INTERNATIONAL WORKSHOP ON BLACK SEA BENTHOS

19-23 April 2004
İSTANBUL -TURKEY

EDITORS
Bayram ÖZTÜRK

Vadim O. MOKIEVSKY   Bülent TOPALOĞLU

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Türk Deniz Araştırmaları Vakfı (TÜDAV)
P.K 10 Beykoz-İstanbul-TURKEY
Phone: +90 216 424 07 72
Fax: +90 216 424 07 71
e-mail: tudav@superonline.com
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PREFACE

International Workshop On Black Sea Benthos, 18–23 April 2004, Istanbul-Turkey

THE BENTHOS OF THE OXIC/ANOXIC INTERFACE IN THE WESTERN BLACK SEA: COMPARATIVE MACRO- AND MEIOFAUNA INVESTIGATIONS ON TRANSECTS FROM THE UKRAINIAN, ROMANIAN AND TURKISH SHELF

Ulf LUTH
Institut für Hydrobiologie und Fischereiwissenschaft, Universität Hamburg

Keywords: Black Sea, Macrofauna, Meiofauna, Oxic/Anoxic Interface, Cluster Analysis

ABSTRACT

Results of benthic investigations including size classes from meiofauna to larger macrofauna from six transects in the western Black Sea are presented. Transects covered the depth interval from 50m to 250m depth including benthic environments from the shelf, the shelf edge and the upper slope. Special interest was set on taxonomic composition and distribution patterns of benthic communities inhabiting the depth zone where the oxic/anoxic interface meets the sea floor. The existence of a highly dynamic O_2/H_2S-transition zone on the sea floor is postulated being characterized by varying oxygen and/or hydrogen sulphide contents in the near bottom water. Besides variations in water conditions benthic communities from the shelf edge or upper slope also have to cope with instability of sediments induced by resuspension of sediments, turbidity currents or methane seeps. Shelf environments on the north-western shelf showed signs of strong eutrophication but also some indications for a restoration of benthic communities in recent years. Below a depth of 130m hardly any larger macrofauna was present similar to other investigations from the 1980's. However, on most transects around 150m depth a densely populated benthic community of smaller size classes dominated by nematodes and oligochaetes, sometimes also with polychaetes and harpacticoids present, was found. From the upper anoxic zone around 190m mostly only few nematodes were obtained.

INTRODUCTION

The depth of the oxic/anoxic interface throughout the basin is largely determined by the meandering cyclonic rim current, which is, besides the meromictic water stratification itself, the dominating hydrographic feature of the almost totally enclosed Black Sea (SKOPINTSEV 1975; for detailed descriptions of the north-western Black Sea hydrography see TOLMAZIN 1985, and AUBREY et al. 1996). The highly dynamic interface zone meets the seafloor at depths between 130m and 180m exerting major influences on the hydrochemical and biogeochemical conditions as well as the distribution of the benthic fauna of lower shelf and upper slope environments (LUTH & LUTH 1997).

Interface dynamics have been the focus of a manifold of investigations (BLATOV et al. 1984, FASHCHUK & AYZATULIN 1986, BEZBORODOV et al. 1988, HONJO & HAY 1988, MURRAY et al. 1989, FASHCHUK et al. 1990, KEMPE et al. 1990, review by VINOGRADOV 1991, BEZBORODOV 1990, SAYDAM et al. 1993, BUESSELER et al. 1994, JONES & GAGNON 1994) but were restricted mainly to open water conditions far away from the shelf. Today the oxic/anoxic interface of the Black Sea is amongst the best known boundaries in marine science when the fields of hydrophysics, hydro-chemistry, marine microbiology and plankton research are concerned. Remarkably, the lower shelf and upper slope regions where the interface meets the seafloor received little to no attention. Especially, the dynamics of near bottom water conditions and benthic response remained beyond the focus of marine science. Traditionally benthic biology focussed on the vertical zonation of biocoenoses and the comparative investigation of the lower limits of benthic life in different regions and over time (CASPERS 1957, ZENKEVICH 1963, BACESCU et al 1971, KISELEVA 1981, ZAIKA et al. 1992) but mainly lacked detailed documentation of habitats and living conditions.

Furthermore, most recent investigations on Black Sea benthos were either predominantly restricted to near shore areas (e.g. compiled in ZENETOS et al. 2000 for Ukrainian, Bulgarian, and Russian coast, STOYKOV & UZUNOVA 2001, Bulgarian coast and shelf) and/or larger size classes i.e. the macrobenthos (GOMOIU 1985, Romanian shelf) or single macrobenthic groups (e.g. MUTLU et al. 1992, MUTLU 1994, Turkish shelf, TERESHCHENKO et al. 1993, Ukrainian and Bulgarian shelf).

The history of meiofauna investigation in the Black Sea (reviewed by SERGEEVA & KOLESNIKOVA 1996) demonstrates that numerous investigations on meiofauna of shallow waters have been conducted and many species, new to the Black Sea, have been described. Additionally, for example even for deeper benthic coenoses like the *Modiolus phaseolinus* coenosis certain assemblages of meiobenthic nematodes have been recognized (SERGEEVA, 1976). However, ZAIKA (1998) stressed the fact that former benthic investigations in deeper waters were generally conducted with bottom grabs which do not allow quantitative investigations of the smaller size classes like the temporary or larger meiofauna and ordinary meiofauna. Therefore, the knowledge on distribution patterns of these size classes across the oxic/anoxic interface zone throughout the Black Sea is still poor.

Linking Black Sea hydrography and benthos-The oxic/anoxic interface meets the sea floor:

This work presents in part the results of a new approach trying to combine recent knowledge in Black Sea oceanography with benthic biology. The focus of this paper is set on the comparison of faunal distribution across the oxic/anoxic interface in three regions of the western Black Sea (Figure 1). The description of habitats and living conditions including short-term dynamics of the oxic/anoxic interface zone in the different regions will be addressed in detail elsewhere. However, for a better understanding of the interface dynamics in lower shelf and upper slope environments and their consequences for the benthic communities a short introduction to the matter is given.

The numerous reports of depth variations of the oxic/anoxic boundary in central regions of the Black Sea (see above) together with few similar observations of this phenomenon in near shelf areas (KEMPE et al. 1991, LUTH & LUTH 1997, LUTH et al. 1998) allow the conclusion that the oxic/anoxic boundary also moves up and down near, or back and forth onto the shelf. However, there is no information so far, about amplitude and frequency as well as possible rhythms of these depth variations.

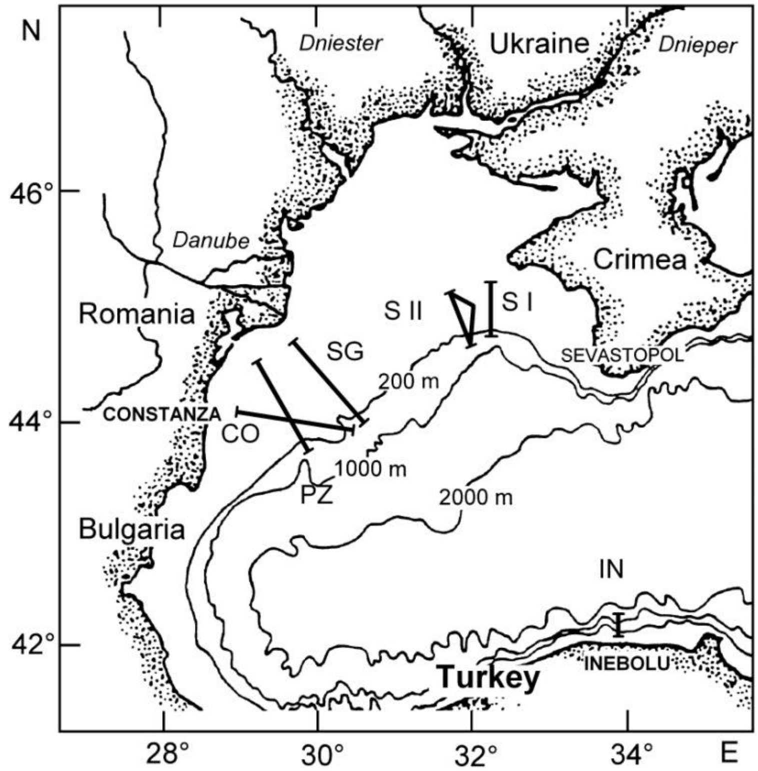

Figure 1: Working areas in the western Black Sea: IN = Inebolu transect, SG = St. Gheorghe transect, S I and S II = Sevastopol transects I and II, CO = Constanza transect, PZ = Portiza transect.

Accepting depth variations of the oxic/anoxic interface on the sea floor as a given natural phenomenon for the Black Sea then each region should be characterized by an individual, average interface depth. From this depth in direction to shallower depths, the probability of an oxic regime increases whereas below this depth anoxic, sulfidic conditions become more and more likely. The limits of such a postulated O_2/H_2S-transition zone are that depth regions at the sea floor where the probability of contact with anoxic deep water or oxic surface water, respectively, will be about zero (Figure 2). The extension of the O_2/H_2S-transition zone, i.e. the area of the seafloor covered, is correlated to the type of interface variations (e.g. periodical or episodical), their intensities (amplitude) and moreover to the angle of slope. For the benthos an oscillation of the oxic/anoxic interface means that the organisms within the O_2/H_2S-transition zone have to cope with changing oxygen and hydrogen sulphide concentrations.

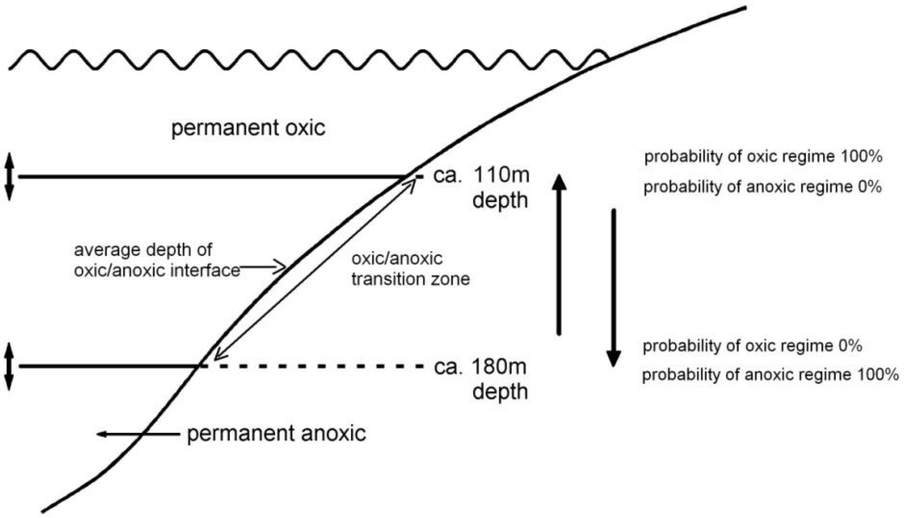

Figure 2: Schematic depiction of the O_2/H_2S-transition zone in the water/bottom contact area of the oxic/anoxic interface on the upper slope of the Black Sea.

MATERIAL AND METHODS

Data and faunal samples for this work were collected on a total of six cruises to different regions of the western Black Sea (Tab. 1)

Table 1: Cruise list with vessels used, cruise dates, area of investigation, and names of transects

Research Vessel, Cruise No.	Cruise dates	Area of investigation	Transect
R/V K. PIRI REIS	18.-27. Sept. 1991	Turkish Shelf of Inebolu	Inebolu
R/V PROFESSOR VODYANITSKIY, 40	10.-18. Oct. 1992	Romanian Shelf, southeast of Danube mouth St. Gheorghe	St. Gheorghe
R/V PROFESSOR VODYANITSKIY, 44	01.-15. Oct. 1993	Ukrainian Shelf, Dnieper Canyon Region	Sevastopol I
R/V POSEIDON, 201/6+7	13. April - 05. May 1994	Romanian Shelf, east of Constanza	Constanza
R/V PROFESSOR VODYANITSKIY, 45	15.-30. June 1994	Ukrainian Shelf, Dnieper Canyon Region	Sevastopol II
R/V PETR KOTTSOV	02.-23. Sept. 1997	Rumanian Shelf, south southeast of Portiza (mouth of Liman Razim)	Portiza

The working area along the Turkish coast was situated between 42°00 to 42°30N and 33°30 to 34°00E north of the town of Inebolu (Figure1) and was, therefore, named Inebolu transect. The region is characterized by a narrow shelf, extending only a few miles out. As a consequence, all sampling stations were inside the Turkish 12-mile-zone. The shelf edge is located a little below 100m water depth. Beyond that water depth is rapidly increasing so that 1000m depth are reached within 20 miles.

Off the Romanian coast the working area spread out between 43°40 to 44°30N and 29°00 to 30°50E. The first transect was chosen in prolongation of the southern mouth of the Danube delta and hence named after it, "St. Gheorghe". It had a length of 65 nm. The second transect, east southeast of the town of Constanza and named after it, had a length of 60nm. The third transect also had a length of 60nm and ran in a south-southeast direction from Portiza (name of transect), the mouth of the Liman Razim, situated south-west of the Danube delta. All three transects included stations from the mid shelf to the slope.

In Ukrainian waters the working area included a north to south transect at 32°10E with a length of 21nm between 45°12 and 44°51N southwest of the Crimean peninsula and east of the Dnieper Canyon (transect I). A second area of investigation in the Dnieper Canyon region with possible influences of methane gas seeps common in that area (EGOROV et al. 1998) had a wider longitudinal range due to the inhomogeneous distribution of seeps (coordinates: 31°35 to 32°05E, 44°52 to 44°43N, size of area:23nm by 9nm, transect II). Both transects were named after the town of Sevastopol, the base harbour of our Ukrainian colleagues and R/V "Professor Vodyanitskiy".

Owing to the spread out shelf in the north-western Black Sea, created by the sediment loads of the rivers Danube, Dniester, Bug, and Dnieper, the distance between the shallowest, near-coast stations

(Depth 50 to 60m) and the shelf edge (situated at about 120m water depth) was a lot bigger than off the Turkish coast. However, the following slope is as steep, or even steeper (up to 16%) as at the Turkish side and therefore the stations of the oxic/anoxic interface zone around the shelf edge were comparatively close together on all transects.

BENTHIC SAMPLING

Samples were taken on transects from the oxic zone, across the oxic/anoxic interface zone to the anoxic zone. In order to gain sufficient information about the living conditions of the benthic fauna the benthic sampling was combined with biogeochemical and hydrographic investigations. These additional data will be the focus of another publication, some parts are published already (Luth & Luth, 1997, Luth. et al., 1998, 1999). However, in the description and discussion of the results of the faunal investigations these data will be referred to for better interpretation.

In order to adequately cover all benthic size classes and to fulfil as well the demands of the accompanying biogeochemical and geological samplings a variety of equipment was used. An overview of equipment and sediment parameters for all cruises is given in Table 2; coordinates of stations are given in Table 3.

Table 2: Benthic sampling overwiev of sampling gear used and sediment parameters as well as benthic size classes investigated.

	sampling gear					sediment parameters (data not presented)				benthic size classes		
Vessel / Cruise	beam-trawl	VanVeen-grab	box corer	multiple corer	ELINOR-lander	grain size	water content	Org. Cont. (ashfree dryweig.)	chloro-plastic pigments	megafauna [> 2cm]	macrofauna [2cm-0,5mm]	meiofauna [< 0,5mm]
PR	+	+	+			+	+	+	+	+	+	+
PV I		+	+	+			+	+	+		+	+
PV II	+	+	+	+		+	+	+	+	+	+	+
PV III	+		+	+		+	+	+	+	+	+	+
POS	+		+	+		$(+^1)$	+	+	+	+	+	+
PK				+	+		$(+^2)$	$(+^2)$			+	$(+^2)$

$(+^1)$ dataset not complete

$(+^2)$ data by kind permission of Dr. W. Riess, MPI, Bremen, other method

For qualitative collections of fauna a 2.5m beam trawl (mesh size 0.5cm at the tail) and a VanVeen grab (0,1m²) were used at different depths (Table 3). The trawl was towed parallel to depth lines, i.e. in the same depth range within one deployment. For the quantitative collection of macrofauna (>500µm) and for temporary and large meiofauna (> 250µm) a modified version of the USNEL-spade box corer (THIEL, 1983; FLEEGER et al., 1988) was used with an improved (almost free) water flow through the box while penetrating the sediment. On RV Pjetr Kottsov macrofauna samples were obtained from the benthic chamber of the ELINOR Lander (JAHNKE & CHRISTIANSEN, 1989). The sampled area covered $0.1m^2$ with both gear.

Bottom samples for the investigations of meiofauna (> 30µm) were taken by multiple corer (BARNETT et al., 1984) except on RV K. Piri Reis where the box corer was used. Meiofauna samples on RV Pjetr Kottsov were also obtained from the benthic chamber of the ELINOR Lander and processed by Dr. W. Riess, Max-Planck-Institute for Marine Microbiology, Bremen, Germany, who kindly allowed the use of his results for this study.

Subsampling for meiofauna (> 30µm) was achieved with small piston-style corers (cut-off plastic syringes, sampling area $3.46cm^2$) down to 5cm sediment depth. We analyzed three replicates taken from different MC tubes which were deep frozen immediately after retrieval, sectioned horizontally into 1cm layers and sieved through a 30µm mesh. On RV PETR KOTTSOV meiofauna subsamples were obtained by small piston-style corers (cut-off plastic syringes, 6.16cm²) down to 9cm sediment depth. With the exception of stations at 77m and 100m where sets of parallels were taken single samples were processed.

For quantitative investigations of the larger organism size classes (> 250µm) the whole sediment content of a box corer (one per station) was used. The samples were sieved (mesh sizes 2000, 1000, 500, and 250µm) with a vertical sediment layer resolution of 0 - 2cm, 2 - 5cm and 5 - 10cm depth.

All faunal samples were fixed with 4% buffered formalin in sea water, stained with 1% Rose Bengal solution and sorted under a low power stereo microscope (PFANNKUCHE & THIEL, 1988). Meiofauna samples on RV PETR KOTTSOV were fixed by 5% buffered formalin in filtered sea water. Organisms were separated in the lab by flotation after NICHOLS (1979) and sieved through a 45µm mesh.

The quantitative investigations were restricted to the metazoans, since quantitative evaluation of foraminifera densities with the Rose Bengal staining method remains rather problematic. These organisms generally need higher concentrations of Rose Bengal and longer staining times which often causes overdying of other organisms. However, foraminifera were found in most samples (sometimes in high densities). They mainly belonged to the calcareous rotalia type or the allogromiids and saccamminids.

Among the metazoans the hydrozoans were excluded from quantitative analyses since the colonies generally disintegrated under the sorting procedure. For both groups a semi-quantitative approach with defined abundance classes was applied (Table 4). Chambered foraminifera had to have at least one stained chamber to be counted; agglutinated species had to be completely dyed. Hydrozoans were estimated by numbers of stained polyps.

The terms for the different abundance classes are used also in the description of the results of the quantitatively analysed groups of organisms.

During the sorting procedure it became evident that the penetration of the fauna was generally restricted to the uppermost centimetres of the sediment. Therefore, the samples for the larger benthic size classes and the meiofauna were sorted down to a sediment depth of 5 (RV Poseidon 2 centimetres only) and 3 centimetres, respectively.

Cluster analyses were performed with the Group Average technique using the PRIMER package.

Table 3: The list of benthic stations research vessels:
PR=K.PIRI REIS, PV = PROFESSOR VODYANITSKIY, POS = POSEIDON, PK = PETR KOTTSOV sampling gear: VVG = VanVeen grab, BC = box corer, MC = multicorer, BT = beam trawl, ELINOR = benthic chamber

cruise	station	gear	depth [m]	date	coordinates [lat.-lon.]
PR	9	BC	50	23.09.91	41°59,8 N - 33°53,5 E
	4	BT	67	18.09.91	42°10,4 N - 33°44,7 E to 42°10,4 N - 33°44,4 E
	20	BC	110	24.09.91	42°08,2 N - 33°54,0 E
	2	VVG	114	18.09.91	42°07,6 N - 33°49,3 E
	3	BT	116-120m	18.09.91	42°07,6 N - 33°49,3 E to 42°07,4 N - 33°47,3 E
	23	BC	130	25.09.91	42°08,5 N - 33°53,4 E
	15	BC	150	24.09.91	42°09,3 N - 33°53,9 E
	18	BC	150	24.09.91	42°09,1 N - 33°53,6 E
	5	BT	174-177	18.09.91	42°10,3 N - 33°57,4 E to 42°10,1 N - 33°56,8 E
	13	BC	190	23.09.91	42°09,8 N - 33°53,1 E
PV I	II	VVG	49	08.10.92	43°59,2 N - 29°08,6 E
	1	BC/MC	59	11.10.92	44°29,8 N - 29°44,4 E
	I	VVG	73	06.10.92	43°49,2 N - 29°55,5 E

	8	BC/MC	130	12.10.92	44°00,7 N - 30°34,5 E
	15	MC	152	16.10.92	44°06,4 N - 30°45,6 E
	13	BC	157	15.10.92	44°06,4 N - 30°47,3 E
	14	BC	180	15.10.92	44°05,7 N - 30°47,9 E
	12	BC/MC	192	15.10.92	44°05,7 N - 30°48,0 E
	9	BC	245	12.10.92	43°58,9 N - 30°36,0 E
	27	MC	245	17.10.92	43°59,3 N - 30°40,3 E
PV II	5148	BC/MC	60	05.10.93	45°12,1 N - 32°10,0 E
	5166	BT	81-87	11.10.93	44°56,7 N - 32°09,3 E to 44°56,5 N - 32°09,5 E
	5153	BC/MC	110	07.10.93	44°53,7 N - 32°09,5 E
	5156	BC/MC	130	08.10.93	44°53,1 N - 32°10,0 E
	5165	BT	123-138	11.10.93	44°53,2 N - 32°09,5 E to 44°52,8 N - 32°09,4 E
PV II cont.	5158	BC/MC	150	09.10.93	44°53,2 N - 32°09,9 E
	5150	MC	190	06.10.93	44°52,0 N - 32°09,9 E
	5150/2	BC	200	06.10.93	44°52,2 N - 32°09,6 E
	5163	BC/MC	260	10.10.93	44°51,6 N - 32°09,8 E
	5171	BC/MC	63	13.10.93	44°52,5 N - 31°51,8 E
	-"-	BT	63	13.10.93	44°52,4 N - 31°51,3 E to 44°52,5 N - 31°51,1 E
	5172	BC/MC	110	14.10.93	44°48,1 N - 31°58,2 E
	5175	BT	110-130	15.10.93	44°48,3 N - 31°58,9 E to 44°48,1 N - 31°58,7 E
	5182	BC/MC	190	16.10.93	44°46,6 - 31°59,0 E
	5176	BT	178-198	15.10.93	44°46,7 N - 31°58,8 E to 44°46,7 N - 31°59,2 E
	stations 5148 - 5163 = transect I, stations 5171 - 5224 = transect II				
PV III	5188	BT	75-77	18.06.94	44°46,1 N - 31°35,4 E to 44°46,1 N - 31°35,6 E
	5186	BC/MC	80	17.06.94	44°46,1 N - 31°35,4 E
	5210	BC/MC	130	21.06.94	44°43,0 N - 31°34,4 E
	5198	BC/MC	150	19.06.94	44°51,7 N - 32°06,0 E
	5212 / 5213	BT	180-200	22.06.94	44°51,2 N - 32°03,4 E to 44°46,6 N - 31°58,7 E
	5220	BC/MC	260	23.06.94	44°46,4 N - 31°59,6 E
	5224	BT	230-260	24.06.94	44°46,5 N - 31°59,6 E to 44°46,4 N - 32°00,0 E
		t	]		
POS	393	MC	50	26.04.94	44°00,0 N - 29°13,1 E
	396	BC	50	26.04.94	43°59,8 N - 29°12,9 E
	438	BC	80	02.05.94	43°49,2 N - 30°00,4 E

POS cont.	440	MC	82	02.05.94	43°49,2 N - 30°00,7 E
	414	BT	82	29.04.94	43°53,5 N - 30°06,7 E to 43°53,6 N - 30°06.7 E
	419	MC	110	30.04.94	43°50,0 N - 30°13,2 E
	424	BC	110	30.04.94	44°04,1 N - 30°18,7 E
	413	BT	110	29.04.94	43°50,5 N - 30°13,2 E to 43°50,8 N - 30°13,1 E
	386	BT	120	24.04.94	43°49,1 N - 30°16,7 E to 43°49,2 N - 30°17,0 E
	400	BC	130	27.04.94	43°48,9 N - 30°20,2 E
	402	MC	130	27.04.94	43°48,6 N - 30°19,6 E
	369	BT	134	22.04.94	43°48,8 N - 30°20,6 E to 43°48,9 N - 30°20,8 E
	345	MC	150	20.04.94	43°49,0 N - 30°33,5 E
	347	BC	150	20.04.94	43°49,0 N - 30°22,6 E
	375	MC	170	23.04.94	43°49,3 N - 30°23,1 E
	376	BC	170	23.04.94	43°49,3 N - 30°23,1 E
	353	BC	200	21.04.94	43°48,8 N - 30°23,0 E
	354	MC	200	21.04.94	43°48,8 N - 30°23,0 E
	370	BT	200	22.04.94	43°49,9 N - 30°16,4 E to 43°49,1 N - 30°16,7 E
PK	1	ELI	62	11.09.97	44°15,1 N - 29°45,0 E
	2	ELI	77	08.09.97	43°53,8 N - 29°58,6 E
	3	ELI	100	07.09.97	43°51,1 N - 30°10,5 E
	4	ELI	130	04.09.97	43°43,1 N - 30°05,9 E
	5	ELI	181	14.09.97	43°42,6 N - 30°06,1 E

Table 4: Abundance classes for semi-quantitative estimation of hydrozoans and foraminifera

No. of individuals	0-3	4-19	20-99	100-499	>500
Abundance class	+	++	+++	++++	+++++
Term	rare	few	less common	common	very common

RESULTS

The vertical successions of benthic biocoenoses and distribution of taxonomic groups across the oxic/anoxic interface zone are better described by a “biological” definition of depth zones - based on O_2/H_2S contents in the near bottom water- rather than water depth (Tab. 5) and will be used in the description of results and discussion.

Table 5: "Biological" definition of the vertical structure of the O_2/H_2S-interface zone at the sea floorin the Black Sea based on O_2/H_2S-contents in the near bottom water. (n.d.=not detectable)

depth zone	**O_2 [µM]**	**H_2S [µM]**
oxic zone	> 50	n.d.
suboxic zone	50 - 5	< 5
anoxic zone	< 5, resp. n. d.	> 5

A) Qualitative and quantitative macrofauna investigations

Four transects sampled by beam trawl (Inebolu, Sevastopol I, Sevastopol II, and Constanza) revealed a rather similar qualitative composition of megafauna (> 2 cm) and of larger macrofauna organisms retained by the net (Table 6). All transects displayed a succession of different benthic biocoenoses with increasing water depth. Most species were found at the shallowest shelf stations in the oxic zone. Mobile forms with high oxygen demands such as crustaceans or fish (only on Inebolu transect) were restricted to this zone. Well known Leitformen as e.g. *Modiolus phaseolinus*, *Pachicerianthus solitarius* or *Aphiura stepanovi* were common on all transects. The further species composition varied in detail (Tab. 6).

Already in the upper suboxic zone, i.e. around the lower shelf or the shelf edge (110 to 130m) the numbers of species declined. The species spectrum switched from mobile to sessile or hemisessile forms (e.g. sponges, anthozoans, holothurians, and ascidians). The trawl sample from 120m depth on the Inebolu transect still presented a variety of macrofauna (Table 6), whereas in the trawls from corresponding depths on the north-western shelf only few species were found (mainly *M. phaseolinus* and *P. solitarius*). From about 130m depth downwards no mega- or macrofauna was retained by the net.

Species composition and number of taxonomic groups as well as the vertical succession of benthic biocoenoses of the qualitative investigations were mirrored by the quantitative macrofauna results (Tab. 6 and Figure 3 a-f). On all transects highest numbers of species or better taxonomic groups were present in the oxic zone and always a strong decline in taxonomic groups was observed to the suboxic zone. With increasing water depth this decline continued but was less pronounced.

An exception was the Inebolu transect where the steep decline in number of taxonomic groups occurred between 130m and 150m depth, already in the suboxic zone(see annex for Table 6.).

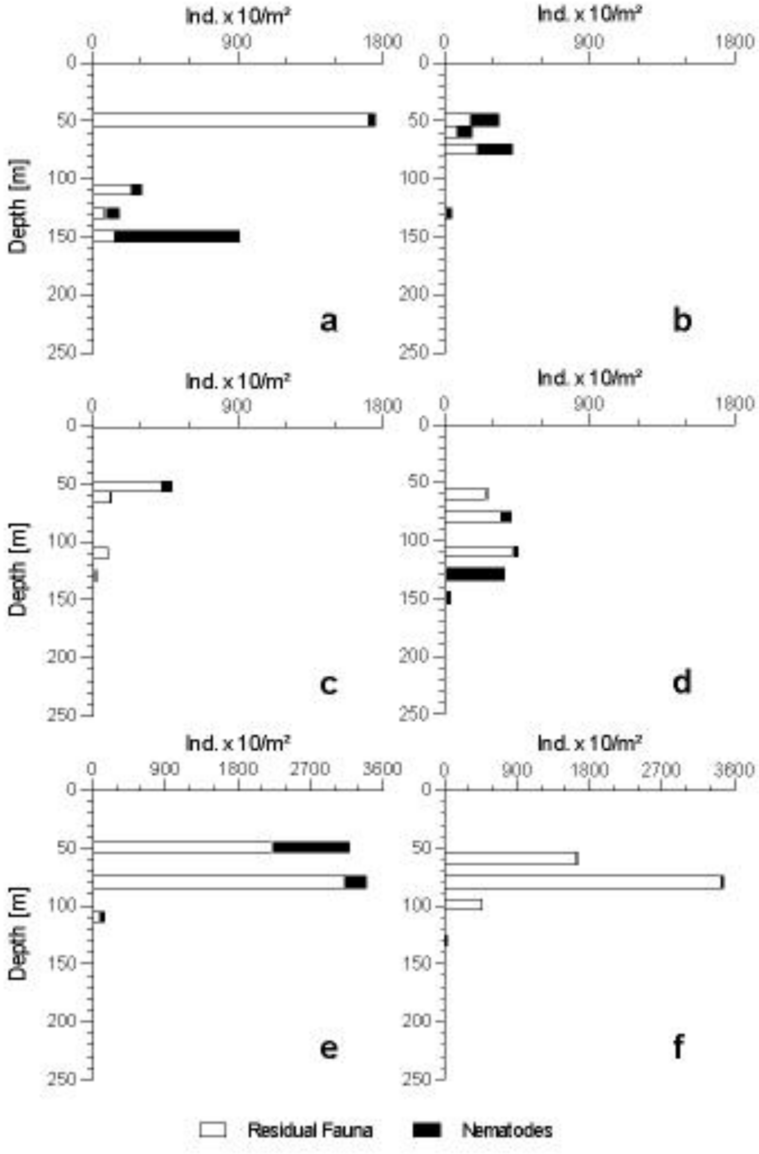

Figure 3: Macrofauna (>500µm) abundances across the O_2/H_2S-transition zone:
a = Inebolu transect, b=St. Gheorghe transect, c & d=Sevastopol transects I & II, e=Constanza transect, f=Portiza transect.

At stations in the lower suboxic zone, respectively upper anoxic zone (approximate depths 170m and 190/200m, Figure 3 a-f), either no macrofauna was found (Sevastopol I or Portiza transect) or only a few individuals (all other transects) of single groups (mostly nematodes) were present.

Differences in taxonomic composition between depth zones along each transect were stronger pronounced than differences between transects. In general, the oxic zones were dominated by bivalves, polychaetes, crustaceans, and echinoderms (Tab. 7 a-f, See annex). Strongly represented groups in the suboxic zones were mainly anthozoans, ascidians, and porifera and partly also the bivalves. With increasing depth and decreasing oxygen content nematodes and oligochaetes became dominant. Consistently, if high total numbers of organisms at stations between 130m or 150m (suboxic zone) occurred they generally resulted from high numbers of individuals of these two groups with nematodes in first rank.

The semi quantitative estimations of foraminifera and hydrozoans showed no regular pattern of distribution (Tab. 7 a-f, see annex). However, these groups were present from the oxic to the suboxic zone on almost all transects, missing only at a few stations. In the anoxic zone only a few parts of hydroids (St. Gheorghe, Sevastopol I) were found most probably transported by drift rather than indicating the presence of a population. Foraminifera occurred in the anoxic zone only at the St. Gheorghe transect but in comparatively high numbers.

As a general tendency, the total numbers of organisms also declined with increasing depth (Figure 3 a-f). By far highest numbers were found in the oxic zone of the Constanza- and the Portiza transect (1666 to 3490 ind/0.1m²). These transects also showed the strongest gradients in faunal densities along stations, i.e. the decline in numbers of organisms towards the suboxic zone was more dramatic as on the other transects. A similar trend was observed at the Inebolu transect with the difference, however, that in the lower suboxic zone (150m) again high densities of benthos were retrieved (913 ind/0.1m²). These high values were confirmed by the results of a second box corer sample taken at the same depth with a total number or organisms of 1406 ind/0.1m² (data not shown).

Comparatively small numbers of organisms were observed at the St. Gheorghe- and the two Sevastopol transects (Figure 3 a-f). The third Romanian transect showed lowest macrofaunal densities in the oxic zone (200 ind/0.1m²). In the suboxic zone (130m station) 139 ind/0.1m² were found and from 150m down only single individuals were observed. The results of the Sevastopol I transect displayed similarly low values, except at the oxic 55m station where roughly twice as much animals as at the St. Gheorghe transect were counted. The Sevastopol II transect was characterized by low densities in the oxic zone, but comparatively high values throughout the suboxic zone.

The size spectra of the macrofauna were generally closely correlated with the taxonomical composition (Fig 4 a-f). Higher percentages of larger (>2mm) and middle-sized (1-2mm) macrofauna were restricted to the oxic and upper suboxic zone. Stations with high bivalve densities such as the 80m station on the Constanza transect and the 63m, 77m, and 100m stations on the Portiza transect also displayed highest amounts of larger animals. Stations dominated by vermiformes, e.g. polychaetes and oligochaetes at the 50m station off Inebolu or polychaetes and nematodes at the 50m station of the Constanza transect were clearly dominated by the smaller macrofauna (1mm-0.5mm). In correspondence with the qualitative results (s. above) at depths of 130m or deeper almost exclusively small macrofauna was found together with an increasing dominance of nematodes and oligochaetes.

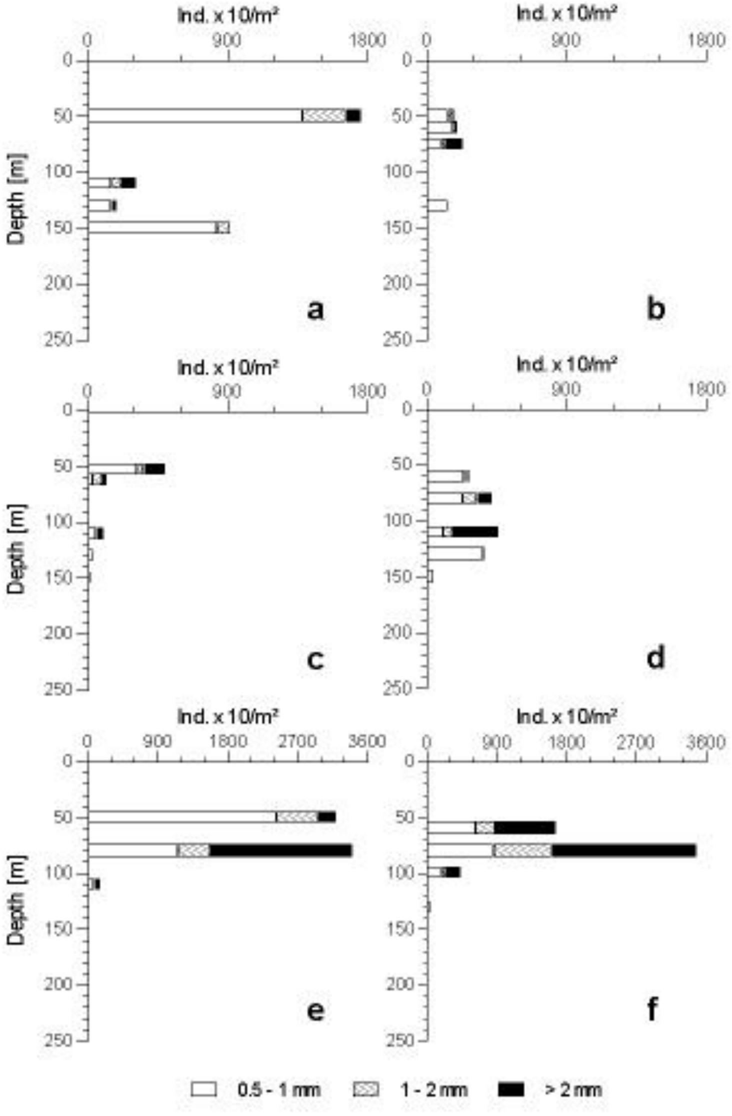

Figure 4: Macrofauna size class distribution across the O_2/H_2S-transition zone: a = Inebolu transect, b=St. Gheorghe transect, c & d=Sevastopol transects I & II, e=Constanza transect, f=Portiza transect.

B) Qualitative and quantitative investigations of temporary and larger meiofauna

Since the first macrofauna investigations conducted on the Inebolu transect revealed increasing amounts of smaller organisms throughout the suboxic zone it became evident that some additional information about the structure of the benthic communities was needed. Therefore, on the following 4 transects (St. Gheorghe, Sevastopol I + II, and Constanza) the spectrum of size classes was extended by the size class 500 – 250µm (Table 8 a-d, see annex).

Only minor differences in taxonomic composition compared to the macrofauna results were found. Deviations in faunal composition occurred due to the restriction of certain taxa to certain size classes. However, missing macrofaunal groups were mostly replaced by meiobenthic groups so that the overall number of taxonomic groups found stayed at the same level or slightly below as in the macrofauna investigations. Consequently, similar declines in taxonomic groups from the oxic to the suboxic zone were observed and in the upper anoxic zone only single to few nematodes were found.

However, overall densities as well as distribution pattern from the oxic to the anoxic zone displayed more or less strong differences compared to the macrofauna investigations (Figure 5 a-d). With the exception of a single station (80m Constanza) all results of the quantitative investigations of the temporary and larger meiofauna lay clearly higher predominately by a multiple. Whereas the course of total numbers of organisms along the Sevastopol II and the Constanza transect displayed a somewhat similar picture to the macrofauna results the patterns of total numbers of organisms along the Sevastopol I and especially along the St. Gheorghe transect strongly differed from macrofaunal distributions. Faunal densities either stayed on the same level throughout the suboxic zone (Sevastopol I, Constanza transect) or even reached highest values in this region (Sevastopol II, St. Gheorghe transect). In general, the trend of increasing dominance of nematodes with increasing depth was even stronger expressed than in the macrofauna investigations.

On the Sevastopol II transect total numbers of organisms increased from the oxic to the suboxic zone similar to the macrofauna. Highest values were found at the 130m station (1725 ind/0.1m^2), about twice as high as the results from the shallowest station (50m, 823 ind/0.1m^2). Similar to the macrofauna total numbers of organisms sharply decreased between 130m and 150m depth. On the Constanza transect a decline of faunal densities with increasing depth similar to the macrofauna could be observed. However, in contrast to the macrofauna, the 50m station was considerably denser populated than the 80m station. Also, the numbers of organisms remained nearly constant throughout the suboxic zone (110m to 150m). Even at 170m depth 4 taxonomic groups were present, each with several individuals. Different from the macrofauna results, on the Sevastopol I transect the total numbers of organisms remained at an almost constant level from the 55m station down to the 150m station with minimum values at the 130m station. Most obvious differences between the results of the macrofauna and the temporary and larger meiofauna were observed at the St. Gheorghe transect with 9 times higher (1815 ind/0.1m², 60m station) values in the oxic zone and 32 times higher values (4509 ind/0.1m², 130m station) in the suboxic zone. The latter one being the overall maximum value of faunal density in the suboxic zone of this size class of all transects.

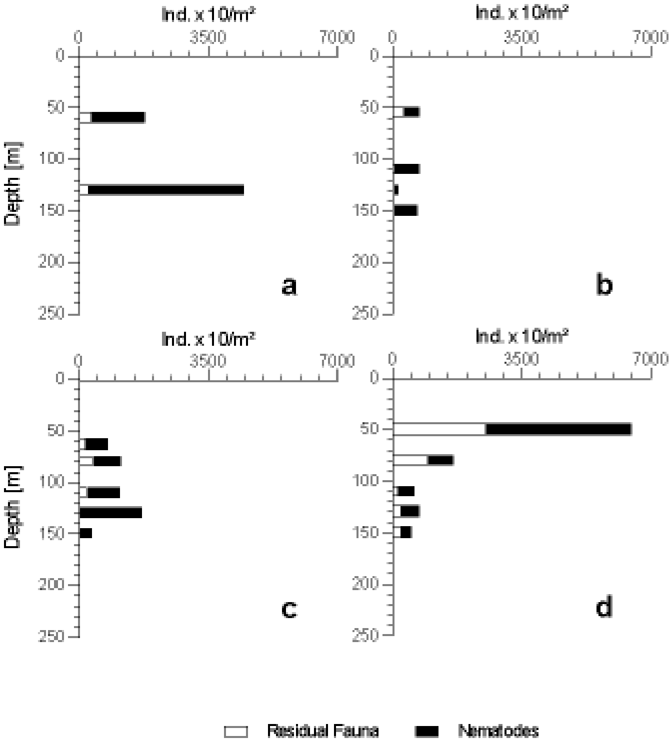

Figure 5: Abundances of temporary and larger meiofauna (500>250µm) across the O_2/H_2S-transition zone: a=St. Gheorghe transect, b & c=Sevastopol transects I & II, d=Constanza transect.

C) Qualitative and quantitative investigations of meiofauna

Clear dominance of nematodes on all transects and almost all stations was the most obvious signal from the meiofauna investigations (Table 9 a-f, Figure 6 a-f). Similar to the smaller size classes in the macrofauna investigations this dominance became stronger with increasing depth.

As with the larger benthos the number of taxonomic groups decreased with depth. However, the values generally remained stable from the oxic to the upper suboxic zone (50m to 110m) and, therefore, in contrast to the larger benthos the decline in number of meiobenthic taxa occurred within the suboxic zone. On the Sevastopol I transect and the Constanza transect the values dropped between 110m and 130m depth whereas on the St. Gheorghe and Sevastopol II transect the decline was observed between 130m and 150m. On the Inebolu transect the number of taxa remained on the same level down to the lower suboxic zone (150m). The results from the Portiza transect displayed a different picture. Here, at the shallowest station (62m) the meiobenthic community only consisted of nematodes and crustaceans. At the 77m and 100m stations also a few other groups were present.

Meiobenthic diversity was highest on the Inebolu transect and at the 80m station of the Constanza transect. The rest of the Constanza transect as well as the St. Gheorghe and the Portiza transect revealed only a few taxonomic groups. The values of the two Sevastopol transects were slightly higher.

In total numbers of organisms the Inebolu and the St. Gheorghe transect showed the highest values. On the other transects only the values of the 130m station of the Sevastopol II transect and the 137m station of the Portiza transect, each in the suboxic zone, reached the same level. Besides, the two Sevastopol transects and the Portiza transect displayed lowest numbers of organisms. In fact, lowest meiofauna densities in the oxic zone were found on the Portiza transect (stations at 62m and 77m). However, densities in the upper anoxic zone (181m) of this transect were above average values. Meiofauna densities on the Constanza transect displayed intermediate levels for all depth zones.

Standard deviations were mostly less than 50% indicating moderate variations in meiofauna distribution. Lowest values were calculated for the Inebolu and the Constanza transect with the exception of the upper anoxic zone stations where standard deviation reached 100%. On the other transects the values were more variable. Higher standard deviations could be found in any depth zone. However, stations from the lower suboxic zone (150m) and the upper anoxic zone (190/200m) displayed mainly low values.

Comparing the distribution patterns of total numbers of organisms it becomes evident that they well mirror the results of the macrofauna and the temporary and larger meiofauna investigations, especially true for the Inebolu and the Sevastopol I transect. Only the results of the Constanza transect showed a different pattern since meiofauna values remained nearly constant down to the 130m station in the suboxic zone which was in clear contrast to the results of the larger benthic size classes. Furthermore, on this transect no meiofauna was found at the deepest suboxic station at 150m depth but at 170m depth on the fringe to the anoxic zone again some nematodes were present. Generally, on all transects in the upper anoxic zone (190m to 200m) only small numbers of nematodes and if any, few individuals of polychaetes and/or harpacticoids were found. The 190m stations of both Sevastopol transects also revealed some juvenile molluscs.

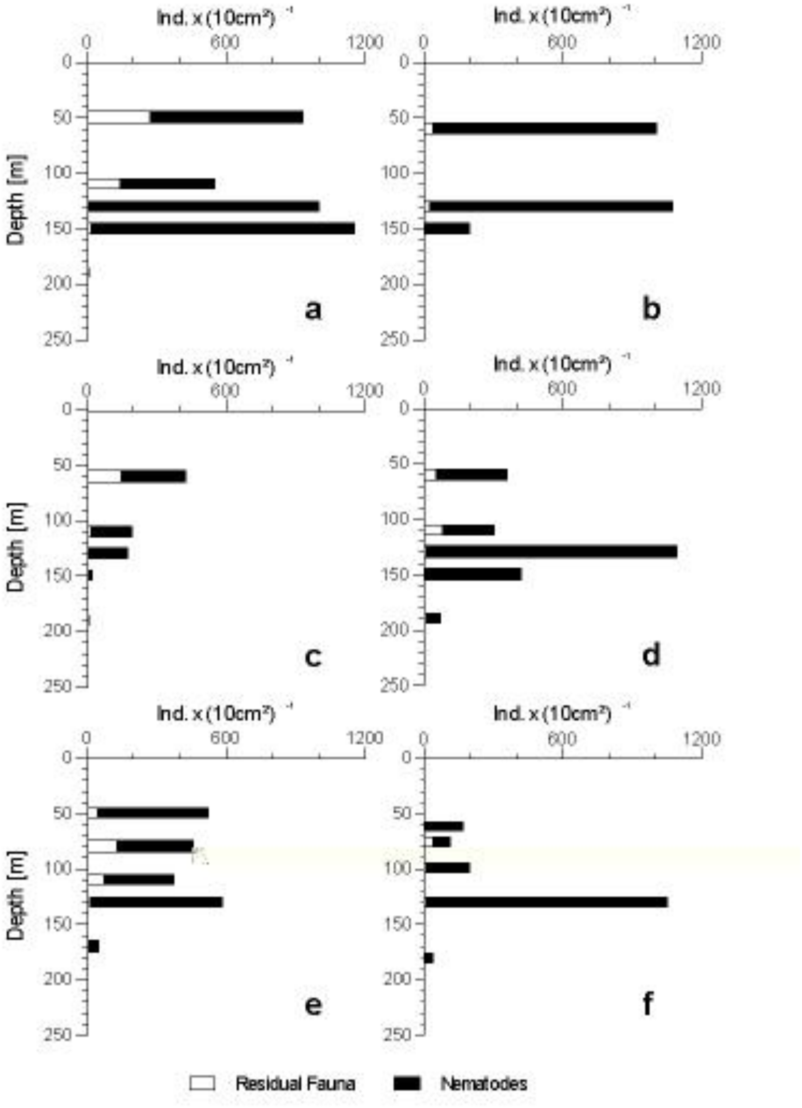

Figure 6: Meiofauna (>32µm) abundances across the O_2/H_2S-transition zone: a = Inebolu transect, b=St. Gheorghe transect, c & d=Sevastopol transects I & II, e=Constanza transect, f=Portiza transect (>45µm).

D) Cluster analyses

Clustering of stations based on similarities of faunal abundances of the different size classes produced the dendograms in figures 7 to 9. Three major levels of differentiation can be distinguished in all three size classes. At first, stations from the anoxic zone and with a faunal distribution pattern as from the anoxic zone clearly separate from the stations of the interface zone and shallow stations. For example, the 150m station of the St. Gheorghe transect for the larger size classes and the 150m station of the Sevastopol transect I for the meiofauna cluster with the anoxic stations. The anoxic stations generally separate on the second level into stations with only nematodes present or stations with other taxa also.

For the macrofauna the second differentiation of the aerobe zone occurs between stations from the lower suboxic zone and stations from the oxic zone together with stations from the upper suboxic zone, which separate again on the third level from the oxic stations (Figure 7). The 130m station from the Inebolu transect is separated from the other stations of the same depth zone but is found in the cluster of the shallower stations of the upper suboxic zone probably owing to the high number of taxa at this station. The oxic stations separate on a fourth level into a cluster of stations with strong shares of bivalves and a cluster dominated by vermiformes and/or crustaceans.

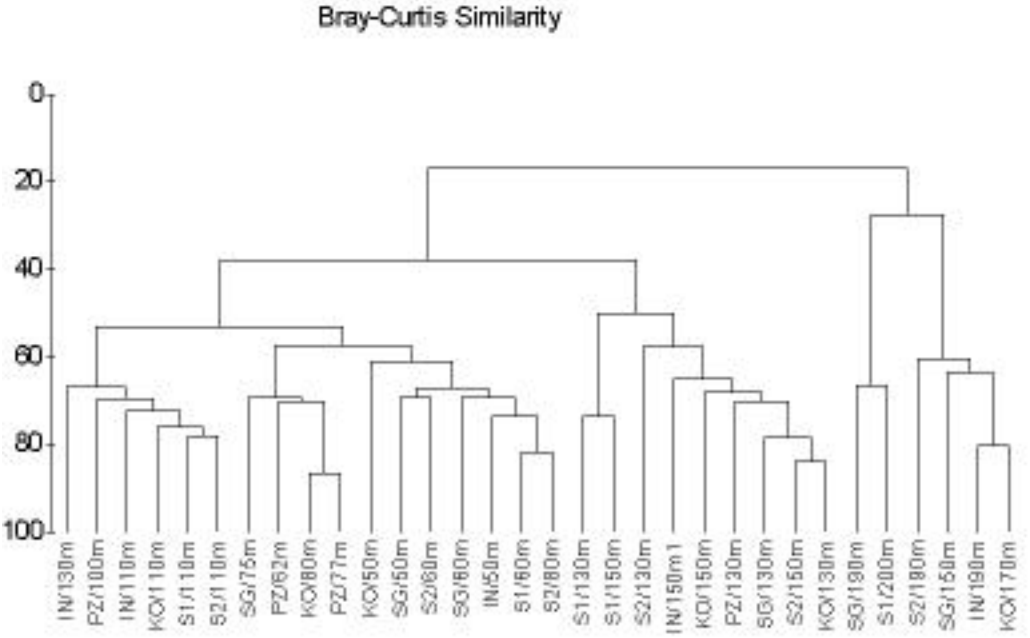

Figure 7: Classification of metazoan macrofauna abundances of the studied stations performed by Group Average Clustering technique.

The second separation level for the temporary and larger meiofauna slightly differs from the macrofauna since nematode dominated stations from the lower suboxic zone of the Sevastopol transects form a cluster separated from all other stations inhabited by more taxa (Figure 8). From the third level on, the differentiation in this size class becomes more complicated since clusters seem to be depending on diversity as well as depth zones. Furthermore, regional differences in faunal distribution gain more importance since clusters are often formed by stations from the same transect or region. Therefore, the shallow stations with higher diversity from the Constanza transect are separated from stations with lower number of taxa either from deeper stations of the same transect or from other areas. However, further clusters also separate comparatively well according to depth zones.

In the meiofauna size class on the second level of differentiation the deeper suboxic zone stations characterized by comparatively low diversity separate from stations with higher numbers of taxa (Figure 9). Consistently, the shallow fully oxic zone station from the Portiza transect (62m) is found in the first cluster since unlikely few taxa occurred at that station. Similar to the dendogram for the temporary and larger meiofauna from the third level on the differentiation by depth zones is superimposed by diversity aspects and regional patterns of faunal abundances

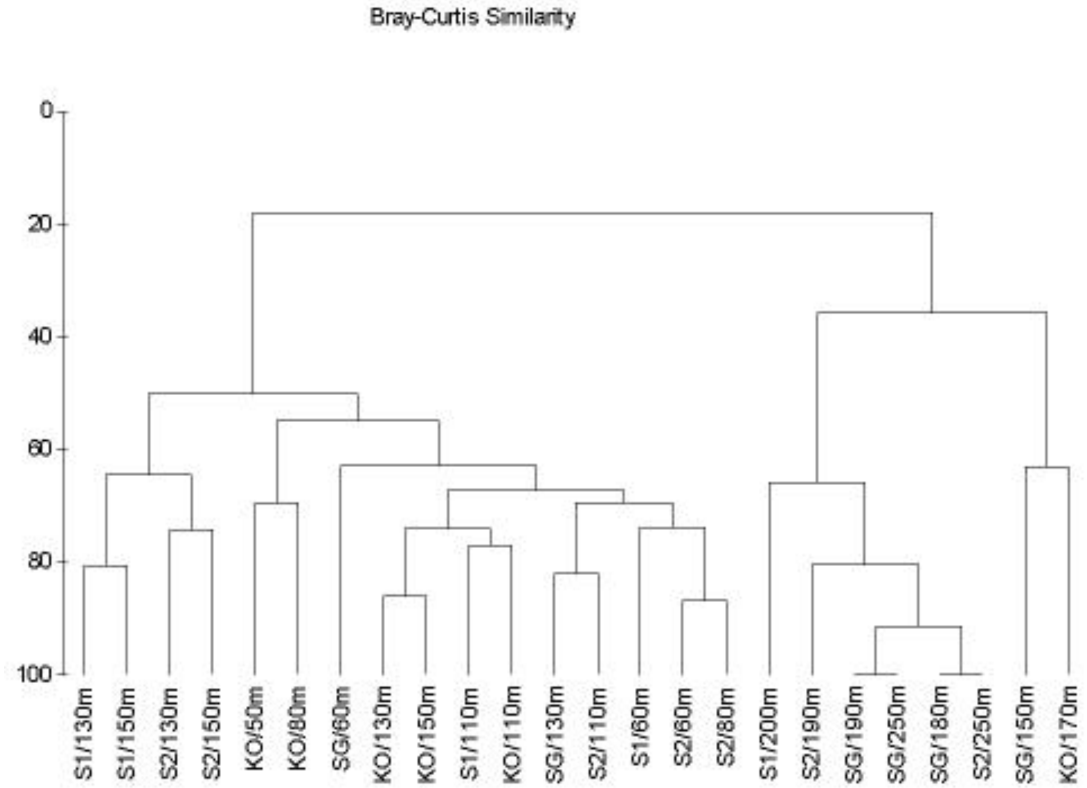

Figure 8: Classification of metazoan temporary and larger meiofauna abundances of the studied stations performed by Group Average Clustering technique.

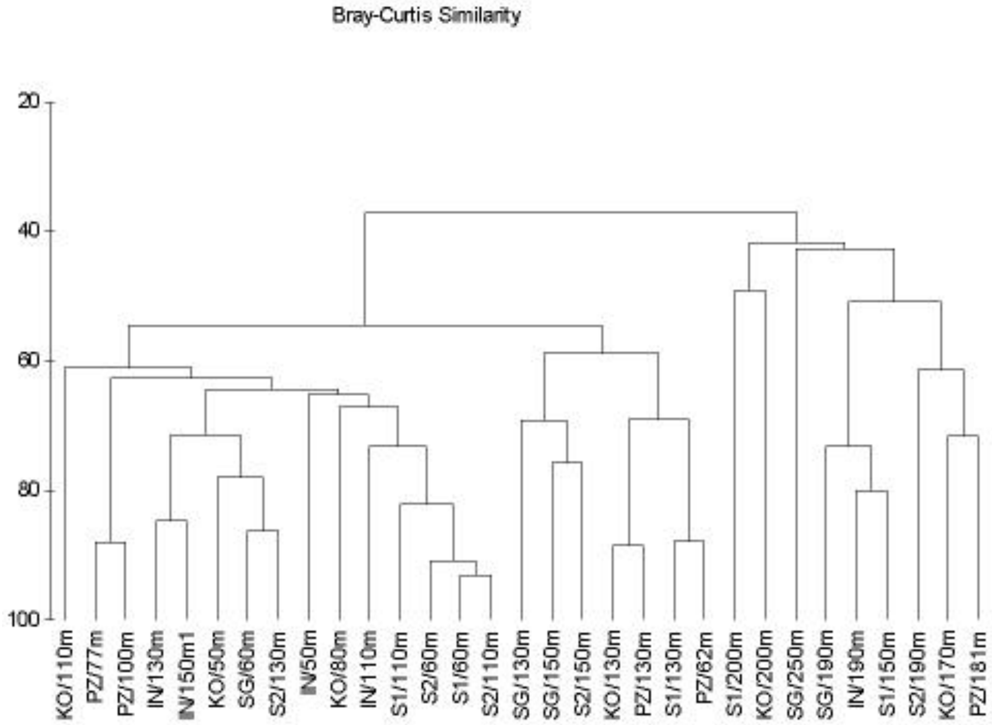

Figure 9: Classification of metazoan meiofauna abundances of the studied stations performed by Group Average Clustering technique.

DISCUSSION

Hydrographic features influencing the oxic/anoxic interface in the working areas:

On a basin-wide scale only minor differences in the depth of the oxic/anoxic interface zone between the different working areas may be assumed, especially when the two Sevastopol transects or the three transects from the Romanian shelf are considered. However, the meandering rim current causes a system of mesoscale currents in the form of anticyclonic eddies or so called jets that are highly variable in time and space (OGUZ et al. 1992, 1994; SUR et al. 1994, 1996). These current features influence the water column stratification down to several hundred meters depth and, therefore, may cause local up- or downward shifts of the oxic/anoxic interface (VINOGRADOV 1991; OGUZ et al. 1992, 1993) and/or erosive processes (LATUN 1990). Hydrographic and hydrochemical observations during all cruises displayed some similarities in general hydrography (LUTH & LUTH 1997, LUTH et al. 1998, LUTH et al. 1999) but for example vertical oxygen and hydrogen sulphide distribution varied considerably not only between working areas but also over time during the observation periods. However, single hydrophysical or hydrochemical measurements only describe the situation at a given moment and do not allow any conclusions about average values or possible shifts (LUTH & LUTH 1997). Consistently, multi-day time series of water stratification parameters e.g. in the Dnieper Canyon region gave strong evidence for activity of anticyclonic eddies and possible interface shifts in the area of the Sevastopol transects (LUTH et al. 1998), and GINSBURG et al. (1998) documented anticyclonic eddies in the same region during spring and summer 1993. Furthermore, similar features have been reported for the Inebolu region (OGUZ et al. 1994; SUR et al. 1994) and own observations (unpublished data) from the Constanza transect region showed strong variations in water stratification parameters over a period of 14 days.

Seafloor morphology and sediment conditions:

Besides hydrography, sediment conditions and morphology of the sea floor undoubtedly influence benthic life. This is especially true for the O_2/H_2S-transition zone of the Black Sea since it is generally situated on the upper slope, just below the shelf break, where the angle of the sea floor strongly increases compared to the shelf. As a result, benthic organisms living in these depth regions have to withstand phenomena like unstable sediments, strong variations in sedimentation rates and near-bottom water currents. SHOPOV et al (1986) described these phenomena for the shelf edge and the vicinity of submarine canyons. Frequent turbity currents from the shelf into the deep basin were described for the Vityaz Canyon region on the Romanian slope by PANIN (1996), situated near the St. Gheorghe transect and were also observed on the Sevastopol transects (LUTH & LUTH 1998 a) near the Dnieper Canyon, a region characterized by frequent lateral transport and resedimentation along the shelf and a source area of turbity currents (DOMANOV et al. 1996). Furthermore, methane gas seep activity with a potential of sediment disturbance (c.f. DANDO & HOVLAND 1992) is common in this region and may also have influenced the observed irregular sediments on some stations of the Sevastopol II transect (EGOROV et al. 1998, LUTH & LUTH 1998 a, b; LUTH et al. 1999). Finally, frontal up- or down-welling events resulting from interaction between shelf break morphology and the meandering cyclonic rim current (AUBREY et al. 1996, ZAIKA 1998) or strong wind periods (VLASENKO et al. 1996) observed on the north-western shelf may disturb sediment diagenesis as well as benthic communities. In undisturbed strata, - as observed on the Inebolu and Portiza transect (unpublished data), partly also on the Constanza, St. Gheorghe and the two Sevastopol transects (LUTH & LUTH 1998 a) - shells of modern bivalve species e.g. *Mytilus galloprovincialis* and *Modiolus phaseolinus* overlay strata of shell debris of dreissenoid bivalves from the lacustrine period (PANIN et al. 1999). On the Romanian and the Ukrainian shelf and slope *Dreissena* valves at certain stations occurred admixed with modern shells in the upper sediment layers or compact *Dreissena* layers even built the sediment surface (Peckmann et al. 2001). Table 10 gives a short summary of sediment observations.

Table 10: Sediment status at benthic stations of all transects (D = *Dreissena* valves in upper sediment layers, L = laminated sediments already in suboxic zone, T = Turbidite or mud slide layers, see text for explanation)

Sediment layering	Transects					
	Inebolu	St. Gheorghe	Sevastopol I	Sevastopol II	Constanza	Portiza
ordinary	all	50m, 60m, 75m, 250m	60m, 110m, 260m	60m, 80m	50m, 80m, 110m, 130m	all
mixed	-	130m, 150m, 180m, 190m (D)	130m, 150m (L), 200m (T)	110m, 130m, 150m, 190m (D), 260m (T)	150m, 170m 200m (T)	-

Benthic fauna:

Comparative investigations of larger scale have in general to cope with certain typical disadvantages such as, samples from different years and/or different seasons, incomplete data sets for certain areas, use of different gear and/or different methods (c.f. ZENETOS et al. 2001). Being aware of this, I tried to avoid as many of this bias as possible. However, reality hits hard sometimes, especially when you are out at sea and may only be overcome by thrust in God and a careful interpretation of results.

Seasonal aspects may have influenced food supply in form of detrital material for the benthic communities but so far no evidence for seasonal variations in community structure has been found for water depths of 50m and deeper for macrofauna (KISELEVA 1981) and meiofauna (SERGEEVA & KOLESNIKOVA 1996). However, differences over the years most probably effected the composition and distribution of benthic fauna, especially true for the Romanian shelf where 3 transects were sampled over a time span of 5 years. The relative decrease in anthropogenic stress to the north-western shelf since the early 90's due to the collapse of the former socialist economy probably favoured a restoration of benthic and pelagic communities in shallow waters (STOYKOV & UZUNOVA 2001) and likely explains to some extend the observed differences between the shelf stations of the St. Gheorghe transect sampled in 1992 and the Constanza transect as well as the Portiza transect sampled in 1994 and 1997, respectively. On the contrary, TODOROVA & KONSULOVA (2000) describe an ongoing deterioration of benthic communities for near shore waters of the Bulgarian coast, however, predominantly in areas of ongoing strong anthropogenic impact such as the bays of Varna and Burgas.

a) taxonomic composition

Since taxonomic aspects were of minor focus in this work and will be addressed in detail elsewhere, only some major aspects are discussed. Faunal material from the six transects expressed some taxonomic differences most obvious among the larger benthic size classes like mega- and macrofauna where systematic classification down to species level was comparatively easy. Taxonomic differences most likely mirrored regional distribution patterns as described in former publications (CASPERS 1957, ZENKEVICH 1963, BACESCU et al. 1971, KISELEVA 1981, ZAIKA et al. 1992). However, well known macrobenthic Leitformen as e.g. *Modiolus phaseolinus*, *Pachicerianthus solitarius* or *Amphiura stepanovi* were common on all transects. Strongest differences were observed between the Turkish shelf and the five transects from the north-western shelf (Table 6). For example, the holothurian *Stereoderma kirschbergi*, more or less common at the lower shelf stations of the Inebolu transect was almost absent on the north-western shelf, where *Oestergrenia digitata* was regularly found around 50 to 80m depth. *Leptosynapta inhaerens* was more dispersedly distributed but found at shallow stations on the north-western and the southern shelf. The macrobenthic nematode *Metoncholaimus albidus* inhabiting the deeper suboxic zone of the Inebolu transect in considerably high numbers was solely found on the southern shelf. However, some other deviations in faunal composition may have originated from different levels of environmental stress in the working areas. For instance, fish, caught in the beam trawl, and larger crustaceans were only found off Inebolu but were absent on the Romanian and the Ukrainian shelf. These findings could indicate that in the early nineties the shallower benthic biocoenoses on the shelf near Inebolu were in better conditions, consisting also of organisms of higher trophic levels, whereas on the north-western shelf eutrophication processes had already deteriorated these habitats (ZAITSEV et al. 1989, ZAITSEV 1992, 1993, GOMOIU 1993, BRONFMANN 1993, AUBREY et al. 1996, ZAIKA 1998). The results of the quantitative investigations also showed some evidence to support this supposition (see below).

Decline in numbers of taxonomic groups with depth was consistent through all benthic size classes indicating that living conditions are governed by the same main factors. However, total numbers of individuals may differ considerably according to individual conditions at each station or working area, respectively. The major factor is, obviously, the decreasing concentration of dissolved oxygen in the near-bottom water with increasing depth owing to the general Black Sea stratification. Therefore, the vertical zonation of fauna is to the largest extent controlled by the hydrographic regime, clearly demonstrated by the fact that differences in taxonomic composition between depth zones along each transect were stronger pronounced than differences between transects or working areas. This is also supported by cluster analyses, most obviously for the macrofauna.

However, the megafauna (>2cm) and the larger macrofauna (>1mm) showed a higher sensitivity to low oxygen values since their numbers of taxonomic groups diminished already in the upper suboxic zone, i.e. around the lower shelf or the shelf edge (around 110m depth, dissolved oxygen values in the near bottom water around 50µM). This is also indicated by the observed switch from mobile to sessile or hemisessile forms (e.g. sponges, anthozoans, holothurians, and ascidians) at those depths, as mobility usually requires higher respiration rates. Consequently, larger benthic organisms were absent from about 130m depth downwards. However, sediments down to about 150-170m contained large amounts of dead shells of *Modiolus phaseolinus* which could indicate a somehow deeper limit of the larger macrobenthos. In previous decades the lower limits of macrobenthos where generally described for these depths (CASPERS 1957, ZENKEVICH 1947, 1963, BACESCU et al. 1971, KISELEVA 1981) but seemed to have risen to shallower depth in recent decades (ZAIKA et al. 1992, MIKHAILOVA 1992). On the other hand, more recent investigations of the deepest benthic biocoenoses of the Black Sea revealed high levels of natural patchiness (MIKHAILOVA 1992; as well as TERESHCHENKO et al. 1992; POLIKARPOV et al. 1996, 1998 for the bivalve *Modiolus phaseolinus*). Keeping this in mind, interpretation of single samples becomes rather tricky and if possible, replicate sampling should be applied, especially true for the larger size classes (LUTH & LUTH 1997). This is also supported by the fact that certain larger organisms were caught in the trawls but were absent in the box corer samples (e.g. *M. galloprovincialis* on the Sevastopol II transect, or certain porifera on the Constanza transect) indicating that their densities being too low to be quantified by box corer sampling.

Through all size classes highest numbers of taxa were often found in the phaseoline belt (ZAIKA et al. 1990) at stations between 80m to 110m depth situated in the lower oxic and upper suboxic zone, respectively. Own observations of virtually undisturbed samples from these depths obtained with the multi corer displayed the existence of a water filled “interstitial” between the dense *Modiolus* layers close to the sediment surface. This “*Modiolus* interstitial” most probably enhances the variety of microhabitats - especially for small size organisms - resulting in increased numbers of taxa.

However, also for the smaller benthic size classes (smaller macrofauna to meiofauna) a drop in numbers of taxonomic groups occurred slightly below the upper suboxic zone (110m) towards the upper slope. At depths below 130m where dissolved oxygen values approach very low concentrations around 5µM and at some stations traces of hydrogen sulphide were detected the smaller size classes became dominant. For living under low oxygen conditions a small body size is of advantage when the ratio between body surface and volume allows diffusive oxygen uptake through the body wall (LEE & ATKINSON 1976). Consistently, vermiform morphotypes such as oligochaetes and especially nematodes gained increasing importance in the deeper benthic biocoenoses, most strongly pronounced in the meiofauna investigations. Both taxonomic groups, in general, are known for their high tolerance to low oxygen conditions and hydrogen sulphide (GIERE 1993) as well as for dominance in strongly eutrophicated habitats.

The somewhat different picture at the Inebolu transect where the steep decline in number of taxonomic groups occurred even deeper, between 130m and 150m, is a clear indication for a different setting of living conditions in the O_2/H_2S-transition zone in this part of the southern shelf, controlled either by a different hydrography and/or other environmental factors such as less eutrophication than in the north-western regions as mentioned above (LUTH & LUTH 1997).

Distribution patterns:

Benthic fauna was generally restricted to Lebensformen adapted to live on the seafloor or close to the sediment surface, the so called epifauna. A likely reason is that oxygen values in the near-bottom water are generally too low to enable infaunal life especially from the upper suboxic zone downwards. Dwelling forms usually pump oxic waters through their burrows to sustain below the RPD-layer. According to ZAIKA (1998) a convergence zone between shelf waters and the cyclonic rim current causes downwelling of nutrients and pollutants just above the shelf break resulting in enhanced depletion of oxygen values in the near-bottom water and an uplift of the RPD-Layer close to the sediment surface. Consistently, faunal densities rapidly decrease with depth of sediment. Test counts on the Inebolu transect revealed only 10% or less of the total numbers of organisms to be found below 5cm sediment depth and microelectrode profiles from the Romanian and Ukrainian shelf demonstrated that oxygen rapidly diminishes in the sediment (C. Luth, pers. comm.).

Foraminifera and hydroids were present almost along the whole depth spectrum from the oxic zone down to the lower suboxic zone, the former being sometimes even found in the anoxic zone. However, an interpretation of the semiquantitative estimations remains problematic since the Rose Bengal staining method used was not adapted to foraminifera investigations and especially the rotalia type specimen seemed to colour sometimes even if they did not really look as having been alive recently. So, the considerable numbers of foraminifera found in the upper anoxic zone of the St. Gheorghe transect may have been an accumulation after passive transport down the slope by resuspension processes rather than a flourishing population. However, certain foraminifera are known to withstand exposure to hydrogen sulphide (MOODLEY et al. 1998).

Since the hydroid colonies disintegrated during the sorting procedure estimations on hydroid densities are very vague. However, high numbers of polyps counted should at least allow the conclusion of an increased probability of a real population at these depths. Single to a few polyps may have been transported by lateral transport and may, therefore, not indicate a steady population. BACESCU (1963) described already in the early 60’s a special biocoenosis at depths similar to the lower suboxic zone in this work which he termed the periazoic zone consisting of polychaetes (*Victoriella* *zaikai*, specified by KISELEVA in 1992 and *Protodrilus sp.*) and specific foraminifera and hydroid species not yet thoroughly investigated. Own observation of a complete and alive hydroid colony in a multicorer tube from 150m depth of the Romanian slope together with the results described above allows to conclude that this certain biocoenosis may still form the deepest benthic belt in the western basin of the Black Sea. However, according to my results nematodes and oligochaetes have to be added as major groups in this depth zone (see below).

The results of the quantitative investigations reflect the taxonomic zonation. The larger size classes were restricted to the oxic and the upper suboxic zone and hardly any macrofauna was found below approximately 130m bottom depth, similar to other investigations (MIKHAILOVA 1992, TERESHCHENKO et al. 1992, ZAIKA et al. 1992, POLIKARPOV et al. 1996, 1998). Only on the Inebolu transect a strong population of macrobenthic nematodes (mainly *Metoncholaimus albidus)* and tubificide oligochaetes was observed at 150m depth confirmed by a parallel sample (data not shown). Since also the meiofauna showed maximum densities at this station for all depths and transects one can assume a relatively stable benthic community at this depth on this transect. Furthermore, hydrographic parameters indicated a probable deeper average depth of the oxic/anoxic interface zone compared to the north-western shelf (LUTH & LUTH 1997).

Highest densities of macrobenthic fauna were observed in the oxic zone of the Constanza and Portiza transects and to some extent of the Inebolu transect where totals numbers reached about half of the two others. The Constanza values may even have been between 10 to 40% higher, since on this transect only the top 2 cm of the sediment were processed. The dominant groups at the 50m station near Inebolu were annelids and echinoderms; on the Constanza transect annelids, nematodes and crustaceans showed highest densities but at both stations little shares of larger animals (>1mm) were present. On the Portiza transect larger specimen made up more than 50%, of which more than 80% were bivalves, outnumbered only by crustaceans. However, the bivalves accounted for 99% of the biomass at this station. High densities of *M. phaseolinus* together with fewer but comparatively large *M. galloprovincialis* (1–4 cm) were responsible for a total biomass of up to 1960 g ww m^{-2} (RIESS et al. 1999). Consistently, all specimens from other groups (997 ind. 10^{-1} m^{-2}) were small in size (up to 4mm) and summed up to a biomass of only 13 g ww m^{-2}. Although no biomass data are available for the other transects it can be assumed from the values of the Portiza transect as well as from benthic turnover rates calculated from *in situ* measurements conducted there (WENZHOEFER et al. 2002) that populations dominated by bivalves represent far higher biomass values and, therefore, benthic turnover than populations dominated by vermiformes, echinoderms and/or small crustaceans. Furthermore, carbon mineralization rates on the shelf were extremely high on the shelf compared to the shelf edge and deeper areas. Decreasing biomass as well as benthic respiration/turnover with depth correlated with decrease in macrofauna. Increasing numbers of organisms of the smaller size classes (especially nematodes) towards the lower suboxic zone did not compensate this decline. Therefore, benthic biomass and turnover values in the O_2/H_2S-transition zone are likely to be generally very low compared to the oxic zone in all working areas and, furthermore, probably throughout the Black Sea.

The obtained peak values for total number of organisms from the 80m and the 77m station of the Constanza and the Portiza transect, respectively, were strongly dominated by *M. phaseolinus* but also strongest varieties of taxa were found (see above) and the size class > 2mm reached highest shares. According to ZAIKA et al. (1990) this depth zone is the centre of the phaseoline belt where maximum densities occur. Similar effects were also observed on other transects were overall faunal densities were comparatively low (St. Gheorghe, Sevastopol II) indicating a more or less strongly pronounced phaseoline belt around the western Basin of the Black Sea. Moreover, huge amounts of empty phaseoline valves were always present in the upper sediment layers of these depths. However, the maxima of dead shells on the Ukrainian shelf were found somewhat deeper (around 125m depth) than for living specimen (80 to 90m depth, POLIKARPOV et al. 1996).

The Constanza and Portiza transects also showed the strongest gradients in faunal densities towards the O_2/H_2S-transition zone reflecting the hydrographic conditions for the Romanian shelf and slope. However, results for the temporary and larger meiofauna for the Constanza transect revealed stable numbers of organisms with comparatively high diversity throughout the suboxic zone and even at 170m a considerable number of organisms was found.

The comparatively lower densities of macrofauna in the oxic zone of the St. Gheorghe and the two Sevastopol transects were most probably caused by different sets of environmental parameters. On the St. Gheorghe transect the macrobenthos expressed clear signs (low numbers, small size, low diversity, dominance of nematodes, c.f. BEUKEMA 1991) of a strongly diminished community probably caused by strong eutrophication including near-bottom water anoxia as described for many areas on the north-western shelf for the late 80's and early 90's (ZAITSEV 1993, GOMOIU 1993, BRONFMANN 1993, AUBREY et al. 1996, ZAIKA 1998). This is also supported by the results from the temporary and larger meiofauna as well as the ordinary meiofauna where densities were comparatively high indicating a shift to smaller size classes.

Low densities in the oxic zone of the Sevastopol region are more difficult to explain. Eutrophication may also be of major importance, although the Danube plum is generally drifting southwards along the Romanian coastal zone. However, formation of counter clockwise gyres on the north-western shelf transporting nutrient rich waters of Danube origin but also from Ukrainian rivers eastwards to Crimea have been reported (VINOGRADOV et al. 1987, GINSBURG et al. 1998). Consistently, the water column over the shelf stations of the Sevastopol transects was characterized by reduced salinities in surface layers indicating fresh water origin. On the other hand the shallower shelf areas in this region are exposed to frequent fishing efforts and bottom trawling (ZENETOS et al. 2000) which may also have negative effects on the benthic fauna.

For the stations situated in the O_2/H_2S-transition zone (110 to 200m) comparably strong differences in faunal distribution of all size classes were observed between the two Sevastopol transects. Besides the Inebolu transect, the Sevastopol transect II displayed highest numbers of macrobenthos throughout the suboxic zone. A community mainly based on nematodes was found through all size classes. Possible influences of frequent seeping of methane gas especially around stations of this transect have been discussed in detail by LUTH & LUTH (1998). Enhanced mixing of near bottom water due to turbulence from bubbling gas may promote living conditions for benthic fauna but could not been proven. Results from the hydrographic survey revealed a deeper onset of hydrogen sulphide in the area of transect II and sediment observations indicated an at least recently happened uprise of the anoxic zone towards the shelf at transect I (Table 10: laminated sediment at 130 and 150 stations of Sevastopol transect I) as described by LUTH et al. (1998). Therefore, it seems likely that regional small scale shifts of the average depth of the interface zone were responsible for the observed differences besides natural variations in form of patchiness which can never be totally excluded.

Whereas the macrofauna samples and the samples for the temporary and the larger meiofauna were obtained from the same box of the box corer (or ELINOR lander, Portiza transect) the meiofauna samples were taken from multiple corer tubes (except for the Portiza transect) and, therefore, do not represent the “on the spot” meiofauna for the corresponding larger benthic size classes. However, the results generally mirror the results of the larger size classes as observed for most transects. Exceptions are the results from the oxic zone of the Constanza and the Portiza transect, where both working areas were characterized by dense populations of macrofauna. Compared to macrofauna densities, the observed meiofauna densities were relatively low may indicating a negative correlation between very high macrofauna densities and meiofauna especially at the 50m station of the Portiza transect where the larger bivalves (*M. galloprovincialis, M. phaseolinus*) were dominant in biomass and macrobenthic crustaceans dominant in numbers and meiofauna was low in density and extremely low in diversity. In the lower suboxic zone, where macrofauna was absent, meiofauna values corresponded again with results of the other transects. Again with one exception, at the 150m station of the Constanza transect the multi corer obviously hit a recently happened turbidity flow containing no benthic life at all. Turbidite influence was observed in sediments of all slope samples from this transect (Tab. 10) but other samples from the O_2/H_2S-transition zone contained fauna. Similar to the 170m station of the Constanza transect where in the temporary and larger meiofauna size class a considerably number of juvenile bivalves (*M. phaseolinus*) was found, few juvenile Modiolus were obtained from the upper anoxic zone of both Sevastopol transect. It is suggested that bivalve larvae may settle at these depths and even become juveniles but do not sustain due to low oxygen values and hydrogen sulphide stress.

As most strongly observed in the meiofauna results, nematode based communities seem to be typical for the deeper parts of the suboxic zone and upper anoxic zone as seen on all transects. Peak densities were found just above the anoxic zone. Lack of predation by macrofauna and food supply in form of relatively fresh organic material which is, due to the absence of mussels not consumed by filter feeders, make the lower boundary of the suboxic zone a hospitable place for dense populations of the nematode dominated smaller size classes.

The stable benthic communities with a diverse and larger fauna found in the oxic zone of the Constanza, Portiza, and Inebolu transects presumably result from comparatively stable environmental and sediment conditions. However, high numbers of organisms and high biomass (Portiza) demonstrate the hypertrophic state of the north-western shelf. Low shares of bivalves on the Inebolu transect and on the Sevastopol transects may indicate the impact of frequent trawling; the latter combined with other unfavourable environmental conditions such as eutrophication, and sediment instabilities.

The average depth of the oxic/anoxic interface on the sea floor on the Romanian shelf and slope seemed to have been relatively stable over the last decade of the 20th century. At least, there is no indication of a general rise from the results of the benthic investigations.

The question whether the changes in macrobenthos depth distribution between the 1950-60's and 1980-90's resulted from a general upshift of the oxic/anoxic interface or a larger variety of environmental factors remains unanswered. However, a possible explanation could be, that not the depth of the limit of life has shifted compared to earlier years of the last century but a shift from larger to smaller size classes has occurred owing to degradation of living conditions caused by eutrophication, at least on the north-western Black Sea shelf. Owing to the lack of adequate sampling gear for quantitative investigations of the smaller size classes in former years (ZAIKA 1998) the information on depth distribution of temporary and larger meiofauna and ordinary meiofauna is rather sparse and, therefore, further work on these benthic size classes is needed.

CONCLUSIONS

The O_2/H_2S-transition zone covers the depth regions at the sea floor influenced by the oxic/anoxic interface in the water column. It includes the areas where the oxic/anoxic interface meets the sediment surface and also those areas influenced by interface oscillations situated above and below the average depth of the interface. Consistently, its vertical extension depends on the type of interface variations (e.g. periodical or episodical), their intensities (amplitude) and moreover on the angle of slope. Benthic organisms living within the O_2/H_2S-transition zone situated usually from the shelf edge to the upper slope not only have to cope with changing oxygen and hydrogen sulphide concentrations but also with instability of sediments induced by resuspension, turbidity currents or methane seeps. The shelf environments in the oxic zone on the north-western shelf are still in a hypertrophic state but showed signs of a restoration of benthic communities in recent years. The lower limit of benthic life is largely determined by the regional hydrographic regime which may differ over comparatively small distances due to mesoscale features such as anticyclonic eddies. Larger macrofauna rapidly diminishes in the suboxic zone and is hardly found below 130m depth. The lower suboxic zone around 150m depth and sometimes even deeper is inhabited by a more or less densely populated benthic community of smaller size classes dominated by nematodes and oligochaetes, sometimes also with polychaetes and harpacticoids. These coenoses diminish towards the upper anoxic zone around 190m depth where densities (mostly nematodes) are generally low.

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ANNEX:

Table 6: List of all Taxa, includes all benthic size classes (stations without fauna not listed)

Taxa				Inebolu-Transect							
			Depth	50m	70m	110m	114m	120m	130m	150m	190m
			Gear	BC	BT	BC	VVG	BT	BC	BC	BC
-Foraminifera:		Rotalia typus indet spp.		+		+			+	+	
	Allogromiidae:	indet spp.		+		+		+	+		
	Saccamminidae:	indet spp.		+		+		+	+		
- Porifera:		indet sp.I				+			+		
	Suberitidae:	Suberites carnosus (Johnston 1848)									
		Suberites prototipus (Swartschewsky 1905)							+		
	Sycettidae:	Sycon ciliatum (Risso 1826)									
- Hydrozoa:		indet spp.		+	+	+		+	+	+	
- Anthozoa:											
	Actiniidae:	Actinia equina (Linne 1766)				+					
	Cerianthidae:	Pachycerianthus solitarius (Rapp 1829)		+		+	+	+	+		
- Turbellaria:	Kalyptorhynchia:	indet sp. I				+			+	+	
- Nemertini:		indet spp.		+		+					
	Lineidae:	Micrura fasciolata (Ehrenberg 1831)		+							
- Nematoda:		indet spp.		+		+			+	+	+
	Oncholaimidae:	Metoncholaimus albidus (Bastian 1865)		+					+	+	
- Kinorhyncha:		indet spp.		+		+			+	+	
- Bivalvia:											
	Cardiidae:	Cardium sp.I		+	+						
		Plagiocardium simile (Milachevitch 1909)		+	+						
	Mytilidae:	Mytilus galloprovincialis (Lamarck 1819)			+						
		Modiolus phaseolinus (Philippi 1844)		+		+	+	+	+		
	Scrobiculariidae:	Abra nitida milachewichi (Nevesskaja 1963)					+	+			
- Gastropoda:		indet spp.		+							
	Hydrobiidae:	Hydrobia sp.I									
	Retusidae:	Retusa truncatella (Locard 1892)									
	Muricidae:	Trophonopsis breviata (Jeffreys 1882)									
- Polychaeta:		indet spp.		+		+			+	+	
	Glyceridae:	indet sp. I									
	Ampharetidae:	Melinna palmata (Grube 1870)		+	+				+		
		Hypania invalida (Grube 1860)		+							
	Capitellidae:	Capitella capitata (Fabricius 1780)							+		
		Heteromastus filiformis (Claparède 1864)		+							
		Notomastus profundus (Eisig 1887)									
	Hesionidae:	Hesionides sp.		+							
	Nephtyidae:	Nephtys hombergii (Savigny1818)			+	+			+		
	Nereidae:	Nereis diversicolor (O. F. Müller 1776)									
	Orbiniidae:	Orbinia sertulata (Savigny 1820)						+			
	Paraonidae:	Aricidea jeffreysii (McIntosh 1879)		+		+					
	Phyllodocidae:	Phyllodoce lineata (Claparède 1870)		+							
	Polynoinae:	Harmothoë imbricata (Linne 1767)		+		+			+		
	Protodrilidae:	Protodrilus sp.I							+		
	Sabellidae:	Chone sp.		+		+					
		Euchone rubrocincta (Sars 1861)									
	Spionidae:	Spio filicornis (Müller 1766)		+							

			Pygospio elegans (Claparède 1863)			+				
		Syllidae:	Exogone gemmifera (Pagenstecheri 1884)	+		+				
			Streptosyllis bidentata (Southern 1863)	+		+			+	
			Sphaerosyllis hystrix (Claparède 1863)	+						
		Trichobranchidae:	Terebellides stroemi (Sars 1835)	+	+	+	+	+		
- Oligochaeta:										
		Tubificidae:	indet spp. +(juv.)	+		+			+	+
- Phoronidea:			Phoronis euxinicola (M. Selys-Longchamps 1907)	+						
- Crustacea:										
	Harpacticoidea		indet spp.	+		+			+	
	Ostracoda		indet spp.	+		+			+	
	Cirripedia									
		Balanidae:	Balanus improvisus (Darwin 1854)	+						
	Amphipoda		indet spp.	+					+	
		Ampeliscidae:	Ampelisca diadema (A. Costa 1853)	+		+				
		Caprellidae:	Caprella sp.I	+						+
			Caprella acanthifera (Leach 1814)	+						
		Corophiidae:	Corophium sp.							
		Oedicerotidae:	Synchelidium maculatum (Stebbing 1906)	+						
	Isopoda		indet sp.I							
		Idoteidae:	Synisoma capito (Rathke 1837)	+						
	Cumacea		indet sp.I	+						
		Pseudocumidae:	indet sp.I							
	Tanaidacea		indet sp.I	+						
		Apseudidae:	Apseudes ostroumovi (Bacescu et Carausu 1947)							
	Mysidacea:		indet sp. I							
	Decapoda									
		Crangonidae:	Crangon crangon (Linne 1758)		+					
		Hippolytidae:	Lysmata seticaudata (Risso 1816)						+	
- Arachnida:										
	Acari		indet spp			+				
	Pantopoda		indet sp.I			+				
- Ophiuroidea:										
		Amphiuridae:	Amphiura stepanovi (Djakonov 1954)	+	+	+		+		
- Holothuroidea:										
		Cucumariidae:	Stereoderma kirschbergi (Heller 1868)			+		+		
		Synaptidae:	Oestergrenia digitata (Montagu 1830)							
			Leptosynapta inhaerens (O. Müller 1776)	+						
- Ascidiacea:			indet sp.I							
		Ascidiidae:	Ascidia aspersa (Müller 1776)							
		Cionidae	Ciona intestinalis (Linne 1767)	+	+					
		Molgulidae:	Ctenicella appendiculata (Heller 1877)	+		+	+	+	+	
			Eugyra adriatica (Drasche 1884)	+						
- Pisces:										
		Clupeidae:	Sprattus sprattus phalericus (Risso 1826)		+					
		Gadidae:	Merlangius merlangius euxinus (Nordmann 1840)		+					
		Gobiidae:	Mesogobius batrachocephalus batrachocephalus (Pallas 1811)		+					
			Gobius melanostomus (Pallas 1811)		+					

Table 6 (continued): List of all Taxa, includes all benthic size classes (stations without fauna not listed)

Taxa				St. Gheorghe-Transect							
			Depth	50m	60m	75m	130m	150m	180m	190m	250m
			Gear	VVG	B-/MC	VVG	B-/MC	B-/MC	B-/MC	B-/MC	B-/MC
-Foraminifera:		Rotalia typus indet spp.			+		+	+	+	+	+
	Allogromiidae:	indet spp.			+	+	+				
	Saccamminidae:	indet spp.			+	+	+				
- Porifera:		indet sp.I				+					
	Suberitidae:	Suberites carnosus (Johnston 1848)									
		Suberites prototipus (Swartschewsky 1905)									
	Sycettidae:	Sycon ciliatum (Risso 1826)									
- Hydrozoa:		indet spp.		+	+		+				
- Anthozoa:											
	Actiniidae:	Actinia equina (Linne 1766)		+		+	+				
	Cerianthidae:	Pachycerianthus solitarius (Rapp 1829)			+						
- Turbellaria:	Kalyptorhynchia:	indet sp. I			+		+				
- Nemertini:		indet spp.			+						
	Lineidae:	Micrura fasciolata (Ehrenberg 1831)		+		+					
- Nematoda:		indet spp.		+	+	+	+	+	+	+	+
	Oncholaimidae:	Metoncholaimus albidus (Bastian 1865)									
- Kinorhyncha:		indet spp.			+						
- Bivalvia:											
	Cardiidae:	Cardium sp.I			+						
		Plagiocardium simile (Milachevitch 1909)									
	Mytilidae:	Mytilus galloprovincialis (Lamarck 1819)		+							
		Modiolus phaseolinus (Philippi 1844)		+		+		+			
	Scrobiculariidae:	Abra nitida milachewichi (Nevesskaja 1963)									
- Gastropoda:		indet spp.			+						
	Hydrobiidae:	Hydrobia sp.I									
	Retusidae:	Retusa truncatella (Locard 1892)									
	Muricidae:	Trophonopsis breviata (Jeffreys 1882)									
- Polychaeta:		indet spp.		+		+	+				
	Glyceridae:	indet sp. I				+					
	Ampharetidae:	Melinna palmata (Grube 1870)		+	+						
		Hypania invalida (Grube 1860)									
	Capitellidae:	Capitella capitata (Fabricius 1780)		+							
		Heteromastus filiformis (Claparède 1864)			+						
		Notomastus profundus (Eisig 1887)									
	Hesionidae:	Hesionides sp.			+	+	+				
	Nephtyidae:	Nephtys hombergii (Savigny 1818)		+							
	Nereidae:	Nereis diversicolor (O. F. Müller 1776)		+							
	Orbiniidae:	Orbinia sertulata (Savigny 1820)									
	Paraonidae:	Aricidea jeffreysii (McIntosh 1879)		+		+					
	Phyllodocidae:	Phyllodoce lineata (Claparède 1870)		+	+	+					
	Polynoinae:	Harmothoë imbricata (Linne 1767)									
	Protodrilidae:	Protodrilus sp.I					+				
	Sabellidae:	Chone sp.		+	+	+					
		Euchone rubrocincta (Sars 1861)									
	Spionidae:	Spio filicornis (Müller 1766)									
		Pygospio elegans (Claparède 1863)		+	+						
	Syllidae:	Exogone gemmifera (Pagenstecheri 1884)			+						

			Streptosyllis bidentata (Southern 1863)							
			Sphaerosyllis hystrix (Claparède 1863)							
		Trichobranchidae:	Terebellides stroemi (Sars 1835)	+	+	+				
- Oligochaeta:										
		Tubificidae:	indet spp. +(juv.)	+	+	+	+			
- Phoronidea:			Phoronis euxinicola (M. Selys-Longchamps 1907)		+					
- Crustacea:										
	Harpacticoidea		indet spp.				+			+
	Ostracoda		indet spp.		+					
	Cirripedia									
		Balanidae:	Balanus improvisus (Darwin 1854)							
	Amphipoda		indet spp.			+				
		Ampeliscidae:	Ampelisca diadema (A. Costa 1853)			+				
		Caprellidae:	Caprella sp.I							
			Caprella acanthifera (Leach 1814)		+	+				
		Corophiidae:	Corophium sp.							
		Oedicerotidae:	Synchelidium maculatum (Stebbing 1906)							
	Isopoda		indet sp.I							
		Idoteidae:	Synisoma capito (Rathke 1837)			+				
	Cumacea		indet sp.I	+		+				
		Pseudocumidae:	indet sp.I		+					
	Tanaidacea		indet sp.I							
		Apseudidae:	Apseudes ostroumovi (Bacescu et Carausu 1947)	+		+				
	Mysidacea:		indet sp. I							
	Decapoda									
		Crangonidae:	Crangon crangon (Linne 1758)							
		Hippolytidae:	Lysmata seticaudata (Risso 1816)							
- Arachnida:										
	Acari		indet spp		+	+				
	Pantopoda		indet sp.I			+				
- Ophiuroidea:										
		Amphiuridae:	Amphiura stepanovi (Djakonov 1954)	+	+	+				
- Holothuroidea:										
		Cucumariidae:	Stereoderma kirschbergi (Heller 1868)							
		Synaptidae:	Oestergrenia digitata (Montagu 1830)			+				
			Leptosynapta inhaerens (O. Müller 1776)	+	+					
- Ascidiacea:			indet sp.I							
		Ascidiidae:	Ascidia aspersa (Müller 1776)							
		Cionidae	Ciona intestinalis (Linne 1767)							
		Molgulidae:	Ctenicella appendiculata (Heller 1877)							
			Eugyra adriatica (Drasche 1884)							
- Pisces:										
		Clupeidae:	Sprattus sprattus phalericus (Risso 1826)							
		Gadidae:	Merlangius merlangius euxinus (Nordmann 1840)							
		Gobiidae:	Mesogobius batrachocephalus batrachocephalus (Pallas 1811)							
			Gobius melanostomus (Pallas 1811)							

Table 6 (continued): List of all Taxa, includes all benthic size classes (stations without fauna not listed)

Taxa				Sevastopol-Transect I					
			Depth	55m	60m	110m	130m	150m	190m
			Gear	BC/MC	VVG	BC/MC	BC/MC	BC/MC	BC/MC
-Foraminifera:		Rotalia typus indet spp.		+			+	+	
	Allogromiidae:	indet spp.		+		+			
	Saccamminidae:	indet spp.		+		+			
- Porifera:		indet sp.I							
	Suberitidae:	Suberites carnosus (Johnston 1848)							
		Suberites prototipus (Swartschewsky 1905)							
	Sycettidae:	Sycon ciliatum (Risso 1826)							
- Hydrozoa:		indet spp.		+		+	+	+	
- Anthozoa:									
	Actiniidae:	Actinia equina (Linne 1766)							
	Cerianthidae:	Pachycerianthus solitarius (Rapp 1829)				+			
- Turbellaria:	Kalyptorhynchia:	indet sp. I							
- Nemertini:		indet spp.			+				
	Lineidae:	Micrura fasciolata (Ehrenberg 1831)		+					
- Nematoda:		indet spp.		+	+	+	+	+	+
	Oncholaimidae:	Metoncholaimus albidus (Bastian 1865)							
- Kinorhyncha:		indet spp.							
- Bivalvia:									
	Cardiidae:	Cardium sp.I							
		Plagiocardium simile (Milachevitch 1909)		+					
	Mytilidae:	Mytilus galloprovincialis (Lamarck 1819)							
		Modiolus phaseolinus (Philippi 1844)		+	+	+	+		+
	Scrobiculariidae:	Abra nitida milachewichi (Nevesskaja 1963)							
- Gastropoda:		indet spp.		+					+
	Hydrobiidae:	Hydrobia sp.I							
	Retusidae:	Retusa truncatella (Locard 1892)							
	Muricidae:	Trophonopsis breviata (Jeffreys 1882)							
- Polychaeta:		indet spp.		+	+	+			+
	Glyceridae:	indet sp. I							
	Ampharetidae:	Melinna palmata (Grube 1870)		+					
		Hypania invalida (Grube 1860)							
	Capitellidae:	Capitella capitata (Fabricius 1780)							
		Heteromastus filiformis (Claparède 1864)			+				
		Notomastus profundus (Eisig 1887)							
	Hesionidae:	Hesionides sp.							
	Nephtyidae:	Nephtys hombergii (Savigny 1818)		+	+				
	Nereidae:	Nereis diversicolor (O. F. Müller 1776)							
	Orbiniidae:	Orbinia sertulata (Savigny 1820)							
	Paraonidae:	Aricidea jeffreysii (McIntosh 1879)		+	+	+			
	Phyllodocidae:	Phyllodoce lineata (Claparède 1870)		+					
	Polynoinae:	Harmothoë imbricata (Linne 1767)							
	Protodrilidae:	Protodrilus sp.I		+	+	+			
	Sabellidae:	Chone sp.		+					
		Euchone rubrocincta (Sars 1861)		+		+			
	Spionidae:	Spio filicornis (Müller 1766)							
		Pygospio elegans (Claparède 1863)							
	Syllidae:	Exogone gemmifera (Pagenstecheri 1884)							

			Streptosyllis bidentata (Southern 1863)					
			Sphaerosyllis hystrix (Claparède 1863)					
		Trichobranchidae:	Terebellides stroemi (Sars 1835)	+	+	+		
- Oligochaeta:								
		Tubificidae:	indet spp. +(juv.)	+	+	+	+	+
- Phoronidea:			Phoronis euxinicola (M. Selys-Longchamps 1907)					
- Crustacea:								
	Harpacticoidea		indet spp.	+		+	+	
	Ostracoda		indet spp.	+		+	+	
	Cirripedia							
		Balanidae:	Balanus improvisus (Darwin 1854)					
	Amphipoda		indet spp.	+		+		
		Ampeliscidae:	Ampelisca diadema (A. Costa 1853)	+				
		Caprellidae:	Caprella sp.I					
			Caprella acanthifera (Leach 1814)	+				
		Corophiidae:	Corophium sp.					
		Oedicerotidae:	Synchelidium maculatum (Stebbing 1906)					
	Isopoda		indet sp.I					
		Idoteidae:	Synisoma capito (Rathke 1837)					
	Cumacea		indet sp.I	+				
		Pseudocumidae:	indet sp.I					
	Tanaidacea		indet sp.I					
		Apseudidae:	Apseudes ostroumovi (Bacescu et Carausu 1947)		+			
	Mysidacea:		indet sp. I	+				
	Decapoda							
		Crangonidae:	Crangon crangon (Linne 1758)					
		Hippolytidae:	Lysmata seticaudata (Risso 1816)					
- Arachnida:								
	Acari		indet spp	+				
	Pantopoda		indet sp.I					
- Ophiuroidea:								
		Amphiuridae:	Amphiura stepanovi (Djakonov 1954)	+	+			
- Holothuroidea:								
		Cucumariidae:	Stereoderma kirschbergi (Heller 1868)					
		Synaptidae:	Oestergrenia digitata (Montagu 1830)	+	+			
			Leptosynapta inhaerens (O. Müller 1776)					
- Ascidiacea:			indet sp.I					
		Ascidiidae:	Ascidia aspersa (Müller 1776)					
		Cionidae	Ciona intestinalis (Linne 1767)					
		Molgulidae:	Ctenicella appendiculata (Heller 1877)	+		+		
			Eugyra adriatica (Drasche 1884)					
- Pisces:								
		Clupeidae:	Sprattus sprattus phalericus (Risso 1826)					
		Gadidae:	Merlangius merlangius euxinus (Nordmann 1840)					
		Gobiidae:	Mesogobius batrachocephalus batrachocephalus (Pallas 1811)					
			Gobius melanostomus (Pallas 1811)					

Table 6 (continued): List of all Taxa, includes all benthic size classes (stations without fauna not listed)

Taxa				Sevastopol-Transect II								
			Depth Gear	63m B-/MC	63m BT	80m B-/MC	110m B-/MC	110 - 130m BT	130m B-/MC	150m B-/MC	190m B-/MC	250m B-/MC
-Foraminifera:		Rotalia typus indet spp.		+		+	+		+			
	Allogromiidae:	indet spp.		+	+	+	+		+	+		
	Saccamminidae:	indet spp.		+		+	+		+			
- Porifera:		indet sp.I										
	Suberitidae:	Suberites carnosus (Johnston 1848)			+			+	+			
		Suberites prototipus (Swartschewsky 1905)										
	Sycettidae:	Sycon ciliatum (Risso 1826)										
- Hydrozoa:		indet spp.		+		+	+		+	+		
- Anthozoa:												
	Actiniidae:	Actinia equina (Linne 1766)										
	Cerianthidae:	Pachycerianthus solitarius (Rapp 1829)			+	+		+	+			
- Turbellaria:	Kalyptorhynchia:	indet sp. I				+						
- Nemertini:		indet spp.			+							
	Lineidae:	Micrura fasciolata (Ehrenberg 1831)				+						
- Nematoda:		indet spp.		+	+	+	+		+	+	+	+
	Oncholaimidae:	Metoncholaimus albidus (Bastian 1865)										
- Kinorhyncha:		indet spp.										
- Bivalvia:												
	Cardiidae:	Cardium sp.I										
		Plagiocardium simile (Milachevitch 1909)				+						
	Mytilidae:	Mytilus galloprovincialis (Lamarck 1819)			+			+				
		Modiolus phaseolinus (Philippi 1844)		+	+	+	+	+	+	+		
	Scrobiculariidae:	Abra nitida milachewichi (Nevesskaja 1963)										
- Gastropoda:		indet spp.										
	Hydrobiidae:	Hydrobia sp.I										
	Retusidae:	Retusa truncatella (Locard 1892)			+							
	Muricidae:	Trophonopsis breviata (Jeffreys 1882)			+							
- Polychaeta:		indet spp.		+	+	+	+			+		
	Glyceridae:	indet sp. I										
	Ampharetidae:	Melinna palmata (Grube 1870)										
		Hypania invalida (Grube 1860)										
	Capitellidae:	Capitella capitata (Fabricius 1780)										
		Heteromastus filiformis (Claparède 1864)										
		Notomastus profundus (Eisig 1887)										
	Hesionidae:	Hesionides sp.								+		
	Nephtyidae:	Nephtys hombergii (Savigny1818)		+			+					
	Nereidae:	Nereis diversicolor (O. F. Müller 1776)										
	Orbiniidae:	Orbinia sertulata (Savigny 1820)										
	Paraonidae:	Aricidea jeffreysii (McIntosh 1879)		+			+					
	Phyllodocidae:	Phyllodoce lineata (Claparède 1870)										
	Polynoinae:	Harmothoë imbricata (Linne 1767)										
	Protodrilidae:	Protodrilus sp.I		+			+					
	Sabellidae:	Chone sp.		+			+			+		
		Euchone rubrocincta (Sars 1861)										
	Spionidae:	Spio filicornis (Müller 1766)										
		Pygospio elegans (Claparède 1863)										

		Syllidae:	Exogone gemmifera (Pagenstecheri 1884)							
			Streptosyllis bidentata (Southern 1863)							
			Sphaerosyllis hystrix (Claparède 1863)							
		Trichobranchidae:	Terebellides stroemi (Sars 1835)	+			+			
- Oligochaeta:										
		Tubificidae:	indet spp. +(juv.)	+	+		+		+	+
- Phoronidea:			Phoronis euxinicola (M. Selys-Longch. 1907)							
- Crustacea:										
	Harpacticoidea		indet spp.	+			+			
	Ostracoda		indet spp.	+			+			
	Cirripedia									
		Balanidae:	Balanus improvisus (Darwin 1854)							
	Amphipoda		indet spp.	+	+					
		Ampeliscidae:	Ampelisca diadema (A. Costa 1853)	+	+		+			
		Caprellidae:	Caprella sp.I				+			
			Caprella acanthifera (Leach 1814)	+	+					
		Corophiidae:	Corophium sp.	+			+			
		Oedicerotidae:	Synchelidium maculatum (Stebbing 1906)							
	Isopoda		indet sp.I							
		Idoteidae:	Synisoma capito (Rathke 1837)		+					
	Cumacea		indet sp.I	+	+		+			
		Pseudocumidae:	indet sp.I							
	Tanaidacea		indet sp.I							
		Apseudidae:	Apseudes ostroumovi (Baces. et Carau. 1947)		+					
	Mysidacea:		indet sp. I							
	Decapoda									
		Crangonidae:	Crangon crangon (Linne 1758)							
		Hippolytidae:	Lysmata seticaudata (Risso 1816)							
- Arachnida:										
	Acari		indet spp	+	+		+		+	
	Pantopoda		indet sp.I							
- Ophiuroidea:										
		Amphiuridae:	Amphiura stepanovi (Djakonov 1954)	+	+		+			
- Holothuroidea:										
		Cucumariidae:	Stereoderma kirschbergi (Heller 1868)		+					
		Synaptidae:	Oestergrenia digitata (Montagu 1830)							
			Leptosynapta inhaerens (O. Müller 1776)							
- Ascidiacea:			indet sp.I							
		Ascidiidae:	Ascidia aspersa (Müller 1776)							
		Cionidae	Ciona intestinalis (Linne 1767)							
		Molgulidae:	Ctenicella appendiculata (Heller 1877)		+			+		
			Eugyra adriatica (Drasche 1884)							
- Pisces:										
		Clupeidae:	Sprattus sprattus phalericus (Risso 1826)							
		Gadidae:	Merlangius merlangius euxinus (Nordm. 1840)							
		Gobiidae:	Mesogobius batrachocephalus batrachocephalus (Pallas 1811)							
			Gobius melanostomus (Pallas 1811)							

Table 6 (continued): List of all Taxa, includes all benthic size classes (stations without fauna not listed)

Taxa				Constanza-Transect								
			Depth	50m	80m	82m	110m	110 - 120m	130m	134m	150m	170m
			Gear	B-/MC	B-/MC	BT	B-/MC	BT	B-/MC	BT	B-/MC	B-/MC
-Foraminifera:		Rotalia typus indet spp.		+	+		+		+		+	
	Allogromiidae:	indet spp.		+	+		+		+			
	Saccamminidae:	indet spp.		+	+		+					
- Porifera:		indet sp.I										
	Suberitidae:	Suberites carnosus (Johnston 1848)				+						
		Suberites prototipus (Swartschewsky 1905)				+						
	Sycettidae:	Sycon ciliatum (Risso 1826)			+	+	+					
- Hydrozoa:		indet spp.		+	+	+	+		+		+	
- Anthozoa:												
	Actiniidae:	Actinia equina (Linne 1766)		+								
	Cerianthidae:	Pachycerianthus solitarius (Rapp 1829)			+	+	+	+				
- Turbellaria:	Kalyptorhynchia:	indet sp. I		+	+							
- Nemertini:		indet spp.										
	Lineidae:	Micrura fasciolata (Ehrenberg 1831)		+	+		+					
- Nematoda:		indet spp.		+	+		+		+		+	+
	Oncholaimidae:	Metoncholaimus albidus (Bastian 1865)										
- Kinorhyncha:		indet spp.		+	+							
- Bivalvia:												
	Cardiidae:	Cardium sp.I		+	+							
		Plagiocardium simile (Milachevitch 1909)		+								
	Mytilidae:	Mytilus galloprovincialis (Lamarck 1819)		+								
		Modiolus phaseolinus (Philippi 1844)		+	+	+	+	+	+		+	
	Scrobiculariidae:	Abra nitida milachewichi (Nevesskaja 1963)										
- Gastropoda:		indet spp.			+						+	
	Hydrobiidae:	Hydrobia sp.I		+								
	Retusidae:	Retusa truncatella (Locard 1892)		+								
	Muricidae:	Trophonopsis breviata (Jeffreys 1882)			+							
- Polychaeta:		indet spp.		+	+	+	+		+		+	
	Glyceridae:	indet sp. I										
	Ampharetidae:	Melinna palmata (Grube 1870)		+								
		Hypania invalida (Grube 1860)										
	Capitellidae:	Capitella capitata (Fabricius 1780)		+	+							
		Heteromastus filiformis (Claparède 1864)		+								
		Notomastus profundus (Eisig 1887)										
	Hesionidae:	Hesionides sp.		+					+			
	Nephtyidae:	Nephtys hombergii (Savigny1818)		+		+						
	Nereidae:	Nereis diversicolor (O. F. Müller 1776)										
	Orbiniidae:	Orbinia sertulata (Savigny 1820)										
	Paraonidae:	Aricidea jeffreysii (McIntosh 1879)		+	+							
	Phyllodocidae:	Phyllodoce lineata (Claparède 1870)		+	+							
	Polynoinae:	Harmothoë imbricata (Linne 1767)		+	+							
	Protodrilidae:	Protodrilus sp.I		+	+		+		+		+	
	Sabellidae:	Chone sp.		+								
		Euchone rubrocincta (Sars 1861)										
	Spionidae:	Spio filicornis (Müller 1766)										
		Pygospio elegans (Claparède 1863)		+								

		Syllidae:	Exogone gemmifera (Pagenstecheri 1884)								
			Streptosyllis bidentata (Southern 1863)								
			Sphaerosyllis hystrix (Claparède 1863)								
		Trichobranchidae:	Terebellides stroemi (Sars 1835)	+	+	+					
- Oligochaeta:											
		Tubificidae:	indet spp. +(juv.)	+	+		+		+		+
- Phoronidea:			Phoronis euxinicola (M. Selys-Longch. 1907)								
- Crustacea:											
	Harpacticoidea		indet spp.	+					+		+
	Ostracoda		indet spp.	+	+						
	Cirripedia										
		Balanidae:	Balanus improvisus (Darwin 1854)								
	Amphipoda		indet spp.	+	+	+					
		Ampeliscidae:	Ampelisca diadema (A. Costa 1853)	+	+						
		Caprellidae:	Caprella sp.I								
			Caprella acanthifera (Leach 1814)	+	+						
		Corophiidae:	Corophium sp.	+							
		Oedicerotidae:	Synchelidium maculatum (Stebbing 1906)								
	Isopoda		indet sp.I		+						
		Idoteidae:	Synisoma capito (Rathke 1837)								
	Cumacea		indet sp.I		+	+					
		Pseudocumidae:	indet sp.I								
	Tanaidacea		indet sp.I								
		Apseudidae:	Apseudes ostroumovi (Baces. et Carau. 1947)	+	+	+					
	Mysidacea:		indet sp. I	+							
	Decapoda										
		Crangonidae:	Crangon crangon (Linne 1758)								
		Hippolytidae:	Lysmata seticaudata (Risso 1816)								
- Arachnida:											
	Acari		indet spp	+	+		+				+
	Pantopoda		indet sp.I		+						
- Ophiuroidea:											
		Amphiuridae:	Amphiura stepanovi (Djakonov 1954)	+	+	+					
- Holothuroidea:											
		Cucumariidae:	Stereoderma kirschbergi (Heller 1868)								
		Synaptidae:	Oestergrenia digitata (Montagu 1830)	+	+						
			Leptosynapta inhaerens (O. Müller 1776)	+		+					
- Ascidiacea:			indet sp.I								
		Ascidiidae:	Ascidia aspersa (Müller 1776)								
		Cionidae	Ciona intestinalis (Linne 1767)								
		Molgulidae:	Ctenicella appendiculata (Heller 1877)				+				
			Eugyra adriatica (Drasche 1884)								
- Pisces:											
		Clupeidae:	Sprattus sprattus phalericus (Risso 1826)								
		Gadidae:	Merlangius merlangius euxinus (Nordm. 1840)								
		Gobiidae:	Mesogobius batrachocephalus batrachocephalus (Pallas 1811)								
			Gobius melanostomus (Pallas 1811)								

Table 6 (continued): List of all Taxa, includes all benthic size classes (stations without fauna not listed)

Taxa			Portiza Transect				
			Depth Gear	62m Elinor	77m Elinor	110m Elinor	130m Elinor
-Foraminifera:		Rotalia typus indet spp.					+
	Allogromiidae:	indet spp.			+	+	
	Saccamminidae:	indet spp.		+	+	+	
- Porifera:		indet sp.I		+			
	Suberitidae:	Suberites carnosus (Johnston 1848)					
		Suberites prototipus (Swartschewsky 1905)					
	Sycettidae:	Sycon ciliatum (Risso 1826)		+	+	+	+
- Hydrozoa:		indet spp.				+	+
- Anthozoa:							
	Actiniidae:	Actinia equina (Linne 1766)					
	Cerianthidae:	Pachycerianthus solitarius (Rapp 1829)			+	+	+
- Turbellaria:	Kalyptorhynchia:	indet sp. I			+		
- Nemertini:		indet spp.					
	Lineidae:	Micrura fasciolata (Ehrenberg 1831)		+	+		
- Nematoda:		indet spp.		+	+	+	+
	Oncholaimidae:	Metoncholaimus albidus (Bastian 1865)					
- Kinorhyncha:		indet spp.					
- Bivalvia:							
	Cardiidae:	Cardium sp.I					
		Plagiocardium simile (Milachevitch 1909)					
	Mytilidae:	Mytilus galloprovincialis (Lamarck 1819)		+			
		Modiolus phaseolinus (Philippi 1844)		+	+	+	
	Scrobiculariidae:	Abra nitida milachewichi (Nevesskaja 1963)					
- Gastropoda:		indet spp.					
	Hydrobiidae:	Hydrobia sp.I			+		
	Retusidae:	Retusa truncatella (Locard 1892)					
	Muricidae:	Trophonopsis breviata (Jeffreys 1882)			+		
- Polychaeta:		indet spp.		+	+	+	
	Glyceridae:	indet sp. I			+		
	Ampharetidae:	Melinna palmata (Grube 1870)					
		Hypania invalida (Grube 1860)					
	Capitellidae:	Capitella capitata (Fabricius 1780)					
		Heteromastus filiformis (Claparède 1864)					
		Notomastus profundus (Eisig 1887)			+		
	Hesionidae:	Hesionides sp.			+	+	
	Nephtyidae:	Nephtys hombergii (Savigny 1818)				+	
	Nereidae:	Nereis diversicolor (O. F. Müller 1776)					
	Orbiniidae:	Orbinia sertulata (Savigny 1820)					
	Paraonidae:	Aricidea jeffreysii (McIntosh 1879)			+	+	
	Phyllodocidae:	Phyllodoce lineata (Claparède 1870)		+	+		
	Polynoinae:	Harmothoë imbricata (Linne 1767)				+	
	Protodrilidae:	Protodrilus sp.I		+			
	Sabellidae:	Chone sp.			+		
		Euchone rubrocincta (Sars 1861)					
	Spionidae:	Spio filicornis (Müller 1766)					
		Pygospio elegans (Claparède 1863)			+		
	Syllidae:	Exogone gemmifera (Pagenstecheri 1884)					

			Streptosyllis bidentata (Southern 1863)				
			Sphaerosyllis hystrix (Claparède 1863)				
		Trichobranchidae:	Terebellides stroemi (Sars 1835)	+	+	+	
- Oligochaeta:							
		Tubificidae:	indet spp. +(juv.)	+	+	+	+
- Phoronidea:			Phoronis euxinicola (M. Selys-Longchamps 1907)				
- Crustacea:							
	Harpacticoidea		indet spp.			+	
	Ostracoda		indet spp.				
	Cirripedia						
		Balanidae:	Balanus improvisus (Darwin 1854)				
	Amphipoda		indet spp.	+	+		
		Ampeliscidae:	Ampelisca diadema (A. Costa 1853)	+	+		
		Caprellidae:	Caprella sp.I		+		
			Caprella acanthifera (Leach 1814)	+	+		
		Corophiidae:	Corophium sp.				
		Oedicerotidae:	Synchelidium maculatum (Stebbing 1906)				
	Isopoda		indet sp.I				
		Idoteidae:	Synisoma capito (Rathke 1837)	+	+		
	Cumacea		indet sp.I		+		
		Pseudocumidae:	indet sp.I				
	Tanaidacea		indet sp.I				
		Apseudidae:	Apseudes ostroumovi (Bacescu et Carausu 1947)	+	+	+	
	Mysidacea:		indet sp. I				
	Decapoda						
		Crangonidae:	Crangon crangon (Linne 1758)				
		Hippolytidae:	Lysmata seticaudata (Risso 1816)				
- Arachnida:							
	Acari		indet spp	+	+		
	Pantopoda		indet sp.I	+	+		
- Ophiuroidea:							
		Amphiuridae:	Amphiura stepanovi (Djakonov 1954)		+		
- Holothuroidea:							
		Cucumariidae:	Stereoderma kirschbergi (Heller 1868)				
		Synaptidae:	Oestergrenia digitata (Montagu 1830)	+	+		
			Leptosynapta inhaerens (O. Müller 1776)		+		
- Ascidiacea:			indet sp.I				
		Ascidiidae:	Ascidia aspersa (Müller 1776)				
		Cionidae	Ciona intestinalis (Linne 1767)				
		Molgulidae:	Ctenicella appendiculata (Heller 1877)		+	+	
			Eugyra adriatica (Drasche 1884)				
- Pisces:							
		Clupeidae:	Sprattus sprattus phalericus (Risso 1826)				
		Gadidae:	Merlangius merlangius euxinus (Nordmann 1840)				
		Gobiidae:	Mesogobius batrachocephalus batrachocephalus (Pallas 1811)				
			Gobius melanostomus (Pallas 1811)				

Table 7 a-f: Composition of macrofauna (>500µm). Individuals per 0.1m², 0-5cm sediment depth

Table 7a: RV. "K. PIRI REIS", September 1991
macrofauna (>500µm) of the Inebolu transect
(Ind. x 10 / m²), 0-5 cm sediment depth

station	PR1/1	PR1/2	PR1/5	PR1/3b	PR1/4
date	23.09.91	25.09.91	25.09.91	24.09.91	24.09.91
depth	50m	110m	130m	150m	190m
gear	BC	BC	BC	BC	BC
size class	macro	macro	macro	macro	macro
Taxa---------					
Foraminifera	++	++	+++	+++	-
Porifera	-	10	2	-	-
Hydrozoa	++++	++++	+++	++++	-
Anthozoa	8	37	5	-	-
Turbellaria	-	-	18	-	-
Nemertini	2	1	-	-	-
Nematoda	43	69	93	771	1
Bivalvia	67	36	2	-	-
Gastropoda	3	-	-	-	-
Polychaeta	1094	23	43	-	-
Oligochaeta	241	5	17	142	-
Harpacticoidea	-	-	-	-	-
Nauplii/Larvae	-	-	1	-	-
Ostracoda	3	2	-	-	-
Cirripedia	18	-	-	-	-
Amphipoda	45	35	1	-	-
Isopoda	2	-	-	-	-
Cumacea	5	-	-	-	-
Tanaidacea	1	-	-	-	-
Pantopoda	-	5	-	-	-
Acari	-	-	-	-	-
Ophiuroidea	195	5	-	-	-
Holothuroidea	1	6	-	-	-
Ascidia	32	84	1	-	-
total no. of Ind.	1760	318	183	913	1
size class distribution					
>2mm	95	95	12	-	-
1-2mm	274	62	11	75	-
0,5-1mm	1391	161	160	838	1
depth destribution					
0-2cm	926	204	129	186	-
2-5cm	834	114	54	727	1
taxonomic composition:					
no. of higher taxa (crustacea = 1)	13	14	11	4	1
main groups (no.of ind.):					
Annelida	1335	28	60	142	-
Crustacea	74	37	1	-	-
Echinodermata	196	11	-	-	-
Bivalvia	67	36	2	-	-

bivalve composition:
Plagiocardium simile + Modiolus phaseolinus

>2mm	18	19	-
1-2mm	5	12	2
0,5-1mm	44	5	-
	P=18	M	M
	P=4, M=1		
	P=21, M=23		
%			
>2mm	27	53	-
1-2mm	7	33	100

Table 7b: RV. "PROF. VODYANITSKIY", October 1992
macrofauna (>500µm) of the St. Georghe transect (Ind. x 10 / m²)
0-5 cm sediment depth, (VVG, 0-10cm)

station	PV1/G2	PV1/1	PV1/G1	PV1/2	PV1/4	PV1/5	PV1/3	PV1/6
date	09.10.92	11.10.92	06.10.92	12.10.92	15.10.92	15.10.92	15.10.92	12.10.92
depth	50m	60m	75m	130m	150m	180m	190m	250m
gear	VVG	BC	VVG	BC	BC	BC	BC	BC
size class	macro	macro	macro	macro	macro	macro	macro	macro
Taxa---------								
Foraminifera	-	++	++	++	++++	++	+++++	-
Porifera	-	-	1	-	-	-	-	-
Hydrozoa	+++	++++	-	++++	-	-	+	-
Anthozoa	1	11	1	-	-	-	-	-
Turbellaria	-	-	-	-	-	-	-	-
Nemertini	1	2	-	-	-	-	-	-
Nematoda	5	107	15	113	2	-	1	-
Bivalvia	11	2	99	-	-	-	-	-
Gastropoda	-	1	-	-	-	-	-	-
Polychaeta	127	34	42	4	1	-	-	-
Oligochaeta	10	35	12	22	-	-	-	-
Harpacticoidea	-	-	-	-	-	-	-	-
Nauplii/Larvae	-	-	-	-	-	-	-	-
Ostracoda	-	1	-	-	-	-	-	-
Cirripedia	-	-	-	-	-	-	-	-
Amphipoda	-	2	18	-	-	-	-	-
Isopoda	-	-	2	-	-	-	-	-
Cumacea	3	2	6	-	-	-	-	-
Tanaidacea	9	-	17	-	-	-	-	-
Pantopoda	-	-	3	-	-	-	-	-
Acari	-	1	7	-	-	-	-	-
Ophiuroidea	11	-	4	-	-	-	-	-
Holothuroidea	2	1	1	-	-	-	-	-
Ascidia	-	-	-	-	-	-	-	-
total no. of ind.	180	199	228	139	3	-	1	-
size class distribution								
>2mm	13	9	96	1	1	-	-	-
1-2mm	29	16	33	2	-	-	-	-
0,5-1mm	138	174	99	136	2	-	1	-
depth destribution								
0-2cm	180	139	228	115	3	-	1	-
2-5cm	0-10cm	60	0-10cm	24	-	-	-	0-10cm
taxonomic composition:								
no. of higher taxa (crustacea = 1)	10	12	12	5	3	1	3	-
main groups (no.of ind.):								
Annelida	137	69	54	26	1	-	-	-

Crustacea	12	5	43	-	-	-	-	-
Echinodermata	13	1	5	-	-	-	-	-
Bivalvia	11	2	99	-	-	-	-	-

bivalve composition:

Mytilus galloprovincialis, Cardium sp.,+ Modiolus phaseolinus

>2mm	-	1	70
1-2mm	-	-	7
0,5-1mm	11	1	22
	My=2 / Mo=9	C	Mo

%

>2mm	-	50	71
1-2mm	-	-	7
0,5-1mm	100	50	22

Table 7c: RV. "PROF. VODYANITSKIY", October 1993
macrofauna (>500µm) of the Sevastopol I transect
(Ind. x 10 / m²), 0-5 cm sediment depth, (VVG, 0-10cm)

station	PV2/1	PV2/G1	PV2/3	PV2/4	PV2/5	PV2/2
date	04.10.93	04.10.93	07.10.93	08.10.93	09.10.93	05.10.93
depth	55m	60m	110m	130m	150m	200m
gear	BC	VVG	BC	BC	BC	BC
size class	macro	macro	macro	macro	macro	macro
Taxa---------						
Foraminifera	++++	-	++++	++++	+++	-
Porifera	-	-	2	-	-	-
Hydrozoa	++	-	++++	-	-	+
Anthozoa	-	-	18	-	-	-
Turbellaria	-	-	-	-	-	-
Nemertini	2	6	-	-	-	-
Nematoda	65	16	2	9	10	-
Bivalvia	119	33	7	5	-	-
Gastropoda	1	-	-	-	-	-
Polychaeta	198	24	39	-	-	-
Oligochaeta	48	3	13	13	12	-
Harpacticoidea	1	-	-	-	-	-
Nauplii/Larvae	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	-
Cirripedia	-	-	-	-	-	-
Amphipoda	34	-	-	-	-	-
Isopoda	-	-	-	-	1	-
Cumacea	6	-	-	-	-	-
Tanaidacea	-	39	-	-	-	-
Pantopoda	-	-	-	-	-	-
Acari	3	-	-	-	-	-
Ophiuroidea	8	8	-	-	-	-
Holothuroidea	4	1	-	-	-	-
Ascidia	15	-	23	-	-	-
total no. of ind.	504	130	104	27	23	-
size class distribution						
>2mm	141	37	41	-	-	-
1-2mm	39	58	7	-	-	-
0,5-1mm	324	35	56	27	23	-
depth destribution						
0-2cm	437	130	92	19	22	-
2-5cm	67	0-10cm	12	8	1	-
taxonomic composition:						
no. of higher taxa (crustacea = 1)	13	8	9	4	4	1
main groups (no.of ind.):						
Annelida	246	27	52	13	12	-
Crustacea	40	39	-	-	1	-
Echinodermata	12	9	-	-	-	-
Bivalvia	119	33	7	5	-	-
bivalve composition:						
Plagiocardium simile + Modiolus phaseolinus						
>2mm	95	11	6	-		
1-2mm	8	22	1	-		
0,5-1mm	16	-	-	5		
	P=?	M	M	M		
	P=?, M=?					
	P=?, M=?					
%						
>2mm	80	33	86	-		
1-2mm	7	66	14	-		
0,5-1mm	13	-	-	100		

Table 7d: RV. "PROF. VODYANITSKIY", October 1993 / June 1994
macrofauna (>500µm) of the Sevastopol II transect (Ind. x 10 / m²)
0-5 cm sediment depth

station	PV2/9	PV3/1	PV2/11	PV3/4	PV3/2	PV2/14	PV3/5
date	13.10.93	17.06.94	14.10.93	21.06.94	19.06.94	16.10.93	23.06.94
depth	63m	80m	109m	130m	150m	188m	250m
gear	BC	BC	BC	BC	BC	BC	BC
size class	macro	macro	macro	macro	macro	macro	macro
Taxa---------							
Foraminifera	-	+++	++++	+++	+	-	-
Porifera	-	-	4	3	-	-	-
Hydrozoa	+++	+++	++++	++	+++	-	-
Anthozoa	-	1	9	5	-	-	-
Turbellaria	-	-	1	-	-	-	-
Nemertini	-	4	-	-	-	-	-
Nematoda	9	65	31	362	32	2	-
Bivalvia	3	98	252	4	4	-	-
Gastropoda	-	-	-	-	-	-	-
Polychaeta	138	112	74	-	2	-	-
Oligochaeta	79	98	15	5	8	-	-
Harpacticoidea	-	-	-	-	-	-	-
Nauplii/Larvae	-	-	-	-	-	-	-
Ostracoda	8	6	-	-	-	-	-
Cirripedia	-	-	-	-	-	-	-
Amphipoda	21	20	3	-	-	1	-
Isopoda	-	-	-	-	-	-	-
Cumacea	12	6	-	-	-	-	-
Tanaidacea	-	3	-	-	-	-	-
Pantopoda	-	-	-	-	-	-	-
Acari	-	7	-	2	-	-	-
Ophiuroidea	7	2	-	-	-	-	-
Holothuroidea	-	1	1	-	-	-	-
Ascidia	-	2	73	-	-	-	-
total no. of ind.	277	425	463	381	46	3	-
size class distribution							
>2mm	18	98	295	8	1	-	-
1-2mm	14	94	62	2	-	-	-
0,5-1mm	245	233	106	371	45	3	-
depth destribution							
0-2cm	239	371	452	290	44	3	-
2-5cm	38	54	11	91	2	-	-
taxonomic composition:							
no. of higher taxa (crustacea = 1)	7	13	12	8	6	2	-
main groups (no.of ind.):							
Annelida	217	210	89	5	10	-	-
Crustacea	41	35	3	-	-	1	-
Echinodermata	7	3	1	-	-	-	-
Bivalvia	3	98	252	4	4	-	-
bivalve composition:							
Modiolus phaseolinus							
>2mm	-	53	228	-	-		
1-2mm	-	23	6	1	-		
0,5-1mm	3	22	18	3	4		

%					
>2mm	-	54	91	-	-
1-2mm	-	24	2	25	-
0,5-1mm	100	22	7	75	100

Table 7e: RV. "POSEIDON", April / May 1994
macrofauna (>500µm) of the Constanza transect
(Ind. x 10 / m²), 0-2 cm sediment depth

station	Pos/8	Pos/13	Pos/12	Pos/9	Pos/1	Pos/3
date	26.04.94	02.05.94	30.04.94	27.04.94	20.04.94	23.04.94
depth	50m	80m	110m	131m	147m	170m
gear	BC	BC	BC	BC	BC	BC
size class	macro	macro	macro	macro	macro	macro
Taxa---------						
Foraminifera	++++	++++	++++	++	++	-
Porifera	-	173	23	-	-	-
Hydrozoa	++++	++	++++	++++	+++	-
Anthozoa	9	4	1	-	-	-
Turbellaria	1	5	-	-	-	-
Nemertini	11	15	4	-	-	-
Nematoda	953	273	51	10	4	5
Bivalvia	79	2468	58	1	-	-
Gastropoda	25	2	-	-	-	-
Polychaeta	1080	72	9	1	-	-
Oligochaeta	32	44	4	2	2	-
Harpacticoidea	31	-	-	-	-	-
Nauplii/Larvae	1	-	-	-	-	-
Ostracoda	14	1	-	-	-	-
Cirripedia	-	-	-	-	-	-
Amphipoda	311	55	-	-	-	-
Isopoda	-	2	-	-	-	-
Cumacea	178	15	-	-	-	-
Tanaidacea	402	157	-	-	-	-
Pantopoda	-	2	-	-	-	-
Acari	24	23	-	-	-	-
Ophiuroidea	57	107	-	-	-	-
Holothuroidea	5	9	-	-	-	-
Ascidia	-	1	11	-	-	-
total no. of ind.	3213	3428	161	14	6	5
size class distribution						
>2mm	230	1834	58	-	-	-
1-2mm	545	427	23	-	-	-
0,5-1mm	2438	1167	80	14	6	5
depth destribution						
0-2cm	3213	3428	161	14	6	5
2-5cm	not pr.	not pr.	not pr.	not pr.	not pr.	not pr.
taxonomic composition:						
no. of higher taxa (crustacea = 1)	14	17	10	6	4	1
main groups (no.of ind.):						
Annelida	1112	116	13	3	2	-
Crustacea	937	230	-	-	-	-
Echinodermata	62	116	-	-	-	-
Bivalvia	79	2468	58	1	-	-

bivalve composition:

Modiolus phaseolinus						
>2mm	65	1549	31	-	-	-
>1mm	2	356	15	-	-	-
>500µm	12	563	12	1	-	-
%						
>2mm	82	63	53	-		
>1mm	3	14	26	-		
>500µm	15	23	21	100		

Table 7f: RV. "PJETR KOTTSOV", September 1997
macrofauna (>500µm) of the Portiza transect
(Ind. x 10 / m²), 0-5 cm sediment depth

station	PK/1	PK/2	PK/3	PK/4	PK/5
date	11.09.97	08.09.97	07.09.97	15.09.97	14.09.97
depth	62m	77m	100m	130m	181m
gear	Elinor	Elinor	Elinor	Elinor	Elinor
size class	macro	macro	macro	macro	macro
Taxa---------					
Foraminifera	+	++++	++++	+	-
Porifera	28	20	17	2	-
Hydrozoa	-	-	+++	++++	-
Anthozoa	-	1	5	1	-
Turbellaria	-	2	-	-	-
Nemertini	28	3	-	-	-
Nematoda	16	33	5	45	-
Bivalvia	673	3021	173	-	-
Gastropoda	-	10	-	-	-
Polychaeta	37	115	31	-	-
Oligochaeta	3	12	1	8	-
Harpacticoidea	-	-	1	-	-
Nauplii/Larvae	-	-	-	-	-
Ostracoda	-	-	-	-	-
Cirripedia	-	-	-	-	-
Amphipoda	484	65	-	-	-
Isopoda	13	8	-	-	-
Cumacea	-	22	-	-	-
Tanaidacea	356	62	16	-	-
Pantopoda	3	2	-	-	-
Acari	6	15	-	-	-
Ophiuroidea	-	79	-	-	-
Holothuroidea	19	8	-	-	-
Ascidia	-	9	239	-	-
total no. of ind.	1666	3490	488	57	-
size class distribution					
>2mm	787	1875	202	1	-
1-2mm	245	740	63	1	-
0,5-1mm	634	873	188	55	-
depth destribution					
0-2cm	1190	3127	420	45	-
2-5cm	476	353	28	12	n.v.
taxonomic composition:					
no. of higher taxa (crustacea = 1)	11	16	9	6	-
main groups (no.of ind.):					

Annelida	41	127	33	8	-
Crustacea	852	157	17	-	-
Echinodermata	19	87	-	-	-
Bivalvia	673	3021	173	-	-

bivalve composition:
Mytilus galloprovincialis + *Modiolus phaseolinus*

>2mm	656	1766	163	-	-
>1mm	9	675	8	-	-
>500µm	7	580	1	-	-
	My = 52 * Mo = 604	Mo	Mo	*(size 1 to 4cm)	
%					
>2mm	98	58	95		
>1mm	1	22	5		
>500µm	1	19	1		

Table 8 a-d: Composition of temporary and larger meiofauna (500>250µm). Individuals per 0.1m², 0-5cm sediment depth.

Table 8a: RV. "PROF. VODYANITSKIY", October 1992
temporary and larger meiofauna (>250µm) of the
St. Georghe transect, (Ind. x 10 / m²), 0-5 cm sediment depth

station	PV1/1	PV1/2	PV1/4	PV1/5	PV1/3	PV1/6
date	11.10.92	12.10.92	15.10.92	15.10.92	15.10.92	12.10.92
depth	60m	130m	150m	180m	190m	250m
gear	BC	BC	BC	BC	BC	BC
size class	t+l meio	t+l meio	t+l meio	t+l meio	t+l meio	t+l meio
Taxa---------						
Foraminifera	+++++	+++	+++	-	-	++
Porifera	-	-	-	-	-	-
Hydrozoa	++++	++++	-	-	-	-
Anthozoa	-	2	-	-	-	-
Turbellaria	58	-	-	-	-	-
Nemertini	-	-	-	-	-	-
Nematoda	1464	4222	16	1	2	2
Kinorhyncha	2	-	-	-	-	-
Bivalvia	-	-	4	-	-	-
Gastropoda	1	-	-	-	-	-
Polychaeta	148	199	-	-	-	-
Oligochaeta	18	69	-	-	-	-
Harpacticoidea	46	14	-	-	-	-
Nauplii/Larvae	-	1	4	-	-	-
Ostracoda	69	1	-	-	-	-
Cirripedia	-	1	-	-	-	-
Amphipoda	-	-	-	-	-	-
Isopoda	7	-	-	-	-	-
Cumacea	-	-	-	-	-	-
Tanaidacea	-	-	-	-	-	-
Pantopoda	-	-	-	-	-	-
	2	-	-	-	-	-
Ophiuroidea	-	-	-	-	-	-
Holothuroidea	-	-	-	-	-	-
Ascidia	-	-	-	-	-	-
total no. of Ind.	1815	4509	24	1	2	2
depth distribution						
0-2cm	1445	4498	24	1	2	2
2-5cm	370	11	-	-	-	0-10cm
taxonomic composition:						
no. of higher taxa (crustacea = 1)	10	7	4	1	1	2
main groups (no.of ind.):						
Annelida	166	268	-	-	-	-
Crustacea	122	17	4	-	-	-
Echinodermata	-	-	-	-	-	-
Bivalvia	-	-	4	-	-	-

Table 8b: RV. "PROF. VODYANITSKIY", October 1993
temporary and larger meiofauna (>250µm) of the
Sevastopol I transect, (Ind. x 10 / m²), 0-5 cm

station	PV2/1	PV2/3	PV2/4	PV2/5	PV2/2
date	04.10.93	07.10.93	08.10.93	09.10.93	05.10.93
depth	55m	110m	130m	150m	200m
gear	BC	BC	BC	BC	BC
size class	t+l meio	t+l meio	t+l meio	t+l meio	t+l meio
Taxa---------					
Foraminifera	++	++++	+++	++++	-
Porifera	-	-	-	-	-
Hydrozoa	++	++++	-	-	+
Anthozoa	-	-	-	-	-
Turbellaria	-	-	-	-	-
Nemertini	1	-	-	-	-
Nematoda	428	650	120	625	2
Kinorhyncha	-	-	-	-	-
Bivalvia	5	17	-	-	-
Gastropoda	-	-	-	-	-
Polychaeta	274	47	-	-	-
Oligochaeta	18	31	48	61	-
Harpacticoidea	-	-	-	-	-
Nauplii/Larvae	-	-	-	-	-
Ostracoda	16	-	-	-	-
Cirripedia	9	11	1	-	-
Amphipoda	-	-	-	-	-
Isopoda	1	-	-	-	-
Cumacea	-	-	-	-	-
Tanaidacea	-	-	-	-	-
Pantopoda	-	-	-	-	-
Acari	-	-	-	-	-
Ophiuroidea	-	-	-	-	-
Holothuroidea	-	-	-	-	-
Ascidia	3	-	-	-	-
total no. of Ind.	755	756	169	686	2
depth destribution					
0-2cm	591	741	131	559	2
2-5cm	164	15	38	127	-
taxonomic composition:					
no. of higher taxa (crustacea = 1)	9	7	4	3	2
main groups (no.of ind.):					
Annelida	274	47	-	-	-
Crustacea	26	11	1	-	-
Echinodermata	-	-	-	-	-
Bivalvia	5	17	-	-	-

Table 8c: RV. "PROF. VODYANITSKIY", October 1993 / June 1994
temporary and larger meiofauna (>250µm) of the
Sevastopol II transect, (Ind. x 10 / m²), 0-5 cm sed. depth

station	PV2/9	PV3/1	PV2/11	PV3/4	PV3/2	PV2/14
date	13.10.93	17.06.94	14.10.93	21.06.94	19.06.94	16.10.93
depth	63m	80m	109m	130m	150m	188m
gear	BC	BC	BC	BC	BC	BC
size class	t+l meio	t+l meio	t+l meio	t+l meio	t+l meio	t+l meio
Taxa---------						
Foraminifera	+++	+++	+++++	++	-	-
Porifera	-	-	-	-	-	-
Hydrozoa	+++	+++	+++	+++	+++	-
Anthozoa	-	-	-	-	-	-
Turbellaria	-	-	-	-	-	-
Nemertini	-	-	-	-	-	-
Nematoda	604	804	922	1691	354	7
Kinorhyncha	-	-	-	-	-	-
Bivalvia	-	95	-	25	-	-
Gastropoda	-	-	-	-	-	-
Polychaeta	96	104	73	-	1	-
Oligochaeta	58	97	130	9	19	-
Harpacticoidea	13	11	26	-	-	-
Nauplii/Larvae	-	-	1	-	-	-
Ostracoda	34	58	2	-	-	-
Cirripedia	10	8	-	-	-	-
Amphipoda	-	-	-	-	-	-
Isopoda	3	1	-	-	-	-
Cumacea	-	3	-	-	-	-
Tanaidacea	-	-	-	-	-	-
Pantopoda	5	14	-	-	-	-
Acari	-	-	-	-	-	-
Ophiuroidea	-	-	-	-	-	-
Holothuroidea	-	-	-	-	-	-
Ascidia	-	-	-	-	-	-
total no. of Ind.	823	1195	1154	1725	374	7
depth destribution						
0-2cm	744	1088	1136	1352	369	7
2-5cm	79	107	18	373	5	-
taxonomic composition:						
no. of higher taxa (crustacea = 1)	7	8	6	5	4	1
main groups (no.of ind.):						
Annelida	154	201	203	9	20	-
Crustacea	60	81	29	-	-	-
Echinodermata	-	-	-	-	-	-
Bivalvia	-	95	-	25	-	-

Table 8c: RV. "POSEIDON", April / May 1994
temporary and larger meiofauna (>250µm) of the
Constanza transect, (Ind. x 10 / m²), 0-2 cm sed. depth

station	Pos/8	Pos/13	Pos/12	Pos/9	Pos/1	Pos/3
date	26.04.94	02.05.94	30.04.94	27.04.94	20.04.94	23.04.94
depth	50m	80m	110m	131m	147m	170m
gear	BC	BC	BC	BC	BC	BC
size class	t+l meio	t+l meio	t+l meio	t+l meio	t+l meio	t+l meio
Taxa---------						
Foraminifera	++++	++++	+++++	++++	+	+
Porifera	-	1	-	-	-	-
Hydrozoa	++	++	++	+++++	+++++	-
Anthozoa	6	-	-	-	-	-
Turbellaria	66	60	-	-	-	-
Nemertini	-	2	-	-	-	-
Nematoda	3942	691	453	500	283	15
Kinorhyncha	-	-	-	-	-	-
Bivalvia	172	595	54	66	41	56
Gastropoda	-	3	-	-	12	-
Polychaeta	1120	162	41	65	158	-
Oligochaeta	22	25	55	28	23	-
Harpacticoidea	417	-	-	101	15	2
Nauplii/Larvae	48	7	-	-	-	-
Ostracoda	471	12	-	-	-	-
Cirripedia	29	3	-	-	-	-
Amphipoda	-	-	-	-	-	-
Isopoda	42	16	-	-	-	-
Cumacea	149	43	-	-	-	-
Tanaidacea	-	-	-	-	-	-
Pantopoda	19	49	4	-	2	-
Acari	-	-	-	-	-	-
Ophiuroidea	-	12	-	-	-	-
Holothuroidea	10	-	-	-	-	-
Ascidia	-	-	3	-	-	-
total no. of Ind.	6513	1681	610	760	534	73
depth distribution						
0-2cm	6513	1681	610	760	534	73
2-5cm	not pr.	not pr.	not pr.	not pr.	not pr.	not pr.
taxonomic composition:						
no. of higher taxa (crustacea = 1)	11	13	8	7	9	4
main groups (no.of ind.):						
Annelida	1142	187	96	93	181	-
Crustacea	1156	81	-	101	15	2
Echinodermata	10	12	-	-	-	-
Bivalvia	172	595	54	66	41	56

Table 9 a-f: Composition of meiofauna (>32µm). Individuals per 10cm², 0-3cm sediment depth

Table 9a: RV. "K. PIRI REIS", October 1991
meiofauna (>32µm) of the Inebolu transect
(Ind. / 10cm²), 0-3cm sediment depth
(3 parallels)

station	PR1/1	PR1/2	PR1/5	PR1/3b	PR1/4
date	23.09.91	25.09.91	25.09.91	24.09.91	24.09.91
depth	50m	110m	130m	150m	190m
gear	KG	KG	KG	KG	KG
size class	meio	meio	meio	meio	meio
area	3,46cm²	3,46cm²	3,46cm²	3,46cm²	3,46cm²
Taxa ---------					
Foraminifera	+++	++	++	++	+
Hydrozoa	++	++++	-	+	+
Turbellaria	-	15	1	2	-
Nemertini	-	-	-	-	-
Gastrotricha	-	-	-	-	-
Nematoda	661	409	1002	1138	15
Kinorhyncha	19	13	1	7	-
Bivalvia	-	4	-	-	-
Gastropoda	1	-	-	-	-
Polychaeta	60	4	2	2	-
Oligochaeta	16	1	-	5	-
Harpacticoidea	105	82	2	2	-
Nauplii/Larvae	53	2	-	-	-
Ostracoda	14	18	1	5	-
Amphipoda	3	2	-	-	-
Isopoda	-	-	-	-	-
Cumacea	-	-	-	-	-
Tanaidacea	-	-	-	-	-
Acari	-	2	-	-	-
Ophiuroidea	6	-	-	-	-
Bryozoa	-	-	-	-	-
total no. of Ind.	938	553	1009	1160	15
stand. deviation	385	193	397	73	15
taxonomic composition:					
no. of higher taxa (crustacea = 1)	9	10	6	8	3

Table 9b: RV. "PROF. VODYANITSKIY", October 1992
meiofauna (>32µm) of the St. Georghe transect
(Ind. / 10cm²), 0-3cm sediment depth
(3 parallels)

station	PV1/1	PV1/2	PV 1/4	PV 1/3	PV 1/6
date	11.10.92	12.10.92	16.10.92	15.10.92	17.10.92
depth	60m	130m	150m	190m	250m
gear	MC	MC	MC	MC	MC
size class	meio	meio	meio	meio	meio
area	3,46cm²	3,46cm²	3,46cm²	3,46cm²	3,46cm²
Taxa ---------					
Foraminifera	-	++	+++	-	-
Hydrozoa	+++	+++	++++	++	-
Turbellaria	-	15	-	-	-
Nemertini	-	-	-	-	-
Gastrotricha	-	-	-	-	-
Nematoda	968	1050	207	7	1
Kinorhyncha	-	-	-	-	-
Bivalvia	-	-	-	-	-
Gastropoda	-	-	-	-	-
Polychaeta	37	13	-	-	-
Oligochaeta	1	-	-	-	-
Harpacticoidea	2	-	-	1	-
Nauplii/Larvae	-	-	-	-	-
Ostracoda	3	-	-	-	-
Amphipoda	-	-	-	-	-
Isopoda	-	-	-	-	-
Cumacea	1	-	-	-	-
Tanaidacea	-	-	-	-	-
Acari	1	-	-	-	-
Ophiuroidea	-	-	-	-	-
Bryozoa	-	-	-	-	-
total no. of Ind.	1012	1079	207	8	1
stand. deviation	634	382	120	2	1
taxonomic composition:					
no. of higher taxa (crustacea = 1)	6	5	3	3	1

Table 9c RV. "PROF. VODYANITSKIY", October 1993
meiofauna (>32µm) of the Sevastopol I transect
(Ind. x . / 10cm²), 0-3cm sediment depth
(3 parallels)

station	PV2/1	PV 2/3	PV2/4	PV 2/5	PV2/2
date	05.10.93	07.10.93	08.10.93	09.10.93	06.10.93
depth	60m	110m	130m	150m	190m
gear	MC	MC	MC	MC	MC
size class	meio	meio	meio	meio	meio
area	3,46cm²	3,46cm²	3,46cm²	3,46cm²	3,46cm²
Taxa ---------					
Foraminifera	+++	+	++++	+	-
Hydrozoa	+	++	+	+++	-
Turbellaria	-	-	-	-	-
Nemertini	-	-	-	-	-
Gastrotricha	-	-	-	-	-
Nematoda	276	176	177	31	7
Kinorhyncha	-	-	-	-	-
Bivalvia	11	6	-	-	4
Gastropoda	-	-	-	-	2
Polychaeta	20	3	-	-	1
Oligochaeta	1	1	-	-	-
Harpacticoidea	81	13	1	-	-
Nauplii/Larvae	30	1	-	-	-
Ostracoda	9	1	6	-	-
Amphipoda	-	-	-	-	-
Isopoda	-	-	-	-	-
Cumacea	-	-	-	-	-
Tanaidacea	-	-	-	-	-
Acari	3	-	-	-	-
Ophiuroidea	-	-	-	-	-
Bryozoa	-	-	-	-	-
total no. of Ind.	431	200	184	31	13
stand. deviation	268	166	36	13	3
taxonomic composition:					
no. of higher taxa (crustacea = 1)	8	7	4	3	4

Table 9d: RV. "PROF. VODYANITSKIY", Oct. 1993/June1994
meiofauna (>32µm) of the Sevastopol II transect
(Ind. x . / 10cm²), 0-3cm sediment depth
(3 parallels)

station	PV 2/9	PV 2/11	PV 3/4	PV 3/2	PV 2/14b
date	13.10.93	14.10.93	21.06.94	19.06.94	16.10.93
depth	60m	110m	130m	150m	190m
gear	MC	MC	MC	MC	MC
size class	meio	meio	meio	meio	meio
area	3,46cm²	3,46cm²	3,46cm²	3,46cm²	3,46cm²
Taxa ---------					
Foraminifera	+++	+++	-	-	+
Hydrozoa	+	+	+++	++	-
Turbellaria	-	-	-	-	-
Nemertini	-	-	-	-	-
Gastrotricha	-	-	-	-	-
Nematoda	306	223	1086	424	65
Kinorhyncha	-	-	-	-	-
Bivalvia	5	16	1	-	10
Gastropoda	-	-	-	-	-
Polychaeta	11	9	12	1	-
Oligochaeta	1	1	1	-	-
Harpacticoidea	30	46	2	-	1
Nauplii/Larvae	3	6	-	-	1
Ostracoda	6	3	1	-	-
Amphipoda	-	-	-	-	-
Isopoda	-	-	-	-	-
Cumacea	-	-	-	-	-
Tanaidacea	-	-	-	-	-
Acari	3	3	-	-	-
Ophiuroidea	1	-	-	-	-
Bryozoa	-	-	-	-	-
total no. of Ind.	365	307	1102	425	76
stand. deviation	44	121	756	90	25
taxonomic composition:					
no. of higher taxa (crustacea = 1)	9	8	6	3	4

Table 9e: RV. "POSEIDON", April / May 1994
meiofauna (>32µm) of the Constanza transect
(Ind. x . / 10cm²), 0-3cm sediment depth
(3 parallels)

station	POS/8	POS/13	POS/12	POS/9	POS/3	POS/5	POS/4
date	26.04.94	02.05.94	30.04.94	27.04.94	20.04.94	23.04.94	21.04.94
depth	50m	80m	110m	130m	150m	170m	200m
gear	MC	MC	MC	MC	MC	MC	MC
size class	meio	meio	meio	meio	meio	meio	meio
area	3,46cm²	3,46cm²	3,46cm²	3,46cm²	3,46cm²	3,46cm²	3,46cm²
Taxa ---------							
Foraminifera	++	++	+	+++	-	-	-
Hydrozoa	+	+++	+++	+	-	-	-
Turbellaria	-	-	-	-	-	-	-
Nemertini	-	-	-	-	-	-	-
Gastrotricha	-	-	-	-	-	-	-
Nematoda	484	338	308	572	-	55	2
Kinorhyncha	-	1	-	-	-	-	-
Bivalvia	-	61	-	-	-	-	-
Gastropoda	-	2	-	-	-	-	-
Polychaeta	7	4	-	-	-	1	3
Oligochaeta	1	-	25	-	-	-	-
Harpacticoidea	30	39	47	16	-	-	2
Nauplii/Larvae	-	-	-	-	-	1	-
Ostracoda	6	4	-	-	-	-	-
Amphipoda	1	-	-	-	-	-	-
Isopoda	-	-	-	-	-	-	-
Cumacea	-	2	-	-	-	-	-
Tanaidacea	-	4	-	-	-	-	-
Acari	-	13	2	-	-	-	-
Ophiuroidea	-	2	-	-	-	-	-
Bryozoa	-	-	-	-	-	-	-
total no. of Ind.	530	469	382	589	-	57	7
stand. deviation	198	64	185	14	-	2	7
taxonomic composition:							
no. of higher taxa (crustacea = 1)	6	10	5	4	-	3	3

Table 9f: RV. "PJETR KOTTSOV", September 1997
meiofauna (>45µm) of the Portiza transect
(Ind. / 10cm²), 0-9cm sediment depth
(stations 2+3, average of 2 parallels)

station	PK1	PK 2	PK 3	PK 4	PK 5
date	10.09.97	08.09.97	06.09.97	15.09.97	14.09.97
depth	62m	77m	100m	130m	181m
gear	ELINOR	ELINOR	ELINOR	ELINOR	ELINOR
size class	meio	meio	meio	meio	meio
area	6,16cm²	6,16cm²	6,16cm²	6,16cm²	6,16cm²
Taxa ---------					
Foraminifera	-	++	+	-	-
Hydrozoa	-	-	-	-	-
Turbellaria	-	-	-	-	-
Nemertini	-	-	-	-	-
Gastrotricha	-	-	-	-	-
Nematoda	172	80	190	1041	47
Kinorhyncha	-	-	-	-	-
Bivalvia	-	-	-	-	-
Gastropoda	-	-	-	-	-
Polychaeta	-	13	7	-	-
Oligochaeta	-	-	-	-	-
Harpacticoidea	2	30	9	16	-
Nauplii/Larvae	-	-	-	-	-
Ostracoda	2	++	++	-	-
Amphipoda	-	-	-	-	-
Isopoda	-	1	-	-	-
Cumacea	-	-	-	-	-
Tanaidacea	-	-	-	-	-
Acari	-	++	++	-	-
Ophiuroidea	-	-	-	-	-
Bryozoa	-	-	-	-	-
total no. of Ind.	176	123	206	1057	47
stand. deviation	-	12	126	-	-
taxonomic composition:					
no. of higher taxa (crustacea = 1)	2	5	5	2	1

A NEW TYPE OF MACROZOOBENTHIC COMMUNITY FROM THE ROCKY BOTTOMS OF THE BLACK SEA

Dragoş MICU[1], Sanziana MICU[2]
[1] National Institute for Marine Research and Development ”Grigore Antipa”, 300 Mamaia Blvd., 900581 Constanta
[2] Faculty of Biology, “Al. I. Cuza” University, 20A Carol I Blvd., 700505 Iaşi,

ABSTRACT

Although the presence of the reef building polychaete *Ficopomatus enigmaticus* (a neozoon) in the Black Sea has long been known to marine biologists, up to now no one has performed a detailed analysis of the macrozoobenthic community established within *Ficopomatus* reefs. As a contibution to the knowledge of the ecological role of this neozoon, this paper aims to demostrate that, although restricted in range, the *Ficopomatus* community has a clearly distinct individuality. We conducted a comparative analysis of both taxonomic structure and functional feeding structure of two types of macrozoobenthic community (*Ficopomatus* –dominated vs. *Mytilus*-dominated).

INTRODUCTION

Prior to 1970, Băcescu (Băcescu et al., 1971) described several subtypes of the *Mytilus*-dominated macrozoobenthic community that covers the rocky bottoms of the Romanian Black Sea shore. While mussels cover almost all rocky bottoms and are of enormous ecological importance for Romanian marine waters, we discovered the existence of another, completely different, type of community. This community develops on hard substrata and it is edified by a neozoon, the reef-building polychaete tubeworm ***Ficopomatus enigmaticus*** (Fauvel 1923) syn. ***Mercierella enigmatica*** Fauvel 1923.

In Europe, *Ficopomatus enigmaticus* was first noticed in northern France (Caen, Normandy) in 1921 (Fauvel, 1923). It was first recorded from London docks in 1922 (Monro, 1924). The origin of this species is not clear, as it occurs in waters of variable salinity in temperate or warm temperate areas of both northern and southern hemispheres. According to Rullier (Rullier, 1966), it originates in the coastal lagoons of India and was transported to Europe on the hulls of English warships during World War I. More recently, it was believed to have been introduced from Australia (Zibrowius & Thorp, 1989). However, recent Australian literature lists *Ficopomatus enigmaticus* as an introduced species, and the best conclusion is that it is clearly southern hemisphere in origin.

In the Black Sea it was first recorded from the brackish Paleostomi Lake in Georgia (Annenkova, 1929). Until the mid-sixties it became established in several other brackish and oligohaline locations along the Black Sea coasts (Zaitsev & Ozturk, 2001). Today it has a disjunct distribution along the Romanian shore, in confined and oligohaline waters like harbours and lagoons.

F. enigmaticus prefers brackish waters, including estuaries, this species is ideal for transport on ships' hulls (most major ports are sited on estuaries) and commercial molluscs that are usually farmed in stagnant brackish lagoons. Worldwide, its disjunct distribution suggests spread by long-range dispersal of mobile adults (on ships' hulls). It is thought to be at, or close to, its temperature minimum for maintaining populations and successful reproduction along the 45° northern latitude parallel (Zibrowius & Thorp, 1989; Thorp, 1994). More northerly populations survive owing to artificially raised water temperatures (Naylor, 1959, 1965). In addition, successful reproduction is considered to be limited to waters of variable salinity.

Within relatively confined waters of variable salinity, *F. enigmaticus* suffers little competition from other serpulids. Such estuarine and lagoonal environments are characteristically areas of high productivity and so filter-feeders such as *Ficopomatus enigmaticus*, which are able to stand considerable variations in salinity, are well placed to reap the benefit. High fecundity, allied with larval retention within semi-enclosed waters, facilitates a rapid increase of numbers and hence the build up of reefs (Dixon, 1981). It thrives exactly in the areas that are most stressing and unsuitable for the majority of other marine biota.

In the Romanian Black Sea, sparse and short-lived *Ficopomatus* individuals may be encountered at open locations, but persistent colonies and compact reefs are present only in sheltered areas, like harbours and lagoons. In such protected waters *F. enigmaticus* covers the entire hard substratum with a mass of erect, contiguous and intertwined calcareous tubes (up to 20 cm long). Succesive generations of worms may raise the thickness of this reef up to more than 50 cm. Perhaps the most important characteristic of *F. enigmaticus* is that the reefs it builds constitute a highly tridimensionally complex biotope, unique in the Black Sea and harboring a diverse fauna.

This paper aims to demonstrate that, although restricted in range, the *Ficopomatus*-community has a clearly distinct individuality. We conducted a comparative analysis of both taxonomic structure and functional feeding structure of the two types of macroinvertebrate community (*Ficopomatus*–dominated vs. *Mytilus*-dominated).

MATERIAL AND METHODS

Our study was carried out inside the Constanta Sud – Agigea harbour (3 sampling stations) and the Belona marina, Eforie Nord (2 sampling stations), positioned as shown on the map. All stations were similar up to a point, the difference consisting mostly in water movement intensity. Samples were taken in March and May 2002.

At each station, all samples were taken from hard substratum (rock or concrete) at the same depth (1.5–2 m), to eliminate confusion due to faunal differences that are depth-dependent. Sampling was done by the author by SCUBA diving, this being the only method that allows for highly accurate, implicit error - free sampling (Flemming & Max, 1996). Diving also allowed for in-situ observations that proved invaluable for later interpretation of the data. In order to solve several questions that arose while processing the samples, we conducted extensive dives, to a depth of 22 m.

Three replicates (625 cm^2) were collected at each station by scraping to the bare rock and then sieved through 1 mm size mesh. The material retained was immediately preserved in 5% buffered formalin. To ensure consistency of the data set, in view of later statistical analysis requirements, all organisms were identified down to species level.

Both numeric abundance and biomass were calculated for each species. Biomass was determined as dry weight by drying the organisms to constant weight (at 105 °C for 7 days).

Two-way ANOVA suggested that the differences (in total abundance per replicate) between sampling periods and sites were not significant ($P<0.05$), so we calculated Shannon diversity and evenness and McNaughton dominance.

Dominance (relative abundance, rA), constancy and ecological significance (W) were calculated both as numeric (using abundance) and gravimetric (using biomass) values.

Dissimilarity of species abundance between samples was calculated using the Bray – Curtis coefficient. As mentioned afore, a two-way ANOVA suggested that total abundance did not differ significantly ($P < 0.05$) between sites and sampling dates, so we could safely avoid data standardisation that would have led to loss of valuable biological information (Clarke & Warwick, 1994).

We used Bray Curtis - based principal coordinates analysis (PCO) and principal components analysis (PCA) to estimate dissimilarities between communities.

To reveal differences in the functional groups that convey energy fluxes of the two communities, macroinvertebrates were classified in five functional feeding groups: passive filter-feeder, active filter-feeder, deposit feeder, shredder, predator. Species which may use several ways of feeding, depending on opportunities, were classified according to the prevalent feeding strategy. Species abundance was quantified as biomass (dry weight).

We used Morisita's modified coefficient to assess similarity in functional feeding group composition of the two communities and Bray – Curtis based PCO to estimate dissimilarities.

Figure 1. Location of sampling sites

RESULTS AND DISCUSSION

Situated 50 m downstream of the Danube – Black Sea Canal locks, **Ecluza** sampling site has highly variable salinity and exposure to waves caused by ships transiting the locks. The mussel-dominated epibiosis forms a continuous layer, 10-15 cm thick, on the concrete walls. The sparse algal cover (*Enteromorpha*, *Cladophora*, *Ceramium*) is replaced by *Obelia* colonies and *Aurelia* polyps (in winter) as depth increases. *Ficopomatus* forms rare, small arborescent colonies. Wave disturbance prevents it from forming reefs.

Shannon diversity and evenness have moderate values (1.77 and 0.38, respectively) due to the relatively high number of species present, but McNaughton dominance is high (0.81) owing to the great abundance of *Mytilus*, *Mytilaster* and *Balanus.*

Numerical analysis shows 15 constant species, of which 3 are dominant *(Mytilus*, *Balanus* and *Ficopomatus)*. The constant presence of many rarer species indicates a diverse, healthy community.

Biomass analysis overthrows the dominance of *Ficopomatus*, which becomes insignificant, and shows a clear dominance of the community by *Mytilus* and *Balanus.*

Table 1. Abundance, dominance and diversity of macrozoobenthic species (rA = relative abundance)

Nr.	**Specia**	**Ecluză**		**Gura Canal**		**Dana 137**		**Belona M**		**Belona F**	
		ind/m^2	**rA**	**Ind/m^2**	**rA**	**ind/m^2**	**rA**	**ind/m^2**	**rA**	**ind/m^2**	**rA**
1	*Obelia longissima*	16	0.014	20	0.041	36	0.35				
2	*Aurelia aurita*	1000	0.868								
3	*Aiptasiamorpha luciae*			24	0.049			64	0.24	560	0.189
4	*Stylochoplana taurica*			8	0.016	117	1.15	32	0.12	112	0.038
5	*Empectonema gracile*							16	0.06		
6	*Neanthes succinea*	184	0.160	1704	3.481	708	6.96	528	1.94	3456	1.165
7	*Syllis gracilis*									16	0.005
8	*Ficopomatus enigmaticus*	13480	11.707	640	1.308	260	2.56	13648	50.18	245250	82.651
9	*Corambe obscura*							80	0.29	144	0.049
10	*Anadara inaequivalvis*	400	0.347	476	0.972	88	0.87				
11	*Mytilus galloprovincialis*	69456	60.321	29424	60.113	1636	16.09	1664	6.12	1171	0.395
12	*Mytilaster lineatus*	1404	1.219	4364	8.916	2160	21.24	4128	15.18	544	0.183
13	*Musculista senhousia*	4	0.003								
14	*Cerastoderma glaucum*	16	0.014			12	0.12			80	0.027
15	*Parvicardium exiguum*	24	0.021	8	0.016						
16	*Papillicardium papillosum`*					4	0.04				
17	*Spisula subtruncata*					4	0.04				
18	*Abra ovata*			24	0.049						
19	*Mya arenaria*	1672	1.452	1320	2.697	144	1.42				
20	*Balanus improvisus*	23280	20.218	10208	20.855	4152	40.83	4464	16.41	35088	11.825
21	*Palaemon elegans*	24	0.021			16	0.16	160	0.59	160	0.054
22	*Palaemon adspersus*	16	0.014			16	0.16	160	0.59	160	0.054
23	*Athanas nitescens*			16	0.033	88	0.87				
24	*Pontophilus fasciatus*					8	0.08				
25	*Pisidia longicornis*	32	0.028	68	0.139	24	0.24	16	0.06		
26	*Rhitropanopeus harrisii*	136	0.118	340	0.695	664	6.53	704	2.59	528	0.178
27	*Pilumnus hirtellus*			4	0.008	4	0.04			16	0.005
28	*Xantho poressa*									32	0.011
29	*Pachygrapsus marmoratus*							16	0.06	32	0.011
30	*Chaetogammarus placidus*									192	0.065
31	*Iphigenella andrusowii*							16	0.06		
32	*Dikerogammarus villosus*							16	0.06		
33	*D. haemobaphes*									176	0.059
34	*Pontogammarus crassus*									112	0.038
35	*Orchestia mediterranea*									384	0.129
36	*Orchestia montagui*	8	0.007					16	0.06		
37	*Microdeutopus gryllotalpa*	568	0.493	20	0.041	4	0.04	784	2.88	592	0.200
38	*Microdeutopus stations*	104	0.090								
39	*Microdeutopus anomalus*	64	0.056								
40	*Amphithoe vaillanti*	8	0.007								
41	*Sphaeroma pulchellum*			68	0.139			464	1.71	4928	1.661
42	*Idothea baltica*							176	0.65	2992	1.008
43	*Tanais cavolinii*	16	0.014	180	0.368						
44	*Clunio marinus*			32	0.065			48	0.18		
45	*Molgula manhattensis*					16	0.16				
46	*Styela clava*					4	0.04				
47	*Neogobius melanostomus*	16	0.014								
48	*Proterorhinus marmoratus*					4	0.04				
49	*Scorpaena porcus*									3	0.001
	TOTAL	115144		48948		10169		27200		296728	

H(S)	**1.77**	**1.82**	**2.51**	**2.33**	**0.99**
E	**0.38**	**0.42**	**0.55**	**0.53**	**0.22**
I $_{DC}$	**0.81**	**0.81**	**0.62**	**0.67**	**0.94**

Gura Canal sampling site is positioned where the brackish part of the Danube – Black Sea Canal enters the Constanța Sud – Agigea seaport. This area is exposed to waves driven by the prevailing NNE winds. Epibiotic cover on the limestone rocks is reduced. At depth, the mussel layer becomes compact, covered by sparse *Obelia longissima* colonies. Underlying sediment accumulations are inhabited by *Abra ovata.*

Shannon diversity and evenness have medium values (1.82 and 0.42 , respectively) due to the relatively high number of species present, but McNaughton dominance is high (0.81) owing to the greater abundance of *Mytilus* and *Mytilaster.*

Numerical analysis indicates 10 constant species, of which 2 are dominant *(Mytilus, Balanus)*. The constant presence of many rarer species indicates a diverse, healthy community. Gravimetric analysis confirms the clear dominance of *Mytilus* and *Balanus.*

Dana 137 sampling site is a dock inside the Constanța Sud – Agigea seaport, about 3 km away from the initial shoreline. Byssus–attached bivalves (*Mytilus, Mytilaster, Anadara*), bivalves living in the sediment (*Mya*, *Parvicardium, Spisula*) and urochordates (*Molgula* and *Styela*) cover the 17 m high concrete seawall with a thin epibiosis.

Shannon diversity and evenness attain the highest values (2.51 and 0.55, respectively) here. Although total abundance is smaller than at other sites, the number of species has increased, especially that of the urochordates and decapod crustaceans. McNaughton dominance is decreasing (0.62).

Numerical analysis indicates 9 constant species, of which 3 are dominant *(Mytilus, Balanus* and *Mytilaster)*. Twelve accesory and accidental species, with low ecological significance, are not characteristic for hard substratum or shallow water. Biomass analysis emphasizes the importance of urochordates and *Anadara*, owing to their high individual biomass.

Belona Mytilus sampling site is situated on the northern and eastern seawalls (4 m high) of the Belona marina, exposed to direct action of waves coming from the south. A thin (5 cm) mussel epibiosis covers the concrete. *Ficopomatus* is present in higher numbers, but it does not form colonies. There are juvenile tube agglomerations inside empty mussel shells, but most of them do not survive to adulthood.

Shannon diversity and evenness are still high (2.33 and 0.53, respectively), while McNaughton dominance increases slightly (0.67).

Numerical analysis indicates 16 constant species, of which 3 are dominant *(Ficopomatus, Mytilaster, Balanus)*. The constant presence of many rarer species indicates a diverse, healthy community. Gravimetric analysis indicates the insignificance of *Ficopomatus*, the dominant species being *Mytilus* and *Mytilaster*. Decapod crustaceans gain importance due to both the high individual biomass of large crabs and the increased numbers of small crabs and shrimp.

Belona Ficopomatus sampling site is situated on the western and southern seawalls of Belona marina, sheltered from both prevailing NNE winds and direct action of waves. Here, *Ficopomatus* builds compact reefs (50 cm thick in places), covering the entire surface of the walls, from the bottom up to the waterline. The calcareous tubes are erect, contiguous and intertwined, forming a complex, sponge–like structure. The apertures of the tubes are welded together in a compact surface.

Normally, there are no live bivalves on a *Ficopomatus* reef, as the fast–growing tubes entwine around the valves, overgrow and finally smother them. Mussel juveniles sometimes attach themselves on the surface of the reef, but they never survive to adulthood. Thus, the worm eliminates competition for space and food. The only mussels that do survive are those littering the floor of the complex network of crevices and tunnels that large crabs are digging in the reef. Constant movements of crabs and fishes (*Scorpaena*, *Gobiidae*) through these narrow spaces prevent settlement of Ficopomatus larvae and destroy the tubes of juveniles that however manage to settle.

Shannon diversity and evenness are at their lowest (0.99 and 0.22, respectively) here. The number of species did not decrease (on the contrary, it increased slightly as compared to neighboring Belona Mytilus site), but their abundances are very unevenly distributed. The community is overwhelmingly dominated by *Ficopomatus*, as shown by the high (0.95) McNaughton dominance.

Numerical analysis indicates 2 dominant (*Ficopomatus* and *Balanus*) and 19 constant but subrecedent species, suggesting a healthy, diverse community that is strongly dominated by the leading species. Biomass analysis confirms the dominance of *Ficopomatus* and *Balanus*. Numeric and gravimetric subdominance is attained by a group of species that never held this status in *Mytilus*–dominated communities: *Palaemon*, *Xantho*, *Orchestia* and *Sphaeroma*.

Although a distance of less than 100 m separates the Belona Mytilus and Belona Ficopomatus sites, the macrozoobenthic communities differ markedly. Ficopomatus is present at all sites, but only here, in sheltered waters, can it develop into a reef and radically change the biotope and the taxonomic structure of the community.

The macrozoobenthic communities that inhabit the other four sites (Ecluza, Gura Canal, Dana 137, and Belona Mytilus) are just variations on the theme of the rocky bottom mussel community, as it was described by Băcescu (Băcescu et al., 1971).

Clustering (Figure 2) resulted in three site groups. Belona Ficopomatus was in a group all by itself, being 92.6% dissimilar to the other four sites. Ecluza and Gura Canal were least dissimilar

(0.46), as both had roughly the same environmental conditions, which favored the highest abundance of *Mytilus*, *Mytilaster* and *Balanus*. Between Belona Mytilus and Dana 137 there was a dissimilarity of (0.63), mainly due to a slightly different species composition. Between the last two groups there was a dissimilarity of 0.78, which can be attributed to a difference in salinity levels that tend to be lower and highly variable at Ecluza and Gura Canal stations.

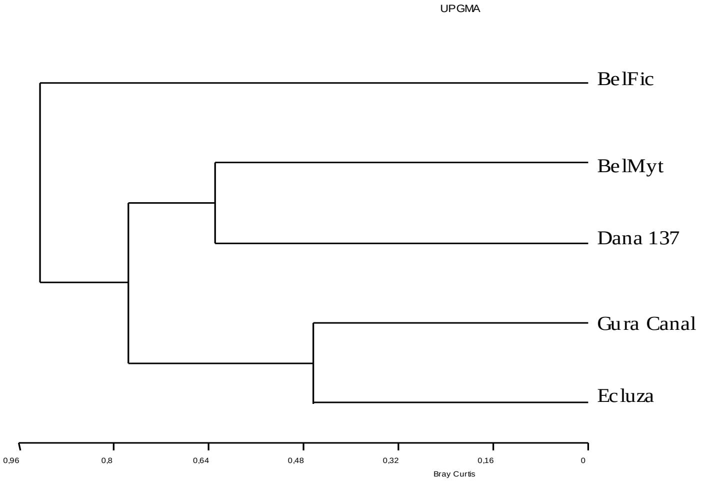

Figure 2 Dendrogram of the between–sites Bray–Curtis dissimilarity

Both PCO and PCA (Figure 3 and Figure 4, respectively) analyses reveal the greatest distance between the *Ficopomatus* community and the other four *Mytilus*-dominated communities, which are more or less (tightly, in the case of PCA) grouped together. The *Ficopomatus* reef is singled out as a clearly different type of macrozoobenthic community, in both species composition and the abundances these attain.

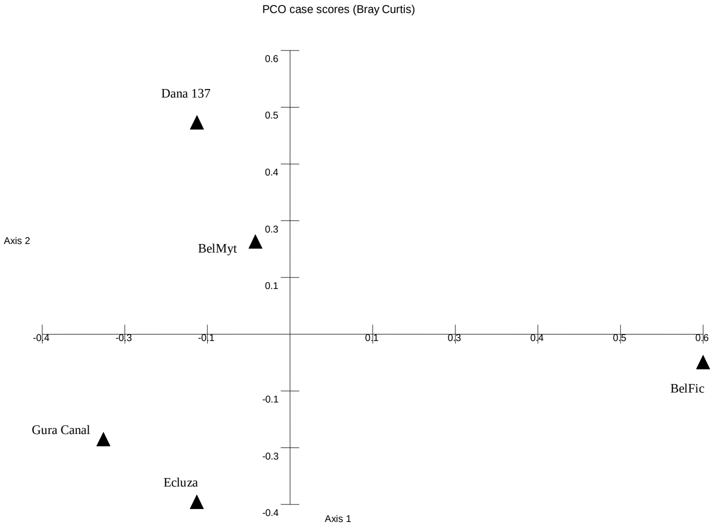

Figure 3 Principal Coordinates Analysis ordination of sites based upon taxonomic community structure

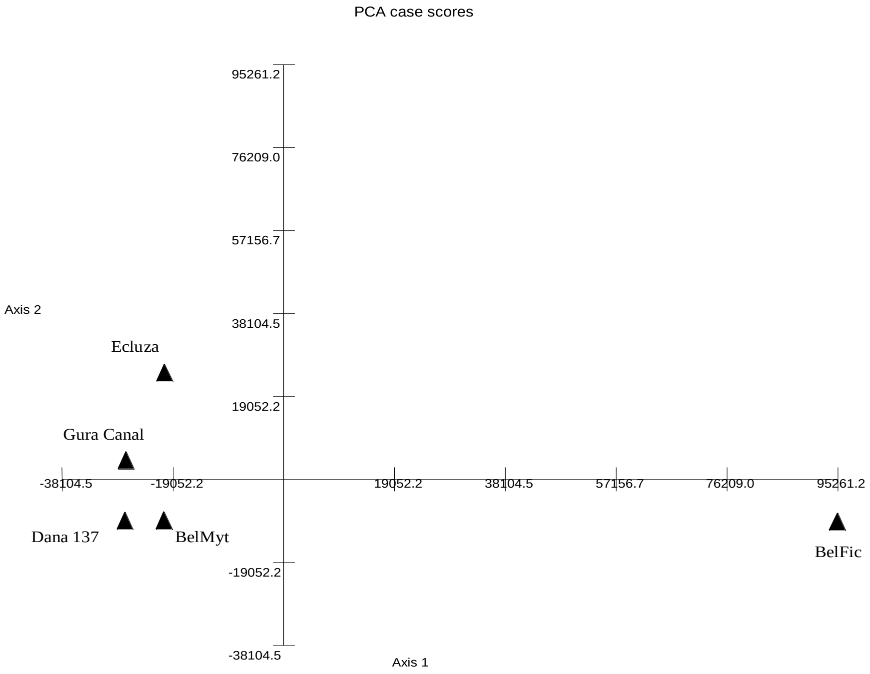

Figure 4. Principal Components Analysis ordination of sites, based upon taxonomic community structure

To see the difference, not only in taxonomic structure but also in the workings of the cenose, we used multivariate analysis to compare the functional feeding group (quantified as biomass, as listed in Table 2) structures of the two types of macrozoobenthic community.

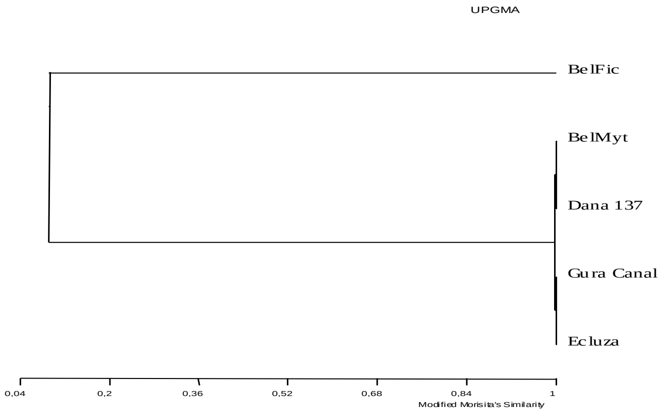

Figure 5. Dendrogram of the between–sites Modified Morisita’s similarity

Two-way ANOVA suggested that there is no significant ($P<0.05$) difference in the total biomass abundance of the replicates, between sites and periods.

Clustering (Figure 5) resulted in extreme differentiation. While the four sites with *Mytilus*-dominated communities had 100% similarity, their similarity, as a group, with the *Ficopomatus* reef site was of only 0.93%.

Table 2. Biomass and composition of functional feeding groups (g DW / m^2)

	Ecluză	**Gura Canal**	**Dana 137**	**Belona M**	**Belona F**
Obelia longissima	1.92	2.4	4.32	0	0
Aurelia aurita	12	0	0	0	0
Aiptasiamorpha luciae	0	0.288	0	0.768	6.72
Ficopomatus enigmaticus	15.224	0.704	0.286	15.013	269.78
Passive filterfeeder	**29.144**	**3.392**	**4.606**	**15.781**	**276.5**
Anadara inaequivalvis	60.16	71.59	13.24	0	0
Mytilus galloprovincialis	3710.1	1350.4	182.3	4471.8	23.317
Mytilaster lineatus	134.88	160.67	171.6	829.28	13.317
Musculista senhousia	0.332	0	0	0	0
Cerastoderma glaucum	0.9088	0	0.572	0	4.544
Parvicardium exiguum	1.1448	0.3816	0	0	0
Papillicardium papillosum	0	0	0.191	0	0
Spisula subtruncata	0	0	4	0	0
Mya arenaria	18.006	7.0838	3.617	0	0
Balanus improvisus	1657.8	726.81	96.01	317.84	810.53
Molgula manhattensis	0	0	91.2	0	0
Styela clava	0	0	22.8	0	0
Active filterfeeder	**5583.3**	**2316.9**	**585.5**	**5618.9**	**851.71**
Neanthes succinea	3.9616	7.029	2.887	0.9424	3.0096
Abra ovata	0	4.32	0	0	0
Clunio marinus	0	0.0006	0	0.0009	0
Deposit feeder	**3.9616**	**11.35**	**2.887**	**0.9433**	**3.0096**
Chaetogammarus placidus	0	0	0	0	13.44
Iphigenella andrusowii	0	0	0	1.12	0
Dikerogammarus villosus	0	0	0	1.12	0
D. haemobaphes	0	0	0	0	12.32
Pontogammarus crassus	0	0	0	0	0.784
Orchestia mediterranea	0	0	0	0	46.08
Orchestia montagui	8	0	0	1.92	0
Microdeutopus gryllotalpa	0.1306	0.0046	9E-04	0.1803	0.1362
Microdeutopus stations	0.0239	0	0	0	0
Microdeutopus anomalus	0.0147	0	0	0	0
Amphithoe vaillanti	0.0072	0	0	0	0
Sphaeroma pulchellum	0	0.5156	0	1.9328	29.754
Idothea baltica	0	0	0	0.864	11.502
Shredder	**8.1765**	**0.5202**	**9E-04**	**7.1371**	**114.02**
Stylochoplana taurica	5.52	0.24	3.51	0.96	3.36
Emplectonema gracile	0	0	0	0.56	0
Syllis gracilis	0	0	0	0	0.0006
Corambe obscura	0	0	0	2.4	4.32
Palaemon elegans	4.8	0	3.2	32	32
Palaemon adspersus	4	0	4	40	40
Athanas nitescens	0	1.6	8.8	0	0
Philocheras fasciatus	0	0	0.8	0	0
Pisidia longicornis	0.96	2.04	0.72	0.48	0
Rhitropanopeus harrisii	3.4768	5.6623	7.12	8.3312	13.178
Pilumnus hirtellus	0	0.1	0.1	0	0.4
Xantho poressa	0	0	0	0	38.4
Pachygrapsus marmoratus	0	0	0	160	320
Tanais cavolinii	0.0064	0.072	0	0	0
Predator	**18.763**	**9.7143**	**28.25**	**244.73**	**451.66**

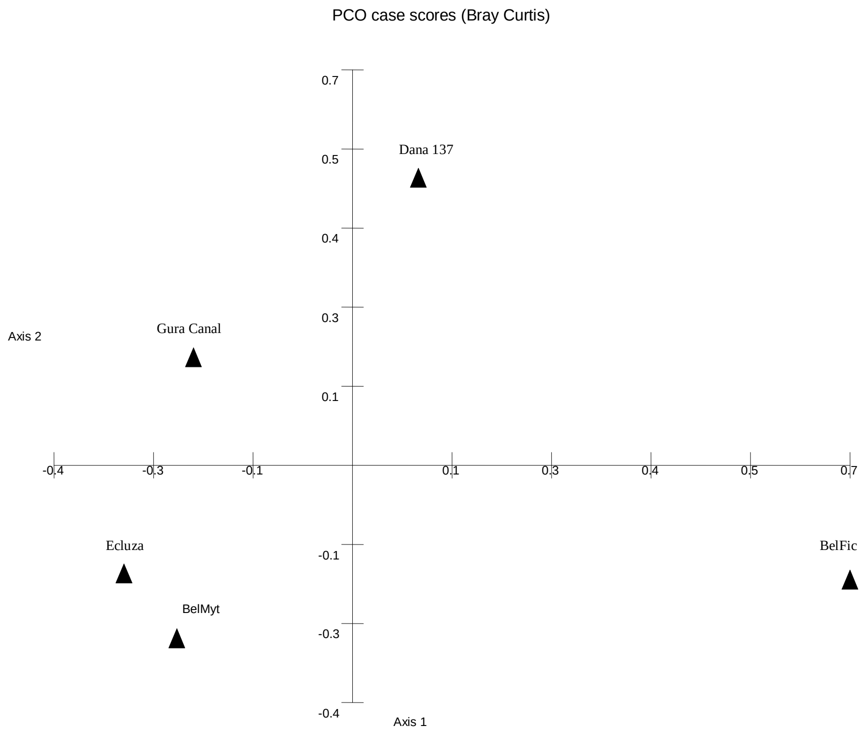

Figure 6. Principal Coordinates Analysis ordination of sites based upon functional feeding group structure

PCO (Figure 6) analysis reveals the greatest distance between the *Ficopomatus* community and the other four *Mytilus*-dominated communities, which are more or less grouped together. The *Ficopomatus* reef is singled out as a clearly different type of macrozoobenthic community.

Inside the Belona marina the two types of community closely coexist, still they maintain their distinct individualities through time, a proof that differences between them cannot be attributed to chance.

We established that two different macrozoobenthic communities, *Mytilus* – dominated and respectively *Ficopomatus* – dominated, are present in the sheltered brackish waters of the Romanian Black Sea, with large differences in species composition, functional feeding-group structure and biodiversity.

Although present at all sites, *Ficopomatus* gains ecological significance and creates a distinct community only there, where environmental conditions allow for building of reefs. Both *Ficopomatus* and *Mytilus* thrive in turbid waters with high organic particulate loads. Both are eurytherm and euryhaline species, *Ficopomatus* being actually the more euryhaline, with a salinity tolerance range of

0 - 55‰ (Dimov et al., 1970). But, while *Mytilus* thrives at exposed sites, for *Ficopomatus* current speeds over 0.4 ms^{-1} are a limiting factor (Dimov et al., 1970), hindering the calcareous tube construction. Thus, the essential environmental factor that dictates the distribution of *Ficopomatus* reefs is water movement intensity.

Ability to modify the biotope through reef building is the key feature of *Ficopomatus*, which leads to the onset of a new type of community.

The question arises whether this type of community, established by a neozoon, poses any threat to native species. Its effects on native species are more likely to be beneficial than problematic. This species favors waters which present some degree of stress to most open-shore marine organisms. Its requirement for variable-salinity water in which to spawn ensures that the major populations do not interfere with most indigenous species.

While *Ficopomatus enigmaticus* can be a fouling nuisance, it can also benefit the waters it invades. As Keene (1980) and Davies et al. (1989) have shown, the presence of large numbers in enclosed waters including marinas, where they would be considered a fouling nuisance, has had very beneficial effects on water quality, reducing suspended particulate loads and improving both the oxygen and nutrient status. Thomas & Thorp (1994) have also shown that a large population of *Ficopomatus enigmaticus* can remove material from suspension and thus have a very beneficial effect on other benthic species within enclosed or semi-enclosed waters.

CONCLUSIONS

We defined a new type of rocky substratum macrozoobenthic community for the Black Sea, edified by the polychaete neozoon *Ficopomatus enigmaticus* Fauvel 1923 (syn. *Mercierella enigmatica* Fauvel 1923). We established the distinct individuality of this community using many ways of data interpretation and multivariate analysis, for more accuracy and self-verification.

Ability to modify the biotope through reef building is the key feature that enables *Ficopomatus* to create this new type of community. This, in turn, depends on water movement intensity as the essential environmental factor.

The *Ficopomatus* reef community clearly differs from those described up to the present from the Black Sea (dominated by one or more of the following species: *Mytilus galloprovincialis*, *Mytilaster lineatus*, *Balanus improvisus*, *Actinia equina*, *Lepidochiton cinereus*), both in taxonomic and functional feeding group structure.

Due to their special environmental requirements, *Ficopomatus* reefs are bound to exist only in limited and disjunct areas. Thus, as a neozoon, *Ficopomatus* does not have an invasive behaviour and does not pose a threat to native species. Quite the opposite, in our opinion the *Ficopomatus* reefs are a positive contribution to the biodiversity of the Romanian Black Sea.

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ANNOTATED CHECKLIST OF THE MARINE *MOLLUSCA* FROM THE ROMANIAN BLACK SEA

Dragoş MICU
National Institute for Marine Research and Development ”Grigore Antipa”, 300
Mamaia Blvd., 900581 Constanta

ABSTRACT

In the Black Sea the *Mollusca* are an important phylum, comprising species that play keystone roles in many benthic biocenoses, have a high ecological significance and potential commercial value. As Romania’s integration into the European Research Area approaches, there is a growing need for achieving compatibility and interoperability between the Romanian scientific data collection systems and existing European marine biodiversity databases. It is therefore imperiously necessary to bring the Romanian scientific nomenclature in accord with European standards (European Register of Marine Species, Check List of European Marine Mollusca). This paper aims at a complete nomenclatural revision of all *Mollusca* species and higher level taxa occurring in the Romanian Black Sea, in accord with CLEMAM. At the same time, it is an accurate inventory of the present diversity of this phylum in the Romanian Black Sea.

INTRODUCTION

The foundation of biodiversity research is correctly identifying and naming species, but, for a very long time, chaos prevailed in the nomenclature of the Black Sea *Mollusca*.

At European and international levels, the scientific community has long agreed upon the need for taxonomic nomenclatural unification. As a consequence, research programmes on the topic and the compilation of several taxonomically oriented databases have been undertaken during the last 10 years. CLEMAM is a taxonomically oriented database of the marine *Mollusca* of Europe and the adjacent areas, aiming to a comprehensive coverage of species in the Eastern Atlantic, the Mid Atlantic Ridge, the Mediterranean and Baltic Seas. CLEMAM aims at being the standing reference for the systematics of European *Mollusca*, as well as a tool for species-oriented bibliographic search. The list of valid names in CLEMAM was contributed to the European Register of Marine Species (ERMS). The creators of CLEMAM intended it to be the taxonomic base for future published and Internet checklists, catalogues and identification guides (www. mnhn.fr/base/malaco.html).

The international scientific community has acknowledged that there is a dearth of recent, comparable and reliable data on zoobenthic diversity of the Black Sea, especially along the Romanian, Bulgarian and Georgian coasts. As Romania's integration into the European Research Area approaches, there is a growing need for achieving compatibility and interoperability between the Romanian scientific data collection systems and existing European marine biodiversity databases. It is therefore imperiously necessary to bring the Romanian scientific nomenclature in accord with the standard reference tools for marine biodiversity training, research and management in Europe (ERMS, CLEMAM).

This paper aims at a complete nomenclatural revision of all *Mollusca* species and higher level taxa occurring in the Romanian Black Sea, in accord with CLEMAM. At the same time, it is an accurate inventory of the present diversity of this phylum in the Romanian Black Sea.

This is certainly not the first attempt at compiling a biodiversity inventory for this phylum in the Romanian Black Sea. But, as earlier checklists (Grossu, 1993; Petran, 1997; Gomoiu & Skolka, 1998) were flawed by numerous unresolved synonymies, erroneous records and omissions, and this is the first checklist drawn in accord with the taxonomical consensus of malacologists, expressed through CLEMAM, I hope that it will be a useful contribution to biodiversity training, research and management in the Black Sea.

MATERIAL AND METHODS

The present checklist covers the Romanian part of the Black Sea in its entirety, from Sulina (including Musura Bay) in the north to Vama Veche in the south, and extending seawards to the continental shelf margin. It does not cover paramarine lakes, lagoons and limans.

The list concerns only marine species. Euryhaline species of fresh or brackish water origin (*Theodoxus*, *Limnocardiidae*), which may be encountered occasionally in some lower salinity areas of the sea (River Danube mouths, Portita, Periboina) were not taken into consideration.

For the drawing up of this list, the author has reviewed all available scientific records of *Mollusca* published in the study area during the last 150 years. Yet, the checklist is not just a compilation of existing bibliography. Not only did I thoroughly investigate the published record. I also examined the comparative material of collections and processed hundreds of benthos samples gathered during research cruises on the Romanian Black Sea. Material was obtained and many useful observations were made during numerous scuba dives made by the author since 1992 over an extensive part of the Romanian Black Sea. In the case of *Cerastoderma*, a widespread taxonomic confusion, which has been perpetuated for too long, needed to be resolved in a definitive way. As we did not want to rely solely on morphology, we used allozyme elctrophoresis and molecular methods.

The main authoritative source for the taxonomy used in this list is CLEMAM. However, this is not a mere transcription of CLEMAM. The completion of this checklist is the result of minute documentation, using all available scientific papers, monographs and identification guides from the Black Sea region. As a result, some genus/species combinations that are neither the original binomen nor the valid name, but have been used in the Black Sea region, are listed as synonyms. At the same time, only a few of the synonyms present in CLEMAM are listed, especially those that have been used by or known to scientists from the Black Sea area. More often than not, including a name on the list did not imply just resolving synonymies in earlier records, but also verifying material to see if the names have been correctly assigned in the first place.

The present paper includes two lists, one of accepted species that actually live or have lived in the Romanian Black Sea and another list of excluded species, that have been erroneously recorded from the Romanian Black Sea in previous checklists or papers.

RATIONALE FOR INCLUSION. To be included in this checklist, a species must meet the following criteria:

- the record was made in the geographical area covered by the checklist (as defined above)
- the record was made between 1850 and 2004
- the species must be recorded as living animals, in suitable environmental conditions.

In very few cases (e.g. *Myosotella myosotis*, *Tellina fabula*, *Pholas dactylus*) we accepted species for which only fresh shells were found in reasonable numbers, on more than one occasion and in suitable environmental conditions.

For each included species, four entries are listed:

1. The **valid name**, as listed in CLEMAM. For species whose taxonomic status is still unresolved we listed the current name with the mention “incertae sedis”.

2. **Synonyms**, of which the first is the basionym, followed by only a few of the synonyms listed in CLEMAM and/or combinations of names that have regional circulation.

3. **Misidentifications** are valid names of other species, which have been misapplied to the species in question. The valid name of the wrong species is listed always, although sometimes the author of the misidentification has used a synonym.

4. **Rationale for inclusion** is shortly stated, followed in brackets by the year in which the species was most recently recorded alive. For neozoa (exotic species) a supplemental note is made, stating “introduced” and the year of the first occurrence in the Romanian Black Sea (the year of the first actual finding on the field, not the year of publication).

As the year of the last record may came from various sources (published papers and books, unpublished data and internal reports of the NIMRD, underwater observations of the author) a citation of the paper which contained the record was not made. All source documents are included in the references.

RATIONALE FOR EXCLUSION. After careful examination I excluded 40 species, on the basis of the following criteria:

Unsupported records include unsubstantiated statements that a certain species exists in the RBS, or the mere mention of such a species in a faunal inventory. When statements were not supported by explicit examination of material, or when data regarding locality of collecting and actual specimens were missing, the records were rejected. Sometimes even the author of the record states explicitly that he has never found the given species in the Romanian Black Sea, but, on the basis of its alleged existence in Bulgarian or Ukrainian waters, he lists it anyway.

Misidentification – in some cases a species which lives in the Romanian Black Sea was misidentified for another species, which does not (and may not live in the whole Mediterranean altogether). The wrong name was then perpetuated in later papers and books and widely used by other authors. The best example for this type of erroneous record is *Cerastoderma edule*, a misidentification of the native *Cerastoderma glaucum*.

Spurious records, made on the basis of single or very few beached shells, fossil or subfossil shells or shell fragments, beached fresh shells of species which cannot survive in the environmental conditions that are characteristic for the Romanian Black Sea, were excluded.

Such fallacious records may be caused by the persistence, on the shore or on submerged beaches, of shells that have been transported by man for food, ornament or as a practical joke, and left or lost in places where they do not live. Also, the fouling on the hulls of oceangoing ships that are docked in Romanian ports may contain dead animals from distant seas, whose shells drop to the bottom and end up on the beach. A characteristic of the Romanian Black Sea is the presence of submerged beaches with rich subfossil shell rubble deposits, from which shells are dislodged by storms and washed up on the shore, or they may be picked up by remote sampling devices.

For each excluded species, four entries are listed:

5. The **valid name**, as listed in CLEMAM. For species whose taxonomic status is still unresolved we listed the current name with the mention “incertae sedis”.

6. **Synonyms**, of which the first is the basionym, followed by only a few of the synonyms listed in CLEMAM.

7. **Misidentifications** are valid names of other species, which have been misapplied to the species in question. The valid name of the wrong species is listed always, although sometimes the author of the misidentification has used a synonym.

8. **Rationale for exclusion** is shortly stated. As the records of excluded species come all from published papers, a reference is given.

RESULTS AND DISCUSSION

List of included species:

POLYPLACOPHORA **Gray 1821**

LEPIDOPLEURIDA Thiele 1909

ISCHNOCHİTONİDAE Dall 1889

Lepidochitona Gray 1821

Valid name: *Lepidochitona caprearum* (Scacchi 1836: *Chiton*)
Synonims: *Chiton caprearum* Scacchi 1836
Chiton polii Philippi 1836
Chiton crenulatus Locard 1832
Misidentifications: -
Rationale for inclusion: found alive in the Romanian Black Sea (RBS) (2003)

Valid name: *Lepidochitona cinerea* (Linne 1767: *Chiton*)
Synonims: *Chiton cinereus* Linne 1767
Chiton marginatus Pennant 1777
Chiton variegatus Philippi 1836
Lepidopleurus carinatus Leach 1852
Misidentifications: -
Rationale for inclusion: found alive in the RBS (2003)

GASTROPODA Cuvier 1797

PROSOBRANCHİA Milne Edwards 1848

VETİGASTROPODA Salvini-Plawen & Haszprunar 1987

TROCHOİDEA Rafinesque 1815

TROCHİDAE Rafinesque 1815

Gibbula Risso 1826

Valid name: *Gibbula divaricata* (Linne 1758: *Trochus*)

Synonims: *Trochus divaricatus* Linne 1758

GİBBULA DİVARİCATA VAR. *DİVERSA* MONTEROSATO 1888

Monodonta lessoni Payraudeau 1826

GİBBULA SPECİALİS COEN 1937

Misidentifications: *Gibbula deversa* Milaschewitsch 1916

Rationale for inclusion: found alive in the RBS (1965)

TRİCOLİİDAE Woodring 1928

Tricolia Risso 1826

Valid name: *Tricolia pullus pullus* (Linne 1758: *Turbo*)

Synonims: *Turbo pullus* Linne 1758

PHASİANELLA PULLA VAR. *ALBİNA* MONTEROSATO 1880

Phasianella pontica Milaschewitsch 1909

TRİCOLİA PULLUS FAROLİTA NORDSİECK 1973

Tricolia milaschevichi Anistratenko & Starobogatov 1991

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2002)

APOGASTROPODA Salvini-Plawen & Haszprunar 1987

CAENOGASTROPODA Cox 1959

CERİTHİOİDEA de Ferrusac 1822

CERITHIIDAE de Ferrusac 1822

Bittium Gray 1847 ex Leach

Valid name: *Bittium reticulatum* (Da Costa 1778: *Strombiformis*)

Synonims: *Strombiformis reticulatus* Da Costa 1778

MUREX SCABER OLİVİ 1792

Cerithiolum reticulatum var. *exilis* Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Bittium submamillatum* (de Rayneval & Ponzi 1854: *Cerithium*)

Synonims: *Cerithium submamillatum* de Rayneval & Ponzi 1854

Turitella pusilla Jeffreys 1856

CERİTHİDİUM SUBMAMİLLATUM VAR. *ECOSTATA* MONTEROSATO 1884

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1961)

TRİPHOROİDEA Gray 1847

TRIPHORIDAE Gray 1847

Marshallora Bouchet 1985

Valid name: *Marshallora adversa* (Montagu 1803: *Murex*)

Synonims: *Murex adversus* Montagu 1803

Triforis perversus var. *obesula* Bucquoy, Dautzenberg & Dollfus 1884

TRİFORİS OBESULUS LOCARD 1886

Biforina perversa var. *parva* Milaschewitsch 1909

Biforina perversa var. *adversa* Milaschewitsch 1916

Triphora adversa Bouchet & Guillemot 1978

Misidentifications: *Monophorus perversus* (Linne 1758: *Trochus*)

Rationale for inclusion: found alive in the RBS (2002)

Monophorus Grillo 1877

Valid name: *Monophorus perversus* (Linne 1758: *Trochus*)

Synonims: *Trochus perversus* Linne 1758

Triforis perversus var. *cylindrata* Monterosato 1878

TRİFORİS PERVERSUS VAR. *GRACİLİS* DAUTZENBERG 1895

Triforis perversus var. *elongata* Pallary 1906

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1977)

CERITHIOPSIDAE Adams H. & A., 1853

Cerithiopsis Forbes & Hanley 1851

Valid name: *Cerithiopsis minima* (Brusina 1865: *Cerithium*)

Synonims: *Cerithium minima* Brusina 1865

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2002)

Valid name: *Cerithiopsis tubercularis* (Montagu 1803: *Murex*)

Synonims: *Murex tubercularis* Montagu 1803

Cerithium acicula Brusina 1865

Cerithiopsis tubercularis var. *nana* Jeffreys 1867

Cerithiopsis tubercularis var. *clarkii* Jeffreys 1867

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1957)

JANTHİNOİDEA Gray 1853

EPITONIIDAE Berry S.S. 1910

Epitonium Roding 1798

Valid name: *Epitonium commune* (Lamarck 1822: *Scalaria*)

Synonims: *Scalaria communis* Lamarck 1822

Scalaria tumida Risso 1826

Scalaria mediterranea Locard&Caziot 1900

Epitonium clathrum minimum Nordsieck 1968

Misidentifications: *Epitonium turtonis* (Turton 1819: *Turbo*)

Rationale for inclusion: found alive in the RBS (1977)

EULİMOİDEA Philippi 1853

EULİMİDAE Philippi 1853

Vitreolina Monterosato 1884

Valid name: *Vitreolina incurva* (Bucquoy, Dautzenberg & Dollfus 1883: *Eulima*)

Synonims: *Eulima incurva* Bucquoy, Dautzenberg & Dollfus 1883

Helix incurva Renieri 1804

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1957)

LITTORINOIDEA Gray 1840

LITTORINIDAE Gray 1840

Melarhaphe Menke 1828

Valid name: *Melarhaphe neritoides* (Linne 1758: *Turbo*)

Synonims: *Turbo neritoides* Linne 1758

Helix petraea Montagu 1803

Littorina basterotii Payraudeau 1826

Littorina neritoides var. *major* Pallary 1900

Misidentifications: *Littorina saxatilis* (Olivi 1792: Turbo)

Rationale for inclusion: found alive (rarely) in the RBS (1971)

RISSOOIDEA Gray 1847

RISSOIDAE Gray 1847

Rissoa Freminville in Desmarest 1814

Valid name: *Rissoa lilacina* Recluz 1843

Synonims: *Rissoa rufilabris* Alder 1844

Rissoa violacea var. *ecostata* Jeffreys 1867

Rissoa rufilabrata Locard 1886

Rissoa splendida var. *vesiculosa* Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1998)

Valid name: *Rissoa membranacea* (Adams J. 1800: *Turbo*)

Synonims: *Turbo membranaceus* Adams J.1800

Rissoa grossa Michaud 1832

Rissoa venusta Philippi 1844

Rissoa pontica Milaschewitsch 1916

Rissoa vicina Milaschewitsch 1916

Rissoa brunosericea Smagowicz 1977

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Rissoa parva* (da Costa 1778: *Turbo*)

Synonims: *Turbo parvus* da Costa 1778

Rissoa semicostulata Anton 1839

Rissoa cerasina Brusina 1866

Rissoa euxinica Milaschewitsch 1909

Turboella parva Nordsieck 1968

Mohrensternia parva Golikov & Starobogatov 1972

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1979)

Valid name: *Rissoa splendida* Eichwald 1830

Synonims: *Rissoa violaestoma* Krynicky 1837

Misidentifications: *Rissoa variabilis* (Megerle von Muhlfeld 1824: *Helix*)

Rationale for inclusion: found alive in the RBS (2002)

Pusillina Monterosato 1884

Valid name: *Pusillina lineolata* (Michaud 1832: *Rissoa*)

Synonims: *Rissoa lineolata* Michaud 1832

Rissoa euxinica var. *devexa* Milaschewitsch 1916

Turboella ehrenbergi gwyni Nordsieck 1972

Misidentifications: *Rissoa parva* (Da Costa 1778: *Turbo*)

Rationale for inclusion: found alive in the RBS (2004)

Valid name: *Pusillina philippi* (Aradas & Maggiore 1844: *Rissoa)*

Synonims: *Rissoa philippi* Aradas & Maggiore 1844

Rissoa pusilla Philippi 1836

Rissoa nana Philippi 1844

Rissoa dolium Nyst 1845

Rissoa dolioliformis Locard 1886

Misidentifications: *Rissoa parva* (Da Costa 1778: *Turbo*)

Rissoa obscura Philippi 1844

Rationale for inclusion: found alive in the RBS (1979)

Setia Adams H. & A. 1854

Valid name: *Setia valvatoides* (Milaschewitsch 1909: *Rissoa*)

Synonims: *Rissoa valvatoides* Milaschewitsch 1909

Cingula valvatoides Grossu 1956

Cingulopsis valvatoides Ilvina 1966

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Alvania Risso 1826

Valid name: *Alvania lactea* (Michaud 1832: *Rissoa*)

Synonims: *Rissoa lactea* Michaud 1832

Massotia dajerleini Monterosato 1886

Massotia lactea Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1986)

CAECIDAE Gray 1850

Caecum Fleming 1824

Valid name: *Caecum trachea* (Montagu 1803: *Dentalium*)

Synonims: *Dentalium trachea* Montagu 1803

Caecum elegans Periaslavzev 1891

Caecum trachea var. *pontica* Milaschewitsch 1909

Misidentifications: *Caecum subannulatum* de Folin 1870

Rationale for inclusion: found alive in the RBS (1961)

HYDROBIIDAE Troschel 1857

Hydrobia Hartmann 1821

Valid name: *Hydrobia acuta* (Draparnaud 1805: *Cyclostoma*)

Synonims: *Cyclostoma acutum* Draparnaud 1805

Leachia cornea Risso 1826

Paludestrina glyca Servain 1880

Misidentifications: *Hydrobia ventrosa* (Montagu 1803: *Turbo*)

Heleobia stagnorum (Gmelin 1791: *Helix*)

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Hydrobia ventrosa* (Montagu 1803: *Turbo*)

Synonims: *Turbo ventrosus* Montagu1803

Ventrosia pontieuxini Radoman 1973

Ventrosia ventrosa Giusti & Pezzoli 1985

Misidentifications: *Hydrobia acuta* (Draparnaud 1805: *Cyclostoma*)

Heleobia stagnorum (Gmelin 1791: *Helix*)

Rationale for inclusion: found alive in the RBS (2003)

Heleobia Stimpson 1865

Valid name: <u>*Heleobia stagnorum* (Gmelin 1791: *Helix*)</u>

Synonims: *Helix stagnorum* Gmelin 1791

Helix stagnalis Linne 1767

Paludina salinasii Aradas & Calcara 1843

Peringia pyramidalis Bourguignat 1876

Semisalsa dalmatica Radoman 1974

Semisalsa graeca Radoman 1974

Semisalsa rausiana Radoman 1974

Misidentifications: *Hydrobia acuta* (Draparnaud 1805: *Cyclostoma*)

Hydrobia ventrosa (Montagu 1803: *Turbo*)

Rationale for inclusion: found alive in the RBS (1986)

TORNIDAE Sacco 1896

Tornus Turton 1829

Valid name: <u>*Tornus subcarinatus* (Montagu 1803: *Helix*)</u>

Synonims: *Helix subcarinata* Montagu 1803

Delphinula pusilla Calcara 1839

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1971)

TRUNCATELLIDAE Gray 1840

Truncatella Risso 1826

Valid name: <u>*Truncatella subcylindrica* (Linne 1767: *Helix*)</u>

Synonims: *Helix sucylindrica* Linne 1767

Turbo truncatus Montagu 1803

Paludina desnoyersii Payraudeau 1826

Truncatella montagui Lowe 1829

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1936)

CALYPTRAEOİDEA Lamarck 1809

CALYPTRAEIDAE Lamarck 1809

Calyptraea Lamarck 1799

Valid name: <u>*Calyptraea chinensis* (Linne 1758: *Patella*)</u>

Synonims: *Patella chinensis* Linne 1758

Patella sinensis Gmelin 1791

Calyptraea polii Scacchi 1836

Calyptraea vulgaris Philippi 1836

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2004)

MURİCOİDEA Rafinesque 1815

MURICIDAE Rafinesque 1815

Trophonopsis Bucquoy, Dautzenberg & Dollfus 1883

Valid name: <u>*Trophonopsis breviatus* (Jeffreys 1882: *Trophon*)</u>

Synonims: *Trophon breviatus* Jeffreys 1882

Trophon breviatus var. *lactea* Milaschewitsch 1916

Trophon breviatus var. *striata* Milaschewitsch 1916

Misidentifications: *Trophonopsis muricatus* (Montagu 1803: *Murex*)

Rationale for inclusion: found alive in the RBS (2004)

Rapana Schumacher 1817

Valid name: *Rapana venosa* (Valenciennes 1846: *Purpura*)
Synonims: *Purpura venosa* Valenciennes 1846
Rapana thomasiana Crosse 1861
Rapana pontica Nordsieck 1968
Misidentifications: *Buccinum bezoar* Linne 1758
Rationale for inclusion: found alive in the RBS (2004)
introduced 1964, common

NASSARIIDAE Iredale 1916
Nassarius Dumeril 1806

Valid name: *Nassarius nitidus* (Jeffreys 1867: *Nassa*)
Synonims: *Nassa nitida* Jeffreys 1867
Nassa reticulata var. *pontica* Kobelt 1878
Nassa reticulata var. *mediterranea* Milaschewitsch 1909
Nassa reticulata var. *modesta* Milaschewitsch 1909
Misidentifications: *Nassarius reticulatus* (Linne 1758: *Buccinum*)
Rationale for inclusion: found alive in the RBS (2004)

Cyclope Risso 1826

Valid name: *Cyclope neritea* (Linne 1758: *Buccinum*)
Synonims: *Buccinum neriteum* Linne 1758
Cyclops kamiesch Chenu 1859
Cyclope westerlundi Brusina 1900
Cyclonassa brusinai Andrussov
Cyclonassa kamischiensis var. *atra* Milaschewitsch 1916
Cyclonassa kamischiensis var. *exigua* Milaschewitsch 1916
Misidentifications: *Cyclope pellucida* Risso 1826
Rationale for inclusion: found alive in the RBS (2004)

CONOİDEA Rafinesque 1815

CONIDAE Rafinesque 1815

Bela Leach in Gray 1847

Valid name: *Bela nebula* (Montagu 1803: *Murex*)

Synonims: *Murex nebula* Montagu 1803

Mangelia ginnania Risso 1826

Pleurotoma fuscata Deshayes 1835

Raphitoma affinis Locard 1892

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1927)

Mangelia Risso 1826

Valid name: *Mangelia costata* (Donovan 1804: *Murex*)

Synonims: *Murex costatus* Donovan 1804

Mangelia balteata Reeve 1846

Mangelia atlantica Pallary 1920

Misidentifications: *Mangelia pontica* Milaschewitsch 1908

Rationale for inclusion: found alive in the RBS (1936)

Valid name: *Mangelia pontica* Milaschewitsch 1908

Synonims: -

Misidentifications: *Mangelia costata* (Donovan 1804: *Murex*)

Rationale for inclusion: found alive in the RBS (2002)

HETEROBRANCHİA Gray 1840

HETEROSTROPHA Fischer P. 1885

OMALOGYROİDEA Sars G. O. 1878

OMALOGYRİDAE Sars G. O. 1878

Omalogyra Jeffreys 1860

Valid name: *Omalogyra atomus* (Philippi 1841: *Truncatella*)

Synonims: *Truncatella atomus* Philippi 1841

Skenea nitidissima Forbes & Hanley 1853

Omalogyra atomus var. *fasciata* Monterosato 1877

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1993)

PYRAMİDELLOİDEA Gray 1840

PYRAMİDELLİDAE Gray 1840

Chrysallida Carpenter 1857

Valid name: *Chrysallida brusinai* (Cossmann 1921: *Pyrgulina*)

Synonims: *Pyrgulina brusinai* Cossmann 1921

Odostomia turbonilloides Brusina 1869

Parthenia incerta Milaschewitsch 1916

Misidentifications: -

Rationale for iclusion: found alive in the RBS (1957)

Valid name: *Chrysallida emaciata* (Brusina 1866: *Turbonilla*)

Synonims: *Turbonilla emaciata* Brusina 1866

Turbonilla ambigua Weinkauff 1868

Parthenia emaciata Milaschewitsch 1916

Misidentifications: *Chrysallida sarsi* Nordsieck 1972

Rationale for iclusion: found alive in the RBS (1976)

Valid name: *Chrysallida fenestrata* (Jeffreys 1848: *Odostomia*)

Synonims: *Odostomia fenestrata* Jeffreys 1848

Chemnitzia rigacci Conti 1864

Parthenia fenestrata Milaschewitsch 1916

Tragula fenestrata Golikov & Starobogatov 1972

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Chrysallida indistincta* (Montagu 1808: *Turbo*)

Synonims: *Turbo indistinctus* Montagu 1808

Turbonilla delpretei Sulliotti 1889

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Chrysallida interstincta* (Adams J. 1797:*Turbo*)

Synonims: *Turbo interstinctus* Adams J. 1797

Turbo interstinctus Montagu 1803

Odostomia penchynati Bucquoy, Dautzenberg & Dollfus 1883

Parthenia flexicosta Locard 1886

Chrysallida farolita Nordsieck 1972

Misidentifications: *Chrysallida terebellum* (Philippi 1844: *Chemnitzia*)

Chrysallida juliae (de Folin 1872: *Truncatella*)

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Chrysallida juliae* (de Folin 1872: *Truncatella*)

Synonims: *Truncatella juliae* de Folin 1872

Parthenina tenuistriata Milaschewitsch 1909

Misidentifications:

Rationale for inclusion: found in the RBS (1965)

Valid name: *Chrysallida pontica* Grossu 1986 **incertae sedis**

Synonims: -

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1998)

Valid name: *Chrysallida terebellum* (Philippi 1844: *Chemnitzia*)

Synonims: *Chemnitzia terebellum* Philippi 1844

Odostomia moulinsiana Fischer P. 1864

Pyrgulina denticula Coen 1933

Misidentifications: *Chrysallida indistincta* (Montagu 1808:*Turbo*)

Chrysallida intermixta (Monterosato 1884: *Pyrgulina*)

Chrysallida interstincta (Adams J. 1797: *Turbo*)

Rationale for inclusion: found alive in the RBS (1986)

Eulimella Gray 1847

Valid name: *Eulimella acicula* (Philippi 1836: *Melania*)

Synonims: *Melania acicula* Philippi 1836

Eulima subcylindrata Dunker in Weinkauff 1862

Eulimella acicula var. *intersecta* de Folin 1873

Misidentifications: -

Rationale for inclusion: found in the RBS (1989)

Valid name: *Eulimella scillae* (Scacchi 1835: *Melania*)

Synonims: *Melania scillae* Scacchi 1835

Eulima macandrei Forbes 1844

Odostomia nisoides Brugnone 1873

Misidentifications: -

Rationale for inclusion: found in the RBS (1961)

Odostomia Fleming 1813

Valid name: *Odostomia acuta* Jeffreys 1848

Synonims: *Odostomia acuta* var. *attenuata* Marshall 1893

Odostomia acuta var. *gracilis* Marshall 1893

Odostomia umbilicata Alder 1850

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Odostomia carrozai* van Aartsen 1987

Synonims: -

Misidentifications: *Odostomia unidentata* (Montagu 1803: *Turbo*)

syn. *O. albella* (Loven 1846: *Turbonilla*)

Odostomia scalaris MacGillivray 1843

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Odostomia eulimoides* Hanley 1844

Synonims: *Turbonilla oscitans* Loven 1846

Odostomia dubia jeffreys 1848

Odostomia novegradensis Brusina 1865

Misidentifications: *Turbo pallida* Montagu 1803 **incertae sedis**

Odostomia scalaris MacGillivray 1843

Rationale for inclusion: found alive in the RBS (1976)

Valid name: *Odostomia nitens* Jeffreys 1870

Synonims: -

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1959)

Valid name: *Odostomia plicata* (Montagu 1803: *Turbo*)

Synonims: *Turbo plicatus* Montagu 1803

Odostomia vitrea Brusina 1865

Odostomia plicata var. *carinata* Marshall 1893

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1959)

Valid name: *Odostomia scalaris* MacGillivray 1843

Synonims: *Odostomia rissoides* Hanley 1844

Odostomia alba Jeffreys 1848

Odostomia rissoides var. *exilis* Jeffreys 1867

Odostomia rissoiformis Milaschewitsch 1909

Misidentifications: *Odostomia eulimoides* Hanley 1844

Rationale for inclusion: found alive in the RBS (2004)

Turbonilla Risso 1826

Valid name: *Turbonilla delicata* (Monterosato 1874: *Odostomia*)

Synonims: *Odostomia delicata* Monterosato 1874

Chemnitzia gracilis Philippi 1844

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1986)

Valid name: *Turbonilla pusilla* (Philippi 1844: *Chemnitzia*)

Synonims: *Chemnitzia pusilla* Philippi 1844

Turbonilla pupaeformis Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1986)

EBALİDAE Waren 1995

Ebala Leach in Gray 1847

Valid name: *Ebala pointeli* (de Folin 1868: *Turbonilla*)

Synonims: *Turbonilla pointeli* de Folin 1868

Ebala tenuis de Folin 1870

Odostomia pointeli var. *turgida* Monterosato 1878

Anisocycla pointeli planulata Gougerot & Feki 1981

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

OPİSTHOBRANCHİA Milne Edwards 1848

CEPHALASPİDEA Fischer P. 1883

RETUSİDAE Thiele 1925

Retusa Brown 1827

Valid name: *Retusa mammillata* (Philippi 1836: *Bulla*)

Synonims: *Bulla mammillata* Philippi 1836

Bulla striatula Forbes 1844

Retusa striatula Golikov & Starobogatov 1972

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1986)

Valid name: *Retusa piriformis* Monterosato 1878

Synonims: -

Misidentifications: *Pyrunculus hoernesii* (Weinkauff 1866: *Bulla*)

Rationale for inclusion: found as fresh shells the RBS (1998)

Valid name: *Retusa truncatula* (Bruguiere 1792: *Bulla*)

Synonims: *Bulla truncatula* Bruguiere 1792

Bulla truncata Adams J. 1800

Cylichna truncatella Locard 1883

Retusa truncatula var. *opima* Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Cylichnina Monterosato 1884

Valid name: *Cylichnina robagliana* (Fischer P. in de Folin 1869: *Bulla*)

Synonims: *Bulla robagliana* Fischer P. in de Folin 1869

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

Valid name: *Cylichnina umbilicata* (Montagu 1803: *Bulla*)

Synonims: *Bulla umbilicata* Montagu 1803

Cylichna strigella Loven 1846

Cylichnina variabilis Milaschewitsch 1909

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

SACCOGLOSSA Von Ihering 1876

STİLİGERİDAE Iredale & O'Donoghue 1923

Calliopaea d'Orbigny 1837

Valid name: *Calliopaea bellula* d'Orbigny 1837

Synonims: -

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1986)

LİMAPONTİİDAE Gray 1847

Limapontia Johnston 1836

Valid name: *Limapontia capitata* (Muller O.F. 1774: *Fasciola*)

Synonims: *Fasciola capitata* Muller O.F. 1774

Limapontia nigra Johnston 1835

Chalidis caeruleus de Quatrefages 1844

Pontolimax varians Meyer & Mobius 1865

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1975)

ACOCHLİDİOİDEA Odhner 1937

MİCROHEDYLİDAE Odhner 1937

Parahedyle Thiele 1931

Valid name: *Parahedyle tyrtowii* (Kowalewsky 1901: *Hedyle*)

Synonims: *Hedyle tyrtowii* Kowalewsky 1901

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1966)

NUDİBRANCHİA de Blainville 1814

DORİDİNA Odhner 1934

CORAMBİDAE Bergh 1871

Corambe Bergh 1869

Valid name: *Corambe obscura* (Verrill 1870: *Doridella*)

Synonims: *Doridella obscura* Verrill 1870

Corambe sargassicola Bergh 1871

Corambe batava Kerbert 1886

Doridella burchi Marcus Ev. & Er. 1967

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2004)

introduced 1996, common

AEOLİDİİNA Odhner 1934

TERGİPEDİDAE Bergh 1889

Tergipes Cuvier 1805

Valid name: *Tergipes tergipes* (Forskal 1775: *Limax*)

Synonims: *Limax tergipes* Forskal 1775

Tergipes lacinulatus de Blainville 1824

Eolidia despecta Johnston 1835

Eolis neglecta Loven 1846

Misidentifications: *Tergipes edwardsii* Nordmann 1844

Rationale for inclusion: found alive in the RBS (1961)

Embletonia Alder & Hancock 1851

Valid name: *Embletonia pulchra* (Alder & Hancock 1884: *Pterochilus*)

Synonims: *Pterochilus pulcher* Alder & Hancock 1844

Embletonia faurei Labbe 1923

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1975)

Tenellia Costa A. 1866

Valid name: *Tenellia adspersa* (Nordmann 1845: *Tergipes*)

Synonims: *Tergipes adspersus* Nordmann 1845

Embletonia pallida Alder & Hancock 1854

Aeolidia tergipedina Verany 1846

Misidentifications: *Tergipes lacinulatus* de Blainville 1824

Rationale for inclusion: found alive in the RBS (1966)

GYMNOMORPHA Salvini-Plawen 1973

BASOMMATOPHORA Schmidt A. 1855

ELLOBİOİDEA Pfeiffer 1854

ELLOBİİDAE Pfeiffer 1854

Myosotella Monterosato 1906

Valid name: *Myosotella myosotis* (Draparnaud 1801: *Auricula*)

Synonims: *Auricula myosotis* Draparnaud 1801
Alexia obsoleta Pfeiffer 1854
Phytia letourneuxi var. *tanousi* Pallary 1912
Misidentifications: -
Rationale for inclusion: found as freesh shells in the RBS (1987)

BİVALVİA Linne 1758
PTEROMORPHİA Beurlen 1944
ARCOİDA Stoliczka 1871
ARCİDAE Lamarck 1809
Anadara Gray 1847

Valid name: *Anadara inaequivalvis* (Bruguiere 1789: *Arca*)
Synonims: *Arca inaequivalvis* Bruguiere 1789
Arca cornea Reeve 1844
Arca rufescens Reeve 1844
Misidentifications: -
Rationale for inclusion: found alive in the RBS (2004)
introduced 1984, common

NOETİİDAE Stewart 1930
Striarca Conrad 1862

Valid name: *Striarca lactea* (Linne 1758: *Arca*)
Synonims: *Arca lactea* Linne 1758
Arca perforans Turton 1819
Misidentifications: -
Rationale for inclusion: found alive in the RBS (1927)

MYTİLOİDA de Ferrusac 1822

MYTİLİDAE Rafinesque 1815

Mytilus Linne 1758

Valid name: *Mytilus galloprovincialis* Lamarck 1819

Synonims: *Mytilus galloprovincialis* var. *frequens* Milaschewitsch 1906

Mytilus galloprovincialis var. *trepida* Milaschewitsch 1906

Mytilus edulis zhurmunski Scarlato & Starobogatov 1979

Misidentifications: *Mytilus edulis* Linne 1758

Rationale for inclusion: found alive in the RBS (2004)

Mytilaster Monterosato 1883

Valid name: *Mytilaster lineatus* (Gmelin 1791: *Mytilus*)

Synonims: *Mytilus lineatus* Gmelin 1791

Mytilus crispus Cantraine 1835

Mytilus minimus var. *squalidermis* Danilo & Sandri 1856

Misidentifications: *Mytilaster marioni* (Locard 1889: *Mytilus*)

Mytilaster minimus (Poli 1795: *Mytilus*)

Rationale for inclusion: found alive in the RBS (2004)

Modiolus Lamarck 1799

Valid name: *Modiolus adriaticus* (Lamarck 1819: *Modiola*)

Synonims: *Modiola adriatica* Lamarck 1819

Modiola cavolinii Scacchi 1833

Modiola lamarckiana Locard 1886

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1979)

Modiolula Sacco 1898

Valid name: <u>*Modiolula phaseolina* (Philippi 1844: *Modiola*)</u>

Synonims: *Modiola phaseolina* Philippi 1844

Modiola radiata Hanley 1844

Modiola imberbis Brusina 1866

Misidentifications: *Modiolus adriaticus* (Lamarck 1819: *Modiola*)

Rationale for inclusion: found alive in the RBS (2003)

Musculista Yamamoto & Habe 1958

Valid name: <u>*Musculista senhousia* (Benson in Cantor 1842: *Modiola*)</u>

Synonims: *Modiola senhousia* Benson in Cantor 1842

Modiola radiata Hanley 1844

Modiola imberbis Brusina 1866

Misidentifications: *Modiolus arcuatulus* (Hanley 1843: *Modiola*)

Rationale for inclusion: found alive for the first time in the RBS (2002)

introduced 2002, rare

PTERİOİDA Newell 1965

PECTİNİDAE Rafinesque 1815

Chlamys Roding 1798

Valid name: <u>*Chlamys glabra* (Linne 1758: *Ostrea*)</u>

Synonims: Ostrea glabra Linne 1758

Pecten sulcatus Lamarck 1819

Pecten glaber var. *pontica* Bucquoy, Dautzenberg & Dollfus 1898

Pecten glaber var. *albida* Milaschewitsch 1916

Pecten ponticus var. *rubra* Milaschewitsch 1916

Misidentifications: *Chlamys varia* (Linne 1758: *Ostrea*)

Pecten solaris Born 1780

Rationale for inclusion: found alive in the RBS (1971)

ANOMİİDAE Rafinesque 1815

Anomia Linne 1758

Valid name: *Anomia ephippium* Linne 1758

Synonims: *Anomia patellaris* Lamarck 1819

Anomia adhaerens Clement 1879

Anomia boletiformis Locard 1886

Misidentifications: *Pododesmus patelliformis* (Linne 1761: *Anomia*)

Rationale for inclusion: found alive in the RBS (1965)

OSTREOİDA de Ferrusac 1822

OSTREİDAE Rafinesque 1815

Ostrea Linne 1758

Valid name: *Ostrea edulis* Linne 1758

Synonims: *Ostrea lamellosa* Brocchi 1814

Ostrea adriatica Lamarck 1819

Ostrea taurica Siemaschko 1847

Ostrea sublamellosa Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1927)

Crassostrea Sacco 1897

Valid name: *Crassostrea gigas* (Thunberg 1793: *Ostrea*)

Synonims: *Ostrea gigas* Thunberg 1793

Gryphaea angulata Lamarck 1819

Crassostrea laperousii Schrenk 1861

Misidentifications:

Rationale for inclusion: found alive in the RBS (2003)

introduced 1995, rare

HETERODONTA Neumayr 1884

VENEROİDA Adams H. & A. 1857

LUCİNİDAE Fleming 1828

Loripes Poli 1791

Valid name: *Loripes lacteus* (Linne 1758: *Tellina*)

Synonims: *Tellina lactea* Linne 1758

Amphidesma lucinale Lamarck 1818

Lucina lactoides Deshayes 1848

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1976)

Lucinella Monterosato 1883

Valid name: *Lucinella divaricata* (Linne 1758: *Tellina*)

Synonims: *Tellina divaricata* Linne 1758

Cardium arcuatum Montagu 1803

Lucina commutata Philippi 1836

Divaricella divaricata var. *elata* Bucquoy, Dautzenberg & Dollfus 1896

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1976)

LEPTONİDAE Gray 1847

Hemilepton Cossmann & Peyrot 1911

Valid name: *Hemilepton nitidum* (Turton 1822: *Lepton*)

Synonims: *Lepton nitidum* Turton 1822

Kellia compressa Milaschewitsch 1909

Erycina prismatica Cossmann & Peyrot 1911

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1959)

MONTACUTİDAE Clark W. 1855

Mysella Angas 1877

Valid name: *Mysella bidentata* (Montagu 1803: *Mya*)

Synonims: *Mya bidentata* Montagu 1803

Erycina nucleata Recluz 1843

Misidentifications: *Mysella ovata* (Jeffreys 1881: *Montacuta*)

Rationale for inclusion: found alive in the RBS (1957)

CARDİİDAE Lamarck 1809

Acanthocardia Gray 1851

Valid name: *Acanthocardia paucicostata* (Sowerby G.B. II 1841: *Cardium*)

Synonims: *Cardium paucicostatum* Sowerby G.B. II 1841

Cardium laticostatum Mayer-Eymar 1898

Cardium paucicostatum var. *impedita* Milaschewitsch 1916

Misidentifications: *Acanthocardia echinata* (Linne 1758: *Cardium*)

Rationale for inclusion: found alive in the RBS (2004)

Parvicardium Monterosato 1884

Valid name: *Parvicardium exiguum* (Gmelin 1791: *Cardium*)

Synonims: *Cardium exiguum* Gmelin 1791

Cardium pygmaeum Donovan 1800

Cardium parvum Philippi 1844

Cardium simile Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2004)

Papillicardium Sacco 1899

Valid name: <u>*Papillicardium papillosum* (Poli 1791: *Cardium*)</u>

Synonims: *Cardium papillosum* Poli 1791
Cardium polii Payraudeau 1826
Cardium fragile Reeve 1844
Cardium obliquatum Aradas 1847

Misidentifications: *Parvicardium exiguum* (Gmelin 1791: *Cardium*)
Parvicardium scabrum (Philippi 1844: *Cardium*)

Rationale for inclusion: found alive in the RBS (2004)

Cerastoderma Poli 1795

Valid name: <u>*Cerastoderma glaucum* (Poiret 1789: *Cardium*)</u>

Synonims: *Cardium glaucum* Poiret 1789
Cardium clodiense Brocchi 1814
Cardium lamarcki Reeve 1844
Cardium edule var. *batesoni* Bucquoy, Dautzenberg & Dollfus 1892
Cardium edule var. *quadrata* Bucquoy, Dautzenberg & Dollfus 1892

Misidentifications: *Cerastoderma edule* (Linne 1758: *Cardium*)

Rationale for inclusion: found alive in the RBS (2004)

MACTRİDAE Lamarck 1809

Spisula Gray 1837

Valid name: <u>*Spisula subtruncata* (da Costa 1778: *Trigonella*)</u>

Synonims: *Trigonella subtruncata* da Costa 1778
Mactra triangula Brocchi 1814
Mactra deltoides Lamarck 1818
Mactra euxinica Krynicky 1837

Misidentifications: *Mactra stultorum* (Linne 1758: *Cardium*)

Rationale for inclusion: found alive in the RBS (2004)

MESODESMATİDAE Gray 1840

Donacilla Lamarck 1819

Valid name: *Donacilla cornea* (Poli 1791: *Mactra*)

Synonyms: *Mactra cornea* Poli 1791

Donax plebeius Montagu 1803

Amphidesma donacillum Lamarck 1818

Donax ellipticus Krynicky 1837

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

SOLENİDAE Lamarck 1809

Solen Linne 1758

Valid name: *Solen marginatus* Pulteney 1799

Synonyms: *Solen marginatus* var. *adusta* Bucquoy, Dautzenberg & Dollfus 1895

Solen marginatus var. *major* Bucquoy, Dautzenberg & Dollfus 1895

Solen marginatus var. *pontica* Milaschewitsch 1916

Misidentifications: *Solen vagina* Linne 1758

Rationale for inclusion: found alive in the RBS (1950)

TELLİNİDAE de Blainville 1814

Tellina Linne 1758

Valid name: *Tellina donacina* Linne 1758

Synonyms: *Tellina trifasciata* Pennant 1777

Tellina lantivyi Payraudeau 1826

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1976)

Valid name: *Tellina fabula* Gmelin 1791

Synonyms: *Fabulina fabuloides* Monterosato 1884

Tellina fabulina Locard 1886

Angulus fabula var. *propinqua* Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found fresh shells in the RBS (1959)

Valid name: <u>*Tellina tenuis* da Costa 1778</u>

Synonims: *Tellina exigua* Poli 1791

Tellina exigua Deshayes 1835

Misidentifications: *Tellina carnaria* Linne 1758

Tellina incarnata Linne 1758

Rationale for inclusion: found alive in the RBS (2003)

Gastrana Schumacher 1817

Valid name: <u>*Gastrana fragilis* (Linne 1758: *Tellina*)</u>

Synonims: *Tellina fragilis* Linne 1758

Tellina striatula Olivi 1792

Psammotaea tarentina Lamarck 1812

Psammobia jugosa Brown 1827

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2003)

DONACİDAE Fleming 1828

Donax Linne 1758

Valid name: <u>*Donax trunculus* Linne 1758</u>

Synonims: *Donax laevigatus* Gmelin 1791

Donax julianae Krynicky 1837

Donax brevis Requien 1848

Serrula adriatica Monterosato 1884

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2004)

SEMELİDAE Stoliczka 1870

Abra Lamarck 1818

Valid name: *Abra alba* (Wood W. 1802: *Mactra*)

Synonims: *Mactra alba* Wood W. 1802

Syndosmya occitanica Recluz 1843

Abra alba var. *pontica* Milaschewitsch 1916

Misidentifications: *Erycina renieri* Bronn 1831

Rationale for inclusion: found alive in the RBS (2004)

Valid name: *Abra prismatica* (Montagu 1808: *Ligula*)

Synonims: *Ligula prismatica* Montagu 1808

Abra fragilis Risso 1826

Syndesmya fragilis Milaschewitsch 1916

Abra milaschevici Nevesskaja 1963

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2004)

Valid name: *Abra segmentum* (Recluz 1843: *Syndosmya*)

Synonims: *Syndosmya segmentum* Recluz 1843

Erycina ovata Philippi 1836

Scrobicularia fabula Brusina 1865

Misidentifications: *Tellina apelina* Renier 1804

Rationale for inclusion: found alive in the RBS (2002)

VENERİDAE Rafinesque 1815

Chamelea Morch 1853

Valid name: *Chamelea gallina* (Linne 1758: *Venus*)

Synonims: *Venus gallina* Linne 1758

Venus nucleus Statuti 1880

Venus nuculata Locard 1892

Misidentifications: *Chamelea striatula* (da Costa 1778: *Pectunculus*)

Rationale for inclusion: found alive in the RBS (2004)

Gouldia Adams C. B. 1847

Valid name: *Gouldia minima* (Montagu 1803: *Venus*)

Synonims: *Venus minima* Montagu 1803

Venus inquinata Lamarck 1818

Venus cyrilli Scacchi 1836

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1976)

Pitar Roemer 1857

Valid name: *Pitar rudis* (Poli 1795: *Venus*)

Synonims: *Venus rudis* Poli 1795

Venus ochropicta Krynicky 1837

Meretrix rudis var. *radiata* Bucquoy, Dautzenberg & Dollfus 1893

Misidentifications: *Pitar mediterranea* (Dautzenberg 1891: *Meretrix*)

Rationale for inclusion: found alive in the RBS (2003)

Irus Schmidt F. C. 1818

Valid name: *Irus irus* (Linne 1758: *Donax*)

Synonims: *Donax irus* Linne 1758

Tellina cornubiensis Pennant 1777

Venerupis irusiana Locard 1892

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1960)

Paphia Roding 1798

Valid name: *Paphia aurea* (Gmelin 1791: *Venus*)

Synonims: *Venus aurea* Gmelin 1791

Venus florida Lamarck 1818

Venus petalina Lamarck 1818

Tapes aureus var. *ovata* Jeffreys 1864

Tapes anthemodus Locard 1886

Tapes aureus var. *rugata* Bucquoy, Dautzenberg & Dollfus 1893

Tapes aureus var. *radiata* Bucquoy, Dautzenberg & Dollfus 1893

Tapes lineatus Milaschewitsch 1916

Tapes discrepans Milaschewitsch 1916

Tapes proclivis Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (2004)

PETRİCOLİDAE Deshayes 1839

Petricola Lamarck 1801

Valid name: *Petricola lithophaga* (Philippson 1788: *Venus*)

Synonims: *Venus lithophaga* Philippson 1788

Rupellaria reticulata Fleuriau de Bellevue 1802

Mya decussata Montagu 1808

Petricola costellata Lamarck 1818

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1974)

MYOİDA Stoliczka 1870

MYİDAE Lamarck 1809

Mya Linne 1758

Valid name: *Mya arenaria* Linne 1758

Synonims: *Mya elongata* Locard 1886

Mya arenaria var. *ovata* Jensen 1900

Mya pseudoarenaria Schlesch 1931

Misidentifications: *Mya truncata* Linne 1758

Rationale for inclusion: found alive in the RBS (2004)

introduced 1967, common

CORBULİDAE Lamarck 1818

Lentidium de Cristofori & Jan 1832

Valid name: *Lentidium mediterraneum* (Costa O. G.1829: *Tellina*)

Synonims: *Tellina mediterranea* Costa O. G. 1829

Tellina parthenopeana delle Chiaje 1830

Lentidium maculatum de Cristofori & Jan 1832

Corbula mactriformis Biondi Giunti 1859

Corbulomya trigonula Monterosato 1884

Misidentifications: *Corbula gibba* (Olivi 1792: *Tellina*)

Rationale for inclusion: found alive in the RBS (2004)

PHOLADİDAE Lamarck 1809

Pholas Linne 1758

Valid name: *Pholas dactylus* Linne 1758

Synonims: *Pholas muricata* da Costa 1778

Pholas hians Solander 1786

Pholas callosa cuvier 1817

Pholas dactylina Locard 1886

Misidentifications: -

Rationale for inclusion: found as fresh shells in the RBS (1971)

Barnea Risso 1826

Valid name: *Barnea candida* (Linne 1758: *Pholas*)

Synonims: *Pholas candida* Linne 1758
Barnea spinosa Risso 1826
Pholas papyracea Spengler 1793
Barnea candida var. *pontica* Milaschewitsch 1916

Misidentifications: -

Rationale for inclusion: found alive in the RBS (1962)

TEREDİNİDAE Rafinesque 1815

Teredo Linne 1758

Valid name: *Teredo navalis* Linne 1758

Synonims: *Teredo marina* Sellius 1733
Teredo batava Spengler 1793
Teredo vulgaris Lamarck 1801

Misidentifications: -

Rationale for inclusion: found as fresh shells in the RBS (2003)

The widely used old name *Biforina perversa*, which was restored to *Triphora adversa* (Bouchet & Guillemot, 1978) was later shown to be attributed to two different species, *Monophorus perversus* and *Marshallora adversa*, type species of the new genus *Marshallora* erected by Bouchet (Bouchet, 1985). The specimens found by the author in 2002 (after a long absence of recent records in the Romanian Black Sea) belonged all to *Marshallora adversa*. Unfortunately, there was no preserved material for the verification of older records of *Biforina perversa*, so we could not ascertain whether they belonged to *Marshallora adversa* or *Monophorus perversus*. As the differences between these two species are subtle and have not been known to Romanian malacologists, I considered as the most conservative approach to include both species in the checklist, giving as the last record for *Monophorus perversus* the date of the last record of *Biforina perversa* in the Romanian Black Sea.

Recent morphological and biochemical studies (Rolan & Luque, 1995; Sanjuan, Perez-Losada & Rolan, 1997) demonstrated that the name *Nassarius reticulatus* has been used until recently for two different valid species: *Nassarius reticulatus*, an Atlantic species which may be present in the Mediterranean only in parts of the Alboran Sea, and *Nassarius nitidus*, the most common and widespread nassariid throughout the Mediterranean, including the Black Sea.

In the past, numerous species belonging to the prosobranch genus *Cyclope* were described from the Mediterranean and Black Seas. Most of them have been synonymized. At present, in the Mediterranean there are only two species of *Cyclope* deemed as valid: *Cyclope neritea* and *Cyclope pellucida*., of which only *C. neritea* is present in the Romanian Black Sea. The question of whether *C. donovani* is a synonym of *C. neritea* or *C. pellucida* remains unresolved.

Odostomia carrozai is the valid name for the pyramidellid previously known as *Odostomia albella* (a misidentification) in the Black Sea region, which has not been recorded until now from Romanian waters. This is therefore the first record of *Odostomia carrozai* from the Romanian Black Sea.

Musculista senhousia is a bag-mussel, native to the Western Pacific, from Siberia and the Kuril Islands, through Korea, Japan, China and south to Singapore. This is the first record of *Musculista senhousia* from the entire Black Sea.

M. senhousia is a classical opportunist, in that it can experience large variations in population size, reflecting a high growth rate, high mortality rate, a short life span and a long planktonic dispersal stage. (Zenetos et al., 2003). It has been introduced worldwide, to North America in 1924 (Crooks, 1996), New Zealand in 1970 and Australia in 1983 (Slack-Smith & Brearley, 1987). The first Mediterranean record is from Israel in 1964 (Barash & Danin, 1971). In the Western Mediterranean it is known from the French lagoons (Hoenselaar & Hoenselaar, 1989); in the Adriatic from Ravenna Lagoon (Lazzari & Rinaldi, 1994) and Slovenia (De Min & Vio, 1997). Most introduction, worldwide, are linked to imports of *Crassostrea gigas* and *Tapes phillipinarum* for aquaculture purposes (Zenetos et al., 2003).

In the Black Sea we found the first living specimens in March 2002, inside the Constanta Sud – Agigea harbour. The introduction most probably occurred by means of hull fouling and/ or ballast water, as there are no aquaculture facilities in the area.

There are two species of *Cerastoderma* currently accepted as valid in the European seas: *Cerastoderma edule* and *Cerastoderma glaucum*.

C. edule inhabits the Atlantic coasts of Europe and may be present in the western part of the Alboran Sea, but does not naturally occur in the Mediterranean (Poutiers, 1987).

C. glaucum is also present on the Atlantic coasts of Europe, where it may occur in sympatry with *C. edule*, although the two species usually have different ecological requirements (Rygg, 1970; Brock, 1979; Brock, 1982; Lindegarth et al., 1995). *C.glaucum* is the only *Cerastoderma* species native to the Mediterranean and it is widespread throughout the whole basin, including the Black Sea. Due to the high variability of this species, many ecomorphs or colour morphs of *C.glaucum* have been described as species or subspecies in the Black Sea. Reviewing papers, identification guides and a huge amount of material collected all along the Romanian Black Sea shore, the author could not find even a single specimen that could, on the basis of morphological criteria (Brock, 1978), be assigned to *C. edule*. Molecular evidence obtained analysing *Cerastoderma* specimens collected at various locations all over the Romanian shelf (Micu & Kelemen, unpublished data) and compared with the literature (Brock, 1987; Hummel et al., 1994; Andre et al., 1999) also demonstrated the presence of only one species, *C.glaucum*.

List of excluded species

GASTROPODA Cuvier 1797
PROSOBRANCHİA Milne Edwards 1848
ARCHAEOGASTROPODA Thiele 1925
DOCOGLOSSA Troschel 1866
PATELLOİDEA Rafinesque 1815
PATELLİDAE Rafinesque 1815
Patella Linne 1758

Valid name: *Patella ulyssiponensis* Gmelin 1791
Synonims: *Patella tarentina* Salis 1793
PATELLA CAERULEA VAR. *TENUİSTRİATA* WEİNKAUFF 1880
Patella vulgata var. *cimbulata* De Gregorio 1884
Patella pontica Valenciennes in Monterosato 1888
Patella pontica Milaschewitsch 1914
Misidentifications: *Patella caerulea* Linne 1758
Patella vulgata Linne 1758
Rationale for exclusion: spurious record **(**subfossil shells only) by Grossu, 1986
never found alive in the RBS

VETİGASTROPODA Salvini-Plawen & Haszprunar 1987
FİSSURELLOİDEA Fleming 1822

FİSSURELLİDAE Fleming 1822

Diodora Gray 1821

Valid name: *Diodora graeca* (Linne 1758: *Patella*)

Synonims: *Patella graeca* Linne 1758

PATELLA RETİCULATA DONOVAN 1803

Patella apertura Montagu 1803

Fissurella graeca var. *conica* Monterosato 1884

Misidentifications: -

Rationale for exclusion: spurious record (subfossil shell fragments only) by Grossu, 1986 never found alive in the RBS in the BS it lives only in the prebosforic area.

SCİSSURELLOİDEA Gray 1847

SCİSSURELLİDAE Gray 1847

Scissurella d'Orbigny 1824

Valid name: *Scissurella costata* d'Orbigny 1824

Synonims: *Scissurella laevigata* d'Orbigny 1824

SCİSSURELLA STRİATULA PHİLİPPİ 1844

Schismope striatula Milaschewitsch 1916

Scissurella costata var. *laevigata* Nordsieck 1972

Misidentifications: -

Rationale for exclusion: spurious record (subfossil shell fragments only) by Grossu, 1986 never found alive in the RBS in the BS it lives only in the prebosforic area

TROCHOİDEA Rafinesque 1815

TROCHİDAE Rafinesque 1815

Gibbula Risso 1826

Valid name: *Gibbula adriatica* (Philippi 1844: *Trochus*)

Synonims: *Trochus adriaticus* Philippi 1844

TURBO CREMENSİS ANDREİEZEWSKİ 1832

Gibbula adriatica var. *tunetana* Pallary 1914

Misidentifications: *Trochus adansonii* Payraudeau 1826

Gibbula deversa Milaschewitsch 1916

Rationale for exclusion: spurious record (subfossil shells only) by Grossu, 1986 never found alive in the RBS

Valid name: *Gibbula albida* (Gmelin 1791: *Trochus*)

Synonims: *Trochus albidus* Gmelin 1791

TROCHUS ALBİDUS VAR. *PONTİCA* MİLASCHEWİTSCH 1908

Gibbula albida var. *pontica* Grossu 1956

Misidentifications: -

Rationale for exclusion: unsupported record by Grossu, 1986, supposed to exist in the RBS only because it has been cited from Ukraine and Bulgaria

APOGASTROPODA Salvini-Plawen & Haszprunar 1987

CAENOGASTROPODA Cox 1959

CERİTHİOİDEA de Ferrusac 1822

CERİTHİİDAE de Ferrusac 1822

Cerithium Bruguyere 1789

Valid name: *Cerithium alucastrum* (Brocchi 1814: *Murex*)

Synonims: *Murex alucaster* Brocchi 1814

*CERİTHİUM SYKES*İ BRUSİNA İN KOBELT 1907

CERİTHİUM SYKESİ VAR. *PONTİCA* MİLASCHEWİTSCH 1916

Misidentifications: *Cerithium vulgatum* Bruguiere 1792

Rationale for exclusion: spurious record (subfossil shells only) by Grossu, 1986 never found alive in the RBS in the BS it lives only on the Crimean and Anatolian coasts

JANTHİNOİDEA Gray 1853

EPITONIIDAE Berry S.S. 1910

Epitonium Roding 1798

Valid name: *Epitonium turtonis* (Turton 1819: *Turbo*)

Synonims: *Turbo turtonis* Turton 1819

Scalaria tenuicostata Michaud 1829
Scalaria planicosta Bivona 1832
Scalaria turtonae Locard 1892
Epitonium turtonae karpathense Nordsieck 1969

Misidentifications: -

Rationale for exclusion: the description given by Grossu for *E. turtonis* is erroneous most likely a misidentification of *E.commune* (Lamarck, 1822)

RİSSOOİDEA Gray 1847
CAECIDAE Gray 1850
Caecum Fleming 1824

Valid name: *Caecum armoricum* de Folin 1869

Synonims: *Dentalium trachea* Montagu 1803
Brochina incompta Monterosato 1884
Caecum tenue Milaschewitsch 1912

Misidentifications:

Rationale for exclusion: unsupported record by Grossu, 1986 in the BS it allegedly lives only on the Crimean and Caucasian coasts

NATİCOİDEA Guilding 1834
NATICIDAE Guilding 1834
Euspira Agassiz 1838

Valid name: *Euspira fusca* (de Blainville 1825: *Natica*)

Synonims: *Natica fusca* de Blainville 1825
Natica plicatula Reeve 1855
Natica compacta Jeffreys 1885

Misidentifications: *Natica sordida* Swainson 1821

Rationale for exclusion: spurious record (subfossil shells only) by Grossu, 1986 in the BS it lives only in the prebosforic area

MURİCOİDEA Rafinesque 1815

MURICIDAE Rafinesque 1815

Trophonopsis Bucquoy, Dautzenberg & Dollfus 1883

Valid name: *Trophonopsis muricatus* (Montagu 1803: *Murex*)

Synonims: *Murex muricatus* Montagu 1803
Fusus asperrimus Brown 1827
Trophon curta Locard 1892

Misidentifications: *Trophonopsis breviatus* (Jeffreys 1882: *Trophon*)

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS in the BS it lives only in the prebosforic area

OPİSTHOBRANCHİA Milne Edwards 1848

CEPHALASPİDEA Fischer P. 1883

HAMİNOEİDAE Pilsbry 1895

Haminoea Turton & Kingston 1830

Valid name: *Haminoea navicula* (da Costa 1778: *Bulla*)

Synonims: *Bulla navicula* da Costa 1778
Bulla cornea Lamarck 1822
Bulla folliculus Menke 1853

Misidentifications: -

Rationale for exclusion: spurious record (shell fragments only) by Grossu, 1986 never found alive in the RBS in the BS it lives only on the Crimean coast and in the prebosforic area

CYLİCHNİDAE Adams H. & A. 1854

Cylichna Loven 1846

Valid name: *Cylichna cylindracea* (Pennant 1777: *Bulla*)

Synonims: *Bulla cylindracea* Pennant 1777
Bulla cylindrica Bruguiere 1792
Cylichna elongata Locard 1886

Misidentifications: -

Rationale for exclusion: spurious record (subfossil shells only) by Grossu, 1993 never found alive in the RBS in the BS it lives only in the prebosforic area

Acteocina Gray 1847

Valid name: *Acteocina pontica* Grossu 1986 **incertae sedis**

Synonims: -

Misidentifications: -

Rationale for exclusion: spurious record (subfossil shells only) by Grossu, 1993 never found alive

GYMNOMORPHA Salvini-Plawen 1973

BASOMMATOPHORA Schmidt A. 1855

ELLOBİOİDEA Pfeiffer 1854

ELLOBİİDAE Pfeiffer 1854

Ovatella Bivona Ant. 1812

Valid name: *Ovatella firminii* (Payraudeau 1826: *Auricula*)

Synonims: *Auricula firminii* Payraudeau 1826
Ovatella punctata Bivona 1832
Pythia ferminii Beek 1838

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998

BİVALVİA Linne 1758

PROTOBRANCHİA Pelseneer 1889

NUCULOİDA Dall 1889

NUCULİDAE Gray 1824

Nucula Lamarck 1799

Valid name: *Nucula nucleus* (Linne 1758: *Arca*)

Synonims: *Arca nucleus* Linne 1758
Glycimeris argentea da Costa 1778

Arca margaritacea Bruguiere 1792

Nucula nucleata Locard 1886

Misidentifications: -

Rationale for exclusion: spurious record (subfossil shell fragments only) by Grossu, 1986 never found alive in the RBS in the BS it lives only in the prebosforic area

Valid name: *Nucula sulcata* Bronn 1831

Synonims: *Arca nucleus* Linne 1758

Nucula polii Philippi 1836

Nucula rugosa Ponzi 1872

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998

NUCULANİDAE Adams H. & A. 1858

Nuculana Link 1807

Valid name: *Nuculana pella* (Linne 1767: *Arca*)

Synonims: *Arca pella* Linne 1767

Arca interrupta Poli 1795

Lembulus rossianus Risso 1826

Leda pelliformis Locard 1886

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 in the BS it lives only in the prebosforic area

PTEROMORPHİA Beurlen 1944

ARCOİDA Stoliczka 1871

ARCİDAE Lamarck 1809

Arca Linne 1758

Valid name: *Arca noae* Linne 1758

Synonims: *Arca abbreviata* Bucquoy, Dautzenberg & Dollfus 1891

Arca gualtieri Renier 1804

Pectunculus mussolis Pallary 1920

Misidentifications: -

Rationale for exclusion: spurious record (subfossil shell fragments only) in the BS it lives only in the prebosforic area

Valid name: *Arca tetragona* Poli 1795

Synonims: *Arca cardissa* Lamarck 1819

Arca argenvillea Risso 1826

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 in the BS it lives only in the prebosforic area

MYTİLOİDA de Ferrusac 1822

MYTİLİDAE Rafinesque 1815

Musculus Roding 1798

Valid name: *Musculus discors* (Linne 1767: *Mytilus*)

Synonims: *Mytilus discors* Linne 1767

Mytilus discrepans Montagu 1803

Musculus filatovae Scarlato 1955

Misidentifications: *Modiolarca subpicta* (Cantraine 1835: Modiolus)

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

PTERİOİDA Newell 1965

PECTİNİDAE Rafinesque 1815

Pecten Muller O. F. 1776

Valid name: *Pecten maximus* (Linne 1758: *Ostrea*)

Synonims: *Ostrea maxima* Linne 1758

Pecten vulgaris da Costa 1778

Pecten maximus var. *minor* Locard 1888

Misidentifications: *Pecten jacobeus* (Linne 1758: *Ostrea*)

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

Chlamys Roding 1798

Valid name: <u>*Chlamys flexuosa* (Poli 1795: *Ostrea*)</u>

Synonims: *Ostrea flexuosa* Poli 1795

Pecten isabella Lamarck 1819

Pecten plicatulus Risso 1826

Pecten biradiatus Tiberi 1855

Misidentifications: *Chlamys glabra* (Linne 1758: *Ostrea*)

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

Valid name: <u>*Chlamys varia* (Linne 1758: *Ostrea*)</u>

Synonims: *Ostrea varia* Linne 1758

Ostrea versicolor Gmelin 1791

Pecten varius var. *pyxoidea* Bucquoy, Dautzenberg & Dollfus 1889

Chlamys bruei coeni Nordsieck 1969

Misidentifications: *Chlamys glabra* (Linne 1758: *Ostrea*)

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

ANOMİİDAE Rafinesque 1815

Pododesmus Philippi 1837

Valid name: <u>*Pododesmus patelliformis* (Linne 1761: *Anomia*)</u>

Synonims: *Anomia patelliformis* Linne 1761

Anomia pectiniformis Poli 1795

Anomia elegans Philippi 1844

Misidentifications: *Anomia ephippium* Linne 1758

Rationale for inclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

LİMİDAE Rafinesque 1815

Limaria Link 1807

Valid name: <u>*Limaria tuberculata* (Olivi 1792: *Ostrea*)</u>

Synonims: *Ostrea tuberculata* Olivi 1792

Limaria inflata Link 1807

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

HETERODONTA Neumayr 1884

VENEROİDA Adams H. & A. 1857

LUCİNİDAE Fleming 1828

Lucinoma Dall 1901

Valid name: <u>*Lucinoma borealis* (Linne 1767: *Venus*)</u>

Synonims: *Venus borealis* Linne 1767

Tellina radula Montagu 1803

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

THYASIRİDAE Dall 1900

Thyasira Lamarck 1818

Valid name: <u>*Thyasira flexuosa* (Montagu 1803: *Tellina*)</u>

Synonims: *Tellina flexuosa* Montagu 1803

Lucina sinuata Lamarck 1818

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

CARDİİDAE Lamarck 1809

Cerastoderma Poli 1795

Valid name: <u>*Cerastoderma edule* (Linne 1758: *Cardium*)</u>

Synonims: *Cardium edule* Linne 1758

Cardium edule var. *major* Bucquoy, Dautzenberg & Dollfus 1892

Cardium edule var. *nuciformis* Milaschewitsch 1916

Misidentifications: *Cerastoderma glaucum* (Poiret 1789: *Cardium*)

Rationale for exclusion: the record *Cardium edule* var. *nuciformi*s living in the Sinoe Lagoon by Borcea 1927 must be a misidentification of *Cerastoderma glaucum*

MACTRİDAE Lamarck 1809

Mactra Linne 1767

Valid name: *Mactra stultorum* (Linne 1758: *Cardium*)

Synonims: *Cardium stultorum* Linne 1758

Cardium corallinum Linne 1758

Mactra cinerea Montagu 1808

Mactra paulacciae Aradas & Benoit 1872

Misidentifications: -

Rationale for exclusion: spurious record (a single beached valve) by Grossu, 1962 never found alive in the RBS

DONACİDAE Fleming 1828

Donax Linne 1758

Valid name: *Donax semistriatus* Poli 1795

Synonims: *Donax fabagella* Lamarck 1818

Donax trifasciatus Risso 1826

Serrula clodiensis Monterosato 1884

Misidentifications: *Donax trunculus* Linne 1758

Donax venustus Poli 1795

Rationale for exclusion: spurious record (a few beached valves) by Grossu, 1993 never found alive in the RBS

Valid name: *Donax venustus* Poli 1795

Synonims: *Donax venusta* Poli 1795

Donax modestus Risso 1826

Donax radiatus Krynicky 1837

Misidentifications: *Donax semistriatus* Poli 1795

Donax vittatus (da Costa 1778: *Cuneus*)

Rationale for exclusion: spurious record (a few beached valves) by Grossu, 1962 never found alive in the RBS

GLOSSIDAE Gray 1847

Glossus Poli 1795

Valid name: *Glossus humanus* (Linne 1758: *Cardium*)

Synonims: *Cardium humanum* Linne 1758

Isocardia cor var. *valentiana* Pallary 1903

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

VENERİDAE Rafinesque 1815

Clausinella Gray 1851

Valid name: *Clausinella fasciata* (da Costa 1778: *Pectunculus*)

Synonims: *Pectunculus fasciatus* da Costa 1778

Venus brogniartii Payraudeau 1826

Venus fasciata var. *raricostata* Jeffreys 1864

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS in the BS it lives only in the prebosforic area

Timoclea Brown 1827

Valid name: *Timoclea ovata* (Pennant 1777: *Venus*)

Synonims: *Venus ovata* Pennant 1777

Venus radiata Brocchi 1814

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS in the BS it lives only in the prebosforic area

MYOİDA Stoliczka 1870
CORBULİDAE Lamarck 1818
Corbula Bruguiere 1797

Valid name: *Corbula gibba* (Olivi 1792: *Tellina*)

Synonims: *Tellina gibba* Olivi 1792
Mya inaequivalvis Montagu 1803
Corbula nucleus Lamarck 1818
Corbula rosea Brown 1844

Misidentifications: -

Rationale for exclusion: spurious record (subfossil shells only) by Grossu, 1993 never found alive in the RBS in the BS it lives only in the prebosforic zone

GASTROCHAENİDAE Gray 1840
Gastrochaena Spengler 1783

Valid name: *Gastrochaena dubia* (Pennant 1777: *Mya*)

Synonims: *Mya dubia* Pennant 1777
Chama parva da Costa 1778
Mytilus ambiguus Dillwyn 1817
Gastrochaena modiolina Lamarck 1818

Misidentifications: -

Rationale for exclusion: unsupported record by Grossu, 1962 in the BS found as empty shells only, in the prebosforic area

HİATELLİDAE Gray 1824
Hiatella Daudin in Bosc 1801

Valid name: *Hiatella arctica* (Linne 1767: *Mya*)

Synonims: *Mya arctica* Linne 1767

Hypogaea barbata Poli 1795

Sphenia bilirata Gabb 1861

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

TEREDİNİDAE Rafinesque 1815

Teredo Linne 1758

Valid name: *Teredo utriculus* Gmelin 1791

Synonims: -

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

ANOMALODESMATA Dall 1889

PHOLADOMYOİDA Newell 1965

THRACİİDAE Stoliczka 1870

Thracia Leach in de Blainville 1824

Valid name: *Thracia papyracea* (Poli 1791: *Tellina*)

Synonims: *Tellina papyracea* Poli 1791

Mya declivis Pennant 1812

Amphidesma phaseolinum Lamarck 1818

Thracia mitella de Gregorio 1884

Misidentifications: -

Rationale for exclusion: spurious record (a single subfossil valve) by Carausu, 1970 never found alive in the RBS

SCAPHOPODA Bronn 1862

DENTALİİDA da Costa 1776

DENTALİİDAE Gray 1847

Dentalium Linne 1758

Valid name: *Dentalium novemcostatum* Lamarck 1818

Synonims: -

Misidentifications: -

Rationale for exclusion: unsupported record by Gomoiu & Skolka, 1998 never found in the RBS

Acteocina pontica is a subfossil species, first found by Grossu (Grossu, 1993) in sediments from the Razelm – Sinoe Lagoon. This is the second record of the species from Romanian shelf sediments. We found two, well preserved but obviously subfossil, shells in the Cape Midia – Constanta area, in subfossil shell rubble accumulations at dephts of 30 – 40m.

CONCLUSIONS

For several included species (*Gibbula divaricata*, *Epitonium commune, Vitreolina incurva*, *Caecum trachea*, *Truncatella subcylindrica*, *Bela nebula*, *Striarca lactea*, *Chlamys glabra*, *Ostrea edulis*, *Solen marginatus*, *Barnea candida*) there are no recent records, for periods ranging between 20 and 77 years. The lack of recent records can be explained, at least partially, through the sharp biological decline induced by intense eutrophication and pollution during the ’70s and ’80s. Nevertheless, we must not underestimate the importance of other factors: the very low intensity of research efforts directed towards or related to the biodiversity of the *Mollusca*, as well as the use of improper sampling methods that could never yield positive results. Also, some of these species (*Melarhaphe neritoides, Alvania lactea, Caecum trachea, Vitreolina incurva, Striarca lactea*, *Chlamys glabra, Hemilepton nitidum, Pholas dactylus*) were rare even in the pristine conditions before 1950.

With the recent melioration of environmental conditions along the Romanian shores and the advent of more intense scientific attention of a higher quality, some of these rare species may be recorded again, as it already happened in a few cases (*Tricolia pullus, Marshallora adversa, Mangelia pontica, Chrysallida fenestrata, Ebala pointeli, Donacilla cornea, Donax trunculus, Gastrana fragilis, Pitar rudis*). That is why we must not rush to consider extinct the species for which recent records are lacking.

Following the natural ongoing process of mediterranisation of the Black Sea, accelerated by global warming, environmental conditions along the Romanian shores might become favorable so as to allow the settlement of species that are listed as excluded at the moment.

At the same time, the constant influx of neozoa is likely to bring more additions to this list. *Musculista senhousia* is the most recent neozoon that entered the Black Sea, but it will certainly not be the last. The unsaturated character of the Black Sea benthos means that our benthic fauna is not as diverse as its environment could afford, so we expect that more neozoa will appear in the future.

In this paper I strived to provide the best possible image on the diversity of the *Mollusca* from the Romanian Black Sea at this particular moment in time. The checklist remains open to future changes and additions, reflecting the changing biodiversity of the Black Sea.

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WWW.SOMALİ.ASSO.FR/CLEMAM

WWW.DIGILANDER.LIBERO.IT/CONCHİGLİEVENEZİANE

WWW.İBSS.İUF.NET/BLACKSEA/SPECİES/FREELİFE/MOLLUSCA

PRESENT STATE OF BENTHIC MACROPHYTE COMMUNITIES OF NORTH CAUCASUS COAST OF THE BLACK SEA

Dimitriy F., AFANAS'EV
Rostov State University

At present time, the chemical and organic pollution of North Caucasus coast of the Black Sea is determined the state of the macrophytobenthos. Although present pollution level by the oil products, heavy metals, polychlorbiphenyls of the whole sea environment is rather low than same years early, the local levels of pollutants accumulation in seabed sediments and benthos can be tens or hundreds times as high as ambient water standard.

Such high values of pollutants accumulations is particularity of harbours such as Novorossijsk, Tuapse and seabeaches (Anapa, Gelendgic, Sochy region). However, in condition of narrowness of North Caucasus shelf, the local fouls are leading to a gap of spatial continuum of autochthonal phytobenthos. Nowadays, the areals of some species have a trend to fragmentation and breakdown into small parts.

So, the information on adaptability of the biggest Black Sea brown algae, edominants, *Cystoseira barbata et C. crinita* with reference to anthropogenic pollution nowadays is very important. We try to do a complex investigation of macrophytobenthosis adaptation on different levels of living matter organization. All methods we used was described earlier (Afanas'ev, Stepan'an, 2001; Gromov, Milutina, Afanas'ev, 2001). In this paper we shall show only the most important changes in functional and structural markers of benthic macrophyte state.

On the cell level the increase of MDA (malondialdehyde) – content in the body of *Cystoseira* from the polluted place was shown by us (Table 1, Figure 1) on the material from different places of the north-eastern part of the Black sea, where the pollution levels are discerned: Island Bolshoj Utrish < beak-head Shescharis < beak-head Ljubvi. MDA is the product of lipid peroxidation, which enhanced when organism are involved in process of degradation and destruction, promoted by some damaging factors, such as acids, herbicide, oil products, and others (Dat et al., 1998; del Rio et al., 1998; Iturbe-Ormaetxe et al., 1998; Gromov, Milutina, Afanas'ev, 2001).

Table 1. MDA - content in the branches of 5-th order of *Cystoseira crinita* (age ~ 3 year) from the different areas in the north-eastern part of the Black sea. Depth - 0,2 m. July, 2003.

Area	Island Bolshoj Utrish (north-end of Abrau peninsula)	beak-head Shescharis (Novorossijsk bay)	beak-head Ljubvi (Novorossijsk bay)
Main pollutants	relative clean ecotop	oil products	nutrients, organic substances, oil products
MDA (nmol/g tissue)	22,177±1,176 (control)	27,563±1,114* p = 0,0045	31,023±1,238* p = 0,00086

* - significant difference;

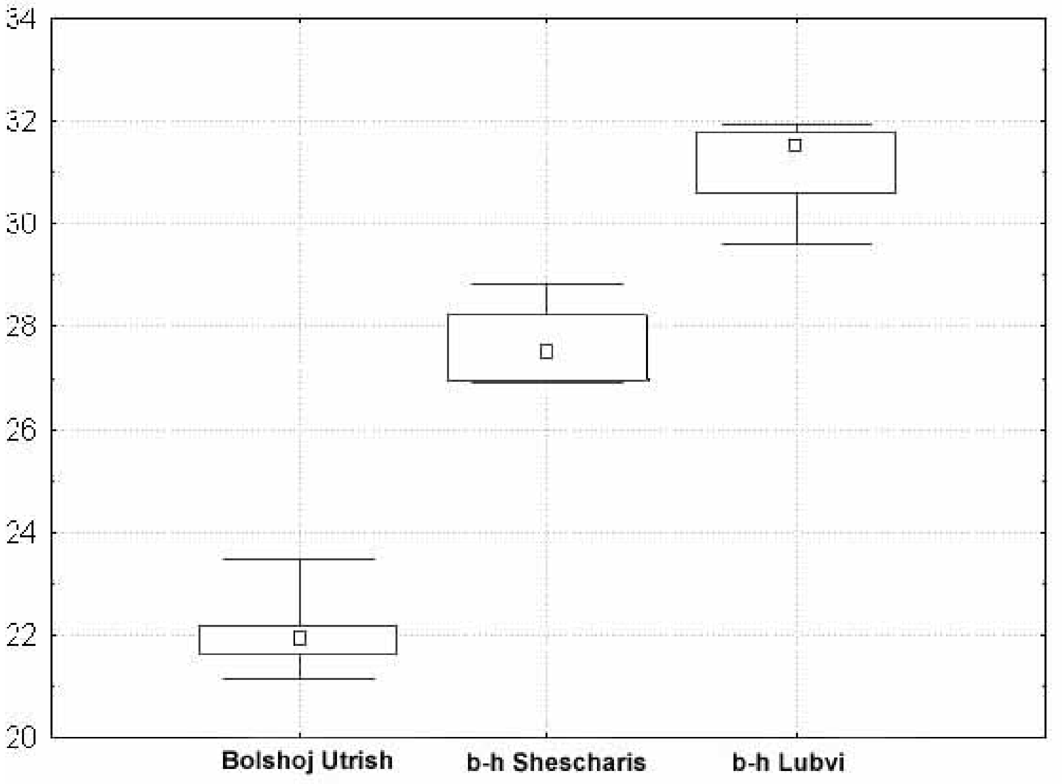

Figure 1. Box and Whisker plot of MDA – content in the thallus of *Cystoseira crinita* from different water areas (see table 1).

In some expeditions which was held in spring and summer, 1999 – 2003 and was dedicated to complex investigation of macrophytobenthos structure on the North Caucasus coast of Black Sea from Tuapse to Tamanskij gulf, some dramatic facts was observed.

We proved that some populations of *Cystoseira* from the polluted place, have a lower average age than from relative clean ecotops (Figure 2,3,4; Depth – 1 meter, July, 2003).

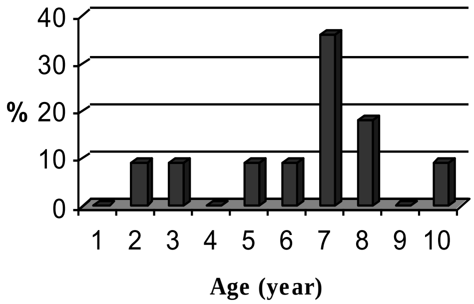

Figure 2. Age structure of population of Cystoseira crinita from area near I. Bolshoj Utrish

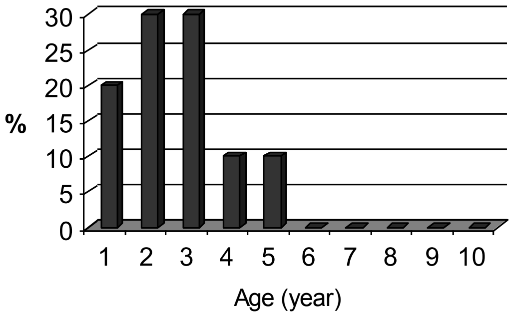

Figure 3. Age structure of population of Cystoseira crinita from the area near beak-head Lubvi

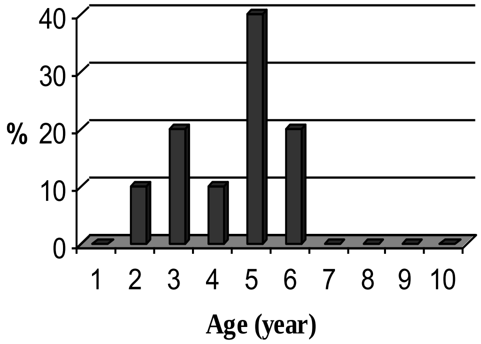

Figure 4. Age structure of population of Cystoseira crinita from area near beak-head Shescharis

The average age of *Cystoseira crinita* from the area near I. Bolshoj Utrish (clean ecotop) (depth - 1 m) is 6,3 year, from the area near beak-head Shescharis, which is characterized by oil pollution (there is an oil terminal near Shescharis) on the same deep is 4,4 year, from the area near beak-head Ljubvi, which is situated in the west side of Novorossijsk bay and characterized by complex fouls, is 2,6 year. So, there is a great decline in seaweed's maturity of the described ecotops, and there is the non-direct dependence: a lot of pollution is depended the short life-cycle of *Cystoseira*.

Furthermore, on the ecosystem level the increasing degradations of associations of *Cystoseira* are leading to a big discrepancy between small cenopopulations of *Cystoseira barbata,* that has already been partially isolated (Afanas'ev, Stepan'an, 2001). Thus, the fields of brown algae *Cystoseira barbata et C. crinita*, which create favorable conditions for some species of bottom fish, are subjected to threat of annihilation. This scenario can bring some biological (disappearance of some species of macrophytes, such as *Polysiphonia opaca, Ceramium ciliatum, Apoglossum ruscifolium, Laurencia sp.*), ecological (carrion algae, anoxia) and economic consequences, because both species of *Cystoseira* can be harvested, as a source of alginate, which is used in cosmetic and pharmaceutical industry.

Another important change of last decade in spatial distribution of benthic macrophyte communities of North Caucasus coast has been the narrowing of canopy belt, caused, on our opinion, by increasing turbidity of water and, as a consequence, low light penetration. This expansion in water turbidity is leading to a great reduction of deep macrophytocenosis, such as *Codietum purum, Codietum phyllophorosum, Phyllophoretum purum, Phyllophoretum codiosum* and decline of macrophytobenthic production in general. For example, lowest boundary of benthic macrophyte communities in 1970-th was about 25 – 35 meters deep (Kalugina-Gutnik, 1975; Gromov, 1998), and now no more than 15 – 25 meters, even in the relatively clean ecotops, such as the areas near beak-heads Penay, Doob and north-end of Abrau peninsula (Gromov, Afanas'ev, Shevchenko, 2001).

So, on the different levels of living matter organization there are different negative changes of some characteristics of macrophytobenthos during the last decade: the oxidative stress on the cell level in the thallus of edominants, the downfall of adults *Cystoseira* on the population level, the decline of macrophytobenthic diversity on the ecosystem level. We estimate the present state of benthic macrophyte communities of North Caucasus coast of the Black Sea as a critical.

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CONTEMPORARY DYNAMICS OF COASTAL BENTHIC COMMUNITIES OF THE NORTH CAUCASIAN COAST OF THE BLACK SEA

Margarita V. CHIKINA., Nikita V. KUCHERUK
P.P.Shirshov Institute of Oceanology RAS, Moscow, Russia
chikina@chip.sio.rssi.ru, kucheruk@sio.rssi.ru

ABSTARCT

The study of the North Caucasian coastal benthos, carried out by Institute of Oceanology RAS in 1999-2003, showed strong changes in biodiversity and species structure of coastal communities. The rise of the muddiness that coincided with the introduction of *Mnemiopsis leidyi*, invoked moving of phytal zone, claying of coastal sands and disappearance of the communities, which were known for the Caucasian coast from the beginning of the 20th century. Nowadays, the most depressed communities are at the south of the explored area, where the absence of dominants and subdominants of coastal communities, the decrease of coastal benthos biodiversity and quantitative abundance can be observed. At a depth of 15-25 m, where previously the core of the rich and diverse community with bivalve *Chamelea gallina* dominance was located, now an exotic bivalve *Anadara inaequivalvis* dominates.

In the North, near Anapa, along with practically the same decrease of biodiversity, there is no decrease of benthos biomass in comparison with the data obtained in 1989 and during the earlier years.

Keywords: Black sea, zoobenthos, biodiversity, exotic species, *Anadara inaequivalvis*.

INTRODUCTION

Until the 1980s the species composition and quantitative distribution of the Black sea macrozoobenthos could have been characterized as seasonally stable with comparatively small annual fluctuations in density and biomass. Strong changes began in the year 1989. Some species disappeared while others were introduced and became dominant. The biomass of *Chamelea gallina* biocenosis increased in more then 4 times, comparing with 1960-1970s, and a new bivalve appeared in the community – *Anadara inaequivalvis* (Alekseev R.P., Sinegub I.A., 1992). The arc shell *Anadara* *inaequivalvis* (*Bruguière*, 1789), is an Indopacific Arcidae which first appeared in the Black sea near the Bulgarian coast in 1983. It is known in the Mediterranean sea since the end of the 1960s. Immigration of the species was most likely due to the accidental transportation of juvenile stages in the ballast water of tank ships coming from the Pacific. This Indopacific bivalve was not only well adapted in the new habitat, but in recent years its density has so increased that the community of *Chamelea gallina* seems to be seriously compromised by its presence (Figure1).

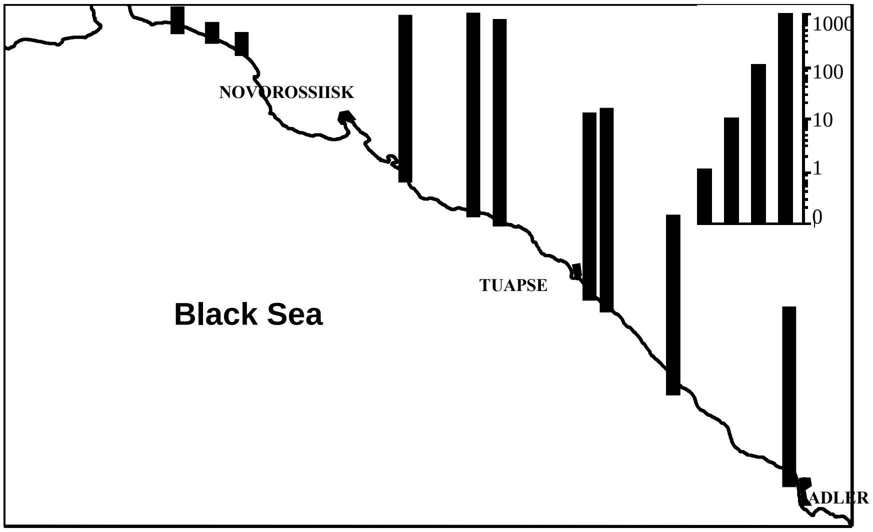

Figure1. The distribution of the biomass of *Anadara inaequivalvis* along the North Caucasian coast (logarithmic scale).

We suppose that it is connected with abiotic factors, like organic carbon content and the grain-size structure of sediments, which are different in those parts (sands near Anapa and rocks to the south from Novorossiysk). The investigated area to the south from Novorossiysk is more eutrophic, rich in organic matter and anoxic crises due to massive algal blooms are frequent. At the same time, the area near Anapa is hydrologically separated from the main Black sea current due to the quasistable anticyclone circulation and has smaller concentrations of organic matter. And *Anadara inaequivalvis* is apparently better adapted to anoxia then *Chamelea gallina*, due to the presence of hemoglobin in the ark shell erythrocytes. Therefore long life spans and reduced mortality rates, coupled with greater respiratory efficiency, most likely endows *A.inaequivalvis* with a high resistance to environmental stresses (Cortesi P. et al., 1992). So, the local overwhelming of other bivalve species by the arc shell seems to be the consequence of both ecological and anthropogenic factors.

The purpose of this work is to study contemporary conditions of zoobenthos and to make analysis of changes in benthic communities, observed near the North Caucasian coast during last several years.

MATERIAL AND METHODS

Material was collected in five cruises of R/V “Akvanavt” in summer and autumn each year from 1999 to 2003. It was taken more then 100 stations along the North Caucasian coast from Adler to Kerch Strait (Figure2).

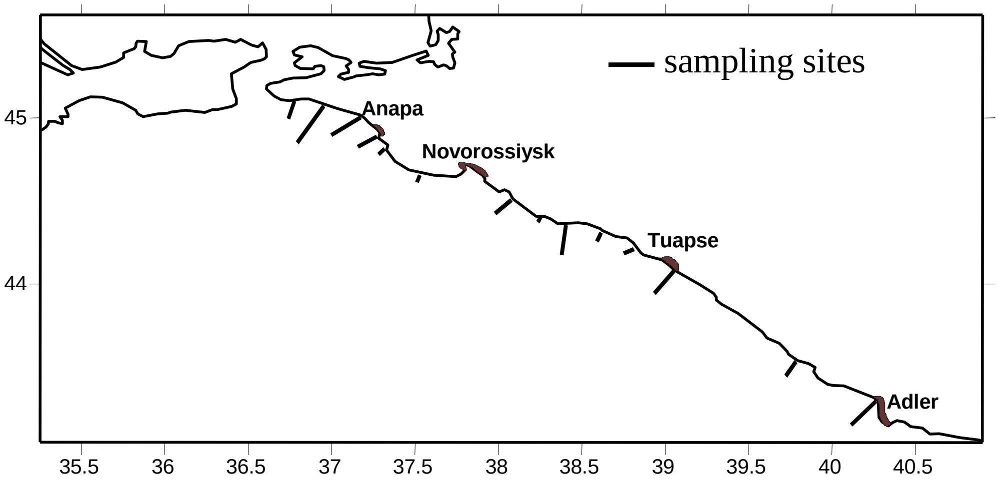

Figure2. Location of the sampling sites on the North Caucasian coast in 1999-2003

Five diver grabs with sampling area 0,1 m^2 were taken at each station. Samples were sieved through a 0,5 mm sieve and preserved in 4% formaldehyde, for subsequent sorting in laboratory.

RESULTS AND DISCUSSION

Investigations produced an unexpected result. The North Caucasian coast now can be divided into two quite different parts, according to the state of coastal benthos, the first one – from Anapa to Kerch Strait, the second one – from Novorossiysk to Adler.

The southern part of the shelf have undergone especially strong changes. The rise of the muddiness that coincided with the introduction of *Mnemiopsis leidyi*, invoked moving of phytal zone, destroy of algae communities at a depth of more than 10 m, and that opened for Rapana the way to the large amount of food objects and caused drastic increase in the number of this predator In 1999 density of its population on hard bottom ran up to 50 specimens per square meter. Community with *Chamelea* *gallina* dominance was obtained only at shallow depth of 5-11 m, biomass and abundance of *C.gallina* corresponded with the data, cited for this depth range in 1963 (Kiseleva M.I., 1977). But at a depth range of 20-30 m, which was mentioned by Kiseleva as the "core of *C.gallina* biocenose", the situation was quite different: *C.gallina* has completely disappeared. (Figure3).

A range of species, for example, bivalves *Gouldia minima* and *Acanthocardia paucicostata*, which were the community subdominants in 1980-1989, were absent too. However, in 2000 the situation again radically changed. The enormous quantity of juvenile *Chamelea* (up to 13000 sp/m^2) was observed at a depth 10-18 m and deeper – at a depth of 20-35 m a large amount of juvenile specimens of an alien bivalve *Anadara inaequivalvis* (up to 3000 sp/m^2) was found out.

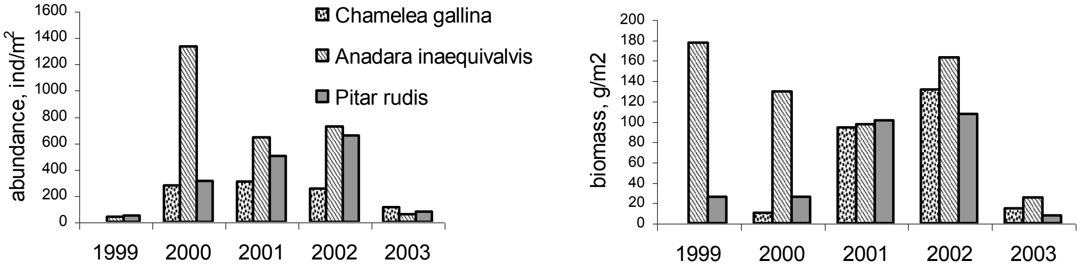

Figure 3. The dynamics of biomass and abundance of dominant species during last years (20-30m).

C.gallina in the Black sea spawns in August-September (Zahvatkina K.A., 1963) and *A.inaequivalvis* in September-October (Kazankova I.I., 2002), therefore, in our probes bivalves, which have settled one year ago, are presented. This conclusion is confirmed with the size-structure analysis of *C.gallina* and *A.inaequivalvis* populations. Individuals of *C.gallina* in the second autumn of life are about 6-10 mm (Chukhchin, 1965), and individuals of *C.gallina* and *A.inaequivalvis* in our samples are about 5-10 mm. We concern the mass settlement of bivalve larvae to be the result of abrupt decrease of ctenofore *Mnemiopsis leidyi* in autumn 1999 due to the invasion of obligate ctenoforefagous ctenofore *Beroe ovata*. Omnivorous ctenofore *Mnemiopsis* eats pelagic bivalve larvae, and its elimination permitted bivalve larvae to settle.

During next two years we didn't observe any new recruitment, neither *A.inaequivalvis*, nor *C.gallina*. Probably that it is connected with large amount of bivalves from elder age groups, which prevent larvae to settle. However such mass settlement led to the delay of bivalve growth, and that became the reason for the reproduction and development of small *Rapana*, which obtained admittance to the large amount of food objects. In normal communities the abundance of young *Chamelea* (5-10 mm) is about several dozens per square meter. As a result, in 2002 we observed very high density of young *Rapana* – from 60 to 120 ind/m^2. And together with high density of *Chamelea* and *Anadara* – about several thousands per square meter, that led to almost complete eating away of bivalve populations in 2003 (Figure3).

The extensive collected material also allowed us to show the decrease of coastal benthos biodiversity (Figure4), comparing with 1960s, when there were several large-scale investigations of the North Caucasian coast (Kiseleva M.I., 1981). Along with the equal total probe square, the number of species in 2001 is half as great as in the year 1963.

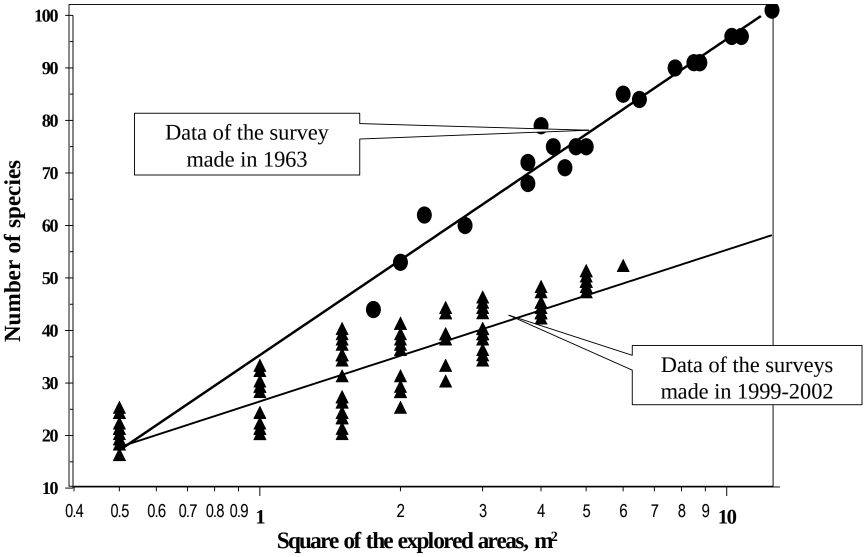

Figure4. The decrease of coastal benthos biodiversity

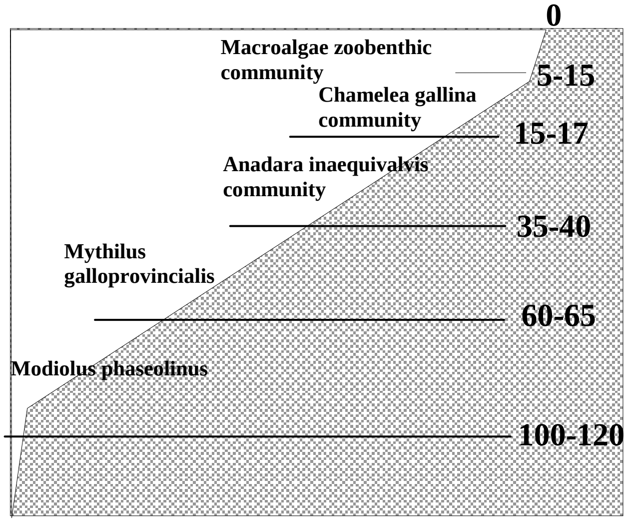

Figure5 Vertical distribution of the coastal benthic communities

Nowadays, the picture of the communities distribution to the south from Novorossiysk is as follows (Figure5): shallow-water sands less then 15 m depth are occupied with *Chamelea gallina* community, at a depth of 15-35 m there is a new community with dominance of *Anadara inaequivalvis*. The *Mytilus galloprovincialis* community exists only at narrow zone between 40 and 50 m.

CONCLUSION

Thus, the contemporary condition of soft bottom benthic communities depends on three factors connected with pelagic and benthic alien species:

1. The replenishment of bottom juvenile bivalve populations depends on the *Mnemiopsis-Beroe* interactions in pelagic zone.
2. Predator *Rapana*, which eats large specimens of benthic bivalves, controls further development of mollusk populations.
3. The ability of *A.ineaquivalvis* to resist the environmental stresses better then the native species do permitted it to become a dominant at a depth range from 15 to 30 m.

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QUALITATIVE AND QUANTITATIVE INVESTIGATIONS ON *ULVA RIGIDA* FACIES FROM THE UPPER INFRALITTORAL ZONE ALONG SINOP COAST, MIDDLE BLACK SEA

Gamze GÖNLÜGÜR- DEMİRCİ[*] and Tuncer KATAĞAN
[*] Ondokuz Mayıs University, Faculty of Fisheries, Department of Hydrobiology,
57000 Sinop, Turkey.
E-mail: gamzeg@omu.edu.tr
Ege University, Faculty of Fisheries, Department of Hydrobiology, 35100
Bornova, İzmir, Turkey

ABSTRACT

In this study, seasonal samples were collected from three different stations (June 1999 and April 2000) in order to determine the biota living in the *Ulva rigida* facies, a common alga distributed along the Black Sea coastline. Samplings revealed the presence of 176 species, 61 of which were algal species, whereas 115 occured within the fauna. Systematic groups were examined qualitatively and quantitatively, as a result of which 47 species were reported as new recordings for the Turkish coast of the Black Sea.

Key words: benthos, black sea, *Ulva rigida*, facies, distribution

INTRODUCTION

U. rigida is a common green alga found in the mediolittoral and infralittoral zones from the Mediterranean to the Black Sea. Due to their unique structure, algae constitute specific substratum for the settlement of a great number of marine animals. Moreover, as photophyll organisms, algal masses provide substantial contribution to the production in the marine coastal zone.

Five species of genus *Ulva* -namely, *U. curvata, U. fasciata, U. fenestrata, U. lactuca* and *U. rigida* - have been recorded from the Turkish coast of the Black Sea. (Aysel & Erdugan, 1995). Due to the fact that *U. rigida* demonstrates a wider distribution along the coast of Sinop, which makes up the area of investigation, this facies of the algae was taken into the scope of the study. Furthermore, there are no readily available studies on the facies of either *Ulva* or any other species along the Turkish coast of the Black Sea. Studies along the Black Sea coastline, on the other hand, are limited to a few on

Cystoseira and *Phyllophora* conducted on the coasts of Bulgaria (Zaitsev & Mamaev, 1997; Konsulov & Konsulova, 2002); Rumania (Bavaro, 1973) and Russia (Kalugina & Gutnic, 1975 ; Zaika et al.,1979).

This study attempts to determine the biological characteristics of an *U. rigida* facies present the Turkish coast of Black Sea, for the first time.

MATERIAL AND METHODS

Between June 1999 and April 2000, three stations were chosen along the Sinop coast and a total of 12 samples (seasonal) taken from each station so as to examine the facies of *U. rigida* (Figure 1). Samplings were carried out according to methods recommended by Boudouresque (1971) and Bellan-Santini (1969) using a 20 x 20 cm frame (quadrate) covered with a 100 μm plankton mesh. The samples were sieved through 250 μm screens, labeled and placed into jars containing 70º ethanol. Following this procedure of sorting, taxonomical determinations were made and the number of individuals for each species computed for ecological evaluations. Soyer 's frequency index (1970) was used for the statistical determination of the frequency of the species in the biotope. According to this index, the species is considered abundant (A) in the community if the F value is > 49; common (C) if 25 ≤ F ≥ 49, and rare (R) if F is < 25. Shannon and Weaver's (1949) formula was used for the diversity of the species within the facies; Pielou's (1975) for the index of evenness; Picard's (1965) for mean abundance; and Bellan-Santini's (1969) for dominancy

Figure 1. Sampling stations

RESULTS

As a result of the samplings carried out in the *U. rigida* facies, 35132 individuals belonging to 176 species were determined. As can be seen from the table (1), qualitatively the dominant taxons were algae, Arthropoda, Annelida and Mollusca, respectively. Quantitatively, however, Arthropoda were the dominant taxon with 73.73 %, followed by Mollusca and Annelida.

Mean abundance values of the species identified in the *U. rigida* facies ranged between 419.417 and 0.083 and their average dominance is ranged from 0.003 to 14.326 %. Accordinly *Stenothoe monoculoides* (14.326 %), *Mytilaster lineatus* (8.539 %), *Caprella acanthifera* (8.041 %), *C. rapax* (7.850 %), *Erichthonius difformis* (7.734%), *Amphithoe ramondi* (7.307 %), *Microdeutopus gryllotalpa* (4.338 %), *Apherusa chiereghinii* (4.164 %), *Leptochelia savignyi* (3.885 %), *Setia valvatoides* (3.214 %), *Platynereis dumerilii* (2.237 %), *Grubeosyllis limbata* (2.160 %), *A. helleri* (1.967 %), *E. punctatus* (1.958 %), *Exogone naidina* (1.788 %), *Dynamene torelliae* (1.691 %) and *Tricolia pullus* (1.403 %) were found to be the dominant species, respectively.

Following an evaluation of the *U. rigida* facies with respect to values of frequency index, it was found that the number of taxons classified under the abundant group was 42, while it was 29 for the common group and 105 for the rare group. Species classified under the abundant and common groups were specified in Table 1 for each systematic group.

Most of the 176 species and 35132 individuals found in *U. rigida* facies were sampled from Station 1 (126 species and 21800 individuals). Ninety and seven species and 7231 individuals were sampled from Station 3, and 92 species and 6101 individuals were sampled from Station 2. Numerical distribution of the identified species and their individuals in accordance with taxons are presented in Figure 1 a and b. Whit respect to number of individuals and species, stations 2 is similar to stations 3.

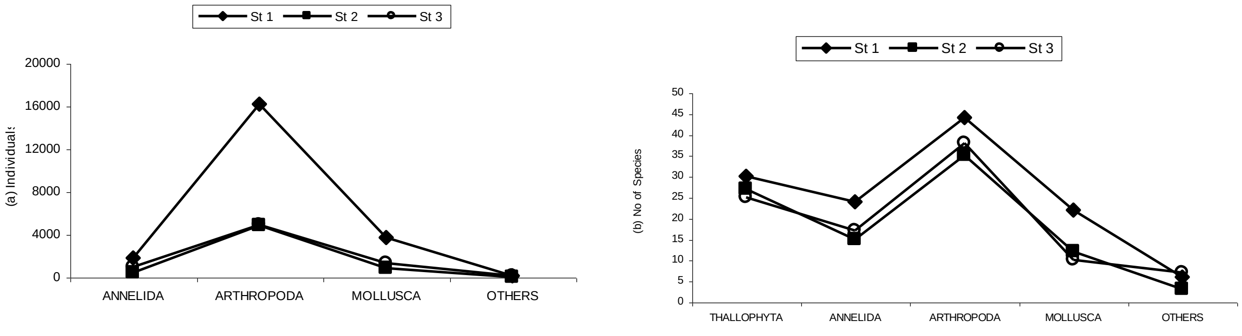

Figure 1- Numerical distribution of the identified species (a) and their individuals (b) in accordance with stations.

Table 1. Distribution of systematic groups by qualitative, quantitative and frequency degrees (Sp, species; Ind, individualSt 1, Karakum Station; St 2, Yuvam Station; St 3, Asmakaya Station)

	Abundant F > 49	*Common* 25 ≤ F ≥ 49	**Rare** F<25	**Sp.**	**Qualitative distribution (%)**	**St1**	**St2**	**St3**	**Ind.**	**Quantitative distribution (%)**
Algae	3 (*Cystoseira barbata, Ulva rigida, Ceramium rubrum var barbatum)*	**5 (Lomentaria clavellosa, Corallina granifera,Ceramium diaphanum var diaphanum, Laurencia pinnatifida, Polysiphonia elongata)**	53	**61**	**34.66**	30	27	25	-	**-**
Annelida	9 (*Harmothoe impar, Eulalia viridis, Exogone naidina,Grubeosyllis clavata,G. limbata, Syllis krohni, Pionosyllis pulligera, Nereis zonata, Platynereis dumerili)*	2 (*Janua pagenstecheri* Oligochaeta (spp.)	22	**33**	**18.75**	24 1779	15 393	17 969	**3141**	**8.94**
Arthropoda	21 (*Caprella acanthifera, C. danilevskii, C. liparotensis, C. rapax, Amphithoe helleri, A. ramondi, Microdeutopus gryllotalpa, Cymadusa crassicornis, Corophium acherusicum, Dexamine spinosa, Apherusa chiereghinii Erichthonius brasiliensis, E. punctatus, Melita palmata, Stenothoe monoculoides, Janira maculosa, Dynamene torelliae, Synisoma capito, Leptochelia savignyi Sirriella jaltensis, Psidia longimana)*	18(*Caprella mitis,, Pseudoprotella phasma, ,Microdeutopus algicola, Dexamine thea, Tritaeta gibbosa, Hyale pontica, H. schmidtii, Erichthonius difformis, Jassa marmorata , J. ocia, Orchemene humilis, Idotea baltica, Cumella limicola, Nannastacus unguiculatus, Hippolyte leptocerus, Athanas nitescens, Pilumnus hirtellus* Pantopoda sp.1)	11	**50**	**28.41**	44 16198	35 4831	38 4872	**25901**	**73.73**
Mollusca	7 *Lepidochitona corrugata Gibbula adansonii,Tricolia pullus,Rissoa splendida, Odostomia* spp., *Mytilus galloprovincialis, Mytilaster lineatus*)	3 (*Setia vavatoides, Ammonicera fischeriana, Abra* sp.)	14	**23**	**13.06**	22 3697	12 854	10 1289	**5840**	**16.62**
Oth	2 (Turbellaria spp., Nemertini spp.)	1 (Nematoda spp.)	6	**9**	**5.12**	6	3	7	**250**	**0.71**
Total No of individuals						**21800**	**6101**	**7231**	**35132**	**100**
Total No of species				**176**	**100**	**126**	**92**	**97**		

Although, no important seasonal variations in the total numbers of the identified taxons were observed, the highest individual number (20583 individuals) was observed in the summer, and lowest number (4178 individual) was observed in the spring. Regarding the number of identified species and their representative individuals, arthropoda was the dominant taxon at all stations in all seasons, with the exception of station 3 (Table 2).

An examination of the diversity index values of arthropoda ranged from 3.651 to 3.859 bit; and the same index ranged from 1.339 to 2.303 bit for mollusca, and ranged from 2.361 to 2.852 bit for annelida. Value of the diversity index of mollusca at station 1 was 2.303, 1.339 at station 2, and 1.482 at station 3, respectively. However, value of the diversity indexes of annelida and arthropoda were found to be higher than that of mollusca at station 3. Regarding the values of the regularity index, molluscs clustered in stations 2 and 3, while no clustering was observed in annelids and arthropods (Table 3).

Table 2.Qualitative and quantitative distribution of the identified systematic groups in accordance with seasons.

Systematic groups		Summer		autumn		winter		spring	
		Sp.	specimens	Sp.	specimens	Sp.	specimens	Sp.	specimens
THALLOPHYTA	St:1	13		7		9		10	
	St.2	8		5		7		16	
	St.3	5		14		4		13	
ANNELIDA	St:1	10	251	17	663	11	678	8	187
	St.2	7	62	7	37	9	228	7	66
	St.3	8	242	10	185	11	398	8	144
ARTHROPODA	St:1	31	9344	29	3860	27	959	28	2035
	St.2	22	3668	17	201	22	384	20	578
	St.3	25	2441	17	387	26	1199	19	845
MOLLUSCA	St:1	15	3115	13	211	12	209	9	162
	St.2	5	456	4	79	8	198	7	121
	St.3	9	927	7	91	5	234	5	37
OTHER ZOOBENTHİC GROUPS	St:1	2	75	2	32	3	19	1	-
	St.2	-	-	-	-	3	21	2	2
	St.3	1	2	1	2	7	96	1	1
TOTAL		94	20583	85	5748	96	4623	94	4178

Table 3. Values of the diversity and regularity indexes of the systematic groups in accordance with stations (H': Values of the diversity index; J': Values of the regularity index).

TAXA	St 1		St.2		St.3	
	H'	J'	H'	J'	H'	J'
ANNELIDA	2.516	0.549	2.361	0.604	2.852	0.698
ARTHROPODA	3.651	0.665	3.719	0.719	3.859	0.730
MOLLUSCA	2.303	0.516	1.339	0.362	1.482	0.428

It was found that, values of the diversity index of arthropoda were to be higher than other taxons in all seasons (Table 4). The same value of the molluscs peaked in autumn (2.353 bit), and decreased to its' minimum level in spring (1.742 bit). Diversity index of annelids ranged from 2 to 2.585 bit, decreased to its' minimum value in summer and peaked in spring. Regarding the evenness indexes in accordance with seasons, molluscs clustered in spring and winter, and annelids clustered in summer. No clustering was observed in autumn. Values of the evenness index of arthropoda ranged from 0.635 to 0.711, and no clustering was observed.

Table 4. Values of the diversity and evennes indices of the systematic groups in accordance with seasons (H': Values of the diversity index; J': Values of the evennes index).

TAXA	summer		autumn		winter		spring	
	H'	J'	H'	J'	H'	J'	H'	J'
ANNELIDA	2.00	0.488	2.489	0.597	2.522	0.617	2.585	0.778
ARTHROPODA	3.755	0.711	2.689	0.538	3.424	0.635	3.473	0.667
MOLLUSCA	2.075	0.531	2.353	0.636	1.880	0.481	1.742	0.446

DISCUSSION AND CONCLUSIONS

A review of previously conducted studies related to *Ulva* facies will reveal that the study carried out by Kocataş (1978) on *U. lactuca* facies in İzmir Bay is probably the most remarkable one. A total of 153 taxons including 27 algae and 126 zoobenthic species were identified in this study. The qualitative composition consisted of crustaceans (30.06 %), polychaetes (20.26 %) and molluscs (17.64 %), respectively. Regarding the mean abundance of the taxons identified, *Mytilus galloprovincialis* and *Bittium reticulatum* (Mollusca) were the dominant species followed by a crustacean, *Erichthonius difformis*. It was also found that, unlike this study, crustaceans dis not exhibit a high level of abundancy. As epibiont species, serpulidae and *Platynereis dumerilii* were quite common.

Kalugina- Gutnic (1975) investigated the algea co-existing with the *U. rigida* facies in the Black Sea and formed three groups. According to the researcher, *U. rigida* formed the first group with *Ceramium rubrum* , the second group with *Cladophora albida*, and the third group with Apoglossum ruscifolium and *Calithamnion granulatum*. In the present study, however, significant amounts of *C. rubrum var. barbatum* occured in the *U. rigida* facies. Moreover, it was found that *U. rigida* coexisted with *C. barbata* on the coast of Sinop , and that the density of species and individuals increased in direct proportion with that of *C. barbata*. Just like in the Karakum Station, other algae in the second and third groups, which Kalugina–Gutnic asserted to be co-existing with *U. rigida*, were found to occur in smaller numbers.

A total of 176 species (Appendix.1), including 61 algae and 115 zoobenthic species, were recorded in this pioneering study of *U. rigida* facies along the Turkish coast of Black Sea. 47 species of them were reported as new records for the Turkish algal flora and fauna. Six of these new species were algae (*Chrysimenia ventricosa, Chylocladia verticillata, Gelidiella pannosa, Ulva fasciata var. taenita, Cladophora aegropila, Feldmannia globifera*), 18 polychaetes (*Harmothoe impar, Eulalia viridis, Autolytus prolifer, Exogone naidina, Grubeosyllis clavata, G. limbata, Parapionosyllis sp., Pionosyllis pulligera, Syllis gerlachi, Syllis gracilis, S. krohni, Nereis zonata, Perinereis cultrifera, Prionospio multibaranchiata, Spio decoratus, Filograna sp., Pileolaria militaris, Janua pagenstecheri*), 13 molluscs (*Acanthochitona fascicularis, Lepidochitona corrugata, Ammonicera fischerina, Bittium scabrum, Cerithidium submamillatum, Cerithiopsis minima, C. tubercularis, Pusillina lineolata, Rissoa splendida, R. variabilis, R. ventricosa, Setia valvatoides, Tricolia pullus*), 10 arthropods (*Corophium insidosum, Dexamine spiniventris, D. thea, Pseudoprotella phasma, Microphyta carinata, Dynamene torelliae, Janira maculosa, Tanais dulongii, Leptochelia savignyi, Nannastacus unguiculatus*).

In conclusion, the *U. rigida* facies first investigated by Kocataş in the Bay of İzmir and the *U. rigida* facies studied along the coast of Sinop in the Black Sea are comparable. When both studies are compared with respect to zoobenthic taxons, it will be seen that 126 species were recorded in the Bay of İzmir as compared to 115 along the coast of Sinop, wihch is consistent with marine ecological laws such as the one which states that, qualitatively, less saline waters (the Black Sea has been referred to in our case) contain fewer number of species than more saline waters (e.g. Aegean Sea). However, the fact that 61 algae were identified along the coast of Sinop as compared to only 27 in the Bay of Izmir requires careful consideration Although both studies were conducted in different *Ulva* facieses,the significant difference between the numbers of algae species identified in both studies probably stems from the fact that especially the samplings in the latter study (the one in the Bay of İzmir) failed to represent all seasons of the year and that only two seasonal samplings were taken annually in both studies. Therefore, synchorized studies in the investigation of facieses have gained a greater importance.

Appendix 1. Composition of the Zoobenthos Along the Sinop Coast (;* new recording for Turkish waters in the Black Sea)

THALLOPHYTA		**PORIFERA**
Phormidium cf tenue	_Ectocarpus siliculosus var dasycarpus_	Porifera sp.
Audouinella secundata	_E. -- var siliculosus_	
*Gelidiella pannosa	_*Feldmannia globifera_	**CNIDARIA**
Gelidium capillaceum f. capillaceum	_Microsyphar polysiphoniae_	_Obelia_ sp.
G. capillaceum f crinita	_Myrionema strangulans_	_Sertularella_ sp.
*Chrysimenia cf ventricosa	_Scytosiphon simplicissimus_	_Aglophenia cf. septifera_
*Chylocladia verticillata	_Zanardinia prototypus_	
Lomentaria clavellosa	_Cladostephus spongiosus_	
Lomentaria sp.	_C. verticillatus_	
Corallina elongata	_Sphacelaria cirrosa f. mediterranea_	PLATHELMINTHES
C. granifera	_Cystoseira barbata_	Turbellaria (spp.)
Fosliella farinosa	**_C. crinita_**	
Jania rubens	_Cystoseira_ sp.	**NEMERTINI**
Melobesia membranacea	_Pringshemiella scutata_	Nemertini (spp.)
Antithamnion cruciatum	_Enteromorpha clathrata_	
A. tenuissimum	_E. intestinalis_	**NEMATODA**
Callithamnion corymbosum	_E. linza_	Nematoda (spp.)
C. granulatum	_E. linza var crispata_	
Ceramium diaphanum var diaphanum	_Enteromorpha_ sp.	
C. -- var elegans	_Ulva fasciata_	
C. -- var zostericolum f.minuscula	_*U. fasciata var taeniata_	
C. rubrum var barbatum	_U. fenestrata_	
Spermothamnion cf flabellatum	_U. lactuca_	
Apoglossum ruscifolium	_U. rigida_	
Laurencia obtusa	_Chaetomorpha linum_	
L. papillosa	_*Cladophora aegropila_	
L. pinnatifida	_C. albida_	
Polysiphonia elongata	_C. laetevirens_	
P. subulifera	_C. pellucida_	
P. tripinnata	_Bryopsis hipnoides var flagellata_	
	B. -- var hipnoides	
ANNELIDA		
OLIGOCHAETA	_*Exogone naidina_	_*Nereis zonata_
Oligochaeta (spp.)	_*Grubeosyllis clavata_	_*Perinereis cultrifera_
POLYCHAETA	_*G. limbata_	_Platynereis dumerili_
*Harmothoe impar	_*Parapionosyllis_ sp.	_Polydora ciliata_
Harmothoe sp.	_Spharosyllis_ sp.	_*Prionospio multibranchiata_
Pholoe synophthalmica	_*Pionosyllis pulligera_	_Prionospio_ sp.
Eulalia sp.	_Syllides fulvus_	_*Spio decoratus_
*Eulalia viridis	_*Syllis gerlachi_	_Polyophthalmus pictus_
Phyllodoce sp.	_*S. gracilis_	_Fabricia stellaris_

		adriatica
**Autolytus prolifer*	**S. krohni*	**Filograna* sp.
Autolytus sp.	*Syllis* sp.	**Janua pagenstecheri*
	Trypanosyllis zebra	**Pileolaria militaris*
MOLLUSCA		
**Lepidochitona corrugata*	**Rissoa splendida*	**Ammonicera fischeriana*
**Acanthochitona fascicularis*	**R. variabilis*	*Chrysallida* sp.
Gibbula adansonii	**R. ventricosa*	*Odostomia* spp.
**Tricolia pullus*	**Pusillina lineolata*	Opistobranche spp.
**Bittium scabrum*	**Setia valvatoides*	*Mytilus galloprovincialis*
Bittium sp.	**Cerithiopsis minima*	*Mytilaster lineatus*
**Cerithidium submamillatum*	**C. tubercularis*	*Parvicardium exiguum*
Rissoa juvenili	*Cyclope neritea*	*Abra* sp.
ARTHROPODA		
CIRRIPEDIA		
Balanus sp.		
AMPHIPODA		
Caprella acanthifera	*Gammarellus angulosus*	**TANAIDACEA**
C. danilevskii	*Gammarus insensibilis*	**Tanais dulongii*
C. liparotensis	*Hyale crassipes*	**Leptochelia savignyi*
C. mitis	*H. perieri*	**MYSIDACEA**
C. rapax	*H. pontica*	*Sirriella jaltensis*
**Pseudoprotella phasma*	*H. schmidtii*	**CUMACEA**
Amphithoe helleri	**Micropythia carinata*	**Nannastacus unguiculatus*
A. ramondi	*Erichthonius brasiliensis*	*Cumella limicola*
Cymadusa crassicornis	*E. difformis*	**DECAPODA**
Microdeutopus algicola	*E. punctatus*	*Hippolyte leptocerus*
M. gryllotalpa	*Jassa marmorata*	*Athanas nitescens*
Corophium acherusicum	*J. ocia*	*Psidia longimana*
**C. insidiosum*	*Orchemene humilis*	*Pilumnus hirtellus*
Dexamine spinosa	*Melita palmata*	**ACARINA**
**D. spiniventris*	*Stenothoe monoculoides*	Pantopoda sp.1
**D. thea*	**ISOPODA**	Pantopoda sp.2
Tritaeta gibbosa	**Janira maculosa*	
Apherusa bispinosa	**Dynamene torelliae*	
A. chiereghinii	*Idotea baltica*	
	Synisoma capito	
BRYOZOA	**CHORDATA**	
Micropora complanata	*Botryllus schlosseri*	

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CONTRIBUTIONS TO THE KNOWLEDGE ON BENTHIC CRUSTACEANS FROM TURKISH BLACK SEA COAST

Gamze GÖNLÜGÜR, *Tuncer KATAĞAN, Murat SEZGİN, *Fevzi KIRKIM
Ondokuz Mayıs University, Fisheries Faculty, Department of Hydrobiology
57000-Sinop-Turkey
*Ege University, Fisheries Faculty, Department of Hydrobiology 35100-
Bornova-İzmir-Turkey
Corresponding author e-mail: msezgin26@hotmail.com

ABSTRACT

The present work is concerned with seven benthic crustacean species, obtanied during benthic samplings by diving at the Sinop Peninsula (Black Sea) coasts at the depth 0.5-15 m, in between June 1999 and April 2000. These species are *Caprella equilibra* Say, 1818, *Harpinia dellavallei* Chevreux, 1910, *Hyale camptonyx* (Heller, 1866), *Leucothoe spinicarpa* (Abildgaard, 1789) (Amphipoda); *Gnathia vorax* (Lucas, 1849) (Isopoda) and *Anapagurus laevis* (Bell, 1845), *Macropodia longirostris* (Fabricius, 1775) (Decapoda). In this study, these seven species are reported first time from the Turkish Black Sea coast. These specimens have been deposited in the museum of the Department of Hydrobiology, Fisheries Faculty, University of Ondokuz Mayıs (O.M.U).

INTRODUCTION

Turkish Black Sea coast are one most poorly studied areas of the Black Sea, although its fauna is for several reasons of special interest. Crustaceans, being one of the most important Arthropod groups, are very little studied in the Turkish Black Sea coast, and also in the whole of the Black Sea.

The information concerning the benthic Crustacean fauna of the Turkish Black Sea coast from systematic, ecological, and zoogeographical point of view is included in a very restricted number of papers: Holthuis (1961), Kocataş (1981, 1982), Ateş (1997), Kocataş & Katağan (2003) for Decapoda; Stock (1967,1968), Caspers (1968), Kocataş & Katağan (1980), Sezgin (1999), Sezgin & Bat (1999), Akbulut & Sezgin (2000), Sezgin et al. (2001), Kocataş et al. (2003) for Amphipoda. Scattered information on the benthic crustaceans of this area can also be found in general faunistic or ecological papers such as Demir (1952), Mutlu et al. (1992), Gönlügür (2003). Although the number of studies of the Turkish shoreline of the Black Sea is limited, in other parts of the Black Sea many studies have been carried out on the Crustaceans on the cost of Bulgaria, Romania, Ukrania and Russia.

The main objective of the present paper is to provide new information on the benthic crustacean fauna of the Turkish Black Sea coast. These new data which would be useful in the process of characterizing the Crustacean fauna of the Turkish Black Sea coast.

MATERIAL AND METHOD

The present study is a part of a research program started in 1999 aiming to study the benthic macrofauna of the Sinop Peninsula coast. During this study material was collected from five stations, in depths between 0.5-15 m. This stations are given on map of Figure 1. Material employed in this research was collected from Sinop Peninsula coasts between June 1999-April 2000 (seasonal) by free or SCUBA diving. Samplings were carried out according to methods recommended by Boudouresque (1971) and Bellan-Santini (1969) using a 20 x 20 cm frame (quadrate) covered with a 100 µm plankton mesh. The samples were sieved through 250 µm screens, labeled and placed into jars containing 70 % ethanol. Samplings were carried out hard substrates.

Specimens were preserved in 70 % ethanol and have been deposited in the Museum of the Department of Hydrobiology, Fisheries Faculty, University of Ondokuz Mayıs. The species were identified and listed according to the revisions given by Bellan-Santini et al. (1982, 1989, 1993) for Amphipoda, Giordoni-Soika (1950), Holdich (1968, 1970) for Isopoda and Zariquiey Alvarez (1968), D'Udekem D'acoz (1996) and Falciaci & Minervini (1996) for Decapoda.

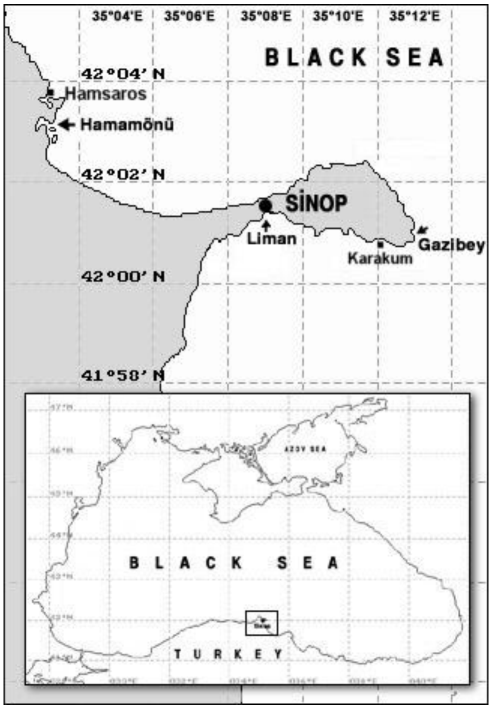

Figure 1. Map showing the location of sampled areas in the Turkish Black Sea Coast

RESULT AND DISCUSSION

A total of seven new record benthic crustaceans (4 Amphipoda, 1 Isopoda, 2 Decapoda) was collected during samplings. The specimens examined in accordance with the original descriptions and, consequently, no further description is required. A review of inventory studies relevant to the species indicates, that *C. equilibra*, *H. dellavallei*, *H. camptonyx*, *L. spinicarpa*, *G. vorax*, *A. laevis*, *M. longirostris* constitutes new records for Turkish Black Sea fauna.

Amphipoda

Caprella equilibra Say, 1818

Material examined: Station Hamsaros, depth 3 m, rocky substratum covered with *Cystoseira* spp., 30.11.1999, 25 individuals; 17.05.2000, 12 individuals - Station Hamamönü, depth 2 m, rocky substratum associated with the bivalve *Mytilus galloprovincialis* Lamarck, 1819., 31.10.1999, 63 individuals, 31.01. 2000, 3 indivudals.

Harpinia dellavallei Chevreux, 1910

Material examined: Station Liman, depth 5 m, Only one specimen was collected on a rocky substratum associated with *Aglaophenia* sp. (Cnidaria), 23.09.1999.

Hyale camptonyx (Heller, 1866)

Material examined: Station Karakum, depth 0.5 m, rocky substratum covered with *Cystoseira barbata* **(**Good. et Wood. Ag., 1821), *C. crinita* Duby and *Ulva* sp., 19.01.2000, 10 individuals – Station Hamamönü, depth 2 m, rocky substratum associated with the bivalve *Mytilus galloprovincialis* Lamarck, 1819, *Corallina* sp., *Cystoseira* sp. and *Ulva* sp., 30.04.2000, 46 individuals.

Leucothoe spinicarpa (Abildgaard, 1789)

Material examined: Station Gazi Bey, depth 0.5 m, Only one specimen was collected rocky substratum covered with *M. galloprovincialis* Lamarck, 1819 , *Bryopsis* sp., *Polysiphonia* sp. and *Cystoseira* sp., 28.04.2000.

Isopoda

Gnathia vorax (Lucas, 1849)

Material examined: Station Hamsaros, depth 3 m, Only one specimen was collected rocky substratum covered with *Cystoseira* sp., 25.08.1999.

Decapoda

Anapagurus laevis (Bell, 1845)

Material examined: Station Hamsaros, depth 3 m, Only one specimen was collected rocky substratum covered with *Cystoseira* sp., 17.05.2000.

Macropodia longirostris (Fabricius, 1775)

Material examined: Station Hamsaros, depth 3m, Only one specimen was collected rocky substratum covered with *Cystoseira* sp., 30.11. 1999.

The number of benthic crustacean species known up to the present from the Black Sea, is approximately 189, estimated after a comprehensive review of the relavant literature. The number of species found in the Turkish Black Sea (~132) comprises 69.8% of the total number of Black Sea species. The relatively low species numbers found in Turkish coast of Black Sea, in comparison with other Black Sea areas should be mainly attributed to the restricted research efforts carried out in this area.

The known fauna of the Turkish Black Sea coast has been enriched after the present study with seven species, corresponding to 6.4 % of the total Turkish Black Sea Crustacean fauna.

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SPECIES DIVERSITY AND TYPE OF HARPACTICOID COPEPOD DISTRIBUTION IN WATER AREAS WITH HIGH ANTHROPOGENIC INFLUENCE

Lesya GARLITSKA
Department of Hydrobiology, Odessa Branch, Institute of Biology of Southern Seas,
National Academy of Sciences of Ukraine, Odessa, 65011, Ukraine.
e-mail: garlitska@farlep.net

ABSTRACT

Harpacticoid copepods had been studied in the Grigorievsky Liman (northwestern Black Sea) in 1992–1997 and 2000–2003. By abundance harpacticoids are on the third place in meiobenthos after nematodes and foraminifers. They make up 15 % of the total number of meiobenthos, and their abundance varies from 0 to 1 432 500 ind.·m^{-2}. The density distribution of these crustaceans and their fraction in the total meiobenthos organisms had a tendency of rising from the upper towards the lower part of the liman. Thirty-five species of harpacticoid copepods belonging to 16 families were registered here. High frequency was recorded for *Ameira parvula*, *Canuella sp.*, *Ectinosoma melaniceps*, *Enhydrosoma gariene*, *Mesochra pontica*, *Microarthridion littorale*, *Nitocra typica*, *Schizopera (Sch.) compacta* and *Paronychocamptus sp.*.

INTRODUCTION

Harpacticoids are one of the most important components of the bottom communities of organisms known as meiobenthos. Usually, they rank second in numbers of multicellular taxa in marine sediments. Free-living nematodes, as a rule, dominate by total numbers (McIntyre, 1969). It is known that harpacticoids make up from 4 % (Coull at al., 1979) to 95 % (Coull & Wells, 1981) of total meiobenthos density on the soft sediments and 11–60 % (Hicks, 1977b) of total meiobenthos in phytal. These crustaceans are able to live in all types of water bodies. In estuarine sediments they facilitate biomineralization of organic matter and enhance nutrient regeneration; they serve as food for a variety of higher trophic levels; and they exhibit high sensitivity to anthropogenic inputs, making them excellent sentinels of pollution (Coull, 1999).

Grigorievsky Liman extends 10 km from north to south with a maximum width up to 1 km. It has a navigation channel of 17 m depth and 400 m width located along the axis of the liman. This is a comparatively small coastal water body with a marine type of flora and fauna. Since being connected with the sea in early 1970s it became a marine bay with a 15.12–17.91 $‰_0$ salinity. Generally, in the coastal area (0–0.5 m) a firm sandy sediment with a small shelly admixture is dominant. In the upper reaches of the liman at 3–6 m depth, the substrate is muddy shell. There is black mud at a 13–17 m depth in the channel. The catchment area of Grigorievsky Liman exceeds its surface tenfold. The influence of different kinds of activity are evident in the water area of the liman and its coastal zone. A large chemical plant is situated here not far from a trading port. The liman and the coastal northwestern Black Sea zone can be designated as anthropogenic-eutrophic. The harpacticoids in this liman have been studied for the first time.

MATERIALS AND METHODS

Samples for these studies were taken in the Grigorievsky Liman in 1992–1997 and 2000–2003 within the framework of scientific projects of the Odessa Branch of the Institute of Biology of Southern Seas (National Academy of Sciences of Ukraine). The samples were taken according to a standard network of stations (Figure 1) at shallow water areas up to 0.5 m depth with a 10 x 10 cm metal frame covered with a 64 µm mesh net. At 4–15 m depth a Peterson dredge with a 0.25 m^2 core area was used for sampling from board ship. Sediments were sampled and leached from a 100 cm^3 surface through a system of soil sieves under which the mesh net was placed. The samples were fixed in 4 % buffered formalin and dyed with Rose Bengal. Some 202 quantitative samples were collected and processed. Not less than 100 specimens of harpacticoid copepods were picked up from 59 samples for further identification.

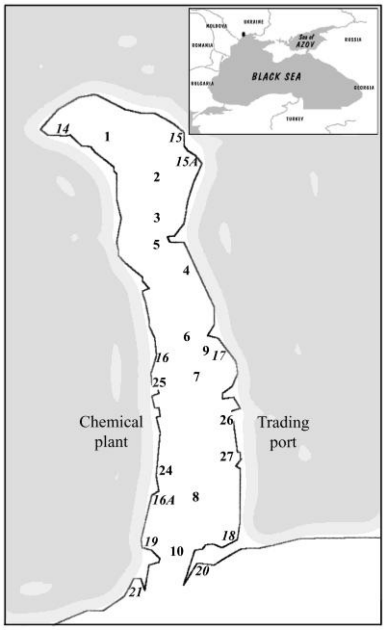

Figure 1. Scheme of stations: regular type – deep water stations, *italic type* – shallow water stations.

RESULTS

HARPACTICOID COPEPOD DISTRIBUTION.

The Grigorievsky Liman harpacticoid copepods rank third in abundance in the group of meiobenthos after nematodes and foraminifers. Making a wide range of density indices (0–1 432 500 ind.·m^{-2}) they make up 15 % of the total number of meiobenthos.

In the winter (February 1993) in spite of low near bottom water temperatures (1–1.4 ˚C) harpacticoids are present in all of the liman area. Meanwhile, their abundance varied in the liman from 4 000 to 19 666 ind.·m^{-2} (Table 1). Higher values were observed at Station 7 (38 666 ind.·m^{-2}) and Station 10 (50 666 ind.·m^{-2}). The moiety of crustaceans in the total density varied from 1 to 13 % (maximum values at Station 1 and 9).

Spring material was sampled in May 1993, 1995, 1996 and 2003. The harpacticoid density had a wide range of variation from 8 000 to 745 000 ind.·m^{-2}, but in three fourths of the samples it did not exceed 100 000 ind.·m^{-2} (Figure 2). The density distribution of these invertebrates and their moiety in the total meiobenthos organisms had a tendency of rising from the upper towards the lower part of the liman (Table 1). Analysis of data has shown that 1996 and 2003 were more favourable periods for development of bottom copepods. In most samples harpacticoids dominated towards the spring. In spite of the twofold increase in mean abundance of crustaceans (210 388 ind.·m^{-2}), heterogeneity of the indices increases, although there is no change in the spatial pattern of distribution.

Table 1. Mean values of harpacticoid copepod abundance (10^{3} ind.·m^{-2}) in different months.

Station	February (1993)	May (1993, 1995, 1996, 2003)	June (1994, 1997, 2000)	August (1993, 1994, 1995, 2003)	September (1997)	October (1997)	November (1992, 1994, 2001, 2003)
1	10.3	27.2	371.8	63.0	0	47.5	78.3
2	19.7	23.2	33.8	66.0	0	85.0	33.4
3	10.7	78.2	66.4	63.1	5.0	0	71.7
4	4.7	20.0	–	22.7	–	–	24.5
5	14.7	32.0	30.0	67.5	–	–	1.7
6	7.3	90.9	227.8	209.0	0	20.0	46.9
7	38.7	104.4	18.0	308.3	7.5	2.5	34.9
8	11.3	115.5	109.6	152.5	5.0	15.0	4.9
9	4.0	15.1	–	187.5	–	–	0
10	50.7	209.1	477.0	312.3	5.0	12.5	9.9
24	–	74.3	332.0	49.2	5.0	2.5	26.8
25	–	128.5	136.0	106.7	7.5	2.5	16.8
26	–	134.0	231.2	235.8	5.0	0	16.2
27	–	284.8	2.0	481.7	25.0	5.0	122.0

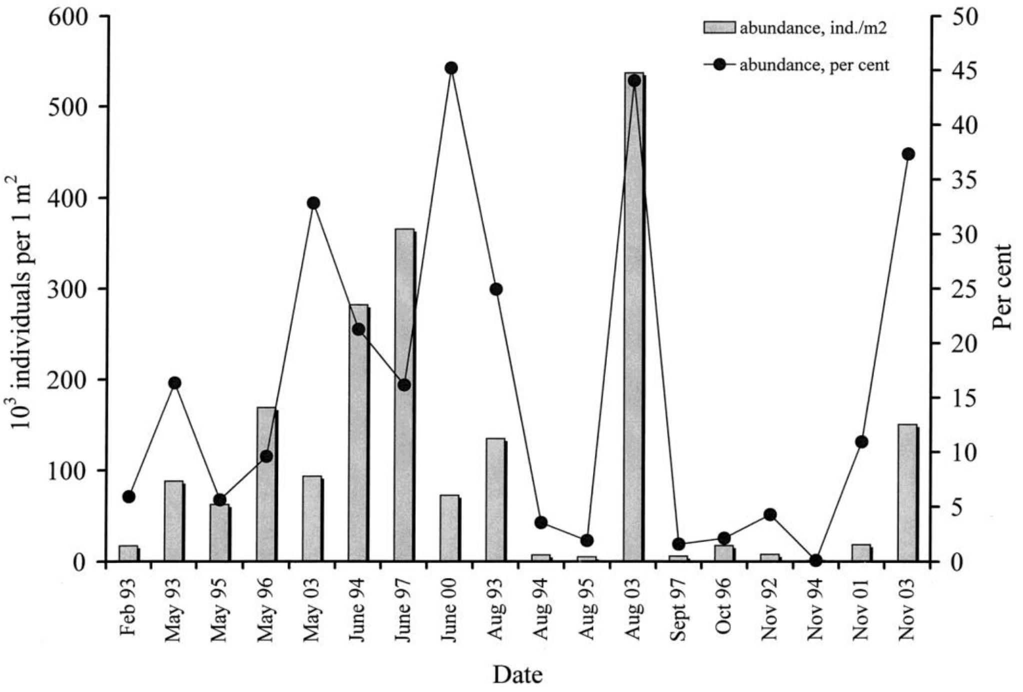

Figure 2. Mean abundance of harpacticoid copepods in 1992–2003.

In August 1994 and 1995 very low indices of harpacticoid copepod density in all of the liman (0–10000 экз.·м$^{-2}$) were recorded. August 1993 had a sufficiently dense harpacticoid settlement which throughout the liman was in the range of 100 000–200 000 ind.·m^{-2}. At those stations where the density was lower, a high density of foraminifers or ostracods and barnacle larvae were observed which could fill the ecological niche of harpacticoids. Harpacticoida made up from 4.1 to 48.4 % of total abundance of meiobenthos organisms. Towards the end of summer 2003 there were favourable conditions for harpacticoid development which allowed to register maximum density values for deep water areas of the liman (Station 7 – 1 102 500 ind.·m^{-2} and Station 27 – 1 462 500 ind.·m^{-2}). At all stations of the middle and lower parts of this water body, harpacticoid copepods were the dominating group of meiobenthos, except for stations 24 and 25.

The beginning of autumn is characterized by a marked drop in abundance of bottom copepods and in their fraction in the total meiobenthos. In September (1997) of the 11 stations under study, ten had density values up to 7 500 ind.·m^{-2}. Of the four years taken into consideration (1992, 1994, 2001 и 2003) November 1994 was the most unfavourable. Copepods were encountered only at two of the 10 stations. As in previous seasons, in late autumn 2003, comparatively high values of harpacticoid density (from 32 500 to 365 000 ind.·m^{-2}) were noted.

According to hydrochemical studies (data of the Odessa Branch of the Institute of Biology of Southern Seas), it was established that in the past five years in the bottom sediment there has been a tendency of changing the redox potential from reducing to oxidizing environmental. This has been confirmed by the gradual increase in nitrate concentration of pore water from 0.080 $mg \cdot l^{-1}$ in 1997 to 0.178 $mg \cdot l^{-1}$ in 2003, and the accumulation of silica (from 6.88 $mg \cdot l^{-1}$ to 11.59 $mg \cdot l^{-1}$). These transformations serve as a prerequisite for the changing conditions in bottom sediment favourable to the development of meiobenthos organisms.

Long term studies on the dynamics of meiobenthos abundance in Grigorievsky Liman have shown that spatial distribution is irregular and depends on a number of factors: type of sediment, depth, salinity, temperature, presence of algal substrate etc (Vorobyova, 1999). The liman can be divided into three parts: upper reaches of the liman, the coastal zone and the rest. Analysis of data has shown that in spite of the wide range of density indices of harpacticoid copepods, a spatial distribution is evident. In the upper reaches the mean values fluctuate from 22 377 to 107 913 $ind. \cdot m^{-2}$ (Figure 3). For the deep water middle and lower parts of the liman they are in the range of 79 846–224 800 $ind. \cdot m^{-2}$. According to the hydrochemical conditions, temperature and other indices in the coastal shallow water zone the harpacticoid density varies from 900 to 410 000 $ind. \cdot m^{-2}$. In June 2003 at Station 15, 15A maximum values – 1 062 500 and 1 512 500 $ind. \cdot m^{-2}$, correspondingly were recorded.

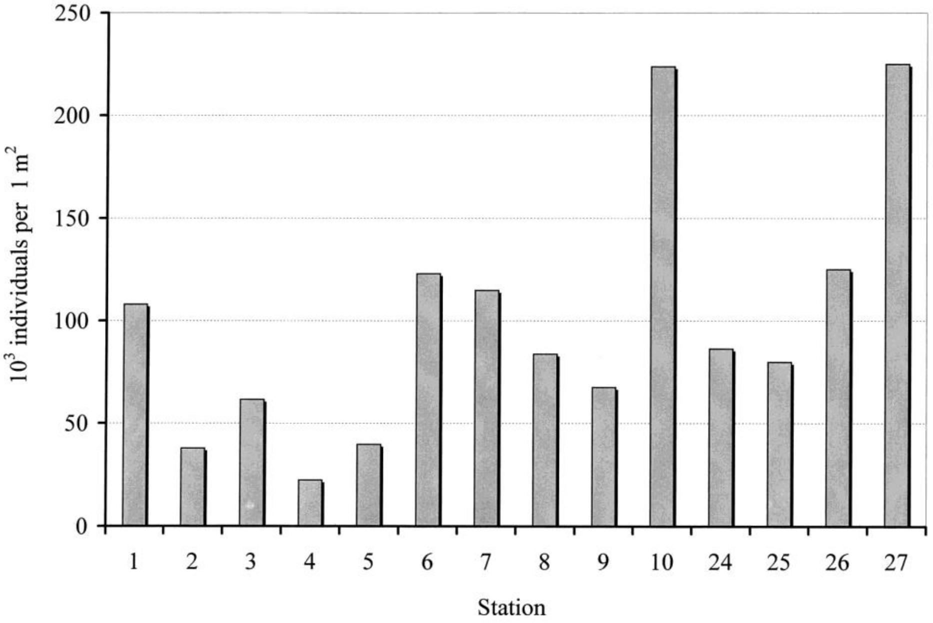

Figure 3. Mean abundance of harpacticoids on the stations of Grigorievsky Liman.

SPECIES DIVERSITY.

Towards the end of the 1960s N. I. Stakhorskaya had studied the zooplankton of Grigorievsky Liman. In the water body among crustanians she discovered 16 species of harpacticoids: *Canuella perplexa*, *Ectinosoma melaniceps*, *Microarthridion littorale*, *Tisbe tenella*, *Tisbe furcata*, *Harpacticus littoralis*, *Harpacticus flexus*, *Harpacticus gracilis*, *Amphiascopsis cinctus*, *Nitocra spinipes*, *Nitocra lacustris*, *Ameira parvula*, *Mesochra lilijeborgi*, *Mesochra aestuarii*, *Mesochra pygmaea* and *Laophonte setosa*.

We began to study the species diversity of harpacticoid copepods in the benthos of the liman for the first time. The materials used for these studies are samples collected in May and August, 2001 and 2003, in shallow water areas up to 0.5 m depth (muddy sand) and from aboard ship at 4–15 m depths (mud). In the liman 28 species of harpacticoids were found and 13 species of them were common for both depths (Table 2). The most frequently encountered species were *Canuella sp*. (as in Huys at al., 1996), *E. melaniceps*, *M. littorale*, *A. parvula* and *Schizopera (Sch.) compacta*.

In the shallow waters of the upper reaches *Enhydrosoma gariene* dominated (Station 14 – 89.6 % of the total amount of harpacticoids) and *Canuella sp.* (Sta. 15 – 90.0 %). Lower down the liman at Stations 16, 16A and 17 in May *Nitocra typica* replaced them (84.0, 80.9 and 65.3 %, respectively), and in August – *Mesochra pontica* (Sta. 16A – 21.1 %, Sta. 17 – 58.7 %) and *Harpacticus flexulosus* (Sta.18 – 61.0 %, Sta. 19 – 31.9 %). High frequency here was recorded for *Canuella sp.*, *M. pontica*, *E. gariene*, *E. melaniceps*, *N. typica* and *Paronychocamptus sp.*. In shallow water areas out of 22 harpacticoid copepod species, 15 species were noted in May and 18 species in August. Eleven species were common for both seasons.

On muddy stations at 4–15 m depths there was no sharp change in species composition throughout all of the liman. However, in the upper part of the liman *Canuella sp.* dominated in the spring as well as in summer (75.8 and 71.8 % correspondingly, for both seasons). In the rest of the liman there was a distinct domination of *Microarthridion littorale* making up on the average 85.5±15.4 % of the total composition. In deep water areas 19 species of harpacticoid copepods were discovered, 9 of which were common for both seasons.

For comparing the species richness of harpacticoids, qualitative samples were collected in August 1993 in the deep water part of the liman, in coastal shallow water zones on hard substrate and algal fouling and at the contiguous seaside. Twenty eight species of benthic copepods were recorded. For deep water stations 13 species of harpacticoid copepods were noted, for shallow water – 27 species and contiguous seaside – 10. More frequently *Canuella sp.*, *E. melaniceps*, *A. parvula*, *Dactylopusia* *tisboides*, *E. gariene*, *Laophonte setosa*, *Microarthridion fallax*, *Nannopus palustris* and *Tisbe histriana* were recorded.

Therefore, taking into consideration the qualitative samples from Grigorievsky Liman, a total of 35 species of harpacticoid copepods belonging to 16 families were registered.

Table 2. Species composition and frequency (%) of harpacticoid copepods in Grigorievsky Liman and contiguous seaside.

Species	Shallow water areas, 0–0.5 m depths	Deep water areas, 4–15 m depths	08-1993*		
			Liman deep water areas	Seaside deep water areas	Liman shallow water areas
Alteutha typica Czerniavski, 1868	–	–	–	–	+
Ameira parvula (Claus, 1866)	6.7	90.5	+	+	+
Canuella sp. (as in Huys at al., 1996)	86.7	81.0	+	–	+
Dactylopusia tisboides (Claus, 1863)	–	9.5	+	+	+
Diarthrodes nobilis (Baird, 1845)	–	–	–	–	+
Ectinosoma melaniceps Boeck, 1865	53.3	38.1	+	+	+
Ectinosoma sp.	13.3	–	–	–	–
Enhydrosoma gariene Gurney, 1930	60.0	76.2	+	+	+
Halectinosoma curticorne (Boeck, 1873)	–	4.8	–	–	+
Harpacticus flexulosus Ceccherelli, 1988	40.0	23.8	–	–	+
Harpacticus flexus Brady&Robertson, 1873	13.3	–	+	+	–
Harpacticus obscurus T.Scott, 1895	20.0	–	–	–	+
Laophonte setosa Boeck, 1865	33.3	23.8	+	–	+
Leptocaris brevicornis (van Douwe, 1904)	6.7	–	–	–	–
Mesochra pontica Marcus, 1965	73.3	14.3	–	+	+
Mesochra pygmaea (Claus, 1863)	6.7	–	–	–	+
Microarthridion fallax Perkins, 1956	26.7	–	–	–	+
Microarthridion littorale (Poppe, 1881)	6.7	100.0	+	+	+
Nannomesochra arupinensis (Brian, 1925)	–	–	–	–	+
Nannopus palustris Brady, 1880	6.7	33.3	+	–	+
Nitocra typica Boeck, 1865	53.3	4.8	–	–	+
Paradactylopodia brevicornis (Claus, 1866)	–	4.8	–	–	+
Paraleptastacus spinicauda (T.&A.Scott, 1895)	–	9.5	–	–	–
Paramphiascopsis longirostris (Claus, 1863)	–	4.8	–	–	–
Parathalestris dovi Marcus, 1966	13.3	–	–	–	–
Paronychocamptus sp.	46.7	–	–	–	–
Schizopera (Sch.) compacta De Lint, 1922	26.7	76.2	+	–	+
Stenhelia (D.) elizabethae Por, 1960	20.0	14.3	+	+	+
Stenhelia (D.) palustris Brady, 1868	13.3	9.5	+	+	+
Tegastes longimanus (Claus, 1863)	–	4.8	–	–	–
Tisbe bulbisetosa Volkmann-Rosso, 1972	–	–	–	–	+
Tisbe furcata (Baird, 1837)	–	–	+	+	+
Tisbe histriana Marcus&Por, 1961	33.3	–	–	–	+
Tisbe sp. 1 (holothuriae group)	–	–	–	–	+
Tisbe sp. 2 (reticulata group)	–	–	–	–	+

Note: * – qualitative samples were used.

CONCLUSIONS

– The Grigorievsky Liman harpacticoid copepods make up a wide range of density indices and change seasonally.

– The density distribution of these crustaceans and their fraction in the total meiobenthos organisms had a tendency of rising from the upper towards the lower part of the liman.

– Thirty-five species of harpacticoid copepods belonging to 16 families were registered here.

– High frequency was recorded for *Ameira parvula*, *Canuella sp*., *Ectinosoma melaniceps*, *Enhydrosoma gariene*, *Mesochra pontica*, *Microarthridion littorale*, *Nitocra typica*, *Schizopera (Sch.) compacta* and *Paronychocamptus sp*..

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CURRENT STATE OF THE ZOOBENTHOS AT THE CRIMEAN SHORES OF THE BLACK SEA

Nikolay K. REVKOV, N.G. SERGEEVA
Institute of Biology of the Southern Seas NASU, 2 Nakhimov av., 99011,
Sevastopol, Ukraine
revkov@ibss.iuf.net; sergeeva@ibss.iuf.net

ABSTRACT

The analysis of current state of zoobenthos at the Crimean shores of the Black Sea is fulfilled. The general features of taxonomical structure, regional peculiarities of bottom fauna development and species number distribution pattern with depth are considered. The results obtained testify the absence of species number reduction at the Crimean coastal zone of the Black Sea over the 2nd half of the XX century. Total number of the macrozoobenthos species registered in the Crimea water area exceeds 560. Filter-feeding mollusks (*Chamelea gallina* and *Modiolula phaseolina* first of all) became the most pronounced "evolutioning" species, determining the quantitative changes of the bottom fauna over the soft-bottoms of the southwestern Crimea during the period 1930-s - 1990-s. The shift to lesser depths: from the zone of the mussel silts (26-50 m) to the silty-sand (13-25 m) of the most productive benthal belt of the southwestern Crimea is marked. Meiobenthos (eumeiobenthos) of the Crimean shelf includes more than 522 species in total. Formation of specific meiofauna composition in areas of the methane gas seeping is marked. The presence of 38 species and 6 genera of Nematoda, which are registered only in the given conditions testify to this.

Key words: zoobenthos, Black Sea, Crimea, biodiversity, long-term changes.

INTRODUCTION

Deterioration of the ecological state in the Black Sea basin, which determined considerable changes of its biological resources structure have been registered in 1970–80-s. Shift of the ecosystems production-destruction balance towards organic matter accumulation occurred (Zaitsev, Mamaev 1997; Alexandrov, Zaitsev, 1998; Black Sea …, 1998). Changes of the northwestern Black Sea shelf fauna in the most conservative ecosystem – benthos became indicative. They revealed themselves in the total transformation of the bottom communities, decrease of the species diversity, changes of the structural characteristics of populations and growth of the morphological anomalies of the definite benthos forms (Bronfman et al., 1994; Zolotaryov, 1994; Alexandrov, Zaitsev, 1998).

Deterioration of the ecological state occurred in the Crimean shelf region also. Analogical benthos changes have been registered here, but they were less prominent by scale and intensity. They affect the northwestern Crimean water area including Karkinitsky gulf (Povchun, 1992) in greater degree and lesser – the western and southern peninsular coast. Local changes in bottom communities structure in the impact water areas of the technogenic and municipal zones of the open sea (Revkov et al., 1992; Long-term changes…, 1992; Revkov et al., 1999a) and bays (Kisseleva et al., 1997; Mironov et al., 2003), occurrence of the morphological anomalies in the populations of the some common species (Petrov, Zaika, 1993; Revkov et al., 1999b), depletion of the macrozoobenthos in different sections of the aerobic benthal (Zaika, 1990; Long-term changes…, 1992; Zaika, Sergeeva, 2001; Makarov, Kostylev, 2002) were characteristic for the last ones. Nevertheless, significant transformation or degradation of the benthal ecosystems at the Crimean shores was not revealed according to the results of the hydrobiological expedition of 1999 on the R/V “Professor Vodyanitsky” (Kiryukhina, Gubasaryan, 2000; Revkov et al., 2002).

1518 species of zoobenthos in the Black Sea in the middle of the 1970-s were known (Kisseleva, 1979). However, only 312 species were noticed from 1984 to 1994 at the Crimean coast out of 875 macrozoobenthos species, which were registered on the Ukrainian shelf before 1973, according to the National report (Black Sea …, 1998). It is no doubt that such considerable reduction of the benthic fauna in the region of Crimea needs more detailed analysis.

MATERIALS AND METHODS

Literature sources and expedition materials (more than 1200 stations totally) from the database of the Shelf Ecosystems department IBSS NASU were used as a base for the analysis of the general macrofauna composition in the Crimean region.

Materials of 1930-s by L.V. Arnoldy (1941) and scheme of the benthos vertical zonality, suggested by him were used under analysis of the long-term quantitative changes of zoobenthos in the southwestern Crimea water area (table 1).

Table 1. Scheme of zoobenthos subdivision in sampling site of the southwestern Crimea (from Arnoldi, 1941)

Index number	Name of groupings	Range of depths, m	Number of sampling stations	
			1930-s	1980-90-s*
I	Sand	1–12	9	41
II	silty-sand	13–25	7	47
III	mussel silts	26–50	6	19
IV	Phaseolina silts	51–110	20	73

Note: * - Database materials of Shelf Ecosystems department of IBSS NANU are used.

Spatial and temporal comparisons of “Indices of Functional Abundance” (IFA) values were conducted for the underlined groupings of zoobenthos. Estimation of the long-term changes in benthos structure (dissimilarities between biocenotical groupings) for the period from 1930-s to 1980–90-s is fulfilled in the SIMPER programme of the PRIMER software package (Chatfield, Collins, 1980; Carr, 1997). A non-transformed matrix of IFA values for species is used in the MDS analysis. Construction of species rank distribution curves have been fulfilled according to the values of species “Density index” (DI).

$\mathrm{IFA} = N_i^{0.25} \times B_i^{0.75}$; $\mathrm{DI} = \mathrm{IFA} \times p$,

N_i and B_i – correspondingly abundance (ind/m^2) and biomass (mg/m^2) of i species,

p – frequency of species occurrence (0–1).изучение распределения studying of distribution

The materials for analysis the taxonomic composition and quantitative distribution of meiobenthos on the Black Sea site of Crimean shelf was collected during 53th cruise of R/V “Professor Vodyanitsky” (spring, 1999). 12 stations were taken at the depth range of 23–260 m in water areas of western, southern and southwestern parts of Crimea (from cape Tarkhankut to Karadag). The taxonomic composition and quantitative distribution of meiobenthos on the soft-bottoms at the Crimean shelf zone were considered according to regions established by V.A. Vodyanitsky (1949).

Features of taxonomical structure of meiobenthos in areas with methane gas seeping are considered. Samples were taken by box- and multicorer (45th cruise of R/V “Professor Vodyanitsky”, July, 1994) in western part of the Black Sea. Experimental plot covered 12 stations across depths 72–232 m 72-232 м. (Sergeeva, 2003).

Macrozoobenthos.

<u>The main tendencies in dynamics of the Crimean region fauna composition.</u> The bottom fauna of the Crimean zone of the Black Sea is represented, mainly, by marine forms, for which the Black Sea average salinity of 18 ‰ is normal. If we’ll take into account only such marine

forms of main taxons (table 2) it appears, that before 1975 the Crimean fauna has been submitted by 83 % of species known for that period in the Black Sea.

While 463 species were registered in the Crimean region benthos before 1975, in 1980–90s there were 471 of them. 551 zoobenthic species were marked near the Crimean shore for all time observation in the groups studied (table 2).

Table 2. Species richness of zoobenthos of the Black Sea and along the Crimean coast

Taxon	The Black Sea, before 1975	Crimean coastal zone		
		before 1975	1980–1990s	For all time observation
PORIFERA	29 (29)	12	14	18
COELENTERATA	36 (32)	24	32	35
Anthozoa	6 (5)	5	4	5
Hydrozoa	27 (24)	16	25	27
Scyphozoa	3 (3)	3	3	3
NEMERTINI	31 (31)	20	3	20
POLYCHAETA	182 (149)	131	121	144
PANTOPODA	7 (4)	4	3	5
CRUSTACEA	230 (150)	125	128	142
Cirripedia	5 (5)	4	5	5
Decapoda	37 (35)	30	32	33
Mysidacea	19 (11)	5	5	7
Cumacea	23 (12)	9	15	15
Anisopoda	6 (4)	4	3	4
Isopoda	29 (22)	17	15	20
Amphipoda	111 (61)	56	54	59
MOLLUSCA	192 (132)	122	141	156
Loricata	3 (3)	2	2	2
Bivalvia	89 (53)	43	46	49
Gastropoda	100 (76)	77	93	105
BRYOZOA	16 (16)	11	13	15
PHORONIDEA	1 (1)	1	2	2
ECHINODERMATA	14 (5)	5	5	5
Ophiuroidea	4 (1)	1	1	1
Holothurioidea	8 (4)	4	4	4
Echinoidea	1 (0)	–	–	–
Asteroidea	1 (0)	–	–	–
CHORDATA (Tunicata, Acrania)	9 (9)	8	8	8
TOTAL:	747 (558)	463	471	551

Note: the number of species usual for waters with normal Black Sea salinity is specified in parentheses.

There are no any evidences of the reduction of species richness of zoobenthos in the Crimean water area in the last quarter of XX century. Moreover, in 1980–90-s bottom fauna of this region was enriched due to: 1) broadening of strictly Black Sea species distributional ranges; 2) introduction of forms, previously noted from the near-Bosporus region only; 3) alien species. Besides, new for sciences species were revealed and described.

For example, group of the Crimean hydroids was replenished by 5 species new for the Black Sea: *Coryne pusilla* (Gaertner, 1774), *Eudendrium annulatum* Norman, 1864, *E. capillare* Alder, 1857, *Opercularella nana* Hartlaub, 1897 и *Stauridia producta* Wright, 1858 (Grishicheva, Shadrin, 1999; Revkov, 2003a). Within the Polychaeta 13 species found new for the Crimean fauna in 1980–90-s, and four of them (*Nerilla taurica* Skulyari, 1997, *Nerilla* sp.1, *Vigtorniella zaikai* (Kisseleva, 1992) и *Protodrilus* sp.1) are new for science (Skulyari, 1997; Kisseleva, 1992, 1996, 1998). The crustaceans were replenished by 13 species, bryozoa by 4 species (Revkov, 2003a). The most numerous additions appeared within mollusks: 6 species of Bivalvia and 25 species of Gastropoda (Revkov, 2003a). But in the last case (for gastropods) we meet imaginary enrichment of the region fauna. Enlarging of their species list took place mostly due to changes in diagnostics keys.

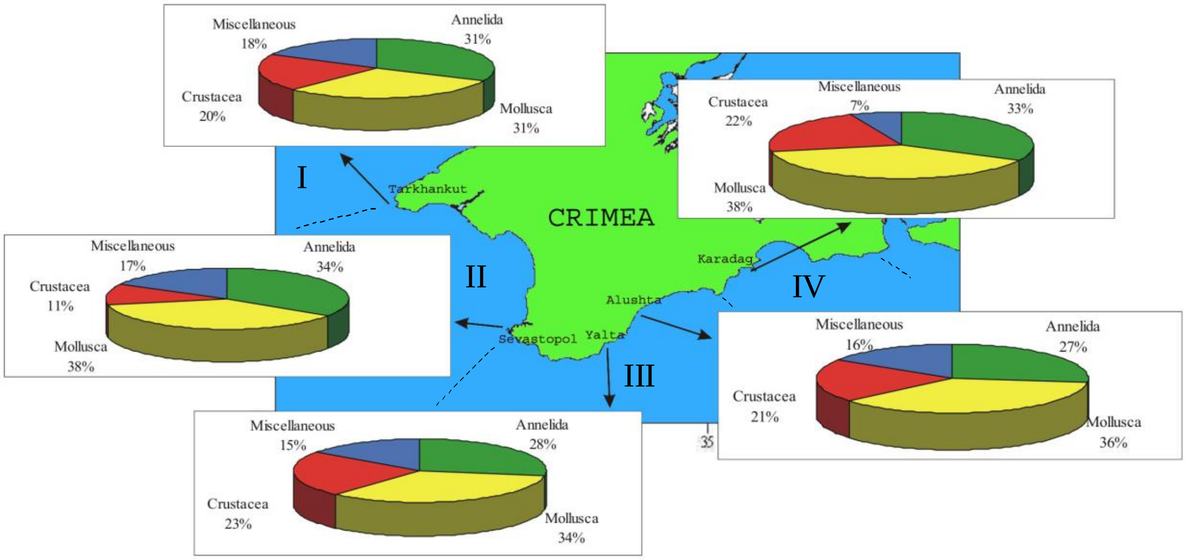

Figure 1. Species quantity ratio (%) of the basic zoobenthos groups by regions
(from Revkov et al., 2002): I – V – regions of Crimean coast (from Vodyanitsky, 1949).

Together with enrichment of the Crimean waters fauna in modern samplings we marked absence of some species earlier registered here. However, this fact we do not treat unequivocally as their disappearance from water area of Crimea. Further investigations will permit to elucidate situation as for the status of species, which “disappeared” from the Crimean shores.

Regional peculiarities of zoobenthos. In our research we follow the scheme (Vodyanitsky, 1949), which subdivides the Crimean Black Sea area into 5 regions: Karkinitsky gulf (region I), Eupatoria – Sevastopol (II), southern coast of the Crimea (III), Feodosia (IV) and the Kerch strait region (V). By the results, obtained in 1999 during 53th cruise on board “Professor Vadyanitsky”, the regional specific nature of the faunal development is noted (Figure 1). In terms of the species number, mollusks (31-38%) and annelids (27–34%) occupy first places in all regions.

Values of benthos abundance and biomass are in the margins of variation of the parameters, earlier marked at corresponding biocenoses of Crimean coastal zone of the Black Sea (Revkov et al., 2002). The absolute maximum of the benthos development is noted in region I (Cape Tarkhankut) in the range of depths 22-31 m (Figure 2). Toward the southeastern part of the Crimea, at relatively shallow-water at depth from 22 to 31 m, the abundance and biomass of the benthos decrease. This takes place due to the formation of different communities at similar depths in different shelf areas. Thus, the peak of the curve for the benthic biomass in the area of Cape Tarkhankut (region I) is formed due to the intense development and absolute dominance of the mussel *Mytilus galloprovincialis*, which forms dense populations on the bottom. At the stations performed in the east, the role of the dominant species transfers to smaller benthic forms, namely, mollusks such as *Chamelea gallina* and *Pitar rudis*.

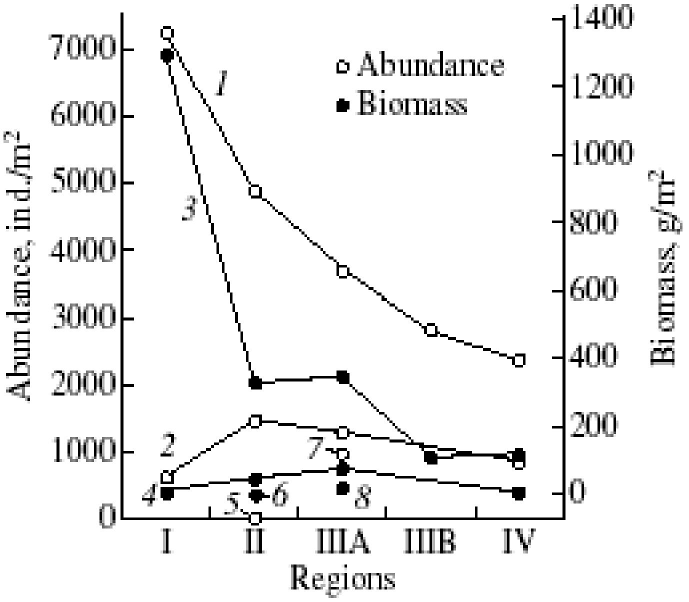

Figure 2. Regional variations in the values of benthic abundance and biomass: 1and 3 – 22-31 m; 2 and 4 – 44-49 m; 5 and 6 – 142 m; 7 and 8 – 83 m (by Revkov et al., 2002).

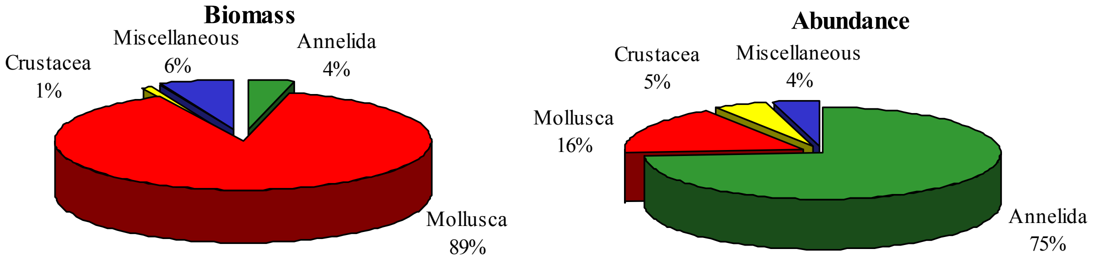

Figure 3. The percent values of abundance and biomass for the main benthic taxa on the soft bottoms at the coast of Crimea

Special features of the shape of the curves of the benthos density in the depth range of 22–31 m are determined by the development of two species of polychaetes, namely, *Aricidea claudiae* and *Prionospio cirrifera*. While in the area off the western Crimea, *P. cirrifera* (27–28% of the total benthos abundance) dominates reaching the absolute maximum of development - 2044 ind/m^2; off the southern coast of the Crimea *A. claudiae* becomes the dominant benthic form with respect to its maximal abundance up to 2142 ind/m^2.

Within the range of depths from 44 to 49 m, in regions II and III A, both parameters of the benthos development have smaller amplitude of variation and are represented by dome-shaped single-peak curves. The polychaetes *A. claudiae*, *Melinna palmata* and *Terebellides stroemi* become the dominant benthic forms with respect to their abundance, whereas in terms of their biomass, the polychaete *T. stroemi*, the mollusks *M. galloprovincialis* and *Spisula subtruncata* and the ascidian *Ascidiella aspersa* prevail.

On the soft-bottoms near the Crimean coast annelids dominate by abundance (75%) and mollusks – by biomass (89%) (Figure 3). The average population density of miscellaneous species (98 ind/m^2) is the minimum at the Crimea shores as compared to those of crustaceans (123), mollusks (393), and polychaetes (1775).

Such mollusks as *Lentidium mediterraneum* and *Chamelea gallina* have an absolute maximal abundance among the species responsible for the high percentage observed over the soft-bottoms at the coast of Crimea. *Capitella capitata* has absolute maximal abundance among Polychaeta group, *Erichthonius difformis* - among crustaceans and *Branchiostoma lanceolatum* – among miscellaneous group (Table 3).

Table 3. Maximal abundance (ind/m^2) of the species responsible for the high percentage observed over the soft-bottoms at the coast of Crimea

Groups	Species	Abundance
Polychaeta	*Capitella capitata* (Fabricius, 1780)	8713
	Brania clavata (Claparede, 1863)	5540
	Heteromastus filiformis (Claparede, 1864)	5229
	Exogone gemmifera Pagenstecher, 1862	4640
	Protodorvillea kefersteini (McIntosh, 1869)	4363
Mollusca	*Lentidium mediterraneum* (Costa, 1829)	23780
	Chamelea gallina (Linnaeus, 1758)	13325
	Tricolia pullus (Linnaeus, 1758)	6700
	Caecum trachea (Montagu, 1803)	6688
	Spisula subtruncata (Costa, 1778)	6538
Crustacea	*Erichthonius difformis* Milne-Edwards, 1830	3170
	Diogenes pugilator Roux, 1828	2500
	Caprella acanthifera Leach, 1814	1860
Miscellaneous	*Branchiostoma lanceolatum* (Pallas)	1109
	Amphiura stepanovi Djakonov, 1954	496
	Pachycerianthus solitarius (Rapp, 1829)	256

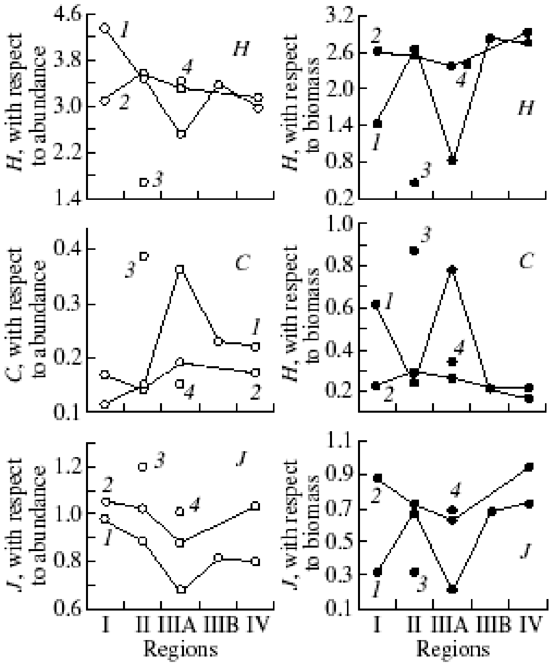

Figure 4. Regional variations in the values of Shannon's (H), Simpson's (C) and Pielou’s (J) ecological indices: 1 – 22-31 m; 2 – 44-49 m; 3 – 83 m; 4 – 142 m
(from Revkov et al., 2002).

Quite high magnitudes of Shannon diversity index calculated by species biomass are shown on fig 4. At 8 of 11 stations it was higher than 2.37 bit/g. For comparison, that average values of the given index in the coastal zoocenosis of the soft-bottoms of the Black Sea coast in most cases do not exceed 2.2 bit/g.

Against the general background of the relatively high values of Shannon’s index of diversity calculated both on the basis of the species abundance and biomass, absolute peaks were recorded in the areas off Cape Tarkhankut (an abundance peak, region I) and off Karadag (a biomass peak, region IV). In both cases, in the area off Yalta (region III A), decreases in the average values of this index are observed.

The lowering of Shannon’s index of diversity noted in the area off Yalta is related to the decrease in the extent of uniformity of the benthic structure (both in terms of abundance and biomass). This decrease results from the mass development of such benthic forms as *Chamelea gallina* and *Aricidea claudiae.* The further examination of the general structure of fauna (despite of biotope type), drive us to consider the area of the western Crimea (including Sevastopol bays) as the most reach of species. Such conclusion is quite logical, because since the Sevastopol biological station foundation in

1871, areas adjacent to Sevastopol were the main polygons for the Black Sea studies.наиболее разнообразно фауна представлена most variously the fauna is submitted

According to traditionally great research interest to the western Crimea section (region II) the number of macrozoobenthos species recently found there is also the highest one inside the Crimean surrounding water areas as whole. In the last decades of XX century it was 383 species or 81% of the known for the total Crimea water area. The macrobenthos fauna of other subdivisions: northern coast of cape Tarkhankut (region I), southern (III), southeastern Crimea (IV) and Kerch strait front (V), are considerably less diverse. It contains correspondingly 230 (49%), 268 (57%), 259 (55%) and 179 (38%) species. The analysis of the most evenly studied Bivalve group gives the same picture. Most divers the fauna of bivalves is represented in the region of the western Crimea. There are 39 species (85% from total number of bivalve species) known for water area of Crimean at 1980–90-s. In the regions of the northwestern, southern, southeastern Crimea and Kerch strait front side we found correspondingly 30 (65%), 28 (61%), 39 (65%) and 28 (61%) of mussels species.

With the further accumulation of faunistic information we may expect growth of general percent of the regions fauna elements being represented, and consequently lowering of the regional faunistic differences. At comparison of the data received for the soft-bottoms and for the Crimean shores as a whole-preservation of shares of the basic benthos taxons was marked (Figure5).

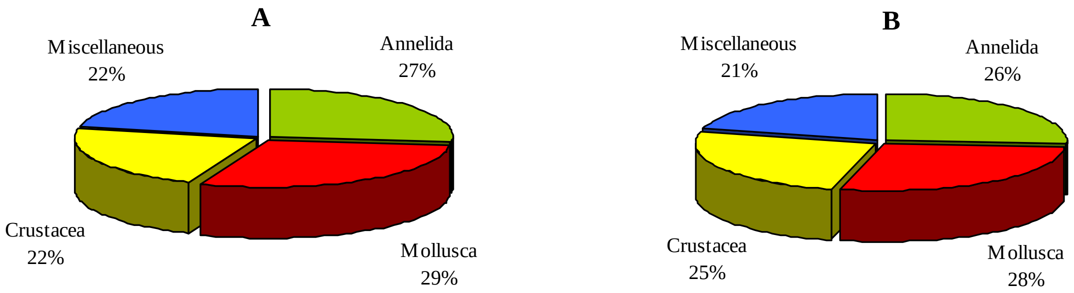

Figure 5. Species richness in main groups of zoobenthos of the Crimean coastal zone of the Black Sea (in percent): A – for soft bottom only, (from Revkov et al., 2002), B – for the Crimean coastal zone (from Revkov, 2003).

In a whole, the highest number of species near the Crimean shore was registered for the mollusks (156 species); annelids (146) and crustaceans (142) are a bit less numerous, and the last position (116 species) is occupied by combined group of “Miscellaneous” species.

Vertical distribution of zoobenthos. The low limit of species distribution in the Black Sea is restricted mainly by the 127–135-meter isobate (Nikitin, 1938). This is stipulated by the hydrological and geomorphological features as well as by species-specific requirements to the living conditions, presence of the seasonal and long-term components of species distribution dynamics (Kisseleva, 1979; Long-term changes…, 1992).

Discord of the distributional limits of some benthic species at the Crimean and Caucasus coasts has been registered before (Kisseleva, 1979). Most of species penetrate deeper at the Caucasus region. Analysis of the materials, obtained in 1980–90-s pointed on the alignment of these differences. Contemporary depths of species dwelling on the Crimean shelf includes, in a fact, corresponding range of depths at the Caucasus shores, registered before.

We determine species with wide (eurybatic species) and narrow (stenobatic species) habitat range in depth according to the analysis of zoobenthos distribution on the soft-bottoms near the Crimean coast in 1980–90-s (about 1200 stations) (table 4). Stenobatic species having relatively narrow vertical boundaries are the basic mass.

Total macrozoobenthos species diversity on the soft-bottoms decreases with depth (fig 6). Peaks of the species diversity are at coastal, relatively shallow water zones: 0–10 and 11–20 m (correspondingly 238 and 242 species). Mollusk fauna is most diverse (81 species) at 11–20 m depth, whereas a diversity of crustaceans and annelids (74 and 80 species respectively) is the highest at the depth of 0–10 m, fauna of miscellaneous species (35) has maximum at 21–30 m depth range.

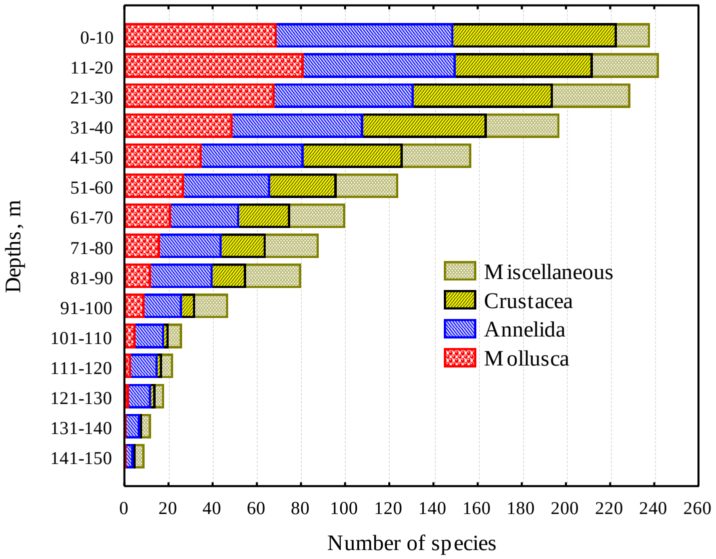

Figure 6. A diagram of vertical distribution of the main zoobenthos groups on the soft bottoms near coast of Crimea (from Revkov, 2003b).

55 macrozoobenthos species were found at the depth of 100 and more meters for the whole period of the bottom fauna investigation at the Crimean shores (Zernov, 1913; Milaschevich, 1916;

Nikitin, 1950; Kisseleva, 1985; Long-term changes…, 1992; our own data). These are – 19 species of the Annelida group, 18 of Mollusca, 7 of Arthropoda, 4 of Coelenterata, 3 of Echinodermata, 2 of Ascidiacea; Nemertini and Porifera were represented by a single species each. More than half of species known from that depth are regarded as “rare or occasional”. Only 26 species can be attributed as “common” for 100 m and more depths (table 5).

Table 4. Examples of some eurybatic and stenobatic species in accordance with their vertical distribution near the Crimean coast of the Black Sea

	Range of depths, m	Species	Group
Eurybatic	0-150	*Nephtys cirrosa* Ehlers, 1868; *Melinna palmate* Grube, 1870	*Polychaeta*
		Ampelisca diadema Costa, 1853	*Crustacea*
		Amphiura stepanovi Djakonov, 1954	*Echinodermata*
	0-140	*Heteromastus filiformis* (Claparede, 1864); *Aricidea claudiae* Laubier, 1967; *Terebellides stroemi* Sars, 1835	*Polychaeta*
	0-130	*Pholoe synophthalmica* Claparede, 1868	*Polychaeta*
		Retusa truncatula (Bruguiere, 1792)	*Mollusca*
Stenobatic	0-20	*Glycera alba* (O.F.Muller, 1776); *Euclymene collaris* (Claparede, 1868); *Tharyx marioni* Saint-Joseph, 1894; *Lysidice ninetta* Audouin et Milne-Edwards, 1833; *Ophelia limacine* (Rathke, 1843); *Polyophthalmus pictus* (Dujardin, 1839); *Goniada bobretzkii* Annenkova, 1929; *Eulalia viridis* (Linnaeus, 1767); *Genetyllis nana* (Saint-Joseph, 1906); *Lagisca extenuata* (Grube, 1840); *Eumida sanguinea* (Oersted, 1843); *Dorvillea rubrovittata* (Grube, 1855); *Brania clavata* (Claparede, 1863); *Polygordius neapolitanus ponticus* Salensky, 1882	*Polychaeta*
		Solen marginatus Pulteney, 1799; *Tornus subcarinatus* (Montagu, 1803); *Hemilepton nitidum* (Turton, 1822); *Acanthochitona fascicularis* (Linnaeus, 1767); *Irus irus* (Linnaeus, 1758)	*Mollusca*
		Corophium bonelli (Milne-Edwards, 1830); *Melita palmate* (Montagu, 1804); *Echinogammarus olivii* (Milne-Edwards, 1830); *Hyale pontica* Rathke, 1837; *Stenothoe monoculoides* (Montagu, 1815); *Apseudopsis ostroumovi* Bacescu et Carausu, 1947	*Crustacea*
	21-50	*Caecum armoricum* (de Folin, 1869)	*Mollusca*
		Hypania invalida (Grube, 1860); *Pterocirrus limbata* Claparede, 1868	*Polychaeta*
		Tritaeta gibbosa (Bate, 1862)	*Crustacea*
	61-90	*Namanereis pontica* (Bobretzky, 1872); *Aonides oxycephala* (Sars, 1862)	*Polychata*

According to M.I. Kisseleva (in press) single specimens of polychaete *A. claudiae, Nephtys* sp., *M. palmata, H. filiformis, T. stroemi, O. armandi* were registered in the region of the Crimean southern coast near lower boundary of the shelf at 200 m depth.

Table 5. Species that can be attributed as “common” for 100 m and more depths

Group	*Species*	Group	*Species*
ANNELIDA	Aricidea claudiae *Laubier, 1967*	MOLLUSCA	*Abra alba* (Wood W., 1802)
	Capitella capitata (Fabricius, 1780)		*Modiolula phaseolina* (Philippi, 1844)
	Heteromastus filiformis *(Claparede, 1864)*		*Plagiocardium papillosum* (Poli, 1795)
	Melinna palmate Grube, 1870		*Retusa truncatula* (Bruguiere, 1792)
	Nephtys cirrosa Ehlers, 1868		*Trophon muricatus* (Montagu, 1803)
	N. hombergii Savigny, 1818	ARTHROPODA	*Ampelisca diadema* Costa, 1853
	Notomastus profundus Eisig, 1887		*Apseudopsis ostroumovi* Bacescu et Carausu, 1947
	Oriopsis armandi (Claparede, 1864)		*Eudorella truncatula* (Bate, 1856)
	Pholoe synophthalmica Claparede, 1868		Pantopoda g. sp.
	Terebellides stroemi Sars, 1835	ECHINODERMATA	*Amphiura stepanovi* Djakonov, 1954
	Oligochaeta g. sp.	CHORDATA	*Ciona intestinalis* (Linnaeus, 1767)
PORIFERA	*Suberites carnosus* Johnston, 1848		*Eugyra adriatica* Drasche, 1884
ANTHOZOA	Pachycerianthus solitarius *(Rapp, 1829)*	NEMERTINI	Nemertini g. sp.

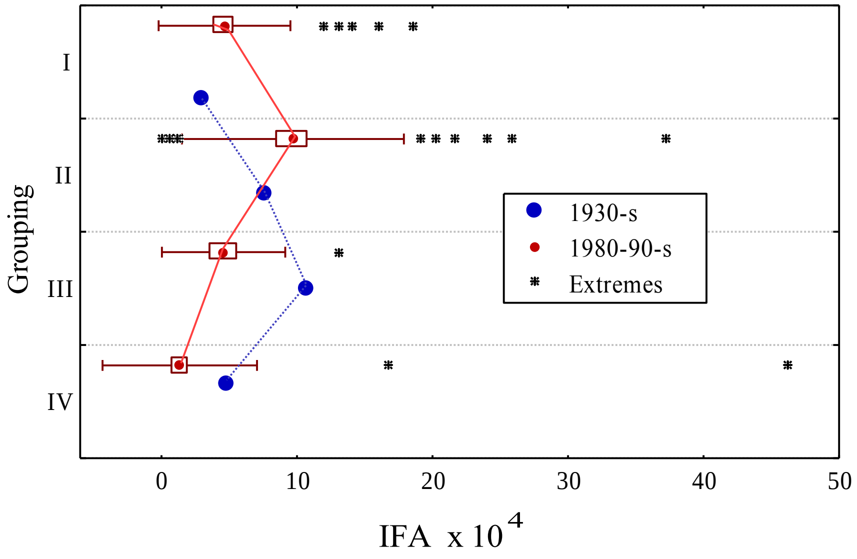

Figure 7. Index of Functional Abundance (IFA) of benthic groupings per different years (from Revkov, 2003c). Range of depths in groupings: I–(sandy zone)–1-12 m, II–(silty-sand)–13-25 m, III–(mussel silt)–26-50 m, IV–(phaseolina silt)–51-110 m.

Long-term changes of zoobenthos in the region of the southwestern Crimea. A lot of data on long-term changes in the bottom fauna composition in the Crimean region have been accumulated now (Kisseleva, 1981; Long-term changes…, 1992; Kisseleva et al., 1997; Revkov, Nikolaenko, 2002; Mironov et al., 2003). The obtained results give many variants for evaluation of changes in the bottom ecosystems of different Crimean water areas. However, it seems that the modern state of ecosystems of the Crimean shelf zone (both from faunistic and structural points of view) is stable or a bit improved being compared with those of 1970-s. These conclusions need more detailed description.

At the model polygon of our investigation considerable decrease in benthos development (measured by IFA-index) is registered only in mussels (III) grouping (Figure 7). One can notice differently oriented long-term drift of corresponding averages in the upper and lower shelf horizons.

Плотность первого вида увеличилась в три раза, второго вида – уменьшилась в 6 раз. The density of the first kind has increased three times, of the second kind – has decreased in 6 times. Плотность первого вида увеличила три раза, второго вида – уменьшился в 6 раз.

Considering sense loading of the IFA–index used, expressed in indirect evaluation of the energy flow through the communities studied, we can speak about changes of zoobenthos average production: 1.5 and 1.3 times increase in the upper (sandy and silt sand groupings correspondingly) and 2.3–3.6 times decrease in the lower (correspondingly mussel and phaseolina silts groupings) horizons of the inhabited benthal. It shifts maximum of absolute production to lesser depths: from the zone of mussel silts (26–50 m) to silty-sand (13–25 m).

According to the results of comparing the benthos groupings of 1930-s and 1980–90-s (SIMPER programme) it appeared, that long-term changes in the coastal sand grouping were caused by changes in development of bivalve mollusks namely *Chamelea gallina* and *Spisula subtruncata* which contribute 73% to the groupings dissimilarity (Bray-Curtis Dissimilarity) (table 6). The abundance (by IFA-index) of the first species increased in three times while of the second species – decreased in 9.8 times. In the silt-sand grouping the most considerable differences (which contribute 78% to dissimilarity) depends on changes in *Ch. gallina* and *Paphia aurea* populations. Importance of the first species, like in I grouping, increased here (IFA-index increased 2.3 times), while the second one decreased considerably (IFA-index felt down 1139 times!). In the mussel silts grouping considerable decrease of *Mytilus galloprovincialis* and *P. aurea* development were registered (66% between grouping dissimilarity): IFA of the first species decreased in 3.5 times, of the second ones – in 62.2 times. In the grouping of phaseolina silt the greatest changes are linked with *Modiolula phaseolina* population (80% of dissimilarity), its IFA-index felt down at 23.7 times.

Thus, the basic contribution to increase of IFA-index value of benthos development in the sandy and silty-sand groupings depends on changes in *Ch. gallina* population. Decrease of total benthos abundance (by IFA-index) in the mussel and phaseolina silt groupings is caused by respective alterations in *M. galloprovincialis*, *P. aurea* (mussel silt) and *M. phaseolina* (phaseolina silt) populations.

One can mark two main points from the species-rank distribution based on DI (fig 8a – d):

1. Positions of dominant species in the corresponding groupings are stable generaly. These dominants are: *Ch. gallina* for the coastal sandy and silty-sand groupings, *M. galloprovincialis* –

for mussel silts grouping, *M. phaseolina* – for phaseolina silts grouping (however in 80th years together with *M. phaseolina* appearance of the new leader of grouping – *M. galloprovincialis* here is marked.).

2. Opposite trends in groupings were occurred: the gap between the dominant species and the others had increased in relatively shallow water (coastal sandy and silty-sand) and decreased in mussel and phaseolina silts groupings.

Evaluation of species importance by their contribution to the intragrouping similarity and by the Density Index value (DI) gave in a whole similar results for groupings I, II and III. But in the phaseolina silt grouping (IV) results differ a bit: by DI value, *M.galloprovincialis* (together with *M.phaseolina*) is at the first place, but by its contribution into intragrouping similarity it does not enter even into five the most important species. In this case deficiency of a method of leading species definition according to DI is revealed, when species leadership (*M.galloprovincialis* in this case) with relatively law level of being met (10%) is determined by high biomass values of its separate specimens. Biocenotically such result is not satisfactory and *M.galloprovincialis* can't be attributed to the leading species of the observed grouping of the phaseolina silt

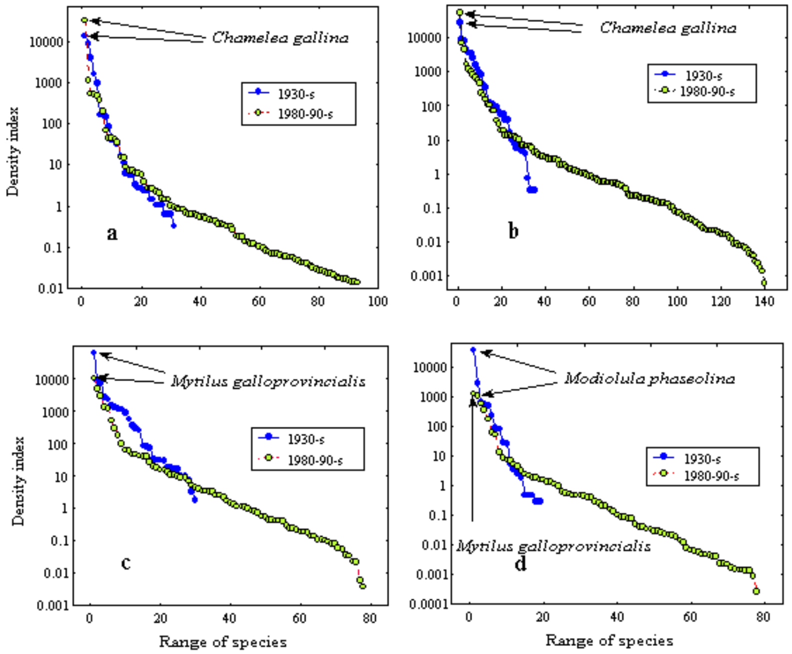

Figure 8. Species rank distribution curves based on Density Index (DI) for the various benthic groupings: coastal sandy (a), silty-sand (b), mussel silt (c) and phaseolina silt (d) groupings (from Revkov, 2003c).

Table 6. Distinctions between the same benthic groupings at the 1930-s and 1980 – 90-s

Species	$\overline{\text{IFA}}$ *		$\overline{\alpha}_i$	$\overline{\alpha}_i/\text{SD}(\alpha_i)$	$\overline{\alpha}_i$ %
	1930-s	1980 – 90-s			
Grouping I	Average dissimilarity 72.52 %				
Chamelea gallina	12848.99	38543.22	37.92	2.22	52.30
Spisula subtruncata	8507.42	864.58	14.86	1.64	20.49
Lucinella divaricata	3880.46	819.35	6.34	1.47	8.75
Donax semistriatus	1594.16	1354.78	3.67	1.32	5.06
Diogenes pugilator	969.52	1331.87	2.32	0.59	3.20
Cyclope neritea	352.43	792.99	1.07	1.49	1.48
Grouping II	Average dissimilarity 81.60 %				
Paphia aurea	138694.47	121.77	48.26	4.26	59.14
Chamelea gallina	27387.95	63386.38	15.67	1.32	19.20
Mytilus galloprovincialis	3937.20	10341.91	2.88	0.41	3.53
Modiolus adriaticus	6718.55	3327.04	2.74	1.16	3.36
Spisula subtruncata	8423.97	5860.01	2.74	1.94	3.35
Lucinella divaricata	3597.02	2438.96	1.13	1.25	1.39
Pitar rudis	4045.58	1694.61	1.07	1.98	1.31
Grouping III	Average dissimilarity 81.17 %				
Mytilus galloprovincialis	64702.59	18352.41	30.17	2.37	37.17
Paphia aurea	45279.34	728.12	23.73	4.39	29.24
Chamelea gallina	879.79	14239.72	5.99	0.57	7.38
Pitar rudis	10810.24	2187.72	4.65	2.43	5.73
Modiolus adriaticus	8963.31	436.28	4.51	4.13	5.55
Spisula subtruncata	4032.88	4755.66	2.79	1.25	3.43
Modiolula phaseolina	2585.07	489.55	1.42	2.99	1.75
Grouping IV	Average dissimilarity 90.50 %				
Modiolula phaseolina	40397.83	1704.56	72.35	4.91	79.94
Molgula euprocta	3443.62	161.74	6.09	5.18	6.72
Mytilus galloprovincialis	559.94	9071.36	4.24	0.32	4.69

* $\overline{\text{IFA}}$ – average values of Index of Functional Abundance; $\overline{\alpha}_i$ – absolute and $\overline{\alpha}_i$% – relative contribution of i-th species to the average Bray-Curtis dissimilarity between the groupings; SD – standard deviation.

Meiobenthos

Taxonomical composition. Questions on structure and chorology of the Black Sea meiobenthos at the coastal zone of Crimea were considered in a number of published works (Kisseleva, 1965; Kisseleva, Slavina, 1964; Kisseleva, 1967; Marinov, 1975; Kolesnikova, 1983; Kisseleva, Sergeeva, 1986; Vorobjeva, Sinegub, 1989; Vorobjeva et al., 1994; Vorobjeva, 1999; Sergeeva, Kolesnikova, 2003). As it follows from the published data, the meiobenthos has high taxonomical diversity and high abundance values in the different regions of the Crimean shelf. Its diversity and abundance development is mainly determined by the habitat depth, biotope character and by edificatoric role of macrobenthos species (Sergeeva, 1985; Kisseleva, Sergeeva, 1986). As a rule free-living nematodes prevail in abundance value; harpacticoids and foraminifera relates to subdominants in the meiobenthos of the soft-bottom (Long-term changes …, 1992; Vorobjeva, 1999).

As a results of researches of the Black Sea fulfilled up to the last decade of the last century, list of meiofauna species was added considerably in such taxonomical groups as Foraminifera (Janko, Vorobjeva, 1990; Janko, Vorobjeva, 1991), free-living nematodes (Sergeeva. 1973; 1974; 1981; Stoikov, 1977), Harpacticoida (Kolesnikova, 1983; 1991), Acari (Bartch, 1996a,b; 1998a,b; 1999), Polychaeta (Kisseleva. 1992; 1996; 1998; Skulary, 1997). Nevertheless, species diversity of the Black Sea meiofauna is still insufficiently investigated.

Species of the soft-shelled foraminifera (suborders Allogromiina and Saccamminina) (Sergeeva, Kolesnikova, 1996; Sergeeva, Anikeeva, 2001), discovered recently by us in the Black Sea testify to this. According to the preliminary data, fauna of the Black Sea soft-shelled foraminifera are presented by 20 species. *Psammophaga simplora* (Arnold, 1982) is the most numerous among them.

Existing fauna of the free-living nematodes in the Black Sea is richer, than it follows from the literature sources. At least 100 representatives of the unknown species and genus of nematodes are in our collection now.

Analysis of the literature and own materials, conducted for the last years, showed that meiobenthos (eumeiobenthos) of the Black Sea Crimean shelf includes 522 species (Sergeeva, Kolesnikova, 2003). In consideration of pseudomeiobenthos (juveniles stages of macrozoobenthos) composition of meiofauna is significantly richer.

Taxonomical diversity of meiobenthos in different regions of Crimea. Number and composition of species, entering into the meiobenthos category vary in regions of the Crimea. This is stipulated not only by the specificity of the geographical regions, but considerably is determined by the different levels of meiobenthos being studied in each Crimean water areas.

According to the results of the last expedition carried out for the purpose of biological and oceanographic monitoring of the Black Sea area of the Crimean shelf in 1999 – all main taxons are present in the meiobenthos within range of depths 20–260 m: Foraminifera, Nematoda, Oligochaeta, Polychaeta, Turbellaria, Kinorhyncha, Nemertini, Bivalvia, Gastropoda, Harpacticoida, Ostracoda, Cumacea, Amphipoda, Acarina. Some earlier unknown meiobenthos organisms conventionally named as “Forma 6” and “Forma 11” have been registered too. These forms are widely distributed in the bottom sediments of the anaerobic zone of the Black Sea (Sergeeva, 2000a,b).

Distribution across depths of the main meiobenthos groups in various regions of the Crimean shores is shown in the Figure 9. The “taxonomical core” consisting of Nematoda, Foraminifera, Harpacticoida and Polychaeta is clearly distinguished. Considerable share of meiobenthos falls to the “Miscellaneous” group. Significant quantitative indices of this group at definite stations, in hypo- and anoxia conditions, are determined by the high abundance of the above mentioned “Forma 11”.

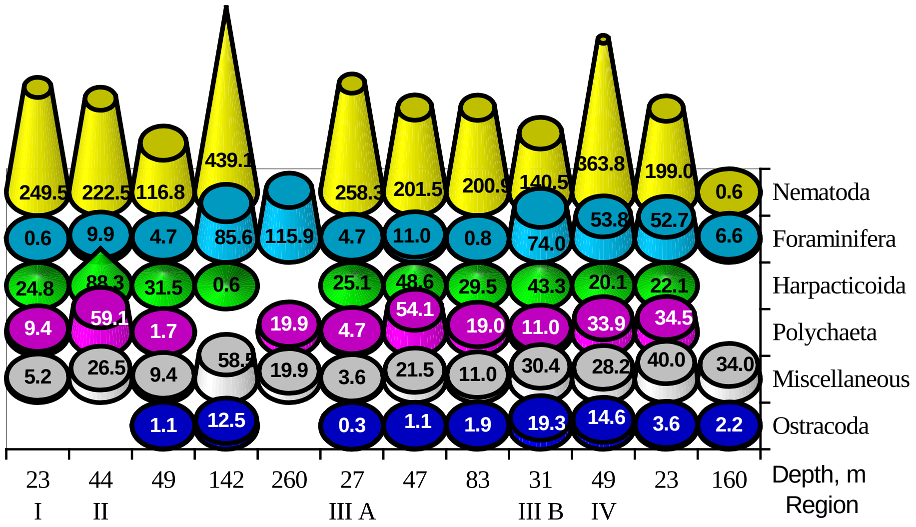

Figure 9. Regional variations of abundance (th. ind/m^2) of the meiobenthos major taxa on the Crimean shelf (spring, 1999) (from Sergeeva, 2003a).

Taxonomical composition of the meiobenthos in the depth range of 23–31 m is the most diverse in the area off Alushta (11 groups). The meiobenthos here in equal shares includes representatives of eu- and pseudomeiobenthos. 7–8 meiobenthos groups were registered in the areas off Yalta, Karadag and Tarkhankut cape. Free-living nematodes make the most numerous group in all regions. Harpacticoids play role of subdominants in the areas off Alushta, Yalta and Tarkhankut cape, turbellaria – in the area off Karadag.

The highest diversity of taxons (11) was registered in II and IV regions (Yalta, Karadag) at the depths of 44–49 m, but in I and II regions (Tarkhankut, Sevastopol) 9 and 7 groups correspondingly. Nematodes are the dominant species at the given depths, and number subdominants makes up kinorhynchs and harpacticoids in the I region, harpacticoids and polychaetes in the II and III region and foraminifers in the IV region. At the depth of 83 meters in area off Yalta (II region) nematodes dominate by abundance; the following positions occupy harpacticoids and polychaetes accordingly.

Taxonomic composition of meiobenthos at 142 and 260 m depths (region II) is peculiar. At the depth of 142 m 11 main groups of meiobenthos is found. Nematodes prevail by abundance, foraminifers and gastropods have subdominant role. Representatives of six main taxons, including “Form 11”, are registered at the depth of 260 m. Foraminifera, presented only by soft shell species, take a leading position. Second and third places belong to polychaetes and “Form 11”, correspondingly. It is interesting to note that at the given depth foraminifera dominate in meiobenthos when nematodes are absent. Just at this depth the greatest population density (115.9 thousand ind/ m^2) of soft shell foraminifera was registered.

The quantitative development of meiobenthos in different regions of Crimea. Average density values of the meiobenthos vary in different regions in limits of 43.4–596.2 thousand ind/m^2, biomass – 0.4–4.6 g/m^2 (Figure 10).

Absolute maximum (930.1 thousand ind/m^2) of the meiobenthos abundance is registered in the II region (southwestern part of the Crimean coast) in one of samples, taken at the depth of 142 m.

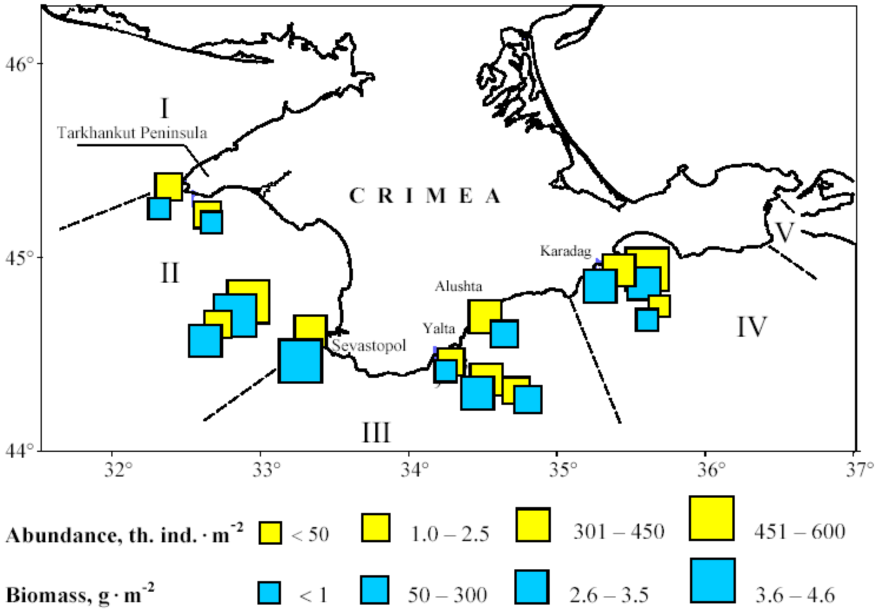

Figure 10. Scheme of meiobenthos' abundance and biomass distribution (from Sergeeva, 2003a).

The highest values of the average meiobenthos density were revealed in II and IV regions (596 and 515 thousand ind/m^2 correspondingly). Maximal development is connected with the depth of 142 m in the southwestern part, and with 49 m in area off Karadag. Minimal abundances were registered in the Karadag water area (43.3 thousand ind/m^2) at the depth of 160 m and to the south from the Tarkhankut cape (165.0 thousand ind/m^2) at the depth of 49 m. The meiobenthos abundance on the studied water area varies mainly in the limits of 300.0–450.0 thousand ind/m^2.

Biomass distribution is of another picture. Its highest magnitudes were registered in the southwestern part of the region II at 142 m depth (4.6 g/m^2) and in Sevastopol water area at 44 m depth (3.9 g/m^2). At 142 m depth 65.2% of biomass is made by hydroid polyps (3.0 g/m^2), 24.0% – by foraminifera. At 44 m depth 77.2% of biomass are made by polychaetes, 18.2% of biomass – by harpacticoids.

Biomass values (2.7–3.1 g/m^2) are comparable in the regions III A (Yalta, 47 m), IV (Karadag, 23–49 m) and southwestern part of the region II at 260 m depth. The main share of meiobenthos biomass in area off Yalta (34.3–80.0%) and off Karadag (63.0–68.0%) is made by polychaetes at 23–

49 m depths; foraminifera made 23.8–24.6%. In the region III B (Alushta) equal contribution to biomass (28.1%) is given by polychaetes and juvenile specimens of bivalve mollusks; harpacticoids give 17.9%.

The least indices of biomass (0.4–0.8 g/m^2) were revealed near cape Tarkhankut, at the near-shore station (27 m depth), in water area off Yalta and off Karadag at 160 m depth. Near the extremity of cape Tarkhankut at 23 m depth, 59.2% of meiobenthos summary biomass were given by polychaetes, 24.6% – by harpacticioids, 12% – by nematodes. To the south of Tarkhankut at 49 m depth 55.5% of biomass is given by harpacticoids, 18.9% – by polychaetes. At 160 m depth (Karadag) acaria (57.5%) and foraminifera (22.5%) make the basis of meiobenthos summary biomass.

While character of the macrobenthos abundance changes in regions is determined by dominance of several species of polychaetes, bivalve mollusks and ascidia (Revkov et al., 2002), changes of meiobenthos abundance are conditioned, mainly, by nematodes mass development. Thus dependence of quantitative development of meiobenthos with macrobenthos ones – is not revealed.

Meiobenthos in the locations of methane gas seeps. The cold seep sources are widely spread in the seas and oceans. At present over 3000 plots of methane gas bubble streams from bottom are known within the range of depths 35–1800 m of the Black Sea. (Egorov et al., 2003). In the Black Sea methane gas seeps were registered for the first time in April 1989 (Polikarpov et al., 1989). From the moment of revealing the fields of methane gas seeps in the Black Sea a great interest occurred to the problems of ecology, conditioned by the methane seeps influence. Complex of interdisciplinary (physical, chemical, oceanographic, biogeochemical and microbiological) researches of methane gas seeps in Crimean region was carried out later.

At present there is lack of information concerning bottom fauna composition in areas with oozing of methane gas in the Black Sea (Luth U, Luth C, 1998; Sergeeva, 2003b). Therefore benthos study in the locations of the methane jet oozing from a bottom is one of actual tasks of marine ecology.

Comparative studies of the Black Sea benthic communities structure in the regions with methane income and without it has been conducted for the first time in 1993–1994 by Luth U, Luth C, (1998). It appeared, that the biomass and biological activity of the bottom communities had close magnitudes in the regions compared. Predominance in the seep region macrobenthos composition of animals, achieving larger sizes is considered by the authors to be an index of greater biocenosis stability.

Our investigations in the regions with methane gas seeping have shown that meiobenthos is characterized by great diversity. It includes 12 main groups of benthic animals, such as: Porifera, Coelenterata, Foraminifera, Nematoda, Kinorhyncha, Oligohaeta, Polychaeta, Turbellaria, Bivalvia, Harpacticoida, Ostracoda, Acarina. Only four groups of meiobenthos such as Nematoda, Turbellaria, Ostracoda and Acarina were registered at the depths of 230-235 m.

The maximal abundance value of meiobenthos reach up to 520.8 th.ind/m^2 at the depth of 70 m. At the depths of 170–235 m the abundance (3.1–11.4 th. ind/m^2) and diversity (4-5 main taxons) of meiofauna are sharply decreased. (Figure 11, 12). Nematoda is the basic (by density) group of meiobenthos in all range of depths. Harpacticoida is the next numerous after Nematoda group of a meiobenthos in a range of depths 70-120 m; Coelenterata and Polychaeta – at the depths of 130-155 m (Figure 13).**We mark, that a specific community of the benthic organisms, adapted to the limited oxygen concentration is formed at the range of depth of 130–150 m. The soft-shelled foraminiferes, large quantity of nematodes species, specific polychaetes (Chrisopetalidae, Nerillidae, Protodrilidae), hydroid polyps and turbellaria are the main components of this community. Representatives of Nematoda dominate in the given community.**

Coelentherata have maximal density 11.3–15.1 thousand ind/m^2 at the depths range of 134–151. Considerable number of coelenterata was registered also in the macrofauna composition at the given polygon at the depths range of 110–150 m (Luth U., Luth C, 1998).

Fauna of foraminifera is represented here by five species, widespread in the Black Sea, but with small population density in the areas studied. They are *Ammonia compacta* (Hofker), *Eggerella scabra* (William), *Lagena* sp. 1, *L.lateralis* (Cushman), *L.perlucida* (Mont). The main share of Foraminifera density at the depths range 70–175 m is made by Allogromiina. Among the last ones *Psammophaga simplora* dominates in a number.

Polychaeta, *Vigtorniella zaikai* Kiss., *Protodilus* sp. 1, *Nerilla* sp. 1, are registered only in the given region with methane gas seeps (Zaitsev, Mamaev, 1997; Kisseleva, 1998; Zaika et al., 1999).

Fauna of Nematoda is represented by 143 species of all known orders within investigated range of depths (Figure 14). The total number of species is 69 and 63–33 at the depth of 150 m and of 120–140 m correspondingly. Mainly taxonomical composition is like at the smaller shelf depths in the Black Sea, and this fact testifies to Nematoda euribiontness. However some representatives are found out only in gas seeping areas to the southwest from the Crimean peninsular at the depths, where minimal oxygen concentrations or its absence were registered. We assume, that there is a formation of specific meiofauna in conditions of methane gas seeping. Presence of 38 species and 6 genera of Nematoda, registered only in the given conditions and earlier unknown for the Black Sea points on this fact.

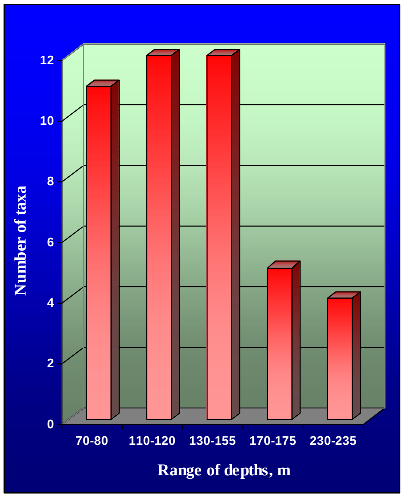

Figure 11. Number of main taxa within locations of methane gas seeping

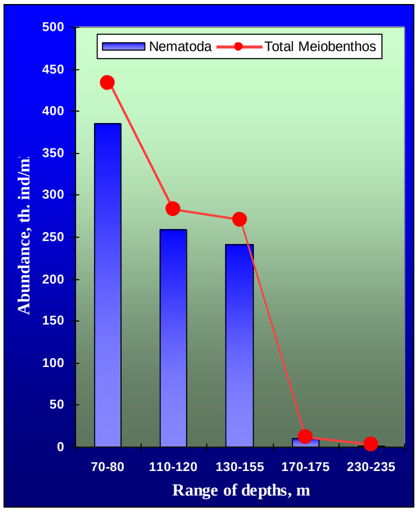

Figure 12. The abundance values of meiobenthos (th. ind/m^2) within locations of methane gas seeping

Meiobenthos abundance in the seeps region of the transition zone of the Black Sea, which is characterized by the oxygen deficit or its absence, achieve significant values, similar and even exceeding the such in the upper and average littoral zones. Mass development of the meiofauna in the suboxygen zone in the seeps region is stipulated by the favorable trophic conditions in the bottom sediments and absence of food competitors. Trophic meiofauna needs are determined by the degree of accumulation and transformation in the bottom sediments the arrived from the water column organic matter and development of the huge microflora biomass. Yu.I. Sorokin (1982) mentions maximum of the microflora total abundance and the most activity of its definite groups in the bottom sediments of the Black Sea slopes at the depths of 100–300 m. The total number of bacteria here, by his calculations, makes 1–5 billion per 1 g of wet sediments. These values of the bacteria total abundance and biomass are close to the analogical indices in the upper layer of the bottom sediments in the mezotrophic and even eutotrophic water areas.

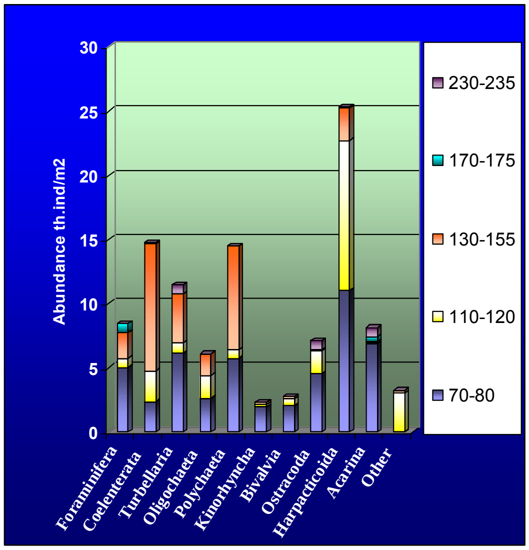

Figure 13. Abundance (th. ind/m^2 and %) of main meiobenthos taxons in area of methane-gas seepings (without consideration of Nematoda).

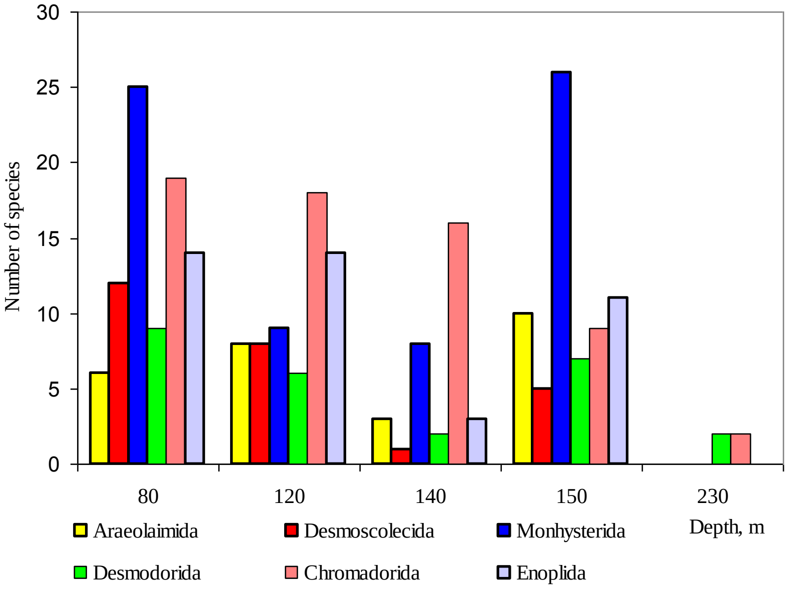

Figure 14. Species representativeness of Nematoda orders across depth within location of methane gas seeping (south-western Crimea (fromby Sergeeva, 2003b)

CONCLUSION

1. The results of fulfilled analysis concerning the bottom macrofauna composition testify the absence of species number reduction at the Crimean coastal zone of the Black Sea over the 2nd half of the XX century. From 62 to 100% of all species, known for Black Sea water areas with normal marine salinity (18), were registered near the Crimean coast in different taxons. The total number of the macrozoobenthos species exceeds 560. On the background of the common relative stability of the benthic fauna species diversity the structural-functional transformations in benthos have been registered. Fauna of mollusks is most diverse (81 species) at the range of depth 11–20 m, of crustaseans and annelids (74 and 80 species correspondingly) – 0–10 m, of “Miscellaneous” (35) – 21–30 m depths.

2. During the period from 1930-s to 1990-s filter-feeding mollusks became the most pronounced “evolutioning” organism, determining the quantitative changes of the bottom fauna over the soft-bottoms of the southwestern Crimea. Extraordinary increase in abundance and biomass of *Chamelea gallina* (within range from 1 to 25 m depths) and decrease of these parameters for *Spisula subtruncata* (1-12 m), *Paphia aurea* (13-50 m), *Mytilus galloprovincialis* (26-50 m) and *Modiolula phaseolina* (51-110 m) have been registered. It shifts maximum of absolute production to lesser depths: from the zone of mussel silts (26–50 m) to silty-sand (13–25 m).

3. Meiobenthos (eumeiobenthos) of the Crimean shelf includes 522 species totally and varying in different regions of Crimean shelf. The last fact is caused not only by specificity of areas itself, but a various extent of meiobenthos investigation level in each of regions.

4. Meiofauna is various and numerous in the locations of methane stream oozing on Crimean shelf. Density of the meiobenthos might achieve and even exceed the respective values have registered for the upper and middle layers of sublittoral. Formation of specific meiofauna composition in regiong with methane gas seeping is marked. Detection of 38 species and 6 genera of Nematoda, which are registered only in the given conditions testify to this.

5. At present, general species diversity condition of the benthic fauna at the Crimean shores can be admitted as satisfactory.

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STRUCTURE OF BENTHIC DIATOMS TAXOCENES IN MODERN CONDITIONS (Crimea, The Black Sea)

Elena L. NEVROVA, Nikolay K. REVKOV, Alexei N. PETROV
The A.O. Kovalevsky Institute of Biology of the Southern Seas, National Academy of Sciences of Ukraine
Nakhimov av. 2, Sevastopol 99011, Ukraine
E-mail: nevrova@ibss.iuf.net, revkov@ibss.iuf.net, alexpet@ibss.iuf.net

ABSTRACT

The total updated list of benthic diatoms from the Crimean coast, including 409 species and intra-species taxa has been prepared. More than a half (55%) of general floristic richness of the Black Sea benthic diatoms is formed by species of the Crimean coast. 48 new and 21 rare species have been revealed for Crimean coast, five of them were recognized as newly-found for the whole Black Sea and 4 species were new for science.

The comparative structural analysis of benthic diatoms taxocenes from two water areas of Crimean coast have been carried out and based on methods of multivariate statistics. Those areas (Laspi and Sevastopol bays) have substantially differed by content of heavy metals and other pollutants in bottom sediments.

The features of spatial organization of benthic diatoms habitats have been investigated for both bays. Statistically significant taxocenotic complexes and subcomplex groupings of diatoms were revealed in each of the bay. Development of diatom taxocene in Laspi bay is caused by worsening of optimal environmental conditions from the central part of the bay towards the both more shallow and deep-water zones. The peak of species richness values coincides with 16-20 m depth, and characterizes the middle sublittoral zone that is the most optimal one for diatom algae inhabitation.

In Sevastopol bay the level of toxicants’ content in bottom sediments and water depth are the leading abiotic factors influencing on peculiarities of diatom taxocene structure. The differences in the structural pattern can be caused by presence an eurybiontic species and species having the highest parameters of development within the certain biotope at all stations of the investigated water area.

Lists of principal species contributing the most input into similarity within taxocenotic complexes of each bay were compounded. Inter-complex differences in taxocenes structure are mostly pronounced and probably caused by different response of discriminating species to a high level of toxicants. Structural differences at sub-complex level are less pronounced and can be conditioned by similar reaction of discriminating species on joint influence of key environmental factors within a certain bay. The most significant discriminating species can also be considered as indicators of the diatom taxocenes condition under comparative assessment of biotopes subjected to miscellaneous anthropogenic load. It is proposed to consider *Tabularia tabulata, Amphora proteus* and *Nitzschia reversa* as indicators of conventionally healthy biotopes, whereas *Tryblionella punctata, Diploneis smithii* and *Nitzschia sigma* can be considered as indicators of biotopes subjected to persistent technogenic impact.

Keywords: benthic diatoms, *BACILLARIOPHYTA,* multivariate statistics, pollutant, Crimea, the Black Sea.

INTRODUCTION

Benthic diatom algae *(BACILLARIOPHYTA)* are leading among all other groups of microphytobenthos by abundance of population and species richness. They are dwelling in all biotopes of sublittoral from a surf zone up to depth of 50-70 m. They have an important role in matter and energy transformation, self-purification processes and in an oxygen balance of coastal water areas. Benthic diatoms are closely associated with certain biotope and directly subjected by environmental factors. It allows consider them as the appropriate indicator of anthropogenic impact during the complex monitoring of sublittoral ecosystems.

Benthic diatom taxocenes in the Western and North-western sectors of the Black Sea are most examined, whereas the shores of Crimea and Caucasus are relatively poorly investigated. The information about diatom’s flora is almost lacking for the Southern and South-eastern parts of the Black Sea.

MATERIAL AND METHODS

The results of studies based on the review of literary data (Nevrova, 2003) and our own materials on benthic sampling survey performed in August 1994 nearby mouth of Sevastopol bay (Nevrova, 1999) and in July 1996 in Laspi bay (Nevrova, Revkov, 2003) (Figure 1).

Samples were taken by the Petersen grab on various types of substrate within range of depths 0.5-52 m (Nevrova et al., 2003). The quantitative counting of mass species, i.e. having abundance more than $7{,}86\times10^4$ cells per cm^2, was performed and recalculated per 1 sm^{-2} of substrate. Density of those species which have not been included in to the quantitative calculation, but have found in samples, was considered to be equal to 10 $cells/cm^2$ in the further counting. Complete taxonomic analysis of diatoms on slides prepared by standard technique of cold burning in acids was carried out

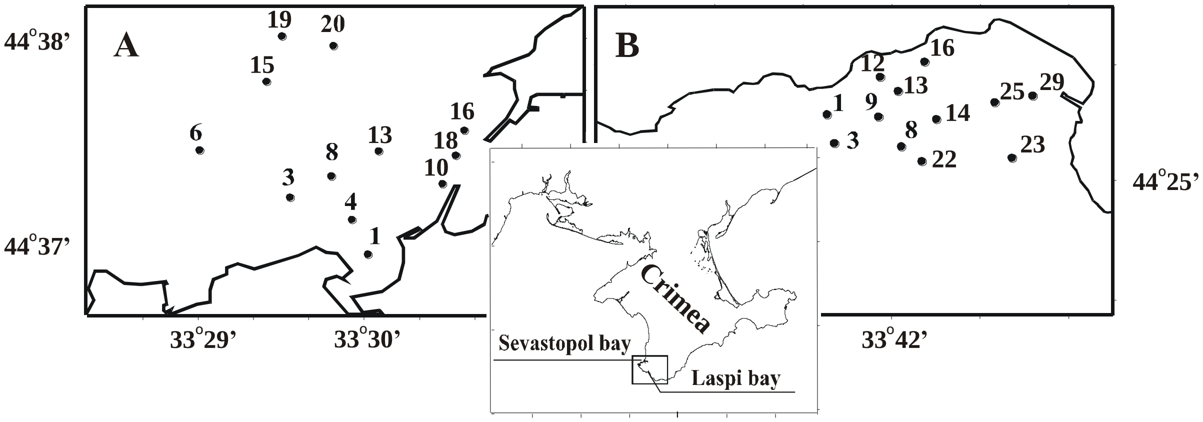


Figure 1. The schematic map of the sampling areas nearby Sevastopol bay mouth (A) and in Laspi bay (B)

The comparative analysis in diatoms taxocene structure features have been fulfilled by application of multivariate statistical algorithms and software package PRIMER (Clarke, Warwick, 2001). Clustering, PCA and nMDS ordination techniques were used for distinguish the group of stations in relation to different environmental conditions (Carr, 1997). Significance of differences between separated group of stations was tested by using permutation/randomization methods (ANOSIM test). The Spearman rank correlation coefficient (ρ) have been evaluated for detection the combination of environmental factors which attains a best match of the high similarities (low rank) in the biotic (abundance data) and abiotic matrices, i.e. to recognize a set of abiotic variables “best-explaining” the spatial alterations in benthic diatoms community patterns across the surveyed bottom area.

Based on the results of PCA analysis, two principal environmental components (PCs) have been revealed: PC1 (making 58 % of total variation explained) is associated with gradient of several heavy metals (Pb, Cu, Mn and Cr) concentration across study area, and PC2 (23 %) can be associated with changes in COC (DDT and PCBs) content in upper 2-4 cm layer of sediments. The contamination gradient has formed by 7 heavy metals: Hg, Cu, Pb, Zn, Ni, Cr, Mn and chlorine-organic compounds was investigated in surveyed water area and possible effect of toxicants on structural characteristics of benthic diatom taxocene was assessed.

SIMPER data analysis was performed for to provide additional information concerning which species are principally responsible for similarity <u>within</u> distinguished benthic assemblages (indicator species) and for differences <u>between</u> such taxocenotic complexes (discriminating species).

Species Diversity of the Benthic Diatoms Taxocene of the Crimean Coast

The list of benthic diatom algae of Crimean coast has been prepared on the basis of literary and own data (Nevrova et al., 2003) and in accordance with the system of higher taxa proposed by Round F.E. (Round et al., 1990). The list includes 409 species and intra-species taxa of benthic diatoms. Meanwhile, in the North-Western region of the Black Sea were found 341 species and intra-species taxa, at the Romanian coast – 353, at the Bulgarian coast – 272 and at the Caucasian shelf – 266.

The highest species richness of diatoms is registered near Crimea that makes about 55 % of total number of the Black Sea benthic diatom species (table 1). Regarding other investigated coastal areas, this relative index was much lower: 36.5 % (Bulgarian coast); 47.3 % (Romanian coast); 35.6 % (Caucasian coast); 45.6 % (North-Western shelf, but without consideration of species from brackish-water estuaries and lagoons). By reviewing of all species dwelling in hypersaline and brackish-water lagoons (Guslyakov, 2003), total updated list of diatoms from NW region includes 604 species and intra-species taxa (i.e. about 80 % of total number of species registered for the Black Sea).

Under comparing diatom species composition of Crimea with other Black Sea regions, the highest extent of species similarity was revealed for North-western region, where Chekanowsky similarity index was 71.3% (for presence/absence transformed species data matrix). This index had a little lower value– 67.4 % in comparison between Crimean and Caucasian coasts. The similarity index of diatom flora between Crimean and Bulgarian coasts was 52.7 %. Among all investigated regions, the lowest degree in species composition similarity index was marked between NW region of the Black Sea and Bulgarian coast (46.1 %).

The list includes 409 species and intra-species taxa, belonging to 81 genera, 45 families, 24 orders, 6 subclasses and 3 classes of division *BACILLARIOPHYTA*. Representatives of class Bacillariophyceae bring 77.5 % of the total number of taxons found belonging to 9 orders, 23 families, 42 genera, 271 species (317 intra-species taxa) of benthic diatoms. Class Coscinodiscophyceae (10.8 %) is represented by 7 orders, 13 families, 19 genera, 39 species (44 intra-species taxa), class Fragilariophyceae (11.8 %) - by 8 orders, 9 families, 20 genera and 42 species (48 intra-species taxa).

The following families are the most representative ones the near Crimean coast: *Bacillariaceae* (4 genera, 58 species), *Catenulaceae* (2 genera, 41 species) and *Naviculaceae* (3 genera, 35 species). The highest richness at genera level have marked for family *Fragilariaceae* (10 genera, 17 species).

The most mass species of benthic diatoms at the Crimean coast, determining the quantitative development of microphytobenthos assemblages are *Striatella delicatula* (Kutzing) Grunow, *Rhabdonema adriaticum* Kutzing, *Grammatophora marina* (Lyngbye) Kutzing, *Tabularia tabulata* (Agardh) Snoeijs, *Licmophora ehrenbergii* (Kutzing) Grunow, *Achnanthes brevipes* Agardh, *Achnanthes longipes* Agardh, *Cocconeis scutellum* Ehrenberg, *Navicula pennata* A. Schmidt var. *pontica* Mereschkowsky, *Navicula* *ramosissima* Agardh, *Berkeleya rutilans* (Trentepohl) Grunow, *Diploneis smithii* (Brebisson) Cleve, *Caloneis liber* (W. Smith) Cleve, *Trachyneis aspera* (Ehrenberg) Cleve, *Pleurosigma angulatum* (Queckett) W. Smith, *Amphora proteus* Gregory, *Amphora coffeaeformis* (Agardh) Kutzing, *Bacillaria paxillifera* (O. Muller) Hendey, *Nitzschia closterium* (Ehrenberg) Reimer et Lewis, *Nitzschia hybrida* Grunow, *Campylodiscus thuretii* Brebisson.

Table 1. Representativeness of benthic diatoms in different regions of the Black Sea

Compared areas	Total number of species and intra-species taxa	References
Laspi bay	208	(Nevrova, Revkov, 2003)
Sevastopol area	247	(10 issues reviewed by Nevrova et al., 2003)
Karadag area	146	(8 issues reviewed by Nevrova et al., 2003)
Total for Crimean coast	**409**	(21 issues reviewed by Nevrova et al., 2003)
NW region of the Black Sea	341	(Guslyakov et al., 1992; Black Sea …Ukraine, 1998)
Romanian coast	353	(Bodeanu, 1979)
Bulgarian coast	273	(Black Sea … Bulgaria, 1998)
Caucasian coast	266	(Proshkina-Lavrenko, 1963; Nevrova, unpubl. data)
Totally for the Black Sea	**747**	

By results of studies through the last 10-15 years, 4 following species were discovered as a new for science: *Amphora karajeae* Guslyakow, *Amphora macarovae* Guslyakow, *Gomphonemopsis domniciae* (Guslyakow) Guslyakow and *Cymbella odessana* Guslyakow. Five new species for the whole Black Sea were found: *Achnanthes pseudogroenlandica* Hendey, *Cocconeis britannica* Naegeli, *Navicula finmarchica* Cleve et Grunow, *Nitzschia sigmoidea* (Ehrenberg) W.Smith, *Undatella quadrata* (Brebisson) Paddock et Sims. Besides, 21 rare species and 48 new ones for the Crimean coastal water areas were also marked (Nevrova et al., 2003).

In the coast water area of western Crimea benthic diatom taxocenes on the different types of natural and artificial substrates in the near-shore zones of Sevastopol are widely studied since the end of XIX- XX centuries.

The flora of diatoms in the investigated part of Sevastopol’s shore accounts 247 species and intra-species taxa, belonging to 3 classes, 23 orders, 40 families, 65 genera of *BACILLARIOPHYTA*. Class Conscinodiscophyceae is represented by 24 species (i.e. 10 % of the total number of species), belonging to 6 orders, 11 families, and 13 genera. Fragilariophyceae is represented by 36 species (14.5 %), relating to 8 orders, 8 families, and 14 genera. Genera *Licmophora* and *Diatoma* are represented by 10 and 5 species respectively, the rest of genera - by 1-3 species. Class *BACILLARIOPHYTA* dominates (75.5 % of total species number), 187 species and intra-species taxa, relating to 9 orders, 21 families, 37 genera are included (Nevrova et al., 2003).

Order Naviculales is the most diversed in number of taxons found : 4 orders, 8 families, 12 genera, 54 species and intra-species taxa. Representativeness of other orders is lower: Baccillariales – 1 family, 4 genera, 34 species and intra-species taxa, Achnanthales – 2 families, 3 genera, 27 species and intra-species taxa, Thalassiophysales – 1 family, 2 genera, 26 species and intra-species taxa. Considerable contribution into the species structure of taxocene makes the genera of *Nitzchia*, *Amphora*, *Navicula*, *Cocconeis* and *Diploneis* (25, 25, 16, 16, 11 species and intra-species taxa, respectively).

As a result of studies in the Sevastopol zone 13 rare species for the Black Sea and 26 new ones for Crimean coast were marked, and one new species for Black Sea was registered - *Achnanthes pseudogroenlandica* (Guslyakov et al., 1992).

The diatom flora of the Southern coast of Crimea was represented by results of studies in Laspi bay (June 1996). The flora of benthic diatoms in the bay is represented by 193 species (208 intra-species taxa), relating to 63 genera, 40 families, 22 orders, 5 subclasses, and 3 classes of *BACILLARIOPHYTA*. The class Coscinodiscophyceae was represented by small number of taxons: 15 species (7.2 % of total number), relating to 3 subclasses, 5 orders, 8 families, 11 genera. In class Fragilariophyceae have been 27 species (13 %), relating to 1 subclass, 8 orders, 9 families, 16 genera. Genus *Licmophora* is represented by 6 species, the rest of genera -by 1-3 species. The class Bacillariophyceae is dominant (79.8% of total number of species) and represented by 166 species and intra-species taxa, 9 orders, 23 families, 36 genera (Nevrova,Revkov, 2003).

Order Naviculales is the most representative in the number of found taxons - 4 suborders, 10 families, 14 genera, 55 species (57 intra-species taxa). Representation of other orders is lower: Bacillariales - 1 family, 4 genera, 26 species and (29 intra-species taxa), Achnanthales - 2 families, 4 genera, 22 species (27 intra-species taxa), Thalassiophysales - 1 family, 1 genera, 22 species (24 intra-species taxa). The significant contribution to the species structure of taxocene is brought by genera of *Nitzschia*, *Amphora*, *Navicula*, *Cocconeis* and *Diploneis* (respectively 24, 21, 1, 17, 14, 10 species and intra-species taxa, respectively).

In the water area of Laspi bay 11 rare species for the Black Sea and 25 new ones for Crimean coast were marked . Among them two species were discovered earlier only in fossils (*Raphoneis amphiceros* Ehrenberg and *Diploneis vetula* (A.S.) Cleve), we have found them as alive. Two new species for Black Sea basin have been discovered for the first time: *Cocconeis britannica* Naegeli and *Navicula finmarchica* Cleve et Grunow (Nevrova, Revkov, 2003).

In the area of eastern Crimea benthic diatoms are mostly investigated in Karadag Natural Reserve' water area. By the present time the list of benthic diatoms of Karadag coast includes 146 species and intra-species taxa, belonging to 48 genera, 34 families, 21 orders, 3 classes of *BACILLARIOPHYTA*. In class Coscinodiscophyceae 5 orders, 7 families, 7 genera, 17 species and intra-species taxa are marked, in Fragilariophyceae - 8 orders, 8 families, 11 genera, 25 species and intra-species taxa, in Bacillariophyceae - 9 orders, 19 families, 30 genera, 104 species and intra-species taxa. Genera *Nitzschia* (16 species and intra-species taxa), *Amphora* (14), *Licmophora* (10), *Cocconeis* (8) and *Navicula* (7) are most widely represented (Nevrova et al., 2003).

Two new species for Black Sea basin were discovered there: *Undatella quadrata* (Brebisson) Paddock et Sims and *Nitzschia sigmoidea* (Roschin et al., 1992).

The Structure of Diatom Taxocene in ecologically healthy biotope (on example of Laspi bay)

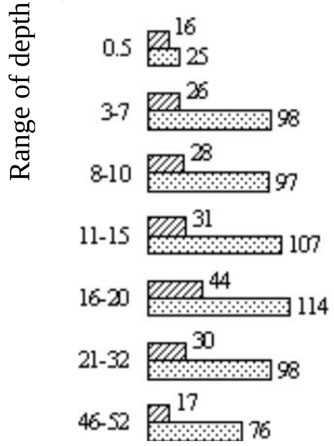
By present, the distinquish of taxocenotic complexes in algology based on predominance of main species and density indexes assemblages. At the present work the analysis of the structural organization of diatoms' assemblages is executed by application of multivariate statistical technique along the routine methods of estimation of species' distribution and alteration of quantitative characteristics of diatoms by depth (Revkov, Nevrova, 2004).

Quantitative estimation of diatoms' development and distribution on depth in Laspi bay. The density of diatoms assemblages ranged from 15.72×10^4 up to 2307.7×10^4 cells•cm^{-2}, averaging 398.9×10^4 cells•cm^{-2} of the bottom area, that is comparable to the similar data for other water areas. For example, in the mouth of Sevastopol bay (the western coast of Crimea) these values changing from 94.32 up to 901.43×10^4 cells•cm^{-2}, averaging 340.64×10^4 cells•cm^{-2}, along the open coast of South-western Crimea is 174.4×10^4 cells•cm^{-2}, within the urban zone where water areas are impacted by moderate level of municipal sewage is 288.0×10^4 cells•cm^{-2}; in the inner, most polluted part of the bay is 18.7×10^4 cells•cm^{-2} (Nevrova et al., 2003). Along the Romanian coast nearby Danube river delta the average density of benthic diatoms was 26.7×10^4 cells•cm^{-2}; while a maximum value 184×10^4 cells•cm^{-2} was registered at 20 m depth (Bodeanu, 1978).

The most mass species determining the general pattern of quantitative development of bottom diatoms in Laspi bay, are colonial *Tabularia tabulata* and *Licmophora gracilis* (average densities are 105.1×10^4 и 58.4×10^4 cells•cm^{-2} , respectively). Other species bring altogether about 61 % of average density of taxocene. The ranged list of the first 20 species is following (in brackets, the percentage of average species density from the total average density of diatom's taxocene is marked): *Tabularia* *tabulata* (25 %), *Licmophora gracilis* (14 %), *Navicula ramosissima* (9 %), *Licmophora abbreviata* (7 %), *Navicula pennata* var. *pontica* (6 %), *Grammatophora marina* (5 %), *Cocconeis scutellum* var. *parva* (5 %), *Cocconeis scutellum* var. *scutellum* (3 %), *Amphora proteus* (2 %), *Licmophora hastata* (2 %), *Nitzschia closterium* (2 %), *Navicula palpebralis* var. *semiplena* (2 %), *Amphora coffeaeformis* (2 %), *Cocconeis euglypta* (1 %), *Bacillaria paxillifera* (1 %), *Diploneis smithii* var. *smithii* (1 %), *Pleurosigma angulatum* (1 %), *Caloneis liber* (1 %), *Thalassionema nitzschioides* (1 %), *Fallacia forcipata* (1 %).

At an estimation of diatoms' distribution on different depth, the total number of species and an abundance of mass forms were taken into account. Quantitative distribution of diatom species in Laspi bay (investigated depth range from 0.5 to 52 м) has bell-shaped trend (Figure 2). A maximal species richness (114 species and intra-species taxa) is registered on the depth of 16-20 m, minimal (25 species and intra-species taxa) is revealed at most shallow zone (depth 0.5 m). The similar tendency is also marked in representativeness (44 species) of mass forms of diatoms. The share of the mass diatom species is rather constant; 3 m deeper it changes within 22-39 % and reaches 57 % at depth of 0.5 m.

Figure 2. Distribution of diatom species number within depth range 0.5 to 52 m:
▨ - quantity of mass species; ⬚ - total quantity of species



The received data allowed to reveal more exactly the tendency in changes of diatom species diversity by depth. So, following to previously postulated opinion (Proshkina-Lavrenko, 1963; Bodeanu, 1979; Nevrova, 1999) species richness increases up to 20 m depth. Our results have shown that the maximum number of species was found out within depth range 16-20 m and gradually decrease towards more deep waters (up to 50 m).

By the results of clustering and nMDS ordination analysis based on Bray-Curtis similarity index all stations were subdivided into two complexes on 30 % similarity level. Complex I include 5 stations sited at depth 0.5 m on rocky substrate and macrophytes; complex II combines 20 stations at depths 3-52 м on soft substrate and macrophytes. Stations of complex II cover almost whole bottom area of Laspi bay (Figure 3) (Revkov, Nevrova, 2004). At 54% Bray-Curtis similarity level the complex II is subdivided to the core zone and group of the marginal stations. The core zone includes two subareas (II_a and II_b) located in the central part of the bay within depth range 8-46 m. The group of marginal stations (subarea II_c) is located both in nearshore (depths 3-5 and 16 м), and in deeper offshore zone (32-52 м) of Laspi bay. The subarea II_c is the least homogeneous and distanced from complex I more far, than the subareas II_a and II_b. This determines the least floral similarity between the complex I and the marginal zone of the complex II (subarea II_c).

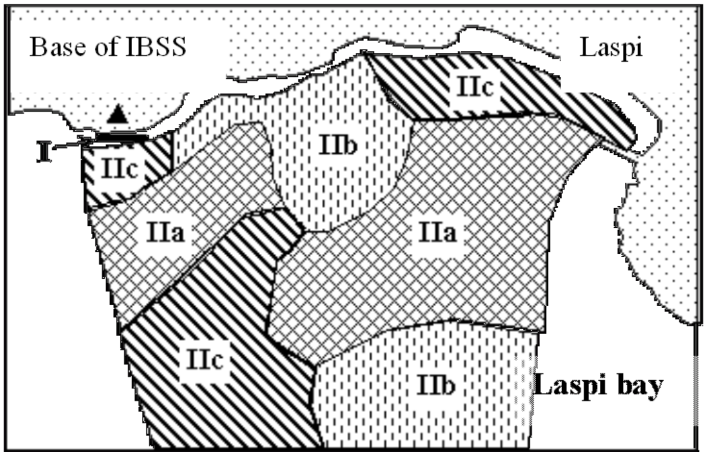


Figure 3. Schematic map of benthic diatom taxocenotic complexes distribution pattern in Laspi bay (by results of the clustering and nMDS ordination analysis) (from Revkov, Nevrova, 2004)

According to the results of clustering and MDS-analysis, the floristic similarity has been revealed for stations located in the neighbouring sites at similar depths but on different type of substrates (soft bottom or macrophytes).

Average similarity within the first complex in comparison with the second complex is appeared to be higher (62.2 against 40.3 %). In the complex I the first top ranged five species are mainly characterized the features of its internal organization, determining 64 % of similarity: *Navicula ramosissima*, *Licmophora gracilis, Grammatophora marina, Tabularia tabulata* and *Navicula pennata* var. *pontica*. In the complex II the similar cumulative percent is achieved at the level of 18 species and the most significant among them is *T. tabulata*.

We determine complex I as *Navicula ramosissima* + *Licmophora gracilis* + *Grammatophora marina* and complex II as *Tabularia tabulata* by dominating species and estimating the species significance by their contribution to intercomplex Bray-Curtis similarity.

In the both complexes among the first top ranged eight species five common ones are marked: *Grammatophora marina, Tabularia tabulata, Navicula pennata* var. *pontica, Cocconeis scutellum* and *Amphora coffeaeformis*. It specifies relative similarity of the complexes, but average distinction between the complexes according to Bray-Curtis similarity is rather high - 75.1 %. There are no pronounced leaders among the species determining this dissimilarity: the contribution of each of the first ten species is changing within 1.79 - 2.99 %. It makes only 29.1 % of the cumulative contribution of all species. The first five of such species are: *Licmophora gracilis* (the contribution to the average dissimilarity between complexes is 2.99 and makes 3.98 % of the cumulative contribution of all species), *Navicula ramosissima* (2.52 and 3.35 %), *Amphora proteus* (2.41 and 3.20 %), *Licmophora abbreviata* (2.37 and 3.16 %) and *Navicula palpebralis* var. *semiplena* (2.21 and 2.94 %). Among the mentioned above species the highest values of dissimilarity has *Licmophora gracilis*, that is the additional basis for its consideration as discriminating species of the examined complexes. Average values of *L. gracilis* population density in the II and the I complexes are different (8087 and 80680 cells•cm^{-2}, respectively). Relative heterogeneity of complex II also characterized by a high level of dissimilarity (64.36%) between its core and marginal zone. The most essential contribution made by such species, as *A. proteus* (1.93 and 3.0 %), *T. tabulata* (1.83 and 2.84 %) and *C. scutellum* var. *parva* (1.71 and 2.65 %).

Earlier marked floristic difference between of complex I and marginal zone of complex II (subarea II$_c$) proves to be true also at a level of the quantitative data. Stations of complex I are less similar to the stations of marginal zone (subarea II$_c$), than with the core stations of complex II (sub areas II$_a$ and II$_b$): corresponding values of dissimilarity I–II$_a$, I–II$_b$ and I–II$_c$ by Bray-Curtis index are 77.85, 66.70 and 79.54 %, respectively.

Ranked distribution of species is one of the methods for estimation of species diversity. The curve of the rank species’ distribution for complex II lies above on the dominance diversity plot and is more flat (i.e. represented by the higher number of species) comparatively with the corresponding curve for the complex I (Figure 4 A). After fractional consideration of complex II (Figure 4 B) distinction in position of curves corresponding to central (II$_a$, II$_b$) and marginal (II$_c$) subareas have been marked. Affinity between II$_c$ curve and curve of complex I have also been shown.

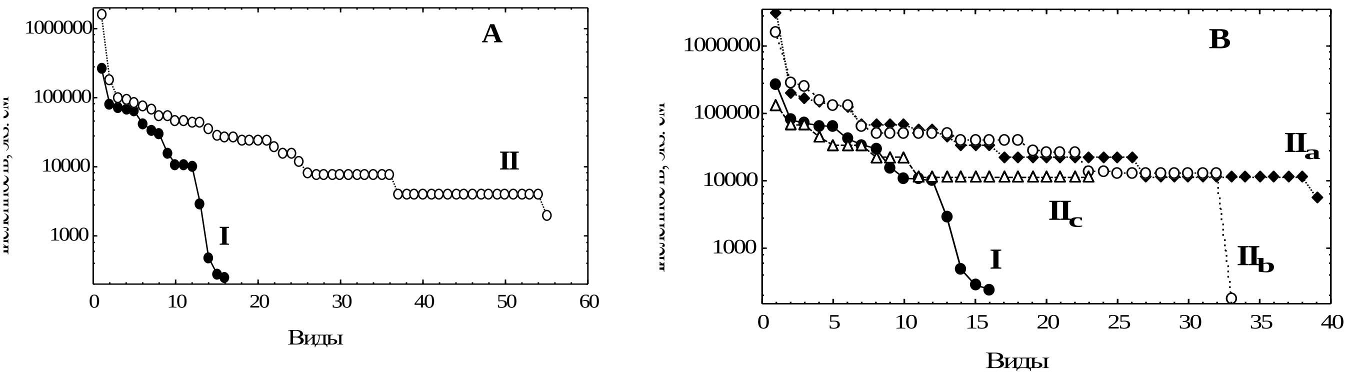


Figure 4. Species rank distribution curves at benthic diatom taxocene in Laspi bay: A – consideration of taxocene at a level of complexes I and II, B – position of species rank distribution curves, corresponding to complex I, to central subareas (II_a, II_b), and to marginal zone (II_c) of a complex II are shown.

As it was mentioned above, the peak on the curve of species richness and representativeness of mass diatom species in Laspi bay have corresponded to depth range 16-20 m. In this case the biotopes corresponding to specified depth can be considered as the optimal zones for development of benthic diatoms in comparison with upper sublitoral. The core of taxocenotic complex II is allocated there (average depth of stations 17±6 м).

The decrease of diatom species richness from central part towards both more deep water and coastal zones of a bay that can be caused by deviation of ecological conditions from optimum and it can be proved by the position and shaped of dominance-diversity curves corresponding to complexes II_c and I.

The affinity of floristic structure between subareas II_a and II_b is revealed by position of dominance-diversity curves (12 species are common within the list of the first 16 top ranged species). There are: *Tabularia tabulata*, *Amhora proteus*, *Navicula pennata* var. *pontica, Navicula palpebralis* var. *semiplena*, *Pleurosigma angulatum*, *Navicula ramosissima*, *Bacillaria paxillifera*, *Amphora coffeaeformis*, *Diploneis smithii* var. *smithii*, *Striatella unipunctata*, *Caloneis liber* and *Nitzschia reversa*. Under the comparison of complex I with subarea II_c, 6 common species were found from the top ranged 16 ones: *Navicula pennata* var. *pontica, Grammatophora marina*, *Cocconeis scutellum* var. *scutellum*, *Tabularia tabulata*, *Auricula insecta* and *Amphora coffeaeformis*. Comparison between complex I and subarea II_c testifyed the similarity of responses of different benthic diatoms' complexes in stressful conditions of habitat. Such adverse factors can be: influence of surf activity, wide range of temperature changes and high level of insulation for shallow water biotopes as well as the unsufficient level of solar radiation for deep-water zone.

The structure of diatom taxocene in polluted biotopes (on the example of Sevastopol bay)

Identification the groups of stations in accordance with level of pollution. Three groups of stations (clusters), corresponding to sites with different pollution levels were distinguished within the Sevastopol bay studied area. Respectively, three certain taxocenotic complexes of diatoms develop within every group of stations (Figure 5). The 1st group (A) corresponded to most shallow zone (average depth 0.5 m, substrate: shell debris and small pebble, dominant species are *Navicula ramossissima* and *Navicula pennata* var. *pontica),* where concentrations of all toxicants were 10-100 times lower then for two other groups. 2nd group (B) of stations (average depth 22,6 ± 3,0 m) characterized by fine sand substrate and highest concentrations of COC and lead. *Nitzschia sigma* and *Cocconeis scultellum* var *scultellum* are the most predominant species. For stations separated into 3rd group (C) (17,5 ± 2,4 m, silty sediments, *N. pennata* var. *pontica*) the highest level of heavy metals content in sediments was found.

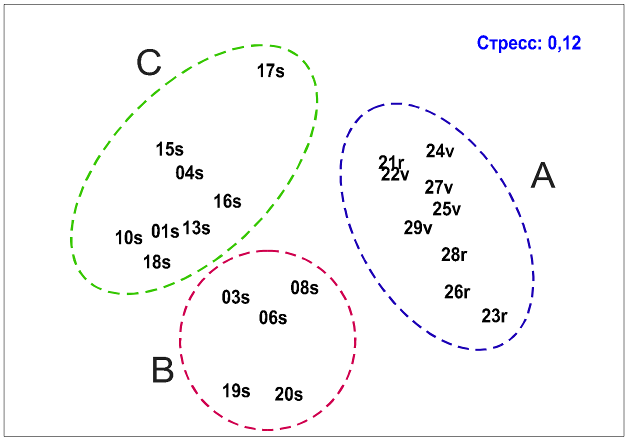


Figure 5. The results of ordination (MDS) analysis: grouping of stations into complexes from Bray-Curtis similarity of diatom algae abundance. Literal notation: samples are taken from sandy/silty substrate (s); from rocks (r) and mussel valves (v).

The average values of concentration of most toxicants (excepting zinc and PCB) were higher of 10-15 % for stations of group B co Stress 0.12 th group C. Average values of taxocene diversity parameters are represented in Table 2.

Table 2. Average values of diatom algae abundance and species richness indices for three groups of stations.

Group (number of stations)	Average depth (м)	Average Abundance (ind/m2)	Total number of species	Number of mass species	Number of rare species
A (9)	0.5 ± 0.1	290800 ± 59190	58	27	31
B (5)	22.6 ± 3.0	1129430 ± 118970	78	13	65
C (8)	17.5 ± 2.4	4265040 ± 1123840	124	43	81

Rather not high values of stress function (0.11-0.12) have been receiving from MDS analysis, has evidenced about reliable allocation of sample projection on 2-D plot. Besides, there is well pronounced separation of stations into 3 main groups. Differences between groups were statistically significant: global R-statistics = 0.88 at a significance level of 0,1 %; pairwise testing gives R_p values from 0.70 to 0.98, (0.1 %). These results testify statistically reliable differentiation of three complexes of stations within the investigated water area. Such pattern can be explained by influence of pronounced environmental gradient upon structure and quantitative parameters of diatom complexes in surveyed part of the bay.

The results of comparative evaluation of Spearman rank correlation coefficient (ρ) have shown that combination of variables "**Depth+Pb+Mn+Cu+DDT**" have mostly influenced upon structural alteration of diatom taxocene (ρ =0,73-0,75).

The analysis of changes in structure of taxocenotic complexes under toxicants' impact gradient. The lists of principal species contributing the most input into similarity within each pollution-related taxocenotic complexes as well as into dissimilarity between complexes were prepared. The average similarity of stations within every allocated complex, evaluated by Bray-Curtis similarity index, appeared to be rather high: for complex A - 54.5 %, B - 56.3 % and C - 52.2 %.

In complex A four top ranged species bring more than 54 % of the total input into determination of diatom assemblage structure similarity. The relative contribution of two most dominating species *Navicula ramosissima* and *N. pennata var. pontica* (19.09 % and 18.28 %, respectively) 2-5 times exceeds the value of contributions of other indicator species from the leading group the determine the structural features in benthic diatom taxocene. Such indicator forms have highest values of the similarity function, that evidenced about most constant parameters of these species development under adverse influence of environmental conditions comparatively with other species.

Under favorable living conditions these two indicator species are able to form colonies, achieving the maximum in density and biomass.

Navicula ramosissima, N. pennata var. *pontica* as well as other indicator species *Amphora coffeaeformis, Cocconeis scutellum* var. *parva* are euritherm, euribiotic and photophylic forms, living mainly in the upper sublittoral zone (0-10 m) and adapted to its stressful conditions (surf activity, high insulation of seabed, wide amplitude of temperature fluctuations, etc).

In complex B, containing stations with highest level of COC and rather not wide range of heavy metals concentration, the cumulative contribution at a level of 50% form 7 species, among them *Navicula pennata* var. *pontica* also dominates. The relative input of this species into similarity within group makes 19.1%, that 2-4 times exceeds contributions of other species. Besides *N. pennata* var. *pontica, Diploneis smithii var. smithii, Tryblionella punctata var. punctata,* and *Ardissonea crystalline* are the most significant species of this complex. These species are adapted to the low level of bottom illumination, they are inhabitants mainly of the middle (10-20 m) and deeper (20-30 м) zones of sublitoral.

In complex C, uniting stations with the widest range of heavy metals concentration, but the lower level of COC, the two most significant species are *Nitzschia sigma* var. *sigma* and *Cocconeis scutellum* var. *scutellum.* They have identical values of the relative input into intra-complex similarity (7.8 %). The cumulative contribution at the 50 % level is achieved due to 10 top ranged species. Five of them - *Diploneis smithii* var. *smithii, Tryblionella punctata* var. *punctata, Navicula pennata var. pontica, Grammatophora marina, Tabularia tabulata* - are common with the list of the most significant species from complex B, that specifies quite close eco-floristic similarity of these complexes. *Tryblionella punctata* var. *coarctata* and *Pleurosigma angulatum* species are shade requiring ones, and being adapted to the low level of insulation can vegetate mainly within the middle and deep water zones of sublitoral.

Thus, using a principle of allocation of biocenotic complexes by dominating species and taking into account the maximal values of similarity function, it is possible to designate complex A as *Navicula ramosissima + N. pennata* var. *pontica,* complex B - as *N. pennata* var. *pontica,* and complex C - as *Nitzschia sigma var. sigma + Cocconeis scutellum* var. *scutellum.*

Besides the marked top ranged species, the following species can also be considered as indicators of certain spatial groupings of benthic diatoms: in complex A - *Amphora coffeaeformis* and *Caloneis liber,* in complex B - *Tryblionella punctata var. punctata, Diploneis smithii* var. *smithii* and *Ardissonea crystallina,* in complex C - *Diploneis smithii* var. *smithii, Tryblionella punctata var. punctata, Navicula pennata var. pontica* and *Grammatophora marina.* These species are characterized by the most substantial input into similarity within corresponding complexes as well as the most constant parameters of development in diatom's taxocene in polluted water areas of Sevastopol bay.

The contribution of the certain species to the dissimilarity between each pair of distinguished taxocenotic complexes is evaluated by values of dissimilarity function ***D.*** The greatest dissimilarity has been revealed under comparison of complex A with complexes C and B, that can be explained due to the differences in the leading abiotic factors (depth, substrate), and also in the average level of toxicants accumulation in the biotope. The content of heavy metals in bottom sediments for stations of complex A was 5-240 times lower (level of COC was 1.2-62 times lower) in comparison with levels of similar variables for complexes C and B. Additionally, "variability increasing" effect of diatom taxocene structure under conditions of high content of toxicants has been shown.

At the analysis of possible combinations of paired comparison between three examined complexes 6 discriminating species have been revealed: *D. smithii* var. *smithii, N. sigma* var. *sigma, T. punctata* var. *punctata, N. ramosissima, C. scutellum* var. *scutellum* and *A. coffeaeformis*. All of them can also be considered as principal indicator species of allocated taxocenotic complexes of benthic diatoms.

Comparative Assessment of Changes in Structure of Benthic Diatoms under different Levels of Technogenic Pollution Impact

The purpose of this study was to assess comparatively the effect of anthropogenic impact mostly by heavy metals and chlorine-organic compounds on the structure and diversity characteristics of benthic diatom taxocenes from two above-described near-shore water areas of southwest Crimea: Laspi bay and Sevastopol bay. Laspi bay is located near boundaries of marine reserve and is unaffected by technogenic pollution, while Sevastopol bay water area is situated within industrial zone of Sevastopol port where average level of toxicant's content in silty bottom sediments was higher of 5-13-fold (heavy metals) and 22-270-fold (other toxicants) comparatively with Laspi bay.

The further analysis has been performed to test whether such differences in environmental conditions can be influencing upon peculiarities in structure of benthic diatoms assemblages in compared bays.

Allocation of inter-regional taxocenotic complexes and intra-complex groupings of diatoms. Results of multivariate statistical analysis have shown that at similarity level about 25 % all sampling stations are subdivided into 2 separate groups (clusters). Each of group consisted of stations located either in Laspi bay or in Sevastopol bay only. At a similarity level about 37 % each of two clusters is subdivided, in one's turn, into 2 subclusters. In Laspi bay (cluster I) subclusters are A and B, each of them contains 6 stations. Cluster II (Sevastopol bay) is also splitted into two subclusters C and D (5 and 7 stations, respectively).

Results of MDS ordination have also revealed the presence of two not overlapped areas on 2-D ordination plot in which the stations are taken in Laspi bay (I) and in Sevastopol bay (II) have been included (Figure 6).

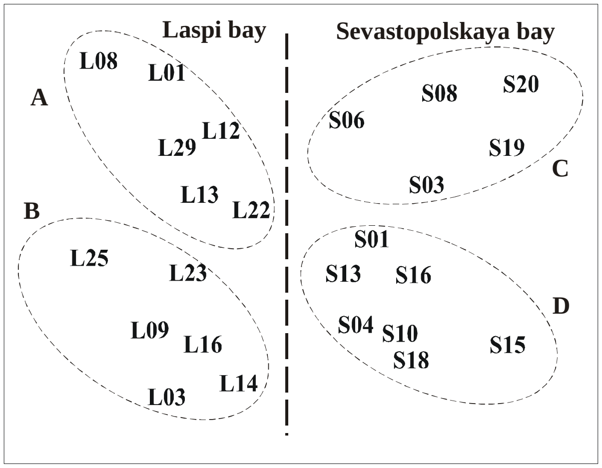


Figure 6. Results of ordination (MDS) analysis: grouping of stations in Sevastopol bay and in Laspi bays into complexes based on Bray-Curtis similarity of diatom algae abundance. The dotted line shows separation of stations between areas and sub-regional groupings (A-D).

Results of ANOSIM test statistically confirmed a differentiation between taxocenotic diatom complexes corresponding to each of two compared locations. Value of global R-statistics was rather high (0.691; at significance level of 0.1%), values of R-statistics for pairwise test have altered within range from 0.79 to 0.98, at significance level of 0.1%. These results also have verified that in each of the compared bays the taxocenotic complexes can be subdivided into two statistically different groupings which characterize by the certain features of diatom structure.

By comparison of 2 surveyed areas (as a whole) there have been was revealed that differences in average abundance of diatoms are insignificant, though average values of total species richness, number of mass and rare species in the healthy bay appear to be higher than in the polluted bay. At the same time, the quantitative characteristics of diatom assemblages in comparison between the allocated interregional groupings are also greatly different (Table 3).

Table 3. Average abundance and other species diversity parameters for 2 main complexes and allocated subcomplex groupings (A-D) of benthic diatoms

Region, grouping	Average abundance (10^6 cells x cm^{-2})	Total number of species	Number of mass species	Number of rare species
Laspi bay (as whole)	3.020±0.562	176	53	123
A	1.079±0.330	145	24	121
B	4.960±2.288	140	47	93
Sevastopol bay (as whole)	2.572±0.413	128	38	90
C	1.132±1.190	78	13	65
D	3.772±0.891	119	36	83

Comparison of structural features of taxocenotic complexes. In the taxocenotic complex of Laspi bay the 11 most significant species (indicator species), determining structural features of taxocene, bring about 48% of total input into average similarity within this complex. *Tabularia tabulata* and *Amphora proteus* are the most top ranged species of this list. The relative contribution of other nine indicator species is less sizeable and decrease from 5.83 % for *Navicula pennata* var. *pontica* up to 2.41 % for *Bacillaria paxillifera.*

In the complex of Sevastopol bay the similar part of total contribution (47.6 %) to average similarity within complex is determined by group of 8 top ranged indicator species (of the total list 128). *N. pennata var. pontica, Diploneis smithii var. smithii* and *Tryblionella punctata* var. *punctata* are leading forms displaying the highest values of their relative contribution (11.23, 9.51 and 5.98 %, respectively). These parameters define the indicator role of the marked species in the given taxocenotic complex which is formed under strong technogenic impact of the biotope. The relative input into average Bray-curtis similarity within this complex of other five significant species is gradually reduced from 4.75 % (*Cocconeis scutellum* var. *scutellum)* up to 3.70 % (*Ardissonea crystallina)*.

While comparing the lists of indicator species of two complexes, from 16 species and intra-species taxa only 4 ones appeared to be common. Such low affinity level (1/4) evidences about pronounced eco-floristic difference between the comparing complexes, probably caused by different tolerance of the most indicator species to the severe pollution extent.

For example, *T. punctata* var. *punctata, N. sigma var. sigma* and *A. crystallina* (marked as leading indicator forms only for Sevastopol bay), usually are met in great density in heavily impacted biotopes. Meantime, significant species, common for both bays (*N. pennata* var. *pontica, C. scutellum, D. smithii* var. *smithii* and *F. forcipata),* are eurytherm and eurybiotic forms, widely developing in different zones of sublitoral. A high dissimilarity level was revealed at comparison of taxocenotic complexes in surveyed bays (average dissimilarity is 68.3 %). It testifies to significant differences between the compared water areas in species structure of taxocenes and quantitative development of key species (Table 4).

Table 4. Contribution from the most significant species (discriminating species) into average dissimilarity between ecological-taxocenotic complexes of diatoms at the Laspi bay and Sevastopol bay

Species	***N***, cells•см$^{-2}$ *		***D*****i*****.**	***D***	***D*****i*****.(%)**
Complexes of Laspi bay and Sevastopol bay – average dissimilarity 68.3 %	**Laspi bay**	**Sevastopol-skaya bay**			
Tabularia tabulata (Agardh) Snoeijs	1139775	69825	2.65	1.55	3.88
Amphora proteus Gregory	150667	69817	1.86	1.51	2.76
Navicula pennata var. *pontica* Mereschkowsky	216392	349108	1.82	1.35	2.69
Tryblionella punctata W. Smith var. *punctata*	33	104625	1.79	1.29	2.62
Diploneis smithii (Brebisson) Cleve var. *smithii*	45867	209275	1.80	1.24	2.63
Bacillaria paxillifera (O. Muller) Hendey	52392	104750	1.49	1.19	2.23
Nitzschia sigma (Kutz.) W. Smith var. *sigma*	6592	104542	1.47	1.16	2.15
Caloneis liber (W. Smith) Cleve var. *liber*	45908	226975	1.48	1.02	2.18
Cocconeis scutellum Ehrenberg var. *scutellum*	72117	122050	1.43	1.06	2.10
Fallacia forcipata (Greville) Stick et Mann	32800	157133	1.45	0.95	2.13
Cocconeis scutellum Ehrenberg var. *parva* Grunow	45908	34875	1.24	1.05	1.81
Ardissonea crystallina (Agardh) Grunow	50	104625	1.41	0.92	2.07
Tryblionella punctata W. Smith var. *coarctata* Grunow	50	52383	0.94	0.92	1.38
Rhabdonema adriaticum Kutzing	0	69917	0.93	0.93	1.36
Cocconeis euglipta Ehrenberg	86825	17458	1.16	0.86	1.70
Amphora coffeaeformis (Ag.) Kutzing var. *coffeaeformis*	58975	17483	1.03	0.85	1.50
Nitzschia reversa W. Smith	39292	17425	0.98	0.87	1.44
Pinnularia quadratarea (A. Schmidt) Cleve	8	104800	1.02	0.77	1.49
Lyrella abrupta (Donkin) Guslyakov et Karaeva	6625	69817	0.98	0.72	1.43
Nitzschia lanceolata W. Smith var. *minor* Van Heurck	6550	52258	0.95	0.68	1.44

Note: ***** ***N***, cells•см$^{-2}$- average abundance of i-th species in comparing complexes, ***D*****i**– absolute and ***D*****i*****(%)*** – the relative contribution of i-th species in average Bray-Curtis dissimilarity between the benthic eco-taxocenotic complexes, ***D*** – dissimilarity function

The most significant indicator species evaluated by their relative contribution into average similarity within complex can also be considered as discriminating species, determining the most contribution to species structure dissimilarity between taxocenotic complexes in compared biotopes. There are *T. tabulata* + *A. proteus* in Laspi bay and *N. pennata var. pontica* + *D. smithii* + *T. punctata var. punctata* in Sevastopol bay.

By consideration of structural-taxonomic differences at the intra-complex level, i.e. between all pair of groupings, the highest average dissimilarity values were recorded for pairs “B-C” and “A-C” (73% and 69%, respectively). For these both pairs *T. tabulata* and *A.proteus* are the leading discriminating forms, bringing the most valuable input into dissimilarity between comparing groupings. These two species are sharply dominated by density in Laspi bay (2-4 times higher than in Sevastopol bay). The similar differences in species structure are also revealed under comparison of other pair of innercomplex taxocenotic groupings (Figure 7). At general, structural differences at subcomplex level are less pronounced and can be conditioned by similar reaction of the discriminating forms, defining differences between groupings, upon joint influence of leading environmental factors within a certain bay.

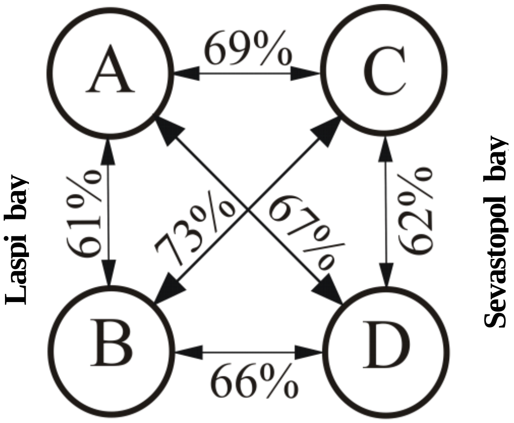


Figure 7. Average dissimilarity (%) between all pairs of intra-complex taxocenotic groupings in compared biotopes

Thus, based on the highest values of dissimilarity function reflecting the high stability of species development in certain ecological conditions, and also taking into account the individual contribution of species (by density) to inter complex differences, several discriminating species have been extracted from the total list of species (see Table 4). Those species can be considered as indicators of the diatom taxocene' condition at a comparative assessment of coastal biotopes subject to persistent technogenic pollution. It is proposed to consider *Tabularia tabulata*, *Amphora proteus* and *Nitzschia reversa* as indicators of conventionally healthy biotopes (Laspi bay), whereas, *Tryblionella punctata* var. *punctata, Diploneis smithii* var. *smithii, Nitzschia sigma* var. *sigma, Fallacia forcipata, Ardissonea crystallina* and *Pinnularia quadratarea* can be marked as indicators of the polluted habitats.

CONCLUSION

Thus, the implemented inventory of the data has showed contemporary state of species richness of benthic diatoms along Crimean coastal zone of the Black Sea. More than a half (55%) of total floristic richness of the Black Sea benthic diatoms is formed by species richness of the Crimean coast diatoms. 48 new and 21 rare species have been found for Crimean coast. Five of them were newly-found for the whole Black Sea and 4 species were new for science. The increase of diatom species richness has recorded through the last decades can be caused by intensification of studies as well as by more active introduction of new species into the Black Sea. The total updated list, including 409 species and intra-species taxa, can be used for the further research on quantitative development and diversity aspects of the Black Sea benthic diatom algae.

By application of algorithms of multivariate statistics the comparative analysis in taxocene structure features of benthic diatoms from two near shore water areas of southwest Crimea is fulfilled. Those areas (Laspi and Sevastopol bays) have substantially differed by levels of heavy metals and other pollutants content in bottom sediments.

The features of spatial organization of benthic diatoms habitats have been investigated for both bays. In each of the bay statistically significant taxocenotic complexes and sub-complex groupings of diatoms were revealed. Development of diatom taxocenes in Laspi bay is caused by worsening of optimal conditions from the central part of the bay towards more shallow and deep-water zones. The peak of species richness values coincides with the middle sublittoral zone (16-20 m depth), which can be considered as the most optimal one for diatom algae inhabitation.

In Sevastopol bay well-pronounced distinctions in the structural organization of benthic taxocenes corresponding to 3 locations with different level of pollution, have been revealed. Such differences can be caused by both presence at all stations of the investigated water area certain eurybiontic species and indicator species having the highest parameters of development within the certain complex (biotope). The basic abiotic factors influencing on peculiarities of diatom taxocene structure are level of toxicants’ content in bottom sediments and water depth.

Lists of main species contributing the most input into similarity within taxocenotic complexes of the each bay were compounded. There were *Tabularia tabulata*, *Amphora proteus*, *Fallacia forcipata* and others for conventionally healthy Laspi bay; while *Navicula pennata* var. *pontica, Diploneis smithii* var. *smithii* and *Triblionella punctata* var. *punctata* - for polluted Sevastopol bay.

Inter-complex differences in structure of taxocenes are mostly pronounced and caused by different response of discriminating species, i.e. determining the most contribution to dissimilarity between complexes, to a high level of toxicants. Structural differences at sub-complex level are less pronounced and can be conditioned by similar reaction of respective discriminating species on joint influence of key environmental factors within a certain bay.

The most significant discriminating species can also be considered as indicators of the diatom taxocene’ condition at a comparative assessment of biotopes subjected to various anthropogenic load. It is proposed to consider *Tabularia tabulata, Amphora proteus* and *Nitzschia reversa* as indicators of conditionally healthy biotopes, whereas *Tryblionella punctata* var. *punctata*, *Diploneis smithii* var. *smithii* and *Nitzschia sigma* var. *sigma* can be considered as indicators of biotopes under persistent technogenic impact.

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ECOLOGICAL ROLE OF BENTHIC AND PELAGIC INVADERS IN BENTHIC ECOSYSTEM, THEIR BIOLOGY AND HISTORY OF INVASION

M.Varshanidze.,A.Guchmanidze.
Georgian Marine Ecology and Fisheries Institute

The Black Sea has become favorable for a number of Benthic and Pelagic species they are: *Cunearca cornea, Mnemopsis leidyi, Callinectes sepidus, Cambusia affinis,Penaeus japonicus, Balanus eburneus, Balanus improvisus* and others. Many species have been accidentally introduced by Man. One of the most important way in which new place is ships, they attached to ships or to the living forms (fish, algae, crabs). By the help of ships they transported from one place to another. The tanks of ship are filled with Ballast water, which contains different species of planktonic organisms. When ballast water is discharged into the sea, the organisms get in a new environment, they adapt to the conditions. The huge number of ocean-going ships means that today there are hundreds of examples of exotic species which have survived their introduction into new environments in ballast water (*Yu.Zaitsez and V.Mamaev*).

From invasive species of Georgian coast of the Black sea, only *Rapana thomasiana, Cunearca cornea, Mnemiopsis leidii, Beroa cucumic, Balanis improvisus, Mericierella enigmatica* are recorded.

According to the data existing in our institute (MEFRI), we can judge only about the distribution of these species. We have a few data about *Rapana thomasiana*. It was studied in 1994-96.

Until 1994,when Rapana first invaded into the bank of Gudauta, the stock of Oyster comprised 18mln ind per 50 m^3. After that the quantity of Oysters started to change sharply, that was caused by invasion of predator mollusk *Rapana thomasiana*.

According to the literature data, in Gudauta bank, during research of Oyster, only 6 individuals of this mollusk were found in July of 1994. During research by the ship" V.Vorobieve" on the region of New Athens by trawl, over 70 individuals of Rapana were caught in November.

Georgian Fisheries Trust has conducted the research in 1994 in Gudauta bank. According to the data for 1994, abundance of oyster started to reduce and abundance of *Rapana thomasiana* has sharply increased. Namely, the first sample has revealed 60 rapanas per 2 live oysters and a large amount of empty shells of oysters. The data was proved again 1950, when the distribution area of the species has increased both, in the North and in South.

The quantity of other commercial mollusk has decreased together with the oysters. And the abundance of *Rapana* has sharply increased 30 fold.

Table 1. Amount of mollusk on the Bank of Gudauta (1949-1950)

MOLLUSK	JULY 1994			APRIL 1950		
	Less productive part of the Bank	More productive part of the Bank	Whole Bank	Less productive part of the Bank	More productive part of the Bank	Whole Bank
Ostrea	17	38	88	0,7	2,4	1,5
Rapana	-	0,1	0,04	2,3	18	10,5
Mytilus	62	44	52	19	16	17
Pecten	50	75	63	9	9	9

Rapid and intensive settling of new mollusk, accompanied by the total destruction of oysters, means that *Rapana* is well adapting to the new conditions and has predator stile of life. It feeds with thick mollusk, preferring *Mytilus* and oyster.

Rapana is perennial mollusk. In our conditions *Rapana* reaches up to 20-40 mm length in the first year of life. During maturity, thickening of the shell and at first spawning it reaches at the second year of life, when its length is 35-78mm. After the maturity and thickening of the shell, growing of *Rapana* become slow, especially during spawning.

Growth intensity depends on depends on food availability. When the food is less, period of growing goes slowly.

Rapana is policycle perennial species. It multiplies in the warm period of the year in July and September.

The process of feeding is important ecological factor and food –chain determines the structure and function of benthic communities. *Gustropoda* takes part in all food chains of the Black Sea coastal zone. In the Black Sea, *Rapana* influences the benthic community, important part of energy it takes on itself, which is transmitted to hydrotropic levels. Intensiveness of feeding in predator mollusk is low. Intensity of feeding depends on the temperature and on the size of mollusk, day-night period. Predator mollusk, like *Rapana* is fed periodically, with rest. The attacks at the victim usually take place at night. After the attack at the victim, it has a period of rest for several days (1-19 on average 4 day).

According to the kind of feeding *Rapana* belongs to the carnivore type. It is generally fed by Bivalve mollusk, which is paralyzed by poison from the trunk. *Rapana* eats Bivalve mollusks –*Mytilus galloprovincialis,Ostrea, Tapes, Vanus, Pecten, Cardium and Castropoda-Patella*. When *Rapana* is given mussel and *Oyster* at the same time, it prefers the first one. This is explained by the fact that the shell of *Mytilus* is thinner than shell of *Oyster*, so for *Rapana* it is easy to penetrate into the shells of Mytillus.

By the staff member of our institute (E.Mickashavidze) size –weight peculiarities and distribution of *Rapana thomasiana* has been studied. .

The shell size has been studied among the different sized populations of *Rapana.* The observation revealed that at the end of the first year, the size of *Rapana* is 20-40mm. In second – year of life individuals (35-78mm) the sexual maturity, shell thickening and first spawning are observed. After maturity and trickening of shells, the growth rate has decreased.

Interdependence of weight and size of *Rapana*, importantly depends on ecological conditions, at first on feeding. Feeding conditions influence on the size if body and weight of meat. Which is well presented on the example of *Rapana*, when the dependence of these two ingredients is directly propitious.

Collected data has enabled to show the picture of *Rapana* distribution on different depths. Maximal quantity was recorded at the depth of 6-15m(20-25 ind). Correlation between different size groups is different. Namely, a great quantity of *Rapana* sized 60-70-80mm(170 ind) is abundant, when quantity *Rapana* with size 30-50 is 10-50. Quantity of *Rapana* the size of which over 80mm also reduced.

In Georgian Black Sea shelf, the catches of 4000-5000t are undertaken every year by Poti Fisheries institution and “Mebaduri” ltd in Batumi.

Rapana thomasiana belongs to the edible mollusks. It is also used for food in Japan and China.

The shell of the mollusk is used for production of souvenirs. For these aim, large quantity of *Rapana* is caught in the Black sea. It is possible to make a feeding powder from shells for birds. From the viewpoint of calories, the meet of the mollusk is richer than the meet of the fish. Food value of mollusk meet is in content of vitamins and such important substances as Fe, Cu, Zn and others.

Cunearca cornea was introduced into the Black Sea from the Adriatic Sea, having initially been brought there from the coastal water of the Philippines in the Pacific Ocean (Yu.Zaitsev.,V.Mamaev). In 1982 a research mission by the head of Marinov (1990) in Varna Bay discovered a new and quite numerous bilalve which was initially classified as Anadara sp.Sveral years later the Romanian hydrobiologist M.T. Gomoiu classified it as Scapharca inaequivalvis. Another year later Starobogatov gave it the name Cunearca coenea, making it a new species in the fauna of the USSR.Research carried out by V.N. Zolotarev and associates (Zolotarev and Zoolotarev19870 showed that the bivalve was quite widespread in the Black Sea, in some places forming dense population, and that it had become a frequent component of the macrozoobenthos of silt sediments (Yu.Zaitsev.,V.Mamaev).

In 1978-1979 in Chorokhi River mouth, in the bethos samples it was revealed Bivalve mollusk Cunearca *cornea*, on the isobath 5-20(E.Mickashavidze). At first, organisms, sized 1-2,5 were recorded, and afterwards, 6-8 sm sized forms. Bivalves were especially abundant in Anaklia bank, where we had fixed mussel collectors. At present, new opportunist species, self-penetrated filtrator mussel *Cunearca cornea*, is widely distributed in our region.

In 1929 the polychaeta *Mercierella enigmatica* (Anenkova,after Marinov, 1977(wa found in the brackish Lake Paleostomi near Poti in the Caucasus and later in Gelendzhik Bay near Novorossisk.It is believed that Mercierella originates in the brackish coastal lakes of India. In 1923 it had been recorded in the Seine estuary in France. It was later carried by ships to the Black Sea., where it colonized low- salinity waters, before penetrating the Caspian Sea.

Mercierella enigmatica was recorded from 1976 in works of E. Mikashavidze and it is met in Poti, Grigoleti, Ochamchire and Gudauta bank. It is especially selects coastal ships and hard substrata, where there is a water flow.

Mosquitofish (*Gambusia affinis)* was brought in Georgia namely in Sokhumi by doctor Rukhadze, from Italy in 1925. From Sofhumi it was spread in whole Caucasus area, south Ukraine and Middle Asia. The aim of Acclimatization was to use Mosquitofish against Malaria disease (Biological method). At the present day it’s spread widely in Georgia. Mosquitofish inhabits fresh water lakes, swamps, ponds, lower reaches of rivers and brackish water: coastal brackish water, freshening places of the Sea. It chooses shallow waters and occurs even polluted places. In Georgia Mosquitofish is presented by two subspecies: *Gambusia affinis affinis* (Baird et Girard 1860) and *Gambusia affinis holbrook* (Girard 1860). There latter is widely spread, while the former is more rare.

Mosquitofish is thermofilic species, in our region optimal temperature is 20-30 ^{o}C . It can stand higher temperature such as 41,5 ^{o}C. When the temperature is as low 6-8 ^{o}C they move to deeper parts of the reservoir, it creeps under the stones or through algae, digs into the grunt at 2-6 cm depth and hibernates. In Georgia it wakes up in April.

Mosquitofish is euryphagous; feeds by the eggs, larva of mosquito and other insects, smaller-sized benthic and pelagic species, larvae of fishes (sometimes of the same species), small tadpoles, also feeds on algae.

The growth of Mosquitofish is more intensive in the Black Sea coastal part, than in eastern Georgia. It quickly grows in May-September, from October the process of growing slows down. Male grows up to 3-4 cm., Female 6-7,5 cm. Life cycle is up to 3 years.

In our conditions Mosquitofish spawns from April till November, when water temperature is up to 15 ^{o}C. Its can reach maturity at age of 1-1,5 month. One vegetation period gives 6-7 generation, with average time interval of 1 month. At one time it gives birth to 15-200 juveniles. The gender ratio is 1:1.

Mosquitofish consumes in large amounts eggs and larvae of mosquito, and is contributes fight against Malaria. At the same time it is harmful for number of fish and amphibia species, as it feeds on their eggs and is their food competitor. However their negative effect is more evident when in large quantities. At the same time mosquitofish is a food source for small predators.

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