RECENT DATA ON BENTHIC POPULATIONS FROM HARD BOTTOM MUSSEL COMMUNITY IN THE ROMANIAN BLACK SEA COASTAL ZONE

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Abstract. On the basis of the analysis of 27 samples collected by diving in 9 stations along the South Sector of the Romanian Black Sea coast, the authors present the qualitative and quantitative state of the benthic community of the hard bottom mussels in the shallow waters. The study, carried out in mid and upper-infralittoral in August 2001, reveals the occurrence of 68 species and 11 supraspecific taxa, with an average density of 750,000 indvs.m^{-2} and a biomass of 16,500 g.m^{-2}: Numerical dominants are represented by worms (~ 460,000 indvs.m^{-2}) and crustaceans (~ 270,000 indvs.m^{-2}), and the weight dominants by mollusks – Mytilus galloprovincialis over 95% (~ 16,300 g.m^{-2}) and crustaceans (~ 137 g.m^{-2}). The general ecological state of the hard bottom mussel benthic community of the Romanian Black Sea coast in August 2001 can be considered satisfactory in comparison with the 1980s.

Keywords: hard substrate with mussel community, Black Sea, Romanian coast, macro- and meio-benthos

INTRODUCTION

The benthos researches of the Romanian Black Sea coast have generally been focused on the sandy bottoms. There are few studies that considered the holistic analysis of epibiont organisms due to numerous difficulties in collecting the quantitative samples. The classic equipment for benthos samplings is efficient only on sedimentary bottoms and only a few dredges can collect samples from the hard bottom. In addition to the researchers getting underwater with the help of the self-contained diving suit, more detailed studies of the stony areas of the benthos could be conducted through directly observing and collecting quantitative samples.

The first quantitative studies on the rocky bottoms associations of the Romanian Black Sea coast were published more than 30 years ago (Băcescu *et al*., 1963, 1971; Gomoiu *et al*., 1974, 1978; Ţigănuş, 1979). Until today, information has actually remained limited, even though some studies of the epibiont organisms, especially referring to fouling, have been published.

Compared to the sandy bottoms, the rocky natural ones occupy far less surface (0.3% of the total surface of the Romanian coast). These may be found only South of Constanta, being represented by a discontinuous band of submerged rocky platforms, interrupted by sandy beaches.

The shortage of rocky bottom was compensated for by the construction of protective coastal dams in the ’70s-’80s, which could be likened to artificial reefs (Gomoiu, 1986,1997). The ecological implications of these water structures have been both positive and negative, even if the shore protective role, for which they were built, proved to be minor and sometimes adverse. The benthic communities grown on the artificial rocky bottoms, similar to the natural stony ones, have a great importance in the ecology of this sector in spite of the limited expansion of the habitat. This is partly due to their qualitative and quantitative abundance and partly to the result of their coenotic structure (Gomoiu *et al*., 1981; Gomoiu, 1986).

The most important function of the associated fauna is to be a vast natural water filter. In most cases, the sessile organisms (mainly in terms of stability and abundance, in the hard bottom biocenosis) are very efficient filtering species, and this has major consequences on the surrounding environment.

The nature of the substratum encourages the settlement and domination of microbenthic sessile and vagile species, the majority being mass species with a large density per unit area, which indicates the maturity of an epibiont system. The macrobenthic dominant species in this biocenosis, such as Mytilus, Mytilaster and Balanus, act as a secondary bottom with many gaps and anfractuosities, forming an array of niches and microhabitats.

The rocky bottom tends to be very complex both as a result of its shallow depth and because of the pronounced hydrodynamism, which leads to a resedimentation of suspended and organic matter.

MATERIAL AND METHODS

In order to analyze the benthic fauna related to the biocenosis of stone mussels from shallow waters, 27 quantitative samples were taken by free diving during August 2001, from 9 stations along the Romanian Black Sea coast between Midia Cape Dam and the coastal sector 2 Mai – Vama Veche:

- Station 1 – (**CM**) Midia Cape sea wall,
- Station 2 – (**MC**) The sea wall in line with "Casino" Mamaia Hotel Complex,
- Station 3 – (**PM**) Pescarie Mamaia sea wall,
- Station 4 – (**TC**) Tataia beach (Constanta) sea wall,
- Station 5 – (**MD**) "Modern" beach (Constanta) sea wall,
- Station 6 – (**AG**) Agigea sea wall,
- Station 7 – (**EN**) Eforie Nord sea wall,
- Station 8 – (**2M**) the sea wall near the 2 Mai fishery,
- Station 9 – (**MV**) natural rocky bottoms from 2 Mai - Vama Veche, in the neighborhood of the meteorological station.

Three samples were taken from each station at three different depths (0, 1m, 2m) by scraping out the epibiosis from an area of 400 cm^2 with the help of a 20 cm long knife. The knife blade served jointly as a measuring reference for scraping a 20 x 20 cm square. The scrape areas were chosen at random. The scraped biological samples were stored in a classic net (only permeable to water); its hatch would close through a binder in order to prevent the loss of the samples in the water.

The samples' fixation was carried out differentially. The larger organisms (mostly bivalves) were preserved in 5 - 6 % neutralized formaldehyde in sea water; vagile micro- and macrobenthic fauna after being separated, were preserved in 80 % alcohol.

The taxonomic identification was performed in its totality for the higher taxa and partially for genera and species.

Analytic ecological indexes and current indexes of biodiversity were used for the statistical processing of the results obtained from the triage.

RESULTS AND DISCUSSIONS

General situation. Benthic communities of the shallow waters in 2001

In terms of space, the rocky bottom of the Romanian littoral belongs to the medio- and infralittoral (upper and inferior), which is populated by a single authentic biocenosis Mytilus galloprovincialis or the stone mussels biocenosis, with a series of varieties depending on the depth.

After analyzing the samples, several aspects of quantitative and qualitative parameters were clarified concerning the benthic fauna of shallow waters stone mussels. 18 supra-specific taxonomic groups were identified comprising 79 taxa. Among them, 15 (75%) are common to all 9 sampling stations. The other 3 groups (25%) Spongia, Tanaidacea and Tunicata are dominant in other well-defined locations in the Southern part of the littoral. Excluding the organisms identified at the group level (Nemertini, Nematoda, Oligochaeta, Harpacticoida, Insecta) and other species from the rest of the groups (Turbellaria, Nemertini, Polychaeta, Halacarida, larvae), there were 68 taxa identified as species/genera.

The analysis of populations' structure by supra-specific taxonomic groups indicates that the qualitative differences among the three depth levels (0, 1, 2m) are much reduced; even if the biological diversity is slightly richer at the depth of 2m, it does not differ basically from 0m and 1m, the most dominant forms remaining the same (Table 1).

Table 1 Populations' structure by supra-specific taxonomic groups

Taxa group	Depth (m)			Taxa group	Depth (m)		
	0	1	2		0	1	2
Spongia	-	1	2	Cirripedia	1	1	1
Coelenterata	2	2	2	Ostracoda	5	5	5
Turbellaria	3+	3+	3+	Copepoda	+	+	+
Nemertini	2+	2+	2+	Amphipoda	10	12	14
Nematoda	+	+	+	Isopoda	4	4	4
Polychaeta	16+	18+	20+	Tanaidacea	2	2	2
Oligochaeta	+	+	+	Decapoda	2	4	6
Mollusca	3	5	5	Insecta	+	+	+
Halacarida	1+	1+	1+	Tunicata	-	1	1

Note: The figures represent the number of taxa identified; + shows that some taxonomic group is present in the samples; - shows absence of any taxonomic group in samples

The real diversity according to the number of species shows a slight boost in the Southern locations, especially for the benthic macrofauna (~ 45 species) compared to the approximately 30 species from other locations. This development of specific biodiversity in the Southern littoral is justified by the stability of physical and chemical properties of the water and the high heterogeneity of habitats (artificial rocky bottom, natural rocky bottom, extensive algae fields, coarse-grained sandy bottoms mixed with debris and sandy enclaves among the rocky bottom) etc. (Fig. 1).

Depending on quantity, the numerical density and the biomass of the main epibiont invertebrate groups (Spongia, Coelenterata, Vermes, Mollusca, Crustacea, Halacarida, Insecta, Tunicata) fluctuated significantly in the analyzed coastal area. The average density calculated at depths for each station is about 750,000 indvs.m^{-2} with an average biomass of approximately 16,500 g.m^{-2}. In each of the dominant cases according to density values, there were worms (~460,000 indvs.m^{-2}) and crustaceans (~270,000 indvs.m^{-2}), followed by mollusks (5,500 indvs.m^{-2}), Halacarida (5,000 indvs.m^{-2}), insects (3,000 indvs.m^{-2}), Coelenterates (180 indvs.m^{-2}), sponges and tunicates (Fig. 2).

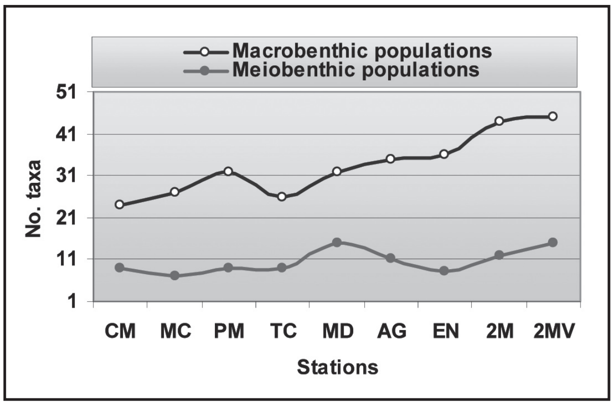

Fig. 1 Variation of macro – and meiobenthic number of species in the biocenosis of the stone mussels from the shallow waters of the coast between Midia Cape – Navodari and Vama Veche, 2001

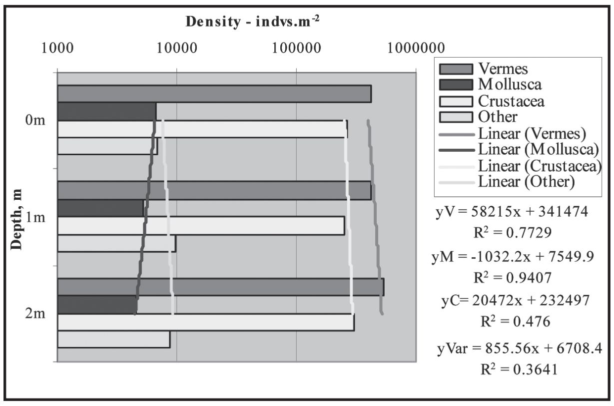

Fig. 2 Variation of average density (D_{AVG}) and biomass (B_{AVG}) of the main groups of epibiontic organisms depending on the depth of the Romanian littoral in 2001

The previous statistics are completely different from those showing the average biomass values where mollusks are the dominant species (~ 16,300 g.m^{-2}), followed by crustaceans (137 g.m^{-2}), Coelenterates and sponges (26 g.m^{-2}), and worms (13 g.m^{-2}). Halacarida, insects and tunicates make up an insignificant biomass of below 1 g.m^{-2}.

Regarding density values, 10 taxa are dominant, making up 96.6 % of the whole, of which only two, Nematoda and Harpacticoida form 92.32 % of the total average densities. The dominant taxa with average density values are: Nematoda, Harpacticoida, Cirripedia (*Balanus improvisus*), Halacarida (*Rhombognathus* sp.), *Polydora ciliata*, *Mytilus galloprovincialis*, *Grubea clavata, Echinogammarus olivii*, larvae of *Chironomida* and *ostracod - Xestoleberis decipiens*. Biomasses are dominant in the ratio of 95.85% of just a single species – *Mytillus galloprovincialis, followed by 9 macrobenthic species: Mytilaster lineatus, Balanus improvisus, Actinia equina, Rhithropanopeus harrisi, Idotea baltica, Sphaeroma pulchellum, Echinogammarus olivii, Melita palmata* and *Platynereis dumerilii* (APPENDIX I).

With an eye on the variation of average density and biomass of vagile meio- and macrofauna from one station to the other, show that the number and weight values increase along the Southern littoral (stations Agigea, 2 Mai, Vama Veche). The factors influencing this increase are the cumulative particular biotic and abiotic conditions at the Southern end of the Romanian coast, where some meio- and macrobenthic communities exhibit a greater variety of species and higher quantitative parameters per unit area (Fig. 3).

A slight decrease in the average biomass of the sessile macrofauna was observed in the more Southern locations. This is essentially due to the nature of substratum (natural calcareous), bottom relief (Sarmatian calcareous shelf), and the main orientation with regard to the direction of the prevailing winds coming from the Eastern and North-Eastern regions, directly influencing aspect to the optimal areas for sessile malacofauna growth. As a result, due to a lack of suitable areas (stones, grottos, niches, safe areas) for the growth of sessile species which are weight dominant, of polistratification of bivalves' colonies, as well as the substratum fragility (Sarmatian limestone), the biomass average values are lower than those for the artificial rocky bottom of safe areas. This is valid only for the shallow waters near the coast (Fig. 4). With the exception of mollusks, crustaceans represent the weight dominant group, with 78% of the total biomass being zoobenthos (Fig. 5).

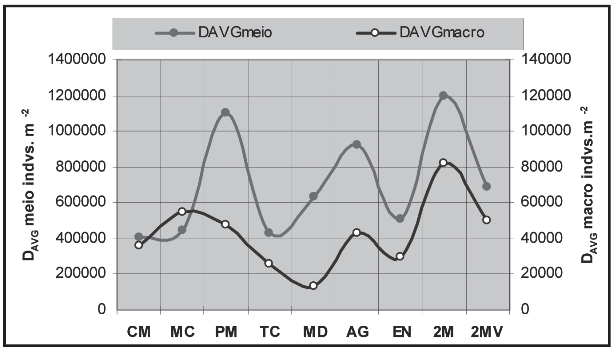

Fig. 3 Variation of average density (D_{AVG}) of the macro – and meiobenthic epibiontic organisms in the shallow waters of the Romanian Black Sea coast, 2001

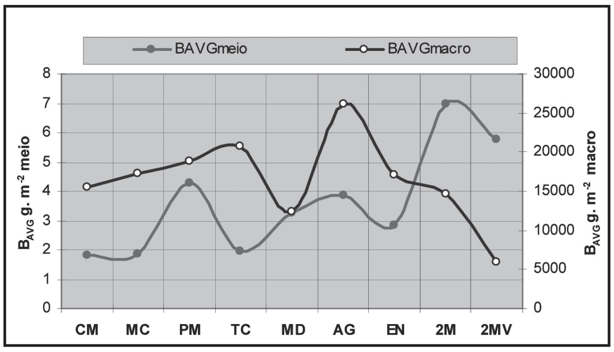

Fig. 4 Variation of average biomass (B_{AVG}) of the macro – and meiobenthic epibiontic organisms in the shallow waters of the Romanian Black Sea coast, 2001

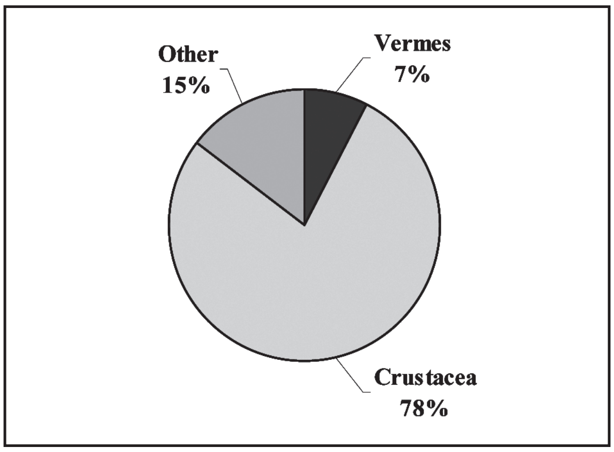

Fig. 5 Average biomass (B_{AVG}) of the main groups of epibiontic organisms (excepting mollusks) in the Romanian Black Sea coast, 2001

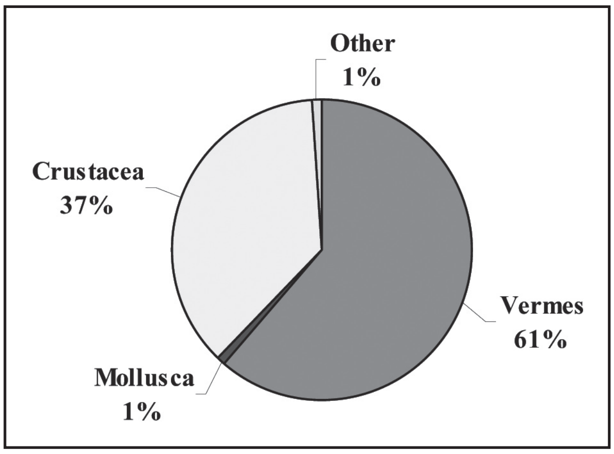

Fig. 6 Average density (D_{AVG}) of the main groups of epibiontic organisms in the Romanian Black Sea coast, 2001

The average density variation of the main groups of organisms shows three numerical heights in the different stations (Casino Pescarie Mamaia, Agigea and 2 Mai). Thus, the total average density for all stations, concerning the meio- and macrobenthic worms, is 61% of the total density of zoobenthos (Fig. 6). Among these, Nematoda and Polychaeta are the most abundant with an average percentage of 92.5% for all stations, and Turbellariata, Nemertina and Oligochaeta with just 7.5% of the total density of zoobenthos. There are 6 species of Polichaeta that are constantly dominant for all three depths: *Polydora ciliata, Grubea clavata, Sphaerosyllis bulbosa, Fabricia sabella, Platynereis dumerilii* and *Neanthes succinea*, where basically, the first 4 are small-sized species with a high ecological plasticity index. Turbellaria has a clear demarcation in the distribution of its three dominant species, where *Leptoplana tremellaris* and *Stylochus tauricus* are the most common species in the rocky infralittoral. Convoluta convoluta shows a high affinity only for natural rocky bottom in the Southern point of the littoral.

The average density variation of the main groups of meio- and macrobenthic crustaceans shows three numerical heights, more or less broad, at Casino Mamaia, Agigea and 2 Mai-Vama Veche, in all stations having an average of 37% of the total zoobenthos density (Fig. 6). Cirripeda, Ostracoda, and Amphipoda have almost identical values for all stations (≥10 000 ind.m^{-2}) with a growing development towards the southern littoral (Fig. 7).

The largest fluctuations are registered for macrobenthic crustaceans such as Isopoda, Decapoda and Tanaidaceea due to the pronounced algal blooming phenomenon from 2001. After an analysis of the populations' structure in supra-specific taxonomic groups, we witness that the numerical and weight variables of the epibiont fauna have been seriously influenced by this phenomenon.

Thus, it was evident that there was migration of macrobenthic forms (Decapoda, Isopoda, Amphipoda) from the deeper levels towards the sub-superficial level, where the oxic conditions allow their survival. At more than 2 meters depth, the epibiont system would be seriously affected by the algal blooming causing a mass mortality of mollusks and other sessile species. A drastic decrease was noted in the number of worms from the structure of the epibiont system.

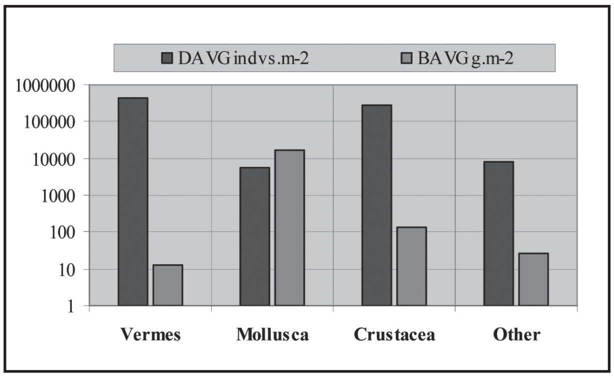

Fig. 7 Variation of average density (D_{AVG}) and biomass (B_{AVG}) of the main groups of epibiontic organisms in the Romanian Black Sea coast, 2001

The juveniles were practically absent. The multi-specific algal blooming phenomenon due to the effect of the heat and predominance of North and North-East marine circulation caused an increase in the water temperature up to 26-28°C and a salinity of less than 10 ‰.

All these conditions influenced an expansive development of diatoms such as: *Leptocylindrus danicus, Cerataulina pelagica* and the dinoflagellate *Prorocentrum minimum*, the latter being known for the huge algal blooming followed by mass mortalities of organisms in the period between 1970-1980 and beginning of the 1990s. During this period, decreases of O_2 were recorded in the littoral waters up to 4.96 $cm^3\ l^{-1}$ and even 2.61 $cm^3\ l^{-1}$; as a result of this phenomenon the saturability decreased to 47.5%, which resulted in a mass mortality of benthic-nektonic and benthic organisms.

The surprisingly low values of the Decapoda in certain locations (*e.g.* Agigea), where they should have been present in considerable densities, are a consequence of the predominance of the crabs *Rhithropanopeus harrisi* and *Pilumnus hirtellus* in the north and in some southern stations. Among these, *Rhithropanopeus harrisi* has simply invaded the epibiont communities without any restriction in the last 10 years. Nevertheless, it does not mean that there is a qualitative decline of reptant decapodes on the Romanian seashore; proof of this is the signalization of some rare listed species such as Pisidia longicornis, which was found in large numbers at Agigea, and Eriphia verrucosa, found at 2 Mai – Vama Veche.

The biomasses generally follow the same tendencies only for the meiobenthic forms; the biomass mainly consists of worms (1.96 $g.m^{-2}$), followed by crustaceans – juveniles of amphipods, copepods and ostracods (1.62 $g.m^{-2}$). As for macrobenthic forms, the majority of biomass invariably consists of mollusks (over 16,000 $g.m^{-2}$) and crustaceans (approximately 135.7 $g.m^{-2}$).

The meiobenthic forms, represented by copepods (*Harpacticoida*) and ostracods (mainly *Xestoleberis decipiens* and *X. aurantia acutipenis*), form 92% of the total abundance of crustaceans; the vagile and sessile macrofauna (Cirripedia, Amphipoda, Isopoda, Tanaidacea and Decapoda), represented mainly by 12 taxa: *Balanus improvisus, Echinogammarus olivii, Microdeutopus gryllotalpa, Idotea baltica, Corophium bonelli, Sphaeroma pulchellum, Stenothoe monoculoides, Hyale perieri, Naesa bidentata, Melita palmata, Jaera nordmanni* and *Amphithoe vaillanti*, forms only 8%.

The general variation in zoobenthos density shows a positive linear function along with the depth increase (R^2= 0.6937). However, the existence of an increased correlation between the ecological indexes of associated zoobenthos and the increase of depth, due to the relative proximity of vertical collection points (0, 1m, 2m) cannot be confirmed. In general the upper zones (mediolittoral, superior infralittoral) are characterized by a relative qualitative homogeneity of faunistic composition due to the proximity to the water surface and the assembly of abiotic factors, which equally affect this shallow-water zone by selecting populations with a more or less uniform distribution. However, even in this case we may observe the existence of increased linear correlations for certain groups, mostly reflecting a natural reality, which can be justified ecologically.

Thereby, two of the four major groups (Mollusca, Varia) record a diminution in the number of populations as depth increases, and Crustacea and Vermes exhibit a conspicuous increase. There is an explanation in the case of the mollusks, where larvae of mussels and *Mytilaster* may find available surfaces for settlement and avoid the competitive interactions with the adult forms from the upper zone of 0m, where free surfaces, which are suitable for being populated by bivalves' larvae, have been cleared due to periodically pronounced hydrodynamism. Thus, we are witnessing a massive colonization of the wave breaking and run-up band with small-sized forms, mainly less than 20mm; recordings also show increased mass density in the superior zones compared to the sub-superficial. These colonies become more stable temporally and spatially with the depth increase, and are able to resist certain bad weather conditions and translocations, with a smaller number of individuals per unit area but with a far bigger size. This spatial endurance and dominance is preserved up to a critical depth when the populations become more sporadic, frequently clogged up because other factors encourage certain epibiont associations to establish themselves, and the means through which they are realized.

The increase in the number of individuals per unit area is compensated by the multilayered structure of the mussel colonies. This strategy, which solves the lack of available areas, is practically absent in the 0m upper zone. There are some exceptions depending on the orientation of areas with the prevailing currents (exposed areas – protected areas). The main factor that prevents mussels from forming beds is hydrodynamism and emersion for a long time permitting the establishment of bivalves for no more than two layers. This condition and all the hydrometeorological and hydrodynamic activity, specific to shallow waters, result in an eloquent selection of associated fauna.

Varia, which is composed of Spongia, Coelenterata, Halacarida, Insecta and Tunicata, records an insignificant reduction in the number of populations with a more marked difference in depth, yet for the species associated with the algae fields and those favoring highly saturated oxic conditions. Thus, the abundance of coelenterates (especially *Actinia equina*) and tunicates (*Botryllus schlosseri*) will decline with depth because they prefer shallow waters and optimal oxic conditions. As for halacarids (*Rhombognathus* sp.) and insects, their preference is for thickets of algal macrophyte (especially for the genera *Ceramium* and *Cladophora*), which obviously record the highest densities in well-lighted shallow waters.

The above theories are valid only for the artificial hard substratum represented by the hydrotechnical coastal protection structures. The situation differs somewhat for the natural substratum due to the interference of other factors that regulate the distribution of these respective groups.

The numerical increase of the crustaceans and worms is due to the accentuated diversity of habitats and the abundance of trophic resources in particular for detritivorous forms (these represent the majority for the qualitative composition of the two groups).

By analyzing the frequency of taxa in the shallow-water biocenosis of Mytillus galloprovincialis, it was discovered that the following species were recorded in the summer season of 2001:

- 13 euconstant species (F – 75.1-100%): Nematoda, *Grubea clavata, Platynereis dumerilii, Polydora ciliata, Sphaerosyllis bulbosa, Mytilus galloprovincialis, Rhombognathus sp., Balanus improvisus,* Harpacticoida, *Echinogammarus olivii, Melita palmata, Idotea baltica, Sphaeroma pulchellum* (APPENDIX I).
- 14 constant species (F – 50.1-75%): *Actinia equina, Leptoplana tremellaris*, Nemertini varia, *Neanthes succinea, Nerine cirratulus, Spio filicornis, Oligochaeta, Xestoleberis decipiens, Amphithoe vaillanti, Hyale perieri, Microdeutopus gryllotalpa, Jaera nordmanni, Rhithropanopeus harrisi,* Insecta (APPENDIX I).
- 20 accessory species (F – 25.1-50.0%);
- 32 accidental species (F-1.0-25%).

With reference to the euconstant and constant species, it was observed that there are 12 species of crustaceans (44.4%) and 11 species of worms (40.7%), which are dominant on locations and depth. The mollusks (1 sp.) and varia (Coelenterata, Halacarida, Insecta – 3 sp.) are qualitatively more homogenous.

Thus, the qualitative diversity of the shallow-water epibiont populations is dominated by the crustaceans and worms that include over 20 euconstant species forming a mature epibiont system. Taking weight into consideration, the epibiont associations have always been dominated by the big-sized sessile malacological fauna, represented by *Mytilus galloprovincialis* and *Mytilaster lineatus*. The function of mollusks in the shallow-water upper zone consists in the complication of primary substratum and the creation of microhabitats for the vagile forms (meio-, macrobenthic) among the byssus filaments, which retain most of the water-mass-driven organic and mineral suspensions.

The random spreading characteristic of benthic organisms and the abundance-related variations of quantitative values are more representative in the southern locations (Agigea, 2 Mai, Vama Veche). The richness of associated populations here is dependent on the heterogeneity of substratum conditions and the multitude of biotopes compared to a more homogenous substratum and a qualitatively depleted fauna in the northern locations (Mamaia, Constanta). Yet, the abundance of the northern sectors' populations records high values of average densities due to the meiobenthic faunistic sector, compensating for the small macrobenthic component present within these locations.

CONCLUSIONS

The results of the ecological analysis of the shallow-water epibiont populations (0-2m), of the littoral sector between Midia Cape and 2 Mai – Vama Veche, in 2001, enabled us to highlight the following general conclusions:

The qualitative structure of shallow-water hard-substratum associated meio- and macrofauna is formed of 18 major taxonomic groups with a total number of 79 taxa, and the total number of identified species/genera-level taxa is 68.

The average abundance of the populations developed on the analyzed artificial substrata varies around 750,000 indvs. m^{-2} with a total average biomass of 16,500 $g.m^{-2}$. The numerical dominants are represented by worms (~ 460,000 indvs. m^{-2}) and crustaceans (~ 270,000 $indvs.m^{-2}$), and the weight variables are dominated by mollusks (~ 16,300 $g.m^{-2}$) and crustaceans (~ 137 $g.m^{-2}$).

The most important role in establishing the density dominants is played by Nematoda and Copepoda in a ratio of 92.32% of the total average densities.

The biomasses are dominated in a ratio of 95.48% by *Mytilus galloprovincialis* species followed by 2 macro-zoobenthic species, *Mytilaster lineatus* and *Balanus improvisus*.

The qualitative analysis on the euconstant (13 sp.) and constant species (14 sp.) indicates that the location and depth dominants are taken by crustaceans (12 sp.) (44.4%) and worms (11 sp.) (40.7%).

The analysis of populations' structure on supra-specific taxonomic groups shows that the qualitative differences among the three levels of depth (0, 1, 2m) are very reduced, and the biodiversity, slightly higher at the depth of 2 m, does not basically differ from 0m and 1m, while keeping the same main forms.

APPENDIX I

GENERAL CHARACTERISTICS OF THE BENTHIC POPULATIONS RECORDED AT THE ROMANIAN LITTORAL, 2001

No.	Taxa	F%	D_{AVG}	D_{ECO}	D_D%	W_D	R_{kD}	B_{AVG}	B_{ECO}	D_B%	W_B	R_{kB}
1	*Dysidea fragilis*	3.7	0.9	25.0	0.000	0.02	75	2.31	62.50	0.014	0.23	39
2	*Halichondria panicea*	7.4	1.9	25.0	0.000	0.04	72	4.63	62.50	0.028	0.46	24
3	*Eudendrium ramosum*	25.9	13.9	53.6	0.002	0.22	57	1.11	4.29	0.007	0.42	25
4	*Actinia equina*	70.4	171.3	243.4	0.023	1.27	32	17.74	25.21	0.108	2.75	4
5	*Convoluta convoluta*	22.2	610.2	2745.8	0.082	1.35	29	0.06	0.27	0.000	0.09	52
6	*Leptoplana tremellaris*	74.1	1375.0	1856.3	0.185	3.70	14	1.65	2.23	0.010	0.86	16
7	*Stylochus tauricus*	44.4	115.8	260.6	0.016	0.83	41	0.17	0.39	0.001	0.22	40
8	Turbellaria varia	48.1	145.4	301.9	0.020	0.97	38	0.01	0.01	0.000	0.04	64
9	Nematoda	100.0	442481.5	442481.5	59.37	77.05	1	0.75	0.75	0.005	0.68	20
10	*Emplectonema gracile*	14.8	23.7	160.0	0.003	0.22	58	0.47	3.20	0.003	0.21	41
11	*Tetrastemma sp.*	48.1	250.0	519.2	0.034	1.27	33	0.75	1.56	0.005	0.47	23
12	Nemertini varia	59.3	204.6	345.3	0.027	1.28	31	0.41	0.69	0.002	0.38	30
13	*Grubea clavata*	92.6	2732.8	2951.4	0.367	5.83	7	0.27	0.30	0.002	0.39	28
14	*Grubea limbata*	33.3	213.9	641.7	0.029	0.98	37	0.06	0.19	0.000	0.11	50
15	*Grubea tenuicirrata*	29.6	125.9	425.0	0.017	0.71	46	0.04	0.13	0.000	0.08	53
16	*Fabricia sabella*	48.1	1250.0	2596.2	0.168	2.84	20	0.10	0.21	0.001	0.17	44
17	*Harmothoe reticulata*	25.9	38.9	150.0	0.005	0.37	52	0.02	0.09	0.000	0.06	57
18	*Hediste diversicolor*	3.7	0.9	25.0	0.0001	0.02	76	0.06	1.75	0.000	0.04	67
19	*Perinereis cultrifera*	14.8	6.5	43.8	0.001	0.11	64	0.03	0.22	0.000	0.05	60
20	*Phylodoce tuberculata*	11.1	6.5	58.3	0.001	0.10	68	0.02	0.20	0.000	0.04	66
21	*Platynereis dumerilii*	81.5	484.3	594.3	0.065	2.30	23	4.12	5.05	0.025	1.43	10
22	*Polydora ciliata*	96.3	4492.6	4665.3	0.603	7.62	5	0.76	0.79	0.005	0.67	21
23	*Pygospio elegans*	14.8	5.6	37.5	0.001	0.11	67	0.00	0.00	0.000	0.01	78
24	*Neanthes succinea*	59.3	403.7	681.3	0.054	1.79	28	2.06	3.47	0.012	0.86	17
25	*Nerilla antennata*	25.9	34.3	132.1	0.005	0.35	53	0.02	0.08	0.000	0.06	58
26	*Nerine cirratulus*	51.9	102.8	198.2	0.014	0.85	40	0.02	0.04	0.000	0.08	54
27	*Notomastus lineatus*	3.7	3.7	100.0	0.0005	0.04	73	0.01	0.21	0.000	0.01	73
28	*Scolelepis ciliata*	48.1	158.3	328.8	0.021	1.01	36	0.05	0.10	0.000	0.12	49
29	*Sphaerosyllis bulbosa*	81.5	1165.7	1430.7	0.156	3.57	15	0.93	1.14	0.006	0.68	19
30	*Sphaerosyllis hystrix*	14.8	23.0	155.0	0.003	0.21	59	0.02	0.12	0.000	0.04	65
31	*Spio filicornis*	51.9	209.3	403.6	0.028	1.21	34	0.06	0.12	0.000	0.14	47
32	*Syllis prolifera*	14.8	34.3	231.3	0.005	0.26	55	0.03	0.19	0.000	0.05	61
33	Polychaeta larvae	3.7	138.9	3750.0	0.019	0.26	54	0.01	0.15	0.000	0.01	75
34	Polychaeta varia	14.8	8.3	56.3	0.001	0.13	63	0.01	0.03	0.000	0.02	71
35	Oligochaeta	70.4	1057.4	1502.6	0.142	3.16	18	0.21	0.30	0.001	0.30	36
36	*Middendorfia caprearum*	29.6	446.3	1506.3	0.060	1.33	30	2.39	8.06	0.014	0.65	22
37	*Tergipes tergipes*	7.4	7.4	100.0	0.001	0.09	70	0.001	0.02	0.000	0.01	77
38	*Cyclope donovani*	3.7	0.6	15.0	0.0001	0.02	77	0.27	7.42	0.002	0.08	55
39	*Mytilaster lineatus*	33.3	888.0	2663.9	0.119	1.99	27	504.78	1514.4	3.059	10.10	2
40	*Mytilus galloprovincialis*	100.0	4143.2	4143.2	0.556	7.46	6	15817.6	15818	95.85	97.91	1
41	*Rhombognathus sp.*	96.3	4906.5	5095.2	0.658	7.96	4	0.05	0.05	0.000	0.17	45
42	Hallacarida varia	33.3	303.7	911.1	0.041	1.17	35	0.003	0.01	0.000	0.02	70
43	*Balanus improvisus*	100.0	7091.7	7091.7	0.952	9.75	3	71.01	71.01	0.430	6.56	3

No.	Taxa	F%	D_{AVG}	D_{ECO}	D_D%	W_D	R_{kD}	B_{AVG}	B_{ECO}	D_B%	W_B	R_{kB}
44	*Cyprideis littoralis*	22.2	72.2	325.0	0.010	0.46	51	0.005	0.02	0.000	0.03	69
45	*Cytherois valkanovi*	11.1	18.5	166.7	0.002	0.17	60	0.001	0.01	0.000	0.01	76
46	*Paradoxostoma intermedium*	22.2	273.1	1229.2	0.037	0.90	39	0.02	0.08	0.000	0.05	62
47	*Xestoleberis aurantia acutipenis*	40.7	2202.8	5406.8	0.296	3.47	16	0.14	0.35	0.001	0.19	42
48	*Xestoleberis decipiens*	55.6	3376.9	6078.3	0.453	5.02	10	0.22	0.40	0.001	0.27	37
49	Harpacticoida	100.0	245555.6	245555.6	32.95	57.40	2	1.23	1.23	0.007	0.86	15
50	*Amphitoe vaillanti*	70.4	505.6	718.4	0.068	2.18	25	2.02	2.87	0.012	0.93	13
51	*Apherusa bispinosa*	18.5	241.7	1305.0	0.032	0.77	45	0.24	1.31	0.001	0.16	46
52	*Caprella acanthifera*	7.4	12.0	162.5	0.002	0.11	65	0.02	0.29	0.000	0.03	68
53	*Corophium bonelli*	37.0	1373.1	3707.5	0.184	2.61	22	0.55	1.48	0.003	0.35	35
54	*Erichthonius difformis*	3.7	18.5	500.0	0.002	0.10	69	0.02	0.45	0.000	0.02	72
55	*Gammarus aequicauda*	40.7	125.0	306.7	0.017	0.83	43	0.62	1.53	0.004	0.39	27
56	*Echinogammarus olivii*	88.9	2563.9	2884.4	0.344	5.53	8	7.35	8.27	0.045	1.99	8
57	*Hyale pontica*	22.2	158.9	715.0	0.021	0.69	47	0.40	1.79	0.002	0.23	38
58	*Hyale perieri*	74.1	1075.7	1452.2	0.144	3.27	17	2.34	3.16	0.014	1.03	11
59	*Jassa ocia*	14.8	160.2	1081.3	0.021	0.56	48	0.14	0.97	0.001	0.11	51
60	*Melita palmata*	85.2	673.1	790.2	0.090	2.77	21	4.04	4.74	0.024	1.44	9
61	*Microdeutopus gryllotalpa*	74.1	1728.3	2333.3	0.232	4.14	12	1.36	1.83	0.008	0.78	18
62	*Nototropis guttatus*	7.4	51.9	700.0	0.007	0.23	56	0.09	1.26	0.001	0.06	56
63	*Stenothoe monoculoides*	48.1	1261.1	2619.2	0.169	2.85	19	0.55	1.14	0.003	0.40	26
64	Amphipoda juv.	3.7	48.1	1300.0	0.006	0.15	61	0.002	0.05	0.000	0.01	79
65	*Jaera nordmanni*	51.9	670.3	1292.7	0.090	2.16	26	0.48	0.92	0.003	0.39	29
66	*Idotea baltica*	96.3	1501.4	1559.2	0.201	4.40	11	9.01	9.35	0.055	2.29	6
67	*Naesa bidentata*	40.7	915.7	2247.7	0.123	2.24	24	3.07	7.53	0.019	0.87	14
68	*Sphaeroma pulchellum*	96.3	1269.5	1318.3	0.170	4.05	13	8.29	8.61	0.050	2.20	7
69	*Leptochelia savignyi*	22.2	73.1	329.2	0.010	0.47	50	0.22	0.99	0.001	0.17	43
70	*Tanais cavolini*	22.2	230.6	1037.5	0.031	0.83	42	0.92	4.15	0.006	0.35	34
71	*Palaemon elegans*	18.5	4.8	26.0	0.001	0.11	66	1.25	6.76	0.008	0.37	31
72	*Eriphia verrucosa*	3.7	0.0	1.0	0.000	0.00	78	0.69	18.58	0.004	0.12	48
73	*Pachygrapsus marmoratus*	22.2	2.0	9.2	0.0003	0.08	71	1.02	4.58	0.006	0.37	32
74	*Pilumnus hirtellus*	33.3	4.4	13.2	0.001	0.14	62	5.11	15.34	0.031	1.02	12
75	*Pisidia longicornis*	3.7	1.3	35.0	0.0002	0.03	74	0.01	0.17	0.000	0.01	74
76	*Rhithropanopeus harrisi*	70.4	29.6	42.1	0.004	0.53	49	14.81	21.05	0.090	2.51	5
77	Larvae megalope	33.3	150.9	452.8	0.020	0.82	44	0.02	0.05	0.000	0.06	59
78	Chironomida larvae	74.1	3021.3	4078.8	0.405	5.48	9	0.30	0.41	0.002	0.37	33
79	*Botryllus shlosseri*	3.7	0.0	1.0	0.000	0.004	79	0.09	2.50	0.001	0.05	63
	Taxa		**Numerical abundance**					**Weight**				
			D_{AVG}	D_{ECO}	D_D%			B_{AVG}	B_{ECO}	D_B%		
	Vermes		457904	469829	61.44			13.19	24.00	0.08		
	Mollusca		5485	8428	0.74			16325	17347	98.93		
	Crustacea		273442	294793	36.69			137.27	202.33	0.83		
	Varia		8419	10433	1.13			26.24	157.46	0.16		
	Total		**745250.3**		**100**			**16501.7**		**100**		

REFERENCES

Băcescu, M., Dumitrescu, E., Marcus, A., Paladian, G., Mayer, R., 1963 – Donnees quantitatives sur la faune petricole de la Mer Noire a Agigea (secteur roumain) dans les conditions speciales de l'annee 1961, Trav. Mus. Hist. Nat. "Gr. Antipa", Bucureşti, 4: 131-155

Băcescu, M., Müller, G.I., Gomoiu, M.-T., 1971 – Cercetări de ecologie bentală în Marea Neagră (analiza cantitativă, calitativă şi comparată a faunei bentale pontice), Ecologie marină, Ed. Acad., Bucureşti, 4: 357

Gomoiu, M.-T., Ţigănuş, V., 1974 – Contributions to the knowledge of the fouling on the Romanian maritime ships, Cercetări marine, IRCM Constanţa, 7: 83-112

Gomoiu, M.-T., Ţigănuş, V., Bondar, C., 1978 – Date privind formarea foulingului în apele de larg ale Mării Negre, Al VIII-lea Simpoz. Biodeter. Climat., Braşov: 375-380

Gomoiu, M.-T., Ţigănuş, V., 1981 – Structure qualitative et quantitative des salissures formees dans les eaux du large de la Mer Noire, Rapp. Comm. Int. Mer Medit., CIESM., Monaco, 27, 2: 185-184

Gomoiu, M.-T., 1986 – Donnees preliminaires sur la structure et le role d'une communaute epibionte formee sur le substrat artificiel, Rapp. Comm. Int. Mer Medit., CIESM., Monaco, 30,2: 17

Gomoiu, M.-T., 1986 – Importanţa construirii de recifi artificiali pentru dezvoltarea mariculturii în zone deschise ale Mării Negre, Probleme de maricultură, IRCM Constanţa: 163-174

Gomoiu, M.-T., 1997 – Recifi artificiali la litoralul românesc. An. Univ. „Ovidius" Constanţa, Seria Biologie-Ecologie, I (1): 159-174

Ţigănuş, V., 1979 – Observations sur la structure qualitative et quantitative de la biocenose des moules de rocher du littoral roumain de la Mer Noire, Rapp. Comm. Int. Mer Medit., CIESM., Monaco, 25(26):159–160