PRESENT STATE OF SHALLOW WATER MACROZOOBENTHOS FROM THE MARINE RESERVE 2 MAI - VAMA VECHE

Valeria ABAZA[1], S. P. GODEANU[2]
[1]National Institute for Marine Research and Development
"Grigore Antipa" Constantza
e-mail: abaza@alpha.rmri.ro
[2]University "Ovidius" Constantza
e-mail: stoica@bucura.ro

ABSTRACT

The qualitative and quantitative structure of the benthic macrofauna from the Marine Reserve 2 Mai – Vama Veche buffer zone in 2006 is presented on the basis of the samples collected in 18 stations network at depths of 1,3, and 5 m from soft and hard bottoms. A total of 60 macrobenthic species have been identified distributed according to depths and substrate type. Upper infralittoral has been dominated in terms of abundance by the vagile fauna (*Microdeutopus gryllotalpa*, *Stenothoe monoculoides*, and *Melita palmata* among crustaceans with abundances up to 5800 ex/m^2, and *Brania clavata*, and *Capitella capitata* among polychaetes with abundances up to 2500 ex/m^2). In terms of biomass sessile species dominated: *Mytilus galloprovincialis* – up to 2711 g/m^2 and *Mytilaster lineatus* – up to1857 g/m^2. Species richness, Shannon-Wiener diversity *H'* and evenness tend to have the highest values at 3 m depth depending of substratum type. Ecological quality of soft bottom benthos of marine reserve buffer zone, based on Marine Biotic Index – AMBI (www.azti.es) has been assessed.

KEY WORDS : macrozoobenthos, marine reserve, species diversity, spatial distribution, ecological significance, Marine Biotic Index, Ecological Quality Ratio

INTRODUCTION

Marine Reserve 2 Mai – Vama Veche was designated in 1980 according to the Decision no. 31 of the Constantza County Council, and confirmed as protected area by Law 5/2000. Not many studies were specially dedicated to this area in the past, except maybe the paper of MULLER (1973) regarding the opportunity of establishing a marine protected area at the Romanian littoral, giving a concise description of the biological features of this area, based on the researches performed in the late '60ies on the entire Romanian waters (BACESCU *et al.*, 1971).

When the custody of this reserve was assigned to the National Institute of Marine Research and Development "Grigore Antipa" Constantza, studies regarding the identification of the main benthic habitats, their mapping, and their classification according to EUNIS have been carried out (ZAHARIA *et al.*, 2002, 2003; MICU, 2007; MICU *et al*., 2007).

MATERIALS AND METHODS

For the present study, samples were collected in September 2006 from the Marine Reserve 2 Mai – Vama Veche shallow waters. In order to assess the macrozoobenthos distribution on different substratum type, six transects perpendicular on the shoreline have been established as follows: four in 2 Mai (B, C, D, E), and two in Vama Veche (J and K) (Fig. 1). On each transect, three sampling sites have been considered: 1 m, 3 m and 5 m; geographical coordinates have been recorded using a portable GPS. One sample was taken from each station, which means that a total number of 18 samples were collected for this study. The stations from 2 Mai were predominantly with sandy substratum and those from Vama Veche with rough substratum.

Samples were collected using a metal frame on a surface of $0.04m^2$ (0.2m x 0.2m) by scuba diving. The sediment within the frame was placed directly into plastic bags, fixed with 40% formaldehyde and labelled. They were transported to laboratory for further processing. In the laboratory, samples were washed through two sieves (1 mm and 0.25 mm). The organisms were later identified to species and counted under a stereomicroscope. In order to determine the biomass, some of the organisms were weighted (wet weight) and for those that could not be weighted, standard tables containing average weights were used.

Fig. 1 – The sampling network in the shallow waters of the marine reserve
2 Mai – Vama Veche in 2006

Qualitative and quantitative structure of the macrobenthic communities from the marine reserve shallow waters was analysed using following ecological indices: species richness (Margalef index, d), abundance (A, ind/m^2), biomass (B, g/m^2), frequency (F), dominance (D) and ecological significance index (W); community diversity was estimated by Shannon-Wiener's diversity index (H', $\log_e$) and Pielou's evenness index (J'). To reveal the distribution of the fauna at different depths (1m, 3m and 5m) and on different types of substrata, based on Bray-Curtis similarity index calculated between stations on the fourth root transformed species abundances, hierarchical clustering on the similarity matrix using group average linking and MDS (non-metric multidimensional scaling) were performed.

In order to assess the ecological quality of the marine reserve shallow waters according to EU Water Framework Directive using macrozoobenthos, AMBI (Marine Biotic Index) and M-AMBI (or EQR – Ecological Quality Ratio) indices were calculated with special computer software elaborated by AZTI (www.azti.es).

RESULTS AND DISCUSSIONS

Together with biological samples, a series of environment parameters have been measured, referring to: seawater temperature, salinity, dissolved oxygen and organic matter in water. In early September, when the samples have been collected, seawater temperature (T˚C) varied between 20 and 22˚C; salinity (PSU) values were not very different from a site to another due to the close vicinity of sampling sites, varying between 16.27 and 16.64‰; dissolved oxygen (O_2) ranged between 5.65 and 7.28 mg/l and organic matter in water column between 0.8 and 2.88 (Fig. 2).

As it is shown, in sampled sites exists an inverse correlation between the variation of the dissolved oxygen and organic matter content, which influenced the distributional patterns of macrozoobenthic fauna.

In this environment conditions, a number of 60 macrobenthic species have been identified at sampled depths. In the southern Romanian littoral these depths correspond to upper infralittoral dominated on hard substrata by sessile organisms as bivalves *Mytilaster*, *Mytilus*, coelenterate *Actinia equina* and crustacean *Balanus improvisus* and on soft bottoms with coarse sands, which has been characterised by bivalve *Donax trunculus*, at present this species becoming very rare (BACESCU *et al.*, 1971).

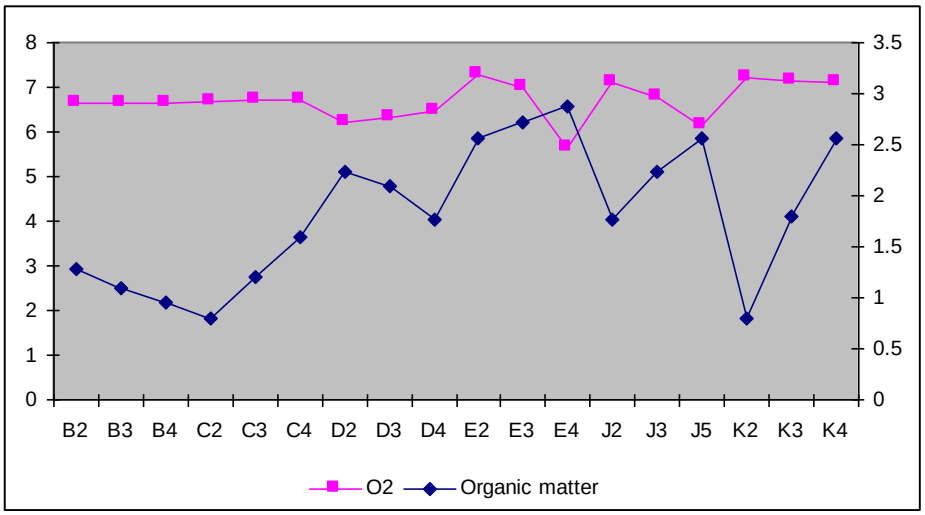

Fig. 2 - Spatial variation of dissolved oxygen (O_2) and organic matter in shallow waters of the marine reserve 2 Mai - Vama Veche in September 2006

As compared to the previous years, in 2006 an increase of species number has been observed (Fig. 3). Thus, studies performed in 2002 revealed the occurrence of 48 species in marine reserve's shallow waters. Their number decreased in 2003 until 30, after 2003 progressively increasing to 60 in 2006. The reduction of species numbers both on hard and mobile substrata from Romanian shallow waters as result of anthropogenic impact was a phenomenon widely mentioned by many authors in the last 30 years (GOMOIU, 1976; DUMITRACHE, 1996/1997; PETRAN, 1997; ABAZA, 2002; DUMITRACHE & ABAZA, 2004; ABAZA *et al.*, 2006). The quantitative parameters of abundance and biomass followed a diminution trend until 2004, in 2006 registering an improvement, especially in abundance; biomass values registered in 2006 were the lowest from the entire analyzed period (Fig. 4). The identified species grouped into polychaetes, molluscs, crustaceans and others have been distributed on the sites differently, according to depth and substrate type (Fig. 5). For a better interpretation of results, the very diverse substratum types from sampled sites have been assigned to sandy, hard or mixed. Hard substratum in this context is not represented by hard rock platform, but by boulders or even hard rock with enclaves of sand or others. In the figure 3 stations C3 and C4 in 2 Mai correspond to mixed substrata dominated by vagile crustaceans in term of species number, and J2, J3, J5 in Vama Veche to hard substrata, which show a very similar structure.

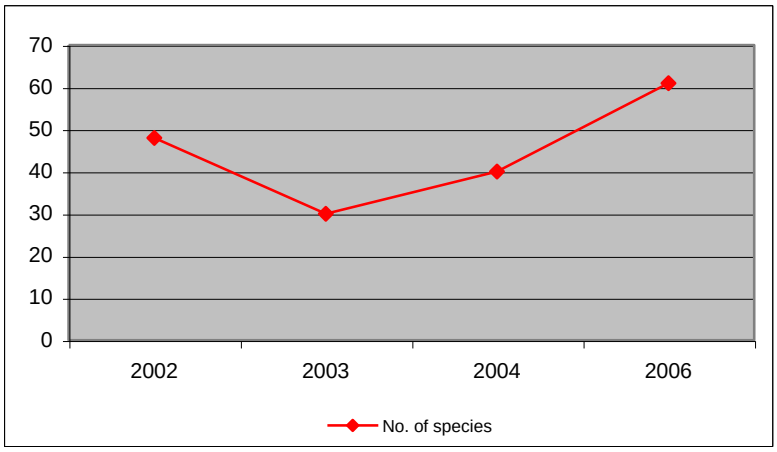

Fig. 3 - Number of macrozoobenthic species recorded between 2002 and 2006 in 2 Mai – Vama Veche marine reserve's shallow water

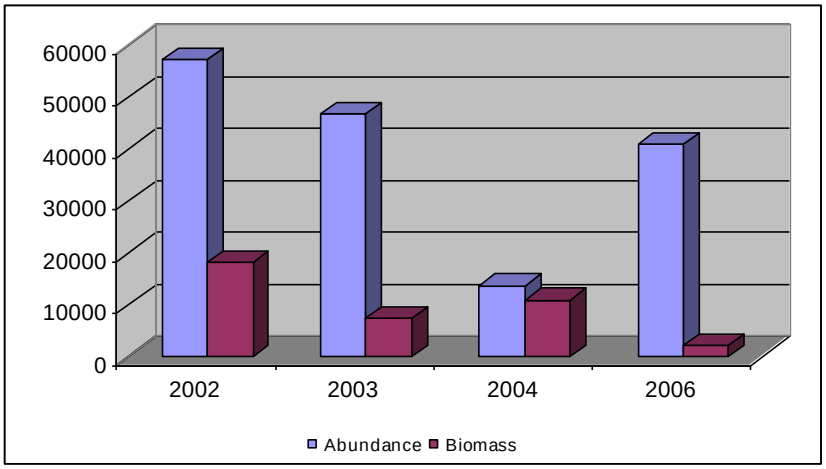

Fig. 4 - Evolution of quantitative parameters of abundance (ind/m^2) and biomass (g/m^2) of the macrozoobenthos from marine reserve's shallow waters between 2002 and 2006

Quantitatively, in term of abundance the stations with hard and mixed substrata were dominated by molluscs (from 12,525 ind/m^2 in C4 to 54,075 ind/m^2 in J3) - *Mytilaster lineatus* representing between 21.36% and 97.83% from the molluscs total abundance – followed by crustaceans (from 8,500 ind/m^2 in C4 to 21,125 ind/m^2 in J3) (Fig. 6). Regarding the biomass, the situation was similar as for abundances; over 95% of the total biomass of macrozoobenthos being given by molluscs (Fig. 7).

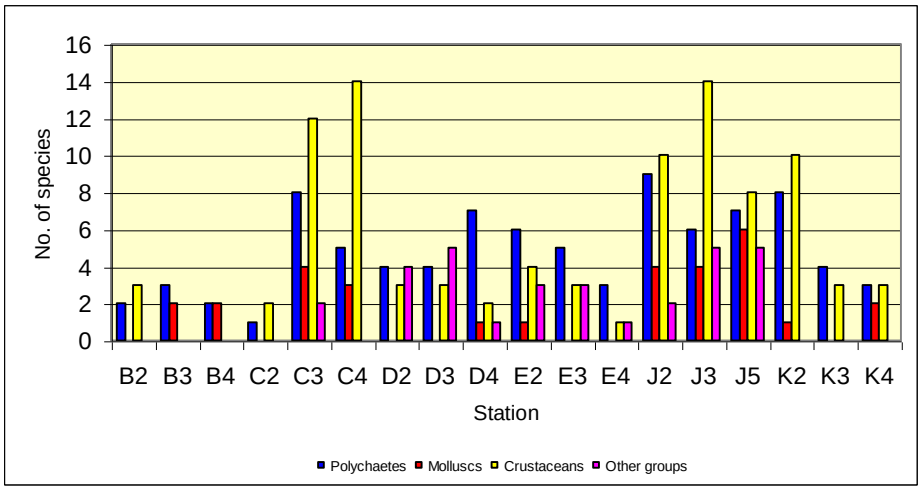

Fig. 5 – Zoobenthic invertebrates' main groups in the investigated sites of the marine reserve in 2006

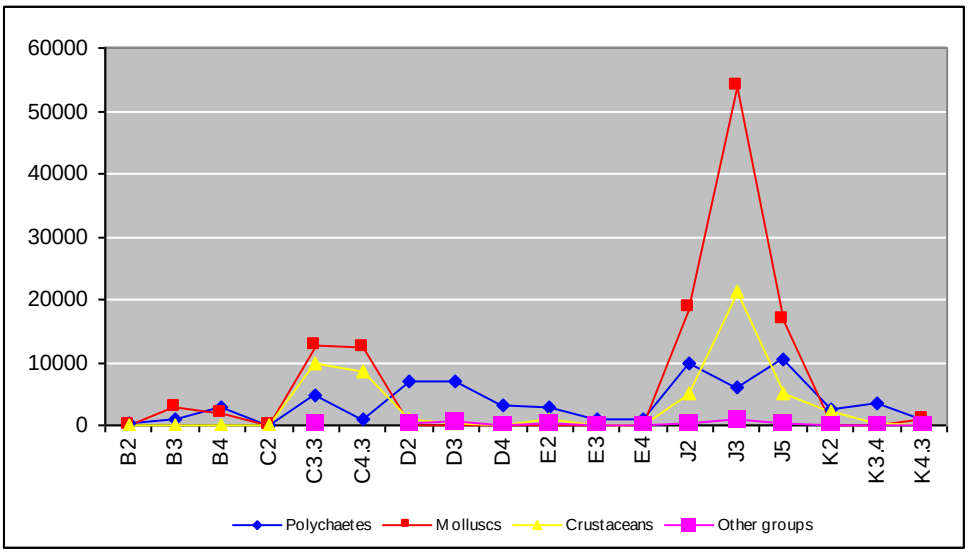

Fig. 6 – Macrozoobenthos total abundance variation in the analysed sampling sites in 2006

On sandy substratum (stations B2, B3, B4, C2 and C4), macrozoobenthos abundance and biomass had the lowest values at all depths, as well as the species number (Fig. 5, 6 and 7).

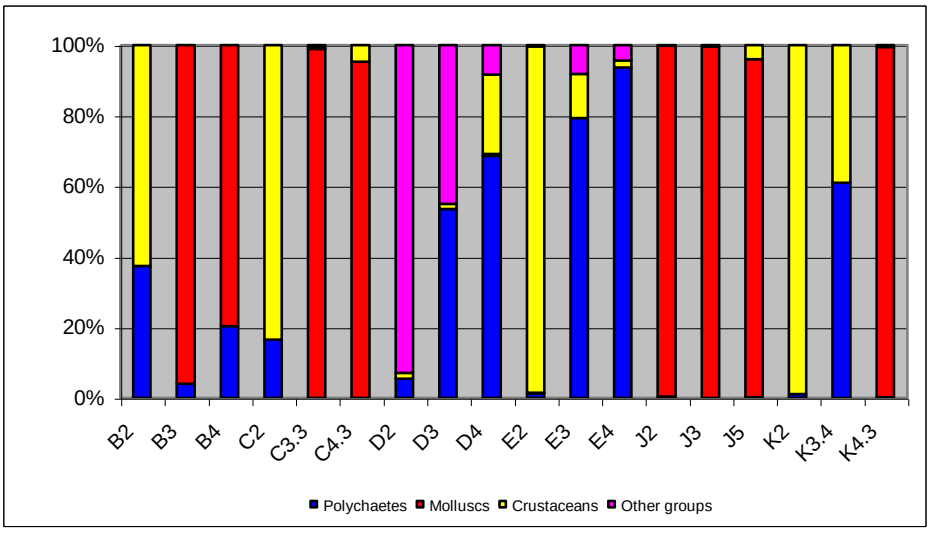

Fig. 7 – Structure of the total biomass of macrozoobenthos in the analysed sampling sites in 2006

The analysis of biotic data by univariate methods indicated the highest values of the Margalef's species richness (d) and Shannon-Wiener diversity (H' – $\log_e$) in the same stations with the highest values of quantitative parameters (C and J) with mixed and hard substrata at 3 m depth (Fig. 8). Pielou's evenness had values ranging between 0.91 and 0.99, which means that in all stations the species were equitable distributed among communities and the communities are stable.

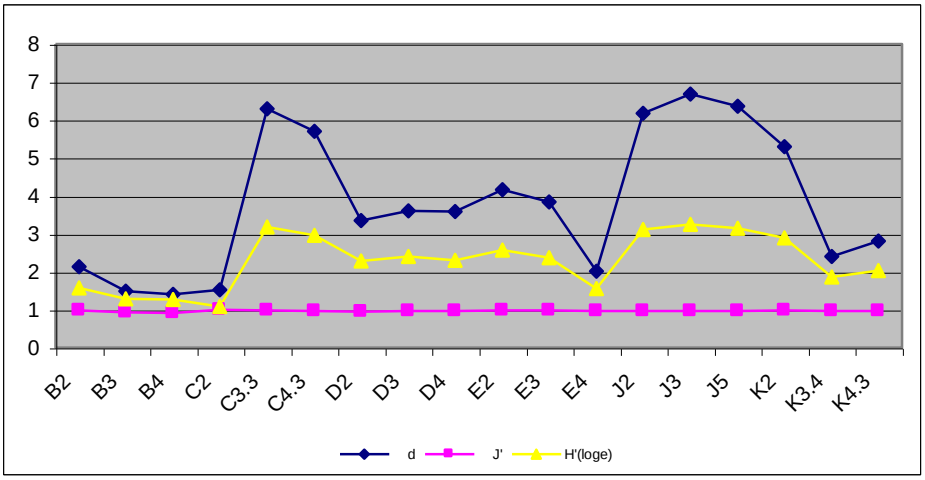

Fig. 8 - Variation patterns of diversity indices of the macrozoobenthos in the analysed sampling sites in 2006

Non-Metric Multidimensional Scaling (MDS) between samples superimposing Bray Curtis similarity showed a particular grouping of samples according to substrate type and depth (Fig. 9). Thus, five main groups were formed around a 40% similarity level and three around 60% similarity levels, which clearly separate the communities from sandy and hard substrata and reveal which of the mixed substrata, are close to hard and to sandy bottoms in term of species composition.

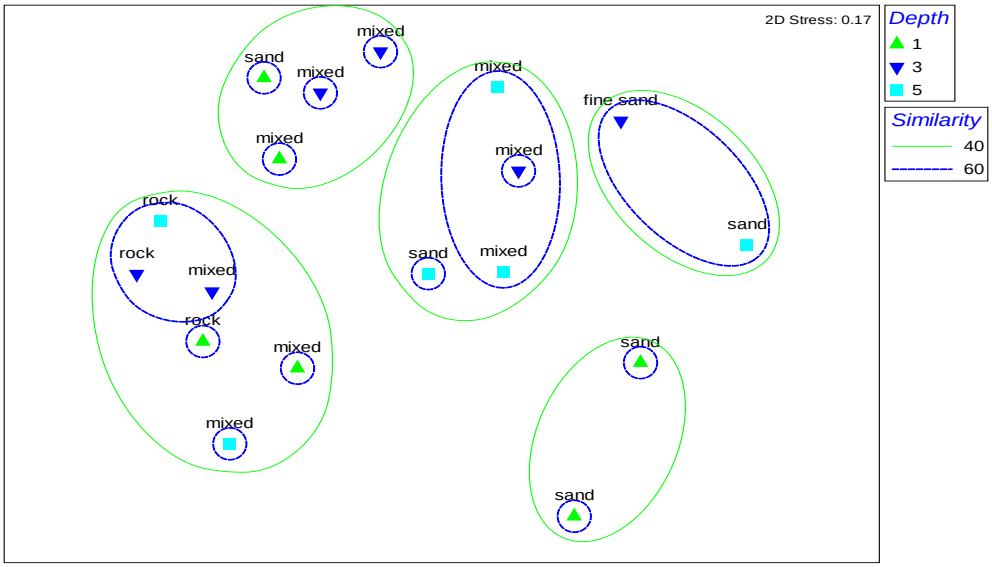

Fig. 9 - Marine reserve shallow water macrozoobenthos 2-dimensional MDS configuration with superimposed clusters

Due to substratum heterogeneity, synecological analysis of the macrobenthic communities was performed separately by substrate type.

On **hard substrate** (stations noted with J), no more than 15 species had frequencies of 100%, but eudominant species, no matter the depth was the bivalve *Mytilaster lineatus*, with the same value of dominance index – D and ecological significance index – W (64.57%) (Fig. 10). Figure 10 presents the distribution of *Mytilaster lineatus* superimposed on MDS and Bray Curtis similarity, showing its preference for different kind of hard substrata. A total number of 42 species have been identified on hard substrata. Dominant species with D and W values of over 5% were only two: cumacean *Iphinoe maeotica* (D, W = 5.28%) and amphipod *Stenothoe monoculoides* (D, W = 5.04%). Among the sub-dominant species, the following can be mentioned: the amphipod *Microdeutopus gryllotalpa* (D, W = 4.33%), the polychetes *Fabricia stellaris* (D, W = 4.24%) *Polydora cornuta* (D, W = 3.76%),

Capitella capitata (D = 3.05%; W = 2.04%) and *Capitella minima* (D = 3.16%; W = 1.04%); also, the amphipod *Melita palmata* (D = 2.47%; W = 1.65%) was among sub-dominant species. *Actinia equina*, a very characteristic species for hard bottoms registered a frequency of 100%, but its dominance and ecological significance was only of 0.57%, which ranked this species among sub-resident species in term of dominance (D), and resident species in term of ecological significance (W).

On **mixed substrata** (nine stations) 46 species have been recorded. The community structure was very heterogeneous; that was the reason for neither of species having a frequency of 100%. Three species namely polychaetes *Brania clavata*, *Capitella capitata* and amphipod *Microdeutopus gryllotalpa* were among euconstant species. In term of dominance, *Mytilaster lineatus* registered the highest percent (20.99%), together with *Brania clavata* and *Lentidium mediterraneum* being listed among eudominant species. From ecological significance (W) point of view, *Brania clavata* ranks first (W=11.81%), followed by *Mytilaster lineatus* (W=9.24%), *Capitella capitata* (W=6.36%) and *Microdeutopus gryllotalpa* as dominant species.

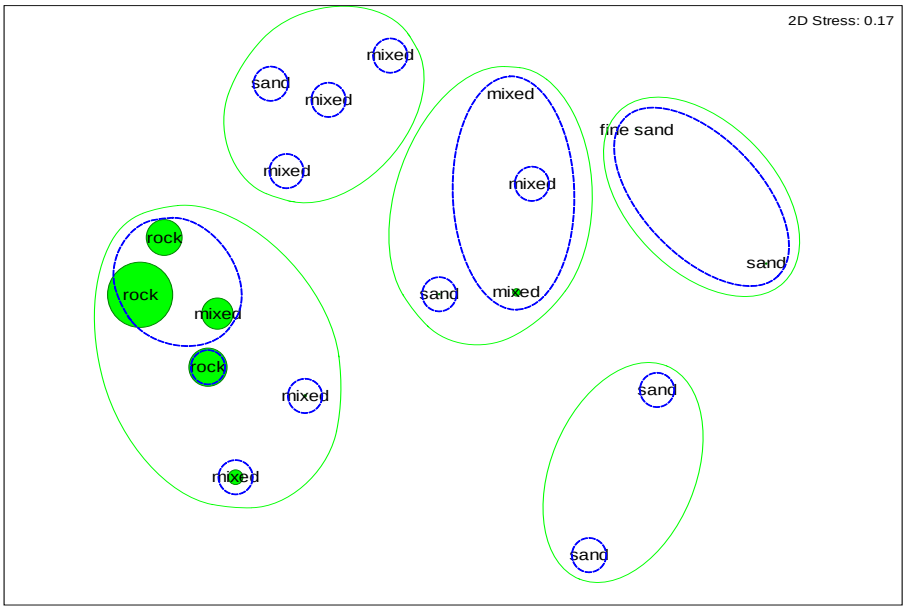

Fig.10 - Distribution pattern of *Mytilaster lineatus* in marine reserve shallow water superimposed on MDS and Bray Curtis similarity according to substrate types

Although *B. clavata* is characteristic species for hard substrata, its dominance on mixed substrata is due to the close vicinity of sandy bottoms along the shallow waters of marine reserve (Fig. 11).

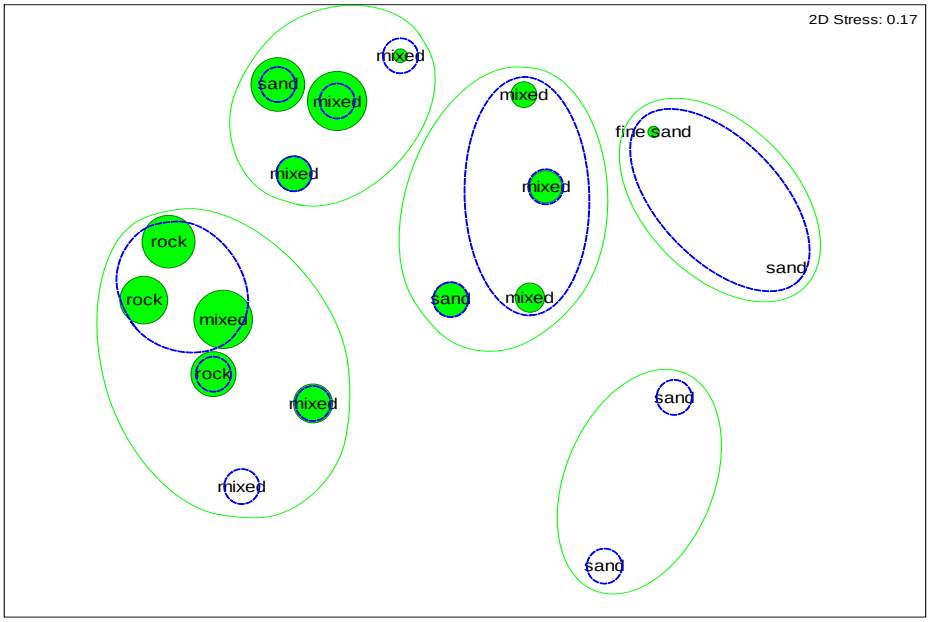

Fig.11 – Distribution pattern of *Brania clavata* in marine reserve shallow water superimposed on MDS and Bray Curtis similarity according to substrate types

On **sandy substratum** only 20 macrobenthic species have been found. BACESCU *et al.* (1971) mentioned for the infralittoral medium and coarse sands the community of bivalve *Donax trunculus*, with the observation, that this biocoenosis is not as continuously as the fine sand biocoenosis of *Lentidium mediterraneum* spread in the northern part of the Romanian shelf. In our sampled sites we didn't found *Donax trunculus*. In the last three decades, this species was considered almost disappeared (PETRAN, 1997); researches performed on mollusc diversity reveal the occurrence of this species, even if its effectives are very low; for that reason it was assigned as critically endangered (CR) and listed in our Red List of marine species (MICU, 2007 personal communication).

Among major taxa, polychaete with nine species was the dominant group. The other groups, as molluscs, amphipods, isopods and nemertians, were represented only by two or three species. In the Romanian southern littoral, the upper infralittoral sands consist mainly by medium grain size to coarse sands, except for some little patches of fine sands. Due to this mixture

of sands, and to the vicinity of coarse substrata represented by boulders or shell gravel or even gravel, the bivalve *Lentidium mediterraneum* had a frequency of only 33%, which rank it among accessory species; in term of dominance the index value of 20.62% situate it among eudominant species (Fig. 12). *Spio decoratus*, another characteristic species for sands had also a frequency of 33%; from the dominance point of view its situation was very similar to *Lentidium*'s, ranking among eudominant species (D = 24.14%. Polychaete *Capitella minima* had the highest ecological significance index (W = 11.76%), followed by *Polydora cornuta* with W = 2.64%. The composition of the sandy communities from the marine reserve shallow waters was very similar to those of mixed substrata, species as *Brania* or *Mytilaster* being frequently encountered.

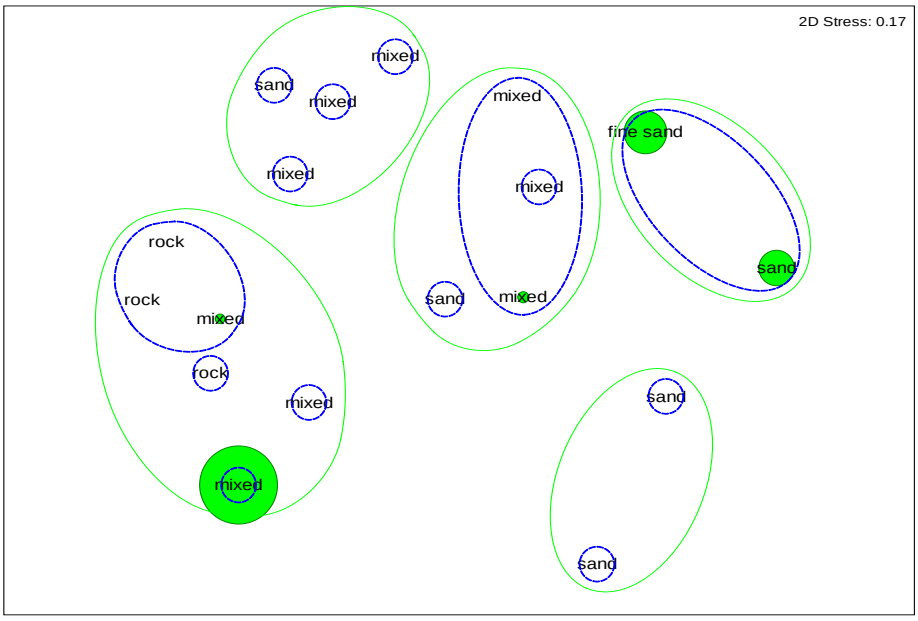

Fig. 12 - Distribution pattern of *Lentidium mediterraneum* in marine reserve shallow water superimposed on MDS and Bray Curtis similarity according to substrate types

In recent years several benthic biotic indices have been proposed for use in marine waters. One of them is AMBI (AZTI Marine Biotic Index) and was designed to establish the quality of European coasts, investigating the response of soft-bottom communities to changes in water quality (BORJA *et al.*, 2000, 2003).

Because the shallow waters of the marine reserve 2 Mai – Vama Veche are part of the reserve's buffer zone and can be influenced by the anthropogenic activities, we used the AMBI to assess the ecological quality of the upper infralittoral. The results was that generally, the ecological quality of the marine reserve shallow waters was slightly disturbed, only one station situated at 1 m depth (C2) in the northern extremity of the reserve showed as extremely disturbed (Fig. 13).

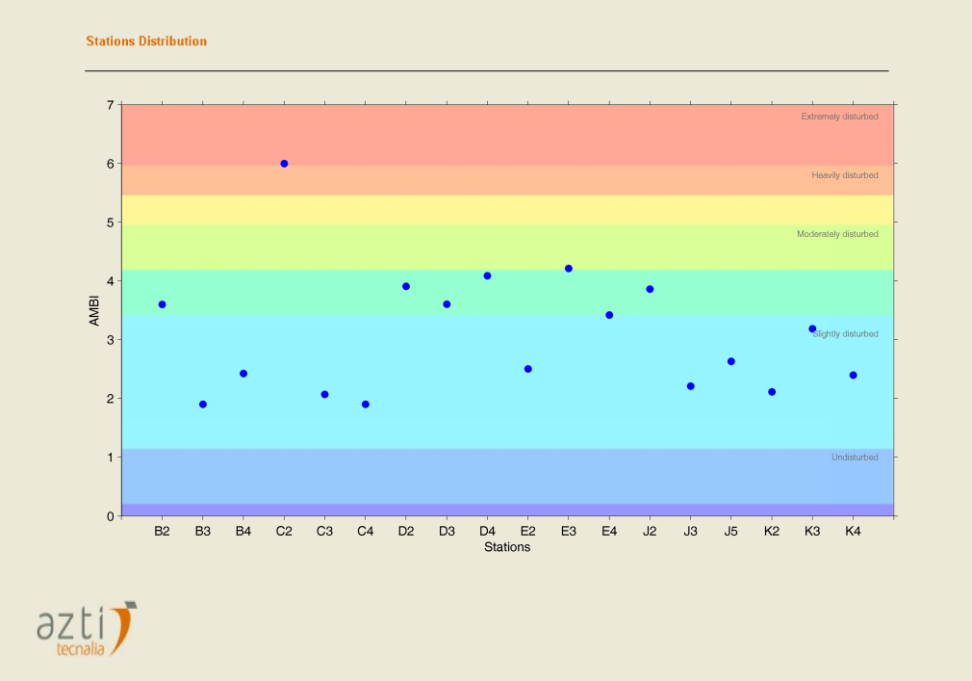

Fig. 13 - AMBI values of the marine reserve shallow water (1 to 5 m depth) in 2006

AMBI was also used for the determination of ecological quality status (EcoQ) within the context of the EU Water Framework Directive (WFD). In this context, it was necessary to elaborate the reference condition. The difficulty in establishing the environmental quality of an ecosystem in the absence of a reference value has been identified previously (MAKSIMOV, 1991). Because reference conditions must incorporate natural variability, in most instances they will be expressed as ranges. The description of the biological reference conditions must permit the comparison of monitoring results with the reference conditions in order to derive an Ecological Quality Ratio (EQR). The EQR represent the relationship between the values of the

biological parameters; its numerical value lies between 0 (bad status) and 1 (high status). This EQR was named M-AMBI (BORJA et al., 2004).

The variation of M-AMBI in the analysed sites, similar to AMBI showed a moderate to good ecological status (0.4 to 0.85) in 14 stations, high status (between 0.85 and 1) in three stations (J3 and J5) and bad ecological status with less than 0.1 in the station C2 assigned by AMBI as extremely disturbed (Fig. 14).

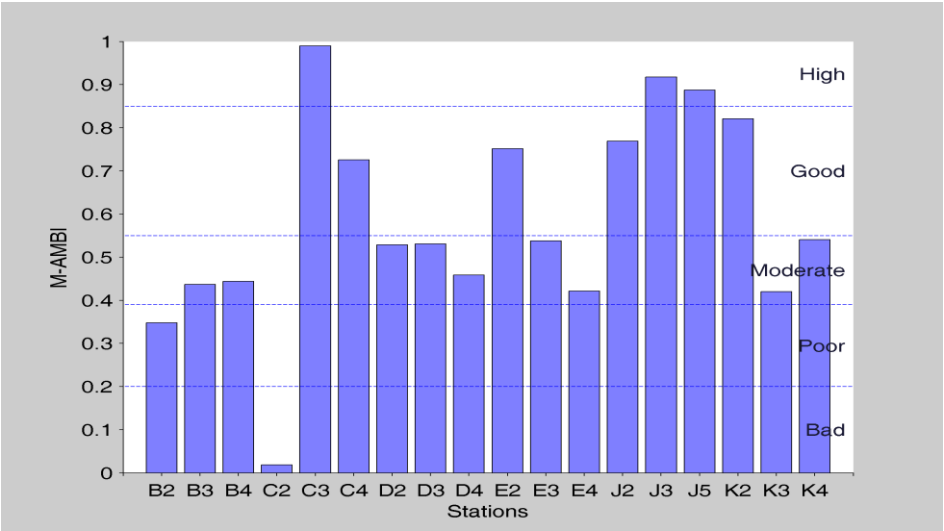

Fig. 14 - M-AMBI values of the marine reserve shallow water (1 to 5 m depth) in 2006

CONCLUSIONS

The study performed on the shallow water macrozoobenthos of the marine reserve 2 Mai - Vama Veche showed the occurrence of 60 species. After a decline in 2003, number of species inhabiting these depths registered a continuous increasing until 2006.

Quantitatively, macrozoobenthos abundance and biomass followed a decreasing trend until 2004. In 2006, an increasing trend in its abundance and respectively a reduction of biomass occurred. Molluscs dominated hard and mixed substrata sites and polychaetes the sandy ones.

Analysis of biotic data by univariate methods showed the highest values of Margalef's species richness (d) and Shannon-Wiener diversity index (H') in the same sites with the highest values of quantitative parameters (C and J) with hard and mixed substrata at 3 m depth.

Non-MDS between samples superimposing Bray-Curtis similarity revealed the presence of five groups of clusters around 40% similarity level and three around 60%, which clearly separate the benthic communities of hard and mobile substrata.

On hard substrate, a total number of 42 species has been identified; the eudominant species no matter the depth was the bivalve *Mytilaster lineatus*, having the same value of dominance (D) and ecological significance (W) index: 64.57%.

On mixed substrata, 46 species have been recorded; the community structure was heterogeneous. Three species were assigned among euconstant species: the polychaetes *Brania clavata* and *Capitella capitata* and the amphipod *Microdeutopus gryllotalpa*.

Sandy substratum has been characterized by 20 species, polychaetes being dominant among major taxa. Although the polychaetes dominated as number of species and ecological significance by *Capitella minima* and *Polydora cornuta* (known as opportunistic species), *Lentidium mediterraneum* was the eudominant species (D=20.62%) on sandy bottoms.

The assessment of AMBI index indicated a slightly disturbed ecological quality, and M-AMBI values a moderate and good ecological status of the studied area.

The general conclusion of the present study indicated that although the species composition of the macrozoobenthic communities of the marine reserve's shallow waters changed in time and some characteristic species (e.g. *Donax trunculus*) are in critical condition, the benthic communities are stable, well structured according to substrate type and in good ecological status.

REFERENCES:

ABAZA V., 2002 - Évolution de la structure de la faune benthique médiolittorale au sud du secteur marin roumain pendant la période 1994-1999. *Lucr. Ses. Şt. „ Viaţa în apă şi pe pământ în mileniul III”*, Agigea, 19-20 Oct. 2001, Univ. „Al. I. Cuza” Iaşi: 177-185.

ABAZA, V., BOICENCO L., BOLOGA A.S., DUMITRACHE C., MOLDOVEANU M., SBURLEA A., STAICU I., TIMOFTE F., 2006. Biodiversity structure from the Romanian marine area. *Cercetari marine – Recherches marines*, INCDM Constanta, **36**: 15-29.

BĂCESCU M., MÜLLER G., GOMOIU M.-T., 1971 - Cercetări de ecologie bentală în Marea Neagră. Analiza cantitativă, calitativă şi comparată a faunei bentale pontice. *Ecologie marină*, Ed. Academiei, Bucuresti, **4**: 1-357.

BORJA A., FRANCO J., PEREZ V., 2000 – A marine biotic index to establish the ecological quality of of soft-bottom benthos within european estuarine and coastal environments. *Marine Pollution Bulletin*, **40**, 12 : 1100 – 1114.

BORJA A., MUXICA I., FRANCO J., 2003 – The application of a Marine Biotic Index to different impact sources affecting soft-bottom benthic communities along European coasts. *Marine Pollution Bulletin*, **46**: 835-845.

BORJA A., FRANCO J., VALENCIA V., BALD J., MUXICA I., BELZUNCE M.J., SOLAUN O., 2004 – Implementation of the European Water Framework Directive from the Basque country (northern Spain): a methodological approach. *Marine Pollution Bulletin*, **48**: 209-218.

DUMITRACHE C., 1996/1997 – Present state of the zoobenthos from the Romanian Black Sea continental shelf. *Cercetari marine – Recherches marines*, IRCM Constanta, **29-30**: 141-150.

DUMITRACHE C., ABAZA V., 2004 - The present state of benthic communities in the Romanian coastal waters. *Cercetari marine – Recherches marines*, INCDM Constanta, **35**: 61-75.

GOMOIU M-T, 1976 – Modificari in structura biocenozelor bentale de la litoralul romanesc al Marii Negre. *Cercetari marine – Recherches marines*, IRCM Constanta, **9 supl**: 119 – 142.

MAKSIMOV V.N., 1991 – Integrated quality evaluation of natural waters. *Hydrobiological Journal*, **27**, 5: 29-33.

MICU D., 2007 – Recent records of *Pholas dactylus* L., 1758 (Bivalvia: Myoida: Pholadidae) from the Romanian Black Sea with the

considerations on its habitat and proposed IUCN regional status. *Acta Zoologica Bulgarica*, **59**, 3: 267-273.

MICU D., TODOROVA V., TUNESI L., MO G., 2007 – EUNIS marine habitats of the Black Sea: inventory and description. *Cercetari marine – Recherches marines,* INCDM Constanta, **37** (in press).

MULLER G.I., 1973 – On the opportunity of a marine reserve to be established at the Rumanian coast of the Black Sea. Atti del convegno internazionale *I Parchi Costieri Mediterranei*, Salerno, Castellabate, (18-22 iun. 1973): 715-730.

PETRAN A., 1997 - *Black Sea Biological Diversity. România*. Black Sea Environmental Series, **4**, UN Publications: 314 pp.

ZAHARIA T., URSACHE C., ZAHARIA M., DUMITRACHE C., ABAZA V., ALEXANDROV L., 2003 – Caracterizarea habitatelor din acvatoriul litoral marin Vama Veche – 2 Mai, *Mediul inconjurator*, **1**: 18-24.

ZAHARIA T., ABAZA V**.**, DUMITRACHE C., URSACHE C., ALEXANDROV L., ZAHARIA M., POPESCU-MIRCENI R., 2002 - Contributions to the knowledge of the present state of the Vama Veche-2 Mai marine reserve benthic habitats. *Cercetari marine - Recherches marines*, INCDM Constanta, **34**: 35-50.