Cercetari marine	I.N.C.D.M.	Nr. 35	2004	61 - 75

THE PRESENT STATE OF BENTHIC COMMUNITIES IN THE ROMANIAN COASTAL WATERS

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ABSTRACT

The present paper analyses the structure and the quantitative evolution of the zoobenthic communities between 2000-2002 when a slight recovery tendency, due to the diminution ecological pressure by eutrophication was noted.
The results are based on the processing of 230 qualitative and quantitative zoobenthic samples, systematically collected in the research cruisses, carried out in the main Romanian Black Sea sectors : predanubian zone, Constantza and the southern part of the littoral, at different bathymetric zones. The recording of the main parameters characterizing the structure and the populations organisation in the communities, the specific composition, the abundance and weight dominance of the species and groups in communities have evinced the tendencies of marine zoobenthic evolution and its present potential productivity.
For comparison data field obtained in the '90ies have been used when a slight improvement in the conservation state of all trophic levels induced by the diminution of the anthropic pressure was recorded.

KEY WORDS: Black Sea, zoobenthos, evolution, biodiversity

As to the major problems of the humanity (food and energetic resources, natural systems equilibrium maintainance), the knowledge of the structure and functions of the ecological systems represents the essential condition for understanding the laws governing these systems in order to elaborate rational exploitation standards and to protect them.

The coastal waters eutrophication, the most important ecological event which the marine environment endured in the last decades, determinated both structural and functional disturbances of marine life. The benthos, a true ecological barometer of such modifications that took place in the aquatic environment, better reflects the ecological pressure effect due to the global development of anthropic influences.

The long term impact of eutrophication/pollution and hipoxy have determinated major modifications in the benthic associations leading to a faunistic fund scarceness, of about 50 to 60 % compared to the '60ies, to a decrease in biodiversity, and a reduction of the populations of some previously abundant species (GOMOIU, 1976, 1981,1985)

The state of present benthic fauna was analysed as to the structure and the quantitative evolution of its communities, under a slight recovery tendency, due to the diminution of the ecological pressure by eutrophication.

SAMPLING METHODOLOGY AND METHODOLOGIES OF DATA ANALYSIS

During 2000-2002 the ecological state of the zoobenthic communities was established based on processing of 230 qualitative and quantitative benthic samples collected in the research cruises, carried out in the main Romanian Black Sea sectors: predanubian zone, Constantza and the southern part of the littoral, at different bathymetric zones.

For comparison data field obtained in the '90ies have been used when a slight improvement in the conservation state of all trophic levels induced by the diminution of the anthropic pressure was recorded.

Standard methods were used for zoobenthos determinations: washing through granulometric sieve (1mm-0.10 mm); all the material retained by the three sieves has been examined by binocular microscope; all animals were extracted and the species or groups of species were identified and counted (in order to determine the density of populations); the larger organisms were measured and weighted (for size class, structure and biomass); for smaller organisms the average weights inscribed in standard tables were used to calculate the biomass.

The general methodology for data analysis consisted of:

- calculations of the specific parameters;
- graphical data analysis, using the graphic facility of the Word software;

To characterize the living organism associations the following parameters have been calculated (GOMOIU, SKOLKA, 2001):

1. Constancy (F%)- - or continuity of appearance indicating the frequency of the species in the studied area:

   F% = (ns/Ns)*100, where:
   - ns - the total number of stations containig species, and
   - NS – the total number of stations carried out in the studied area.
2. Abundance – Total number or biomass of individuals contained in all stations, or absolute number and biomass of the individuals of a certain species or groups of species in an association.
3. Average density or biomass.

RESULTS AND DISCUSSION

Due to its unique characteristics, the Black Sea is particularly sensitive to hydrological regime modifications, eutrophication/pollution and climate changes and represents a region where the succesive events leading to severe ecosystem damages can be identified and understood. This ecological research aimed mainly at two aspects concerning the communities of organisms from the Romanian littoral zones:

- knowledge of the qualitative state of zoobenthic fauna, as for the *species diversity* (Table 1, Fig.1), and
- knowledge of the quantitative structure of zoobenthos.

Table 1

The benthic fauna identified along the Romanian Black Sea littoral (Sulina – Mangalia) between 2000-2002

Zoobenthic species	**2000**	**2001**	**2002**
COELENTERATA			
ANTHOZOA			
Actinia equina (L.)	+	+	+
Actinothoe clavata Ilmoni	-	+	+
Cerianthus solitarius (Forb.)	+	+	+

Zoobenthic species	2000	2001	2002
NEMERTINI	+	+	+
Amphiporus bioculatus (Linne)	-	+	+
Micrura fasciolata (Ehrbg.)	+	+	+
Tetrastemma bacescui	-	+	+
TURBELARIA	+	+	+
Leptoplana tremellaris (O.F.M.)	-	+	+
NEMATODA	+	+	+
Desmoscolex minutus Clap.	+	-	+
KINORINCHA	+	+	+
ARCHIANELLIDA			
Protodryllus flavocapitatus	+	+	+
POLYCHAETA			
Capitella capitata Fabr.	+	+	+
Capitomastus minimus Langrh.	+	+	+
Exogone gemmifera Pagenst.	+	+	+
Fabricia sabella Ehrbg.	+	+	+
Genityllis tuberculata	-	+	+
Grubea clavata (Clap.)	-	+	+
Harmothoe reticulata Clap.	+	+	+
Mysta picta	-	-	+
Melinna palmata Grube	+	+	+
Nephthys hombergii Aud. et M.-Edw.	+	+	+
Nereis diversicolor O.F.M.	-	+	+
N. succinea Leuck.	+	+	+
N. zonata Malmgr.	-	+	+
Phyllodoce maculata (L.)	+	+	+
Ph. tuberculata Bobr.	+	+	+
Platynereis dumerili Aud. et M.-Edw.	+	+	+
Polydora ciliata limicola (Johnst.)	+	+	+
Prionospio cirrifera Wiren	+	+	+
P. malmgreni Clap.	-	+	+
Protodrilus flavocapitatus (Ulj.)	+	+	+
Pygospio elegans Clap.	-	+	+
Sphaerosyllis bulbosa Southern	-	+	+
Spio filicornis (O.F.M.)	+	+	+
Terebellide stroemi Sars	+	+	+
OLIGOCHAETA	+	+	+
TURBELLARIA	+	+	+
Leptoplana alcinoi O.Schm.	-	+	+
L. tremellaris Oersted	-	+	+

Zoobenthic species	2000	2001	2002
MOLLUSCA			
GASTROPODA			
Bittium reticulatum (Costa)	+	+	+
Calyptrea chinensis (L.)	-	+	+
Cyclope neritea (L.)	-	+	+
Cerithiopsis minima (Brusina)	-	+	+
Hydrobia ventrosa (Montagu)	+	+	+
Hinia reticulata (Linne)	-	-	+
Nassarius reticulatus (L.)	+	+	+
Rapana thomasiana thomasiana Grosse	+	+	+
Retusa truncatula Bruguiere	+	+	+
Rissoa splendida Eichwald	+	+	+
Trophon muricatus breviatus Jeffreyss	+	+	+
LAMELLIBRANCHIA			
Abra milaschevici Nevesskaja	+	+	+
A. ovata Philippi	-	+	+
Cardium edule lamarcki Reeve	+	+	+
C. exiguum Gmelin	+	+	+
Chione gallina L.	+	+	+
Corbula mediterranea (Costa)	+	+	+
Modiolus phaseolinus (Philippi)	+	+	+
Mya arenaria L.	+	+	+
Mytilus galloprovincialis Lam.	+	+	+
Polititapes aurea (Milaschievici)	+	+	+
Scapharca inaequivalvis Bruguiere	+	+	+
Spisula subtruncata triangula (Renier)	+	+	+
Tellina tenuis Da Costa	-	+	+
CRUSTACEA			
HARPACTICOIDA	+	+	+
Canuella furcigera Sars	-	+	+
C. perplexa T.& A. Scott	+	+	+
Ectinosoma melaniceps Boeck	-	+	+
Harpacticus littoralis Sars	-	+	+
Tisbe furcata Bairds	-	+	+
CIRRIPEDA			
Balanus improvisus Darwin	+	+	+
AMPHIPODA			
Ampelisca diadema Costa	+	+	+
Apseudopsis ostroumovi Bacescu & Carausu	+	+	+
Corophium acherusicum (Costa)	-	+	+
C. runcicorne D.-V.	+	+	+
Dexamine spinosa (Mont.)	+	+	+
G. olivii M.-Edw.	+	+	+
Melita palmata (Mont.)	-	+	+
Microdeutopus damnoniensis (Bate)	+	+	+

Zoobenthic species	2000	2001	2002
M. gryllotalpa Costa	+	+	+
Nototropis guttatus (Costa)	+	+	+
Orchomene humilis (Costa)	+	+	+
Perioculodes longimanus (Bate & Westw.)	-	+	+
Stenothoe monoculoides Mont.	-	+	+
Phtisica marina Slabber	+	+	+
Caprella acanthifera Leach	-	+	+
CUMACEA			
Cumopsis goodsiri (V. Ben.)	-	+	+
Iphinoe elisae Bacescu	+	+	+
I. maeotica (Sov.)	+	+	+
OSTRACODA	+	+	+
MYSIDAE			
Mesopodopsis slabberi (Van Beneden)	-	+	+
ISOPODA			
Idotea baltica (Pallas)	+	+	+
Sphaeroma pulchellum (Colosi)	+	+	+
S. serratum Fabr.	+	+	+
Synisoma capito (Rathke)	+	+	+
HALACARIDA			
Halacarellus basteri affinis Truessart	+	+	+
DECAPODA			
Carcinus mediterraneus (Czern)	-	+	+
Diogenes pugilator (Roux)	-	-	+
Crangon crangon (L.)	+	-	+
Pilumnus hirtellus (Linne)	-	+	+
Upogebia pussila (Petagna)	-	+	-
BRYOZOA	-	+	+
PHORONIDA			
Phoronis euxinicola S.-Longch.	+	+	+
ECHINODERMA			
Amphiura stepanovi Djak	+	+	+
Leptosynapta inhaerens O.F.M.	+	+	+
TUNICATA			
Ctenicella apendiculata (Hel.)	+	+	+
Eugyra adriatica Drasche	+	+	+
Molgula sp.	-	+	+
PANTOPODA			
Callipalene phantoma (Dohm)	-	+	+
INSECTA			
Clunio marinus (HAL.)	+	+	+

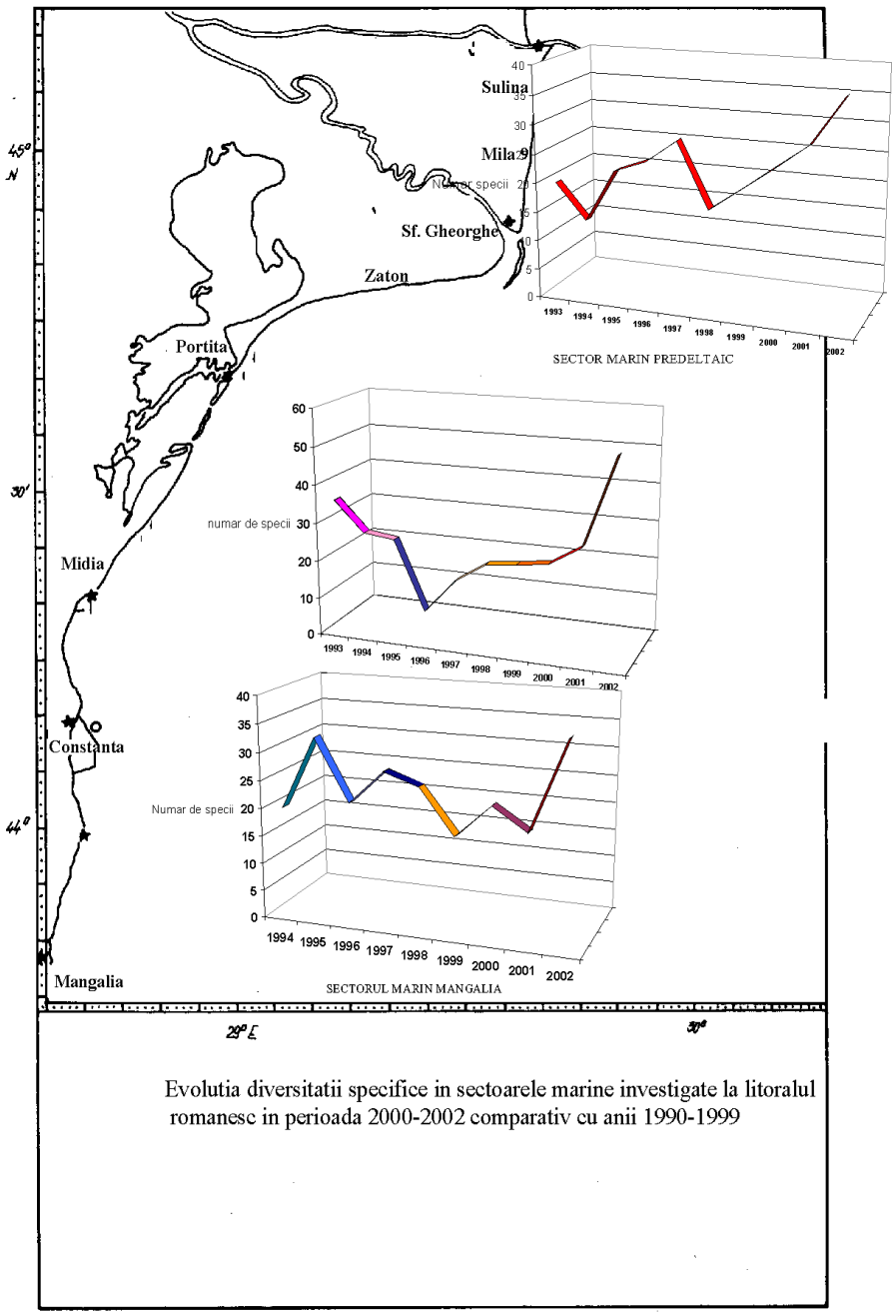

Fig. 1 - The evolution of number of macrozoobenthic species in the main sectors of the Romanian Black Sea littoral between 1990-1999 and 2000-2002

A. Qualitative and quantitative state of benthic communities in the predeltaic sector

The results of recent research, when the phytoplankton did not manifest ample blooms as in previous years, emphasized an improvement of the qualitative structure of the zoobenthic communities. Taking into accout the whole studied area, from Sulina to Portitza, a high *species diversity* at depths ranging between 15 to 50 m, representing the *transition from sandy to mud bottoms* (15 to 30 m depths) and *mud with mussels (Mytilus galloprovincialis*) (30 to 50 m depths) was recorded. Therefore, the number of species continually increased, the macro-benthic fauna being represented by 26 to 38 species between 2000-2002 compared with 20 to 24 species identified in '90ies (Fig. 1).

Regarding the species frequency in the communities the following categories of species could be considered :

- common forms with over 70% frequency -some species with a large ecological vallence, eurioic, existent in all sedimentary substrata, from the shore up to 50 m water depth (e.g. the polychaete worms *Polydora limicola, Neanthes succinea, Melinna palmata, Prionospio cirrifera, Nephthys hombergii*, the crustaceans *Ampelisca diadema, Phtysica marina);*
- frequent forms up to 50% frequency - most of them characteristic to the community with *Mytilus galloprovincialis (*the worms *Harmothoe reticulata, Phyllodoce maculata, Terebellides stroemi);*
- rare forms – species having a presence of 1 to 25% (some species had an unique appearance in the analyzed samples, being met in one or two stations, only). (Table 1).

It should be mentioned that the highest frequency are not registered by those the specific species for the communities, some of them are even rare elements, but the eurioic ones, with a large ecological vallence. The qualitative structure of predeltaic fauna was dominated by the versatile species such as the polychaete worms *Neanthes succinea*, *Polydora limicola*, *Melinna palmata*.

Mytilus galloprovincialis, one of the characteristic species of the community at 30-50 m depths presents a relatively high frequency in the area of interest (F-50%).

Mytilus populations consisted of individuals with a length between 1 to 40 mm. A further indication that environmental conditions are improving is the high percentage of young specimens (with the length between 1to10 mm), which settled on the substratum, about 65% at 30 to 40 m depths.

Regarding the quantitative structure, a slight recovery was noted in *density*, both on the shallow and medium depths zones. *T*he values of density continually increase, about two times higher than those registered in the '90ies (from 2,591 ind/sq.m to 3,140 ind/sq.m at 15-30 m depths and 2,128 ind/sq.m to 3,472 ind/sq.m at 30-50 m depths) respectivelly

Quantitative groups structure was dominated by worms –95 % of the total density. Among polychaetes the numerous species was *Melinna palmata* – 55 %, *Neanthes succinea* – 52 %, *Polydora ciliata* 50% of the polychaetes density (Fig. 2).

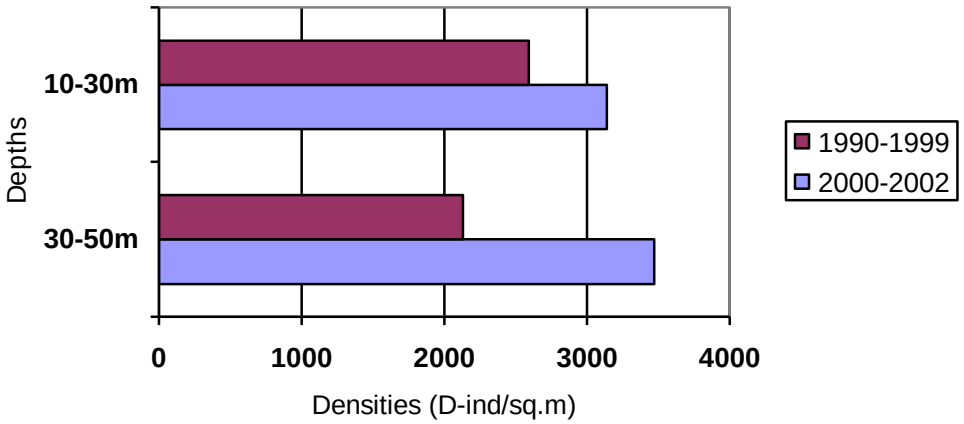

Fig. 2 – The evolution of the average densities of zoobenthic populations on bathymetric zones in the predanubian sector

As for the biomasses there are annual variations in the benthic communities. Data recorded for 2000-2002 showed lower *biomas*s figures compared with 1990-1999. In this particular case the soft clam (*Mya arenaria*) populations flourishing at the beginning of the 70'ies diminished in the last years, representing only 25% of total biomass. In spite of the favourable increased organic substance quantities the decreas of soft clam populations can be justified by the mortalities due to hypoxia, but also due to the bottom fishing trawling with its adverse effects on benthic organisms (Fig.3).

But in the *Mytilus mud*, the values of biomasses indicated an about two times increase, because the molluscs groups are well represented. In this area the mussel was present in large number, big quantities developed here. Therefore, most of the individuals from the analyzed populations were of little and medium size.

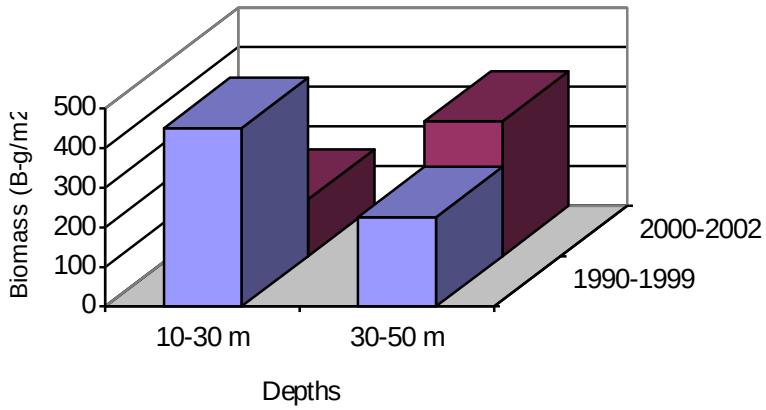

Fig. 3 – The evolution of the average biomasses of zoobenthic populations on bathymetric zones in the predanubian sector

B. Qualitative and quantitative state of benthic communities in the Constantza marine sector

Long term investigations in the Constantza sector showed the beginning of a recovery process as a result of an environmental improvement, mainly by the species diversity rehabilitation. (TIGANUS, DUMITRACHE, 1995). It could be mentioned that, e.g., especially in 1996, the number of species decreased to 9, because in the summer 1995 repeated phytoplankton blooms negatively affected the zoobenthos. Beginning 1997, in the absence of blooms the reaction was quite fast and the biodiversity continually increased, from 18 to 53 species in 2002 (Fig. 1).

Therefore, the organisms belong to the following taxonomic groups : polychaetes - 18 species (33.9%), molluscs – 11 species (20.8%), crustaceans – 11 species (20.8%) and other groups – 13 taxons (24.5%).

Off Constantza, 11 species occured in samples with frequencies ranging between 50 to 95 %, most of them being characteristic species for the biocoenosis (e.g. *Phyllodoce maculata, Nephthys hombergii, Phyllodoce maculata, Terebellides stroemi, Prionospio cirrifera* among the worms polychaetes , *Cardium, Mytilus galloprovincialis* among the molluscs and *Ampelisca diadema, Microdeutopus damnoniensis, Phtysica marina* among the crustaceans*).*

From the quantitative point of view, the *density* data led to the observation that the values are two and three times respectivelly, higher in the

present period comparatively with the '90ies, at different bathymetric zones (Fig. 4). A revigoration tendency of the mollusc and crustacean populations was observed, even if the worms command the density variation for the entire zoobenthic population in this area.

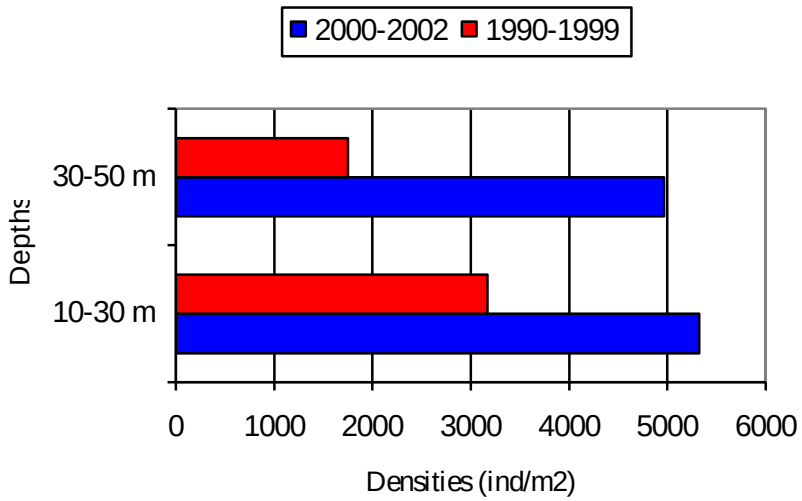

Fig. 4 – The evolution of the average densities of zoobenthic populations on barthymetric zones in the Constantza marine sector

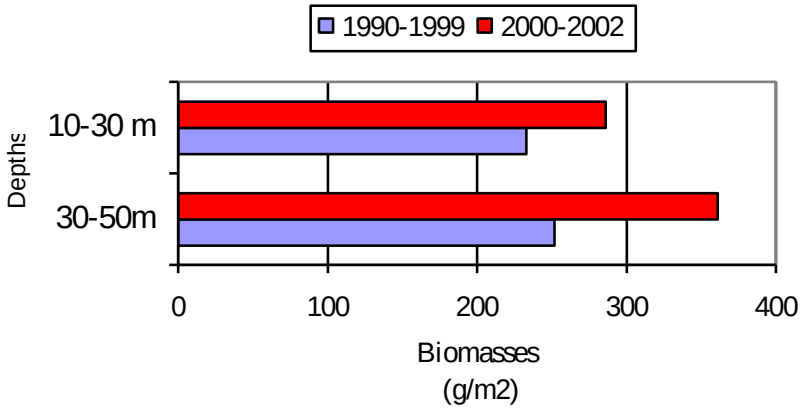

Fig. 5 – The evolution of the average biomasses of zoobenthic populations on bathymetric zones in the Constantza marine sector

Similarly, the *biomass quantities* in this sector registered an increase, also. For example, the values obtained in 2000-2002, ranging between 286

g/sq.m at 10-30 m depths and 361 g/sq.m at 30-50 m depths, were approximately two times higher than those registered in the '90ies, from the same bathymetric depths (Fig. 5). In the *Mytilus galloprovincialis* association a slight process of recovery was observed, regarding the biomasses; there are zones where it seems that the mussel populations are in expansion and grow under favourable conditions.

C. Qualitative and quantitative state of benthic communities in the southern littoral zone

At **Mangalia,** in the mud facies with mussels limited by depths of 30 m to 50 m, 36 macrobenthic species were identified in 2002. The most representative species were the polychaetes *Terebellides stroemi, Prionospio cirrifera, Nephthys hombergi*, *Exogone gemmifera* and *Phyllodoce maculata*, the bivalves *Mytilus galloprovincialis,and Modiolus phaseolinus* and the amphipods, *Corophium runcicorne, Microdeutopus damnoniensis, Iphinoe elisae* and *Phtysica marina*. The frequency of those common species ranged between 66% and 100 %. Other two species recorded 83% frequency, such as polychaetes *Polydora limicola and Melinna palmata*, all of them versatile species. The new marine environment conditions selected a series of benthic organisms which are developing abundant populations. For exemple, the above mentioned tube polychaete *M. palmata* may be considered as the first opportunistic species augmenting its populations.

Regarding the qualitative structure of this area it could be mentioned that this zone is populated by the elements characterizing the biocoenoses with muddy bottoms, as well as by iliophylic and opportunistic species .

Mytilus galloprovincialis, one of the characteristic species of the community, evinces a relatively high frequency in this area (F-60%).

From the quantitative point of view, the benthic populations recorded high annual variations (Fig. 6, 7). A slight rehabilitation only with respect density quantities has been observed in present (2000-2002). The analysis of benthic populations showed that the worms, molluscs and crustaceans have a variable importance to the quantitative structure. As a rule, the worms dominate the *numerical abundance*, while the molluscs dominate the weight. As to *biomasses,* the values have not registered significant changes; there were zones with biomasses ranging between 100,0 to 700,0 g/sq.m in 2000-2002 as well as in 1996-1998.

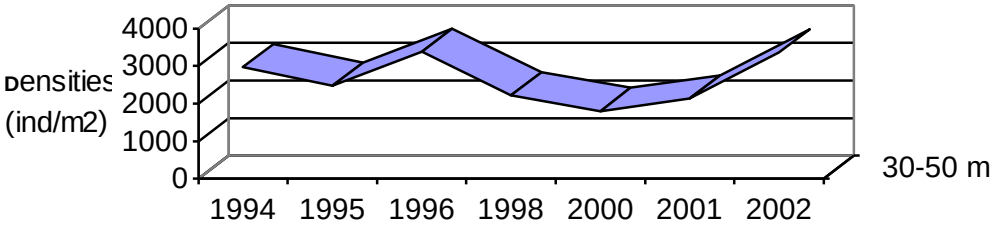

Fig. 6 – The evolution of the average densities of zoobenthic populations on bathymetric zones in the Mangalia sector

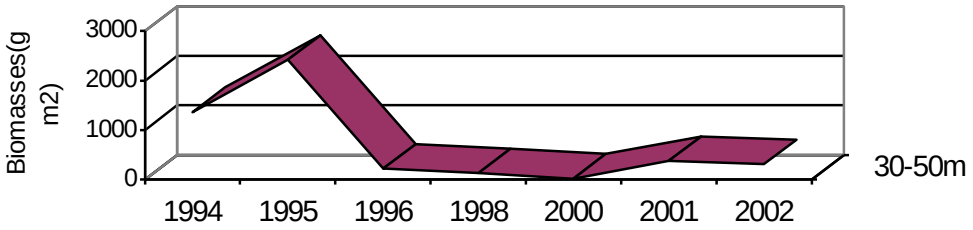

Fig. 7 – The evolution of the average biomasses of zoobenthic populations on bathymetric zones in the Mangalia sector

CONCLUSION

The observations reveal a noticeable *increase of the biological diversity*. The qualitative structure of the biocoenosis in different marine zones evinces the continuous in number of species increase. Between 2000-2002, the situation was better than before, because 38 species were identified compared to 24 in the predanubian sector. In front of Constanta and Mangalia

a high biodiversity have been registered, too: 53 and 36 species respectively were identified, compared with 18 and 28 species respectivelly, between 1990-1999.

Concerning the species frequency the characteristic species do not have the highest frequency, some of them are even rare elements, but the eurioic ones, with a large ecological vallence.

A general look on *densities of populations* on the biotic bottoms in the three sectors taken into consideration showed that the values of this specific parameter registered an increase at all bathymetric levels. Quantitative groups structure was dominated by worms –95 % of the total density. Among polychaetes the most numerous species were *Melinna palmata* – 55 %, *Neanthes succinea* – 52 %, *Polydora ciliata* 50% of the polychaetes density.

As for the biomasses there are annual variations in the benthic communities. Therefore, in the shallow water ***predanubian sector*** about three times lower biomasses were registered compared with the '90ies. The soft clam (*Mya arenaria*) populations flourishing at the beginning of the 70'ies diminished in the last years, representing only 25% of total biomass. In spite of the increased organic substance quantities as a favouring factor, the decrease of soft clam population can be justified by the mortalities due to hypoxia but, also, due to the bottom fishing trawling with its adverse effects on benthic organisms. Beginning at 30 m to 50 depths, the biomass values indicated an about two times increase, because the mollusc groups, mainly bivalva *Mytilus galloprovincialis*, are well represented.

Long term investigations in the Constantza sector showed the beginning of a process of recovery, mainly by the species diversity rehabilitation, as a result of an improvement in the environmental conditions. This revigoration tendency was also observed, in the determinated density and biomass quantities. Therefore, the values of numerical abundance and biomasses were two and three respectively times higher than those registered in the last decade.

At Mangalia a slight rehabilitation only in density quantities has been observed . The worms, mollusc and crustacean groups had a variable to the quantitative structure.The worms dominate the *numerical abundance*, while the molluscs dominate the weight. As to *biomasses*, the values had not registered significant changes, there were zones with biomasses ranging between 100.0 to 700.0 g/sq.m in 2000-2002 as well as in '90ies.

Even if since the '90ies, under diminished ecological pressure with negative consequences, the benthic communities are slowly recovering, the general state of this biotic component of the marine ecosystem remains still fragile.

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