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Article

Long - term variations in macrobenthos diversity at the Istanbul Strait's (Bosporus) outlet area of the Black Sea

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Abstract
This work continues a series of studies on deep-water benthos in the Istanbul Strait's (Bosporus) outlet area of the Black Sea, conducted within the framework of the EU 7th FP project HYPOX (In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies) EC Grant 226213. The aim of that study was the analysis of long-term changes in diversity and structure of the benthic fauna inhabiting the depth zone where the oxic/anoxic interface zone meets the sea floor. Time comparison interval covers the period from 1958 to 2010. In general, the diversity or densities of macrozoobenthos were positively related with environmental factors such as sediment, depth and oxygen concentration. Outcome of the long- term environmental degradation period was the loss of diversity. Macrobenthos communities *Terebellides stroemi – Amphiura stepanovi* and *Modiolula phaseolina* essentially rebuilt its structure. Unstable hydrodynamics and oxygen depletion are two crucial factors of decrease diversity in *T. stroemi – A. stepanovi* community. The species composition of *M. phaseolina* community at the border of the hydrogen sulfide area is distinct from those dwelling in oxic areas of the Black Sea. Living organisms of macrobenthos were not found at the oxygen content near 12 µmol L^{-1} (160 m). This confirms that oxygen depletion at great depths is the limiting factor of life in the Black Sea. During MSM/15-cruise (2010) was found a large species of the polychaete *Sabella pavonina* (Savigny, 1822). This species was new record for the Black Sea.

Key words: oxic/anoxic interface, macrobenthos distribution, biotopes at border of the hydrogen sulfide area, Black Sea

Introduction

Pioneer studies of benthic fauna in the Bosporus outlet area were done in 1890, where new mollusks species were discovered in this area, which were previously not described from the Black Sea (Ostroumov 1893, 1894). During benthos studies off Cape Karaburun west of the Istanbul Strait outlet area it was noted for the first time that organisms, that are specific to the Bosporus area, occur also in the Black Sea west of the Bosporus S.A. Zernov (1913). L.I. Yakubova (1948) identified 20 Mediterranean benthic species north-west of the Bosporus outlet, which were specific to the Bosporus outlet area. Bãcesco & Mãrginneanu (1959) and Bãcesco (1960) published data from six stations in the western part of the Bosporus area. These studies identified and described 15 species of macrobenthos and 20 species of meiobenthos that were not only new to the Black Sea, but also new to biological literature. Kaneva–Abadjiéva (1959) described 12 new mollusc species in the study area.

Several ostracods species specific only to the Bosporus outlet area of the Black Sea were described in the late fifties and early sixties (Caraion 1959, Marinov 1962, Shornikov 1966), including the first notes about living starfish *Marthasterias glacialis* and the description of some features of the echinoderms fauna Marinov (1959). The echinoderm fauna and the abundance of basket stars and holothurians species were investigated by Vinogradov and Zakutsky (1964). Fauna of polychaetes was studied by Dumitrescu (1960, 1962) and Rullier (1963) with the discovery of species new to the Black Sea.

Further studies of the macrobenthic fauna in the Bosporus outlet area were made by the Department of Benthos of IBSS, during the July 1958 and June 1980 RV 'Academic Kovalevsky' cruises in the Bosporus area (Zaika 1991). Benthos stations were sampled at depths of 70–113 m. From these studies three ecological communities could be distinguished, namely *Modiolula phaseolina*, located to the north-east of the Bosporus outlet, and the ecological communities *Sternaspis scutata* and *Amphiura stepanovi – Terebellides stroemi* located to the north-west of the Strait. The highest density biomass of *M. phaseolina* and total benthos was observed in the near-Bosporus Black sea region (Kiseleva & Mikhailova 1992). These earlier studies indicated that the distribution of Mediterranean species in the Bosporus outlet area was controlled by the Mediterranean outflow through the Istanbul Strait, which transports the larvae of benthic animals from the Sea of Marmara. These larvae would then settle on the substrate of the shelf and upper slope of the outlet area (Kiseleva 1960; Kiseleva & Mikhailova 1992).

Fauna from the deeper parts of the Black Sea was studied during the EU projects HERMES (2006-2009) & HYPOX (2009-2012). Two oceanographic expeditions were conducted to survey fauna at the deep-water part in the outlet area of the Istanbul Strait's (Bosporus) during cruises of the RV 'Arar' (November 2009) and the RV '*Maria S. Merian'* 15/1 (April-May 2010). During RV '*Maria S. Merian'* 15/1 cruise macrobenthos was sampled and distribution on the Black Sea shelf and the upper slope area off the Bosporus Strait outlet area. Black Sea studies within HYPOX included effects of oxygen on benthic fauna of Bosporus outlet area. Apart from the inflow of Mediterranean water, the Bosporus outlet area is characterized by a rim current at the shelf margin and hypoxia below 100 m water depth. The oxic, warm, and saline Mediterranean water cascades down the continental shelf to greater depths where it mixes with the adjacent anoxic waters, detaches from the slope and forms the so-called "Bosporus Plume" (Frederich *et al*. 2014).

Material and Methods

Study site

The combined effect of great depth (>2000 m), shallow sill depth (35 m) of the Istanbul Strait (Bosporus) outlet, large amount of river water input, and the inflow of warm and saline Mediterranean water creates a distinct basin-wide water-column stratification with a chemocline/pycnocline at 100 to 150 m, separating an oxic and an anoxic zone. Between the oxic and anoxic waters there is a suboxic zone, which is important for biogeochemical and redox reactions (e.g., Murray et al. 1989, 1993; Codispoti et al. 1991; Latif et al. 1991; Baştürk et al. 1994). The less saline surface water of the Black Sea flows through the Strait into the Marmara Sea as the upper current (605 $km^3\ yr^{-1}$) and the more saline and warm Mediterranean water (310 $km^3\ yr^{-1}$) from the Marmara Sea enters the Black Sea as an undercurrent. The Mediterranean water from the Istanbul Strait spreads over the Strait's outlet shelf area of the Black Sea as a few m-thick sheets, and then sinks along the continental slope in a series of lateral intermediate depth intrusions (Özsoy & Ünlüata 1997). In addition to being characterized by the inflow of the warm (14.5°C) and saline Mediterranean Water (28–34‰), the Istanbul Strait's outlet area is influenced by the cyclonic rim current, which is important for the surface circulation of the Black Sea (Oğuz et al. 1993).

The upper water layer in the Bosporus outlet area of the Black Sea has a temperature of 24–25°C in summer and less than 6°C in winter, a salinity of about 15–17‰ and dissolved oxygen of 95–115%. The lower water layer of the Black Sea is depleted in oxygen, has a temperature of 8.5–9.1°C, a salinity of 22-23‰ and a hydrogen sulfide concentration of >350 $\mu mol\ L^{-1}$ in the deepest part of the basin (Neretin et al. 2001). An intermediate water mass, commonly referred to as cold intermediated layer (CIL), occurs at 50 to 75 m with temperatures ranging from 6.5 to 8.8°C and a salinity of 18–22‰. With increasing water depth the "normal" concentration (around 300 $\mu mol\ L^{-1}$) of dissolved oxygen in the water decreases and oxygen deficiency and depletion occurs, which is of environmental importance for the fauna.

Macrobenthos communities were studied during 15/1 cruise of RV '*Maria S. Merian*' in 2010 at the deep water part of Istanbul Strait outlet area of the Black Sea, where less saline surface waters of the Black Sea interact with the saline Mediterranean waters, creating a special ecological system and rapid transitions from oxic, hypoxic and anoxic water conditions. With increasing water depth, dissolved oxygen in the water decreases and oxygen deficiency and depletion occurs, which is of environmental importance for the fauna. These types of conditions are referred to as hypoxia and anoxia, respectively. Under hypoxic conditions, many aerobic organisms are affected in their vital activity and studies by Rosenberg (1980) showed that the lower level of tolerance for benthic organisms is less than 2 ml L^{-1} (corresponding to approximately 90 µmol L^{-1}). This value is often taken as the boundary between normoxia and hypoxia (Frederich et al. 2014).

Sampling procedures

Macrofauna were sampled during 15/1 cruise of RV '*Maria S. Merian*' in 2010 at the Istanbul Strait outlet area of the Black Sea with box-corer of 0.1 m^2, at depths from 80 to 172 m. The sampled material was washed mesh 1 mm sieve system a preserved in 75% alcohol, which is known to preserve morphological structures without distortion. We avoided prior fixation in formalin to avoid damage to calcareous taxa. Processing of the material in 1958, 1960 and 1989 was carried out according to a similar method at water depths of 70–113 m (Figure 1). For each species, the average abundance was N, specimen • m^{-2}, the average wet biomass was B, g m^{-2}, the frequency of species occurrence in percentage - P,%.

Total macrobenthos abundance data 1958, 1960, 1989, 2010 are deposited in the Earth System database www.PANGAEA.de and is available at https://doi.pangaea.de/10.1594/PANGAEA.777378; https://doi.pangaea.de/10.1594/PANGAEA.874792.

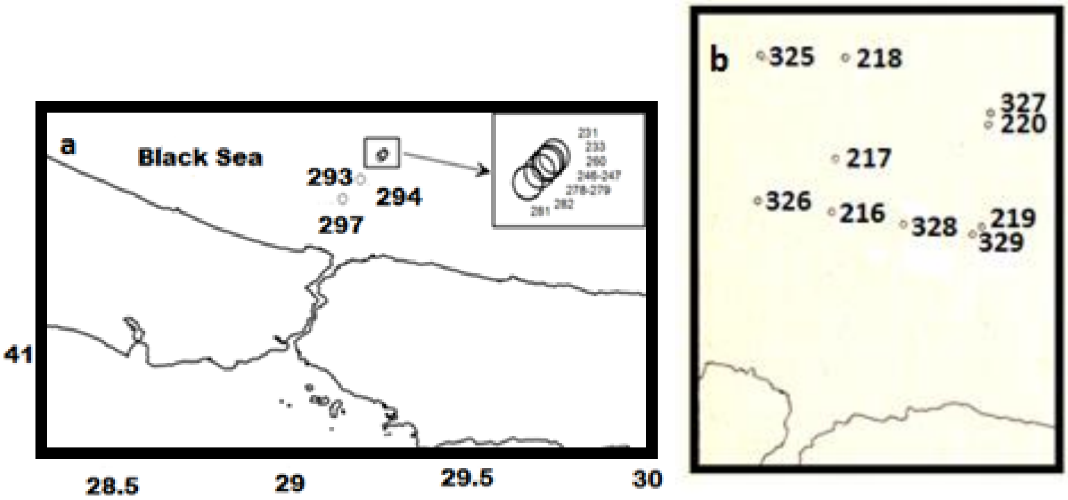

Figure 1. Macrobenthos sampling stations in the Istanbul Strait's (Bosporus) outlet area of the Black Sea (RV 'Maria S. Merian' 15/1, April-May 2010) – (**a**), July 1958 and June 1960 RV 'Academic Kovalevsky' cruises in the Bosporus area – (**b**).

Data analysis

The comparative biodiversity of different faunas 1958, 1960, 1989 and 2010 implied as main components the number of species per area unit (expressed as relative abundance of species) and evenness (Pielou 1966). Dominance level in communities was estimated by Simpson (1949) and Berger-Parker (1970) indices, which show a trend of concentration controlling community diversity. Species richness was estimated by Margalef (1958) and Menhinick indices (Whittaker 19770).

To assess the trends in diversity in soft-sediment benthic communities were conducted a hypothetical comparison of species diversity. Studied communities considered intrinsically identical. Samples (1958, 1960, 1989 and 2010) were obtained according to similar collecting techniques. Both these conditions cannot be dispensed with rarefaction application (Krebs 1999).

Analysis of long-term structural modifications performed in benthos communities made on lognormal model (Preston 1948, 1962, 1980). With disturbance effect dominance in community increases, this causes a deviation from lognormal model (Gray & Mirza 1979; Gray 1983; Bonsdorff & Koivisto 1982; Warwick 1986; Mazlumyan 1989; Mazlumyan et al. 2009; Boltachova et al. 2011).

Results and Discussion

Macrobenthos composition. In 2010 on study site 47 species of macrozoobenthos were recorded: Porifera-1, Cnidaria-2, Polychaeta-17, Crustacea-10, Mollusca-8, Echinodermata-3 and Tunicata-4 (Table 1 Representatives of Nemertea and Oligochaeta were not identified to the species. Species nomenclature followed the World Register of Marine Species (WoRMS) (Costello et al., 2013)

Table 1.Summarised macroinvertabrate distribution data.

Species	N*	F
Porifera g.sp.	1	8
Cnidaria		
Virgularia mirabilis (Müller, 1776)	20	8
Pachycerianthus solitarius (Rapp, 1829)	15	25
Nemertea g.sp.	3	8
Annelida (Oligochaeta) g.sp.	18	33
Annelida (Polychaeta)		
Aonides paucibranchiata Southern, 1914	10	8
Aricidea claudiae Laubier, 1967	5	17
Dipolydora caulleryi (Mesnil, 1897)	10	8
Galatowenia sp.	50	25
Harmothoe reticulata Claparède, 1870	2	8
Heteromastus filiformis (Claparède, 1864)	19	50
Maldanidae g.sp.	7	8
Melinna palmata Grube, 1870	11	16
Nephtys hombergii Savigny in Lamarck, 1818	11	42
Nephtys sp.	3	8
Nereididae g.sp.	3	8
Notomastus profundus (Eisig, 1887)	13	8
Orbinia sp.	10	8
Paraonides neapolitana (Cerruti, 1909)	10	17
Phyllodoce maculata (Linné, 1767)	3	8
Phyllodocidae g.sp.	3	8
Terebellides stroemi Sars, 1835	156	42
Arthropoda (Crustacea)		
Ampelisca diadema (Costa, 1853)	48	33
Ampelisca sp.	3	8
Medicorophium runcicorne (Della Valle, 1893)	168	16
Cymodoce erythraea euxinica Bacesco, 1959	33	8
Ericthonius sp.	10	8
Eudorella truncatula (Bate, 1856)	3	16
Harpinia crenulata Boek, 1876	23	25
Orchomeme humilis (A.Costa, 1853)	10	8
Phtisica marina Slabber, 1769	10	8
Synisoma capito (Rathke, 1837)	3	8

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Table 1.

Mollusca		
Abra renieri (Broun, 1836)	40	25
Calyptrea chinensis (Linnaeus, 1758)	3	8
Modiolula phaseolina (Philippi, 1844)	258	33
Parvicardium simile (Milaschewisch, 1909)	20	8
Retusa truncatula (Bruguière, 1792)	3	8
Spisula subtruncata (da Costa, 1778)	1	8
Tritia neritea (Linnaeus, 1758)	3	8
Trophonopsis breviata (Jeffreys, 1882)	3	8
Echinodermata		
Amphiura stepanovi Djakonov, 1954	507	50
Stereoderma kirchsbergii (Heller, 1868) Panning, 1949	20	16
Synapta hispida Heller, 1868	43	25
Chordata (Tunicata)		
Ascidiacea g. sp.	13	8
Ascidiacea g. sp.2	3	8
Ascidiacea g. sp.3	3	8
Molgula appendiculata Heller, 1877	3	8
Total abundance	1623	

*Values are mean (N) number of individuals (ind*m^{-2}), frequency of species occurrence (F, %*)

To the category of dominant species (frequency of species occurrence ~50%) can be attributed only two species of basketfish *Amphiura stepanovi* and the polychaete *Heteromastus filiformis*. The group of common species includes nine species: polychaetes *Nephtys hombergi*, *Terebellides stroemi*, *Galatowenia* sp.; bivalve molluscs *Modiolula phaseolina* and *Abra renieri*; amphipods *Ampelisca diadema* and *Harpinia crenulata*; soft coral *Pachycerianthus solitarius*, holoturia *Synapta hispida*. All these species are common and observed in other areas of the Black Sea.

Of the benthic fauna dwelling only at the Bosporus outlet area the sea pen *Virgularia mirabilis*, polychaetes *Dipolydora caulleryi* and *Paraonides neapolitana*, isopod *Cymodoce erythraea* have been found. In meiobenthos sample in the same expedition (station 298) a large species of the polychaete *Sabella pavonina* Savigny, 1822 was found. This species was new record for the Black Sea.

Quantitative macrobenthos values varied within wide limits: the abundance interval varies from 40 to 7000 ind* m^{-2}; the biomass interval varies from 0.03 to 380.48 g*m^{-2}. On study site macrobenthos average number was 1623 ind* m^{-2}, average biomass was 66.01 g*m^{-2}. The highest values of abundance and biomass were marked for *A. stepanovi*: (maximum abundance reaches 2400 ind* m^{-2}; average abundance was 507 ind* m^{-2}). Mollusc *M. phaseolina was* second in terms of abundance (maximum abundance was1600 ind* m^{-2}; average abundance reaches 258 ind* m^{-2}). Polychaete *T. stroemi* was third in terms of abundance (maximum abundance was 1480 ind* m^{-2}; average abundance reaches 156 ind* m^{-2}). A large number of amphipods *Medicorophium runcicorne* (maximum abundance was 1800 ind* m^{-2} and average abundance was 168 ind* m^{-2}) were also found. The largest average biomass of *M. phaseolina* was 36.6 g*m^{-2} (maximum reaches 355.2 g*m^{-2}) and for *T. stroemi* average biomass was 10.7 g*m^{-2} (maximum reaches 108.4 g*m^{-2}). In descending next were three species: *A. stepanovi* (5,3 g*m^{-2}), *Stereoderma kirchsbergii* (3,6 g*m^{-2}), *P. solitarius* (1,9 g*m^{-2}).

Macrobenthos distribution along depth and the oxygen gradient.
In the Black Sea the peculiarity of the biotope conditions is stipulated by presence of a hydrogen sulfide deep-water layer, locating at depths of more than 100 m. It affects macrobenthos distribution, species richness, abundance and biomass (Fig. 2, 3). A sharp boundary in macrobenthos abundance extends to a depth of about 140 m, while at a depth of 152 - 172 m only annelids were found: Oligochaeta and

polychaetes: *H. filiformis*, *N. hombergii*, *Aricidea claudiae*, *Melinna palmata*. However, even these species were present in a small amount. In other seas bathymetric habitat boundaries for most species found in our collections is much broader than in the Black Sea: for *M. phaseolina* it stretches for depths from 0 to 5500 m (Yakubova, 1948). Oxygen depletion creates unstable habitat conditions for benthic communities, resulting in structural changes. Our findings confirm that oxygen availability limits the depth distribution of benthic species in the Black Sea, not the water depth itself (Nikitin 1938, 1948, 1950; Yakubova, 1948).

Data on the oxygen content in the near-bottom layer of water allowed us to analyze macrobenthos distribution in connection with this factor (Frederich et al. 2014)

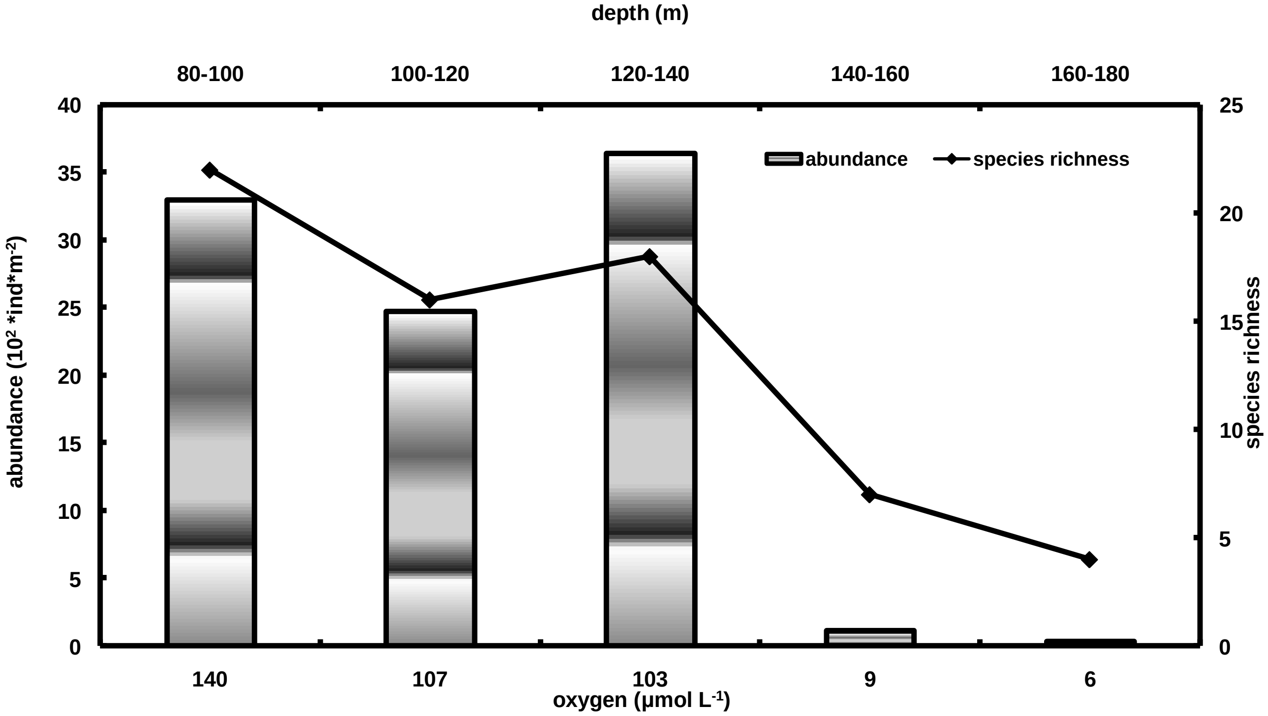

Figure 2. Dependence of the abundance and species richness of the benthos in the Bosporus outlet area on water depth and on the dissolved-oxygen concentration measured just above the sediment: RV 'Maria S. Merian' 15/1, April-May 2010.

Former studies pointed that the species *M. palmata*, as well as *N. hombergii*, *P. solitarius, A. stepanovi*, *M. phaseolina*, *Abra alba* is the most deep-water (120-130 m) communities in the Black Sea dwelling in the border on the oxygen depletion conditions (Nikitin, 1938, 1948). This group of species can tolerate the hypoxia. All these forms in the experiment survived in anoxic conditions for 7 days (Nikitin, 1948). In our studies (2010) complete structured bottom communities were not found with at oxygen concentrations below 10 µM. Composition of macrobenthos was represented only by a few species of annelids. Only two species of polychaetes (*N. hombergii*, *H. filiformis*) and Oligochaeta were found. At all stations with the low oxygen content *N. hombergii*, *H. filiformis* и Oligochaeta (occurrence – 80%) were discovered. Frequency of occurrence of *A. claudiae* was 40%, for *M. palmata* and *T. stroemi* was 20%.

Polychaeta *H. filiformis* should be attributed to species that tolerate oxygen deficiency and dwelling at the deepest depths in the Black Sea in addition to the list of V.N. Nikitin. In the Black Sea this species was first discovered in 1930 (Yakubova, 1930) and subsequently spread widely throughout the water area (Marinov 1977, Kiseleva, 1981).

Biodiversity and structure of communities (comparative analysis)

At depths less than 140 - 150 m communities *T. stroemi* - *A. stepanovi* and *M. faseolina* have been identified. In different years of research (1958, 1989, 2010) species composition turned out to be similar (the Czekanowski - Sørensen index - 0.42). Biomass level varied within a small range. In 1989 much lower macrobenthos abundance has been recorded. This can be explained by different fauna recording method, using in 1989 sampling campaign (Table 2).

Table 2. Macrobenthos species richness, abundance and biomass along the depth gradient at Bosporus outlet area.

Years	Depth, m	Species richness	N, ind.· m^{-2}	B, g·m^{-2}
		T. stroemi – A. stepanovi community		
1958-1960	70 - 98	37	2266	36,8
1989	83 - 100	28	309	48.8
2010	96 - 152	34	3475	61,4
		M. phaseolina community		
1958-1960	80 - 115	38	4214	564
2010	116 - 117	16	2480	263

In 2010 the quantitative characteristics of *M. phasiolina* community were significantly lower than in 1958-1960 (Table 2). The reason for this can be found that in 2010 the community was studied deeper, than in 1958-1960. The Czekanowski - Sørensen index for this community in different years was 0.39.

As mentioned above, in different years (1958, 1960, 1989 and 2010) different abundance of species was observed. Variations in density in comparative studies had been overcome by rarefaction (Dobzhansky & Pavan 1950). Rarefaction method was used for estimating species richness and avoids errors in comparing communities with different species number satisfying the random distribution (Simberloff 1972).

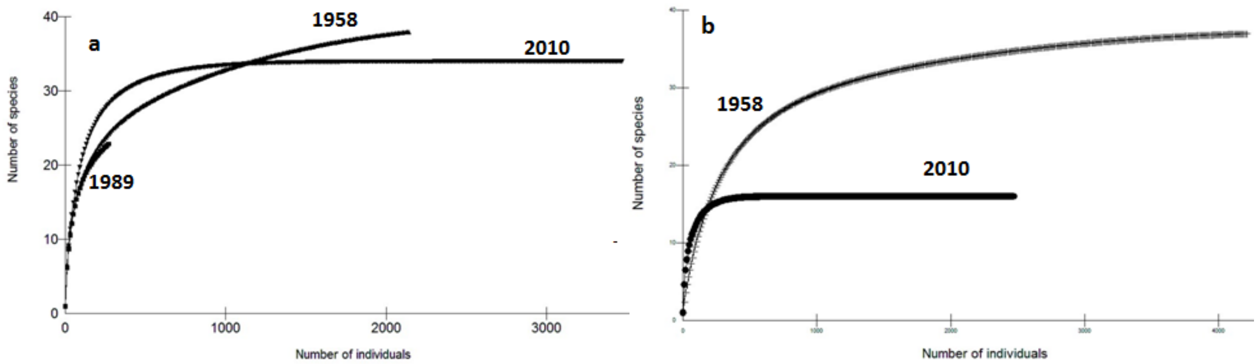

Figure 3. Rarefaction plots for the *T. stroemi – A. stepanovi* - (**a**); *M. phaseolina* – (**b**) communities at the Bosporus outlet area.

On rarefaction curves (Fig. 3) assigned the total species abundance and the total number of individuals. On the curves of *T. stroemi – A. stepanovi* community (Fig. 3) the left, steep slope (1989) indicates that a large fraction of the species diversity remains to be discovered. Rarefaction curve for the *M. phaseolina* communities in 2010 becomes flatter to the right, that means, that a reasonable number of individual samples have been taken (Gotelli & Colwell 2001).

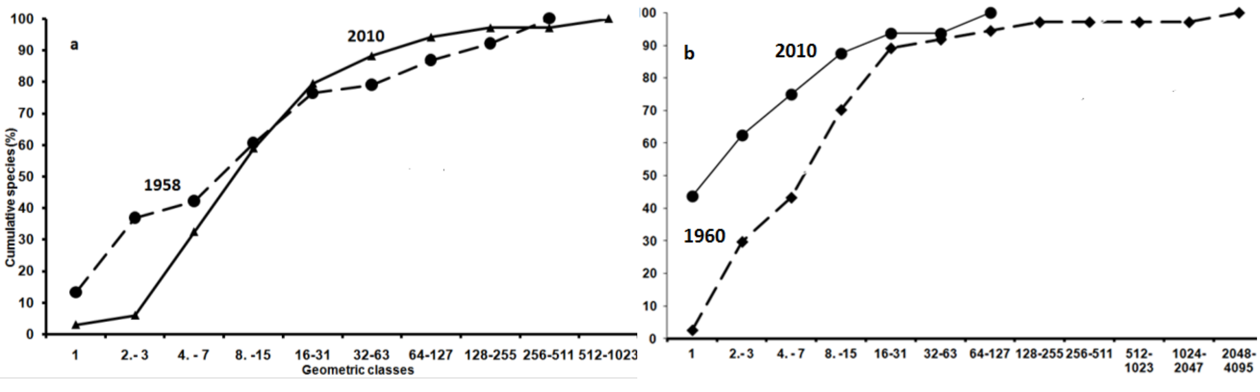

Figure 4. Plots of log-normal model for *T. stroemi – A. stepanovi* (depth 70 - 98 m – 1958, depth 96 - 152 m - 2010*) - (**a**); *M. phaseolina* communities (depth 83-113м -1960, depths 116-117 м - 2010*)-(**b**): (y axis) - cumulative % of species against (x axis) - individuals per species in geometric classes.

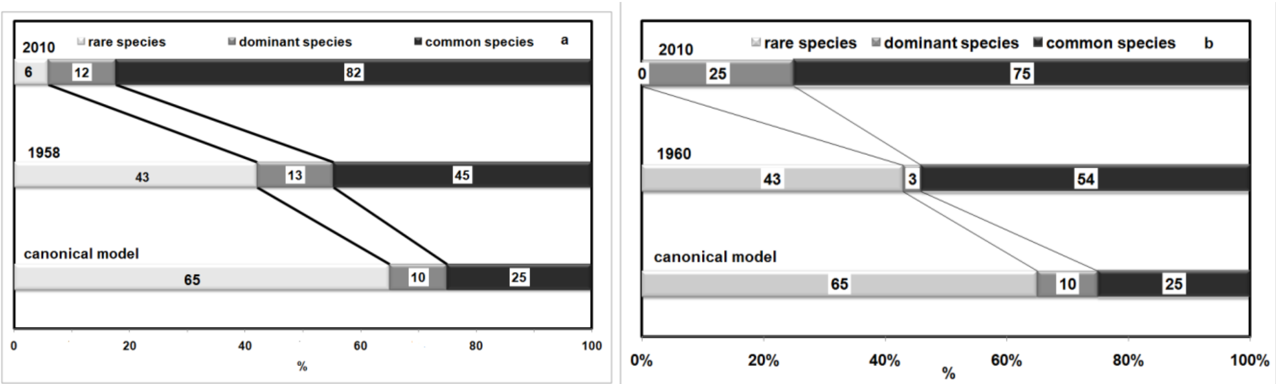

Figure 5. Structure of density for *T. stroemi – A. stepanovi* (depth 70 - 98 m – 1958, depth 96 - 152 m - 2010*) - (**a**); & *M. phaseolina* communities (depth 83-113м -1960, depths 116-117 м - 2010*)-(**b**).

The analysis of distribution for *T. stroemi – A. stepanovi* in 1958-60, 1989 and 2010 for *M. phaseolina* community showed good fit to lognormal model, in its various forms (Fig.4 & 5). Deviations from the canonical model, in the groups of rare & common species pointed on the instability of the deep-water habitats.

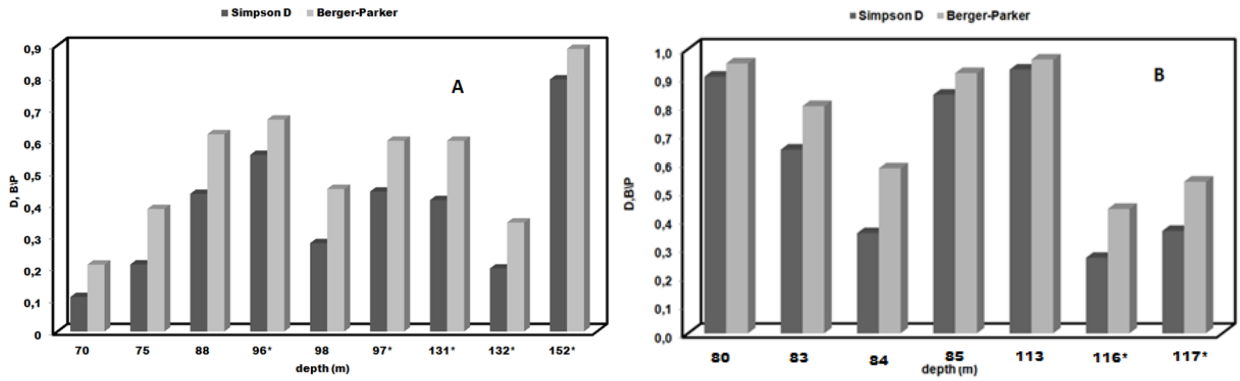

Figure 6. Simpson (D) & Berger-Parker (B\P) indices for *T. stroemi – A, stepanovi* *) - (**A**); & *M. phaseolina* (depth 83-113м -1960, depths 116-117 м - 2010*)-(**B**) communities at the Bosporus outlet area.

Dominance (1958) indices for *T. stroemi – A. stepanovi* community vary in magnitude. Generally dominance does appear to be higher at the deepwater part of the Bosporus outlet area (Fig. 6A). Simpson (D) & Berger-Parker (B\P) trends for *M. phaseolina* community emphasize high dominance in 1960, which is typical of *M. phaseolina* community. Oxygen depletion limits the development of most community components, while tolerated by the dominant species *M. phaseolina* (Kiseleva 1981). Lower dominance was revealed at 2010 in the deepwater part of the Bosporus outlet area, which is fully explained by community structure change (Fig. 6B & 4, 5B).

Investigation of entropy underlined the fundamental relationship between diversity and dominance concentration in studied communities. Shannon diversity index plot for *T. stroemi – A. stepanovi* community (Fig. 7A) showed an opposite of dominance trend with Simpson & Berger-Parker indices. Outcome of environmental degradation is loss of diversity and an increase of dominance (Fig. 7A: depth 96, 152 m), these tendency also correlated with reducing of dissolved oxygen level (Fig.2).

In 1960, a low level of biodiversity observed in the *M. phaseolina* community. In 2010 in the deepwater area marked a higher level of diversity and evenness for both communities. In the middle (80 m) and lower marginal (117 m) habitat area species diversity has close values. At the boundary of the habitat area observed level of diversity and evenness (close to maximum) indicates the stability of relative inter-population distribution (Fig. 7B).

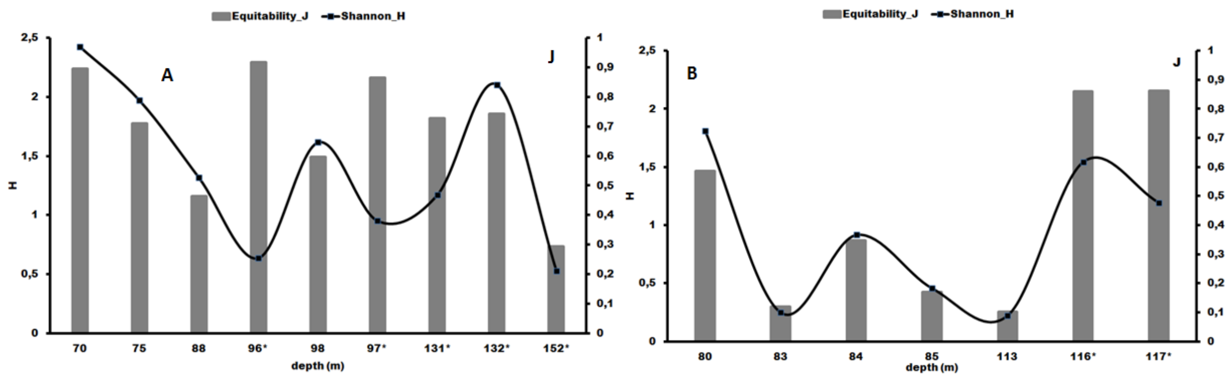

Figure 7. Shannon (H′) & evenness (J) indices for *T. stroemi* - *A. stepanovi* communities at the Bosporus outlet area (depth 70 - 98 m – 1958, depth 96 - 152 m - 2010*) - (**A**); & *M. phaseolina* (depth 83-113м -1960, depths 116-117 м - 2010*)-(**B**) communities at the Bosporus outlet area.

Unstable hydrodynamics and oxygen depletion are two obvious factors of decrease diversity in *T. stroemi* – *A. stepanovi* communities (Figure 7, 8 A). In *M. phaseolina* community the peaks of species richness and species diversity coincide (Fig. 7, 8 A).

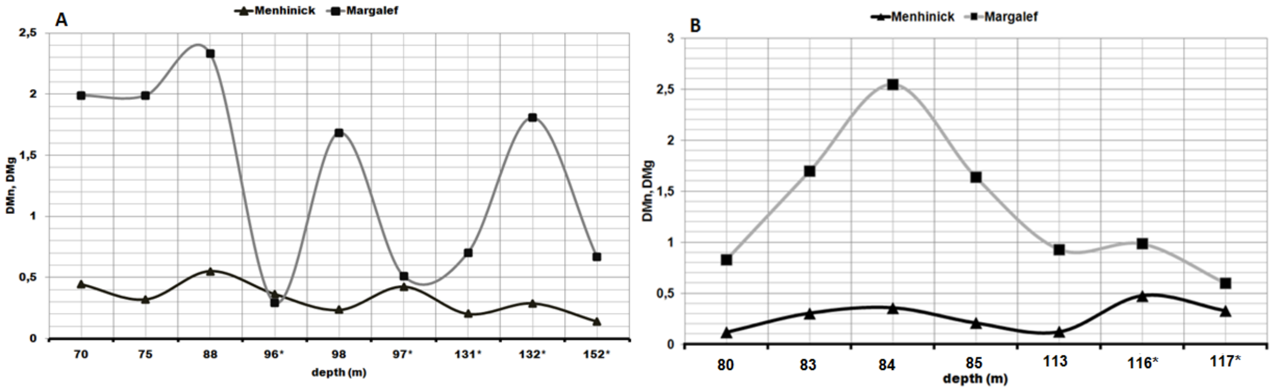

Figure 8. Menhinick (D_{Mn}) & Margalef (D_{MG}) indices for *T. stroemi* – *A. stepanovi* (depth 70 - 98 m – 1958, depth 96 - 152 m - 2010*) *) - (**A**); & *M. phaseolina* (depth 83-113м -1960, depths 116-117 м - 2010*)-(**B**) communities at the Bosporus outlet area.

Conclusions

Molluscs (K-strategists) in the Black Sea are structure forming species under stable oxic environmental conditions (Pianka 1970, 1978). The abundance of K-strategists *M. phaseolina* makes 77% of the community and small r-strategists like annelids make 14%. At the 100-150 m depth level the oxygen content decreased to 140 μM. The density of community restructured: r-strategists like annelids make 42% whereas M. phaseolina makes only 29% of the benthic community. The community of the bivalve *M. phaseolina* is the most deep-water bivalve community in the Black Sea; it dwells on the border of the oxygen depletion. The species composition of *M. phaseolina* community at the border of the hydrogen sulfide area is distinct from those dwelling in oxic areas of the Black Sea. Living organisms of macrobenthos were not found at the oxygen content near 12 μmol L-1 (160 m). This confirms that oxygen depletion at great depths is the limiting factor of life in the Black Sea. The oxygen concentration is correlated with the depth gradient. The structure of macrobenthos communities is disturbed in the anoxic area. Only a limited number of species are able to survive in anoxic conditions, represented mainly by polychaete species: *Nephtys hombergii*, *Melinna palmata*, *Terebellides stroemi*. The composition of the anoxic dwelling community varies in different parts of the Black Sea shelf. *Heteromastus filiformis* (Fam. Capitellidae) and *Aricidea claudiae* (Fam. Paraonidae) joined the group of anoxic dwelling community. Analysis of log normal models pointed on the instability of the deep-water habitats because the structure of the observed communities essentially rebuilt during long term period of study.

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