp mysis, phytoplankton (Synedra ulna, S. barbatula, Nitzschia punctata, Gyrosigma sp., Campylodiscus sp., and others) and zooplankton (nematods, Cladocera : Bosmina longirostris, mosquito larvae). Anguilla feeds on small fish.

Reference

Guerguess, Sh.K., 1979. Ecological study of zooplankton & distribution of macrofauna in Lake Menzalah. Ph.D. thesis, Fac. Sci. Alex. Univ. pp. 361.

Y

Y-I5

Fish Populations in Lake Burullus (Egypt) - III.- Selective Feeding of *Mugil cephalus* and *Liza ramada*

C.-F. H. HOSNY* and M.-T. HASHEM**

*Oceanography Department, Faculty of Science, Alexandria University (Egypt)
**National Institute of Oceanography and Fisheries, Alexandria (Egypt)

The food preferences and feeding patterns for different size groups, i.e. youngs-of-the-year (group I), yearlings (group II) and adults (group III), of Mugil cephalus and Liza ramada from Lake Burullus was studied using three methods of analysis.

The volumetric method of RICKER (1941) demonstrated the feeding patterns of both species based on a high correlation between the existence of sand particles and the occurrence of foraminifera in the stomachs of the individuals under consideration, on one hand, and the amount of detritus vs. the availability of bottom animals such as molluscs and annelids, on the other hand. It should be mentioned, however, detrital particles in the stomach of mullets were not considered as prey since ODUM (1970) have proved that mullets utilize the organic fraction of the soft mud deposited in coastal lagoons and are able to concentrate them in their bodies by a factor of 100:1.

The results suggest, therefore, that young-of-the-year L. ramada feed in mid-water, while older fish eat close to the bottom searching for foraminifera and annelids among sand that constitutes 17.5% of the food ingested. While adult fish tend to feed in mid-water on epiphytic algae attached to the surface of hydrophytes. In the case of M. cephalus, on the other hand, young-of-the-year were found to feed near the surface, and as the fish grow older they tend to feed close to the bottom and scratching epiphytic algae adhered to hydrophytes.

The numerical method of HYNES (1950) suggested the possible transform in the feeding habits of mullets in the lake. Thus M. cephalus was found to be strictly carnivorous as young-of-the-year and becomes omnivorous as adult. L. ramada, however, was found to be highly versatile in its feeding habits, the young-of-the-year were found to consume plant prey at a relatively higher level than animal prey. The yearling fish, on the contrary, were found to consume more animal prey than plants. The situation is reversed again in adult individuals.

The electivity index of IVELV (1961) demonstrated the selective behavior of the different size groups of mullets in lake Burullus. It was found that M. cephalus will prefer animal to plant matter, this is quite clear especially in the young-of-the-year individual, where strongly selective feeding of animal diet occurs. In the yearling and adult fish, however, the diet seem to be rather balanced, yet it is still deviated towards animal matter of the sedentary nature, suggesting that the individual of this species feed closer to the bottom as they grow older. Table 1 showed that the amount of sand, detritus increase soundly in older individuals as they are accidentally ingested while the fish is seeking for its target animal prey.

For L. ramada, on the other hand, the diet is more deviated to the plant matter of the diet options. Even with regard to plant matter, selectivity is discernible with preference to Dinoflagellates, green and blue-green algae to diatoms. Moreover, adult individuals have much of a choice in their plant diet than young-of-the-year and yearling individuals. Yearling L. ramada eats a larger variety of animal matter than the other size groups, this species have a positive selection to cladocerans. On the other hand, it is strikingly obvious that L. ramada of any size does not at all feed on molluscs, nematodes, or ostracods.

Electivity index of food items ingested by different size groups of M. cephalus and L. ramada from Lake Burullus during 1987.

Food Items	M. cephalus			L. ramada		
	Gp I	Gp II	Gp III	Gp I	Gp II	Gp III
Diatoms	-0.80	-0.77	-0.66	-0.41	-0.87	-0.87
Chlorophytes	-1.00	-0.66	+0.64	-1.00	-0.24	+0.67
Cyanophytes	-0.79	+0.40	-0.10	-0.71	+0.31	+0.14
Dinoflagellates	-1.00	+0.76	-0.58	+0.91	-1.00	+0.85
Foraminifera	-1.00	+0.28	+0.54	-1.00	+0.67	+0.70
Annelids	-1.00	-1.00	+0.99	-1.00	+0.99	-1.00
Copepods	+0.34	-0.39	+0.11	-1.00	-1.00	-1.00
Molluscs	-1.00	+0.99	-1.00	-1.00	-1.00	-1.00
Nematodes	+0.99	+0.98	+0.98	-1.00	-1.00	-1.00
Ostracods	+0.78	+0.70	-1.00	-1.00	-1.00	-1.00
Cladocerans	+0.77	+0.64	+0.64	+0.83	+0.75	+0.63

REFERENCES

HYNES, H.B.N., 1950. J. Anim. Ecol., 19(1): 35-58.

IVELV, V.S., 1961. Experimental ecology of feeding of fish. New Haven. Yale University Press.

ODUM, W.E., 1970. In: Marine Food Chains (J.H. STEELE, ed.), pp. 222-240. Oliver and Boyd, Edinburgh.

RICKER, W.E., 1941. J. Fish. Res. Bd. Canada, 5: 293-313.

Y-I6

Observations on *Tilapia* Fisheries in Lake Manzalah (Egypt)

N.-M. DOWIDAR, A.-A. EZZAT and C.-F. H. HOSNY

Oceanography Department, Faculty of Science, Alexandria University (Egypt)

Lake Manzalah has long been recognized as the most important fishery ground among the Nile Delta lakes connected to the Mediterranean. According to available catch statistics, its yield has progressively increased from 37 kg/feddan during 1920-29 to 70 kg/feddan during 1962-66 to about 260 kg/feddan in 1979-84. This increase in the total yield per unit area was mostly attributed to the improvement of the productivity of the lake as a result of the progressive increase in nutrient load discharged into the lake by various sources of agricultural and wastewater rich in nutrients (HOSNY, 1987).

Beside these quantitative changes, the lake's fishery was subjected to qualitative variations in its yield that were governed by changes in its water properties, thus during 1930-35 when the average salinity was 24 mg/l, Lake Manzalah was primarily a marine-species-based fishery, when mullets constituted about 80% of its landings. With the gradual freshening of the lake water (average water salinity 8.3 mg/l during 1963-65 to 2.4 mg/l in 1982), it was transferred to a tilapia-based fishery. Quantitatively, tilapia fishery in the lake has increased progressively both in terms of tonnage and percentage reaching about 82.8% of the total yield of the lake during the period 1981-83.

Although it is a common agreement that tilapias constitute the major component of the fisheries of the lake, yet, their percentage contribution to the total catch varied widely according to the method of assessment used by different authors. In the present study tilapias were found to constitute 77.8% of the Tahaweet catch and 72.3% of the Nasha catch, while in the catch of Balla nets they only constituted 61.7%. On the average tilapias constituted about 73.2% of the catch of the three nets used. The last mentioned figure fairly represent the actual percentage of tilapias relative to the total yield from the lake, since the catch of these three gears represent more than 75% of the total landed catch in the lake.

Tilapia population in Lake Manzalah is composed of four species, viz.: Oreochromis aureus, O. niloticus, Tilapia zillii and Sarotherodon galilaeus. The order of abundance of tilapia species was also found to vary according to the method of assessment. The present study proved that the order of relative abundance of the four tilapias by weight are as follows :

	O. aureus	T. zillii	O. niloticus	S. galilaeus
Tahaweet	23.6	37.6	13.3	20.8
Nasha	43.9	29.95	20.0	6.0
Balla	45.6	22.8	24.7	6.9
Average	34.4	33.2	16.5	15.9

The averaging of this relative abundance, however, cancels the effects of gear selectivity and efficiency towards a given species or size. From the average, therefore, it is clear that O. aureus and T. zillii were the most abundant in the lake. The low percentage occurrence of O. niloticus and S. galilaeus may be due to the high rate of exploitation exerted on them in the last few year, being 0.7534 and 0.5345, respectively (HOSNY, 1987). Moreover, the reduction of the O. niloticus stocks reflected on their catch could be explained on the basis of its reduced tolerance to low water temperatures (CHERVINSKY and LAHAV 1976). During the present study, the lowest recorded water temperature was 10C and this is well tolerated by all of the four tilapias inhabiting the lake. However, massive kills of O. niloticus were frequently observed in the early morning following very cold winter nights when temperatures less than 10C must have occurred.

On the other hand, the relative abundance of O. aureus and T. zillii would be explained on the basis of interspecific superiority over S. galilaeus and O. niloticus, respectively. O. aureus is dominating on the expense of S. galilaeus in a similar way as was found in Lake Kinneret. GOPHEN et al (1983) mentioned that this was due to the interspecific competition between the two species, both are mouthbrooders of comparative fecundity, and spawn during the same period, they have a high degree of niche overlap and both feed on phytoplankton. However, O. aureus have the advantage of being able to shift to zooplankton when phytoplankton is not available. Moreover, O. aureus have a wider range of tolerance to salinity variations than S. galilaeus and is thus able to cope with salinity variations in the different zones of the lake.

The preponderance of T. zillii over O. niloticus is partly explained by the relative aggressiveness, both need species type of bottom and vegetation to live within (ITA 1978), but T. zillii is far more aggressive than O. niloticus (CHEN 1976). Furthermore, T. zillii is more euryhaline.

REFERENCES

CHEN, T.P. 1976. Aquaculture practices in Taiwan. Fishing news Books Ltd., Farnham, Surrey, England.

CHERVINSKY, J. and M. LAHAV 1976. The effect of exposure on fingerlings of local tilapia (Tilapia aurea) (Steindachner) and imported tilapia (Tilapia vulcani) (Trewavas) and Tilapia nilotica (Linne) in Israel. Bamidgeh 28: 25-29.

GOPHEN, M., R.W. DRENNER and G.L. VINYARD 1983. Cichlid stocking and the decline of the Galilee Saint Peter's fish (Sarotherodon galilaeus) in Lake Kinneret, Israel. Can. J. Fish. Aquat. Sci., 40: 983-986.

HOSNY, C.F.H. 1987. Studies on fish populations in Lake Manzalah. Ph.D. Thesis, Alexandria University.

ITA, E.O. 1978. An analysis of fish distribution in Kainjai Lake, Nigeria. Hydrobiol., 58(3): 233-244.

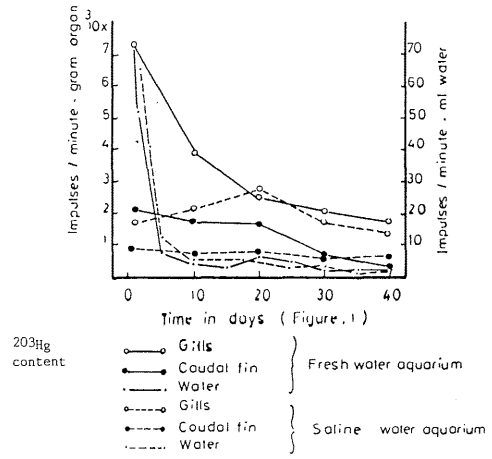
Y

Effect of Environmental Water Salinity on Toxicity and Bioaccumulation of Mercury in *Tilapia zillii* Gerv.

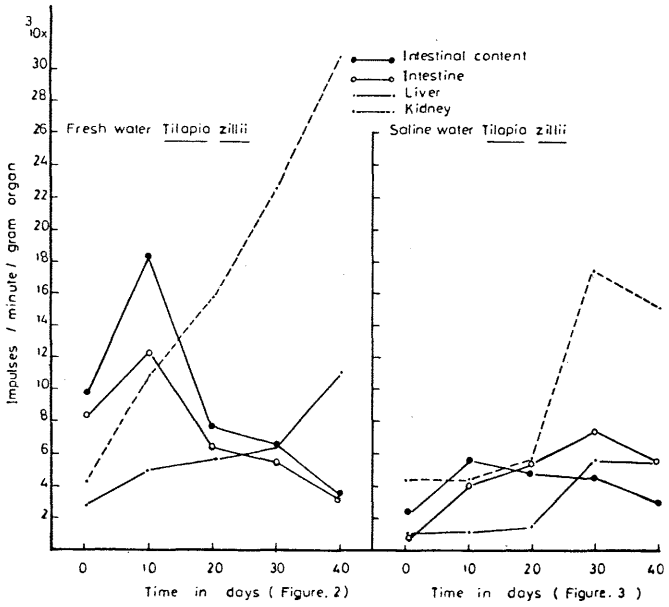
Hamed Hamed SALEH

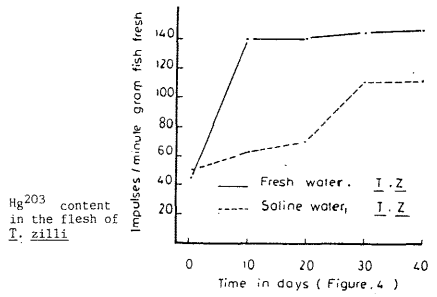
National Institute of Oceanography and Fisheries, Alexandria (Egypt)

Laboratory experiments using the euryhaline fish Tilapia zillii Gerv living in fresh and saline water (30‰) aquaria, polluted with high and low concentrations of mercury (as Hg^{203} cl_2), showed that the toxicity of mercury is mainly due to its bioaccumulation on the gills, whether on the short or long term and this bioaccumulation of mercury on the gills is higher for the fish living in saline water



than that in fresh water as shown in figure 1 (Hg^{203} was measured by Gigar counter and calculated as impulses/minute). However, the mortality of the fishes living in fresh water polluted with mercury was low, but its body contains more mercury than that living in saline water (Figures 2, 3 and 4). The danger of mercury is





probably due to its high adsorption and permeability into water organisms and so its quick disappearance form the water environment during few time which means that its concentration in the water is small and negligible while its content in the water organisms and sediments is considerably high (Figures 1,2,3 and 4) mainly when the aquatic environment is shallow and stagnant.

Anchovy and Sardine Eggs and Larvae on the Continental Shelf of the Ligurian Sea (1985-1989)

Giancarlo ALBERTELLI, Norberto DELLA CROCE and Tecla ZUNINI SERTORIO

Institute of Marine Environmental Science, University of Genoa, C.so E. Rainusso 14, 16038 S. Margherita L. (Italia)

Since 1985 the Institute of Marine Environmental Science is carring on a research on the evaluation of anchovy (Engraulis enchrasicolus) and sardine (Sardina pilcardus) stocks by eggs and larvae method (Albertelli et all., 1988).

The areas of interest under study in the Ligurian Sea are its continental shelf and a pilot area located in the Eastern Riviera (Chiavari).

Double-oblique hauls are collected by sets of bongo plankton net at 4 fixed stations located in the pilot area on the continental shelf (between 40 - 200 m depth) every fortnight. Each time on each station trasparency of water, water column temperature and weather data are recorded. Every forthnight, in the pilot area, currents are also recorded at the same station at 5, 45 and 75 m depths (Fig. 1). Surface hauls are carried out seasonally, every ten miles, over the continental shelf in water about 100 m deep along the ligurian coast within 48 hours (Fig. 1).

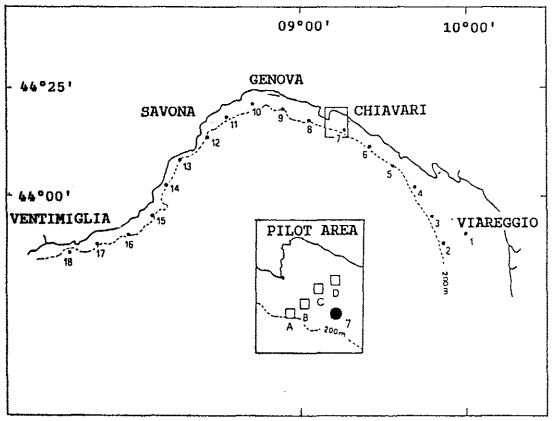


FIGURE 1 - Sampling stations on the continental shelf of the Ligurian Sea and on the Pilot Zone off Chiavari.

The preliminary results have determined the spawning time for anchovy as well as the fluctuations on the eggs and larvae /square metre (Albertelli et all., 1988). Sardine eggs and larvae are present through the years but discontinuously and with low density values.

The biological data concerning 930 samples (Albertelli et all., 1988 a; b; c; 1989) will be examined in relation to some environmental parameters such as "trasparency, temperature on the water column and currents, as well as to weather conditions . Some data are presented in the Table 1.

TABLE 1.

STATIONS	EGGS/SM MEAN VALUE ON 48 MONTHS ANCHOVY	SARDINE	OTHER FISHES	TOTAL	LARVAE/SM MEAN VALUE ON 48 MONTHS ANCHOVY	SARDINE	OTHER FISHES	TOTAL	SURFACE TEMPERATURE IN °C MINIMUM	MAXIMUM	SECCHI DISK TRANSPARENCY IN METRE MINIMUM	MAXIMUM
A	17.61	1.13	31.33	50.07	27.98	3.91	69.87	100.78	12.5	26.1	5	44
B	16.09	2.13	41.34	59.56	41.87	4.85	112.43	158.18	12.2	26.2	6	41
C	14.63	12.19	69.94	96.78	29.91	7.06	139.40	174.61	11.5	26.6	4	33
D	8.62	10.17	62.71	81.71	24.86	5.26	57.64	86.44	11.8	26.3	3.5	30

REFERENCES

ALBERTELLI, G., ANGELINO, M.I.,DELLA CROCE, N. et SALEMI PICONE, P., 1988. Valutazione degli "stocks" di acciughe e parametri ambientali in Mar Ligure. Atti Seminari per la Pesca e l'acquacoltura, Ministero Marina Mercantile - C.N.R., Roma, novembre-dicembre 1986: Vol I: 89-97.

ALBERTELLI, G., DELLA CROCE, N., OLIVARI, E. et SALEMI PICONE, P., 1988. Uova e larve di acciughe nella zona pilota.Chiavari: marzo 1985 - marzo 1986. Ist. Sc. Amb. Mar., Catt. Idrob. Pescic. Univ. Genova, Rapp. Tecn., 27, 12 pp.

ALBERTELLI, G., ANGELINO, M.I., DELLA CROCE, N. et OLIVARI, E., 1988. Uova e larve di acciughe nella zona pilota.Chiavari: marzo 1986 - marzo 1987. Ist. Sc. Amb. Mar., Catt. Idrob. Pescic. Univ. Genova, Rapp. Tecn., 28, 16 pp.

ALBERTELLI, G., D'AMBROSIO, N., DELLA CROCE, N. et OLIVARI, E., 1988. Uova e larve di acciughe nella zona pilota.Chiavari: marzo 1986 - marzo 1987. Ist. Sc. Amb. Mar., Catt. Idrob. Pescic. Univ. Genova, Rapp. Tecn., 29, 40 pp.

ALBERTELLI, G., DELLA CROCE, N., OLIVARI, E. et SALEMI PICONE P., 1989. Uova e larve di acciughe nella zona pilota.Chiavari: marzo 1986 - marzo 1987. Ist. Sc. Amb. Mar., Catt. Idrob. Pescic. Univ. Genova, Rapp. Tecn., 31, 40 pp.

Y-II2

Preliminary observations on the seasonal presence of Teleostean Larvae in the Tyrrhenian Sea

Otello GIOVANARDI and Michele ROMANELLI

ICRAP, via L. Respighi, 5, 00197 Roma (Italia)

Since July 1988 periodic ichthyoplanktonic surveys in waters around Sardinia as well as along the coast of Tuscany-Latium (orientatively from Viareggio to Gaeta) are being carried out in order to evaluate the year by year fluctuations of the local Clupeoid stocks. As the main target species are pilchards and anchovies, two main surveys covering all the mentioned area are carried out each year in coincidence with the reproductive peaks of these species (respectively early summer and autumn-winter). In the sector from Viareggio to Fiumicino (Rome), which has wider continental shelf in the northern part and seems to have higher density of fish eggs and larvae, supplementary surveys are carried out between the main surveys.

In the latter area the sampling scheme is usually set in five 235° oriented transects 30 miles apart; along each transect the stations are placed every 5-10 miles, from the coast line down to -500 m. Due to the limited extension of the continental shelf, which has been found by different authors as the main spawning area of sardines and anchovies, in Sardinia the stations are 10 miles apart along the 100 m isobath.

Year round samplings (usually every 20 days) carried out at fixed stations 3, 5 and 10 miles off Fiumicino allow us to monitore the target species' reproductive season.

Samples are anytime collected at sea by standard "Bongo 20" and "60" ichthyoplankton nets equipped with 236 and 335 micron meshes; the latter has been analyzed for the present purpose. Hauls are always carried out in double oblique, possibly down to 50-70 m, as is done also by the other working groups involved in similar research activities in different areas of the Italian peninsula.

In addition to target species we lately start to identify, in our ichthyoplanktonic material, tsome other fish larvae. As it is well known the identification at the family level is usually simple (at least referring to post-larvae), while the same may not be true when closer identification is sought. On the other side, many species (e.g. Gobiidae) can be differenziated only when far ahead in their development, while most of our post-larvae are in the range 3-6 mm in Standard Length.

DATE	July 1988	November 1988	Febr.-March 1989	March 1989	September 1989
AREA	Viareggio-Gaeta	Viareggio-Fiumicino	Viareggio-Gaeta	Sardinia	Viareggio-Fiumicino
NET TYPE	Bongo 20+60	Bongo 20	Bongo 20	Bongo 60	Bongo 60
SAMPLING STATIONS (n.)	35	31	37	34	35
MEAN FILTERED WATER (m^3)	88.5 ± 54.7	22.8 ± 7.8	16.0 ± 4.2	76.1 ± 19.9	87.4 ± 23.9
Sardina pilchardus (Walb.)	-	56 (69.9)	80 (26.9)	287 (51.7)	-
Sardinella aurita (Val.)	316 (43.4)	-	-	-	25 (1.9)
Engraulis encrasicolus L.	499 (29.0)	-	-	-	100(16.2)
Microstoma microstoma (Risso)	-	1	1	-	-
Myctophum punctatum Raf.	-	-	-	2	5
Myctophides n.e.i.	48	3	6	5	10
Paralepis c. coregonoides Risso	5	1*	-	-	-
Lestidiops pseudosphyraenoides (Risso)	1	-	-	-	-
Evermanella balbo (Risso)	1	-	-	-	-
Anguilliformes n.e.i.	-	-	-	-	6
Gaidropsarus sp.	-	-	3	-	-
Gadiculus argenteus Guich.	-	-	2	-	-
Micromesistius potassou (Risso)	-	-	1	-	-
Merluccius merluccius (L.)	-	-	-	-	17
Sphyraena sphyraena (L.)	5	-	-	-	1
Mugil spp.	-	1	-	-	1
Dicentrarchus sp.	-	-	1	-	-
Serranus cabrilla (L.)	8	-	-	-	1
Serranus hepatus (L.)	30	-	-	-	-
Anthias anthias (L.)	-	-	-	-	1
Callanthias ruber	-	-	-	-	1
Serranidae n.e.i.	-	-	-	-	2
Pagrus pagrus pagrus (L.)	7	-	-	-	1
Pagellus acarne (Risso)	-	2*	-	-	-
Pagellus bogaraveo (Brunn.)	-	-	1	106	10
Diplodus sp.	-	1	1	-	1
Sparus aurata L.	-	-	27	-	-
Sparidae n.e.i.	247	-	-	51	6
Mullus barbatus L.	3	-	-	-	-
Trachurus trachurus (L.)	14	-	6	-	4
Trachurus mediterraneus (Stdr.)	40	-	-	-	6
Carangidae n.e.i.	2	-	-	-	5
Capola macrophthalma (L.)	8	-	-	-	33
Coris julis (L.)	47	-	-	-	-
Labridae n.e.i.	1	2	7	7	-
Trachinus draco L.	1	-	-	-	7
Callionymus spp.	2	-	2	9	19
Gymnammodytes cicerellus (Raf.)	-	-	1	200	-
Blennidae n.e.i.	44	-	-	2	-
Gobiidae n.e.i.	553	5*	9	38	582
Parophidion vassali (Risso)	2	-	-	-	11
Sarda sarda (Bloch)	1	-	-	-	-
Thunnus alalunga (Bonn.)	2	-	-	-	-
Auxis rochei (Risso)	10	-	-	-	8
Thunnidae n.e.i.	2	-	-	-	1
Lepidopus caudatus (Euphr.)	3	-	-	-	44
Scorpaena porcus L.	9	-	-	-	9
Trigla lucerna L.	-	-	1	-	-
Triglidae n.e.i.	-	-	1	-	2
Citharus linguatula (L.)	-	1	-	-	-
Lepidorhombus whiffiagonis (Walb.)	-	-	-	2	-
Arnoglossus laterna (Walb.)	4	-	1	-	16
Arnoglossus kessleri (Schmidt)	4	-	-	-	-
Arnoglossus thori (Kyle)	-	-	-	-	2
Arnoglossus n.e.i.	3	-	-	-	6
Solea vulgaris (Quensel)	-	-	1	-	1
Microchirus variegatus (Don.)	-	-	-	8	-
Buglossidium luteum (Risso)	-	-	-	1	-
Soleidae n.e.i.	-	-	-	-	2
Symphurus ligulatus (Cocco)	-	-	-	-	1
UNIDENTIFIED	109	6	19	59	54
TOTAL	2031	73	146	718	985

* including specimens from WP3 net
( ): rate of collected eggs (all survey) belonging to the species (%)

TAB. 1 : LIST OF FISH LARVAE COLLECTED DURING 5 SURVEYS

Referring to table 1, it is worth noting that almost all of the larvae found in our samples are post-larvae and that the "unidentified" group mainly include larvae and postlarvae having high numbers of myomeres (30/45) and lacking special features such as spines,large fins,etc.,so they should mainly belong to taxonomic families such as *Blennidae*, *Myctophidae*, etc. The table shows clearly the high incidence both of eggs and larvae of Engraulis encrasicholus , Sardinella aurita and Sardina pilchardus; Gobiidae and *Sparidae* are families much represented too. In Sardinia we can also note the importance of the sardine, followed by Gymnammodites cicerellus and Pagellus bogaraveo.

BIBLIOGRAPHY

ABOUSSOUAN A. 1964 - Rec. Trav. Stat. Mar. Endoume, 32 (48): 87-173.

D'ANCONA U., 1931-1957 - Fauna e Flora del Golfo di Napoli, Mon. 38, 1068 pp.

GIOVANARDI O., M. ROMANELLI, 1989 - Nova Thalassia (in press).

MEMORIE R. COM. TALASSOGR. ITAL. , 1931 - 1940, n 183, 205, 209, 218, 220, 224, 226, 230, 231, 241, 255, 259, 270.

RUSSELL F.S., 1976 "The Eggs and Planktonic Stages of British Marine Fishes" Academic Press .

Y-II3

Investigation on the Abundance and Distribution of Pelagic Eggs and Larvae of Teleost Fishes from Izmir Bay

Savas MATER , Oguz UCAL and Murat KAYA

Ege University, Faculty of Science, Department of Hydrobiology, Bornova Izmir (Turkey)

Summary : The data on the abundance and distribution of pelagic eggs and larvae of teleost fishes collected in 1989 from İzmir Bay were evaluated and compared with a previous (1979) investigation.According to the 1979 data ; 42 different Teleost eggs and 34 larvae were present in the pelagic waters of İzmir Bay; but today,these numbers are regressed to 27 and 25 respectively.It is strongly probable that,this regression stems from gradualy increasing pollution in the bay waters.

Methods : Monthly samples were collected during daytime from 10 stations chosen according to their pollution in levels.The first 6 stations display gradually decreasing pollution levels from west to east,while the last 4 stations have no pollution.The samples were taken with a UNESCO WP - 2 Model plankton net having a mesh-size of 200 micrometers and a diameter of 0.57 meters.Vertical hauls were made.

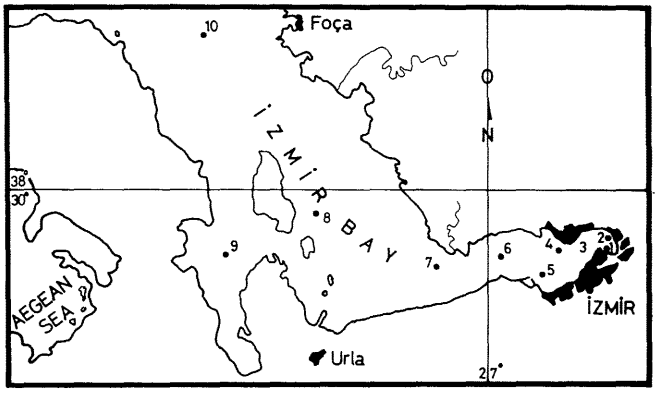


Fig. Location of Stations.

Results : The total material collected in 1989 is 17426 eggs and 304 larvae.62,3 % of the eggs, 32,1 % and 28.% of the larvae belong to Engraulis encrasicholus , Sardina pilchardus and Gobius niger,respectively.A qualitative reduction observed in the bay from west towards east shows that the breeding of the Teleost is under the influence of pollution.The richest stations both qualitatively and quantitatively are situated in the middle and western regions,while eastern stations are quite poor;i.e,while eggs of only one species (E.encrasicholus) were collected from stations no.1,egg samples from 18 different species were obtained from station no.7. The situation is same with respect to the larvae.In station no.1, postlarvae of only E.encrasicholus is found while beginning from 2nd and 3rd stations,it became possible to find G.niger larvae as well.

Compared with the 1979 period ;of that material,75,4 % of the total number of collected eggs (21473) belong to E.encrasicholus and 6,57 % to S.pilchardus.Number of eggs collected in the polluted zone (Station no:1-3) was 4756,belonging only to 5 different species.

In station no.1,no eggs except those of E.encrasicholus are found.Samples collected in 1-3 stations in 1989 belong to two species. The situation is similar in larvae ; two species in stations 1-3 in 1979 and seven species in the same area in 1989 were found.

Seasonally,spring and summer periods are richer both qualitatively and quantitatively than autumn and winter periods. While in September and October,a reneval is evident in ichthyoplankton correlated with temparature.

Summarily,the abundance and distribution of the ichthyoplankton in the bay is mainly influenced by pollution.The investigated two yearly periods ten years apart show that the increasing pollution in the İzmir Bay reduced the species number of Teleost fishes spawning in the region.

References :

Fauna e Flora del Golfo di Napoli 38 Monoggrafia,1931-1957.Uova,larve e stadi giovanili di Teleostei.4 Volumes,X+1068 p(1 vol.,51 pl.).

ABOUSSOUAN,A.,1964.Contribution a l'Etude des Oeufs et Larves pelagiques des poissons téléostéens dans le Golfe de Marseille,Rech. Trav.Stn.Mar.End.Bull.32 Fasc.48,87-171.

MATER,S.,1980.İzmir Körfezi'nde Bazı Teleost Balıkların Pelajik Yumurta ve Larvaları Üzerinde Araştırmalar.Doçentlik Tezi,İzmir.

Y

Composition of Fish Larvae from the Gulf of Kisamos (Crete, Greece) in the periods of May and July 1989

Christine PAPASISSI and Joseph LYKAKIS

Section of Animal Biology, Department of Biology, University of Patras, Patras (Greece)

The data of the present paper concerns with the composition of fish larvae collected in May and July 1989 from the Gulf of Kisamos (NW Crete, Greece). Zooplankton samples have been collected from five stations by using WP-2 (mouth diameter 57 cm and mesh size 200 µm) and Bongo (mouth diameter of each net 61 cm and mesh size 500µm) nets, in order to cover a wide range of larvae sizes. Double oblique hauls were applied at a speed of 2-2.5 knots. Flowmeters were attached to both nets. The average water volumes filtered through nets were 98 m^3 for each Bongo net and 87 m^3 for WP-2 net.

Identification of fish larvae was based on various sources (ABOUSSOUAN, 1964; BERTOLINI ET AL, 1931-1956; DEKHNIK and SINYUKOVA, 1966). In samples collected in May 23rd and July 29th 1989, the fish larvae of the Table 1 were identified.

TABLE 1. Larvae per fish family identified in samples collected in May and July 1989 from the Gulf of Kisamos. The collection period for each larval species and the net type are indicated in parenthesis: M = May, J = July, B = Bongo and WP = WP-2 net

FAMILY	SPECIES
Blenniidae	Blennius gattorugine (M:B,WP), B. ocellaris (M:B-J:B) B. tentacularis (M:B), Blennius sp. (J:B)
Bothidae	Arnoglossus sp (M:B-J:B,WP)
Callionymidae	Callionymus lyra (M:B)
Carangidae	Trachurus mediterraneus(M:B), T. trachurus (M:B)
Cepolidae	Cepola rubencens (M:B-J:B)
Clupeidae	Clupea sprattus (J:B)
Gobiidae	Gobius niger(M:B,WP-J:B,WP), G. minutus(M:B), Crystallogobius linearis (M:B,WP), Gobius sp (M:B-J:B,WP), G. paganellus (J:B)
Labridae	Coris julis (M:B-J:B,WP), Crenilabrus melops (M:B,WP) Labrus bergylta (M:B), Crenilabrus sp (J:B,WP)
Mullidae	Mullus surmuletus (M:B)
Myctophidae	Ceratoscopelus maderensis (M:B-J:B,WP), Diaphus holti (M:B-J:B), Lampanyctus pusillus (M:B,WP-J:B)
Ophiididae	Ophidion barbatum (J:WP)
Paralepididae	Lestidium sphyraenoides (M:B), Lestidium sp (J:B)
Pomacentridae	Chromis chromis (J:B,WP)
Serranidae	Dicentrachus labrax (M:B), Hepatus hepatus (M:B-J:B), Serranus cabrilla (M:B,WP-J:B,WP), S. Scriba (J:B)
Soleidae	Pegusa lascaris (J:B)
Sparidae	Pagrus pagrus (M:B-J:B), Sargus sargus (M:B,WP)
Sternoptychidae	Cyclothone braueri (M:B,WP-J:B), Maurolicus pennanti (M:B-J:B)
Syngnathidae	Hippocampus guttulatus (M:B,WP), Nerophis ophidion (M:B,WP-J:B)
Synodidae	Synodus saurus (J:B)
Triglidae	Lepidotrigla aspera (M:B,WP)

In samples collected in May using Bongo net 30 larval species were identified and 11 ones in WP-2 samples.

The densities of fish larvae collected with WP-2 and Bongo net show differences in all sampling sites of the Gulf of Kisamos (Table 2). Higher densities were recorded in station 1 and 5 (45 and 35 m in depth), and followed by densities in station 2 (300 m in depth).

TABLE 2. Densities of fish larvae in samples of May 1989, in respect to plankton net and station depth

STATION	DEPTH (m)	BONGO-NET (DENSITY n $10m^{-3}$) IDENTIFIED	BONGO-NET UNIDENTIFIED	WP2-NET (DENSITY n $10m^{-3}$) IDENTIFIED	WP2-NET UNIDENTIFIED
S1	45	5.13	0.06	2.57	0.09
S2	300	9.66	0.05	1.82	0.08
S3	250	2.03	0.11	1.08	-
S4	230	1.88	-	0.52	-
S5	35	13.28	-	3.57	-

TABLE 3. Densities (n $10m^{-3}$) of dominant fish larvae in samples collected in May 1989. The numbers in parenthesis show percentages corresponding to the total densities of fish larvae

STATION	BONGO-NET Sargus sargus	BONGO-NET Gobius niger	BONGO-NET Ceratoscopelus maderensis	WP2-NET Sargus sargus	WP2-NET Gobius niger
S1	1.55(15.4)	0.7(6.8)	0.35	1.85(36.0)	0.39(7.5)
S2	2.55(13.2)	1.8(9.3)	0.44	0.79(21.7)	-
S3	0.16(4.0)	0.05(1.3)	0.11	0.82(37.5)	-
S4	0.72(19.1)	0.05(1.3)	0.11	0.40(4.2)	-
S5	0.91(3.4)	10.3(38.9)	0.05	1.06(14.9)	1.13(15.5)

The sizes of fish larvae collected with Bongo net vary between 4.5 to 7.0 mm and those with the WP-2 net between 3.0 to 6.0 mm.

The large number of fish larval species and their low densities in the Gulf of Kisamos suggest an oligotrophic character of this ecosystem. Larvae of Myctophidae are encountered in all sampling sites, indicating an oceanic influence on the entire gulf. Abundant larvae of many fish species of commercial importance (Sargus sargus, Oblada melanura etc.) have been sampled from the gulf.

REFERENCES

ABOUSSOUAN, A., 1964. Contribution a l'etude des oeufs et larves pelagiques des poissons teleosteens dans le Golfe de Marseille. Rec. Trav. St. Mar. End., 32(48): 87-171.

BERTOLINI,F., D'ANCOLA, U., MONTALENTI,G., PADOA, E., SANZO, L., SPARTA, A., TORTONESE, E. and VIALLI, M., 1931-1956. Uova, larve e stadi giovanili di Teleostei. Fauna e Flora del Golfo di Napoli, Mon 38, 1-4, pp 1064.

DEKHNIK, T.V. and SINYUKOVA, V.I., 1966. Distribution of pelagic fish eggs and larvae of the Mediterranean Sea. Part II. On the reproduction and ecology of larvae of Mediterranean Myctophidae. Issledovaniya Planktona Yuzhnykh Morey. Nauka, Moscow, pp 82-108.

Ichthyoplankton of the Egyptian Mediterranean waters. III- Distribution and occurrence of *Sphyraena* Larvae

H.-H. EL-RASHIDY and N.-M. DOWIDAR

Oceanography Department, Faculty of Science, Alexandria University, Alexandria (Egypt)

The present paper entails results on the abundance and distribution of Sphyraena larvae (S. sphyraena and S. chrysotaenia) recorded in the plankton samples collected seasonally from the S.E. Mediterranean waters overlying the continental shelf off the Egyptian coast between longitudes 29° 45' E and 33° 45' E, throughout the period from January 1982 to October 1984. The study area extends from Agami to Arish and is divided into 12 sections. The sections were from west to east : Agami (Ag.), Abu Qir (A.Q.), Rosetta (Ros), Burullus (Bur), Damietta (Dam.), Diba (Di), Gamil (Ga), Port Said (P.S.), Tena (Tn), Bardawil I, II (Brd.I, II), Arish (Ar.). With few exceptions 3 stations were sampled in each section representing inshore (< 50 m), middle (50 - 100 m) and offshore zones (> 100 m). Plankton samples were collected using an ichthyoplankton net of 100 cm mouth opening, 0.5 mm mesh size, fitted with a flowmeter. In each sample the larvae of Sphyraena were sorted and counted, the counts were converted to represent numbers/1000 m^3. The length of the larvae was measured to the nearest 1mm.

A total of 671 larvae of Sphyraena sphyraena and Sphyraena chrysotaenia were recorded in the plankton samples collected in summer and autumn cruises only, i.e. from July to October. About 64% of the total collected Sphyraena larvae were recorded during August. The larvae of S. sphyraena were recorded during July and August, the length composition may indicate that the spawning probably begins during June or early July and ends in late August early September. On the other hand, the length composition of S. chrysotaenia larvae may indicate that the breeding of this species extends to late October. The water temperature ranged between 24° - 29.5° C.

As shown in table (1) Sphyraena larvae were abundant in the inshore waters during early July and August. The highest density (111 L./1000 m^3) was recorded in the inshore water of Agami during August, while in October, the larvae were abundant in the middle zone.

Table 1: Average density of total S. sphyraena and S. chrysotaenia larvae (larvae/m^3) in different zones.

Month	Inshore	Middle	Offshore
August 1982	10.4	3.6	0.1
July 1984	13.3	4.2	not recorded
October 1984	4.5	68.2	9.2

Figure (1 A) shows the distribution and abundance of the different size groups of Sphyraena larvae during July. The distribution pattern during the beginning of the spawning season (July) indicates that the recorded larvae of Sphyraena represent a new brood where 67% of which were distributed in the inshore waters off Rosetta, Burullus and Arish. About 62% of Sphyraena larvae recorded, belong to S. sphyraena and 38% belong to S. chrysotaenia.

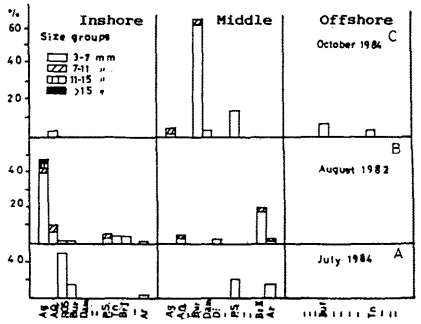


Figure 1 : Distribution and abundance of the different size groups of total Sphyraena larvae in the study area.

During August (peak of larval occurrence; figure 1-B) the newly hatched larvae up till 7 mm represented 86 % of the larvae, and most of which were distributed in the coastal water of the area (from Agami to Arish). S. sphyraena larvae contributed 35% of Sphyraena larvae, they varied in length between 5 - 17 mm and were confined to the inshore and middle zones of the western area (Agami - Abu Qir). This finding agrees with Riskalla (1985) working on the fishery biology of these fishes who reported that S. sphyraena migrates towards the coastal water during the spawning season. The pattern of distribution of S. chrysotaenia larvae during August (figure 1-B) indicated that the newly hatched larvae were abundant in the inshore and middle zones of the eastern area between Port Said and Arish, while during October (figure 1-C) about 94% of the recorded larvae represent a new brood and were common in the middle zones of the eastern part (Burullus, Damietta and Port Said) and also recorded in the offshore water. This is probably attributed to the sensitivity of these larvae to the rapid changes in water temperature near the shore, thus moving towards the deeper water during the autumn where changes of temperature occur less rapidly (De Sylva, 1963).

References :

De-Sylva,D.P.,1963.Stud.Trop.Oceanogr.Miami,1 (VIII):179 pp.

Riskalla, S.I.,1985. M.Sc. Thesis, Faculty of Science, Alexandria Univ.

Y-II6

Ichthyoplankton of the Egyptian Mediterranean waters IV- Distribution and occurrence of Mullet Larvae

N.-M. DOWIDAR and H.-H. EL-RASHIDY

Oceanography Department, Faculty of Science, Alexandria University, Alexandria (Egypt)

The seasonal and spatial distribution and abundance of mullet larvae and fry along the Egyptian Mediterranean coast were studied during the period from January 1982 to October 1984. The stations sampled and the study area are described by El-Rashidy and Dowidar (1990) in this volume.

A total of 859 mullet larvae occurred in the ichthyoplankton samples collected throughout the period of study. The larvae of Mugil cephalus and Liza saliens were observed in plankton samples throughout the period from July to November. As judged from the length frequency of the recorded larvae, it may be concluded that spawning of both species may begin during June and ends in late October - early November. The surface water temperature during this period varied between 21.5° and 28.4° C. These results are in accordance with the spawning seasons determined for both species by various authors from the study of gonad maturation (Rafail, 1968; Abdel Hamid, 1969; Youssef, 1973). Figure (1-A) describes the abundance and spatial distribution of the larvae of M. cephalus and L. saliens which revealed that they mostly spawn in coastal waters particularly in the eastern area (Burullus - Arish), at depths ranging from 20 to 50 m, and a distance of 3.5 - 10 km from the coast.

The larvae of Liza ramada were recorded throughout the period from November to April, contributing about 94% of the mullet larvae recorded during November. The length frequency of the larvae may indicate that the breeding of L. ramada begins in November and probably ends in March with the peak in late November to early December. The surface water temperature varied between 17.7 and 21.5° C. This agrees with the spawning time given by other authors working on the gonad maturation of the fish (El-Sedfy, 1971; Youssef, 1973; El Maghraby et al., 1974). The pattern of distribution of L. ramada larvae (Figure 1 :B & C) shows that the small larvae up till 7 mm were dominant in the offshore and middle zones. This indicates that L. ramada spawns at a distance of 15 - 27 km from the coast covering depths from about 50 to 200 m, during November and December. At the end of the spawning season in February, the larger fry (19 - 29 mm) were recorded in the coastal waters of Damietta and El-Diba, i.e. attracted to shallower depths at drain outlets and estuaries with relatively lower salinities. Our study reveals that M. cephalus larvae were less abundant than those of L. ramada; the later species constituted about 90% of all mullet larvae recorded. Such depletion of M. cephalus larvae may be attributed to the intensive fishing of these larvae for raising in fish farms. Approximately 20 million fry are collected annually from the coastal waters adjoining fresh and brackish water outlets particularly from El-Mex area. This process, in addition to fishing of the sexually mature fish during their spawning migration from the delta lakes to the sea, has undoubtly exhausted the mullet stock in the Egyptian Mediterranean waters. Further more the increasing rate of pollution of the coastal waters particularly in the areas of larval attraction may affect the larval occurrence.

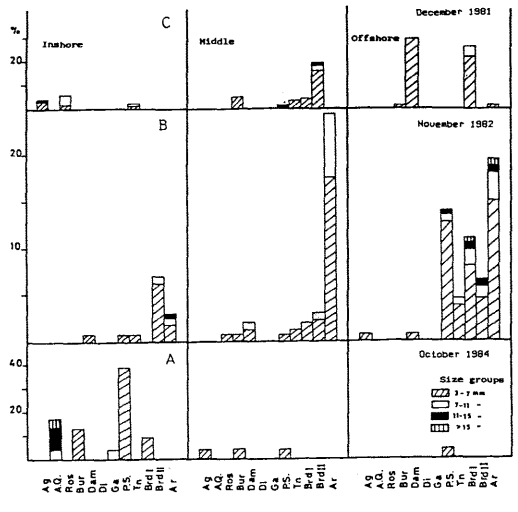


Figure 1 : Distribution and abundance of the different size groups of total mullet larvae.

References :

Abdel Hamid, Kh. 1969. M.Sc. Thesis, Faculty of Science Alexandria Univ.

El-Maghraby,A.M., M.T. Hashem And H.M.-El Sedfy, 1974. Bull.Inst.Ocean. & Fish.,A.R.E. 4 : 3 - 31.

El-Sedfy, H.M.,1971. M.Sc. Thesis, Faculty of Science, Alexandria Univ.

Rafail, S.Z.,1968. Stud. Rev.Gen.Fish.Coun. Mrdit.,35:1-19.

Youssef,F.S.,1973.,M.Sc.Thesis,Faculty of Science,Cairo Univ

Y-II7

The Development Rates of European Pilchard (*Sardina pilchardus* Walb. 1792) Eggs

Bülent CIHANGIR

Dokuz Eylül University, Institute of Marine Sciences and Technology, P.O.Box 478. 35213 Izmir (Turkey)

Using a Bongo-Net, pilchards eggs were collected at the peak of the spawning in İzmir Bay in February 1990. The eggs were roughly seperated from plankton on board and transported to land laboratuary as soon as possible in 6°C. The eggs were sorted according to theirs stages under dissecting microscope in the laboratuary. The earliest stages were Ib 2 taken to three different temperature regimes (13 - 16 - 19 °C). It was estimated that the spawning time of pilchard is between 1900 and 2100 hours (PEREZ and RODRIGUEZ, 1988 ; CIHANGIR (in prep.)). Eggs have been sampled during twilight (1600 - 1900 h.), the sea water temperature was 14 °C at 20 meter depth. It was assumed that youngest captured eggs were 15-18 hours old. In laboratuary experiments, hatching occured in 75 h at 13°C, in 60 h at 16°C and in 55 h at 19°C (Fig.1) (the incubatores were fluctuated to 0.5 - 1.0°C during the experiment). These results are proximate to RUSSEL (1976).

Stages description were adapted from MOSER and AHLSTROM (1985) and ALHEIT et al. (1987).

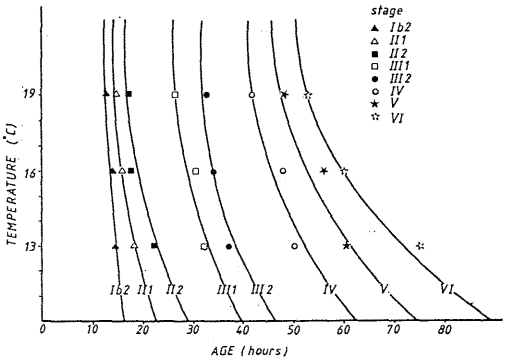
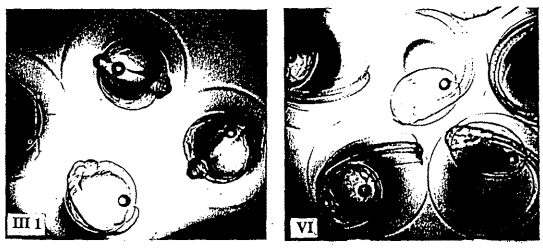


Figure 1. Development rates of pilchard eggs under different temperature regimes.



Various stages of pilchard eggs.

Description of Stages

Ia 1 From fertilization to 64-cell stages.
Ia 2 Formation of the blastodisc.
Ia 3 Formation of the blastodisc as a lense.
Ib 1 Progression of blastoderm until yolk is covered up by 1/2.
Ib 2 Progression of blastoderm until yolk is covered up by 3/4.
II 1 Progression of blastoderm until yolk is covered up by 3/4, blastopore open.
II 2 Blastopore closed. The head region of the embryo apparent.
III 1 Tail starts to seperate from the yolk. The length of the free tail is smaller or equal than 1/2 the head length.
III 2 The length of the free tail is greater than 1/2 the head length.
IV The tail extened 1/4 the length of the yolk sac.
V The tail extened 1/2 the length of the yolk sac.
VI The tail length greater than 3/4 of the length of the yolk sac and hatching.

REFERENCES

ALHEIT, J., WAHL, E. and CIHANGİR, B., 1987. Distribution, Abundance, Development rates, Production and Mortality of Sprat Eggs. ICES C.M. 1987 / H:45. 7p.

CİHANGİR, B., Reproductive biology of European pilchard (*Sardina pilchardus* Walb.) in the Aegean (in prep.).

MOSER, H.G. and AHLSTROM, E.H., 1985. Staging anchovy eggs. *In* R. LASKER (editor), An egg production method for estimating spawning biomass of pelagic fish: Application to the Northern anchovy, *Engraulis mordax*. U.S. Dep. Commer., NOAA Tech. Rep. NFMS 36 : 37-41.

PEREZ, N. and RODRIGUEZ, M., 1988. Histologia de los foliculos post-ovulatories de *Sardina pilchardus* (Walb.) de la plataforma Nor-Atlantica de la Peninsula Iberica. Primeros resultados. Inf. Tec. Inst. Esp. Oceanogr. No 68: 11 p.

RUSSEL, F. S., 1976. The Eggs and Planktonic Stages of British Marine Fishes. Academic Press, London, 524 p.

Y

Early Life History of Anchovy in Catalan Coast (NW Mediterranean)

Isabel PALOMERA

Instituto de Ciencias del Mar, P. Nacional, s/n. 08003 Barcelona (Espana)

Twelve ichthyoplankton cruises were made over the continental shelf of the catalan coast of Spain between 1983 and 1985 in order to determine the distribution and abundance of anchovy (Engraulis encrasicolus) eggs and larvae and other aspects of its early life history.

The results of this study have shown that there are two main spawning subareas in the sampling area: one at the north, influenced by the Golfe de Lion hydrographic conditions, and the other at the south, associated with the River Ebro delta. The maximum densities were found on the shelf break associated with a shelf-slope hydrographic front (Font et al., 1988). Related to the temperature cycle, the duration of the spawning period shows differences in both areas, being shorter in the north than in the south, with peak in both subareas occurring in June. The spawning starts approximately at 13.5 °C but it gets intensified between 18-22 °C; finally when the water temperature decreases the spawning gradually stops. On the north spawning subarea this decrease is faster than on the south one determining shorter reproductive periods.

In spite of a large reproductive period on the south area the total egg production, in 1983, was higher on the north with a value of 44669.7 x 10^{3} against 35077.5 x 10^{3} on the south.

The vertical distribution analysis denotes that the maximum egg and larvae abundance were located above the thermocline specially in very stratified water conditions. Spawning occurs at depths between surface and 10 m. Small larvae (2-4 mm SL) were founded over the same depth range than eggs, while bigger ones were scarcely located with a marked concentration between 10 and 30 m depths. Diel vertical migrations were observed on larger larvae (from 10 mm SL) which were situated near surface during the night but migrate to deeper waters (30 m) during day time.

Related with larval feeding it seems to be a contradiction between the levels of maximum productivity (high chlorophyl) and the distribution of larvae, mainly in zones where anchovy larvae are most abundant. Nevertheless, the main components of the food of other clupeoid larvae (Blaxter & Hunter, 1982) such as dinoflagellates and copepod eggs and nauplii are distributed in western Mediterranean between surface and 50 m (Margalef, 1985) as shown for anchovy larvae.

A growth model for larval anchovy in their natural environment was established, based on the analysis of daily growth increments in the otoliths (Palomera et al., 1988). The Gompertz growth equation suitably describes the growth of this species in a length range of 3 to 23 mm. A instantaneous growth rate of 0.9 mm d^{-1} was calculated for 8 mm larvae at a temperature of 20 °C; that means that the larva ateint a 10 mm length in eight days from first feeding.

Mortality rates were calculated from the decline in abundance of anchovy larvae through succesive age-classes within the peak spawning months of the three years, and egg production and mortality rates compared between the two spawning subareas and among years (Palomera and Lleonart, 1989). Mortality rates ranged from 0.17 to 0.58. Mortality was higher in 1983 than in 1984 and 1985, coinciding with a high production of anchovy eggs in that year. In general, mortality at the northern spawning area was lower than at the southern one. It seems that the profits of exploiting the production over a narrower time period assures higher larvae survival on a more unstable area.

REFERENCES

BLAXTER, J.H.S., J.R. HUNTER, 1982.- The biology of Clupeoid fishes. Adv. Mar. Biol., 20:1-223.

FONT, J., J. SALAT, J. TINTORE, 1988.- Permanent features in the circulation of the Catalan Sea. Oceanologica Acta, Sp. N. 9: 51-57.

MARGALEF, R., 1985.- Environmental control of the mesoscale distribution of primary producers and its bearing to primary production in the western Mediterranean. In: Mediterranean Marine Ecosystems (ed. M. Moraitou-Apostopoulou and V. Kiortsis), pp. 213-229. New Yorkk, Plenum Press.

PALOMERA, I., B. MORALES and J. LLEONART, 1988.- Larval growth of anchovy, Engraulis encrasicolus, in the western Mediterranean. Mar. Biol., 99(2):283-291.

PALOMERA, I. and J. LLEONART, 1989.- Field mortality estimates of anchovy larvae. Engraulis encrasicolus, in the western Mediterranean. J. Fish. Biol., 35(Sup. A): 133-138.

Observations éthologiques et étude des oeufs et larves de Poissons

J. VOSS , S. HAVELANGE , A. LECLOUX , Ch. MICHEL et O. TERAO

Unité de recherche en Ethologie Marine (Service d'Ethologie et Psychologie animales), Aquarium Universitaire de Liège 22, quai Van Beneden, 4020 Liège (Belgique)

L'étude de l'ichthyo-plancton peut avoir une importance considérable notamment comme indicateur halieutique tant sur le plan qualitatif que sur le plan quantitatif. C'est pourquoi il est étonnant de constater le très petit nombre d'espèces de poissons dont les stades larvaires sont effectivement bien connus. Selon ABOUSSOUAN, sur les 571 espèces de poissons téléostéens méditerranéens recensés, seuls les stades larvaires de 117 espèces sont relativement bien connus. Il est en effet très difficile de comprendre l'évolution des larves de poissons au départ de captures planctoniques.

Notre démarche pour tenter une meilleure connaissance des oeufs et des larves de poissons de Méditerranée est essentiellement une démarche éthologique. En effet, intéressés depuis de nombreuses années par l'étude des particularités comportementales des poissons des milieux côtiers rocheux, nous avons acquis peu à peu une bonne connaissance des modalités du comportement de reproduction, des structures sociales, de la communication intraspécifique et du comportement parental des diverses espèces, principalement de Labridés, Serranidés, Gobiidés, Blenniidés, mais aussi de Scorpaenidés, Trachinidés et Bothidés.

Notre approche du problème comporte 2 phases : d'une part, grâce à la connaissance acquise des modalités de la reproduction, nous capturons in situ, en plongée sous-marine, immédiatement après la fécondation, des oeufs de l'espèce étudiée et nous observons leur développement en aquarium à circuit ouvert. D'autre part, nous recherchons au niveau de la baie de Calvi, par différentes captures planctoniques effectuées à partir de la période d'éclosion des oeufs, les larves et les comparons aux observations réalisées lors de la première phase (nous pouvons également capturer les poissons mûrs et travailler par la méthode de fécondation artificielle).

Dans les cas des Labridés et des Serranidés par exemple, nous avons une connaissance précise de la période de reproduction, de l'inférence du rythme nychthéméral et de divers autres paramètres des modalités de la parade, du moment exact où a lieu le rapprochement des sexes et la fécondation, des particularités du cycle parental et du moment de l'éclosion. Pour chacune des espèces observées, nous sommes donc en mesure de prélever, avec certitude quant à la détermination, l'ovule fécondé et d'observer l'incubation en laboratoire et de tenter de prolonger la survie des larves (élevages de Brachionus ou Artemia par exemple). Au départ d'un même lot, il est donc possible d'établir une série de stades de référence du développement de l'oeuf ou de la larve et de tenter de vérifier le "devenir" de ces oeufs en les recherchant dans les captures planctoniques. Pour les Labridés, par exemple, un tel travail devrait lever un voile sur l'évolution et les déplacement des larves pendant leur stade pélagique puis de les suivre dès leur "retour" à la vie semi-benthique.

Notre travail, commencé récemment, a surtout concerné les espèces des genres *Symphodus*, *Coris* et *Thalassoma* (poissons Labridés) et *Serranus scriba* (poisson Serranidé).

A titre exemplatif, l'étude de *S. scriba* (ponte pélagique) s'est déroulée de la manière suivante. Nous avons pu mettre en évidence les modalités de la reproduction de *S. scriba* (Lejeune, Boveroux et Voss, 1980). Celle-ci a lieu du mois de mai à septembre, dans l'heure qui suit la tombée du jour. Après des parades très longues mettant en présence deux poissons de taille identique, la ponte s'effectue soudainement au terme d'une ascension fulgurante en pleine eau (1 à 3 mètres). Au sommet de cette "montée", le poisson qui émet la laitance rattrape celui qui émet les ovules, s'enroule autour de ce dernier.

C'est à ce moment que les produits génitaux sont expulsés. Aussitôt, les 2 poissons redescendent. L'ensemble de cette séquence dure moins d'une seconde. L'observateur-plongeur passe aussitôt une épuisette en filet à plancton à l'endroit concerné puis l'introduit dans un sac de plastique que l'on ferme soigneusement et que l'on ramène au laboratoire.

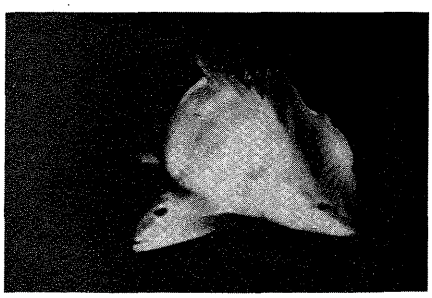


Figure 1
Ponte et Fécondation de *Serranus scriba*, observée le 29 mai 1989 au-dessus de l'herbier de Calvi, par -14 m vers 20 H.

L'étude d'un poisson dont la ponte est démersale est légèrement différente. Ainsi, à titre d'exemple, l'étude de *Symphodus roissali* comporte l'observation précise des diverses phases d'un cycle de reproduction. Pour rappel, la période de reproduction dure 5 semaines, de mars à mai. Elle comprend pour un même mâle une moyenne de 5 cycles de reproduction. Chacun de ceux-ci comportant 1 phase de construction du nid (2 à 3 jours), 1 phase de ponte / fécondation (2 jours) et 1 phase de ventilation des oeufs (± 3 jours) (Michel et Voss, 1982 ; Michel, Lejeune et Voss, 1987).C'est au début de la phase de ventilation que le nid, ou une partie du nid, est prélevé et porté en laboratoire.

En conclusion, la connaissance éthologique des poissons et leur observation en milieu naturel permet de prélever, immédiatement après la ponte, des oeufs dont la détermination est certaine. Des techniques aquariologiques permettent leur observation pendant les premiers jours qui suivent l'éclosion. Les observations ainsi obtenues devront être confrontées aux prélèvements classiques afin de mieux connaître le "devenir" des oeufs et larves en milieu naturel. Une telle technique est applicable à la majorité des espèces à reproduction côtière.

Indépendamment de l'apport précieux pour le systématicien et les études planctonologiques, ces données devraient permettre de clarifier le cycle vital de ces espèces, de mieux connaître cette phase du cycle et de solutionner bien des énigmes éco-éthologiques relevant de la dynamique des populations, de l'adaptation à l'habitat et des stratégies de reproduction en général.

BIBLIOGRAPHIE

LEJEUNE P., J.M. BOVEROUX & J. VOSS, 1980 : **Observation du comportement reproducteur de *Serranus scriba* Linné (Pisces : Serranidae), poisson hermaphrodite synchrone.** Cybium, **4** (3), pp 73-80.

LEJEUNE P., 1985 : **Le comportement social des Labridés méditerranéens** Cah. Ethol. appl., **5** (2), 208 p.

LEJEUNE P. & Ch. MICHEL, 1986 : **L'éclosion synchrone et nocturne des oeufs de *Symphodus ocellatus* (Pisces : Labridae). Adaptation complémentaire au comportement de nidification.** Biology of Behaviour, **11**, pp 36-43.

MICHEL Ch. & J. VOSS, 1982 : **Observation en baie de Calvi du comportement social chez *Symphodus cinereus* (poisson Labridé).** Cah. Ethol. appli., **2** (1), pp 17-35.

MICHEL Ch., P. LEJEUNE & J. VOSS, 1987 : **Biologie et Comportement des Labridés Européens.** Rev. fr. Aquariol., **14**, n° 1-2, 80 p.

Y-II10

Influence de la lumière sur les Larves de Poissons lors de la colonisation récifale

Vincent DUFOUR

Laboratoire d'Ichthyoécologie Tropicale et Méditerranéenne, Ecole Pratique des Hautes Etudes, Centre de Biologie et d'Ecologie Tropicale et Méditerranéenne, Université, 66025 Perpignan (France)

Beaucoup de familles de poissons épibenthiques ou benthiques ont un stade larvaire totalement pélagique. A l'approche de la métamorphose, les larves vont coloniser le substrat pour recruter dans les populations installées.

Il est trés difficile d'étudier in situ cette colonisation larvaire car, d'une part, il s'agit d'animaux relativement peu abondants comparativement au reste du méroplancton, et, d'autre part, l'interface entre le milieu benthique où vivent les communautés installées et la colonne d'eau d'où proviennent ces larves est extrêmement étendue.

Pour palier à ces difficultés, nous avons étudié ce phénomène dans un milieu dont l'interface pélagos/benthos est relativement étroite. Nos travaux se sont déroulés sur un récif insulaire, où nous avons observé le passage des larves au niveau du front récifal. Cette zone est une frontière naturelle entre l'océan et le milieu lagonaire puisqu'elle représente la partie la plus externe du récif ceinturant l'île. Par ailleurs, la faible profondeur du front (<1m) provoque le déferlement des vagues océaniques donnant un afflux permanent d'eau vers le lagon. La colonisation du milieu lagonaire par les larves océaniques se fait donc obligatoirement en franchissant cette zone.

L'échantillonnage a été réalisé en posant un filet à plancton rectangulaire sur le substrat récifal afin qu'il recoive le flux d'eau provenant des vagues déferlant à quelques mètres en avant. Il fonctionne ainsi comme un échantillonneur passif en eau courante. Nous avons réalisé, de cette façon, des séries de prélèvements selon des cycles nycthéméraux et lunaires afin de voir quelles sont les réponses larvaires aux variations jour/nuit et à la présence de la lune.

Nous présentons ici les résultats obtenus sur des familles de poissons vivant en Méditerranée, notamment les Callyonimidae, Labridae, Blennidae, Scorpaenidae et les Gobiidae.

Entre 1988 et 1989, 10 cycles d'échantillonnage sur 24 heures et 5 nuits complètes ont été réalisés, ainsi que 3 cycles lunaires, à raison de 2 demi-nuits (18h à 24h) par phase lunaire. Les résultats obtenus montrent trés clairement le rôle de l'alternance jour/nuit sur la colonisation récifale: les larves ont des abondances dix à cent fois plus importantes aprés la tombée du jour. Ce phénomène a été observé sur 18 mois d'intervalle et sur des îles éloignées de prés de mille kilomètres. Aucun auteur n'avait auparavant observé un comportement nocturne aussi marqué pour une colonisation récifale. Il faut aussi mentionner à ce propos que les abondances larvaires sont trés fortes dès le crépuscule, et qu'elles peuvent persister toute la nuit.

L'éclairement lunaire semble avoir une influence négative sur l'arrivée des larves au niveau du récif: les abondances sont toujours plus fortes pour les nuits proches de la nouvelle lune que pour celles de pleine lune. On observe même que lors des premiers et derniers quartiers lunaires, les larves sont plus abondantes durant les périodes nocturnes où la lune est absente.

Ces deux influences, solaire et lunaire, semblent prévaloir sur l'ensemble des autres facteurs environnementaux. En revanche, il est certain que les facteurs biotiques, liés par exemple à la présence des bancs de larves et à leur état de développement, conditionnent en premier lieu l'existance ou non de colonisation sur le récif en un temps et à un endroit donné.

Nous avons également montré que ce conditionnement donne des réponses différentes selon les familles, voir même selon les différentes espèces d'une même famille habitant un même lieu. En effet si les Labridae, Scaridae et Gobiidae présentent une abondance particulièrement forte en pleine nuit, les Blenniidae semblent coloniser le front uniquement lors du crépuscule, avant la nuit complète. Ceci étant plus vrai pour certains genres que pour d'autres. Les Callyonimidae semblent également débuter leur colonisation au crépuscule, mais avec une plus grande variabilité.

Y-II11

Modern Relational Databases for the identification of Fish Larvae of the Mediterraean Sea

C. PAPASISSI* and R. FROESE**

*Department of Biology, Section of Animal Biology, University of Patras (Greece)
**Institut für Meereskunde, Düsternbrooker Weg 20, 2300 Kiel 1 (F.R.G.)

Identification of fish larvae is a difficult task,because body proportions and pigmentation may change considerably in the course of the larval development.
In this paper we suggest a key of 278 fish larvae species of the Mediterranean Sea,dealing with modern relational databases. The first key of this form concerns 126 species of fish larvae of the Northeast Atlantic (FROESE and PAPASISSI, 1989).
The commercial software package DataEase 4.0 was used for the database.Modern relational databases provide features like choice fields(only one choice from a list of predefined entries is allowed for a field),query-by-forms(very user-friendly way of searching) and graphics.About 80 descriptive, meristic and morphometric characters of postlarvae have been defined as useful for identification. The data in the fields are taken from the literature. All measurements and characters used in the database were extracted from drawings and descriptions provided by the following authors: ABOUSSOUAN 1964, AHLSTROM 1984, BERTOLINI et all 1931-56.
The test of this database identification system was conducted with larvae sampled in the Gulf of Kissamos(Krete 1988-89) and pre-identified by C.Papasissi.The results have prooved that all larvae could be identified by using a few characters and can be summarized as follows:
- All larvae could be identified by using all measurements and 1-4 characters.
- Some identifications were performed with 1 to 4 morphometric characters and with 1 to 5 descriptive ones.

The proposed strategy for searching is the use of 7 measurements,with some range and then if necessary, the proceeding with additional characters.
An example from the tested larvae follows.

Species	Characters used	Possible species
Blennius ocellaris	all measurements	23
Blenniidae	strikingly large pectorals late	3
	ventral row on tail	2
	additional descriptive characters	1
	strikingly large pectorals late	9
	ventral row on tail	3
	additional descriptive characters	1

The results demonstrate that this database identification key has remarkable advantages over traditional identification keys,because the identification can be succeeded quickly by using the morphometric characters and some descriptive ones,instead of searching for uncertain characters.

References

ABOUSSOUAN, A. 1964. Contribution a l'etude des oeufs et larves pelagiques des poissons teleosteens dans le Golf de Marseille. Rec. Trav. St. Mar. End., 32(48): 87-171

AHLSTROM, A. et al. 1984. Ontogeny and systematics of fishes. Special Publication Number 1, American Society of Ichthyologists and Herpetologists: 760 pp.

BERTOLINI, F; D'ANCONA, U.; MONTALENTI, G.; PADOA, E.; RANZI, S.; SANZO, L.; SPARTA, A.; TORTONESE, E.; VIALLI, M. 1931-1956. Uova, larve e stadi giovanili de Teleostei. Fauna e Flora del Golfo di Napoli,Mon 38, 1-4,pp 1064.

FROESE, R. and C. PAPASISSI 1989.The use of modern relational databases for identification of fish larvae.ICES C.M.1989/L:12:13pp.

Y

Recherche fondamentale et Etudes d'Impact : vers un Plan Général d'Utilisation Rationnelle de l'Espace Littoral

Denise BELLAN-SANTINI et Gérard BELLAN

Station Marine d'Endoume, Rue de la Batterie des Lions, Marseille (France)

En règle générale, une étude d'impact a pour but, à partir d'un "état des lieux", de mettre en évidence ce que pourrait être l'effet d'un aménagement sur le milieu considéré .

Elle a un caractère prévisionnel et doit envisager des solutions concrètes susceptibles de remédier aux nuisances prévisibles. Elle peut aussi être conduite tout exprès pour remédier à des nuisances déjà provoquées et observées. Elle a le plus souvent un caractère local et alors seul un site ou un aménagement spécifique est envisagé. La protection et la mise en valeur du milieu marin, tant en terme de respect de la qualité de ce milieu qu'en fonction des inévitables contraintes liées aux activités humaines et à leur accroissement, nécessitent parfois que l'on prenne en compte simultanément un plus grand nombre de sites et d'aménagements (préexistants ou envisagés). Celà conduit à la notion de schéma de mise en valeur du milieu marin, ce, quelle que soit la terminologie -plus ou moins dissimulatrice- utilisée. Il s'agit alors de proposer, à grande échelle, des solutions conciliant protection du milieu et activité humaine .

Pour ces études, il faut tenir compte de l'ensemble des données scientifiques disponibles, sur le milieu littoral (courantologie, sédimentologie et géochimie des sédiments, bactériologie, nuisances et rejets polluants -domestiques et industriels- en mer, état des peuplements marins benthiques -en particulier- établis sur substrats meubles et solides, herbiers, etc...)." C'est de la valeur de ces données scientifiques, de leur densité ainsi que de la connaissance des corrélations existant entre elles que dépendra la pertinence de l'étude d'impact et des divers plans d'aménagement.

Un problème de ce type a été récemment posé aux auteurs par une administration nationale agissant dans le cadre d'un département français: les Bouches du Rhône. Le secteur maritime concerné s'étendait de l'est de la baie de la Ciotat à l'embouchure du Petit Rhône, vers l'ouest, sur environ 200 km.
L'étude avait la définition et les buts suivants:
A partir "des différents types d'urbanisation (urbanisation diffuse ou dense sans industries, urbanisation avec industries légères peu ou non polluantes, urbanisation avec industries). et avec les anénagements subséquents liés à ces types d'urbanisation (ports, terres-pleins, plages, artificielles, etc...), il fallait effectuer:

-une estimation des types de pollution ou nuisances liés au développement des différents types d'urbanisation. Eventuellement, faire des suggestions sur les modalités de réduction des nuisances et des rejets en mer.

-une estimation des effets probables de ces nuisances sur le milieu marin vivant (faune, flore, communautés, mariculture, etc...)

Dans une première étape, l'étude a permis la création de fiches et de cartes très précises synthétisant l'ensemble des données par secteurs géographiques physionomiquement homogènes, conduisant à la délimitation, vis à vis de l'urbanisation , de trois grands types de zones:

1- Zones à protéger impérativement.

2- Zones urbanisées ou susceptibles d'urbanisation, correspondant à des noyaux urbains préexistants pour lesquelles des tentatives de réhabilitation du milieu devraient être systématiquement entreprises.

3- Zones intermédiaires susceptibles d'accepter une urbanisation strictement règlementée et surveillée, pour lesquelles la réhabilitation du milieu devrait être un impératif absolu.

Dans une seconde étape, un tableau à caractère synthétique a été dressé.Pour celà un recensement complet des différents types d'aménagement a été réalisé, pour chaque type d'aménagement les diverses formes de nuisances, directes et indirectes, ont été répertoriées et l'impact sur le milieu marin de celles-ci a été mis en évidence et circonscrit.

Par la suite, il serait intéressant d'évaluer selon une échelle qui pourrait être chiffrée, le niveau comparé de ces nuisances et le degré de l'impact sur le milieu marin. Les évaluations chiffrées permettraient une approche globale du "risque" écologique et pourraient servir en particulier aux "décideurs". Les auteurs mesurent toute la difficulté de l'établissement, forcément empirique, de telles échelles qui devront avoir une valeur dépassant largement le cadre local et qui, pour celà, devront être testées longuement sur le terrain avant leur emploi "en routine" Une telle mise au point, suivie d'une période de mise à l'épreuve exigent une très large concertation de spécialistes d'ores et déjà sollicités.

Bibliographie.

PERRERA G. e GIACCONE G. 1986. Il mare costiero visto dal Biologo. 152 p. La concezione biologica dell'Inquinamento. 69 p. Stamp. tipolitogrp. Assoc., Palermo

BELLAN G. et BELLAN-SANTINI D. 1988. Propositions pour une surveillance et une gestion du milieu littoral marin (principalement méditerranéen):141-152 *in* "La Gestion des systèmes écologiques: des progrès de la recherche au développement des techniques. AFIE éd.: 375 p.

BELLAN G. et BELLAN-SANTINI D.1989. Analyse des sites littoraux de la façade méditerranéenne des Bouches du Rhône, en vue de leur urbanisation . Rapport DDE.

Procédures de l'évaluation de l'impact des projets d'épuration et décharge d'eaux usées en mer

I. DI GERONIMO* , C. GIACCONE** et M. SORTINO***

*Istituto di Scienze della Terra, Università di Catania, Corso Italia 55, Catania (Italia)
**Istituto di Botanica, Università di Catania, Via Longo 19, Catania (Italia)
***Dipartimento di Botanica, Università di Palermo, Via Archirafi 91, Palermo (Italie)

La France, en 1976 puis les Etats Unis en 1977, ont été les premiers pays à introduire une règlementation nationale pour l'évaluation de l'impact.

Ultérieurement, en 1985, la CEE, après un débat long et approfondi, donnait des directives fondées sur le principe de l'évaluation préventive de l'environnement intégrée dans le processus de développement. Ces directives, acceptées par les Etats membres en 1988, ont rendu obligatoires les Etudes de l'Evaluation de l'Impact sur l'Environnement (E.I.E.) pour un grand nombre de projets concernant l'environnement aquatique et, tout particulièrement, l'environnement marin.

L'Italie a mis officiellement en oeuvre les Etudes d'impact (Valutazione d'Impatto Ambientale) à la suite des Décrets pris en Conseil des Ministres du 10/8/1988 et du 27/12/1988. Ces Décrets ne fournissent de règles techniques pour la mise en oeuvre des Etudes que pour les projets pris en compte dans l'Annexe I de la Directive CEE de 1985.

En fait, plusieurs Régions italiennes avaient déjà introduit, de leur propre chef, les Etudes d'Impact tant dans les Plans Régionaux d'assainissement des Eaux que dans les Programmes de mise en oeuvre des Réseaux d'assainissement des Villes. Dans ce cadre, on est passé, au cours des années 1970-1980, des premières Etudes d'Impact (E.I.) en milieu marin dans la Baie de Muggia (Trieste), dans la lagune d'Orbetello (Livourne), à Porto Torres et à Portoscuso (Sardaigne), à Augusta (Sicile) à de véritables études de l'Evaluation de l'Impact sur l'Environnement (E.I.E.) en suivant les normes officielles.

Il s'agit, notamment, de E.I.E. en mer pour des projets de rejets urbains des villes de Catane et Palerme, confiés à Italispaca S.A., une Société du Groupe IRI-ITALSTAT. On peut y ajouter les premières Etudes de faisabilité pour les Réserves marines (Loi n° 979/82) confiées par le Ministère de la Marine marchande à un Groupement d'Universités et ayant pour objectif la rédaction du Plan réglementaire et de gestion des Réserves marines, parmi lesquelles les Iles Pélagiennes et l'Archipel Toscan.

Selon la réglementation italienne, dans la mise en oeuvre des E.I.E. en mer, il faut contrôler la compatibilité organique du projet :

a)dans le cadre de référence de la programmation régionale ;

b)dans le cadre de référence du projet général ;

c)dans un cadre de référence environnementale au niveau de l'écosystème, intégré par des corrélations entre les composants biotiques et abiotiques et le développement des activités humaines.

Pour ce qui concerne l'E.I.E. en mer des rejets industriels et urbains des villes de Palerme et Catane, le cadre de référence environnemental est constitué par les vingt grands secteurs côtiers entre lesquels la Sicile avait été préalablement partagée. Pour chacune de ces régions, on a analysé les composants et les facteurs environnementaux en établissant des cartes thématiques, des études statistiques à partir des données historiques, des analyses biocénotiques, sédimentologiques, chimiques, physiques, des mesures de productivité et de production phyto-planctonique. Tous ces résultats ont été évalués en terme d'Ecosystème.

Les études particulières de site affecté à la décharge de rejets, conduites pendant 12 mois, concernent :

1)l'atmosphère (météorologie, anémométrie);
2)les eaux (houlographe, courantométrie, chimie, physique et bactériologie);
3)le substrat (bathymétrie, morphologie, sédimentologie, géotechnique, magnétométrie);
4)la flore et la faune (analyse bionomique, descripteurs-indices-environnementaux, cartographie/biocénotique, photographie et cinématographie) ;
5)les écosystèmes.

Dans l'évaluation analytique de chaque impact et de l'impact global du projet, l'utilisation de supports cartographiques permet de synthétiser les résultats de l'analyse.

Cette méthodologie est accompagnée par le relevé des effets du projet sur l'environnement en utilisant des descripteurs (indices) exprimant de façon synthétique l'ampleur des modifications sur les ressources du site et qui, en même temps, mettent en évidence les effets supplémentaires qui pourraient se réaliser.

L'information provenant de l'élaboration de paramètres variés et, parfois complexes, mesurés et/ou estimés, élaboration aussi détaillée et complète que possible, est indispensable pour satisfaire aux exigences des procédures administratives.

Dans l'E.I.E., du fait que les résultats de l'étude sont analysés et vérifiés par les autorités techniques et administratives compétentes ainsi que par les composantes socio-économiques intéressées au projet, il est nécessaire que la méthodologie et les techniques adoptées soient très claires et faciles à interpréter.

On a, pour cela, rédigé un tableau résumant les résultats de l'étude quant à la spécificité du projet et quant à la qualité de l'environnement, ainsi que l'ampleur de chaque impact en particulier et de l'impact global du projet.

Finalement, on a estimé les valeurs potentielles des ressources et des impacts, positifs et négatifs, à partir de valeurs pré-établies en multipliant la valeur de la ressource par celle de l'importance de l'impact.

Y-III3

Environmental Impact Assessment for Thermoelectric Power Plants in the Coastal Zone

R. AMBROGI* and R. VITALI**

*ENEL - DSR - Centro Ricerca Termica e Nucleare di Milano (Italia)
**ENEL - DCO - Unità Laboratorio di Piacenza (Italia)

1. Interaction of coastal power plants with the marine biota

Thermoelectric power-plants need a cooling system for condensating exhausted steam, after the phase of electricity generation. In the case of power stations built on the coast, the once-through cooling circuit operates with sea water, collected by pumps and discharged back to the sea, having removed the condenser heat and sometimes after a chemical anti-fouling treatment.
The effects of power plant operations on the marine environment, and particularly on biota, may occur both at the water intake and at the discharge structures.
The intake systems, when drawing cooling water, capture the living organisms with little or no swimming ability. The largest forms are retained by the screens that protect the circulation pumps and are washed back to the sea by cleaning devices mounted on the rotating screens.
Planktonic organisms are entrained through the whole cooling system, undergoing mechanic, thermal and chemical stresses, before returning to the marine environment.
At the discharge point, besides the delayed effects on the biological components that have passed through the plant, the effects on the organisms interested by the thermal plume of the effluent are taken into account.

2. Outline of environmental impact studies for marine power stations

ENEL pioneered environmental impact studies (E.I.S.) in the site of power stations, long before the existing legislative constraints. The experience gathered up to now has shown that a multidisciplinary approach is necessary in the case of marine biota analysis, in order to take into account the relations between biotic and abiotic parameters potentially influenced by the operation of power plants.
E.I.S.s are structured in a previsional phase, before the start of the project, and a monitoring phase, during the energy production of the plant.
In the first phase, the oceanographic and biological patterns of the surrounding area are described, and the expected physical and chemical perturbations are simulated, in order to identify the areas of concern and to estimate the magnitude of effects.
In the monitoring phase, selected organisms or communities are examined, which have been shown either directly influenced, or good indicators of ecological stability for a reasonably long time interval.

3. The case of a coastal power station

We have chosen the case of the previsional study for the Brindisi South power station as an example of the Italian approach to E.I.S.
The plant is located on the Southern Adriatic, has a total power of 2640 MWe, derives 100 m^3/s of sea water, and warms water +8°C in the condenser.
Geology and morphology of the bottom, sea currents, water and sediment quality have been described as the principal oceanographic features. Macrobenthos, plankton and nekton have been chosen as biological descriptors.
The impact assessment has been formulated by sub-dividing into elementary actions the plant project and its completion. Each action was to have effects separately analysed in qualitative or quantitative terms. Both the building and the operation actions were considered.
Estimations of biomass entrained or impinged on the intake structures were done with reference to an existing power station. Tri-dimensional mathematical models have been used to simulate the patterns of dispersion of the thermal effluent and of residual chlorine following anti-fouling treatment, given the oceanographic conditions prevailing in the area.

4. The case of an estuarine power station

The power station of Porto Tolle is located on the main branch of the Po River Delta, a few kilometers before its mouth, opening into the Adriatic Sea. It also consists of 4 standard units of 640 MWe, water derivation and thermal increase are similar to those in Brindisi. The station features two cooling circuits: the first, which is most frequently used, takes fresh water from the river and discharges downstream, the second can draw brackish water from a nearby lagoon and discharge directly to the sea.
The power station being situated in an area of great environmental value, the concern about possible changes brought about by its operation have stimulated a very thorough and long-lasting investigation. The environmental campaigns started in 1972, as soon as the project of the plant was approved, and continued through a pre-operational phase (1977-1980) and an operational phase (1986-1988). A five year long monitoring phase has been started in 1990. The hydrologic conditions received much attention, and gave interesting results, facing the difficult problem of the interaction of fresh and sea water, influenced by the rate of river discharge and by tidal currents. The measurement of the distribution of river flow among the different branches, the exchange of water between the lagoon and the sea, and the dispersion of the river plume in the Adriatic were used also to calibrate a physical model and several mathematical models. The prevision and the assessment of the distribution of thermal increase in the various water bodies helped to identificate areas for the assessment of biological and chemical properties.
Water quality was monitored, both from the point of vue of chemical hazards to aquatic life and of health protection. Phytoplankton and zooplankton communities and their temporal dynamics were studied in connection with hydrologic and chemical information. The macrobenthic assemblages dwelling in soft and hard bottoms gave useful indications about the evolution of the environment during the long term interval. Finally, fish communities were investigated, with special reference to migration of juveniles into the river branches and to commercial catches in the lagoon.
The overall comparison of results obtained in the pre-operational and operational phase revealed that the most important changes are most likely linked to the evolution of the environment under the anthropic pressure on the whole basin of river Po and are not attributable to the power station.

Y-III4

Prediction of the Environmental Impact of Coastal Population on the Quality of the Sea

Günay KOCASOY

Department of Chemical Engineering, Bogazici University, Bebek, Istanbul (Turkey)

The increase of coastal population -especieally by tourists- is something considered as flourishing of the socio-economic conditions of the district. Too little -if any- attention is given to the effects caused by this situation. In the present study taking into consideration the quality of the seawater as the main parameter affecting the population of tourists, an attempt has been done in order to predict the variation of the quality of seawater with population. To achieve that, the beaches were classified according to their use -and consequently the amount of wastewater discharged into the sea -into four groups: I)coasts that are used only for swimming and recreational purposes, II) coasts used simultaneously for dwelling, swimming and recreational purposes, III) coasts along which only dwellings exist, and IV) natural and man-made harbours.

Bodrum -one of the most popular touristic resorts of Turkey -was selected as the experimental site where six beaches; one from gorup I, one from group II, one from group III, two from group IV and one transitional group I-II, were selected as the survey areas. Three stations close to each other in approximately 10-20 meters from the shore were chosen for sampling. Samples collected at all three stations at each survey beach were mixed to obtain a typical composite sample. Samples were collected three times a day - early in the morning before people started coming to the beach; at noon when the beach was most crowded; and late in the afternoon when people started to leave the beach. During the survey 40320 observations were made between December 1985 to February 1988. Parameters such as atmospheric pressure, air temperature, cloudiness, sunny period, prevailing wind direction and its speed, precipitation, light intensity, turbidity, seawater temperature, pH, colour, salinity and coliform concentration were determined. Assuming the concentration of the total coliform as the most important microbial pollution indicator for beaches an attempt has been done for the determination of the variation of coliform concentration as a function of the remaining paratemers. To achieve this a multilinear regression program was used in which the number of total coliform was treated as the dependent variable while the others were accepted as independent variables. As a result of this analysis, the following relation was obtained:

$$N = \frac{(C_1 \sqrt{P} + C_2)}{10^{A-3}}$$

$$A = \frac{\ln(I^{0.29}\, T_u^{-0.072}) + 1.22}{0.95^{\theta-20}}$$

where

N is the number of total coliforms per 100 milliliters,
I is the intensity of light (lux),
Tu is the turbidity (FTU),
θ is the temperature of seawater (°C),
P is the population density (number of people/100m^2),
C_1 is the population density coefficient and
C_2 is the coastal characteristic coefficient.

The coefficients C_1 and C_2 of this equation have been found to have the values given below:

Coast Group	C_1	C_2
I	15.7	0.020
I-II	78.4	0.223
II	220.5	0.682
III	281.7	0.293
IV	1310.5	2173.0

Parameters such as BOD, total nitrogen, total phosphorus etc. proved that they didn't contribute significantly to the total coliform concentration. The correlation obtained between actual determined values and the values estimated by the derived equation is above 86 percent.

The results obtained by this study is a significant contribution for the prediction of the environmental impact of tourist population to seawater quality and consequently for the prevention of the deterioration of the environment and protection of public health.

Y

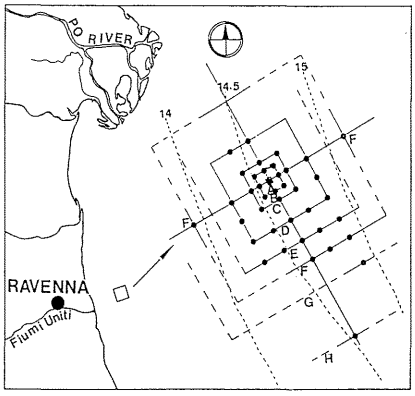
Integrate Evaluating Program on Drilling Discharge Effects in a Northern Adriatic Sea Site

F. FRASCARI*, G. ROSSO*, G. BORTOLUZZI*, A. BARBANTI*, G. QUARANTOTTO*, M. RAVAIOLI*, A.-M. BONVICINI PAGLIAI**, R. CREMA**, A. CASTELLI**, M. MAURI**, E. ORLANDO** and D. PREVEDELLI**

*Istituto per la Geologia Marina C.N.R., V. Zamboni 65, Bologna (Italia)
**Dipartimento di Biologia Animale, Università di Modena, V. Università, 4, Modena (Italia)

The effects of water-based drilling muds and cuttings were evaluated at a gas drilling field located offshore Ravenna (Italy) in the Northern Adriatic Sea on 15 m deep bottoms. Nine wells were drilled in a 3000 m deep Plio-quaternary sequence of muds, silts and marly clays. The discharge consisted of 4000 tons of cuttings and 2000 tons of drilling muds composed mainly of bentonites and baritine added with chromium lignosulphonates, lignites and sodium hydrate.

The study was promoted by AGIP (AA.VV.,1989) and performed over four sampling occasions including a preoperative survey (June 1985), two operative surveys (February 1986 - September 1986) and a postoperative survey (June 1987). Sampling was carried out along a grid elongated in the direction of the prevailing autumn - winter water currents (NNW-SSE) (Fig.). In the grid, collecting stations were located closer to each other near the platform.



At the preoperative survey, the drilling area was found to receive silty clayey sediments from the Po and some smaller rivers. Natural levels of some heavy metals (mainly Fe, Cr, Pb, Mn, Cu, Zn) and their surface increase derived from urban and industrial wastes were evaluated. The chemical effects of drilling mud discharge were estimated, by comparison, in following surveys. Biological effects were evaluated by means of taxonomic and structural analysis of macrozoobenthic communities and heavy metal incorporation in a target species. The bivalve Corbula gibba was chosen as the target species due to its abundance throughout the whole study area.

The results evidenced the following effects:

1. Physical: due to the platform. This structure interacts with the waves and water currents causing turbulence, erosion and re-suspension of bottom material, with grain size sorting. Under conditions of high hydrodynamic energy, a selective deposition of particles discharged by cuttings along the direction of the main water currents takes place.

2. Physical: due to the discharge material. Due to the discharge of heterogeneous material a deposition of different grain size particles occurs around the platform, which will be re-elaborated by later dynamic events

3. Chemical: due to discharge of drilling fluids These include: mean increases of an order of magnitude for Ba, about 38% for Cr, 85% for Pb and decreases of 52% for Cu. These elements, originally associated to the cuttings and drilling muds, at discharge are bound to particles having well defined size and depositional patterns. Thus, their migration is strongly influenced by the hydrodynamic situation both at discharge and afterwards.

4. Biological: on the macrozoobenthic community. A generalized reduction in species richness, diversity and abundance was observed. Complete defaunation was found at some stations located near the platform. Opportunism of particular species which is typical in chemically polluted bottoms did not occur. Some areas showed settling by mixticolae species in relation to grain size variation of the sediment. Generally, the observed variation of benthic communities can be ascribed mainly to a physical impact, in terms of burying, grain size variation and changes at the sediment-water interface.

5. Biological: heavy metal incorporation by the target species. The values of Cu, Zn, Mn and Cr in Corbula gibba, elaborated to exclude the effects of biological variables, were increased in the post-operative period. Over the sampling area grid, the values were homogeneous only in the first operative period. In the following periods, a significant correlation with distance from the platform was found for Cr and Zn, especially along the direction of the prevailing water current.

The spatial extent of environmental impact includes a smaller area closer to the drilling site where effects were recorded in all the above mentioned aspects. Detectable modifications of the benthic communities are limited to this area. Its extension corresponds well with the areas of deposition of the heavy and coarse materials. Outside this area, and mainly along the SSE direction, a second zone of environmental impact can be evidenced only by the chemical modification of sediments and by heavy metal incorporation in the target species. Maximum disturbances were detected during the second operative survey. The postoperative survey shows a pattern of partial recovery .

REFERENCE

AA.VV. - 1989 - Studio delle alterazioni litologiche, geochimiche e biologiche dei fondali marini interessati dagli scarichi dei fluidi di perforazione della piattaforma Antares - Alto Adriatico. Frascari F. & Bonvicini Pagliai A.M.Eds ,

Procédures d'Etude de l'Impact d'Installations Susceptibles de Rejeter des Effluents Radioactifs en Mer Méditerranée

Dominique P. CALMET

Agence Internationale pour l'Energie Atomique, B.P. 100, Vienne (Autriche)

Depuis des siècles, les océams sont exploités pour leur ressources biologiques et minérales tout en étant utilisés comme réceptacles des déchets résultants des activités humaines. Mais alors qu'ils ont une capacité limitée d'assimilation des polluants, la population humaine et la production de déchets ne cessent de croître. Cette situation, en particulier en domaine littoral, est une cause de conflits entre les différents utilisateurs des ressources marines et a conduit à des accords entre Etats pour limiter les effets de la pollution.

De nombreuses installations liées à la production d'énergie électrique sont installées en domaine côtier, estuarien et fluvial. Leur construction engendre des modifications de l'environnement et leur fonctionnement génère des déchets. Ainsi, les installations nucléaires de fabrication de combustibles, de production d'électricité et de retraitement des combustibles irradiés produisent des déchets radioactifs gazeux, liquides et solides. Avant d'être mises en service, ces installations sont soumises à une autorisation préalable qui dépend d'une étude de l'impact des éventuels rejets d'effluents radioactifs sur les populations humaines et l'environnement. Pour les pays méditerranéens, les réglementations nationales s'inscrivent dans une approche communautaire de la protection de l'environnement.

En 1958, la première Conférence des Nations Unies sur le droit de la mer [1] a recommandé que l'Agence internationale de l'énergie atomique (AIEA) fasse toutes études et prenne toutes mesures nécessaires pour aider les Etats à surveiller le rejet ou l'immersion des matières radioactives dans les mers, à promulguer des normes et des règlement internationalement acceptables visant à prévenir la pollution des mers par des matières radioactives en quantités qui risqueraient de nuire à l'homme et à ses ressources. Dès 1961, l'AIEA établissait les critères de controle des rejets de radioéléments en mer [2] sur la base des recommandations de la Commission internationale de protection radiologique [3]. Depuis, d'autres publications ont précisé la méthodologie pour évaluer l'impact des radionucléides sur les systèmes aquatiques [4], en particulier celle de la modélisation des processus de transfert des radionuclides dans l'environnement [5].

En 1972, la Conférence des Nations Unies sur l'environnement [6] pose comme principe que "la prévision rationnelle constitue un outil essentiel pour réconcilier les conflits entre les besoins de développement et le besoin de protéger et d'améliorer l'environnement". La Conférence établit les principes généraux pour l'évaluation et le contrôle de la pollution marine qui intégrent le concept de protection de l'environnement par la prévention de la pollution en minimisant les rejets de substances dangereuses.

En 1976 les Etats méditerranéens se sont dotés d'une convention régionale pour la protection de la mer Méditerranée contre la pollution [7] ratifiée par la Communauté économique européenne en 1978. Dans le protocole relatif à la protection contre la pollution d'origine tellurique, ils proposent la mise en place de normes communes d'émission pour "les substances radioactives, si leurs rejets ne sont pas conformes aux principes de la radioprotection définis par les organisations internationales compétentes en tenant compte de la protection du milieu marin". La délivrance d'une autorisation pour le rejet de déchets doit tenir compte des caractéristiques et composition du déchet, de sa nocivité, des caractéristiques du milieu marin récepteur, des atteintes possibles aux écosystèmes marins et des utilisations de l'eau de mer. En collaboration avec les organisations internationales compétentes, des normes et critères communs sont élaborés concernant le contrôle des installations susceptibles de polluer sensiblement le milieu marin tout en tenant compte "des caractéristiques locales, écologiques, géographiques et physiques, de la capacité économiques des Etats et leur besoin de développement, du niveau de la pollution existante et de la capacité réelle d'adsorption du milieu marin".

En parfait accord avec la notion de prévention de la pollution, la directive du Conseil des Communautés européennes du 27 juin 1985 [8] concernant l'évaluation des incidences de certains projets publics et privés sur l'environnement souligne que "la meilleure politique de l'environnement consiste à éviter, dès l'origine, la création de pollutions ou de nuisances plutôt que de combatttre ultérieurement leurs effets". La directive propose l'harmonisation des principes d'évaluation des incidences sur l'environnement des projets de travaux de construction, d'installations ou d'ouvrages. L'évaluation des incidences sur l'environnement doit identifier, décrire et évaluer "les effets directs et indirects d'un projet sur l'homme, la faune et la flore, le sol, l'eau, l'air, le climat et le paysage, les biens matériels et le patrimoine culturel". Le maître d'ouvrage doit compléter ces informations par une description du site, la conception et la dimension du projet, les données nécessaires pour identifier et évaluer les effets principaux que le projet est susceptible d'avoir sur l'environnement et une description des mesures envisagées pour éviter et réduire des effets négatifs importants et, si possible, y remédier. Les réacteurs nucléaires ainsi que les installations de stockage des déchets radioactifs sont soumis à une telle évaluation. En outre ces installations sont soumises à une autorisation préalable visant à vérifier leur conformité avec les normes de base relatives à la protection sanitaire de la population contre les dangers résultant des rayonnements ionisants, explicitées dans la directive du 15 juillet 1980 [9].

Les objectifs et l'application des procédures d'étude d'impact des installations nucléaires susceptibles de rejeter des effluents faiblement radioactifs dans l'environnement méditerranéen sont donc clairement spécifiés dans des recommandations internationales, une convention régionale et des directives communautaires. Les législations nationales des Etats méditerranéens reprennent ces dispositions qui sont appliquées sur le territoire sous leur judiriction.

[1] UNCLOS I, 1958. United Nations Conference on the Law of the Sea.

[2] IAEA, 1961. Radioactive Waste Disposal into the Sea. Safety Series No.5, Vienna.

[3] CIPR, 1977. Recommandations de la Commisison Internationale de Protection Radiologique, Publicatioo CIPR 26.

[4] IAEA, 1979. Methodology for Assessing Impacts of Radioactivity on Aquatic Ecosystems. Tech. Rep. Ser. No.190, Vienna.

[5] IAEA, 1982. Generic Models and Parameters for Assessing the Environmental Transfer of Radionuclides from routine Releases.

[6] UN, 1972. Conference on the Human Environment. A/Conf. 48/14 and Annexe III.

[7] PNUE, 1982. Convention pour la Protection de la mer Méditerranée contre la pollution et protocoles y relatifs.

[8] CCE, 1985. Dir. du Cons. du 27 Juin 1985. Evaluation des incidences de certains projets publiques et privés sur l'environnement.

[9] CCE, 1980. Dir. du Cons. du 15 juillet 1980, portant modification des directives fixant les normes de bases relatives à la protection sanitaire de la population et des travailleurs contre les dangers résultant des rayonnements ionisants.

Y-III7

Etudes d'Impact sur le Littoral Espagnol, notamment Catalan : Un Protocole d'Evaluation du Milieu, spécialement en ce qui concerne la construction de Ports de Plaisance

J.-D. ROS et J. ROMERO

Departament d'Ecologia, Facultat de Biologia, Universitat de Barcelona, Diagonal. 645, 08028 Barcelona (Espagne)

Un des impacts les plus importants sur le littoral Méditerranéen Espagnol est la construction de ports de plaisance. Une vingtaine sont actuellement en projet ou déjà en cours de réalisation; sur le seul littoral Catalan, on en trouve, en moyenne, un tous les cinq kilomètres. La demande sociale d'études d'impact concernant des actions humaines (ports, restructuration de plages) dans le domaine littoral est donc forte.

Ce sont, en fait, des études de prévision d'impact, car normalement elles sont exigées avant la réalisation des oeuvres et ont pour but tant la connaissance de l'état biologique zéro, envisageant un contrôle ultérieur hypothétique, que la documentation, pour l'Administration, sur les caractéristiques bio-écologiques de la zone et l'avis d'experts sur les conséquences éventuelles des constructions. L'étude d'impact est un document consultatif, rarement publié ou même disponible.

La Loi du Gouvernement Autonome Catalan donne des directives sur la manière de réaliser ces études. Malgré ces précisions, l'interprétation est encore souvent trop large et permet des études d'impact peu approfondies. Ces directives prévoient essentiel-lement que l'analyse des systèmes écologiques de la zone d'influence du port de plaisance comportera l'étude des communautés benthiques et des constituants organiques des sédiments, à la même échelle que la bathymétrie générale. La méthodologie à suivre sera précisée de façon que l'étude puisse se répéter dans le futur et permette d'établir des comparaisons. Seront investigués les biocoenoses, horizons ou faciès, qui constituent les niveaux les plus appropriés du point de vue écologique, ainsi que les populations de quelques espèces les plus caractéristiques des biocoenoses. Avec toutes ces études, on élaborera le rapport d'impact, qui devra considérer les effets possibles sur le milieu littoral de la construction du port de plaisance. Nous exposons ici un protocole établi, à usage interne, par une équipe de notre laboratoire qui a conduit un certain nombre de ces études d'impact.

Le domaine abiotique ne fait pas l'objet d'étude, sauf en des cas très précis. Des données de références sont, en principe, disponibles en ce qui concerne la qualité de l'eau pour les divers secteurs de la côte. C'est également le cas pour l'hydrographie (courants, hydrodynamisme...) et la dynamique littorale sédimentaire, étudiés par des travaux préliminaires de génie.

a.- Philosophie générale. La rapidité que l'on exige des études d'impact contraint à orienter les recherches sur des ensembles biologiques relativement stables, qui intègrent bien des variations environnementales et déjà reconnus comme indicateurs de la qualité de l'eau et du milieu. Les peuplements benthiques remplissent ces conditions, spécialement les peuplements sur substrat dur et les herbiers de Phanérogames.

La zone d'étude, établie à partir des données abiotiques, est normalement comprise entre 5 et 150 Ha. Dans cette zone, il s'agit :

a.- d'identifier les peuplements présumés soumis à l'impact;

b.- de cartographier ces peuplements de la façon la plus précise;

c.- d'étudier de manière quantitative les espèces dont la biomasse est la plus importante et, si possible,la répartition, dans l'espace, de cette biomasse;

d.- d'établir un bilan de la diversité biologique existante.

b - Etudes qualitatives. Dans un premier temps, une prospection par les moyens qui conviennent le mieux (plongée, apnée) à la nature et à l'hétérogénéité du milieu, permet de dresser une liste des ensembles biologiques présents, selon les critères classiques de la bionomie benthique Méditerranéenne. Cette prospection permet aussi de se faire une opinion sur la variabilité, la répartition, etc. des peuplements en vue d'une optimisation de l'échantillonnage ultérieur.

c.-Transects. Une série de transects perpendiculaires à la ligne de côte est établie, dont le montant total dépend du temps disponible, de l'hétérogénéité des peuplements et de la surface totale de la zone à étudier. Le transect est délimité par un filin marqué mètre par mètre, et suivi en plongée; la profondeur, le peuplement repéré et, si possible, une estimation semi-quantitative sont notés à chaque marque.

d - Cartographie. Les transects fournissent la base de la cartographie, qui est complétée par des plongées inter-transects. On établit habituellement une carte à l'échelle 1 : 2000 à 1 : 25.000.

e.- Etudes quantitatives. Sur la base de b, c, et d, on prépare un programme d'échantillonnage quantitatif. Le nombre d'échantillons doit être réduit (entre 5 et 15). La distribution des échantillons se fait en fonction des peuplements repérés, et vise à couvrir une représentation de biocoenoses le plus large possible. Les échantillons sont pris par récolte totale (grattage dans les fonds durs, bennes dans les meubles) sur des aires minimales préalablement connues. L'expression de l'abondance se fait en biomasse et/ou recouvrement et/ou nombre d'individus. Les échantillons sont prélevés en des points parfaitement repérés.

f - Etude de la diversité biologique. Cet échantillonnage permet d'établir un liste relativement exhaustive des espèces présentes au niveau de la macrofaune et de la macroflore, bien que l'on se heurte à des difficultés taxonomiques si l'on ne dispose pas de spécialistes. On considère comme prioritaire l'étude des Mollusques et des Polychètes sur fonds meubles et des Algues, Mollusques, Polychètes et Crustacés sur substrats durs. Des tableaux de descripteurs synthétiques sont dressés (indice de diversité, biomasse totale, etc.). Des échantillons qualitatifs complémen-taires permettent éventuellement de compléter la liste des espèces.

g - Phanérogames marines. Une attention spéciale leur est accordée. Des études de macrostructure (couverture, tombants de matte, matte morte, etc.) et de microstructure (densité en faisceaux/m2) sont réalisées.

h - Photographie. Des transects photographiques complètent la documentation fournie.

Ce protocole de travail présente l'avantage de la standar-disation et de la dépuration depuis plusieurs années d'utilisation. Il est certainement semblable aux protocoles employés par d'autres équipes en d'autres régions, et il semblerait logique que cette réunion de la C.I.E.S.M. puisse permettre une formalisation identique qui serait appliquée aux différents laboratoires et groupes de travail de la Communauté Scientifique Méditerranéenne, ce qui permettrait la normalisation d'études d'impact réalisées dans tout son périmètre.

Y-IV1

Le Genre Eudendrium (Cnidaria) : révision des espèces méditerranéennes

Jean MARINOPOULOS

Station Marine d'Endoume, Rue de la Batterie des Lions, Marseille (France)

La famille des *Eudendriidae* Hincks 1968 est représentée, en Méditerranée, par douze espèces appartenant au genre *Eudendrium* Ehrenberg 1834 (espèces-type: *Tubularia ramosa* Linné 1758). Le genre *Myrionema* Pictet 1893,(espèce-type:*Myrionema amboinensis* Pictet 1893) ne présente que des différences mineures avec le genre *Eudendrium* et il est réuni à ce dernier.

L'identification des espèces du genre *Eudendrium* a, jusqu' à présent, été difficile: la plupart des critères discriminatoires proposés par les divers auteurs ne peuvent être pris en considération car ils sont généralement soumis à des variations individuelles entre colonies d'une même espèce, parfois même entre éléments d'une même colonie, variations qui sont parallèles chez beaucoup d'espèces. On doit écarter en tant que critères de valeur spécifique:

a) Les dimensions des diverses parties constitutives des colonies, qui dans les colonies jeunes ou développées dans un milieu défavorable sont beaucoup plus faibles que celles atteintes par de grandes colonies développées dans un milieu favorable.

b) Le port des colonies; une espèce susceptible d'atteindre une grande taille passe d'abord par des stades rampants, puis ramifiés non fasciculés, dans des milieux défavorables, ces stades peuvent ne pas être dépassés.

c) L'importance plus ou moins grande des annelures du périsarc, qui varie souvent de la base au sommet, et même d'un rameau à l'autre d'une même colonie.

d) Le nombre de tentacules des hydranthes, qui varie en fonction de leur taille

e) L'existence ou l'absence (à première vue) d'une gouttière glandulaire à la partie inférieure du corps des hydranthes.

f) La position des polypes fertiles ou des blastostyles sur l'hydrorhize ou sur l'hydrocaule, qui dépend du degré de développement de la colonie.

g) Le nombre des chambres spermiques des gonophores mâles, qui est très variable sur une même colonie.

k) La distinction, pour les gonophores femelles, de deux catégories de spadices (streptospadice ou orthospadice), un même spadice passant successivement par ces deux stades de développement.

Il résulte de la précédente énumération que seuls quelques caractères morphologiques très marqués, mais qui ne se retrouvent pas dans l'ensemble des espèces du genre, peuvent servir de critères spécifiques. Afin de tenter d'éliminer ces obstacles, on a fait appel à l'étude des nématocystes.

La difficulté majeure était d'assimiler chacune de ces espèces à l'aspect général et au port d'espèces anciennement décrites, bien que les descriptions et les figures originales soient notoirement insuffisantes. Néanmoins les noms attribués aux espèces différenciées par leur cnidome présentent de fortes probabilités pour être exacts.

Les hydranthes de toutes ces espèces possèdent deux types de nématocystes (cf.synthèse de Mariscal 1974).

Le premier type, toujours constitué de petits Eurytèles microbasiques hétérotriches à capsule mytiliforme (dimensions: 6x2,5 à 9x4 µm suivant les espèces et les colonies), constitue à lui seul la totalité des nématocystes des tentacules et est dispersé dans l'ectoderme des parois du corps. Ce premier type ne fournit pas d'élément utile pour la détermination des espèces.

Le second type, réparti sur les parois du corps des hydranthes fournit un critère pour la discrimination des espèces, et ceci à partir des nématocystes non dévaginés. Ces nématocystes sont divisées en deux catégories.

a) Nématocystes dont la taille varie de 16x7,5 à 31x11µm: Atriches isorhizes: *E.carneum* Clarke 1882. Eurytèles microbasiques hétérotriches: *E. calceolatum* Motz-Kossowska 1905, *E. ramosum* (Linné) 1758, *E. amboinense* (Pictet) 1893, *E. rameum* (Pallas) 1766. Eurytèles macrobasiques holotriches:*E. glomeratum* Picard 1952, *E. motzkossowskae* Picard 1952, *E. fragile* Motz-Kossowska 1905.

b) Nématocystes dont la taille varie de 8x4 à 12x5 µm: Atriches isorhizes: *E. racemosum* (Gmelin) 1791. Atriches anisorhizes: *E. capillare* Alder 1856. Eurytèles microbasiques hétérotriches:*E. armatum* Tichomiroff 1887,. *E. cf.arbuscula* Str. Wright 1859.

Certaines espèces peuvent également être identifiées par la forme particulière du spadice des gonophores femelles (*E. calceolatum, E. glomeratum, E. carneum, E.racemosum) ou par la présence des "cnidophores" (E. racemosum, E. armatum).*

REFERENCES BIBLIOGRAPHIQUES

MARISCAL R.N., 1974 *Nematocysts. In: Coelenterate Biology. MUSCATINE, L and LENHOFF, H.M Ed: Academic Press, New York, 129-178.*

MILLARD N.A.H., 1975 *Monograph of the Hydroida of Southern Africa. Ann. S. Afr. Mus. 68:1-513.*

PICARD, J., 1951 *Note sur les Hydraires littoraux de Banyuls-sur-Mer.Vie et Milieu. 2: 338-349*

PICARD, J., 1955 *Hydraires des environs de Castiglione (Algérie). Bull.Stn. Aquic. Pêche. Castiglione (n.s) 7: 181-199.*

Remerciements: Nous tenons à remercier J.Picard qui nous a donné la première version de cette clé.

CLE DES ESPECES MEDITERRANEENNES DU GENRE EUDENDRIUM

1 -Nématocystes de taille variant de 16 à 31 µm situés uniquement dans l'hypostome, le corps de l'hydranthe et dans l'hydrocaule. 2
1 -Nématocystes de taille variant de 8 à 12 µm situés uniquement dans l'hypostome, le corps de l'hydranthe et dans l'hydrocaule. 10

2 -Hampe visible 3
2 -Hampe invisible
(gonophore femelle mature à spadice bifide et acuminé) *E.carneum*

3 -Hampe longue et droite 4
3 -Hampe longue et spiralée 8

4 -Hampe épaisse 5
4 -Hampe fine 6

5 -Hampe avec 2 renflements occupant les 2/3 de la longueur du nématocyste (gonophore femelle mature à spadice en forme de "hache") *E. calceolatum*
5 -Hampe rétrécie vers le milieu de sa longueur et occupe moins le 2/3 de la longueur du nématocyste *E. cf. arbuscula*

6 -Hampe occupant les 2/3 aux 3/4 de la longueur du nématocyste 7
6 -Hampe occupant toute la longueur du nématocyste *E. rameum*

7 -Nématocystes des tentacules de longueur supérieure à deux fois la largeur (au moins 2 cercles des tentacules, présence des zooxanthelles) *E. amboinense*
7 -Nématocystes des tentacules de longueur inférieure à deux fois la largeur *E.ramosum*

8 -Nématocystes disposés en amas isolés et saillants sur la moitié inférieure du corps (gonophore femelle aux amas spermiques bisexuels) *E.glomeratum*
8 -Nématocystes disposés en 2 couronnes, l'une à l'hypostome et l'autre dans la moitié inférieure du corps 9

9 -Hampe à enroulement spiralé suivant le grand axe *E.motzkossowskae*
9 -Hampe à enroulement spiralé suivant le petit axe *E.fragile*

10 -Hampe visible 11
10 -Hampe invisible (parfois des cnidophores aux polypes, gonophore femelle mature à spadice bifide non acuminé) *E.racemosum*

11 -Nématocyste ovoïde régulier (parfois des cnidophores en bout de rameau) *E.armatum*
11 -Nématocyste fusiforme *E. capillare*

Spéciation chez les Chaetognathes du genre *Spadella* dans quelques grottes sous-marines de la Méditerranée Nord-Occidentale

Jean-Paul CASANOVA

Laboratoire de Biologie Animale (Plancton), Université de Provence, 3 Place Victor Hugo, 13331 Marseille Cédex 3 (France)

Le premier Chaetognathe cavernicole, *Spadella ledoyeri*, a été décrit dans la grotte sous-marine obscure des Trémies, près de Cassis (Casanova, 1986). J'avais alors émis l'hypothèse qu'aux trois paramètres essentiels caractérisant ce biotope sélectif bien particulier, obscurité, calme hydrodynamique et rareté des proies, semblaient correspondre trois adaptations de l'espèce, à savoir, respectivement : grand développement de la tache pigmentée des yeux, réduction des nageoires latérales et régime plus ou moins nécrophage. Cette découverte m'a incité à poursuivre les recherches dans les grottes et, grâce à la collaboration de deux collègues [1], j'ai pu obtenir des spécimens de la région marseillaise et du Parc régional naturel de Corse.

1.- Inventaire spécifique

On trouvera, dans le tableau 1, l'inventaire des espèces récoltées dans les grottes prospectées.

a) *Spadella ledoyeri.* Les trois exemplaires capturés dans la grotte du Grand Conglu correspondent à la diagnose de l'espèce, notamment la réduction des nageoires latérales. On note cependant deux différences avec ceux de la grotte des Trémies. L'une concerne les nageoires latérales, qui débutent un peu en avant du septum transversal, l'autre les dimensions beaucoup plus faibles de la tache pigmentée des yeux : à taille comparable (4,7 et 4,8 mm), celle-ci est deux fois plus grande chez les spécimens de la grotte des Trémies (fig. 1a,b).

b) *Spadella sp.1.* Il s'agit de cinq spécimens qui ressemblent à *S. cephaloptera*, espèce néritique commune en Méditerranée, mais qui en diffèrent par quelques caractères morphologiques (couronne ciliaire, vésicules séminales) et physiologique (mode de reproduction).

La couronne ciliaire, réniforme, déborde largement les parois du cou sur la collerette (fig.1c) ; elle est ovale ou circulaire et plus petite chez les spécimens de *S. cephaloptera* décrits par les auteurs (Ghirardelli, 1968) et chez ceux provenant de récoltes que j'avais effectuées dans l'étang de Diana (Corse orientale) en été 1966 (fig.1d).

Les vésicules séminales, petites, sont situées très près de l'extrémité du segment caudal, à une distance comprise entre le quart et le cinquième postérieur, alors qu'elles en sont plus éloignées chez *S. cephaloptera* (entre le tiers et le quart postérieur).

Si la position des vésicules séminales est un caractère relativement stable, on sait que la forme et la taille de la couronne ciliaire varient chez certaines espèces (Ghirardelli, 1968). Pour s'appuyer sur ces critères morphologiques, il faudra, d'une part, observer un plus grand nombre d'échantillons et, d'autre part, les comparer à des spécimens de *S. cephaloptera* du golfe de Marseille.

Le mode de reproduction particulier de cette forme, en revanche, plaiderait en faveur d'un isolement reproductif. En effet, la fécondation croisée est la règle chez les Spadelles et j'ai même mis en évidence des relations entre la morphologie du corps et la parade sexuelle chez une nouvelle espèce de *Paraspadella* des côtes du Japon, en cours de description. Or, chez trois de ces spécimens cavernicoles, l'autofécondation est évidente : sur une photographie de l'un d'eux (fig.1e), on voit bien les spermatogonies, réunies en amas réguliers, circuler dorsalement depuis les vésicules séminales jusqu'aux orifices génitaux femelles, le long de la base des nageoires latérales, entre celles-ci et la collerette.

c) *Spadella sp. 2.* Là aussi le nombre de spécimens étudiés est faible : quatre, qui proviennent de la grotte de la Faille sur la côte occidentale de la Corse près de Galéria. Tous de très petite taille (2,4 à 2,8 mm), bien que mûrs, ils se caractérisent, semble-t-il, par l'absence de nageoires latérales, qui pourrait ne pas résulter de leur détérioration, comme l'atteste l'excellent état de la nageoire caudale dans tous les cas. Mais il faudra s'en assurer par d'autres récoltes avant de décider de leur statut taxonomique.

grottes	Cassis	Golfe de Marseille		Corse
	Trémies	Grand Conglu	Riou-Moyade	La Faille
(profondeur-longueur)	(15-70m)	(25-50m)	(23-30m)	(8-50m)
Spadella ledoyeri	9	3		
Spadella sp.1		1	4	
Spadella sp.2				4

Tabl.1.- Inventaire des *Spadella* récoltées à l'aide de pièges dans quatre grottes sous-marines de Méditerranée.

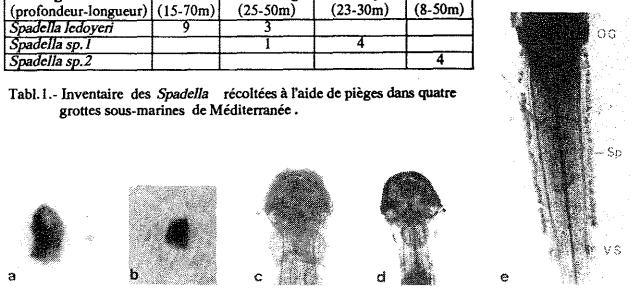


Fig.1.- Tache pigmentée de l'oeil de *Spadella ledoyeri* de la grotte des Trémies (a) et du Grand Conglu (b). Couronne ciliaire de *Spadella sp.1* (c) et *S. cephaloptera* de l'étang de Diana (d). Autofécondation chez *Spadella sp.1* (e) : observer les amas de spermatogonies (Sp) circulant des vésicules séminales (VS) vidées aux orifices génitaux femelles (OG).

2.- Discussion

Bien que la découverte des Chaetognathes cavernicoles soit récente et les observations encore fragmentaires, comme on vient de le voir, on peut néanmoins déjà tirer quelques enseignements sur la spéciation de ces organismes dans les grottes sous-marines de Méditerranée.

En l'état actuel des connaissances, seule *Spadella ledoyeri* peut être tenue pour une bonne espèce. Les grottes où elle vit, celle des Trémies notamment, n'étant immergées que depuis le dernier stade glaciaire, cela signifie vraisemblablement que son isolement spécifique serait récent, à moins qu'elle n'ait déjà existé dans des grottes restées immergées durant ce stade. Il semble, en effet, que l'on ne puisse pas la tenir pour une espèce profonde vivant aussi dans le milieu cavernicole comme cela a été montré chez quelques groupes zoologiques tels que les Spongiaires (Pouliquen, 1969), les Scléractiniaires (Zibrowius, 1971) ou les Bryozoaires (Harmelin, 1976), car aucun Chaetognathe bentho-planctonique abyssal, ni aucune des Spadelles trouvées jusqu'à 1500 m de profondeur ne montrent de réduction des nageoires latérales. Les dimensions de la cellule pigmentée de l'oeil, en revanche, sont vraisemblablement une adaptation à la luminosité ambiante de chaque grotte; des mesures de celle-ci devraient le confirmer.

La modification du mode de reproduction (remplacement de la fécondation croisée par l'autofécondation) est, semble-t-il, une étape préalable dans le processus de spéciation; l'obscurité régnant dans les grottes, qui rendrait impossible la parade sexuelle décrite chez les Spadelles, peut l'expliquer. Les expériences prévues de croisement entre *S. cephaloptera* et *Spadella sp.1* permettront de dire si cette dernière a franchi le stade de l'identité spécifique.

Références

Casanova (J.-P.), 1986.- *Rapp. Comm. int. Mer Médit,* 30 (2), P-III 5 : 196.
Ghirardelli (E.), 1968.- *Adv. mar. Biol.,* 6 : 271-375.
Harmelin (J.G.), 1976.- *Mém. Inst. océanogr., Monaco*, 10 : 1-326.
Pouliquen (L.), 1969.- *C.R. Acad. Sci., Paris* (sér.D), 268 : 1324-1326.
Zibrowius (H.), 1971.- *Rapp. Comm. int. mer Médit.,* 20 (3) : 243-245.

1) Je remercie les Drs. M. Verlaque (Laboratoire d'Ecologie du Benthos et de Biologie végétale marine, Marseille-Luminy) et H. Zibrowius (Station marine d'Endoume) de m'avoir confié ce matériel.

The Stagnone Sound (W Sicily) : a case history in the adaptation of Zoobenthos to a marine segregated environment

Renato CHEMELLO* and Silvano RIGGIO**

*Istituto di Scienze della Terra dell'Università di Catania (Italia)
**Istituto di Zoologia dell'Università di Palermo, Via Archirafi, 18, 90123 Palermo (Italia)

Reproductive isolation of the genotypes selected in a peculiar environmental system is a prerequisite for the evolution of new taxa, which in the terrestrial biota is attained through the onset of spatial and/or ecological barriers. The constancy of the leading abiotic parameters and the physical continuum of the marine environment are on the other hand a severe restraint towards the isolation of selected gene pools, due to the high dispersal power of planktonic larvae. According to MAYR(1966),"...the genetic component of the phenotypic variation with changing water conditions seems smaller in the marine animals...The very free gene flow will result in a highly panmictic condition. All this counteracts local genetic differentiation and favors developmental flexibility...". A theoretical model of a marine biotope favourable to genetic isolation is provided by a segregated coastal lagoon widely communicating with the open sea and affected by an intense water renewal which results in salinities and temperatures by no means lower than in the open sea: in such a case the larvae inflowing with the currents should be selected against factors -as the water temperature and local salinity- related solely to the hydrodynamism and the nature of the substrata thereby giving rise to different types which could in their turn migrate back into the sea. Shallow seabeds encircled by islands and stretching around arid or semiarid continental regions fit the model: a case is provided by the bottoms off the Gulf of Gabes, Tunisia; a second case is the shallow sound of the Stagnone di Marsala. This "marine lagoon" communicates with the open sea through its northernmost and southernmost mouths; inside the lagoon at least three minor basins can be identified from the hydrodynamic point of view, distinguished by depths varying from 0.10m to 2.0m and spatially separated by three flat calcareous islets (RIGGIO et al., 1983) .

The marine zoobenthos is characterized by the frequent occurence of phenotypes which can be referred to as: a) partly or wholly reversible adaptations to the dominant thermal and hydrodynamic conditions; b) irreversible processes of genotypic selection and ecological segregation.

Numerous examples of both phenomena are observed in typically marine groups. Reversible adaptations to the hydrodynamism, of a non-genetic nature, are observed in the following taxa: the benthopleustonic populations of the Demospongia *Geodia cydonium*, characterized by sterrasters sensibly smaller than open sea populations (CORRIERO,1982-83); the colonies of the Hydroid *Aglaophenia harpago* attaining a gigantic size; *Plumularia obliqua*, (Hydroidea) showing a peculiar intrathecal morphology; *Cladocora caespitosa* living as an epibiont with corallites far longer than normal; the epiphytic Bryozoan *Aetea sica* budding well developed sacculi (RIGGIO S. e R. CHEMELLO, 1986). Within the genetically established types can be listed all the endemisms sofar described in widely plastic taxa. Three new species of Doridacea have been so far identified among the Opistobranchia.They are *Chromodoris* sp. (GARCIA-GOMEZ et al., in press), *Discodoris* sp. and *Doriopsilla* sp. The Gastropod *Calliostoma laugieri spongiarum*, whose distribution is restricted to the coast of the Gulf of Gabes and the Stagnone di Marsala as well (CHEMELLO and RIGGIO, a; b, in press) is also frequent; even the fish fauna includes an endemism, a small sized Gobiid, *Pomatoschistus tortonesei*, which is not reported elsewhere. No data are available for other taxonomic groups, which are still under study.

The high frequency of microevolutive phenomena in the zoobenthos and the convergence observed in most characters makes their occurence by chance rather unlikely; moreover the "endemisms" are by no means consistent with the evolutionary patterns typical of brackish coastal lagoons in central and northern Mediterranean. Their unique morphological characteristics stress the influence exerted on the benthic fauna of by a marine semiclosed system inside the lagoon, restricted to its central basin and including the two islets. The high summer temperatures and salinities and the skimming-oscillating water flow should select genotypes particularly well adapted to ecological factors typical of a sea situated much more South. Similar conditions dominate in the Gulf of Gabes and both biotopes might be a source of rapid biogeographic differentiation.

References.

CHEMELLO R. and S. RIGGIO, in press. A up to date list of the Mollusca recorded in the Stagnone di Marsala (W. Sicily), *X int Malacological Congress of Unitas Malacologica*, Tubingen, 27, 08-05-09, 1989.

CHEMELLO R.and S. RIGGIO, in press. The role of the Mollusca in the Stagnone di Marsala (W. Sicily) as a model of an ecological approach to a southern marine lagoon . *Ibidem*, 1989.

CORRIERO, G., 1982-83. Note sul popolamento di Poriferi dello Stagnone di Marsala (Sicilia). *Nova Thalassia*, 6, suppl.: 213-223.

GARCIA-GOMEZ J.C., R. CATTANEO-VIETTI and R. CHEMELLO, in press. On a new and a little known Chromodoride (Mollusca: Nudibranchia) from the Mediterranean Sea. *Actas VII Congr. Nac. de Malacologia*, Sevilla: 1-19.

RIGGIO S., S. CALVO, G. di PISA, G. GENCHI, A. LUGARO and S. RAGONESE, 1983. The Stagnone lagoon (W. Sicily): an ecological approach to the management of its natural resources. *Rapp. Comm. int. Mer Médit.*, 28,6:143-146.

RIGGIO S. e R. CHEMELLO, 1986. Lo Stagnone di Marsala (Sicilia occidentale): area confinata o laboratorio per l'evoluzione di taxa bentonici? *Nova Thalassia*, 8, suppl. 3: 683-684.

Y-IV4

Les Ophelia (Annélides Polychètes) de Méditerranée Occidentale: Première approche phénétique et phylogénétique

Denise BELLAN-SANTINI, Jean-Claude DAUVIN et Gérard BELLAN

Station Marine d'Endoume, 13007 Marseille et Station Biologique, 29680 Roscoff (France)

Depuis de nombreuses années, le genre *Ophelia* a attiré l'attention des systématiciens et des écologistes marins (Bellan,1964). Quatre espèces sont signalées en Méditerranée occidentale: *Ophelia amoureuxi* Bellan et Costa,1988, *Ophelia bicornis* Savigny,1820, *Ophelia neglecta* Schneider,1887 et *Ophelia roscoffensis* Augener,1910; *O. bicornis* peut être considérée comme un complexe polymorphique. Ses différents phénotypes se distinguent par le nombre de branchies et leur niveau d'apparition. *O. neglecta* pourrait présenter une variabilité similaire, même si elle est nettement moins développée.

Dans le cadre d'une révision complète de la famille (Bellan et *al.*, 1990; Bellan et *al*, en préparation): caractères taxonomiques, validité des coupures des différents taxons, affinités et hiérarchisation de celles-ci, distribution écologique et géographique des différentes espèces, nous abordons ici l'approche phénétique et phylogénétique des espèces ouest-méditerranéennes. Des matrices de caractères ont été dressées comprenant l'ensemble des caractères morphologiques pour chacune des quatre espèces et leurs variétés morphologiques, soit un total de 13 taxons. Une étude de similarité phénétique a été réalisée en utilisant le coefficient de Sokal et Michener (1958). Les caractères ont été polarisés en apomorphes et plésiomorphes sans tenir compte des différents degrés intermédiaires jugés dans ce cas trop subjectifs. Les analyses phylogénétiques (cladogrammes) ont été effectuées à l'aide des programme PHYLIP et McClade (Bellan et *al.*, 1990).

RESULTATS ET DISCUSSIONS

Le phénogramme (Fig.1)permet la séparation des taxons en quatre ensembles dont deux ne comprennent qu'une seule espèce. Le premier monospécifique (1):*O. amoureuxi*, abranche, le second également monospécifique (2):*O. roscoffensis* avec un nombre important de branchies (23 paires), un ensemble (3) avec les deux formes de *O. neglecta* (17 et 18 paires de branchies) et(4) les 9 formes de *O. bicornis* (11 à 15 paires de branchies). La similitude entre les taxons appartenant aux groupes 3 et 4 est très élevée (>80%). Les formes A, B et C d'*O. bicornis* sont mieux discriminées selon le caractère "niveau d'apparition de la première paire de branchies" que selon le caractère "nombre de paires de branchies".

L'analyse phylogénétique (Fig.2) génère un seul arbre de compatibilité (clique) avec 29 caractères et un seul arbre parcimonieux (Wagner) de 40 pas qui présente un Indice de cohérence de 0,72 (sur MacClade) (Fig.2). Au total, on recense 19 autapomorphies ou synapomorphies. On peut, encore, distinguer les trois ensembles: 1, 2 et 3+4. Le groupe 3+4 se montre relativement bien homogène.Toutefois la séparation des formes de *O. bicornis* (+ *O. amoureuxi*) se fait au niveau de deux caractères discriminants (14 et 25). Deux caractères convergents sont intéressants à étudier. Le caractère 21 sépare les formes B et C d'*O. bicornis* (+ la forme abranche d'*O. amoureuxi*) présentant une réduction antérieure des branchies. Le caractère 28 sépare *O. amoureuxi* abranche et la forme A12, dernier avatar de la lignée *O. bicornis* forme A. Ce caractère convergent peut signifier que l'origine phylogénétique de l'absence de branchies chez *O. amoureuxi* est différente de la réduction des branchies dans les formes A, B et C d'*O. bicornis*.Il y aurait deux processus de spéciation différents aboutissant à une certaine similitude morphologique. Ceci n'est d'ailleurs pas en contradiction avec l'étude phylogénétique des genres d'Opheliidae (Bellan et al., 1990).

Pour conclure, on peut se poser le problème du niveau taxonomique réel des espèces du genre *Ophelia* qui semble, tout au moins en Méditerranée, constituer un unique groupe monophylétique:
1- au niveau spécifique ou sub-spécifique de la distinction entre *O. neglecta* et *O. bicornis*,
2- au niveau générique ou sub-générique pour *O. amoureuxi*.

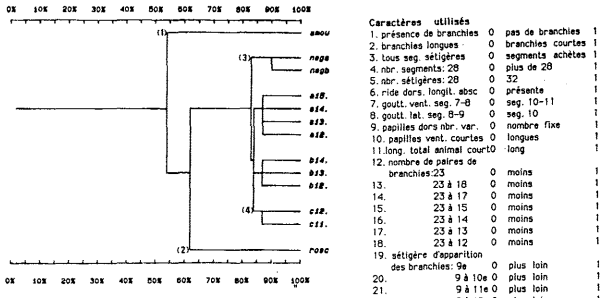


Fig. 1: Phénogramme (a, b, c,= formes a, b et c de *O. bicornis*)

Caractères utilisés			
1. présence de branchies	0	pas de branchies	1
2. branchies longues	0	branchies courtes	1
3. tous seg. sétigères	0	segments achètes	1
4. nbr. segments: 28	0	plus de 28	1
5. nbr. sétigères: 28	0	32	1
6. ride dors. longit. absc	0	présente	1
7. goutt. vent. seg. 7-8	0	seg. 10-11	1
8. goutt. lat. seg. 8-9	0	seg. 10	1
9. papilles dors nbr. var.	0	nombre fixe	1
10. papilles vent. courtes	0	longues	1
11.long. total animal court	0	long	1
12. nombre de paires de branchies:23	0	moins	1
13. 23 à 18	0	moins	1
14. 23 à 17	0	moins	1
15. 23 à 15	0	moins	1
16. 23 à 14	0	moins	1
17. 23 à 13	0	moins	1
18. 23 à 12	0	moins	1
19. sétigère d'apparition des branchies: 9e	0	plus loin	1
20. 9 à 10e	0	plus loin	1
21. 9 à 11e	0	plus loin	1
22. 9 à 12e	0	plus loin	1
23. 9 à 13e	0	plus loin ou pas	1
24. dernier sétigère avec branchies au 31	0	avant	1
25. 31 à 27	0	avant	1
26. 31 à 25	0	avant	1
27. 31 à 24	0	avant	1
28. 31 à 23	0	avant	1
29 31 à 22	0	avant	1

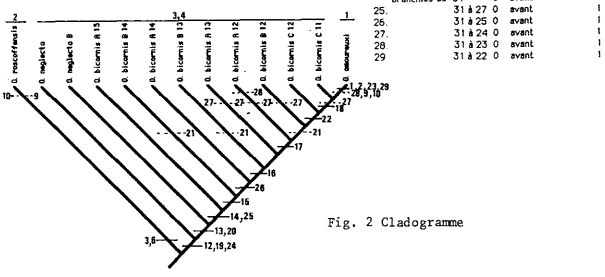


Fig. 2 Cladogramme

Bibliographie sommaire

BELLAN G., 1964 Contribution à l'étude systématique, bionomique et écologique des Annelides Polychètes de la Méditerranée. *Rec. Trav. St. mar. Endoume* (33-49) 372p.

BELLAN G., D. BELLAN-SANTINI et J.C. DAUVIN.1990 Phénétique et phylogénie des Opheliidae (Annélides Polychètes). *C. R. Acad. Sc. Paris*,310, sér.3:75-181

SOKAL R.R., MICHENER C.D., 1958 A statistical method for evaluating systematic relationships. *Univ. Kansas Sci. Bull. Lawrence, 38,:* 1409-1438

Y-IV5

Genetic comparison of two species of the genus *Gammarus* (*G. insensibilis* and *G. aequicauda*) from different geographic areas

T. PATARNELLO*, P.-M. BISOL* and B. BATTAGLIA*/**

*Dipartimento di Biologia, Università di Padova, Via Trieste 75 - 35121 Padova (Italia)
**Istituto di Biologia del Mare, C.N.R., Venezia (Italia)

Electrophoretic analyses of several species of Amphipods have been carried out in recent years with the purpose of studying their genetic structure and to elucidate possible mechanisms of genetic adaptation to the environment.

Two species of the genus Gammarus, namely G. insensibilis Stock and G. aequicauda Martynov, proved very suitable for this kind of research (Bisol et al., 1987). These species seem to occupy different niches in the environments from which they were collected: G. insensibilis lives in more "marine" habitats, whereas G. aequicauda is more common in brackish water areas where it is subjected to more exacting conditions. Laboratory experiments have shown a higher resistance of the latter to wider ranges of temperature and salinities (Brun, 1971). However, occasionally, the two species can occur together.

The present study concerns the comparison of the genetic structure between and within populations of the two mentioned species sampled in the lagoon of Venice and in two lagoons of Southern France.

In the lagoon of Venice, G. insensibilis was collected near S. Felice Island, and G. aequicauda at Piovini. In Southern France, G. insensibilis was collected at Salses-Leucate and G. aequicauda at Canet Saint-Nazaire.

The electrophoretic analyses were carried out on 17 loci according to Selander et al. (1971). The loci considered for the calculation of the genetic distance were: AP, APK, EST-1, EST-2, FH, GAPDH, GOT-1, HK, LAP-1, MDH-1, MPI, PGI, PGM and XDH.

The results obtained indicate that the Italian and the French populations of G. insensibilis exhibit heterozygosity levels (0.029 and 0.038, respectively) which are not very dissimilar from one another. In both cases the observed values do not differ significantly from the expected ones. All the loci analysed in the two populations are in Hardy-Weinberg equilibrium.

As to the comparison between the two G. aequicauda populations, the mean observed heterozygosities appear quite different (Venice, Hobs=0.078; Canet Saint-Nazaire, Hobs=0.038). Previous studies conducted on a population of G. aequicauda from Sigean (not far from Canet Saint-Nazaire) indicate a similar heterozygosity value (Hobs=0.037) (Bisol et al., 1987). This confirms the lower polymorphism of the population from Canet compared with the one from Venice.

Considering the single loci analysed in the two G. aequicauda samples, PGI and MPI appear as the main responsible ones for the observed differences. In fact, MPI shows an observed heterozygosity of 0.535 in the Venetian population, whereas the French population is monomorphic. Similarly, the observed heterozygosity at PGI locus is 0.60 in the sample from Venice and 0.094 in that from Canet.

The evaluation of the genetic distance performed according to Nei (1972) shows, first of all, that the distance between G. insensibilis and G. aequicauda is the one expected between two good species (D = 0.1402). A high genetic similarity was found between the two geographic populations of G. insensibilis (D = 0.0014), whereas the genetic distance between the Venetian and the French populations of G. aequicauda is greater (D = 0.0314). In any case the latter value is within the range of those characterizing local populations of the same species, though it points out a higher rate of differentiation between the G. aequicauda populations in comparison with the G. insensibilis ones. It is difficult to establish the causal factors of such differentiation. However, considering that G. aequicauda lives in areas which are ecologically more marginal and exacting, it seems legitimate to hypothesize natural selection at work, although the concurrence of non selective forces cannot be discarded.

References

Bisol P.M., Patarnello T. and Battaglia B. 1987. Variabilità genetica in Anfipodi del genere Gammarus di ambienti salmastri. Accad. Naz. Lincei Rend. Fis., 80: 593-601.

Brun B. 1971. Variation intraspécifiques et spéciation chez deux espèces de gammares d'eau saumatre du groupe Gammarus locusta. Thèse, Marseille, C.N.R.S., A.O., 6247.

Nei M. 1972. Genetic distance between populations. Amer. Nat., 106: 283-292.

Selander R.K., Smith M.H., Yang S.J., Yohnson W.E. and Gentry J.B. 1971. Biochemical polymorphism and systematics in the genus Peromiscus. I. Variation in the old-field mouse (Peromiscus plionotus. "Studies in Genetics", IV, Univ. Texas Pubbl., 7103: 49-90.

Résumé

Dans ce travail on a comparé, par analyse électrophorétique, la structure génétique de quelques populations géographiques (Adriatique septentrional et Méditerranée près de la cote Française) des deux espèces de Gammarus: G. insensibilis Stock et G. aequicauda Martynov. Les résultats montrent que les populations de G. insensibilis sont très semblables entre elles, tandis que les populations de G. aequicauda semblent différentes. On a aussi calculé la distance génétique, soit entre les deux espèces, soit entre les populations de chaque espèce. On discute brèvement des mécanismes qui peuvent être responsables des différences observées.

First record of *Antithamnion ogdeniae* Abbott (Ceramiaceae, Rhodophyta) from Italy

Fabio PIZZUTO and Donatella SERIO

Istituto e Orto Botanico dell'Università, Via A. Longo 19, 95125 Catania (Italia)

The genus Antithamnion Naegeli (1847), redefined by Wollaston (1968) on the basis of the features of the type species A. cruciatum Naegeli, is essentially characterized by: axes completely lacking rhizoidal cortication; opposite, distichous or decussate whorl-branchlets, with a small basal cell nearly quadrate in form not bearing pinnae; pinnae oppositely, alternately or unilaterally ramified; gland cells on specialized branches of two-four cells.

In the Mediterranean Sea the genus Antithamnion is represented by five species (Cormaci and Furnari 1989): A. heterocladum Funk, A. piliferum Cormaci et Furnari, A. tenuissimum (Hauck) Schiffner, A. cruciatum and A. ogdeniae Abbott. The first three are endemic, while the last two are distributed also in the Atlantic.

In May and in November 1989, respectively at Ponza (Pontine Islands) and Vulcano (Aeolian Islands), at 20 m depth were collected some tetrasporangial plants of A. ogdeniae. This is the first record of this species from Italy.

The thalli show the typical features of the species as described by Abbott (1979), i.e.:plants erect, 4-12 mm tall; whorl- branchlets opposite, decussate, alternately ramified; gland cells frequent throughout plant, formed on 2-3 celled branchlets growing on the abaxial side above each major furcation, each gland cell resting on 2 cells (fig. 1). The first record of A. ogdeniae from the Mediterranean, is that by Athanasiadis (1985) from the Aegean Sea. Nevertheless, on the basis of the comparative study by Athanasiadis (op. cit.) between A. ogdeniae and A. antillanum, Cormaci and Furnari (1987) consider that the species reported as A. antillanum by Boudouresque et Verlaque (1976) from Corsica, should be referred to A. ogdeniae. Moreover, on the basis of the iconography by Boisset (1987: 340) and by Barceló (1987: 374), the records of A. antillanum from the Mediterranean Spanish coast are to be referred to A. ogdeniae too. In fact, they illustrate some of the main features that differentiate this species from A. antillanum, viz.: erect axes, with equal or sub-equal whorl-branchlets; the presence of opposite pairs of pinnae at the lower part of whorl-branchlets; gland cells on 2(3) celled branches.

In conclusion, the finding of A. ogdeniae in the middle and lower Thyrrenian suggests a continuity in the distribution of this species in the Mediterranean Sea (fig. 2) from the western basin, from which it was recorded as A. antillanum, to the eastern one.

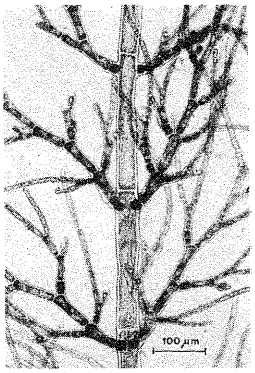


Fig.1. A. ogdeniae: middle part of the thallus showing the typical features of the species.

Fig.2. Distribution map of A. ogdeniae in the Mediterranean (from Spain and Corsica reported as A. antillanum).

REFERENCES

ABBOTT, I.A., 1979. Some tropical species related to Antithamnion (Rhodophyta, Ceramiaceae). Phycologia 18: 213-227.

ATHANASIADIS, A., 1985. North Aegean marine algae. I. New records and observations from the Sithonia peninsula, Greece. Bot. Mar. 28: 453-468.

BOUDOURESQUE, C.F. et VERLAQUE, M., 1976. Sur quelques Rhodophycées interéssantes des côtes de Corse. Bull. Soc. Phycol. France 21: 56-64.

BARCELO', M.C., 1987. Estudi de la flora bentònica marina del país Valencià. Tesis doctoral, Universitat de Barcelona.

BOISSET, F, 1987. Estudio del fitobentos esciafilo infralitoral de sustratos duros, en el litoral Valenciano (España): flora y vegetacion. Tesis doctoral, Universitat de València.

CORMACI, M. and FURNARI, G. 1987. Antithamnion piliferum sp. nov. (Ceramiaceae, Rhodophyta) from Eastern Sicily (Mediterranean Sea). Cryptogamie, Algologie, 8(3): 223-232.

CORMACI, M. and FURNARI, G. 1989. World distribution of the genus Antithamnion Naegeli (Rhodophyta, Ceramiaceae). Jpn. J. Phycol., 37: 23-30.

NAEGELI,C.,1847. Die neueren Algensysteme. Zurich, 275 p., 10 pl.

WOLLASTON, E.M., 1968. Morphology and taxonomy of southern Australian genera of Crouanieae Schmitz (Ceramiaceae, Rhodophyta). Aust. J. Bot., 16: 217-417.

ACKNOWLEDGMENTS

We are grateful to M. Cormaci and G. Furnari for their helpful suggestions.
This work was supported by a Grant from the Italian Ministry of Public Education.

Taxonomic and biogeographic observations on some species of the genus *Cystoseira: C. sauvageauana, C. barbatula and C. pelagosae*

Mario CORMACI, Giovanni FURNARI, Giuseppe GIACCONE and Donatella SERIO

Istituto e Orto Botanico della Università, via Longo 19, Catania (Italia)

Cystoseira sauvageauana Hamel

C. sauvageauana is known as a not-tophulose species. However, a phenological study carried out along Eastern Sicily coast (Motta, 1990), showed that during the winter months the species has a large number of tophules which decrease in size in spring up to disappear at all in summer. The occurrence of tophules in C. sauvageauana is therefore linked to the seasonality. That, is of relevant interest for the taxonomy of the genus Cystoseira. In fact, it's highly probable that it occurs in other species (e. g. C. adriatica Sauvageau s.l., C. jabukae Ercegovic, C. corniculata Hauck s.l.) considered as tophulose or not-tophulose on the basis of the study of specimens collected only in one season. In such view, a revision of the species of Cystoseira, based on the study of specimens collected at the same locality every months, should be effected. Such a study, on the species from Eastern Sicily, is now ongoing in our laboratory.

Cystoseira barbatula Kuetzing

During the study on benthic flora and vegetation of Lampedusa island, a community with a caespitose species of Cystoseira extending from 0 to 5 m depth was found. The species shows the following features: not foliose, bearing "bouquets" of adventitious branches on the axis, with smooth naked apices slightly protruding, with compact subulate receptacles provided with spinous outgrowths often caducous. So, it well corresponds to C. graeca Gerloff et Nizamuddin described on the basis of Herbarium specimens, some of which labelled as C. barbatula Kuetzing. But, the examination of the type material of C. barbatula, borrowed from The National Herbarium of Victoria (MEL), showed that both the species from Lampedusa and that one named by Gerloff and Nizamuddin C. graeca, well correspond to C. barbatula. Therefore, the species C. barbatula, for a long time considered as synonym of C. barbata C. Agardh, regains full validity. This is the first record of a very large and well structured community with this species, described from the Gulf of Naples, but that seems to be distributed mainly in the eastern Mediterranean (Gerloff and Nizamuddin, 1975 as C. graeca) (Fig. 1). In that paper it was also reported from Catania where, however, we never found it.

Cystoseira pelagosae Ercegovic

This species was described by Ercegovic (1952) on specimens collected at Palagruz island (Adriatic Sea) at a depth of 20-40 m. Then it has been recorded from Capo Rizzuto (high Ionian Sea) by Giaccone (1969), from Ustica island, from Scopello (Trapani) by Giaccone et al. (1985) and more recently from the Gulf of Orosei (eastern Sardinia) by Serio (1990) (Fig. 1). It is a quite rare species living in the Adriatic Sea, in the lower infralittoral and circalittoral, while in the other localities, in the upper infralittoral. This bathymetric distribution, different according to the geographic area, raises interesting questions on the ecology of the species. In fact, it seems to occupy habitats shallower and shallower as one goes from East to West, even though it has been recently recorded, but with doubt, from Corsica (Verlaque, 1988) at a depth of 35-40 m. Therefore, the ecology of this species is still not perfectly clear.

In conclusion, the genus Cystoseira should be reviewed from both taxonomic and biogeographic points of view, since the diacritic characters as "caespitose", "tophulose", "foliose" are not consistent and that several Ercegovic's adriatic endemisms resulted widely distributed.

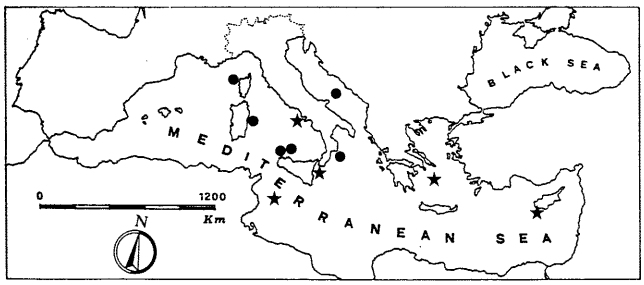


Fig.1. Distribution map of C. pelagosae (●) and C. barbatula (★). The record of C. pelagosae from Corsica is doubtful.

REFERENCES

ERCEGOVIC, A., 1952. Jadranske Cistozire. Fauna i Flora jadrana. Kn. 2 Split.

GERLOFF, J. and NIZAMUDDIN, M., 1975. Three new species of the genus Cystoseira C. AG. Willdenowia, 7: 565-582.

GIACCONE, G., 1969. Raccolte di fitobenthos sulla banchina continentale italiana. Giorn. Bot. Ital., 103: 485-514.

GIACCONE, G., COLONNA, P., GRAZIANO, C., MANNINO, A.M., CORMACI, M., FURNARI, G., e SCAMMACCA, B., 1985. Revisione della flora marina di Sicilia e isole minori. Boll. Acc. Gioenia Sci. Nat. Catania, 18: 537-781.

MOTTA, G., 1990. Fenologia morfologica e riproduttiva di Cystoseira sauvageauana Hamel (Phaeophycophyta, Fucales). Boll. Acc. Gioenia Sci. Nat. Catania. (in press).

SERIO, D., 1990. Osservazioni sulla flora algale del Golfo di Orosei (Sardegna). Boll. Acc. Gioenia Sci. Nat. Catania. (in press).

VERLAQUE, M., 1988. Végétation marine de la Corse (Méditerranée). VII. Documents pour la flore des algues. Bot. Mar., 31 (2): 187-194.

VALIANTE, R., 1883. Le Cystoseirae del golfo di Napoli. Fauna und Flora des Golfes von Neapel, 7: 1-30.

ACKNOWLEDGMENTS - We are grateful to Mrs. D. Sinkora for the loan of the type material of C. barbatula from the National Herbarium of Victoria. This work was supported by a Grant from the Italian Ministry of Public Education.

Y-IV8

Paléobiogéographie du Crustacé intersitiel *Microcharon* dans le Bassin Méditerranéen Occidental

Nicole COINEAU

Observatoire Océanologique de Banyuls, Laboratoire Arago, UA 117 CNRS, Université P. et M. Curie, Banyuls-sur-Mer (France)

Les Isopodes interstitiels, Microcrustacés de l'ordre du mm, vivent dans l'eau des espaces intrasableux des sédiments marins, littoraux et continentaux. Leur répartition est interprétée dans le cadre de la biogéographie évolutive (Blondel, 1986) à partir d'arguments complémentaires tirés de la systématique et la phylogénie, l'écologie, des modèles de spéciation par vicariance ou par dispersion, de l'évolution par progenèse corrélative de la colonisation des sédiments par les formes de surface ancestrales, des théories relatives à l'entrée d'ancêtres marins dans les eaux phréatiques (continentales), de la paléogéographie, la Tectonique des Plaques et de l'évolution de la Téthys.

Dans le Bassin méditerranéen occidental, la même espèce de *Microcharon* peuple les plages de sables grossiers des rivages d'Italie, de l'ouest de France, d'Espagne, du Maroc et de la plupart des îles méditerranéennes ; cette espèce n'existant pas le long des côtes atlantiques, a peut-être été isolée de la lignée atlantique lors de la fermeture du détroit de Gibraltar au Messinien ; les formes marines de l'Atlantique occupent encore leur milieu d'origine. D'après le modèle biogéographique biphase d'évolution (Boutin et Coineau, 1990) l'ancêtre marin a dû s'adapter dans un premier temps à la vie interstitielle dans la zone infralittorale ou intercotidale téthysienne ; puis selon la "Regression Model Evolution" (Stock, 1980), il est entré dans les eaux souterraines continentales lors des régressions de la Téthys, entraînant une évolution par vicariance ; la spéciation et les évènements cladogénétiques seraient donc liés à l'histoire de la Téthys. Il est d'ailleurs frappant de constater que toutes les espèces continentales se situent dans des territoires qui ont été recouverts par la Téthys à une ou plusieurs reprises depuis le Mésozoïque (Dercourt *et al.*). Les espèces primitives de la région de Madrid en Espagne et du Haut-Atlas de Marrakech au Maroc pourraient provenir de la régression de la mer turonienne, tandis que l'ancêtre d'une autre espèce plus répandue du Maroc aurait pu être mise en place lors du retrait de la Téthys qui succède à la transgression éocène. Au nord de la Péninsule Ibérique, la spéciation a pu se produire lors des régressions de l'Eocène Supérieur, les zones occupées par *Microcharon* ayant été envahies par la Téthys au Cénomanien, au Sénonien et à l'Eocène inférieur et moyen ; à l'est, le rôle de la Téthys a pu jouer jusqu'au Pliocène, ainsi que dans le Sud-Ouest de la zone bétique. Cette dernière région comporte des espèces relativement primitives qui pourraient provenir du bloc Alboran resté émergé au cours des diverses transgressions qui ont recouvert les territoires bétiques.

En France, les espèces pyrénéennes se seraient individualisées lors des régressions de l'Eocène, tandis que les formes du Sud-Est plus dérivées, s'alignent soit sur les rivages de la Téthys au Tortonien, au S.E. du Massif Central, soit dans les régions transgressées par le golfe rhodanien pliocène, la spéciation remontant au post Pliocène seulement. Il en est de même aux Baléares, en Sardaigne et en Italie, où les espèces ont dû s'individualiser lors de la régression post-Pliocène. Il n'est pas impossible qu'en Sardaigne, la transgression interglaciaire ait pu entrer en jeu également, l'espèce sarde présentant une apomorphie remarquable. Par contre, en Corse et en Algérie, la spéciation daterait de régressions nettement plus anciennes. Le bloc Corso-Sarde était relié à l'Ibérie et au continent européen à l'Oligocène, et l'espèce corse pourrait avoir été mise en place au cours de la régression du Burdigalien ou du Langhien.

La chronologie de la spéciation établie d'après l'histoire géologique de la Méditerranée permet de dater les divergences des clades. Il existe en outre une bonne concordance entre les reconstitutions phylogénétiques et les évènements historiques liés à la Tectonique des Plaques et à l'évolution de la Téthys, les espèces les plus primitives étant apparues à la suite des régressions les plus antérieures, et les espèces les plus évoluées provenant du retrait de la Téthys le plus récent.

BLONDEL J., 1986. Biogéographie évolutive. Coll. Ecol., 20, Masson, Paris, 221 p.

BOUTIN C. et N. COINEAU, 1990. "Regression Model" modèle biphase d'évolution et origine des micro-organismes stygobies interstitiels continentaux. Revue Micropaléont. (sous presse).

DERCOURT *et al.*, 1985. Présentation de 9 cartes paléogéographiques au 1/20 000 000e s'étendant de l'Atlantique au Pamir, pour la période du Lias à l'Actuel. *Bull. Soc. Géol. Fr.*, 8, I (5) : 637-652 + 10 cartes couleur.

STOCK J.H., 1980. Regression Model Evolution as examplified by the genus *Pseudoniphargus* (Amphipoda). *Bijdr. Dierk.* 50 (1) : 105-144.

Y-IV9

Mise à jour des données biogéographiques sur le peuplement de Spongiaires de la Méditerranée

Maurizio PANSINI

Istituto di Zoologia dell'Università, Via Balbi 5, 16126 Genova (Italia)

Bien que le peuplement de Spongiaires de la Méditerranée soit assez bien connu, il continue de susciter un intérêt remarquable, un bon nombre de contributions ayant paru au cours des dix dernières années.

Cette recherche bibliographique se propose de mettre à jour les données sur les Spongiaires méditerranéennes à partir de la note sur les affinités de ce peuplement publiée par Vacelet (1980). On a utilisé comme point de départ la liste d'espèces (non publiée) que cet auteur a bien voulu me confier et la liste publiée par Pulitzer-Finali (1983). L'analyse a été limitée au peuplement de Démosponges puisque pour les Hexactinellides on a eu seulement l'addition de *Yalonema tomphsoni* Marshall aux sept espèces déjà connues pour la Méditerranée (Uriz, 1986), et que la situation n'a pas variée pour les Calcarea depuis 1980.

Les données utilisées sortent d'une interprétation personnelle des synonymies, qui exclut 53 espèces considérées comme incertaines (pour la plupart anciennes et uniques citations, souvent avec des descriptions insuffisantes) et qui ne tient pas compte des variétés.

Avec ces réductions le nombre des Démosponges connues pour la Méditerranée est de 512; il augmente de 59 unités par rapport à la liste de Vacelet (1980) et diminue de 35 unités par rapport à la liste de Pulitzer-Finali (1983). 35 espèces nouvelles ont été décrites après 1980. Le nombre des nouvelles signalisations pour la Méditerranée - plus difficilement éstimable - à cause des changements des synonymies - comprend sûrement au moins 5 espèces (*Esperiopsis fucorum* (Esper), *Halichondria agglomerans* Cabioch, *Haliclona fistulosa* (Bowerbank), *Haliclona rava* (Stephens), *Oceanapia isodictyformis* (Carter), mais d'autres données sont en train d'être publiées.

Endémiques	Atlantiques tempérées	Atlantiques froides	Atlantiques chaudes	Indo-pacifiques	Circum-tropicales	Cosmopolites
234	64	105	31	14	13	51
45,7 %	12,5 %	20,5 %	6 %	2,7 %	2,5 %	10 %

Tab. 1 - Affinités biogéographiques du peuplement de Démosponges méditerranéennes (nombre d'espèces et % de la faune).

En considérant les affinités biogéographiques du peuplement de Démosponges (Tab. 1), on voit que le noyau d'espèces le plus important (234) est celui des endémiques méditerranéennes, qui répresente le 45,7 % du total. Cette valeur, même avec une analyse plus sélective des données disponibles, s'est augmentée d'un point en pourcentage dans les dix dernières années, surtout à cause d'une meilleure connaissance des niveaux relativement profondes (80-120 m) de la Méditerranée occidentale. Il devrait toutefois décroire au fur et à mesure que progressent les études sur les régions biogéographiques limitrophes et les zones profondes (Uriz, 1983). En effet les études récentes de Boury-Esnault & Lopes (1985) sur les Açores et de De Weerdt & Van Soest (1986) sur la partie sud-est de l'Atlantique du Nord, ont signalé en Atlantique 9 espèces qui étaient considérées comme endémiques de la Méditerranée. Boury-Esnault, Pansini et Uriz (en préparation) en étudiant les échanges faunistiques entre la Méditerranée et l'Atlantique au niveau des fonds au dessous de 150 m (mission française Balgim) ont trouvé en Atlantique 7 espèces considérées comme endémiques de la Méditerranée et en Méditerranée 8 espèces atlantiques.

Parmi les (200) espèces qui hors de la Méditerranée se retrouvent en Atlantique celles avec affinités froides (province atlantique boréale, 20,5 %) sont plus nombreuses que celles avec affinités tempérés (région lusitanienne et maurétanienne, 12,5 %) ou chaudes (région sénegalienne et espèces anfiatlantiques, 6%). Deux groupes presque équivalents d'espèces sont communs à l'aire indopacifique (2,7 %) ou ont une distribution circumtropicale. Les échanges avec la Mer Rouge à travers le canal de Suez restent très réduits, mais cette donnée peut être liée à la connaissance - encore mauvaise - du bassin oriental. 10 % des espèces méditerranéennes peuvent être considérées cosmopolites ou à large répartition.

Cette mise à jour - qui concerne au moins 10 % des espèces de Démosponges méditerranéennes - confirme l'affinité plus évidente de ce peuplement avec la faune de l'Atlantique Nord-Est. Le nombre très élevé des espèces endémiques peut être surestimé (Vacelet, 1980) mais il témoigne de l'existence d'un peuplement très particulier qui s' est développé dans un milieu où le niveau de spéciation peut être rélativement rapide, en fonction des fluctuations climatiques et des variations de niche qui en sont la conséquence (Sarà, 1985).

Références

Boury-Esnault, N. & T. Lopes, 1985. Les Démosponges littorales de l'Archipel des Açores. *Ann. Inst. océanogr.*, Paris, **61** (2):149-225.

De Weerdt, W.H. & R.W.M. Van Soest, 1986. Marine shallow-water Haplosclerida (Porifera) from the south-eastern part of the North Atlantic Ocean. *Zool. Verhandelingen*, Leiden, **225**: 3-49.

Pulitzer-Finali, G., 1983 - A collection of Mediterranean Demospongiae (Porifera) with, in appendix, a list of the Demospongiae hitherto recorded from the Mediterranean Sea. *Ann. Mus. Civ. St. Nat. G. Doria*, Genova, **84**:445-621.

Sarà, M., 1985 - Ecological factors and their biogeographic consequences in the Mediterranean ecosystems. In Mediterranean Marine Ecosystems, M. Moraitou-Apostolopoulou et V. Kiortsis ed., Plenum Publish. Corp, New York: 1-17.

Uriz, M., 1983 - Présence de l'espèce *Esperiopsis fucorum* (Demospongia, Poecilosclerida) en Méditerranée. *Vie et Milieu*, **33** (3/4):237-240.

--- 1986 - *Hyalonema thompsoni* Marshall, une nouvelle Hexactinellide Mèditerranéenne et ses affinités avec *H. infundibulum* Topsent. *Rapp. Comm. int. Mer Médit.*, **30**(2):11.

Vacelet, J., 1980 - Les affinités du peuplement de Spongiaires de la Méditerranée. *Journées Etud. Systém. et Biogéogr. Mèdit.*, C.I.E.S.M.:29-30.

Y

Biogeographical remarks about the Ascidian littoral fauna of the Strait of Gibraltar (Iberian Sector)

A. RAMOS-ESPLA*, V. BUENCUERPO**, E. VAZQUEZ*** and F. LAFARGUE****

*Institut d'Ecologia Litoral, Ctra. Benimagrell s/n. El Campello. Alicante (Espana)
**Departamento de Biologia Animal I, Facultad Biologia, Universidad Complutense de Madrid, 28040 Madrid (Espana)
***Departamento de Biologia Animal, Facultad Biologia, Universidad de Santiago de Compostela, Santiago de Compostela, La Coruna (Espana)
****Laboratoire Arago, 66650 Banyuls-sur-Mer (France)

* Study included in the Project PB87-0051-c02 of the Spanish DGICYT

The ascidians are considered excellent material for biogeographical studies, having an higher percentage of endemisms than other benthic groups (Pérès & Picard, 1964). The biogeography of ascidians has been little studied in the Mediterranean Sea. Peres (1958) establish the biogeographical elements (Atlantic -Mediterranean, Senegalense, endemic, paleomediterranean, Arctic, immigrated from the Red Sea, circumtropical and cosmopolitan, giving a necessary view of the whole.

Fifty-seven ascidians species have been collected on littoral hard-bottoms (0 to 30 m depth) in the Iberian sector of Gibraltar Strait and adjacent zones (from Càdiz to Fuengirola, Màlaga). These species have been divided in five biogeographical groups, according to Ramos (1988)

1. Atlantic-Mediterranean species (47.4%), from British Isles (western sector) to Dakar. Three elements may be separated: i) Lusitanian-Mauretanian components (26.4%) from British Isles to Cape Blanco (*C. nana, D. fulgens, D. lahillei, D. spongiforme, P. lacazei, P. canetense, L. perforatum, S. elegans, S. argus, A. coeruleum, A. densum, A. albicans, D. variolosus, S. socialis, P. squamulosa*); ii) Senegalense component (3.5%) from Senegal (*D. obscurum, P. dura*); iii) Mediterranean component (17.5%), which appears in Atlantic area (Canary and Azores Islands, Portugal) (*P. adriaticum, D. granulosum, S. blochmanni, R. neapolitana, C. edwardsi, P. ingeria, P. fumigata, H. papillosa, M. polymorphus, M. nudistigma*)
2. Endemic species (17.5%), signaled only in the Mediterranean sea (*D. coccineum, D. commune, T. inarmatum, Tridemnum pedunculatum n. sp., C. dellavallei, A. conicum, A. haouarianum, P. crucigaster, P. cyrnusense, M. savigny*).
3. Boreal species (17.5%), reaching north European waters (North Sea, Scandinavia) (*C. lepadiformis, P. crystallinus, D. maculosum, T. cereum, S. turbinatum, P. aurantium, A. mentula, P. rustica, P. pomaria, M. occulta*).
4. Tropical affinity species (8.8%) (*C. dellechiajei, D. candidum, P. viridis, E. turbinata, M. exasteratus*).
5. Cosmopolitan species (8.8%) (*D. coriaceum, D. listerianum, P. bilobatum, B. schlosseri, B. leachi*).

	Gibraltar	Alboran	Levante	Cataluña	Baleares
Atlantic-Mediterranean	47%	42.5%	42.5%	42%	42%
endemic (Mediterranean)	17.5	19.5	20.5	24	28
boreal	17.5	21	19	18	14
cosmopolitan	9	10	10	10	.9
tropical affinity	9	7	8	.6	.7

Table 1. Percentages of the biogeographical elements of the Gibraltar Strait in comparison with the different sectors of the Iberian Mediterranean (modified from Ramos,1988)

According to table 1,a strong presence of the Atlantic -Mediterranean component is observed, and a gradual decrease of the endemic one. The low percentage of the Boreal species is probably due to the shallowness of the bottom sampled (no more of the -30m depth).

The Mediterranean component (endemic + Mediterranean species reaching Canary and Açores Islands, and Portugal) is about 35%, that means an high influence of shallow mediterranean waters on this sector.

It is noted the presence of the Atlantic species *Polycarpa rustica* and *Stolonica socialis*, and Indopacific one *Didemnum candidum*.

References

PERES,J.M.,1958. Origine et affinités du peuplement en ascidies de la Méditerranée. *Rapp. P. V. CIESM.*,14:493-502
PERES,J.M. & PICARD,J.,1964. Nouveau Manuel de Bionomie Benthique de la Méditerranée. *Recl.trav.Stn.mar.Endoume*,47(31):5-137.
RAMOS ESPLA,A.A.,1988. Ascidias litorales del Mediterràneos Ibérico. Faunistica, ecologia y biogeografia. Tesis Doctoral, Universidad de Barcelona.

Eritrean Decapods in the Levant - Biogeography in motion

Bella S. GALIL

Israel Oceanographic and Limnological Research Institute, P.O.B. 8030, Haifa and Center for Nature Conservation Research, George S. Wise Faculty of Life Sciences, Tel Aviv University (Israel)

The Levant basin, a warm and salty cul-de-sac, is remarkably poor, both in species and individuals, compared with the rest of the Mediterranean. But, since the opening of the Suez Canal over 120 years ago, more than 200 Eritrean species colonized the Levant (Por, 1978) bringing about a profound change in the local fauna.

Ecological, geographical and historical factors have favoured the process, termed Lessepsian migration, that is, the colonization of the Mediterranean by Eritrean species migrating through the Suez Canal. Decapods are among the more prominent migrants, to date thirty one species of Eritrean decapods became established and founded thriving populations along the Mediterranean coast of Israel (Holthuis and Gottlieb, 1958; Lewinsohn and Holthuis, 1964; Galil, 1986).

Three migrants have been discovered but recently. A species of Metapenaeopsis - an Indo-Pacific genus not previously reported from the Mediterranean - is the sixth migrant penaeid. Metapenaeopsis aegyptia is known from the Red Sea, Djibouti and the Maldive Islands. It appears that within a remarkably short space of time it has succeeded in well establishing itself and forming flourishing populations. Panulirus ornatus (Fabricius), recently found in Haifa Bay, is widely distributed throughout the Indo-Pacific but has only been recorded twice from the Red Sea (Holthuis, 1968). P. ornatus is known to conduct seasonal migrations (Moore and Macfarlane, 1984) and is known to inhabit shallow coastal waters and lagoons (George, 1968). Its euryhalinity and proclivity for migration mark it as a candidate for lessepsian migration. Matuta banksi Leach is another widely distributed Indo-Pacific species, commonly found on shallow sandy bottoms, that occurs in the Red Sea and was found lately off our coast.

Biogeographically, the fauna of the Israeli coast is part of the Mediterranean, sharing origin as well as basic organization of its communities. However, it is set apart from other regions of the Mediterranean by some peculiar properties derived from its position, origin and and distribution of species. The thirty-one Eritrean decapods that have entered the Mediterranean are now well established in various habitats in the southern Levant basin and comprise almost 20% of the known decapod fauna in our waters. This large contingent of successful colonizers demonstrates that some types of habitats for tropical species are available in the region. The Lessepsian migration is an ongoing process and we expect that a continuously growing proportion of the fauna will be composed of migrants and change the faunal picture of this corner of the Mediterranean - a fascinating, unique phenomenon of zoogeographical modification through human interference.

References

Galil, B.S., 1986. Red Sea decapods along the Mediterranean coast of Israel: ecology and distribution. Proc. III Int. Con. Isr. Soc. Ecol. Environ. Sci. 3:179-183.

George, R.W., 1968. Tropical Spiny Lobsters, Panulirus spp. of Western australia (and the Indo West Pacific). J. R. Soc. West Aust. 51(2):33-38.

Holthuis, L.B., 1968. The Palinuridae and Scyllaridae of the Red Sea. Zool. Meded. Leiden, 42(26):281-301, 2 pls.

Holthuis, L.B. and E. Gottlieb, 1958. An annotated list of the decapod crustacea of the Mediterranean coast of Israel with an appendix listing the Decapoda of the Eastern Mediterranean. Bull. Coun. Israel, 7B(1-2):1-126, figs 1-15, 3 pls.

Lewinsohn, Ch. and L.B. Holthuis, 1964. New records of decapod crustacea from the Mediterranean coast of Israel and the Eastern Mediterranean. Zool. Meded. Leiden, 40(8):45-63, figs 1-5.

Moore, R. and J.W. Macfarlane, 1984. Migration of the ornate Rock Lobster Panulirus ornatus (Fabricius) in Papua New Guinea. Aust. J. Mar. Freshwater Res. 35:197-212.

Por, F.D., 1978. Lessepsian migration. The influx of Red Sea Biota into the Mediterranean by way of Suez Canal. In: Billings, W.D., Golley, O.L. Lange and J.S. Olson (eds.) Ecological Studies, 23:1-228. figs 1-47, pls 1-10.

Y

Y-IV12

Etat des connaissances sur la Faune Marine Méditerranéenne

G. FREDJ* , D. BELLAN-SANTINI** et M. MEINARDI*

*Laboratoire d'Océanographie Biologique, Université de Nice (France)
**Centre d'Océanologie de Marseille, GDR ECOPROPHYCE, Station Marine d'Endoume, Marseille (France)

A partir de la banque de données biologiques MEDIFAUNE et d'une abondante littérature ancienne et récente, on a tenté de dresser un état des connaissances de la faune marine méditerranéenne et de ses relations avec la faune marine mondiale. Les différents points suivants sont abordés.

1. La faune méditerranéenne:

1.1. Essai d'évaluation des faunes marines mondiale et méditerranéenne:

Un tableau général contenant les données ou estimations mondiales,celles de Méditerranée, le contenu vérifié de MEDIFAUNE ainsi que l'état des compléments en cours a été dressé.

Cette compilation nous a permis de séparer les groupes bien connus de ceux qui le sont moins bien et qui nécessiteraient des études plus approfondies.

1.2. Vitesse d'acquisition des connaissances en Méditerranée:

Les connaissances sur la faune méditerranéenne n'ont pas augmenté régulièrement mais par étapes . Les grandes étapes d'acquisition des connaissances sont analysées pour un certain nombre de groupes-tests. Pour cela nous avons pris les groupes représentés en Méditerranée par plus de 150 espèces, que nous comparons à l'ensemble de la faune.

1.3. Analyse et discussion des résultats.

Ces tentatives d'évaluation de l'importance de la faune marine méditerranéenne par rapport à la faune marine mondiale, du rythme de sa connaissance posent un certain nombre de problèmes qu'il est nécessaire de cerner afin de relativiser certains résultats et d'élaborer quelques conclusions .

2. Répartition des espèces méditerranéennes d'après MEDIFAUNE:

L'existence d'une banque permet d'enregistrer avec certitude et d'une manière très complète un certain nombre de données brutes et de données élaborées mettant en évidence, lorsqu'on les analyse, les caractéristiques générales de la faune méditerranéenne.

2.1. Résultats bruts:

Ces données peuvent être totalisées et fournir des bilans aussi bien hors de Méditerranée que dans l'ensemble de la Méditerranée et dans ses différents bassins.

2.2. Aspects qualitatifs plus précis:

L'existence de différents problèmes taxonomiques généraux ou biogéographiques simultanément dans plusieurs groupes zoologiques peut être mis en évidence à l'aide d'une banque du type de MEDIFAUNE.

Des exemples tels que ceux concernant des espèces ou des groupes-tests, des taxons posant des problèmes de distribution biogéographique ainsi que divers exemples de spéciation sont fournis.

2.3.Répartition bathymétrique:

La répartition bathymétrique est très souvent fournie de manière globale sans tenir compte des densités de répartition et des récoltes accidentelles. Les données précises contenues dans une banque permettent de relativiser certaines généralisations abusives ou écologiquement aberrantes.

2.4.Conclusions:

L'aide d'une banque de données est soumise à un certain nombre de contraintes qu'il nous paraît utile de discuter en même temps que les avantages de l'outil.

3. L'endémisme méditerranéen :

L'endémisme apparent n'est pas équivalent dans tous les groupes; il est le résultat d'un certain nombre de facteurs externes(histoire, pression sélective..), biologiques (mode de dispersion, adaptatibilité du génome,..)et de conditions conjoncturelles (état des connaissances) . Un bilan actuel complet est extrêmement difficile mais un état provisoire peut être dressé selon:

3.1. L'importance numérique (niveau générique et spécifique)
3.2. La répartition géographique
3.3 La répartition bathymétrique.

4. Conclusions générales:

Un certain nombre de conclusions générales peut être tiré de ce bilan sur l'état des connaissances avec:

4.1.Les points-clés paraissant acquis et sur lesquels il ne paraît pas nécessaire de revenir dans un proche avenir.

4.2. Les problèmes posés et qui peuvent fournir de fructueuses voies de recherches.

Nous classerons ces problèmes selon deux plans : sur le plan fondamental d'une part et sur le plan plus directement appliqué d'autre part.

Sur le plan fondamental se situent l'accroissement des connaissances dans les secteurs ou les milieux encore peu ou mal connus, les problèmes de répartition quantitative des espèces, enfin l'approche génétique des espèces endémiques, des vicariantes et, plus simplement des différentes populations d'une même espèce.

Sur le plan appliqué,nous distinguerons, d'une part, les problèmes liés à la protection de l'environnement et des espèces rares ou sensibles,d'autre part ceux concernant l'exploitation des espèces d'intérêt économique et les bases fondamentales de l'aquaculture.

Y-V1

Flux of Transuranium Nuclides in the Northwestern Mediterranean following the Chernobyl Accident

S.-W. FOWLER* , S. BALLESTRA* , J. LA ROSA* , E. HOLM** and J.-J. LOPEZ*

*International Laboratory of Marine Radioactivity, IAEA, 19, Avenue des Castellans (Monaco)
**Radiation Physics Department, Lund University, Lasarettet, Lund (Sweden)

Introduction

Biogeochemical flux studies have furnished data on the vertical flux of natural and artificial radionuclides through the water column in the North Pacific and North Atlantic, however, until recently similar information for the Mediterranean has been lacking (Fowler et al., 1987; in press). As part of the French DYFAMED Programme, sediment traps were moored in the Ligurian Sea at 200 m depth approximately 15 nautical miles off the coast of Corsica. The total depth of the water column at this station was 2200 m. The automated sediment traps were set to collect six consecutive samples at intervals of every 6.25 days during April-May 1986. On 26 April 1986, the accident at Chernobyl occurred and subsequent sampling of air, sea water, plankton and sedimenting particles allowed assessing the behaviour and transport of Chernobyl-derived radionuclides in the northwestern Mediterranean Sea (Fowler et al., 1987; Whitehead et al., 1988; Holm et al., 1988). Here we report the concentrations of $^{239+240}$Pu and ^{241}Am in various samples collected before and after the Chernobyl fallout was detected in this region.

Results and Discussion

The Chernobyl fallout was first detected in Monaco on 30 April and subsequent wet and dry fallout analyses indicated that peak Chernobyl fallout delivery to the sea surface near Monaco occurred during 4-5 May (Whitehead et al., 1988). The total integrated deposition of $^{239+240}$Pu at Monaco following the accident was 10±1 mBq m^{-2}. The ^{241}Am/$^{239+240}$Pu activity ratio was 0.13±0.03 corrected to 26 April. This ratio is lower than the integrated ratio today from nuclear test fallout (0.36) but will increase rapidly due to the decay of ^{241}Pu since the ^{241}Pu/$^{239+240}$Pu ratio was unusually high (=86) in the Chernobyl fallout. The deposition of $^{239+240}$Pu was only about 0.02% of the previous integrated deposition from nuclear test fallout, which means that post-Chernobyl samples contain activity from both source terms. The two sediment trap samples collected before 26 April are considered to contain only background levels of $^{239+240}$Pu and ^{241}Am arising from nuclear testing fallout (Table 1). Thus, an average ^{241}Am background concentration in sedimenting particles of 0.78 Bq kg^{-1} dry can be computed. Plutonium concentrations in the first two samples varied to a greater degree and an average concentration of 3.7 Bq kg^{-1} may be representative. Fission product analyses indicated that the maximum concentrations of Chernobyl-derived radionuclides were found in particles at 200 m during 8-15 May (Fowler et al., 1987). Comparison of the average pre-Chernobyl levels with the transuranic concentrations measured in particles collected between 8-15 May indicate an increase in $^{239+240}$Pu and ^{241}Am by a factor of 2.6 and 4.7, respectively (Table 1). Transuranic concentrations decreased thereafter similar to those of the fission products (Fowler et al., 1987) indicating the pulsed nature of the vertical flux of Chernobyl-derived radionuclides associated with sinking particles.

Microscopic examination of the sediment trap samples showed that a large proportion of the particulates was zooplankton fecal material. Zooplankton netted over the traps and particularly their freshly excreted fecal pellets also contained relatively high concentrations of transuranics (Table 1). In the case of plutonium, concentrations were quite similar in fresh fecal pellets and in the particulates from 200 m. If we assume that most of the particles in the traps were fecal pellets (Fowler et al., 1987), the increased Am/Pu ratio in the sinking particles from 8-15 May compared to that in pellets produced over the traps on 6 May suggests that sinking fecal pellets scavenged ^{241}Am to a greater extent than $^{239+240}$Pu as they sank through the water column. A similar observation has been made for these transuranics in north Pacific waters (Fowler et al., 1983).

Table 1. Concentrations, activity ratios and vertical fluxes of transuranics in the northwestern Mediterranean before and after the Chernobyl accident. Concentrations in zooplankton and their fecal pellets are also given for comparison.

Sample/Date	Concentration $^{239+240}$Pu (Bq kg^{-1} dry)	Concentration ^{241}Am* (Bq kg^{-1} dry)	Ratio Am/Pu	Mass flux (mg m^{-2}d^{-1})	Flux $^{239+240}$Pu (mBq m^{-2}d^{-1})	Flux ^{241}Am (mBq m^{-2}d^{-1})
Sediment trap (200 m)						
13-20 April	5.43	0.87	0.16	213.7	1.16	0.19
20-26 April	2.00	0.68	0.34	111.5	0.22	0.076
26 April-2 May	3.00	1.51	0.50	63.9	0.19	0.096
2-8 May	3.22	1.05	0.33	65.5	0.21	0.069
8-15 May	9.70	3.63	0.37	53.6	0.52	0.19
15-21 May	4.71	2.83	0.60	57.6	0.27	0.16
Zooplankton (0-100 m) 6 May	0.016	0.004	0.25			
Fecal pellets (0-100 m) 6 May	7.4	0.63	0.09			

*^{241}Am values corrected for ingrowth from ^{241}Pu

From Table 1, the integrated vertical flux through 21 May of post-Chernobyl $^{239+240}$Pu associated with sinking particles is calculated to be approximately 7.5 mBq m^{-2}. Comparison of this value with the total integrated wet and dry deposition at Monaco cited above suggests that 75% of the plutonium deposited in this region had fluxed through 200 m depth within one month following the accident. To our knowledge there are no other comparable transuranic data from sediment trap studies which were underway in European waters following the accident. Nevertheless, our results have demonstrated that small, but significant inputs of $^{239+240}$Pu and ^{241}Am resulting from the Chernobyl accident were measureable in the northwestern Mediterranean. Our data also suggest that both radionuclides were rapidly scavenged from the surface layers and transported to depth by sinking biogenic debris.

References

FOWLER, S.W., BALLESTRA, S., LA ROSA, J. & FUKAI, R. Deep-Sea Res. 30: 1221-1233 (1983).
FOWLER, S.W., BUAT-MENARD, P., YOKOYAMA, Y., BALLESTRA, S., HOLM, E. & NGUYEN, H.V. Nature 329: 56-58 (1987).
FOWLER, S.W., BALLESTRA, S. & VILLENEUVE, J.-P. Cont. Shelf Res. (in press).
HOLM, E., AARKROG, A., BALLESTRA, S. & LOPEZ, J.J. Proceedings 4th Intern. Symp. Radioecology, pp. A-22, Centre d'Etudes Nucleaires de Cadarache, France (1988).
WHITEHEAD, N.E., BALLESTRA, S., HOLM, E. & WALTON, A. J. environ. Radioactivity 7: 249-264 (1988).

Estimation of the 137Cs deposited in Aegean Cretian and Ionian Seas after the Chernobyl Accident

P. KRITIDIS and H. FLOROU

Institute of Nuclear Technology, Radiation Protection, NCSR "Democritos", Aghia Paraskevi, Athens (Greece)

Greece is one of the European countries significantly affected by the Chernobyl accident., The average value of ^{137}Cs deposition in the mainland part is estimated to be approximately 6 kBq m^{-2}, the regional averages vary between <1.3 and 30 kBq m^{-2}, while local maxima up to 60 kBq m^{-2} have been observed (KRITIDIS and PAPANICOLAOU, 1987). Most of the data for the caesium deposition (over 400) come from gamma-spectrometry of soil samples collected by a standard procedure from all the regions of the country.

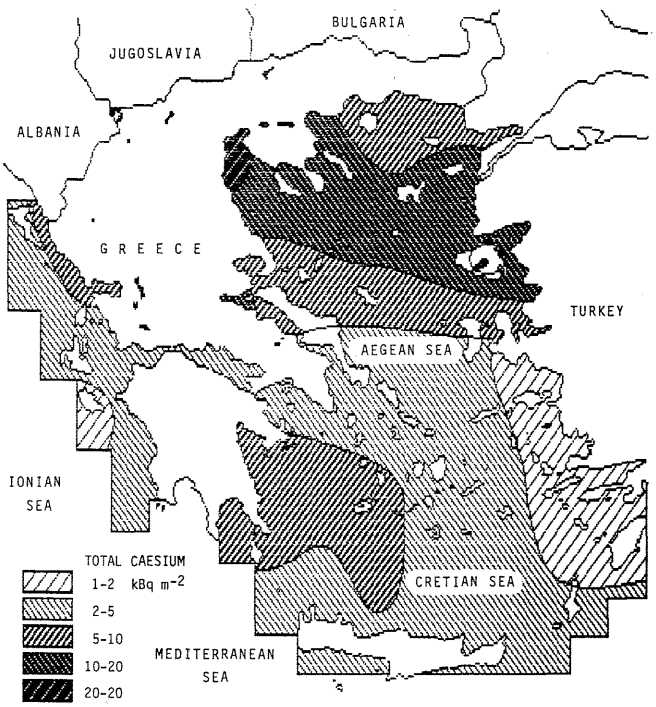


Fig.1. Estimated deposition pattern for total caesium and borders of the sea areas of integration. Note that ^{137}Cs activity equals 66% of the total caesium activity.

A large part of the Greek territory is located close (<50 km) to the sea. The Aegean Sea is surrounded by or includes 23 regions for which the caesium deposition has been estimated. 10 of them belong to islands and 13 to the mainland part of the country. The Ionian Sea includes 4 island regions and borders with 7 mainland regions of the West Greece coast. This allows making a rough estimation of the amounts of ^{137}Cs deposited in the Aegean Sea and in certain parts of the Ionian Sea by interpolating the deposition values for sea regions located between the island and/or mainland "points" and integrating the interpolated values over certain sea areas.

The reliability of such a procedure could be criticized taking into account the irregularities observed in the deposition pattern of the mainland part. To have an idea of the possible deviations of the estimated values from the real ones, we used the data from the coastal and border regions to interpolate for the *inner* parts of the country and to compare the results with the known values for these parts. This led, for two regions of Central Greece, to an underestimation of the regional average by 2-2.5 times. It is clear that the interpolated "sea deposition pattern" provides only a very rough idea of the real situation.

The interpolated data from the above "test" were used also to calculate the average value of the ^{137}Cs deposition in the inland part (38 regions) and to compare it with the average based on the known values. In this case the underestimate was only 12% due to the fact that the interpolation procedure had to be applied in only 8 of the 38 regions. This indicates that the *average* deposition values as well as the total ^{137}Cs input estimated for the Aegean and Ionian Sea could differ from the real value by no more than e.g. ±50%.

The interpolated caesium deposition patterns for the Aegean and Ionian Seas are shown in Fig.1. The average deposition of ^{137}Cs in the Aegean Sea (including Cretian Sea as shown in Fig.1) is estimated to be 4 kBq m^{-2} and the total caesium input in this area of 205,000 km^2 is roughly 8.2×10^{14} Bq. The respective values for the part of the Ionian Sea shown in Fig.1 (area of 24,300 km^2 including the Korinthiakos gulf) are 2.5 kBq m^{-2} and 6×10^{13} Bq. Therefore about 9×10^{14} Bq (24 kCi) of ^{137}Cs has been deposited in a 230,000 km^2 marine area surrounding Greece. If one accepts the estimations presented in DOE (1987), this corresponds to 2.4% of the ^{137}Cs activity deposited in Western Europe and to 0.8% of the total ^{137}Cs released from the damaged Chernobyl reactor.

REFERENCES

KRITIDIS P. and PAPANICOLAOU E., 1987. Deposition of caesium and contamination of certain products. Proc. Regional I.R.P.A. Congress, Rome (Italy), 12-13 Oct. 1987.

DOE/ER-0332, 1987. Health and Environmental Consequences of the Chernobyl Nuclear Power Plant Accident. US Department of Energy, Springfield (USA): p.3.30.

The Radioactivity Levels in Rapana Thomasiana thomasiana from the Bosphorus and Black Sea after the Tchernobyl Accident

A.-M. BULUT, S. TOPCUOGLU, N.SEZGINER, M. SONMEZ and N. BAYULGEN

Cekmece Nuclear Research Center, P.O. Box 1, Airport, Istanbul (Turkey)

Some papers have been published on the occurrence of Tchernobyl radionuclides in the marine environment of the Black Sea (Topcuoglu et al., 1988a; Guven et al., 1990). Radioactivity measurements in some bioindicator marine organisms, particularly those living beneath the sediments were made in order to correlate radionuclides concentration in the organisms with those in the sediments.

The shellfish Rapana thomasiana thomasiana (Gross) was collected from the Bosphorus and Black Sea during the period 1986-1988. The wet weight was determined for all samples. Prior to radioactivity analysis, the soft parts of the animals were dissected. All samples were pooled, freeze-dried for several days to a constant weight and counted.

Table 1. Radioactivity levels in the soft parts of R.thomasiana thomasiana (Bq g^{-1} dry weight). To convert these units to wet weight divide by 4.

Coll. date	Location	^{134}Cs	^{137}Cs	^{106}Ru	^{110m}Ag	Tot.β
1986						
July	Fatsa	0.009±0.005	0.029±0.003	0.143±0.030	0.005±0.004	0.160
Dec.	Sinop	ND	0.002±0.001	0.019±0.008	0.003±0.002	0.168
Dec.	Fatsa	0.007±0.003	0.027±0.004	0.126±0.043	0.007±0.006	0.157
Dec.	Bosp.	ND	0.005±0.003	ND	ND	0.147
1987						
Feb.	Fatsa	0.006±0.004	0.029±0.015	0.065±0.023	0.013±0.010	0.165
June	Fatsa	0.003±0.002	0.009±0.005	0.041±0.012	0.004±0.003	0.185
June	Bosp.	ND	0.003±0.002	ND	0.003±0.002	0.171
July	Sinop	ND	ND	0.015±0.009	0.005±0.004	0.190
Aug.	Bosp.	ND	ND	ND	ND	0.185
1988						
Feb.	Fatsa	ND	0.007±0.006	ND	ND	0.178
Mar.	Sinop	ND	ND	ND	0.002±0.001	0.163
Mar.	Bosp.	ND	ND	ND	ND	0.167

All samples were counted in February and January 1988.

ND: Not Determined

^{134}Cs activity was detected only in Fatsa samples during 1986 and 1987. ^{134}Cs activity was also detected in Black Sea algae during 1987 (Guven et al., 1990). ^{137}Cs activity in July 1986 was 0.029 Bq g^{-1} in the Fatsa sample, decreasing slightly at the same site in June 1987. At the same time, the ^{137}Cs activity was found at very low levels in both Sinop and Bosphorus samples in 1986. It should be noted that the ^{134}Cs and ^{137}Cs activities were found to be higher in Fatsa samples than at other locations. These results were also in good agreement with our prior work (Topcuoglu et al., 1988b). The deposition of the Tchernobyl radionuclides in hazelnut product was found to be higher in the eastern Black Sea region than in the western Black Sea.

The ^{106}Ru activity in the Fatsa sample in July 1986 was 0.143 Bq g^{-1} and decreased to 0.065 Bq g^{-1} level in February 1987 at the same location. ^{106}Ru was also detected in Sinop samples during 1986 and 1987.

After the Tchernobyl accident, ^{110m}Ag was also measured in marine organisms. In the present work, we also detected ^{110m}Ag activity at low levels, in all samples collected during 1986 and 1987 except in those from the Bosphorus.

^{90}Sr activity was below 1×10^{-4} Bq g^{-1} in all samples.

REFERENCES

GÜVEN,K.C., PLEVNELI,M. and CEVHER,E. & TOPCUOGLU,S., KÖSE,N., BULUT,A.M. and BAYÜLGEN,N. 1990. The Radioactivity Level of Black Sea Marine Algae Before and After The Chernobyl Accident. Toxicological and Environmental Chemistry (in press).

TOPCUOGLU,S., BULUT,A.M., BAYÜLGEN,N., KÜÇÜKCEZZAR, R. and KÖSE,N. 1988a. Radioecological Studies in Black Sea Fish After The Chernobyl Accident. In 1st National Medical Physics Meeting, Istanbul, 5-9 Oct. 1987, 264-68, Faculty of Medicine, Cerrahpaşa, Istanbul.

TOPCUOGLU,S., BULUT,A.M., BAYÜLGEN,N., ESEN,N., AKGÜN,F., KUT,D., KÜÇÜKCEZZAR, R., YARINLIOGLU,A., ALTUNDAG,N. and SARIMEHMETOGLU,O. 1988b. The Study of Chernobyl Radioactivity Levels in Hazelnut Products. 1st National Medical Physics congre, pp.255-258, Istanbul.

Y-V4

Radioactivity Levels in Marine Algae from the Black Sea and Marmara Sea

K.-C. GUVEN*, S. YURDOGLU**, N. GUNGOR**, S. TOPCUOGLU**, E. CEVHER*** and B. OZTURK****

*Institute of Marine Science and Geography, Istanbul (Turkey)
**Cekmece Nuclear Research Center, P.O. Box 1, Airport, Istanbul (Turkey)
***Faculty of Pharmacy of the University, Istanbul (Turkey)
****School of Aquatic Products of the University, Istanbul (Turkey)

The accident at Tchernobyl nuclear power station on 26 April 1986 has been the subject of radionuclide contamination surveys in algae (Guven et al., 1990), fish, (Topcuoglu et al., 1988) and sediments (Buesseler et al., 1987) of the Black Sea. In this work the algae were collected from the Turkish coasts of the Black Sea in 1989 and Marmara Sea during 1981-1989 and their gamma isotopic analysis was made using γ-ray spectrometry (Canberra, S 85). The gross beta radioactivities of the samples were also measured with a gas-flow proportional counter.

Table 1

Algae	Location	date	Bq/g^{-1}, dry weight ^{134}Cs	^{137}Cs	^{40}K
Chaetamorpha linum	Şile	(1)	nd	0.010±0.006	1.476±0.216
C. linum	Sinop	(1)	nd	0.011±0.005	2.525±0.268
Ulva rigida	Şile	(1)	<0.005	0.011±0.006	0.749±0.210
U. rigida	Amasra	(2)	nd	0.006±0.003	0.541±0.228
U. rigida	Araklı	(2)	nd	0.007±0.004	0.537±0.230
U. lactuca	Sinop	(1)	nd	0.005	1.021±0.622
Cystoseira barbata	Igneada	(1)	<0.005	0.015±0.009	0.901±0.175
C. barbata	Beşikdüzü	(2)	<0.005	0.015±0.009	0.340±0.203
C. barbata	Çayeli	(2)	nd	0.015±0.007	0.430±0.126
C. barbata	Sarp	(2)	nd	0.007±0.003	1.579±1.379
Ceramium rubrum	Şile	(1)	nd	0.006±0.004	0.817±0.209
C. rubrum	Sinop	(1)	nd	0.012±0.007	0.906±0.301
Phyllophora nervosa	Şile	(1)	nd	0.009±0.005	0.597±0.149

Collection date: (1) Jun. 1989, (2) Jul. 1989, Counting date: Aug.-Dec.1989, Feb. 1990

The ^{137}Cs levels found in the algae samples collected from regions of the Black Sea in 1989 are given in Table 1. As can be seen, ^{137}Cs was detected in some of the samples but ^{134}Cs was only detected in Ulva rigida and Cystoseira barbata.

Table 2

Algae	Location	date	Radionuclide concentration Bq/g^{-1}, dry weight ^{106}Ru	^{134}Cs	^{137}Cs	^{40}K
Ulva lactuca	(1)	a) 25.9.1987 b) 1.4.1988	<0.010	<0.005	0.011±0.003	0.620±0.077
Corallina granifera	(2)	a) 10.10.1987 b) 17.10.1988	<0.010	nd	nd	0.110±0.038

Collection sites: (1) Çanakkale, (2) Gelibolu, a) Collection date, b) Counting date, nd: not detected.

Radioactivity in the algae collected from the region of the Marmara Sea is shown in Table 2. Of the algae collected from Canakkale in 1987, ^{134}Cs and ^{137}Cs activities were detected in Ulva lactuca. ^{137}Cs alone was detected in Cystoseira barbata, Padina pavonia and Ceramium rubrum collected in 1989. ^{137}Cs was also found in Codium fragile collected from Canakkale in 1983 and 1987, but not in 1989. ^{106}Ru activity was detected at the <0.010 level in U. lactuca and Corallina granifera. Total β-activities were found to be between 0.163-1.392 Bq/g.

In our earlier study of radionuclides in the algae of the Black Sea, it was found that contamination due to Tchernobyl was present and it gradually diminished until 1988 (Guven et al., 1990). Comparison of the results from the earlier work with those of the present study showed that radionuclide contamination of the algae diminished over time. The highest contamination appeared at Igneada, Inebolu-Sinop and Sarp on the coasts of the Black Sea.

REFERENCES

BUESSELER,K.C., LIVINGSTON,H.D., HONJO,S., HAY,B.J., MANGANINI,S.J., DEGENS,E., ITTEKKOT,V., IZDAR,E. and KONUK,T. (1987). Chernobyl radionuclides in a Black Sea sediment trap. Nature, 329, 825-28.

GÜVEN,K.C., PLEVNELİ,M., CEVHER,E., TOPCUOĞLU,S., KÖSE,N., BULUT,M. and BAYÜLGEN,N. 1990. The radioactivity level of Black Sea marine algae before and after the Chernobyl accident. Toxicological and Environmental Chemistry (in press).

TOPCUOĞLU,S., BULUT,A.M., BAYÜLGEN,N., KÜÇÜKCEZZAR,R. and KÖSE,N. (1988). Radioecological studies in Black Sea fish after the Chernobyl accident, In 1st National Medical Physics Meeting, Istanbul, 8-9 Oct. 1987, 264-68, Faculty of Medicine, Cerrahpaşa, Istanbul.

Y-V5

Radiocesium Levels in Algae, Shellfish and Sediment Samples collected from the Eastern Mediterranean Coast of Turkey

S. TOPCUOGLU*, D. KUT*, N. ESEN*, K.-C. GUVEN** and E. CEVHER***

*Cekmece Nuclear Research Center, P.O. Box 1, Airport, Istanbul (Turkey)
**Institute of Marine Science and Geography, Istanbul (Turkey)
***Faculty of Pharmacy of the University of Istanbul (Turkey)

Radioactive contamination from the Tchernobyl accident in the marine environment of Turkey has been detected in fish (Topcuoglu et al., 1987), algae (Guven et al., 1990) and shellfish (Bulut et al., in press). In this study we report the data obtained on the radioactivity levels in algae, shellfish and sediments collected from eastern Mediterranean coasts of Turkey in 1989.

The algae samples were collected from Akkuyu, Yumurtalik, Botaş and Karataş. Patella sp. were collected in Akkuyu. The sediment samples were taken with a Beckman type dredge from approximately a 10 m depth in the Akkuyu area. The samples were dried and analysed by a γ-ray Canberra S-85 4 K MCA spectrometer coupled to a high purity Germanium detector (Ortec GMX).

Table 1

Sample	Location		^{134}Cs	^{137}Cs	^{40}K
ALGAE					
Cystoseira crinita	Akkuyu	(1)	nd	nd	1.198±0.169
C. fimbriata	Akkuyu	(1)	nd	0.0021±0.0018	0.879±0.174
Padina pavonia	Akkuyu	(1)	nd	0.0019±0.0018	0.701±0.125
Jania rubens	Akkuyu	(1)	nd	0.0024±0.0020	0.166±0.077
Halopteris sp.	Akkuyu	(1)	nd	0.0016±0.0015	0.471±0.116
Dictyota dichotoma	Akkuyu	(1)	nd	0.0022±0.0019	1.272±0.136
Cladostephus verticilatus	Akkuyu	(1)	nd	nd	0.967±0.237
Padina pavonia	Yumurtalık	(2)	nd	nd	-
Jania rubens	Yumurtalık	(2)	nd	nd	-
Sargassum hornshuchii	Yumurtalık	(2)	nd	0.0032±0.0026	-
S. hornshuchii	Botaş	(2)	nd	nd	-
S. hornshuchii	Karataş	(2)	nd	nd	-
S. linea	Karataş	(2)	nd	0.0025±0.0021	-
SHELLFISH					
Patella sp. (soft part)	Akkuyu	(1)	nd	0.0020±0.0018	<0.061±0.006
Patella sp. (shell)	Akkuyu	(1)	nd	0.0019±0.0018	<0.061±0.006
SEDIMENT					
Sample 1	Akkuyu	(1)	nd	0.0025±0.0021	0.241±0.044
Sample 2	Akkuyu	(1)	nd	0.0020±0.0017	0.290±0.145

(1) Collection date July 1989, Counted date Sept. 1989
(2) Collection date June 1989, Counted date Feb. 1990
nd: not detected

The results are given in Table 1. They indicate that ^{134}Cs activity was not detected. ^{137}Cs was found in the sampler in varying amounts, i.e. in very low or non-detectable levels.

Comparison of the results with those of the earlier study showed that the amounts of ^{137}Cs in Cystoseira fimbriata and Jania rubens were 0.0047 and 0.0039 Bq/g respectively in 1984 but diminished to 0.0021 and 0.0024 Bq/g. At the same time, the amounts of ^{137}Cs in sediments collected from Akkuyu were negligible in 1984 and 1989 (Cnaem, 1986). On the other hand, the ^{137}Cs activity levels are also in the same range in Antalya sediments collected in 1986 before and after Tchernobyl accident (unpublished data).

These results indicate that the effect of the Tchernobyl accident was not apparent in the Mediterranean coasts of Turkey.

REFERENCES

BULUT,A.M., TOPCUOĞLU, S., SEZGİNER, N., SÖNMEZ, M. and BAYÜLGEN, N. The radioactivity levels in Rapana thomasiana thomasiana from the Bosphorus and Black Sea after the Tchernobyl accident, (in press)

ÇKAEM (1986). Pre-Operational Environmental Radioactivity Surveillance Programme For Akkuyu Nuclear Power Plant, Final Report, Çekmece Nuclear Research and Training Center.

GÜVEN,K.C., PLEVNELİ,M., CEVHER,E., TOPCUOĞLU,S., KÖSE,N., BULUT,A.M. and BAYÜLGEN,N. 1990. The radioactivity level of Black Sea marine algae before and after the Chernobyl accident. Toxicological and Environmental Chemistry (in press).

TOPCUOĞLU,S., BULUT,A.M., BAYÜLGEN,N., KÜÇÜKCEZZAR,N. and KÖSE,N. 1988. Radioecological studies in Black Sea fish after the Chernobyl accident. In 1st National Medical Physics Meeting, Istanbul, 8-9 Oct. 1989, 264-68, Faculty of Medicine, Cerrahpaşa, Istanbul.

Y

Le 137Cs et le 134Cs dans les Sédiments Marins Superficiels de la Zone Côtière Cannes-Monaco et du Nord du Canal de Corse

Yolande THOMMERET* et Lang HUYNH NGOC**

*Centre Scientifique de Monaco, 16 Boulevard de Suisse, 98000 (Monaco)
**Laboratoire International de Radioactivité Marine (A.I.E.A.), 19 Avenue des Castellans, 98000 (Monaco)

INTRODUCTION

Parmi les radionucléides dispersés dans l'atmosphère et dans les milieux terrestre et marin après l'accident de Tchernobyl, le ^{137}Cs et le ^{134}Cs ont été analysés dans des sédiments marins superficiels prélevés en mai 1986 dans l'embouchure du Rhône, de 1987 à 1989 le long de la côte de Cannes à Monaco à des profondeurs de -12m à -175m par le N/O Catherine Laurence de l'Observatoire océanologique de Villefranche-Sur-Mer et en 1987 dans le nord du canal de Corse à l'est de Bastia sur des fonds de -200m à -500m par le N/O Winnaretta-Singer du Musée océanographique de Monaco.

Certaines carottes sédimentaires, d'une dizaine de centimètres de longueur, obtenues par benne Van Veen ou par carottier Kullenberg, ont été debitées en section de 1 à 2cm pour déterminer la distribution verticale des deux radiocesium. Les échantillons secs ont été analysés par spectrométrie gamma (détecteur au germanium associé à un ensemble gèré par ordinateur).

RESULTATS ANALYTIQUES

Les teneurs en ^{137}Cs et en ^{134}Cs dans les sédiments étudiés montrent la différence des depôts en ^{137}Cs et en ^{134}Cs du secteur continental et du secteur ilien.

Le long des côtes de Monaco à l'embouchure du Rhône , où les profondeurs de prélèvement s'échelonnent de -12 à -175m, les teneurs en ^{137}Cs varient de 0 á 14 $Bq.kg^{-1}$ poids sec dans toutes les colonnes sédimentaires, le ^{134}Cs présent dans les niveaux supérieurs des carottes á des concentrations oscillant de 0 à 1,8 $Bq.kg^{-1}$ poids sec, n'apparaît plus au-dessous de 5cm. Dans la distribution verticale des deux radiocésium de la carotte prélevée en février 1987 à Cannes à -175m de profondeur, la concentration en ^{137}Cs qui decroît rapidement depuis le niveau 0-2cm de la carotte, est encore mesurable à l'horizon 10-12cm, le ^{134}Cs de teneur plus réduite 0,3 $Bq.kg^{-1}$ à 2-4cm est absent dans des niveaux inférieurs à 4cm. A titre comparatif, des teneurs de 0,7 à 0,3 $Bq.kg^{-1}$ poids sec avaient été mesurées dans les quatre centimètres supérieurs des sédiments fins vaseux carottés en octobre 1965 à -110m de profondeur à 350m au sud du Cap Ferrat, Alpes Maritimes (43°40'3 N -7°19'6 E), (Thommeret,1985).

Les sédiments de l'embouchure du Rhône, carottés quelques jours après l'accident de Tchernobyl, ont été rapidement enrichis en ^{137}Cs (268 $Bq.kg^{-1}$ poids sec) et en ^{134}Cs (114 $Bq.kg^{-1}$ poids sec) confirmant les observations de Delfanti et al (1988). Selon ces auteurs les concentrations les plus élevées en radiocésium dues à la contribution de Tchernobyl sont généralement trouvées dans les secteurs directement soumis aux influences des apports fluviatiles. D'autres auteurs, Calmet et al (1988) ont également montré qu' au niveau des embouchures des fleuves les sédiments sont marqués plus profondement en fonction de l'importance des apports fluviatiles.

Dans les sédiments du nord du canal de Corse carottés en juillet 1987 entre -200 à -500m aucune trace de ^{134}Cs n'a été identifiée, le ^{137}Cs (3,0 $Bq.kg^{-1}$ poids sec) est mesuré dans les deux premiers cm de la carotte de -200m à l'exclusion des autres niveaux et des autres prélèvements.

Parallèlement aux mesures radiométriques des sédiments , les teneurs en ^{137}Cs et en ^{134}Cs des poussières atmosphériques collectées sur la terrasse du Musée océanographique de 1986 à 1990 ont les valeurs suivantes exprimées en $Bq.m^{-3}$):

	^{137}Cs	^{134}Cs	
Mai 1986	1,5E0	0,8E0	Ballestra et al
Mai 1987	24E-6	7E-6	
Mai 1988	10E-6	1E-6	
Mai 1989	5E-6		n.d
Jan 1990	2E-6		n.d

Les sédiments côtiers de Cannes à Monaco prélevés à profondeurs réduites et dans des stations proches de la côte ont été soumis à des apports telluriques et des apports terrrigènes balayant des zones plus étendues que les sédiments du canal de Corse carottés entre -200 et -500m où les particules radioactives de Tchernobyl n'étaient pas parvenues en juillet 1987.

Révélant l'introduction des retombées de Tchernobyl dans les sédiments marins superficiels analysés, les teneurs en ^{137}Cs sont, à l'exception des sédiments de l'embouchure du Rhône, analogues à celles trouvées par Calmet et Fernandez (1988) dans la prémière cartographie de la distribution du ^{137}Cs des depôts récents où les teneurs fluctuent de 0,5 á 35 $Bq.kg^{-1}$ poids sec pour des sédiments des côtes françaises de Méditerranée et de la plaine abyssale du bassin occidental méditerranéen.

BIBLIOGRAPHIE

BALLESTRA S.B., HOLM E., WALTON A., WHITEHEAD N.E. (1987).- Fallout deposition at Monaco following the Tchernobyl accident. J.Enviro.Radioactivity, 5: 391-400.

CALMET D., FERNANDEZ J.M. (1988). - Processus sédimentaire et niveaux d'activité du ^{137}Cs dans les sédiments de Méditerranée nord- occidentale. Radionuclides, a tool for oceanography, p 440.

CALMET D., FERNANDEZ J.M., GONTIER G., CHARMASSON S., BARON Y. (1988).- Distribution spatio-temporelle des radioéléments issus des retombeés de l'accident de Tchernobyl au sein des différents compartiments du bassin méditerranéen. Rapp. Comm.Int.Mer.Medit.31,2:310.

DELFANTI R., FIORE R., LAVARELLO O., PAPUCCI C. (1988).- Environmental radioactivity along the italian coastal marine environment. Int.Conf.on Environmental radioactivity in the mediterranean aera Barcelone May 1988.

DELFANTI R., PAPUCCI C. (1988).- Characteristics on Tchernobyl fallout in the italian coastal marine environment. Int.Conf.on environmental radioactivity in the mediterranean aere. Barcelone May 1988.

THOMMERET Y. (1985).- Activités scientifiques du laboratoire de radioactivité appliquée. Bull.No 1 du Centre Scientifique de Monaco, 78 pages.

Environmental Cs-137 Concentration Factors for Black Sea Biota. - Preliminary Data

Iolanda OSVATH* , Alexandru BOLOGA** and Constantin DOVLETE*

*Environmental Radioactivity Research Laboratory, Institute of Meteorology, C.P.11-2, Bucharest (Romania)
**Romanian Marine Research Institute, Contantza (Romania)

Using field-derived data, Cs-137 concentration factors (CF) were calculated for some common species of fish, mollusca and macrophyta populating the Romanian sector of the Black Sea. The preliminary data presented in this paper are based on the analysis of 140 of the biota samples and 60 of the surface water samples collected during 1987-1989.

Water sampled quarterly from one 30 Nautical miles (Nm) offshore and four shore-line locations (Fig. 1), unfiltered, was infra-red evaporated to residue. Collected from the same area (43°45' N to 44°15' N, within 30 Nm offshore), biota samples - whole body for fish and algae and soft part for mollusca - were washed, then ashed at 450°C.

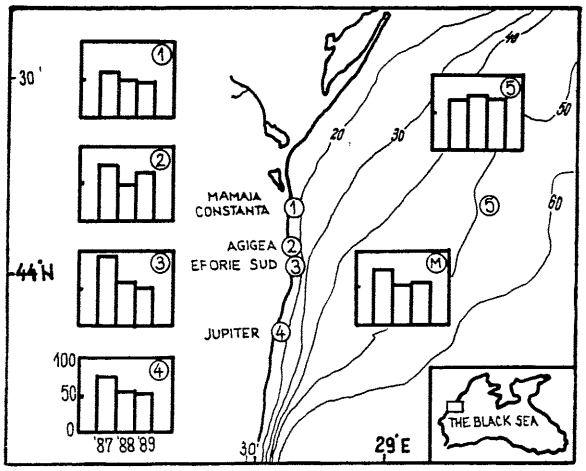


Fig. 1 Cs-137 concentration in Black Sea water (mBq/l) in 1987, 1988 and 1989 : annual mean values for each sampling site (1-5); annual mean values for all sampling sites together (M), used in CF computation.

Gamma spectrometrical analyses were performed using low-background, high resolution equipment.

Concentration factors were computed for Cs-137, as radionuclide of major interest following the Chernobyl accident in 1986. Annual mean values (including all sampling points) of Cs-137 concentration in water (Bq/l), and individual, as well as annual mean per species values of Cs-137 concentration in marine biota (Bq/kg fresh weight) were used in computations. The concentration factors thus obtained (Table 1) are in agreement with those in (IAEA, 1985; GOMEZ et al, 1987).

Table 1

Species	Characteristics	Concentration factor range			
		annual mean	individual values	annual mean	individual values
Sprattus sprattus phalericus	P,E	62-69	33- 93		
Engraulis encrasicolus ponticus	P,E	35-59	17- 59		
Merlangius merlangus euxinus	D,F	45-50	38- 61	fish	
Gobius melanostomus	D,E	53-61	45- 53	35-69	17- 93
Trachurus mediterraneus ponticus	P,E	50-53	45- 67		
Mytilus galloprovincialis	B,E,F	13-27	8- 37		
Mya arenaria	B,E,F	24-47	21- 42	mollusca	
Scapharca inaequivalvis	B,E,F	9-38	13- 58	9-38	8- 58
Rapana thomasiana	G,F	21-27	9- 37		
Enteromorpha intestinalis	C,F	30-49	19- 60		
Enteromorpha linza	C,F			macro-algae	
Cladophora sericea	C,F	24-33	22- 33	24-60	19-124
Bryopsis plumosa	C,F	26-44	26- 44		
Ceramium elegans	R,F	43-60	19-124		

D-demersal P-plankton-feeder E-edible F-feedstock ingredient
B-Bivalvia G-Gastropoda C-Chlorophyta R-Rhodophyta

REFERENCES

GOMEZ L.S., MARIETTA M.G., JACKSON D.W., 1987. Compilation of Selected Marine Radioecological Data for the U.S. Subseabed Program: Summaries of Available Radioecological Concentration Factors and Biological Half-Lives, SAND86-2674, Uc-70

IAEA, 1985. Technical Reports Series No. 247

ACKNOWLEDGEMENT

Part of the basic radioactivity data was obtained under International Atomic Energy Agency research contract no. 4805/RB - "Monitoring of marine water, sediment and biota radioactivity in samples from the Black Sea".

Y-V8

Radioactive Contamination of the Romanian Black Sea Coast during 1989

I.-I. GEORGESCU*, A. PANTELICA** and M. SALAGEAN*

*Polytechnical Institute, Faculty of Chemical Technology, Bucharest (Romania)
**Institute for Physics and Nuclear Engineering, Bucharest (Romania)

Abstract

Samples of bottom sediments, mussels, the polychaete Melina palmata and macrophytes were sampled from north to south along the Black Sea Romanian coast during 1989. Gamma spectrometry with a Ge(Li) detector was used to investigate the fission product ^{137}Cs and the natural long-lived families of U-Ra and Th. The highest contamination was found at Portitza in front of the Lagoon Razelm, south of the Danube delta.

Introduction

The aim of this work is to investigate the presence of ^{137}Cs ($T_{\frac{1}{2}}$=30 y) and the long-lived nuclides of the natural U-Ra and Th families in bottom sediments, mussels and macrophytes of the Black Sea Romanian coast. It must be emphasized that the marine samples have been collected on approximately the same geographical coordinates in the aerobic-anaerobic zone of the Black Sea, for more than 20 years, when this marine environmental radioactive study began in the Polytechnical Institute of Bucharest. In this manner it is possible to obtain an overall insight about the changes in radioactivity in marine samples after the Chernobyl accident on 26 April 1986.

Materials and Methods

At the end of March 1989, the macrophytes Enteromorpha l. and Ceramium r. were collected on the sea-side at North Eforie and Mangalia. During June 1989, the bivalves Mytilus galloprovincialis and Mya arenaria were sampled together with the corresponding bottom sediments from north to south as follows: Sulina, Sf. Gheorghe, Portitza in front of Lagoon Razelm, and Constantza. Alga, sediment, mussels of about 5cm length after separation of soft tissues from the shell, as well as the polychaete Melina palmata (only at Portitza) were dried at 105°C, and ground to a fine powder. Radioanalysis was performed by gamma spectrometry using a Ge(Li) detector coupled to a multichannel analyzer and counting for 28 to 42 hours. At the Portitza sampling site, the following characteristics were: position 44°29'N, 29°20'E, offshore D=17.3 marine miles; water depth h=40 m; liquid discharge of Danube, Q=6830 m^3/s; on the bottom: water temperature = 6.5°C, salinity S=18.23‰, current velocity V=8 cm/s, current direction α=100°.

TABLE 1. Concentration of radionuclides in marine Black Sea Romanian coast samples during March-June 1989, in $Bq.Kg^{-1}$/dry.

Sample	^{134}Cs	^{137}Cs	^{238}U	^{232}Th	^{40}K
Sediment (Sulina)	1.9±0.5	33± 2	21± 2	22± 2	400± 25
Sediment (Sf.Gheorghe)	4.8±0.5	39± 2	14± 2	16± 2	312± 20
Sediment (Portitza)	0.8±0.5	119± 5	43± 3	58± 3	1100± 60
Sediment(Constantza)	5 ± 1	42± 2	18± 1	15± 2	310± 20
Soft tissue *Myt.g.* (Sulina)	9 ± 2	64± 5	22± 3	15± 5	285± 45
Soft tissue *Myt.g.* (Sf.Gheorghe)	6 ± 4	27± 5	< 30	< 40	250± 40
Soft tissue *Myt.g.*	6 ± 3	35± 5	< 2	< 46	745± 50
Soft tissue *Mya a.*	4.3 ±1.4	35± 3	8± 6	17± 3	275± 25
Melina palmata(Polychaete) (Portitza)	31 ± 2	247±12	40±14	50± 5	780± 50
Soft tissue *Myt.g.*	3 ±0.6	26± 2	< 6	6± 3	185± 25
Soft tissue *Mya a.* (Constantza)	< 4	23± 2	< 12	< 18	443± 44
South Eforie	15± 6	34±10	55±30	< 107	1044± 40
Enteromorpha l. Mangalia	2.7±0.6	19± 1	8.3±1.7	6.6±2.2	468± 25
South Eforie	< 14	61±15	38± 9	46±11	607± 35
Ceramium r. Mangalia	< 12	30± 7	< 45	< 24	530± 40

Results and Discussion

From the results shown in Table 1, the following conclusions can be drawn: (1) the higher concentration of ^{137}Cs at Portitza is explained by the presence of illite and kerogen in the fine silty clays which were confirmed by XR, EPR and IR studies (1,2); (2) the radioactivity due to ^{137}Cs, rapidly decreased in marine samples collected during 1989 on the Romanian Black Sea shore.

REFERENCES

1. GUEGUENIAT, P. et CARBONNIE, M. 1976. Contamination de sédiments marins par le ^{137}Cs en fonction de leur composition en Argiles et en Carbonates. Rapp. Comm. int. Mer Médit., 23, 7, pp. 133-135.
2. GEORGESCU, I.I. and MEGHEA, A. Spectral characterization of the Romanian bottom Black Sea sediments contaminated by ^{137}Cs. (In press).

Y-V9

Radioactive Contamination of the Turkish Eastern Black Sea Coast due to Chernobyl Accident

S. TUNCER and A. BAYSAL

Biology Department, Science Faculty, Karadeniz Technical University, Trabzon (Turkey)

The released massive quantities of radionuclides (Cs-134, Cs-137, Ce-141, Ce-144, Ru-103, Ru-106, No-95 etc.) to the lower atmosphere from the Chernobyl Nuclear Power Station on April 26, 1986, have environmental radioecological implications that extend to the future.

Some studies have been carried out to investigate radioactivity in sediment and some species of economic importance (Georgescu et al., 1988 a,b).

The behaviour of Chernobyl radionuclides in the Black Sea is given in Fig.1. As shown in Fig.1. some radionuclides detected in the surface waters were very rapidly removed to the sediment trap at 1071 meters within less than two months.

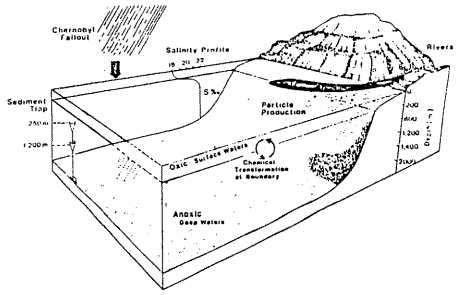


Fig.1. Behaviours of some Chernobyl radionuclides (Ken O. Buesseler, Woods Hole, USA)

Trachurus mediterraneus, Mugil saliens, Engraulis encrasicholus ponticus, Mytilus galloprovincialis, Enteromorpha linza and **Cystoceira barbata** were chosen to monitor Cs-134, Cs-137 in the Trabzon littoral region of Turkey. All samples were dried and powdered. Radioactivity counting was performed by gamma spectrometry (Tennelec) coupled to a Germanium detector.

According to the data presented in Table 1, radioactivity levels varied with species, location and trophic level. For example, Cs-134 and Cs-137 ranged between 3-20 and 5-130 Bq/kg dry weight, respectively.

TABLE 1. Concentrations of radionuclides in selected samples from the Trabzon littoral region. (Bq/kg in dried material)

Samples	Cs-134	Cs-137
M. saliens	20	107
T. mediterraneus	9	47
E.e. ponticus	3	5
M. galloprovincialis	12	130
E. linza	9	35
C. barbata	4	27

Mussels have a high capacity to accumulate heavy metals and radionuclides from ambient waters (Tunçer and Yaramaz, 1986) and gray mullets are omnivores. Both species tend to accumulate excessive amounts of radionuclides; thus, the highest levels of Cs-137 were found in **M.** saliens and **M.** galloprovincialis and the lowest activity was detected in **E.e.** ponticus.

REFERENCES

GEORGESCU, I., SALEGAN, M. et PANTELICA, A., 1988a. Sur la radioactivité de **Mytilus galloprovincialis** recoltée du nord au sud littoral Roumain et de quelques plantes de la flore spontanée d'août à octobre 1987. Rapp. Com. Int. Mer Médit., 31, 2, 308.
GEORGESCU, I., SALEGAN, M. & PANTELICA, A., 1988b. On the radioactivity of the Romanian littoral Zone after the Chernobyl accident during 1986. Rapp. Comm. Int. Mer Médit., 31, 2, 308.
TUNCER, S. & YARAMAZ, O., 1986. Etudes des métaux lourds (Zn, Cu, Pb, Hgt) chez certaines organismes autour de l'ile Karantina (Urla/Izmir-Turquie). Rapp. Comm. Int. Mer Médit., 30, 2, 42.

Y