# GENERAL DATA ON THE MARINE BENTHIC POPULATIONS STATE IN THE NW BLACK SEA, IN AUGUST 1995

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**Abstract**: The author presents the qualitative and quantitative data of the populations recorded in August 1995 on the sedimentary bottoms of NW continental shelf of the Black Sea. Species diversity and abundance of population are low. More than 120 taxa, having on the average about 30,000 sps/m$^2$and 230 g/m$^2$, were identified in the 30 studied stations. Benthic populations have had a regressive evolution. It seems that the H2S from the deeper zones pushed periazoic floor from the formerly 150-180 m, to the 120-150 m depth level. More researches are necessary to establish the biodiversity with specific methods.

**Key words**: Black Sea, benthos, biodiversity, abundance

## INTRODUCTION

The NW part of the Black Sea represents an embayment having as the offshore limit an imaginary straight line linking the shores between Cap Caliacra (Bulgaria) and Cap Tarhkanhut (Ucraina); the zone having a surface of about 63,900 km$^2$, a volume of water of 1,910 km$^3$ and an average depth of 30 m composes the continental shelf bottoms, usually not deeper than 100 m (Vinogradov, 1967). Three of the main Black Sea Rivers - Danube, Dniestr and Dnieper, annually discharge about 266 km$^3$ water, that is more than 75% of the total river runoff; huge quantities of sediments (150*10$^6$ tons) are also discharged into the sea. The great diagonal of Europe, the Danube River plays the most important ecological role influencing NW Black Sea. These rivers collect their waters from the catchements whose total area (Danube - 817,000 km$^2$, Dniester - 72,100 km$^2$ and Dnieper - 504,000 km$^2$) is 22 times greater than the NW Black Sea where they discharge; the volume of discharged water represents about 14% of the volume of the collecting basin. A counterclockwise gyre, mostly wind-induced (85-90% frequency of occurrence), dominates the water transport in the shelf zone; this results in a total water exchange of 5,200 km$^3$.yr$^{-1}$ with the deep sea (Tolmazin, 1985).The Danube water is thus usually transported southwards along the Romanian coast, very well illustrated by an experiment with floating bottles (Serpoianu & Nae, 1977).

The NW Black Sea was a traditionally important spawning and foraging area for many invertebrate and fish species, the nutrient supply via rivers inducing a high primary production – phytoplankton, microphytobenthos, macrophyta (famous perennial algae *Phyllophora* and *Cystoseira* and the sea grass *Zostera*) (Bacescu, 1960; Zakutzkyi & Vinogradov, 1967, Zenkevich, 1963).

The Black Sea has often been mentioned as an example of marine province where a process of naturally induced eutrophication occurs as a result of the permanent discharge of river-born nutrients. All that is because of the processes that exist in the NW Black Sea, formerly characterized by the highest bioproductivity, the highest ecological diversity and the richest fisheries.

The benthos of the North–West Sector of the Black Sea was well known thanks to the intense studies carried out in the '50s–'60s period, studies presented synthetically in the monumental work entitled "Researches of benthal ecology in the Black Sea. Qualitative, Quantitative and Comparative analysis of Pontic benthal fauna" (Bacescu, Müller et. Gomoiu, 1971).

In the 1950s and 1960s in the NW Sector of the Black Sea about 20 associations and communities were identified (Fig.1), some of them having macrobenthic populations with densities richer than 4000 sps/m$^2$(Fig.2) and biomasses higher than 2-5 kg/m$^2$ (Fig.3) biomasses.

It is well known that the Black Sea, a remnant of the Paleo–Tethys Ocean, with a very convulsed geological history, had experienced very drastic environmental changes during the Quaternary and recent geologic evolution. About 7000 years ago the connection with the Mediterranean again opened and the formation of the present chemical regime of the Black Sea was started. The present salinity structure of the Black Sea waters was formed some 3000 years ago when the melting of the glacial ice was complete.

The molluscs data suggest that no drastic changes have occurred during the last 3000 years with respect to the specific diversity, supply of organic water and bottom water oxygenation.

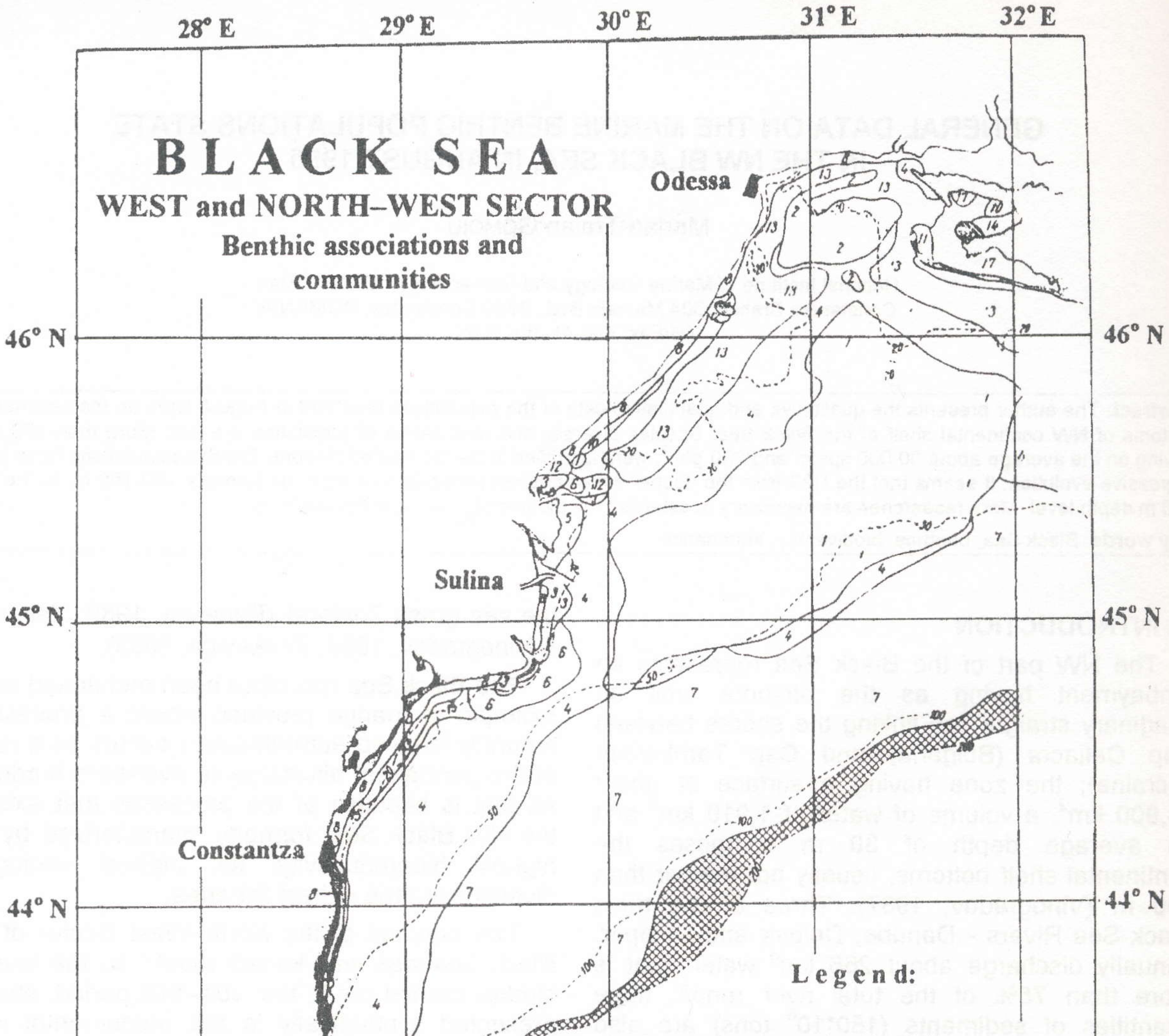



**Fig.1** The map of distribution of the main benthic population associations and communities on the continental shelf (after Băcescu, Müller and Gomoiu, 1971)

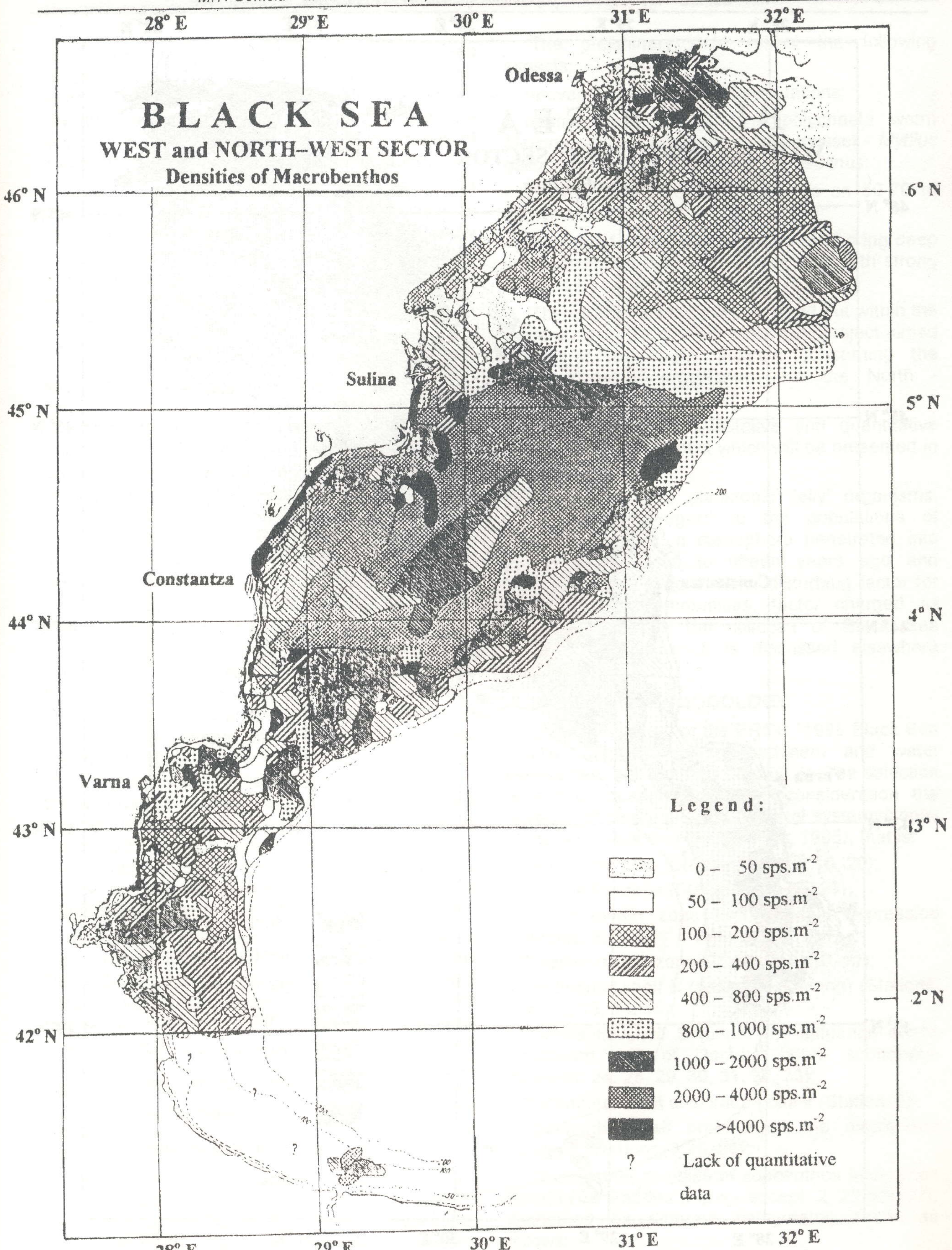



**Fig.2** The map of distribution of macrobenthic population densities on the continental shelf (after Băcescu, Müller and Gomoiu, 1971)

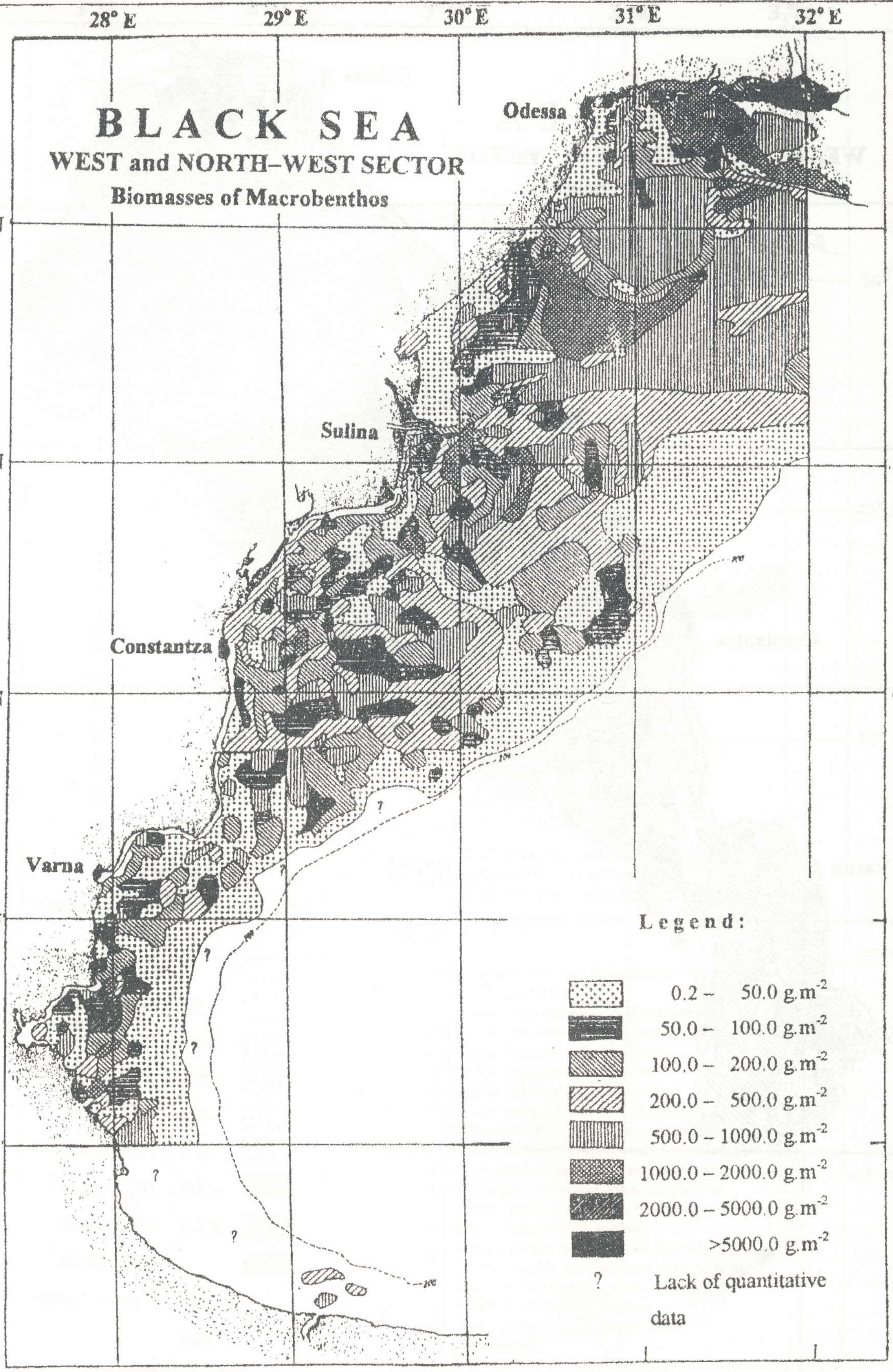



**Fig.3** The map of distribution of macrobenthic population biomasses on the continental shelf (after Băcescu, Müller and Gomoiu, 1971)

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 successive events leading to severe damages of ecosystems can be identified and understood.

The developments since the 1950s of agricultural and industrial activities, especially in the seawater catchement areas of the tributary rivers, primarily changed the chemical composition of the freshwater in the sea. As a result, multiple and complex changes occurred in the ecosystems (Chirea et Gomoiu, 1986; Gomoiu, 1981, 1982, 1992 etc.). Algal blooming became chronic, inducing the increasing of the organic matter in and sediments, appearance of hypoxic and anoxic conditions, mass mortality of benthic organisms. Many species have disappeared or reduced their number or biomass and some predatory, opportunistic species develop rapidly. The species having high commercial value reduced their stocks drastically leading to the fisheries failure. Pollution is increasing. The Black Sea receives an unknown amount of domestic and industrial untreated wastewaters.

The constructions of reservoirs for hydroelectric power generation and diversion of water to arid regions control the discharges of the major Black Sea rivers. The construction of several dams on the tributaries resulted in a decrease of freshwater and sediments discharge into the Black Sea (e.g. to 52% for the Dnieper and to 40% for the Dniester (Tolmazin, 1985). Huge freshwater reservoirs act as a trap for the sediments. The embankment of the riverbanks or the rectification of the river course, decrease the capacity of the flooding plains to buffer and filter nutriments of pollutants. The defense works for the protection of the coasts, or the building of new harbours are other facts which influence negatively the littoral ecosystems.

Initiated as a reaction of the scientific world to the increasingly dramatic ecological situation of the Black Sea, EROS 21-the Black Sea component of EROS 2000-an interdisciplinary long-term research project on biogeochemical processes at the land-sea interface of contrasting European coastal seas, brought through a cruise organized in August 1995 with the R/V. "Prof. Vodyanitskyi" new data on the actual state of the NW Black Sea ecosystems important for the understanding and prediction of the alterations in this basin.

Thus the results of the EROS 2000 Black Sea cruise, obtained from the benthos stations performed on the board R/V. "Prof. Vodyanitskyi" in August 1995 (Panin et al., 1996) represent, through the condition of benthic populations, very important proofs of the recent regressive evolution of the ecosystem in this sea.

The preliminary data reflect the following aspects:

- impoverishment of benthic populations;
- relative dominance of the polychaeta worm *Melinna palmata* populations and mussel - *Mytilus galloprovincialis* and *Modiolus phaseolinus*;
- relatively high diversity of species on 60-70 m bathymetric strip;
- presence of some polychaeta worms boring deep in the sediment thickness - black mud with strong $H_2S$ smell - in anoxic conditions.

The ecological researches carried out within the framework of EROS-2000 Black Sea project aimed mainly at two major aspects concerning the communities of organisms from the North - Western Black Sea:

- knowledge of the qualitative and quantitative state of benthos - aspect which will be presented in this paper;
- knowledge of the planktonic "jelly" organisms, with a special regard to the populations of *Mnemiopsis leidyi*, a ctenophore penetrated into the Black Sea ten to fifteen years ago and meanwhile becoming a major disturbing factor for the planktonic communities, factor charged as guilty specially for the collapse of Black Sea fisheries, aspect which is discussed elsewhere (Gomoiu, 1997).

## SAMPLING METHODOLOGY

During the Leg 2 of the EROS "1995 Black Sea Cruise", 33 stations for sediment and water assessment were carried out (Fig.4). The selection of station locations took into consideration the covering of all 6 major depositional systems/zones of the NW Black Sea (Panin et al., 1995), that is:

- ➢Delta Front area (Stations: 16, 17, 19, 20);
- ➢Danube Prodelta (Stations: 18, 22, 23);
- ➢Dniepr mouth zone and Odessa Depression (Stations: 6, 7, 8);
- ➢Dniester mouth zone (Stations: 9, 10, 11);
- ➢Continental shelf N (sediment starving) (Stations: 1, 4, 12, 13, 14, 15);
- ➢Continental shelf S (under the influence of the Southward drift of Danube borne sediments) (Stations: 24, 25, 29, 30, 31, 32, 33);
- ➢Continental shelf at Crimean coast (Station: 5);
- ➢Continental shelf break near the oxic/anoxic interface (Stations: 3,26, 28);

Quantitative samples of zoobenthos have been taken in 30 stations (Fig.4 - except: 2, 21 and 27), distributed on different bathymetric zones as follows:

- ➲ 0-9.9 m – 1 station (7);
- ➲ 10-19.9 m – 4 stations (9, 11, 16, 31);

➲ 20-29.9 m – 8 stations (6, 10, 17, 19, 20, 22, 24, 30);
➲ 30-39.9 m – 3 stations (8, 13, 15);
➲ 40-49.9 m – 2 stations (18, 29);
➲ 50-59.9 m – 5 stations (1, 12, 23, 25, 32);
➲ 60-69.9 m – 4 stations (4, 5, 14, 33);
➲100-150 m – 3 stations (3, 26, 28);

At each station 2-3 sub-samples have been taken during the cruise, more than 120 samples of zoobenthos, stored in plastic bags (mostly meio- and microbenthos) have been preserved in 4% formaldehyde and stained with Congo red, to be subsequently sorted and studied in the Constantza laboratory. Some sediment samples taken and analyzed on-board for other purposes have also been preserved for faunistical qualitative and quantitative determinations.

The analyses of the zoobenthos samples have been carried out as follows:

↬ the content of each plastic bag was discharged (for short interval - 30-60 minutes) into a plastic basin containing top filtered water; this operation is done in order to soften the material and to prevent the possible damages of the water jet during the washing of the tiny meiobenthic organisms;

↬ washing of the sample through three sieves-1 mm, 0.250 mm and 0.100 mm mesh size – in order

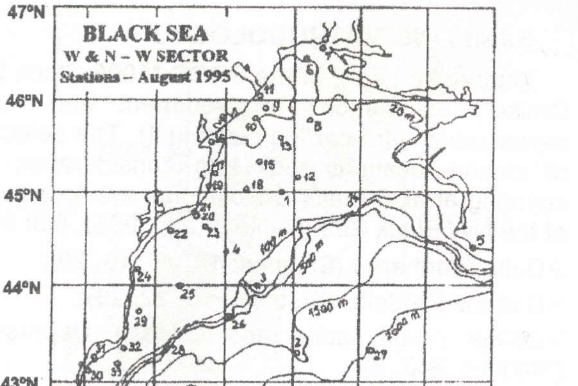



**Fig.4** The location of the map stations performed by the R/V "Prof. Vodyanitskiy" during EROS-2000 Black Sea1995 Cruise, Leg 2

to remove the mud and to separate macro- and meio-zoobenthos; the washing was done slowly, stirring very gently by hand to prevent the damaging or loss of animals, and using a single fresh (tap) water jet from a low pressure hose; the sieve was gently shaken in water so that a flow occurred in a straight line downwards and thus the animals were obtained in good conditions;

↬ all the material retained by the three sieves has been examined by the binocular microscope; all animals were extracted, using fine tweezers and the species or group of species were identified and counted (in order to determine the density of populations); the larger organisms were measured and weighed (for size class, structure and biomass); for smaller organisms, the average wet weights inscribed in standard tables were used to calculate the biomass.

## METHODOLOGIES OF DATA ANALYSIS

The general methodology for data analysis consisted of:

↬ calculations of specific parameters;

↬ graphical data analysis, using mostly the graphic facility of the Excel 7.0 software;

↬ statistical data analysis.

Besides the usual statistical parameters, the data concerning the structure of zoobenthos populations were totally or partially processed; to characterize the living organism associations on the W and NW Black Sea continental shelf the following parameters have been calculated:

1. Number of occurrence in stations for each species/organisms (abbreviated usually $N_{occ}$);

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

$$F\ \% = (ns/NS) * 100, \text{ where:}$$

- ns - the total number of stations containing species, and
- NS - total number of stations carried out in the studied area or associations;

According to the values of the frequency index (F%) the species can be distributed into the following classes:

- F25 - accidental species having a presence of 1-25 % in the studied area or in association;
- F50 - accessory species having a presence of 25.1-50 % in the studied area or in association;
- F75 – constant species having a presence of 50.1-75 % in the studied area or in association ;
- F100 – euconstant species having a presence of 75.1-100 % in the studied area or association.

3. Abundance (A) - Total number or biomass of individuals counted on all stations, or absolute number or biomass of the individuals of a certain species or group of species in an association.

4. Dominance (D%) - or relative abundance, indicating the percentage of the number or biomass of the individuals belonging to a species or a group of species (ni) from the total number or biomass of all species individuals in the samples from the studied area (Ni):

$$D\% = (ni//Ni) * 100$$

5. Average density or biomass ($D_{avg}$, $B_{avg}$)

$$D_{avg} = AN/N;\ B_{avg} = AB/N$$

- AN - abundance (number);
- AB - abundance (biomass);
- N - number of stations.

6. Ecological density or biomass (**$D_{eco}$, $B_{eco}$**)

$$D_{eco} = AN/Na;\ B_{eco} = AB/Na$$

- AN - abundance (number);
- AB - abundance (biomass);
- Na - number of stations containing the considered species.

7. Index of ecological significance (**W**) - representing the relation between the constancy and abundance (density or biomass) reflects in a complex way the rank of each species in the community or association:

$$W = (F * A) \text{ or } W = (C * D)$$

Taking into account the indices of the frequency and dominance the index of ecological significance (W) serves to order the rank of species (**$Rk_W$**).

## QUALITATIVE AND QUANTITATIVE STATE OF BENTHAL COMMUNITIES

The main results and conclusions are presented as follows:

The stations have an uneven distribution in the research area, both as "covering" of depositional systems and as "covering" of different bathymetric zones (Fig.5).

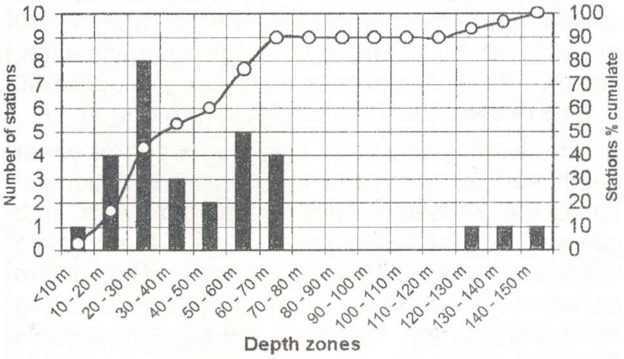



**Fig.5** Repartition of the number of benthos stations performed in 1995 on depth zones

Most of the stations (50%) were performed on shallow "biotic" bottoms, to a depth of 30-40 m and influenced mainly by the Danube, Dniester and Dnieper and on the inner shelf to a depth of 60-70m; 3 stations were performed on the outer shelf zone, at depths of 120-150 m.

In 1995, 127 taxons were found on the biotic bottoms in the NW Black Sea, only 119 being determined to the species (Table 1). The organisms belong to the following taxonomic groups: red algae --Rhodophyta-2 species (1.5%), worms-46 species (36.2%), molluscs-13 species (10.2%), crustaceans-41 taxons (32.2% and other groups-25 taxons (19.6%). Most species (almost 40%) had a unique appearance in the analyzed samples, therefore being met just in one station; only 15-20% of the species appeared in more than 8-10 stations (Fig.6).

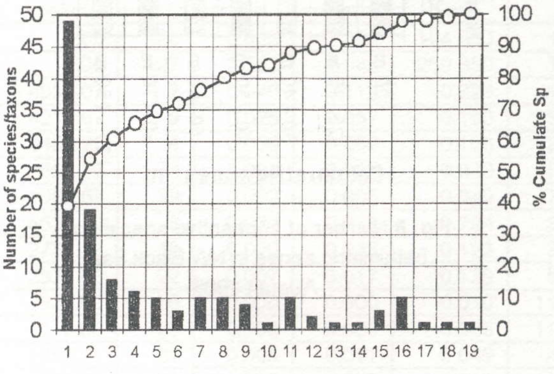



**Fig.6** Benthic biodiversity in NW Black Sea, August 1995

The number of benthic taxa varies from one depositional system to another, as well as from one bathymetric zone to another. The highest species diversity was recorded on the continental shelf influenced by the Danube River discharge and the lowest on the bottoms near the shelf break (Fig.7).

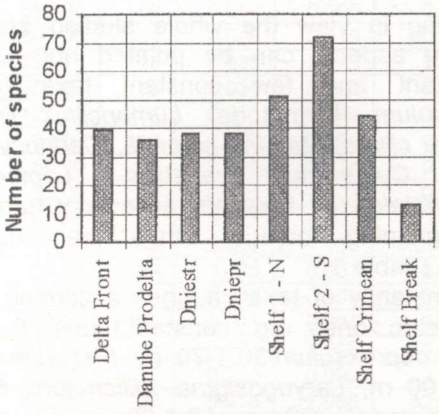



**Fig. 7** Number of zoobenthic species on depositional system / zones in NW Black Sea, August 1995

Referring to different bathymetric zones, the highest diversity seems to be at levels of 20-30 m and 60-70 m; the lowest diversity was recorded in deeper zones of 120-150 m (Fig.8). The microzoobenthos forms are everywhere more numerous than the macrozoobenthos ones (Fig.8).

Within the zoobenthos the ratio macrobenthos: meiobenthos for the number of species is 1:3:5 (28:97). The diverse taxons have a variable

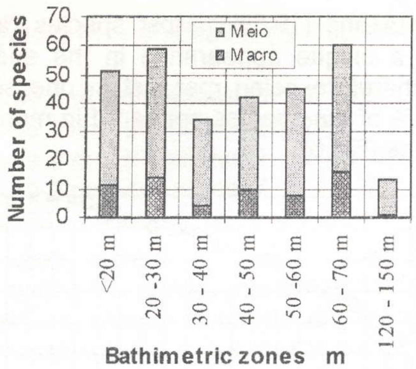



**Fig. 8** Number of zoobenthic species on bathimetric zones in NW Black Sea, August 1995

importance in the make up of densities and biomasses, the worms representing the dominant for the numerical abundance (43.6%) while the molluscs are the weight dominant (75.5%). In the case of densities, the ratio macro: meio are 1:128 for the forms from the varia group, 1:24 for the worms, 1:4 for crustaceans and 1:1 for molluscs, 68:1 for varia and 1:1 for crustaceans. The most abundant groups of species were the foraminifera (16 living species and 39 in thanatocoenosis), molluscs (13 living forms and 77 in the thanatocoenosis).

Having in view the whole studied zone the following aspects can be pointed out. Lock of euconstant and few constant taxa (*Nonion depressulum,* Nematoda, *Lumbricillus lineatus, Polydora ciliata, Melinna palmata, Carinocythereis rubra, Cytheroma variabilis, Leptocythere multipunctata)*: 22 taxa are accessory forms and the remaining majority forms are accidental species (Table 1).
The constancy of taxa changes according to the bathymetric zones, e.g.: constant forms - $F_{100}$ / are *Nonion depressulum*/30.1-70 m; *Fissurina lucida*/ 60.1->100 m; *Laryngosigma williamsoni*/ 60.1-70 m; Nematoda/ <30 m, 50.1-60 m; *Lumbricillus lineatus*/ 40.1-50 m, 60.1-70 m; *Nereis succinea*/ 20.1-30 m; *Nereis rava*/ 0-30 m; *Mytilus galloprovincialis*/ 30.1-40 m, 50.1-60 m; *Modiolus phaseolinus*/ 50.1-60 m; *Carynocythereis rubra*/ 30.1-70 m; *Cytheroma variabilis*/ 40.1-60 m; *Leptocythere multipunctata*/ 30.1-50 m; *Phtysica marina*/ 60.1-70 m; etc.

It is worth mentioning that in spite of its gaps in the depths range 70-110 m or in the Eastern part of research area, the station network put in evidence the main biocoenosis of benthic organisms, as follows:
- *Mytilus galloprovincialis* association (Stations 9, 10, 19);
- *Modiolus phaseolinus* association (Stations 4, 5, St.-14);
- *Mya arenaria* association (Stations 20, 22, 24);
- Mussels association with *Phyllophora* (Stations 8, 9, 13, 15);
- Ecotonal transitional zone *Mytilus* - *Modiolus* (Stations 1, 12, 25);
- Periazoic zone (Stations 3, 26, 28) etc.

Anoxic conditions were recorded in some of the stations (6, 7, 11, 16, 17), the samples having a strong $H_2S$ smell; however, living organisms were met in all these stations, the bottoms being anoxic but not also azoic (Table 2).

Mortalities affecting the benthic organisms were recorded in the samples collected from stations 18, 23, 29; for some samples (Stations 3, 26, 28), even if macroscopic observation on shipboard did not evidence any living organisms, subsequent laboratory analyser led to the conclusion that the studied sediments were not azoic, being characterized especially by the presence of worms.

From a quantitative viewpoint, the benthic populations record high variations from one station to another, "scarcity" being the general characteristics of most of the forms. As a rule, for the North – Western Black Sea, the general densities of benthic organisms populations have a decreasing tendency with increasing depth (Fig.9).

The biomasses are more reduced in the stations performed in shallow waters; from 20-30 m up to 50-60 m depth they remain quite high, usually with values greater than 250 g/m$^2$, after 60 m they decrease with increasing depth (Fig.9).

The worm population, very numerous at water depth <30 m, command the density variation for the entire zoobenthic population; otherwise, one can say that the worm density has a tendency to decrease with increasing depth. The worm biomasses vary greatly, in some places reaching more than 50 g/m$^2$ thanks to the big size species (Fig.10).

In the North – Western Black Sea the molluscs have relatively reduced populations as individual numbers, with densities <1000 indvs/m$^2$ but with quite high biomasses, in many stations more than 200 g/m$^2$ (Fig.11).

The crustacean populations, unlike those of worms or molluscs, have as a rule density and biomasses increasing towards the deeper bottoms, from 30 m to 70 m depths (Fig.12).

Among the 127 species of benthic organisms just a few are more abundant. High densities, cumulated representing more than 70% of the numerical total, have been recorded for the following macrobenthal species: the tube polychaet *Melinna palmata*, the bivalve *Mytilus*

**Table 1** Ecological parameters characterising benthic populations from NW Black Sea in August 1995

| Crt no. | SPECIES | $N_{occ}$ | F% | DENSITIES | | | | BIOMASSES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | D% | $D_{avg}$ sps/m² | $D_{eco}$ sps/m² | $Rk_W$ | D% | $B_{avg}$ g/m² | $B_{eco}$ g/m² | $Rk_W$ |
| 1 | *Phyllophora nervosa* | 2 | 6.67 | 0.00 | 0.00 | 0.00 | 126 | 3.623 | 8.323 | 124.850 | **10** |
| 2 | *Phyllophora brodiaei* | 1 | 3.33 | 0.00 | 0.00 | 0.00 | 127 | 3.763 | 8.645 | 259.350 | **12** |
| 3 | *Ammonia beccari* | 15 | 50.00 | 8.43 | 2478.53 | 4957.07 | **2** | 0.049 | 0.112 | 0.223 | 19 |
| 4 | *Ammonia tepida* | 9 | 30.00 | 4.30 | 1264.40 | 4214.67 | **9** | 0.025 | 0.057 | 0.190 | 32 |
| 5 | *Nonion depressulum* | 16 | 53.33 | 6.17 | 1813.47 | 3400.25 | **4** | 0.036 | 0.082 | 0.153 | 20 |
| 6 | *Protelphidium martcobi* | 7 | 23.33 | 0.53 | 154.67 | 662.86 | 24 | 0.003 | 0.007 | 0.030 | 55 |
| 7 | *Protelphidium subgranosus* | 3 | 10.00 | 0.37 | 108.27 | 1082.67 | 39 | 0.002 | 0.005 | 0.049 | 71 |
| 8 | *Cribroelphidium poeyanum* | 8 | 26.67 | 5.93 | 1743.87 | 6539.50 | **6** | 0.034 | 0.078 | 0.294 | 31 |
| 9 | *Elphidium ponticum* | 11 | 36.67 | 3.41 | 1001.47 | 2731.27 | **10** | 0.020 | 0.045 | 0.123 | 33 |
| 10 | *Elphidium pulvereum* | 4 | 13.33 | 1.30 | 382.80 | 2871.00 | 22 | 0.007 | 0.017 | 0.129 | 51 |
| 11 | *Elphidium haagensis* | 1 | 3.33 | 0.03 | 7.73 | 232.00 | 78 | 0.000 | 0.000 | 0.010 | 112 |
| 12 | *Elphidium incertum* | 1 | 3.33 | 0.01 | 3.87 | 116.00 | 90 | 0.000 | 0.000 | 0.005 | 118 |
| 13 | *Fissurina lucida* | 7 | 23.33 | 0.87 | 255.20 | 1093.71 | 21 | 0.005 | 0.011 | 0.049 | 49 |
| 14 | *Fissurina fragilis* | 1 | 3.33 | 0.01 | 3.87 | 116.00 | 91 | 0.000 | 0.000 | 0.005 | 119 |
| 15 | *Esosyrinx jatzkoi* | 2 | 6.67 | 0.12 | 34.80 | 522.00 | 48 | 0.001 | 0.002 | 0.023 | 87 |
| 16 | *Lagena vulgaris* | 4 | 13.33 | 0.36 | 104.40 | 783.00 | 34 | 0.002 | 0.005 | 0.035 | 67 |
| 17 | *Laryngosigma williamsoni* | 5 | 16.67 | 0.24 | 69.60 | 417.60 | 38 | 0.001 | 0.003 | 0.019 | 69 |
| 18 | *Nodosaria calomorpha* | 1 | 3.33 | 0.01 | 3.87 | 116.00 | 92 | 0.000 | 0.000 | 0.005 | 120 |
| 19 | *Sycon ciliatum* | 1 | 3.33 | 0.13 | 38.67 | 1160.00 | 54 | 0.058 | 0.133 | 4.000 | 45 |
| 20 | *Haliclona implexa* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 112 | 0.192 | 0.440 | 13.200 | 34 |
| 21 | *Obelia longissima* | 1 | 3.33 | 0.03 | 7.90 | 237.00 | 77 | 0.003 | 0.006 | 0.189 | 77 |
| 22 | *Pachycerianthus imperator* | 1 | 3.33 | 0.02 | 5.27 | 158.00 | 84 | 0.002 | 0.004 | 0.126 | 82 |
| 23 | *Actinothoe clavata* | 1 | 3.33 | 0.00 | 0.97 | 29.00 | 122 | 0.000 | 0.001 | 0.023 | 102 |
| 24 | *Carinina heterosoma* | 1 | 3.33 | 0.03 | 9.00 | 270.00 | 73 | 0.014 | 0.032 | 0.950 | 61 |
| 25 | *Micrura fasciolata* | 2 | 6.67 | 0.01 | 4.03 | 60.50 | 75 | 0.005 | 0.011 | 0.163 | 66 |
| 26 | Nemertini varia | 6 | 20.00 | 0.29 | 86.33 | 431.67 | 32 | 0.062 | 0.142 | 0.711 | 27 |
| 27 | *Enoplolainus conicus* | 3 | 10.00 | 0.08 | 23.40 | 234.00 | 47 | 0.000 | 0.000 | 0.000 | 123 |
| 28 | *Enoplus euxinus* | 8 | 26.67 | 0.09 | 26.93 | 101.00 | 41 | 0.000 | 0.000 | 0.000 | 109 |
| 29 | *Chromadorella pontica* | 1 | 3.33 | 0.07 | 19.67 | 590.00 | 60 | 0.000 | 0.000 | 0.001 | 126 |
| 30 | Nematoda varia | 19 | 63.33 | 33.82 | 9940.77 | 15695.95 | **1** | 0.008 | 0.019 | 0.030 | 38 |
| 31 | *Lumbricillus lineatus* | 16 | 53.33 | 1.18 | 347.60 | 651.75 | 15 | 0.030 | 0.070 | 0.130 | 21 |
| 32 | Olygochaeta varia | 13 | 43.33 | 1.40 | 412.20 | 951.23 | 16 | 0.036 | 0.082 | 0.189 | 22 |
| 33 | *Phyllodoce lineata* | 3 | 10.00 | 0.04 | 12.13 | 121.33 | 56 | 0.018 | 0.042 | 0.425 | 47 |
| 34 | *Phyllodoce micossa* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 113 | 0.002 | 0.004 | 0.116 | 83 |
| 35 | *Phyllodoce maculata* | 2 | 6.67 | 0.01 | 4.00 | 60.00 | 76 | 0.006 | 0.014 | 0.210 | 64 |
| 36 | *Harmothoe reticulata* | 2 | 6.67 | 0.01 | 3.53 | 53.00 | 80 | 0.001 | 0.002 | 0.034 | 80 |
| 37 | *Lagisca extenuata* | 1 | 3.33 | 0.01 | 3.33 | 100.00 | 100 | 0.001 | 0.002 | 0.060 | 91 |
| 38 | *Polynoe scolopendrina* | 3 | 10.00 | 0.02 | 5.13 | 51.33 | 69 | 0.001 | 0.003 | 0.03067 | 74 |
| 39 | *Sthenelais boa* | 2 | 6.67 | 0.01 | 1.70 | 25.50 | 99 | 0.000 | 0.001 | 0.017 | 90 |
| 40 | *Syllis variegata* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 114 | 0.000 | 0.001 | 0.027 | 101 |
| 41 | *Exogone gemmifera* | 1 | 3.33 | 0.01 | 1.67 | 50.00 | 108 | 0.001 | 0.001 | 0.040 | 95 |
| 42 | *Nereis succinea* | 11 | 36.67 | 0.67 | 197.23 | 537.91 | 19 | 0.857 | 1.968 | 5.368 | **8** |
| 43 | *Nereis longissima* | 1 | 3.33 | 0.03 | 9.90 | 297.00 | 72 | 0.043 | 0.099 | 2.970 | 48 |
| 44 | *Nereis diversicolor* | 11 | 36.67 | 0.19 | 55.97 | 152.64 | 29 | 5.218 | 11.988 | 32.695 | **2** |
| 45 | *Nereis rava* | 12 | 40.00 | 0.54 | 159.57 | 398.92 | 20 | 0.694 | 1.595 | 3.986 | **9** |
| 46 | *Nereis zonata* | 8 | 26.67 | 0.16 | 46.97 | 176.13 | 37 | 0.204 | 0.470 | 1.761 | 15 |
| 47 | *Nereis pelagica* | 1 | 3.33 | 0.01 | 1.80 | 54.00 | 107 | 0.008 | 0.018 | 0.540 | 68 |
| 48 | *Nereis costae* | 2 | 6.67 | 0.01 | 2.10 | 31.50 | 86 | 0.009 | 0.021 | 0.315 | 57 |
| 49 | *Perinereis cultrifera* | 2 | 6.67 | 0.09 | 26.33 | 395.00 | 50 | 0.007 | 0.016 | 0.237 | 62 |
| 50 | *Platynereis dumerilii* | 2 | 6.67 | 0.00 | 1.03 | 15.50 | 105 | 0.001 | 0.002 | 0.033 | 81 |
| 51 | *Nephthys hombergi* | 5 | 16.67 | 0.05 | 13.70 | 82.20 | 49 | 0.058 | 0.134 | 0.804 | 30 |
| 52 | *Nephthys cirrosa* | 2 | 6.67 | 0.01 | 2.10 | 31.50 | 87 | 0.008 | 0.019 | 0.284 | 58 |
| 53 | *Aricia estrullii* | 1 | 3.33 | 0.01 | 3.30 | 99.00 | 101 | 0.001 | 0.002 | 0.050 | 93 |
| 54 | *Aricia latreyllii* | 1 | 3.33 | 0.00 | 0.70 | 21.00 | 125 | 0.000 | 0.000 | 0.011 | 110 |
| 55 | *Spio filicornis* | 2 | 6.67 | 0.02 | 4.50 | 67.50 | 74 | 0.001 | 0.001 | 0.021 | 88 |
| 56 | *Polydora ciliata* | 16 | 53.33 | 1.36 | 399.13 | 748.38 | **12** | 0.290 | 0.666 | 1.249 | **11** |
| 57 | *Prionospio cirrifera* | 5 | 16.67 | 0.03 | 9.57 | 57.40 | 52 | 0.023 | 0.052 | 0.311 | 41 |
| 58 | *Magelona papillicornis* | 1 | 3.33 | 0.00 | 1.20 | 36.00 | 110 | 0.000 | 0.001 | 0.022 | 104 |
| 59 | *Paraonis fulgens* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 115 | 0.000 | 0.000 | 0.001 | 125 |
| 60 | *Heteromastus filiformis* | 3 | 10.00 | 0.02 | 6.03 | 60.33 | 64 | 0.002 | 0.005 | 0.052 | 70 |
| 61 | *Capitella capitata* | 11 | 36.67 | 0.12 | 36.03 | 98.27 | 36 | 0.005 | 0.012 | 0.032 | 46 |

**Table 1** Continued

| Crt no. | SPECIES | $N_{occ}$ | F% | DENSITIES | | | | BIOMASSES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | D% | $D_{avg}$ sps/m$^2$ | $D_{eco}$ sps/m$^2$ | $Rk_W$ | D% | $B_{avg}$ g/m$^2$ | $B_{eco}$ g/m$^2$ | $Rk_W$ |
| 62 | *Pectinaria koreni* | 9 | 30.00 | 0.30 | 87.30 | 291.00 | 27 | 0.192 | 0.442 | 1.472 | 14 |
| 63 | *Melinna palmata* | 16 | 53.33 | 1.13 | 331.13 | 620.88 | 14 | 4.702 | 10.802 | 20.253 | **4** |
| 64 | *Terebellides stroemi* | 9 | 30.00 | 0.09 | 25.33 | 84.44 | 40 | 0.883 | 2.028 | 6.760 | **7** |
| 65 | *Euchone rubrocincta* | 1 | 3.33 | 0.01 | 4.13 | 124.00 | 88 | 0.001 | 0.002 | 0.074 | 89 |
| 66 | *Protodryllus flavocapitatus* | 2 | 6.67 | 0.01 | 3.30 | 49.50 | 81 | 0.001 | 0.003 | 0.045 | 78 |
| 67 | *Nerilla antennata* | 1 | 3.33 | 0.02 | 5.40 | 162.00 | 83 | 0.001 | 0.003 | 0.097 | 85 |
| 68 | Larve Polychaeta | 15 | 50.00 | 1.39 | 408.97 | 817.93 | 13 | 0.031 | 0.070 | 0.141 | 23 |
| 69 | Polychaeta varia | 8 | 26.67 | 0.24 | 71.97 | 269.88 | 30 | 0.019 | 0.044 | 0.166 | 39 |
| 70 | *Cerithium vulgatum* | 1 | 3.33 | 0.05 | 15.73 | 472.00 | 65 | 0.001 | 0.002 | 0.047 | 94 |
| 71 | *Calyptraea chinensis* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 116 | 0.024 | 0.055 | 1.650 | 54 |
| 72 | *Nassa reticulata* | 1 | 3.33 | 0.01 | 2.20 | 66.00 | 104 | 0.431 | 0.990 | 29.700 | 24 |
| 73 | *Mytilus galloprovincialis* | 11 | 36.67 | 0.42 | 123.97 | 338.09 | 17 | 54.140 | 124.380 | 339.219 | **1** |
| 74 | *Modiolus adriaticus* | 1 | 3.33 | 0.01 | 1.67 | 50.00 | 82 | 0.049 | 0.113 | 3.400 | 36 |
| 75 | *Modiolus phaseolinus* | 6 | 20.00 | 0.34 | 101.23 | 506.17 | 25 | 4.511 | 10.363 | 51.817 | **5** |
| 76 | *Cardium edule* | 2 | 6.67 | 0.02 | 5.40 | 81.00 | 59 | 2.377 | 5.462 | 81.930 | **6** |
| 77 | *Venus gallina* | 1 | 3.33 | 0.01 | 4.40 | 132.00 | 85 | 0.019 | 0.044 | 1.320 | 56 |
| 78 | *Spisula subtruncata* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 117 | 0.354 | 0.814 | 24.42 | 28 |
| 79 | *Abra alba* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 118 | 0.006 | 0.013 | 0.396 | 72 |
| 80 | *Mya arenaria* | 4 | 13.33 | 0.01 | 2.50 | 18.75 | 55 | 8.169 | 18.767 | 140.750 | **3** |
| 81 | Larve gastropoda | 8 | 26.67 | 0.27 | 80.17 | 300.63 | 28 | 0.004 | 0.008 | 0.031 | 52 |
| 82 | Larve bivalvia | 10 | 33.33 | 0.52 | 151.97 | 455.90 | 23 | 0.007 | 0.015 | 0.045 | 44 |
| 83 | *Phoronis euxinicola* | 2 | 6.67 | 0.01 | 2.00 | 30.00 | 89 | 0.001 | 0.002 | 0.024 | 86 |
| 84 | *Callistocythere abjecta* | 5 | 16.67 | 0.37 | 108.27 | 649.60 | 31 | 0.003 | 0.007 | 0.042 | 59 |
| 85 | *Callistocythere crispata* | 7 | 23.33 | 0.22 | 65.73 | 281.71 | 33 | 0.002 | 0.004 | 0.018 | 63 |
| 86 | *Callistocythere diffusa* | 14 | 46.67 | 7.13 | 2095.73 | 4490.86 | **3** | 0.059 | 0.136 | 0.292 | 17 |
| 87 | *Callistocythere flavidofusca* | 1 | 3.33 | 0.03 | 7.73 | 232.00 | 79 | 0.000 | 0.001 | 0.015 | 107 |
| 88 | *Carinocythereis carinata* | 2 | 6.67 | 0.03 | 7.73 | 116.00 | 66 | 0.000 | 0.001 | 0.008 | 97 |
| 89 | *Carinocythereis rubra* | 18 | 60.00 | 2.30 | 676.67 | 1127.78 | **8** | 0.019 | 0.044 | 0.073 | 29 |
| 90 | *Cyprideis littoralis* | 3 | 10.00 | 0.21 | 61.87 | 618.67 | 42 | 0.002 | 0.004 | 0.040 | 73 |
| 91 | *Cytheroma variabilis* | 17 | 56.67 | 5.24 | 1538.93 | 2715.76 | **5** | 0.044 | 0.100 | 0.177 | 18 |
| 92 | *Cytheroma* sp. | 1 | 3.33 | 0.07 | 19.33 | 580.00 | 61 | 0.001 | 0.001 | 0.038 | 96 |
| 93 | *Cytheromorpha fuscata* | 1 | 3.33 | 0.01 | 3.87 | 116.00 | 93 | 0.000 | 0.000 | 0.008 | 114 |
| 94 | *Leptocythere devexa* | 3 | 10.00 | 0.46 | 135.33 | 1353.33 | 35 | 0.004 | 0.009 | 0.088 | 65 |
| 95 | *Leptocythere histriana* | 1 | 3.33 | 0.01 | 3.87 | 116.00 | 94 | 0.000 | 0.000 | 0.008 | 115 |
| 96 | *Leptocythere lopatici* | 2 | 6.67 | 0.03 | 7.73 | 116.00 | 67 | 0.000 | 0.001 | 0.008 | 98 |
| 97 | *Leptocythere multipunctata* | 16 | 53.33 | 2.92 | 858.40 | 1609.50 | **7** | 0.024 | 0.056 | 0.105 | 26 |
| 98 | *Levocytherura remanei* | 1 | 3.33 | 0.09 | 27.07 | 812.00 | 58 | 0.001 | 0.002 | 0.053 | 92 |
| 99 | *Loxoconcha aestuari* | 1 | 3.33 | 0.01 | 3.87 | 116.00 | 95 | 0.000 | 0.000 | 0.008 | 116 |
| 100 | *Loxoconcha granulata* | 15 | 50.00 | 1.51 | 444.67 | 889.33 | **11** | 0.013 | 0.029 | 0.058 | 35 |
| 101 | *Loxoconcha rhomboidea* | 1 | 3.33 | 0.04 | 11.60 | 348.00 | 71 | 0.000 | 0.001 | 0.023 | 103 |
| 102 | *Paradoxostoma simile* | 2 | 6.67 | 0.03 | 7.73 | 116.00 | 68 | 0.000 | 0.001 | 0.008 | 99 |
| 103 | *Sclerochilus gewemulleri* | 4 | 13.33 | 0.11 | 30.93 | 232.00 | 43 | 0.001 | 0.002 | 0.015 | 75 |
| 104 | *Semicytherura calamitica* | 1 | 3.33 | 0.01 | 3.87 | 116.00 | 96 | 0.000 | 0.000 | 0.008 | 117 |
| 105 | *Xestoleberis cornelii* | 12 | 40.00 | 0.80 | 235.87 | 589.67 | 18 | 0.007 | 0.015 | 0.038 | 43 |
| 106 | *Stenothoe monoculoides* | 1 | 3.33 | 0.00 | 0.97 | 29.00 | 123 | 0.000 | 0.001 | 0.017 | 105 |
| 107 | *Microdeutopus gryllotalpa* | 1 | 3.33 | 0.01 | 2.93 | 88.00 | 103 | 0.003 | 0.006 | 0.176 | 79 |
| 108 | *Stenogammarus* sp. | 1 | 3.33 | 0.00 | 1.03 | 31.00 | 121 | 0.000 | 0.001 | 0.030 | 100 |
| 109 | *Corophium volutator* | 3 | 10.00 | 0.02 | 6.33 | 63.33 | 63 | 0.001 | 0.003 | 0.025 | 76 |
| 110 | *Orchomene humilis* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 119 | 0.000 | 0.001 | 0.017 | 106 |
| 111 | *Erichtonius hunteri* | 1 | 3.33 | 0.00 | 0.83 | 25.00 | 124 | 0 000 | 0.000 | 0.011 | 111 |
| 112 | *Ampelisca diadema* | 7 | 23.33 | 0.04 | 10.97 | 47.00 | 46 | 0.024 | 0.055 | 0.234 | 37 |
| 113 | *Phtisica marina* | 7 | 23.33 | 0.05 | 15.70 | 67.29 | 45 | 0.012 | 0.027 | 0.114 | 42 |
| 114 | *Caprella acanthifera* | 4 | 13.33 | 0.02 | 4.83 | 36.25 | 62 | 0.004 | 0.009 | 0.065 | 60 |
| 115 | *Apseudes ostroumovi* | 9 | 30.00 | 0.39 | 114.90 | 383.00 | 26 | 0.100 | 0.230 | 0.766 | 16 |
| 116 | *Iphinoe maeotica* | 2 | 6.67 | 0.01 | 1.93 | 29.00 | 97 | 0.000 | 0.000 | 0.003 | 113 |
| 117 | *Iphinoe elisae* | 6 | 20.00 | 0.07 | 20.30 | 101.50 | 44 | 0.004 | 0.010 | 0.050 | 53 |
| 118 | *Cumella limicola* | 1 | 3.33 | 0.00 | 1.10 | 33.00 | 120 | 0.000 | 0.000 | 0.005 | 121 |
| 119 | *Eudorela truncatulla* | 1 | 3.33 | 0.01 | 1.97 | 59.00 | 106 | 0.000 | 0.000 | 0.014 | 108 |
| 120 | *Balanus improvisus* | 2 | 6.67 | 0.05 | 14.50 | 217.50 | 57 | 0.063 | 0.145 | 2.175 | 40 |
| 121 | *Copidognathus* sp. | 1 | 3.33 | 0.01 | 3.13 | 94.00 | 102 | 0.000 | 0.000 | 0.005 | 122 |
| 122 | *Harpacticus flexus* | 1 | 3.33 | 0.01 | 3.60 | 108.00 | 98 | 0.000 | 0.000 | 0.002 | 124 |
| 123 | *Harpacticus gracilis* | 1 | 3.33 | 0.00 | 1.20 | 36.00 | 111 | 0.000 | 0.000 | 0.001 | 127 |
| 124 | *Tisbe furcata* | 1 | 3.33 | 0.01 | 1.67 | 50.00 | 109 | 0.001 | 0.003 | 0.100 | 84 |

**Table 1** Continued

| Crt no. | SPECIES | $N_{occ}$ | F% | DENSITIES | | | | BIOMASSES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | D% | $D_{avg}$ sps/m$^2$ | $D_{eco}$ sps/m$^2$ | $Rk_W$ | D% | $B_{avg}$ g/m$^2$ | $B_{eco}$ g/m$^2$ | $Rk_W$ |
| 125 | *Crustacea varia* | 4 | 13.33 | 0.03 | 10.00 | 75.00 | 53 | 0.008 | 0.019 | 0.141 | 50 |
| 126 | *Amphiura stepanovi* | 4 | 13.33 | 0.04 | 12.30 | 92.25 | 51 | 0.097 | 0.224 | 1.679 | 25 |
| 127 | *Molgula euprocta* | 2 | 6.67 | 0.02 | 7.20 | 86.40 | 70 | 8.139 | 18.699 | 224.388 | 13 |
| | TOTAL: | | | | **29394.0** | | | | **229.7** | | |
| | **Worms** | | | | 12819.4 | | | | 30.9 | | |
| | **Molluscs** | | | | 492.5 | | | | 161.0 | | |
| | **Crustaceans** | | | | 6575.8 | | | | 0.9 | | |
| | **Foraminifera** | | | | 9430.8 | | | | 0.4 | | |
| | **Varia** | | | | 75.4 | | | | 36.5 | | |

**Table 2** Data on the benthos recorded in the NW Black Sea stations on the bottoms with anoxic conditions (S – Number of species/taxons; D – densities sps/m$^2$; B – biomasses g/m$^2$)

| Stations/ Depth m | Co-ordinates/ *Data* | Observation on bord | Quantitative data S | D | B |
|---|---|---|---|---|---|
| 6 / 23 | 46$^0$25'4510 N<br>31$^0$11'2481 E<br>*13.08.1995* | Soft black muddy bottom covered by a thin yellow- orange oxidized layer consisting mainly of organic matter. The upper layer consists of sylty-sandy black mud with $H_2S$ smell, and contains *Abra* shells (*A. alba, A. ovata* and *A. nitida*) as dominant species, together with other molluscs, especially small gastropods (*Bittium reticulatum, Hydrobia ventrosa, Retusa truncatella, Rissoa splendida*, etc.). This upper layer seems to be formed in the last decades (showing a high sedimentation rate). Living polychaets could be observed in the upper 25-35 cm of the sedimentary column. The bottom seems to be anoxic but not azoic. | 11 | 29425 | 31.8980 |
| 7 / 8 | 46$^0$33'6351 N<br>31$^0$25'1128 E<br>*13.08.1995* | The upper black sylty mud layer 40 cm thick, with $H_2S$ smell, contains living polychaets. In the subjacent sandy and sylty black mud layer shells of *Corbula* and rare *Mytilus* and even *Mya* could be found; the presence of *Mya* shows that these sediments could be formed in the '50$^{th}$ or '60$^{th}$, the subsequent sedimentation rate being very high. | 16 | 31883 | 67.5976 |
| 11 / 11 | 46$^0$62'0097 N<br>30$^0$29'0018 E<br>*14.08.1995* | Soft bottom consisting of mud covered by gray-yellow matter (oxidized), 1-2 cm thick, with small holes made by organisms. The core had 50 cm in length consisting of black soapy mud, sandy sediments with old molluscs shells of Adacnidae in the lower part and *Mya arenaria* and other psammobiontic species in the more recent upper sylty mud layers. No living organisms have been recorded proving that conditions are anoxic but not azoic. | 20 | 87639 | 7.7261 |
| 16 / 16 | 45$^0$32'3061 N<br>29$^0$46'5704 E<br>*17.08.1995* | Typical anoxic black, "greasly" mud having a superficial layer of yellow-brownish matter (oxidised organic matter and very fine sediments). At 30-40 cm bellow the bottom surface one find *Mya arenaria* shells, having both wholls valves, lying on dark black laminated mud (more dense and compact than the above lying sediments. Living Polychaets have been recorded proving that the conditions are anoxic but not azoic. | 8 | 33840 | 4.8400 |
| 17 / 26 | 45$^0$12'2347 N<br>29$^0$50'8251 E<br>*18.08.1995* | Black oozy bottom, having specific smell, with a top layer consisting of yellow-orange very fine sediments ("rusty creamlike") having at the surface worm tubes of 2-3 mm height. In the "greasy" mud rare shells of *Mya arenaria* and *Cerastoderma edule lamarckii*, as well as tubes of *Melinna palmata* can be found; have a distinct colour (yellow-brown) being sometimes inhabited by worms penetrating 25-30 cm in the sediments which is rich in organic matter but under anoxic conditions. | 16 | 55260 | 13.6997 |

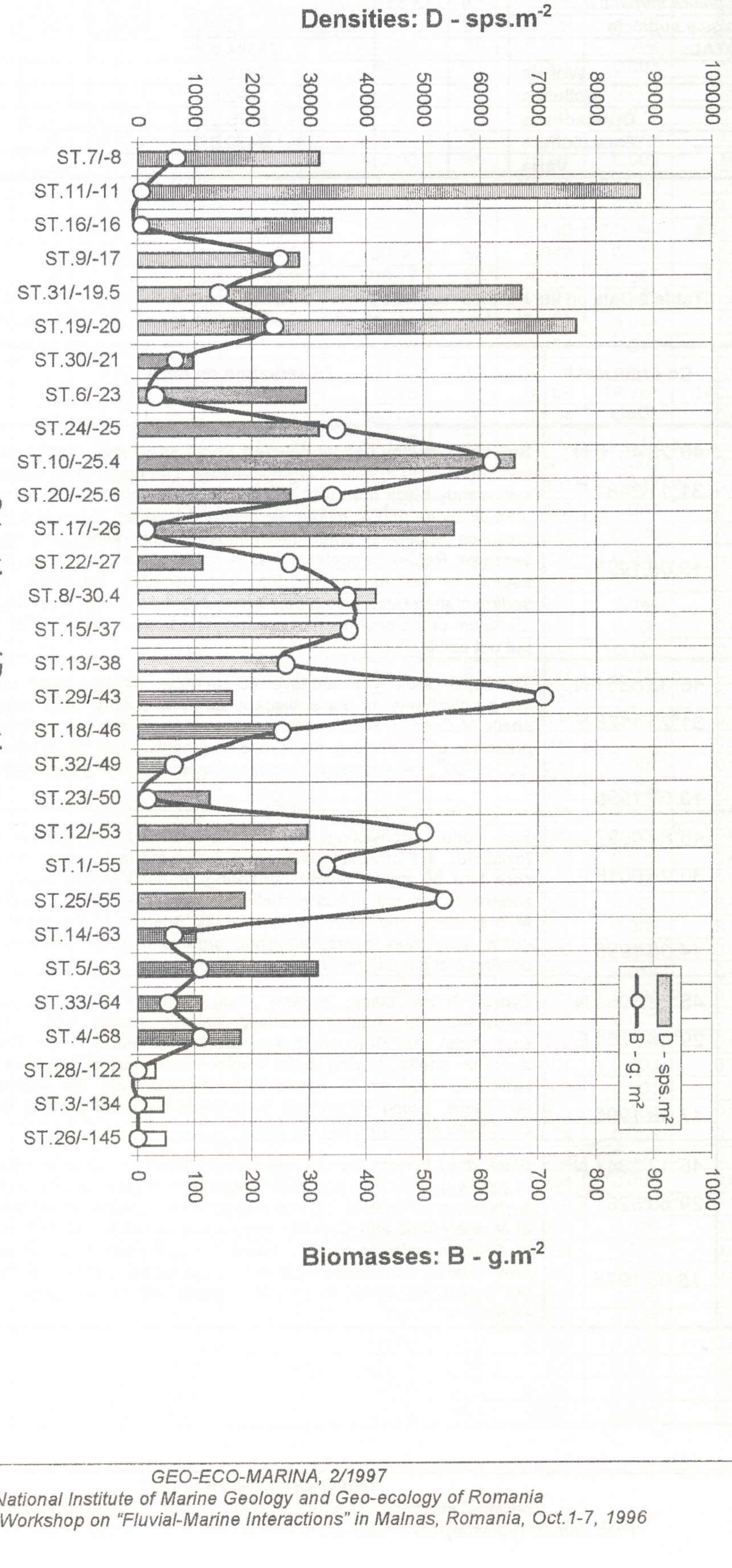
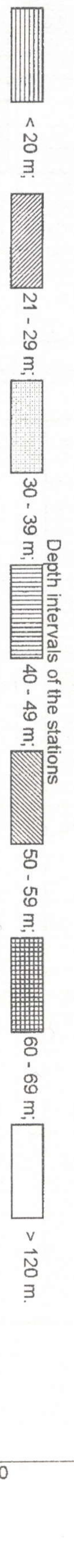



**Fig.9** Variation of benthic organisms abundance in different stations/depth performed in August 1995 on the continental shelf of the NW Black Sea



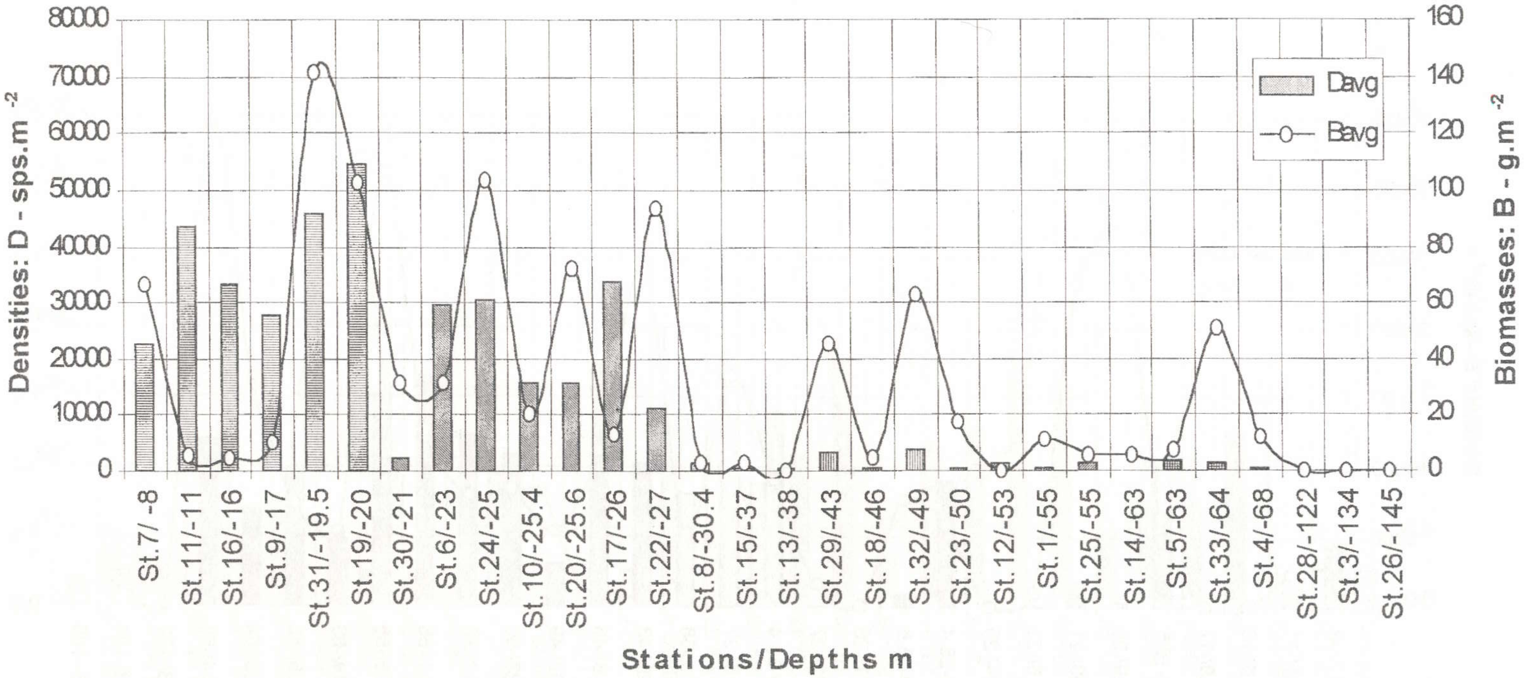
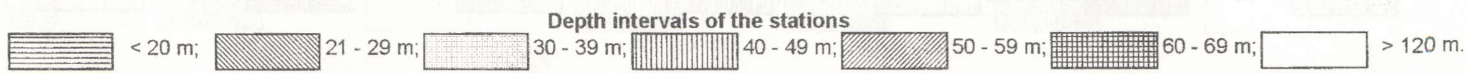



**Fig.10** Worms populations at different stations/depths in NW Black Sea, August 1996



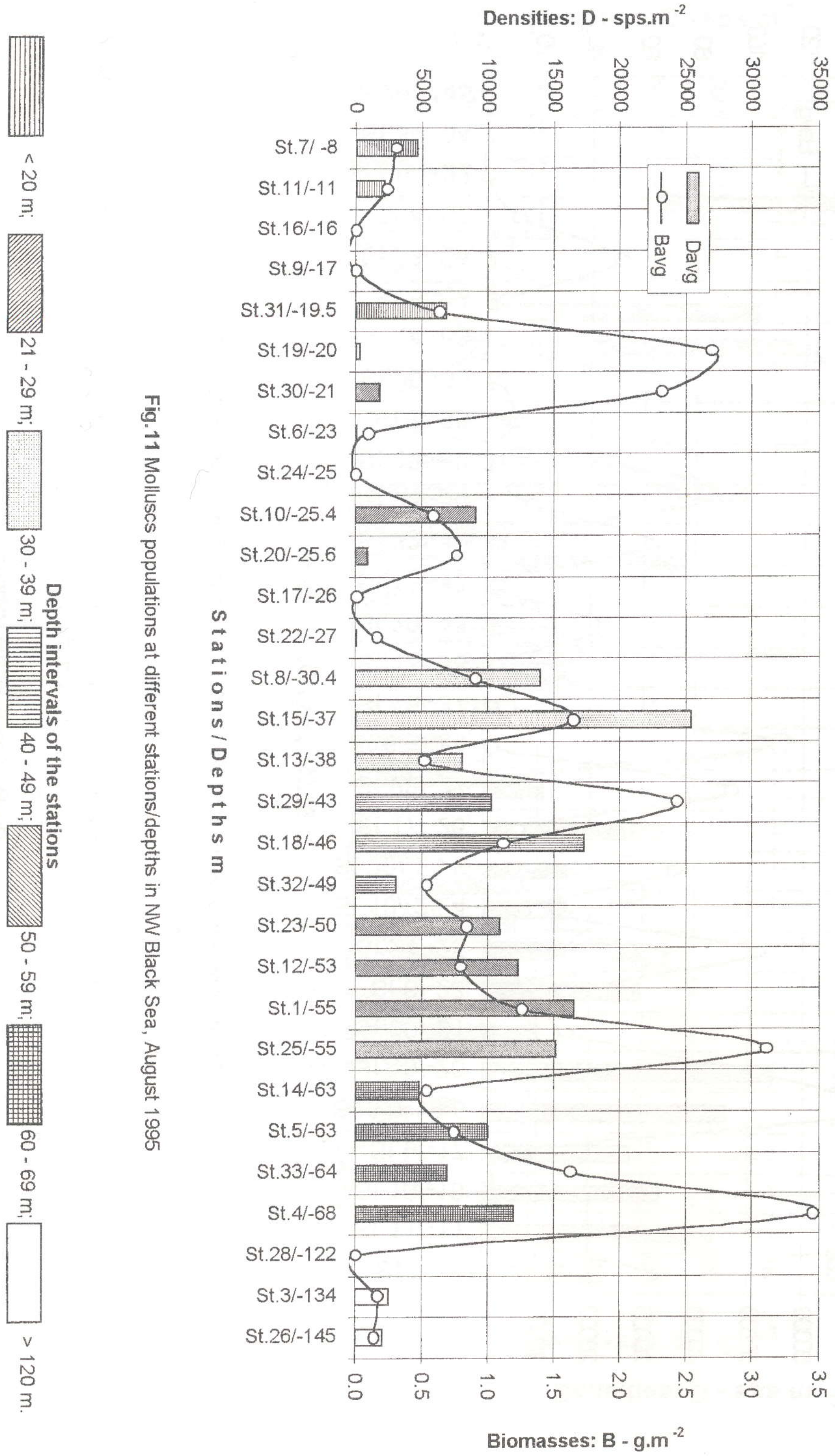



**Fig.11** Molluscs populations at different stations/depths in NW Black Sea, August 1995

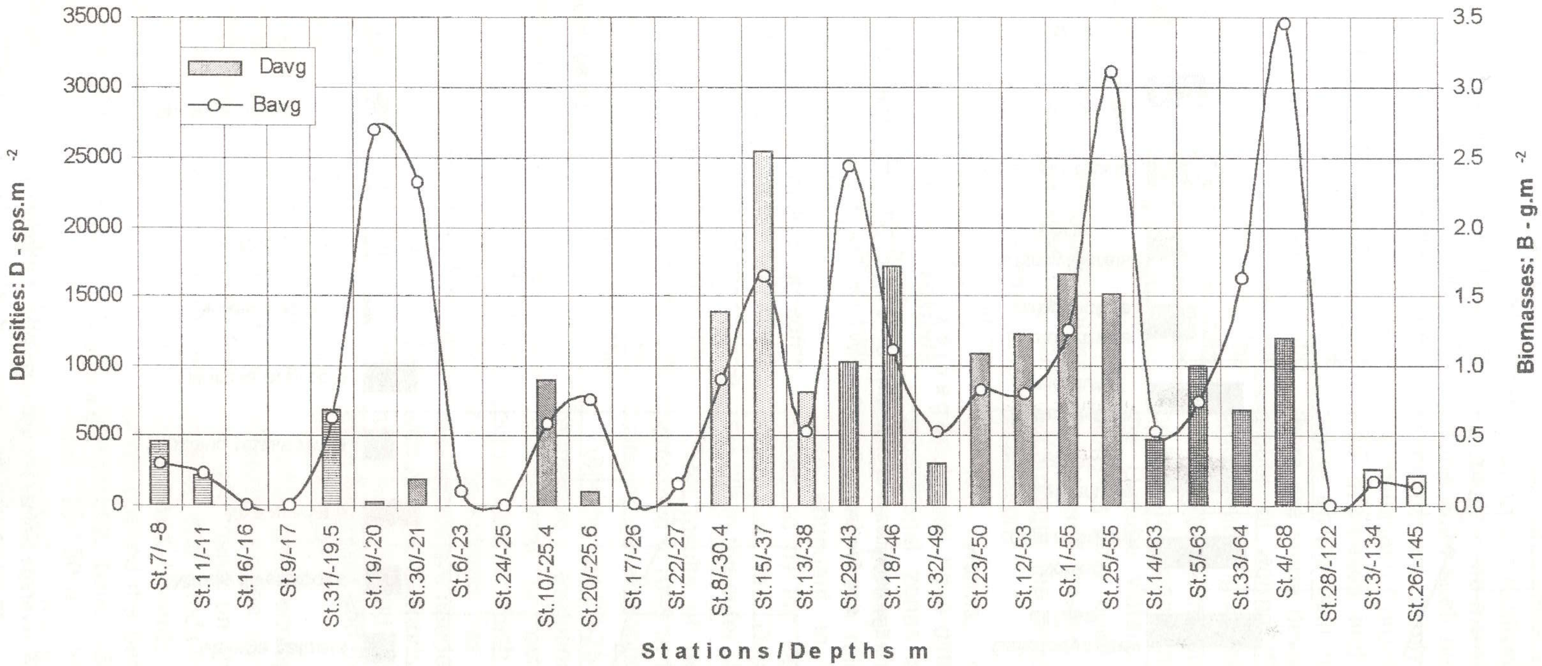
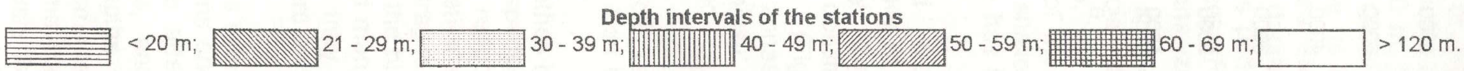



**Fig.12** Crustaceans populations at different stations/depths in NW Black Sea, August 1995



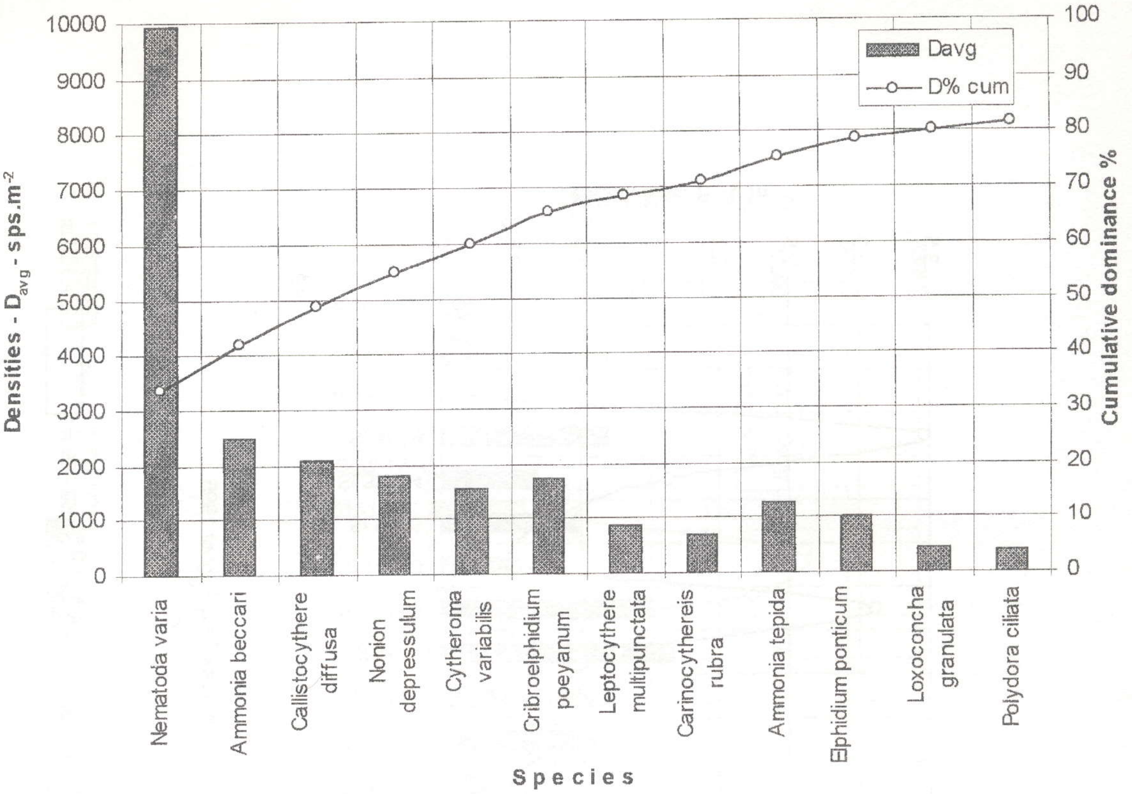



**Fig. 13** Average densities and cumulative dominance (D% cum) of the first 12 ranked species (according W) in NW Black Sea, August 1995

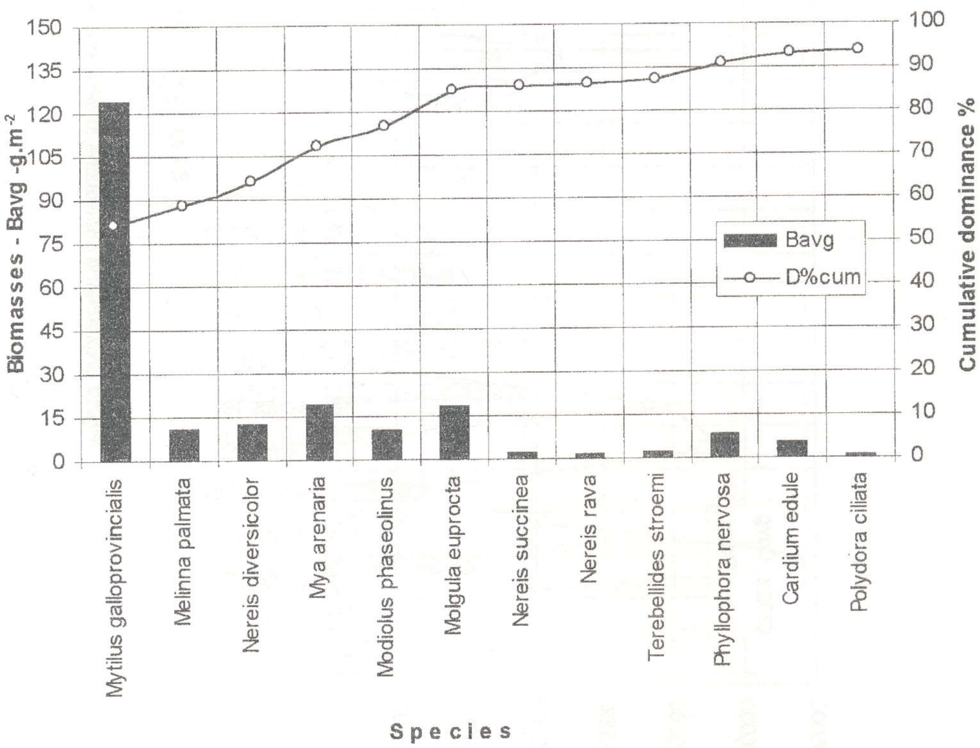



**Fig. 14** Average biomasses and cumulative dominance (D% cum) of the first 12 ranked species (according W) in NW Black Sea, August 1995

*galloprovincialis*, the crustacean *Apseudes ostroumovi*, the polychaet *Nereis diversicolor* and the bivalve *Modiolus phaseolinus*; excepting *Apseudes*, replaced by the bivalve *Mya arenaria*, the same species command more than 85% of the general biomass. Therefore, from a total of 28 macrobenthic forms only 6 are more important as abundance. Among the meiobenthic taxons those with the highest densities are: nematodae, the foraminiferae *Ammonia beccarii* and *Nonion depressulum* and the ostracodae *Callistocythere diffusa* and *Cytheroma variabilis*; these forms dominate the densities in a proportion of over 60% (Fig.13). For the meiobenthic populations the biomass dominants are not given by the numerically abundant species but only by the large-size polychaeta species – *Nereis succinea*, *Nereis rava*, *Polydora ciliata*, *Pectinaria koreni* and *Nereis zonata*, representing together more than 75% of the total biomass (Fig.14).

Taking into account all the benthic populations from the NW Black Sea in August 1995, we can assume that only 12 taxa, mostly Nematoda, Foraminifera, Ostracoda, Polychaeta give more than 80% from general density (Fig.13) and only 6 taxa, *Mytilus galloprovincialis, Melinna palmata, Nereis diversicolor, Modiolus phaseolinus, Molgula ectoprocta* and *Nereis succinea* give more than 80% from the average biomass (Fig.14).

A general look at the distribution of some populations on the biotic bottoms in the NW Black Sea leads to the following remarks:

❶The association of benthic organisms dominated by red algae from the *Phyllophora* genus can hardly be recognized due to scarcity of species, even if a "rudiment" of the famous "field" from the '60s can still be found here (Fig.15).

❷The depth mussels association, the phaseolinae one and the ecotonal zone between them generally retain their position and abundance but are greatly reduced as number of species; they form two major concentration fields on the continental shelf in the Western part of the research area (Fig.16).

❸ The foraminifera forms, usually controlling the densities, make up a large concentration area near the Dniestr liman; more reduced agglomerations were met South of the Caliacra Cape and on the Caucasus coast; on the Romanian continental shelf the foraminiferae densities are as a rule reduced, up to 50 indvds.dm$^{-2}$.

❹ The ostracode have higher densities (>100 invds.dm$^{-2}$) in the deeper zone (40-70 m); around station 15 they represent 65% from the total number of macro- and meio-benthic forms, reaching their highest abundance; the shallow zones influenced by Danube and Dniestr are deprived of ostracodae.

The analysis of benthic populations from the NW Black Sea in connection with the different subzones (depth or depositional) has led to the following conclusions:

↳The benthic organisms communities from diverse bathymetric zones, up to 70 m depth, are made up of a relatively low number of species (35-60 species) the meiobenthal ones being dominant; on the outer shelf between 120-150 m, the 10-15 forms met are mainly meiobenthic. On an average the densities of organisms decrease as the depth also decreases and the biomasses are usually higher on the bottoms of 30-60 m depth (Fig.17); there are some deviations from this pattern if the groups of worms (Fig.18), molluscs (Fig.19) or crustacean (Fig.20) are separately analyzed.

↳The greatest number of benthic species center on the shelf zones under the beneficial influence of the Danube waters. Nevertheless, the greatest densities have been met in front of the Danube, Dniestr and Dnieper, in relatively shallow zones; accordingly, the weight abundance has the same disposition.

↳ The worms, molluscs and crustaceans populations have different abundance in the eight depositional zones analyzed, only exceptionally being a parallelism between densities and biomasses. As a rule, the worms (Fig.21), are more abundant in the shallow zones directly influenced by the Danube and Dniestr, molluscs (Fig.22) in the Dniestr zone and crustaceans (Fig.23) in the outer shelf zone.

The results of benthic ecological researches performed in1995 in the NW Black Sea led to the following general conclusions:

①In the last 20-25 years the benthos has had a regressive evolution, many species have disappeared or catastrophically reduced their populations so much that its qualitative state may be considered as extremely fragile. Future researches are needed to establish the biodiversity with specific methods. It seems that many species have such limited abundance that they have not even been met and therefore they are on the verge of extinction.

②The great ecological pressures with negative influences on the benthic populations originate on the one hand on the land, these affecting the shallow and medium depth zones, and on the other hand towards the great depths with $H_2S$ which pushed the periazoic floor from the formerly bathymetric band 150-180 m to the bathymetric band 120-150 m. This is a hypothesis that has to be checked in the future with more stations and samples.

③The "biotic" bottoms from the North–Western Black Sea are frequently affected by the

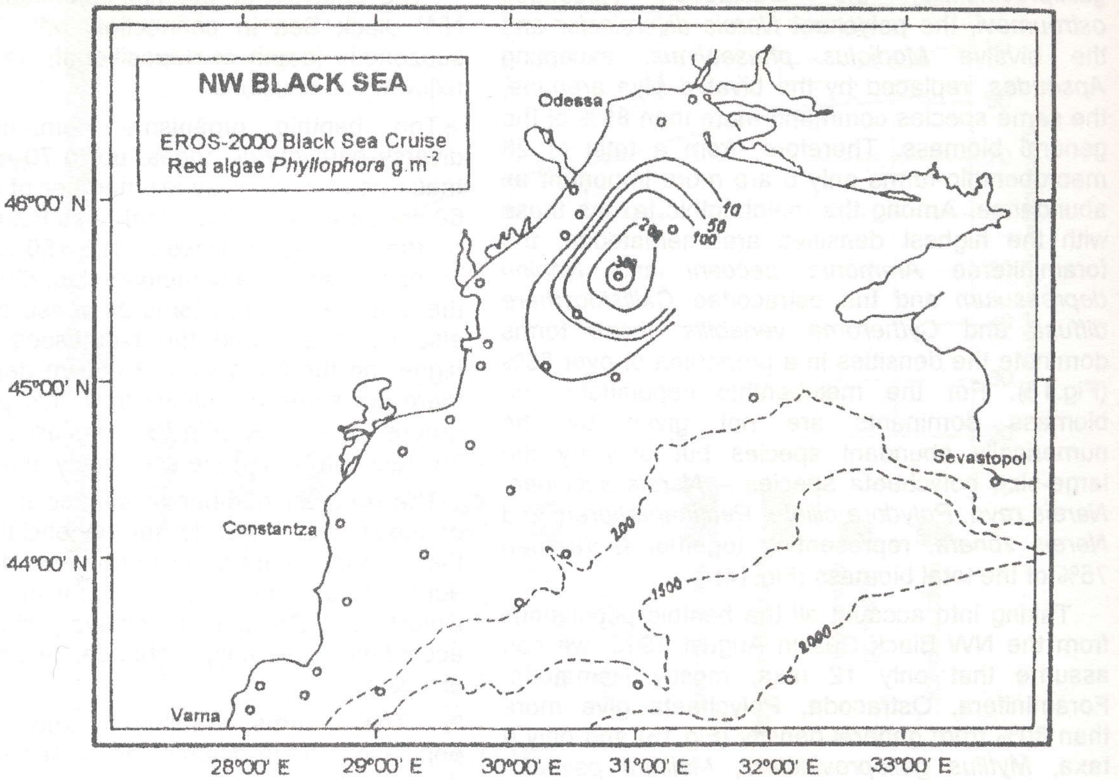



**Fig.15** Quantitative (g.m$^{-2}$) distribution of Red algae *Phyllophora* in NW Black Sea, August 1995

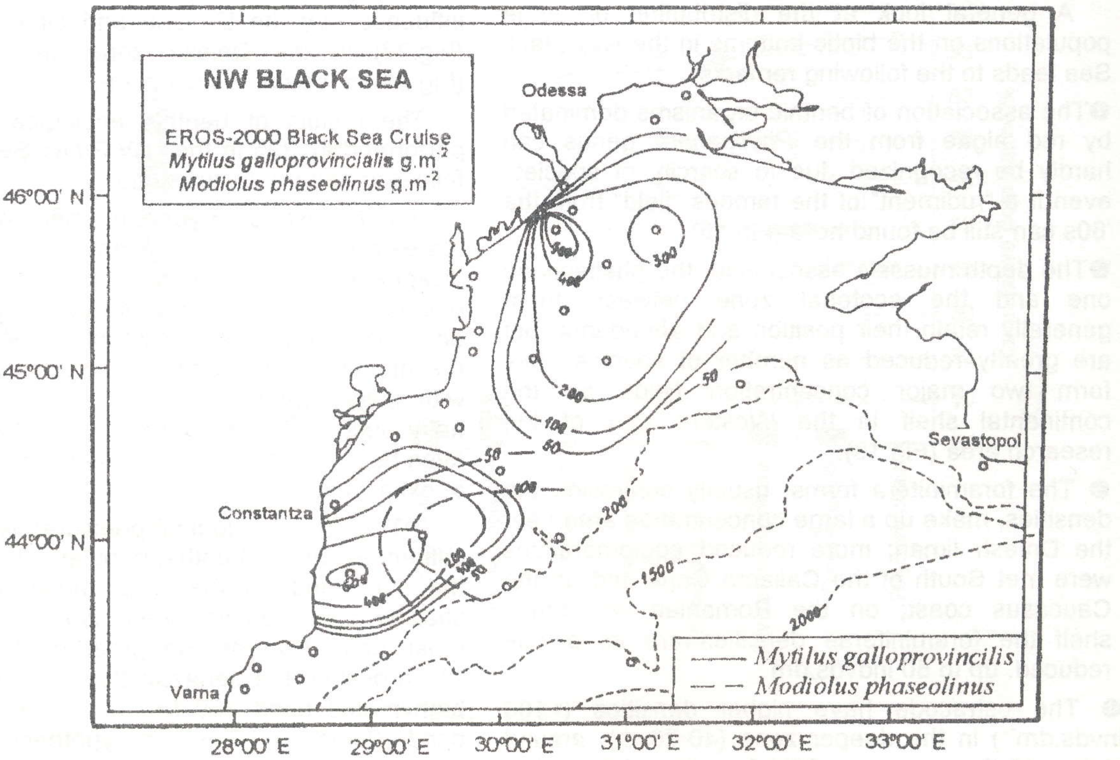



**Fig.16** Quantitative (g.m$^{-2}$) distribution of Red algae *Mytilus galloprovincialis* and *Modiolus phaseolinus* in NW Black Sea, August 1995

**Fig. 17** Average densities and biomasses of zoobenthic populations on bathymetric zones in NW Black Sea, August 1995

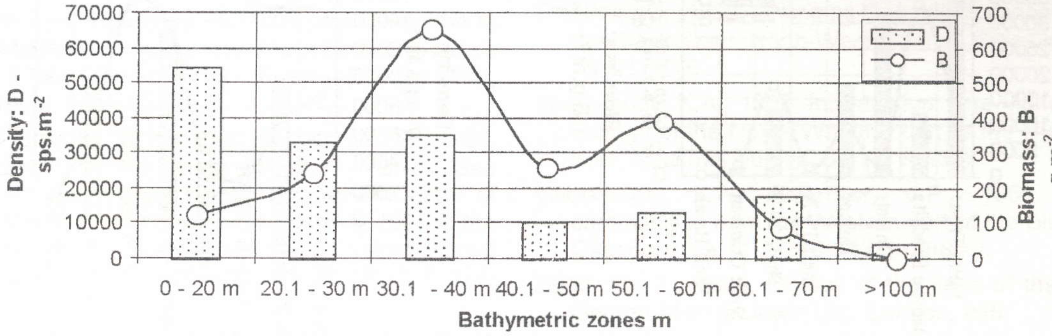



**Fig.18** Average densities and biomasses of worms populations on bathymetric zones in NW Black Sea, August 1995

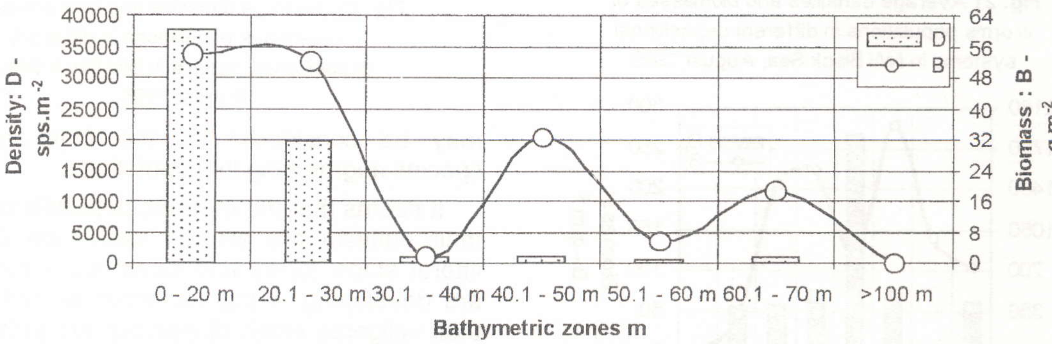



**Fig. 19** Average densities and biomasses of molluscs populations on bathymetric zones in NW Black Sea, August 1995

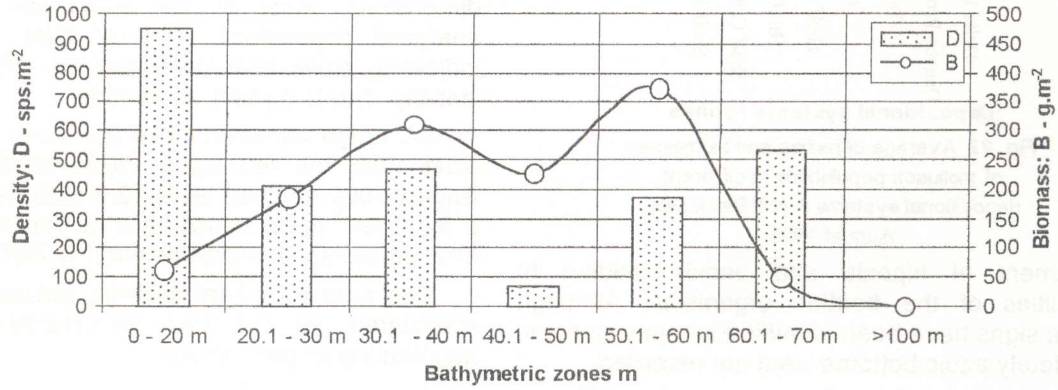
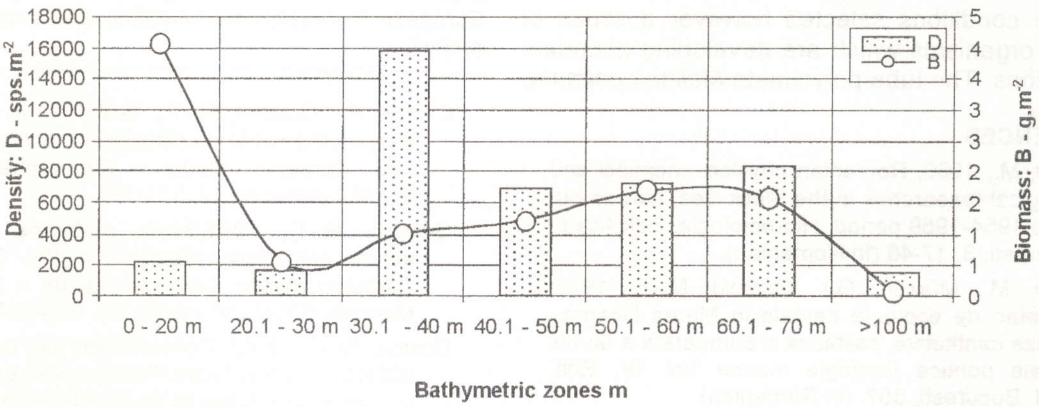



**Fig. 20** Average densities and biomasses of crustaceans populations on bathymetric zones in NW Black Sea, August 1995



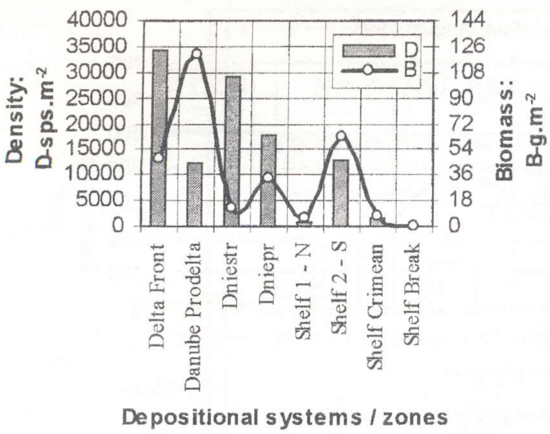



**Fig. 21** Average densities and biomasses of worms populations in different depositional systems in NW Black Sea, August 1995

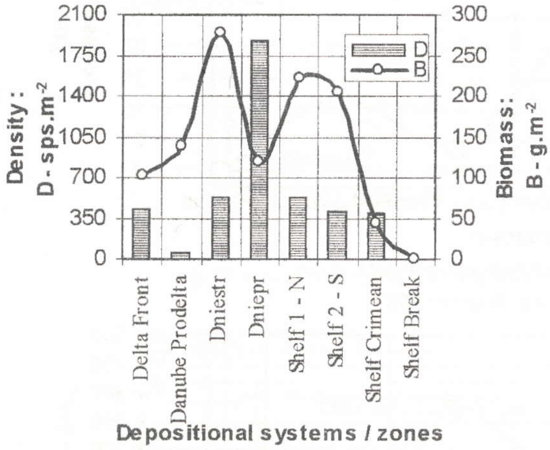



**Fig. 22** Average densities and biomasses of molluscs populations in different depositional systems in NW Black Sea, August 1995

installment of hipoxia and anoxia leading to mortalities of the benthic organisms. Although anoxia signs have been identified in many stations, completely azoic bottoms were not recorded.

④In spite of the high ecological pressures determined by disturbing biotic or abiotic factors, the marine environment analyzed with its new extreme conditions selected however a series of benthic organisms which are developing abundant populations. The tube polychaete *Melinna palmata*,

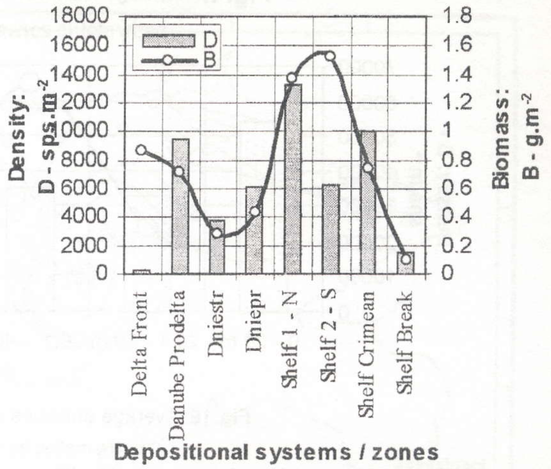



**Fig. 23** Average densities and biomasses of crustaceans populations in different depositional systems in NW Black Sea, August 1995

may be considered as the first opportunistic species augmenting its populations.

It seems that the mussels populations thanks to their euriecie are also in expansion (they have littoral stone forms and depth mud forms, which are developing in big quantities in certain zones, their veligerae easily dispersing everywhere, falling and growing where the conditions are favorable). As a rule the mussels do not reach the former dimensions; most of the individuals from the analyzed populations were of little size, thus indicating biotic bottoms conditions with reduced stability, only 2-3 years at the most.

⑤A rough assessment of the living organisms stock (less the red algae *Phyllophora*) which in August 1995 reached up to 12.3 millions tones (on a 8200 km$^2$ area) shows that its constitution was 54% mussels, 5% *Modiolus* and 5% *Melinna*.

The tube polychaet *Melinna palmata* may be considered as the first opportunistic species augmenting its populations.

### Acknowledgements

This paper was elaborated within the EROS-2000 Black Sea Project. We express our thanks to the European Comission for financing and supporting this project.

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