

Zoogeography of the Free-living Metazoan Invertebrate Animals (Metazoa: Invertebrata) from the Bulgarian Sector of the Black Sea and the Coastal Brackish Basins

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Abstract: A total of 19 phyla, 39 classes, 123 orders, 470 families and 1537 species are known off the Bulgarian Black Sea coast. They include 1054 (68.6%) marine and marine-brackish species, and 508 (33.0%) freshwater-brackish, freshwater and terrestrial species connected with water. The most species-rich taxa are the Arthropoda (802 species, 52.2%), Annelida (173 species, 11.2%) and Mollusca (152 species, 9.9%). The depth distribution of 800 (75.9%) marine and marine-brackish species is analysed. The groups of stenohypo- (52 species, 6.5%), stenoepi- (465 species, 58.1%), meso- (115 species, 14.4%) and eurybathic species (168, 21.0%) are represented. The marine and marine-brackish species are classified into 162 zoogeographical categories, combined into 4 main groups and 16 subgroups. The main portion of the Black Sea fauna has Atlantic-Mediterranean origin and represents the impoverished Atlantic-Mediterranean fauna (740 species, 70.2%). It includes cosmopolitan, Atlantic-Indian, Atlantic-Pacific, endemic and Caspian relict species. The benthic (115, 97.5%) and marine (114, 96.6%) species of the Black Sea endemics (118 species, 11.2%) predominate. The brackish endemics (11 species, 9.3%) are mostly represented by Caspian relicts. Most of the Caspian relicts (41 species, 3.9%) are benthic brackish species (38, 92.7%). The freshwater-brackish, freshwater and terrestrial species connected with water, are classified into 80 zoogeographical categories, combined into 3 groups and 5 subgroups. Typical of the coast is the prevalence of the species found in the Palaearctic and beyond it (296 species, 58.3%). Species found only in the Palaearctic but in more than one subregion (79 species, 15.5%), and species found within one Palaearctic subregion (126 species, 24.8%): the Euro-Siberian (55 species, 10.8%) and the Mediterranean (71 species, 13.9%) are reported. Attention is paid to the invasive alien species and the conservation of the fauna.

Key words: Bulgarian Black Sea coast, invertebrate, zoogeography, invasive alien species, conservation

Introduction

The first studies on the Bulgarian Black Sea fauna date back more than 100 years (CHICHKOFF 1907, 1908, 1912). Since then, a vast material of faunistic data concerning Bulgarian part of the Black Sea has been accumulated. These data show that considerable changes in the Black Sea cenoses were caused by some invasive species, introduced in the last 100 years (CVETKOV, MARINOV 1986, KONSULOV 1998, GOMOIU *et al.* 2002). However, the published catalogues and reviews so far do not include zoogeographical analyses of the Bulgarian Black Sea fauna (VALKANOV 1957a,

VALKANOV, MARINOV 1964, MARINOV, GOLEMANSKY 1989, MARINOV 1990, KONSULOV, KONSULOVA 1993, 1998, KONSULOV 1998). Contemporary systematic reviews were made only for individual taxonomic groups, for example, these included in the monograph series Fauna of Bulgaria (Polychaeta, MARINOV 1977; Harpacticoida, APOSTOLOV, MARINOV 1988), in review papers (Mollusca, WILKE 1996, HUBENOV 2005, 2007a, 2007b), and in PhD theses (Nematoda, STOYKOV 1980; Crustacea: Malacostraca, UZUNOVA 2006). Usually, the benthic hydrobionts were studied

separately from the plankton forms. Zoogeographical characterisation was published only for Polychaeta, Harpacticoida, Malacostraca, and Mollusca, but the zoogeographical analyses of these groups were made according to their origin or areography, and are difficult to compare. There is no a comprehensive zoogeographical review of the Bulgarian Black Sea fauna.

The aim of this work is to report the results of the zoogeographical analysis of the Bulgarian marine invertebrate fauna on the basis of recent data for the distribution of the free-living marine species and the species inhabiting the coastal brackish basins.

Material and Methods

The present work summarises the investigations on the Bulgarian Black Sea territory and aquatory during the last two centuries. It is based on the papers of CASPERS (1951a, 1951b), VALKANOV (1957), VALKANOV, MARINOV (1964), MARINOV, GOLEMANSKY (1989), MARINOV (1990), KONSULOV, KONSULOVA (1993, 1998), KONSULOV (1998) and GOLEMANSKY (2007). The work also includes data from 832 publications and PhD theses of KONSULOV (1991), KAMBURSKA (2004), TODOROVA (2005), UZUNOVA (2006) and TRAYANOVA (2008). Some coastal wetlands have been recently investigated in connection with their management plans (Durankulak Lake, Shabla Lake, Pomorie Lake, Atanasovsko Lake and the Poda Protected Area). These investigations are also included in the present work.

The brackish species are listed in the marine or freshwater groups depending on whether they are marine-brackish or freshwater-brackish. Attention is paid to the alien and invasive species that had changed considerably the Black Sea cenoses in the 20th century. The conservation significance of the fauna is specified.

Zoobenthos. The number of zoobenthic species is about 1000, belonging to 19 phyla. The zoobenthic species have been studied better in Bulgaria than in other Black Sea countries. Arthropoda, Annelida, Mollusca, and Nematoda have the greatest species diversity. Since some taxonomic groups have not yet been sufficiently studied, it could be accepted that the species diversity is higher. Three main zones are established in the Bulgarian Black Sea coastal area – supralittoral, mediolittoral (littoral, pseudolittoral) and sublittoral (infralittoral, circalittoral). In these zones, 12 biocenoses and many groups are differentiated, each of them being characterised by specific species composition (KANEVA-

ABADJIEVA 1960a, 1960b, 1962, VALKANOV, MARINOV 1978, MARINOV 1990, KONSULOV, KONSULOVA 1993, 1998, REVKOV *et al.* 2008).

Zooplankton. It includes representatives of Protozoa, Coelenterata, Ctenophora, Rotifera, Annelida (larvae), Arthropoda, Mollusca (larvae), and Chordata (VALKANOV *et al.* 1978, KONSULOV 1991, 1998, KONSULOV, KONSULOVA 1993, 1998). Depending on the thermal conditions, the zooplankton is classified as thermophilic, eurythermic and cryophilic. The depth distribution depends on the oxygen concentrations in the water (up to 100-175 m). The zooplankters have a specific distribution according to seasons and depth, which is determined by their thermal and trophic requirements (SHIGALOVA *et al.* 2008).

Coastal basins. There are about 40 lakes, marshes and areas flooded by rivers along the Bulgarian coast (VARBANOV 2002, HRISTOVA 2012). The presence of brackish elements is a special feature of the fauna in those basins. A “saline wedge”, situated below the fresh waters, is formed. In this “wedge” the bottom inhabitants are marine or brackish, whereas those in the upper water layers are freshwater species. The marine brackish species endure water down to about 1‰ salinity and the freshwater forms withstand water salinisation from 1.5‰ to 8‰. Many euryhaline marine species also take part in the formation of the coastal basins fauna, which can vary from marine to freshwater, depending on the water salinity. Nineteen rivers flow into the Bulgarian part of the Black Sea, forming limans, where oligo- and euryhaline species can be found. Therefore, it is difficult to consider the fauna of these rivers separately from the coastal stagnant basins (VALKANOV 1935, 1936, DRENSKY 1947, PETRBOK 1947, KANEVA-ABADJIEVA 1957, 1976, ZASCHEV, ANGELOV 1959, MIHAILOVA-NEIKOVA 1961, KANEVA-ABADJIEVA, MARINOV 1967, STOYKOV 1979, MARINOV 1990, TRAYANOVA 2003, 2008).

Weaknesses in the data obtained from the literature, which limit the recovery of comparable information, include: the different levels of study of individual taxa; insufficient research of many groups; existence of rich synonymy; obsolete data; lack of reviews on most taxa; unexplored territories; extended periods for collecting data about the individual areas; predominance of ecological studies over faunistic studies; prioritisation of research in monitored or protected areas; separated studies on benthos and plankton. These weaknesses lead to the following issues:

Continuous extending of existing historical faunistic lists. As a result, the species diversity in a

given area based on the published lists can be higher than the real one.

Demanding workloads related to ecological, conservation and monitoring studies, prevents specialists from allocating time for faunistic studies.

Incomparability of benthos – plankton data. Many studies are dedicated on either benthos only or plankton only, despite the fact that most taxa have both a benthic and planktonic life stages.

There is no unanimity among the experts about the zoogeographical status of the Black Sea, which is either considered as an independent subregion or is unified with the Mediterranean Sea (and the Lusitanian Atlantic subregion). The zoogeographical classification used here (Table 3) is based on the works of GURYANOVA (1964), DE LATTIN (1967), GOLIKOV, STAROBOGATOV (1968, 1972), STAROBOGATOV (1970), MORDUKHAY-BOLTOVSKOGO (1972), GOLIKOV (1982), NESIS (1982), RIEDL (1983), ABBOTT, DANCE (1991), ELDER, PERNETTA (1991), BRUYNE (2003), HOOK (2008), and EARLE, GLOVER (2009).

The zoogeographical categorisation of species is done on the basis of data about their distribution, taken from the literature and the following on-line databases: Antarctic Invertebrates, CLEMM (Check List of European Marine Mollusca), DAISIE (Delivering Alien Invasive Species Inventories for Europe), EOL (Encyclopedia of Life), ERMS (European Register of Marine Species), EUNIS biodiversity database, Fauna Europaea, Global invasive species database, Global Names Index, ITIS (Integrated Taxonomic Information System), Marine Planktonic Copepods, Marine Species Identification Portal, MarLIN (The Marine Life Information Network), NARMS (North Atlantic Register for Marine Species), NeMys, NOBANIS (European Network on Invasive Alien Species), PESI (A Pan-European Species Directories Infrastructure), PlanktonNet Image, OBIS (Ocean Biogeographic Information System), The World of Copepods, World Polychaeta Database, and WoRMS (World Register of Marine Species).

Results and Discussion

A total of 19 phyla, 39 classes, 123 orders, 470 families and 1537 species have been reported off the Bulgarian Black Sea coast (Table 1). These taxa include 1054 (68.6%) marine and marine-brackish species, as well as 508 (33.0%) freshwater-brackish, freshwater and terrestrial species connected with water. A small number of supercosmopolitan species (17), inhabitants of the marine, freshwater and terrestrial cenoses, are included in both groups. Five

phyla (Nematoda, Rotifera, Annelida, Arthropoda and Mollusca) have a high species richness (over 100 species). Of those, the richest in species are: Arthropoda (802 species, 52.2%), Annelida (173 species, 11.2%) and Mollusca (152 species, 9.9%). The remaining 14 phyla include from 1 to 38 species. The Bulgarian fauna comprises about 70% of the known 2000-2200 species from the Black Sea and Azov Sea. For individual taxa this percentage varies considerably and depends on the level of study. The species composition varies depending on whether the authors considered only marine and marine-brackish species or included freshwater-brackish, freshwater and terrestrial species, related to water. The Ukrainian and Russian Black Sea coasts, which are rich in brackish basins, are considerably richer also in brackish taxa compared to the Bulgarian Black Sea coast.

Most marine invertebrates have been established throughout the Bulgarian Black Sea coast. The species, which are found either in the northern or in the southern part of the coast, are about 20%. The Black Sea water below the depths of 180–200 m is enriched with dissolved H₂S, which makes the deep-sea life impossible. The groups of **steno-**

Table 1. Taxonomic diversity of the invertebrate animals from the Bulgarian part of the Black Sea (**Note.** The endoparasitic forms of Plathelminthes, Nematoda and Acanthocephala are not included.)

Phyla	Classes	Orders	Families	Species
Porifera	2	6	13	23
Cnidaria	3	10	25	38
Ctenophora	2	3	3	4
Plathelminthes	1	5	16	29
Nemertini	2	3	9	26
Gastrotricha	1	2	6	13
Nematoda	2	8	34	112
Cephalorhyncha	1	2	3	4
Rotifera	1	4	22	121
Annelida	5	16	49	173
Tardigrada	2	3	5	5
Arthropoda	4	28	199	802
Mollusca	3	20	65	152
Bryozoa	2	3	9	19
Phoronida	1	1	1	1
Entoprocta	1	1	1	1
Chaetognatha	1	1	1	1
Echinodermata	2	3	3	6
Chordata	3	4	6	8
Total	39	123	470	1537

(epi- and hypo-), **meso-**, and **eurybathic** species are represented. The depth distribution is analysed for 800 (75.9%) marine and marine-brackish species, according to available data (Table 2). Most species are found at depths from 0 to 25 m, on sandy (396 species) and rocky (257 species) bottom substrates.

The most numerous are the **Stenoepibathic** species (465 species, 58.1%). The inhabitants of the supralittoral zone, shallow coastal zone (to 5-10 m), as well as the species that reach the depth to 15-30 m, close to the mesobathic forms, belong to this group. An intermediate niche, closer to the mesobathic forms, is occupied by some representatives of the group, which reach higher depths. They belong to 16 phyla, and the most numerous of them are the representatives of Arthropoda, Annelida, and Mollusca.

The **Stenohypobathic** species are the smallest group (52 species, 6.5%). They can rarely be found at depths below 25 m and usually reach the highest density below 60-120 m. They belong to 10 phyla, of which the representatives of Arthropoda and Nematoda predominate. Recently, some species of Nematoda, Polychaeta, and Harpacticoida have been established in hypoxic habitats at depths below 200-250 m (SERGEEVA, ZAIKA 2013).

The **Mesobathic** species (115, 14.4%) reach depths over 40 m in the Black Sea. Some species could be considered mesostenobathic forms. They belong to 10 phyla, of which the representatives of Arthropoda and Mollusca prevail.

The group of **Eurybathic** species (168, 21.0%) includes the Black Sea species, which are found in both shallow and deep waters. Most eurybathic species reach depths of 130-150 m. They belong to 12 phyla, of which the representatives of Arthropoda, Nematoda, Annelida and Mollusca predominate.

The formation of the Black Sea fauna is connected with the origin of the Black Sea basin itself. The Upper Miocene Sarmatian Sea (18-30‰, a descendant of the Tethys Ocean) gave rise to the Pontian Sea-Lake, from which two separate basins were formed later: the Black Sea and the Caspian Sea. Initially, the Black Sea basin had been inhabited by fauna similar to that of the Caspian Sea [Chaudian Sea (12-14‰) and Palaeoeuxinian Sea (6-8‰)]. Then, the Black Sea was connected with the Mediterranean Sea and became saline, so the Mediterranean fauna penetrated into it, whereas the Caspian fauna retreated to the brackish coastal parts [time of Uzunlar Sea (16‰) and Karangat Sea (22-30‰)]. Later, the connection with the Mediterranean Sea was severed, and the brackish basin [the New Euxinian Sea (7‰)] originated, where the Mediterranean fauna disappeared. Recently, 7000-

Table 2. Distribution of the invertebrate animals by categories according to depth (**Note.** Only marine and brackish species for which data are available are included.)

Phyla	Epi-bathic	Hypo-bathic	Meso-bathic	Eury-bathic
Porifera	2		4	9
Cnidaria	7	1	2	10
Ctenophora	1			1
Plathelminthes	13			
Nemertini	5	4	6	5
Gastrotricha	4			
Nematoda	21	14	11	29
Cephalorhyncha		1	1	1
Rotifera	12			
Annelida	79	3	16	19
Tardigrada	5			
Arthropoda	239	21	36	74
Mollusca	69	2	33	15
Bryozoa	5	1	3	
Phoronida				1
Entoprocta	1			
Chaetognatha	1			
Echinodermata		3		3
Chordata	1	2	3	1
Total	465	52	115	168

8000 years ago, this basin was connected again with the Mediterranean Sea and its level increased. The marine fauna invaded it and the current Black Sea was formed (MISCHEV, POPOV 1978, SHOPOV 1993, DIMITROV *et al.* 1998, EVLOGIEV 2009, STUDENCKA, JASIONOWSKI 2011).

Then, before the last glaciation, a connection with the Caspian basin arose (via Manych channel), and Caspian interglacial immigrants invaded the Black Sea (MORDUKHAY-BOLTOVSKOY 1960, NEVESSKAYA 1965, STAROBOGATOV 1970, SHOPOV 1996). Most authors accept those species as Caspian relicts (known also as Sarmatian, Pontian, Pontian-Caspian, or autochthonous faunal elements). They are concentrated mainly in the coastal liman lakes and the mouths of the Black Sea rivers and inhabit both the freshwater and brackish basins. Part of those species are subfossils for the sea itself. The Caspian relicts usually have Pontian or Pontian-Caspian ranges. Some of them have entered the river systems of Central and Western Europe or spread to other continents where they are considered invasive alien species. According to MORDUKHAY-BOLTOVSKOY (1960), the evolution of the Caspian fauna gave rise to the origin of eurybenthic oligoha-

line and freshwater forms, which began to acquire new habitats with their pervasion in the Black Sea. The „relicts” *Dreissena polymorpha* Pallas and *D. bugensis* Andrusov – two of the most invasive recent mollusks, are a typical example. Recent data (mainly in the online databases) on the distribution of many relict taxa disputed their relict nature. It was reported that these taxa are widespread outside the Pontian-Caspian region. These may be invasive relict forms (a small number of species) or species with unclear distribution, accepted as relicts. The main portion of the Caspian relicts (41 species, or 3.9%) is benthic brackish forms (38 species, or 92.7%).

The marine and marine-brackish species are classified into 162 zoogeographical (areographical) categories, combined into 4 main groups and 16 sub-groups (Table 3).

The main portion of the Black Sea fauna (740 species, or 70.2 %) has Atlantic–Mediterranean origin and represents the impoverished Atlantic-Mediterranean fauna. As this fauna was becoming impoverished, the stenobiotic Lusitanian-Mediterranean species were eliminated, so this category is represented by the eurybiontic forms, found mainly along the European coast up to Scotland, North Sea and Scandinavia. Thus, an impression is created of the atlantisation of this fauna, manifested differently in the various taxonomic groups, benthic and planktonic forms. The atlantisation is poorly expressed in the planktonic forms (50 species, or 42.4%) and expressed mostly in the benthic forms (712 species, or 72.8%). There is no considerable difference (in percentages) between the atlantisation of the marine (716 species, or 69.9%) and the brackish species (101, or 65.6%).

Some of the Arctic- and Antarctic-Atlantic (high-latitude boreal and antiboreal) species (43 species, or 4.1%) are not presented in the Mediterranean Sea. Their percentage varies slightly as their number is insignificant in the brackish and planktonic forms. The Arctic-North-Atlantic-, Arctic-Boreal-Atlantic-Mediterranean and circum-European species predominate (total of 26 species, or 2.5%). Not all of the Holatlantic and North Atlantic species (99 species, or 9.4%) are presented in the Mediterranean Sea. The marine and benthic species prevail, of which the North-Atlantic-, Boreal-Atlantic- and Holatlantic-Mediterranean and Boreal Atlantic-Pontian species (total of 76 species, or 7.2%) predominate. Among the tropical- and subtropical Atlantic species (109 species, or 10.3%), the Lusitanian-Mediterranean species (79, or 7.5%) predominate. The East and Northeast Atlantic species are most numerous (251

species, or 23.8%). The main portion of them is the Celtic-Lusitanian-Mediterranean (148 species, or 14.1%) and Celtic-Pontian (44 species, or 4.2%) species. The Mediterranean species (90, or 8.5%) are poorly represented in the planktonic and brackish communities. Almost all Pontian-Caspian species (28, or 2.7%) are benthic and brackish (27 species, or 17.5%).

The Pontian species (Black Sea endemics) are 118 (11.2%). The benthic (115, or 97.5%) and marine (114, or 96.6%) species predominate. The brackish species (11, or 9.3%) are most often Caspian relicts. Some of the Pontian species is likely to be found in other seas as well in future studies. This refers mainly to the groups of Nematoda, Ostracoda and Copepoda, which are well-studied in the Black Sea. Most of the Black Sea endemic species are concentrated in several groups – Porifera, Nemertini, Nematoda, Rotifera, Ostracoda, and Copepoda. Many endemic species, known from previous studies, are currently synonymised or downgraded to subspecies. Thus, in recent malacological literature there are no data on endemic species in the Black Sea, as in previous publications [e.g., KANEVA-ABADJIEVA (1960a) recorded 24 species of endemic mollusks from the Bulgarian Black Sea coast]. Many species have changed after their penetration into the Black Sea and they are described as new taxa.

The number of species with cosmopolitan (121 species, or 11.5%), Atlantic-Pacific (120 species, or 11.4%) and Atlantic-Indian (72 species, or 6.8%) type of distribution is considerably smaller than the species of Atlantic type. The above mentioned species predominate among the marine and benthic species but their percentage is the highest in the plankton (from 8.5 to 28.0%). The differences in the percentages are not big for the benthic, marine and brackish forms (from 5 to 11%) with the exception of the brackish Atlantic-Pacific species (18.2%). Most cosmopolitan forms (2/3) have Atlantic-Indian-Pacific distribution. The Holatlantic and East Atlantic-Indian-Pacific species (58 species, or 5.5%) predominate, of which the Atlantic-Mediterranean-Indo-Pacific species are the most numerous (37 species). The number of North Atlantic-Indian-Pacific species (15) and the tropical and subtropical Atlantic-Indian-Pacific species (6) is smaller. About 1/3 of the cosmopolitan species have Arctic-Antarctic-Atlantic-Indian-Pacific distribution and the typical cosmopolitans and Subcosmopolitans (a total of 25 species, or 2.4%) predominate. About 1/4 of the species with Atlantic-Pacific type of distribution belong to the Arctic-Antarctic-Atlantic-Pacific species (23, 2.2%). The

Table 3. Zoogeographical characteristics of the marine and brackish invertebrate fauna from the Bulgarian Black Sea coast

Zoogeographical scheme of the used categories and main taxa	Total		Benthos		Plankton		Marine		Brackish	
	number	%	number	%	number	%	number	%	number	%
COSMOPOLITAN TYPE	121	11.48	105	10.74	25	21.19	119	11.63	18	11.69
Arctic-Antarctic-Atlantic-Indian-Pacific	42	3.98	36	3.68	7	5.93	42	4.10	7	4.54
Cosmopolitan	15	1.42	10	1.02	5	4.24	15	1.47	5	3.25
Subcosmopolitan	10	0.95	10	1.02	1	0.85	10	0.98	2	1.30
Arctic-Antarctic-Atlantic-Mediterranean-Indo-Pacific	4	0.38	4	0.41			4	0.39		
Arctic-Atlantic-Mediterranean-Indo-Pacific	6	0.57	6	0.61			6	0.59		
Arctic-Atlantic-Mediterranean-Indo-North Pacific	1	0.09	1	0.10			1	0.09		
Arctic-North Atlantic-Mediterranean-Indo-Pacific	1	0.09	1	0.10			1	0.09		
Arctic-North Atlantic-Mediterranean-Indo-North Pacific	2	0.19	2	0.20			2	0.19		
Antarctic-Atlantic-Mediterranean-Indo-North Pacific	2	0.19	1	0.10	1	0.85	2	0.19		
Antarctic-Pontian-Indo-Pacific	1	0.09	1	0.10			1	0.09		
Atlantic-Indian-Pacific	79	7.49	69	7.05	18	15.25	77	7.53	11	7.14
HOLATLANTIC AND EAST ATLANTIC-INDIAN-PACIFIC	58	5.50	49	5.01	15	12.71	57	5.58	10	6.49
Atlantic-Mediterranean-Indo-Pacific	37	3.51	31	3.17	12	10.17	36	3.52	7	4.54
Atlantic-Mediterranean-Indo-West Pacific	4	0.38	2	0.20	2	1.69	4	0.39	1	0.65
Atlantic-Mediterranean-Indo-Southwest Pacific	3	0.28	3	0.31			3	0.29		
Atlantic-Mediterranean-Indo-New Zealand	4	0.38	4	0.41			4	0.39	2	1.30
Atlantic-Mediterranean-Indo-North Pacific	2	0.19	2	0.20			2	0.19		
Atlantic-Mediterranean-Indo-Northwest Pacific	3	0.28	3	0.31			3	0.29		
Atlantic-Mediterranean-Red Sea-Pacific	2	0.19	1	0.10	1	0.85	2	0.19		
East Atlantic-Mediterranean-Indo-Pacific	2	0.19	2	0.20			2	0.19		
East Atlantic-Mediterranean-Indo-Southwest Pacific	1	0.09	1	0.10			1	0.09		
TROPICAL AND SUBTROPICAL ATLANTIC-INDIAN-PACIFIC	6	0.57	5	0.51	2	1.69	6	0.59		
Circum[sub]tropical	3	0.28	2	0.20	1	0.85	3	0.29		
Lusitanian-Mediterranean-West Indo-West Pacific	1	0.09	1	0.10			1	0.09		
Mediterranean-Indo-West Pacific	1	0.09	1	0.10			1	0.09		
Pontian-Indo-New Zealand	1	0.09	1	0.10			1	0.09		
NORTH ATLANTIC-INDIAN-PACIFIC	15	1.42	15	1.53	1	0.85	14	1.37	1	0.65
North Atlantic-Mediterranean-Indo-Pacific	3	0.28	3	0.31	1	0.85	2	0.19	1	0.65
North Atlantic-Mediterranean-Indo-West Pacific	1	0.09	1	0.10			1	0.09		
North Atlantic-Mediterranean-Indo-Malayan	2	0.19	2	0.20			2	0.19		
North Atlantic-Mediterranean-Indo-New Zealand	5	0.47	5	0.51			5	0.49		

Table 3. Continued

Zoogeographical scheme of the used categories and main taxa	Total		Benthos		Plankton		Marine		Brackish	
	number	%	number	%	number	%	number	%	number	%
North Atlantic-Mediterranean-Red Sea-Northeast Pacific	1	0.09	1	0.10			1	0.09		
Northeast Atlantic-Mediterranean-Indo-New Zealand	3	0.28	3	0.31			3	0.29		
ATLANTIC-INDIAN TYPE	72	6.83	67	6.85	10	8.47	70	6.84	7	4.54
Arctic-Antarctic-Atlantic-Indian	4	0.38	4	0.41			4	0.39		
Arctic-Atlantic-Mediterranean-Indian	1	0.09	1	0.10			1	0.09		
Arctic-Atlantic-Mediterranean-North Indian	1	0.09	1	0.10			1	0.09		
Arctic-North Atlantic-Mediterranean-Red Sea	1	0.09	1	0.10			1	0.09		
Antarctic-Atlantic-Mediterranean-Indian	1	0.09	1	0.10			1	0.09		
Atlantic-Indian	68	6.45	63	6.44	10	8.47	66	6.45	7	4.54
TROPICAL AND SUBTROPICAL ATLANTIC-INDIAN	7	0.66	5	0.51	2	1.69	7	0.68	2	1.30
Lusitanian-Mediterranean-Indian	1	0.09	1	0.10			1	0.09		
Lusitanian-Mediterranean-Mauritanian-West Indian	1	0.09	1	0.10			1	0.09		
Lusitanian-Mediterranean-West Indian	1	0.09	1	0.10			1	0.09		0.65
Lusitanian-Mediterranean-Northeast Indian	2	0.19	2	0.20			2	0.19	1	0.65
Mediterranean-North Indian	1	0.09	1	0.10			1	0.09		
Mediterranean-Red Sea	1	0.09			1	0.85	1	0.09		
HOL ATLANTIC- AND NORTH ATLANTIC-INDIAN	36	4.42	33	3.37	5	4.24	34	3.32	3	1.95
Atlantic-Mediterranean-Indian	6	0.57	6	0.61			5	0.49	1	0.65
Atlantic-Pontian-Indian	1	0.09	1	0.10			1	0.09		
Atlantic-Mediterranean-North Indian	1	0.09	1	0.10			1	0.09		
Atlantic-Mediterranean-Northeast Indian	2	0.19	2	0.20			2	0.19		
Atlantic-Mediterranean-West Indian	2	0.19	2	0.20	1	0.85	2	0.19		
Atlantic-Mediterranean-Red Sea	2	0.19	2	0.20			2	0.19		
North Atlantic-Mediterranean-Indian	7	0.66	7	0.72	3	2.54	6	0.59		
North Atlantic-Mediterranean-North Indian	6	0.57	5	0.51	1	0.85	6	0.59		
North Atlantic-Mediterranean-Northeast Indian	5	0.47	5	0.51			5	0.49	1	0.65
North Atlantic-Pontian-Northeast Indian	1	0.09	1	0.10			1	0.09	1	0.65
North Atlantic-Mediterranean-West Indian	1	0.09	1	0.10			1	0.09		
North Atlantic-Mediterranean-Red Sea	2	0.19			2	1.69	2	0.19		
EAST AND NORTHEAST ATLANTIC-INDIAN	25	2.37	25	2.56	3	2.54	25	2.44	2	1.30
East Atlantic-Mediterranean-Indian	4	0.38	4	0.41	1	0.85	4	0.39	1	0.65
East Atlantic-Mediterranean-West Indian	1	0.09	1	0.10			1	0.09		
East Atlantic-Mediterranean-Southwest Indian	1	0.09	1	0.10			1	0.09		

Table 3. Continued

Zoogeographical scheme of the used categories and main taxa	Total		Benthos		Plankton		Marine		Brackish	
	number	%	number	%	number	%	number	%	number	%
East Atlantic-Mediterranean-Red Sea	2	0.19	2	0.20			2	0.19		
Celtic-Lusitanian-Mediterranean-Indian	7	0.66	7	0.72			7	0.68	1	0.65
Celtic-Lusitanian-Mediterranean-West Indian	5	0.47	5	0.51	2	1.69	5	0.49		
Celtic-Lusitanian-Mediterranean-Northwest Indian	2	0.19	2	0.20			2	0.19		
Celtic-Lusitanian-Mediterranean-Northeast Indian	1	0.09	1	0.10			1	0.09		
Celtic-Pontian-Northeast Indian	2	0.19	2	0.20			2	0.19		
ATLANTIC-PACIFIC TYPE	120	11.38	94	9.61	33	27.97	118	11.53	28	18.18
Arctic-Antarctic-Atlantic-Pacific	23	2.18	20	2.04	4	3.39	23	2.25	3	1.95
Arctic-Antarctic-Atlantic-Mediterranean-Boreal Pacific	1	0.09	1	0.10	1	0.85	1	0.09		
Arctic-North Atlantic-Mediterranean-Pacific	2	0.19	2	0.20			2	0.19		
Arctic-North Atlantic-Mediterranean-North Pacific	5	0.47	4	0.41	1	0.85	5	0.49		
Arctic-North Atlantic-Mediterranean-Northeast Pacific	4	0.38	4	0.41			4	0.39		
Arctic-North Atlantic-Pontian-Northeast Pacific	1	0.09			1	0.85	1	0.09	1	0.65
Arctic-Boreal Atlantic-Mediterranean-Boreal Pacific	3	0.28	3	0.31			3	0.29		
Arctic-Boreal Atlantic-Pontian-Boreal Pacific	3	0.28	2	0.20	1	0.85	3	0.29	2	1.30
Arctic-Boreal Atlantic-Pontian-Northeast Pacific	1	0.09	1	0.10			1	0.09		
Arctic-Atlantic-Mediterranean-Southwest Pacific	1	0.09	1	0.10			1	0.09		
Arctic-Celtic-Mediterranean-New Zealand	1	0.09	1	0.10			1	0.09		
Antarctic-Atlantic-Mediterranean-Pacific	1	0.09	1	0.10			1	0.09		
Atlantic-Pacific	97	9.20	74	7.57	29	24.58	95	9.27	25	16.23
HOLATLANTIC AND NORTH ATLANTIC-PACIFIC	26	2.47	22	2.25	6	5.08	26	2.54	3	1.95
Atlantic-Mediterranean-Pacific	14	1.33	13	1.33	3	2.54	14	1.37		
Atlantic-Mediterranean-North Pacific	1	0.09			1	0.85	1	0.09		
North Atlantic-Mediterranean-Pacific	6	0.57	4	0.41	2	1.69	6	0.59	2	1.30
Boreal Atlantic-Pontian-Pacific	1	0.09	1	0.10			1	0.09	1	0.65
Atlantic-Mediterranean-Japonic	1	0.09	1	0.10			1	0.09		
Atlantic-Mediterranean-Northeast Pacific	3	0.28	3	0.31			3	0.29		
TROPICAL AND SUBTROPICAL ATLANTIC-PACIFIC	7	0.66	6	0.61	1	0.85	7	0.68		
Lusitanian-Mediterranean-West Pacific	1	0.09	1	0.10			1	0.09		
Mediterranean-Japonic	2	0.19	2	0.20			2	0.19		
Mediterranean-Mauritanian-Guinean-Tasmanian	1	0.09	1	0.10			1	0.09		
Lusitanian-Mediterranean-New Zealand	2	0.19	1	0.10	1	0.85	2	0.19		

Table 3. Continued

Zoogeographical scheme of the used categories and main taxa	Total		Benthos		Plankton		Marine		Brackish	
	number	%	number	%	number	%	number	%	number	%
Mediterranean-New Zealand	1	0.09	1	0.10			1	0.09		
NORTH ATLANTIC-PACIFIC	19	1.80	19	1.94			18	1.76	1	0.65
North Atlantic-Mediterranean-North Pacific	3	0.28	3	0.31			3	0.29		
Boreal Atlantic-Mediterranean-Boreal Pacific	2	0.19	2	0.20			2	0.19		
Boreal Atlantic-Pontian-Boreal Pacific	1	0.09	1	0.10			1	0.09		
Circumboreal-Mediterranean	2	0.19	2	0.20			2	0.19		
North Atlantic-Mediterranean-Northeast Pacific	2	0.19	2	0.20			2	0.19		
Boreal Atlantic-Mediterranean-Northeast Pacific	2	0.19	2	0.20			2	0.19		
Northeast Atlantic-Mediterranean-North Pacific	2	0.19	2	0.20			2	0.19		
Northeast Atlantic-Mediterranean-Aleutian	1	0.09	1	0.10			1	0.09		
Northeast Atlantic-Mediterranean-Japonic	2	0.19	2	0.20			2	0.19		
Celtic-Pontian-Japonic	1	0.09	1	0.10					1	0.65
Pontian-Northeast Pacific	1	0.09	1	0.10			1	0.09		
NORTH AND SOUTH ATLANTIC-PACIFIC	28	2.66	17	1.74	12	10.17	27	2.64	15	9.74
Circumboreal-Mediterranean-Australian	1	0.09	1	0.10	1	0.85	1	0.09	1	0.65
North Atlantic-Mediterranean-South Pacific	2	0.19	1	0.10			2	0.19	1	0.65
North Atlantic-Mediterranean-Southeast Pacific	1	0.09	1	0.10			1	0.09		
North Atlantic-Mediterranean-Southwest Pacific	3	0.28	2	0.20	2	1.69	3	0.29	2	1.30
Boreal Atlantic-Mediterranean-Southwest Pacific	4	0.38	2	0.20	2	1.69	4	0.39	1	0.65
North Atlantic-Mediterranean-New Zealand	9	0.85	4	0.41	5	4.24	8	0.78	6	
Carolinian-Celtic-Pontian-New Zealand	1	0.09	1	0.10			1	0.09	1	0.65
Northeast Atlantic-Mediterranean-Southwest Pacific	2	0.19	2	0.20			2	0.19	1	0.65
Northeast Atlantic-Mediterranean-New Zealand	1	0.09	1	0.10			1	0.09		
Celtic-Lusitanian-Mediterranean-New Zealand	3	0.28	1	0.10	2	1.69	3	0.29	2	1.30
Celtic-Lusitanian-Pontian-New Zealand	1	0.09	1	0.10			1	0.09		
HOL ATLANTIC- AND SOUTH ATLANTIC-PACIFIC	9	0.85	4	0.41	6	5.08	9	0.88	5	3.25
Atlantic-Mediterranean-Southwest Pacific	4	0.38	2	0.20	3	2.54	4	0.39	2	1.30
Atlantic-Pontian-Southwest Pacific	1	0.09			1	0.85	1	0.09	1	0.65
Atlantic-Mediterranean-New Zealand	4	0.38	2	0.20	2	1.69	4	0.39	2	1.30
EAST AND WEST ATLANTIC-PACIFIC	8	0.76	6	0.61	4	3.39	8	0.78	1	0.65
East Atlantic-Mediterranean-Pacific	1	0.09	1	0.10			1	0.09		
Northeast Atlantic-Mediterranean-East Pacific	1	0.09	1	0.10			1	0.09		

Table 3. Continued

Zoogeographical scheme of the used categories and main taxa	Total		Benthos		Plankton		Marine		Brackish	
	number	%	number	%	number	%	number	%	number	%
Atlantic-Mediterranean-West Pacific	4	0.38	2	0.20	3	2.54	4	0.39	1	0.65
North Atlantic-Mediterranean-West Pacific	2	0.19	2	0.20	1	0.85	2	0.19		
ATLANTIC TYPE	740	70.20	712	72.80	50	42.37	716	69.99	101	65.58
Arctic-Antarctic-Atlantic	43	4.08	41	4.19	7	5.93	42	4.11	5	3.25
Arctic-Antarctic-North Atlantic-Mediterranean	1	0.09	1	0.10			1	0.09		
Arctic-Atlantic-Mediterranean	4	0.38	4	0.41			4	4.11		
Arctic-North Atlantic-Mediterranean	12	1.14	11	1.12	2	1.69	11	1.07	1	0.65
Arctic-North Atlantic-Pontian	1	0.09	1	0.10			1	0.09		
Arctic-Boreal Atlantic-Mediterranean	7	0.66	7	0.72	1	0.85	7	0.68	3	1.95
Arctic-Boreal Atlantic-Pontian	3	0.28	3	0.31			3	0.29	1	0.65
Arctic-Circumeuropean-Mauritanian	1	0.09	1	0.10			1	0.09		
Arctic-Circumeuropean	4	0.38	3	0.31	2	1.69	4	0.39		
Arctic-Celtic-Pontian	1	0.09	1	0.10			1	0.09		
Circumeuropean-Mauritanian	1	0.09	1	0.10			1	0.09		
Circumeuropean	7	0.66	7	0.72	2	1.69	7	0.68		
Antarctic-Celtic-Lusitanian-Mediterranean	1	0.09	1	0.10			1	0.09		
Atlantic	697	66.13	671	68.61	43	36.44	674	65.88	96	62.34
HOLATLANTIC AND NORTH ATLANTIC	99	9.39	95	9.71	8	6.78	98	9.58	13	8.44
Holatlantic-Mediterranean	13	1.23	12	1.23	2	1.69	12	1.17	5	3.25
Atlantic-Mediterranean	5	0.47	5	0.51			5	0.49		
Atlantic-Pontian	2	0.19	2	0.20			2	0.19		
North Atlantic-Mediterranean	27	2.56	25	2.56	3	2.54	27	2.64	3	1.95
North Atlantic-Pontian	5	0.47	5	0.51			5	0.49	1	0.65
Boreal-Antiboreal Atlantic-Pontian	1	0.09	1	0.10			1	0.09		
Boreal Atlantic-Mediterranean	23	2.18	22	2.25	2	1.69	23	2.25	3	1.95
Boreal Atlantic-Pontian	13	1.23	13	1.33	1	0.85	13	1.27	1	0.65
Virginian-Celtic-Lusitanian-Mediterranean	1	0.09	1	0.10			1	0.09		
Carolinian-Celtic-Lusitanian-Mediterranean	4	0.38	4	0.41			4	0.39		
Carolinian-Celtic-Pontian	1	0.09	1	0.10			1	0.09		
Caribbean-Celtic-Lusitanian-Mediterranean	4	0.38	4	0.41			4	0.39		
TROPICAL AND SUBTROPICAL ATLANTIC	109	10.34	99	10.12	8	6.78	108	10.56	9	5.84
Tropical Atlantic-Mediterranean	1	0.09	1	0.10			1	0.09		

Table 3. Continued

Zoogeographical scheme of the used categories and main taxa	Total		Benthos		Plankton		Marine		Brackish	
	number	%	number	%	number	%	number	%	number	%
Virginian-Carolinian-Caribbean	2	0.19	1	0.10	1	0.85	2	0.19		
Carolinian-Lusitanian-Mediterranean	2	0.19	2	0.20			2	0.19		
Carolinian-Lusitanian-Pontian	1	0.09	1	0.10			1	0.09		
Caribbean-Lusitanian-Mediterranean	5	0.47	4	0.41			5	0.49		
Caribbean-Mediterranean-Mauritanian	1	0.09	1	0.10			1	0.09		
Lusitanian-Mediterranean-Mauritanian-Guinean	5	0.47	5	0.51			5	0.49		
Lusitanian-Mediterranean-Mauritanian	11	1.04	8	0.82	2	1.69	11	1.07		
Lusitanian-Mediterranean-South African	1	0.09	1	0.10			1	0.09		
Lusitanian-Mediterranean	79	7.49	74	7.57	5	4.24	78	7.62	9	5.84
Lusitanian-Pontian	1	0.09	1	0.10			1	0.09		
EAST AND NORTHEAST ATLANTIC	251	23.81	244	24.94	16	13.56	247	24.14	32	20.78
East Atlantic-Mediterranean	10	0.95	10	1.02			10	0.98		
Celtic-Lusitanian-Mediterranean-Mauritanian	26	2.47	26	2.66	1	0.85	26	2.54	1	0.65
Celtic-Lusitanian-Mediterranean	148	14.04	147	15.03	7	5.93	147	14.37	21	13.64
Celtic-Lusitanian-Pontian	15	1.42	12	1.23	4	4.24	13	1.27	5	3.25
Celtic-Mediterranean	6	0.57	6	0.61			6	0.59		
Celtic-Pontian-Caspian	2	0.19	1	0.10	1	0.85	2	0.19	2	1.30
Celtic-Pontian	44	4.17	42	4.29	3	2.54	43	4.20	3	1.95
MEDITERRANEAN-PONTIAN-CASPIAN	238	22.58	233	23.82	11	9.32	221	21.60	42	27.27
Holomediterranean	23	2.18	22	2.25	1	0.85	23	2.25	3	1.95
Mediterranean	28	2.66	28	2.86			28	2.74		
East Mediterranean	9	0.85	9	0.92	1	0.85	9	0.88		
North Mediterranean	3	0.28	3	0.31			3	0.29		
Adriatic-Aegean-Pontian	3	0.28	3	0.31			3	0.29		
Adriatic-Pontian	10	0.95	10	1.02			10	0.98		
Aegean-Pontian	14	1.33	14	1.43	1	0.85	13	1.27		
Pontian-Caspian-Aral	2	0.19	2	0.20	1	0.85	2	0.19	1	0.65
Pontian-Caspian	28	2.66	27	2.76	2	1.69	16	1.56	27	17.53
Pontian	118	11.19	115	11.76	5	4.24	114	11.14	11	7.14
CASPIAN RELICTS	41	3.89	39	3.99	4	3.39	21	2.05	38	24.67
Total	1054		978	92.88	118	11.21	1023	97.15	154	14.62

Atlantic-Pacific species (97, 9.2%) predominate, most of them having North and South Atlantic-, Holatlantic, North Atlantic- and North Atlantic-Pacific distribution (a total of 73 species, or 6.9%). The Atlantic-Mediterranean-Pacific species (14 species) are the most numerous. A small number of the Holatlantic-, South Atlantic-, East and West Atlantic- and Tropical and Subtropical Atlantic-Pacific species (a total of 24 species, or 2.3%) occur as well. Most of the species with Atlantic-Indian type of distribution include Holatlantic, North Atlantic-Indian and East and Northeast Atlantic-Indian species (a total of 61 species, or 5.8%). The North Atlantic-Mediterranean-Indian and Celtic-Lusitanian-Mediterranean-Indian species (7 species each) are the most numerous. Seven tropical and subtropical Atlantic-Indian and 4 Arctic-Antarctic-Atlantic-Indian forms occur as well.

The freshwater-brackish, freshwater and terrestrial species, connected with water, recorded from the Bulgarian Black Sea coast, are classified into 80 zoogeographical categories, combined into 2 main groups and 5 subgroups (Table 4).

Species distributed in the Palaearctic and beyond it. This group (296 species, or 58.3%) includes 36 zoogeographical categories, of which 29 comprise species of the **Northern type** (widely distributed in the Holarctic or Palaearctic) and 7 – species of the **Southern type** (distributed only in the southern Palaearctic). The group is important for the zoogeography of the coastal fauna because of its great species diversity. It is connected with the typical of the sea coasts natural habitats, which provide optimal conditions for the development of its representatives, and is poorly presented in the inland water basins. The difference between the brackish, freshwater and terrestrial species is from 8.7% to 37.0% (from 74 to 271 species). The species of the northern type have large range and ecological flexibility. The cosmopolitan, subcosmopolitan and Holarctic species (a total of 184 species, or 36.2%) are the most numerous. These species, except the Holarctic ones, are almost not represented in the terrestrial forms. In the brackish communities, the Holarctic species are poorly represented (17 species). The species of the southern type are the best represented in the terrestrial forms (11 species, or 5.5%). The presence of this group in different taxa depends on whether they include highly mobile and widespread species or comprise less mobile species and more closely connected with certain conditions. In the latter case, the specific natural habitats to which the species are adapted are more important.

Species distributed only in the Palaearctic but in more than one subregion (Palaearctic type).

A total of 79 species (15.5%) included in this group has been established along the Bulgarian coast. They belong to 11 zoogeographical categories. This group comprises from 8.1% to 25.9% (from 14 to 65 species) of the brackish, freshwater and terrestrial forms. The Transpalaearctic, West Palaearctic, West and Central Palaearctic and Holopalaearctic species (a total of 63 species, or 12.4%) are the most numerous. This ratio is almost the same and varies from 1.9% to 8.5% (from 4 to 18 species) in the freshwater and terrestrial forms. The group is poorly represented in the brackish forms – from 0.6% to 2.3% (from 1 to 4 species). The number of the European-North African species (from 3 to 5 species in the group) varies insignificantly. Two species have a longitudinal disjunction of their ranges that includes parts of Siberia and Central Asia.

Species distributed within one subregion of the Palaearctic.

This group (126 species, or 24.8%) includes species with the **Euro-Siberian** and **Mediterranean type** of distribution. The Mediterranean-Central Asian species are also included here since many authors unify the Mediterranean and Central Asian subregions. The species with the Mediterranean type of distribution are considered in a broader sense, and include some elements (Submediterranean, Subiranian, and Pontian) that can be also considered separately (GRUEV, KUSMANOV 1994, 1999, GRUEV 1995, 2000). The **Euro-Siberian species** are 55 (10.8%), of them the European species (31 species, or 6.1%) are the most numerous. They are combined into 9 zoogeographical categories, and include from 6.9% to 11.5% (from 12 to 48 species) brackish, freshwater and terrestrial species. The Euro-Siberian species are mostly freshwater and less brackish species. Thirty-six species have European distribution only, of which 31 are widespread in Europe, and 5 – in its particular regions (Central and South Europe). The **Mediterranean species** are 71 (13.9%), of which the Holomediterranean species (19 species, 3.7%) are the most numerous. The group includes species, which belong to 24 zoogeographical categories, with different origin, distribution and ecological preferences. It includes from 7.7% to 28.4% (19-57 species) brackish, freshwater and terrestrial species. This group is represented best in the terrestrial and poorly in the freshwater species. The endemics (11 species, 2.2%) are poorly represented – their number varies from 4 to 7 species. Among the terrestrial species more regional endemics are found. The specific conditions along the coast do

Table 4. Zoogeographical characteristics of the brackish, freshwater and terrestrial invertebrate fauna from the Bulgarian Black Sea coast

Zoogeographical scheme of the used categories and main taxa	Total		Brackish (rare marine)		Freshwater		Terrestrial	
	number	%	number	%	number	%	number	%
Species distributed in Palaearctic and out of it	296	58.27	127	73.84	271	65.14	74	36.81
Northern type	282	55.51	126	73.25	262	62.98	63	31.34
Cosmopolitan	75	14.76	54	31.40	74	17.79	2	0.99
Subcosmopolitan	41	8.07	22	12.79	39	9.37		
Holarctic-Palaeotropical-Neotropical	5	0.98	2	1.16	4	0.96	1	0.50
Holarctic-Palaeotropical-Australian	2	0.39			1	0.24	1	0.50
Holarctic-Palaeotropical	3	0.59	2	1.16	3	0.72		
Holarctic-Neotropical-Oriental-Australian	3	0.59	1	0.58	3	0.72	1	0.50
Holarctic-Neotropical-Oriental	8	1.57	4	2.32	7	1.68	4	1.99
Holarctic-Neotropical-Afrotropical-Australian	3	0.59			2	0.48	1	0.50
Holarctic-Neotropical-Afrotropical	6	1.18	3	1.74	5	1.20	1	0.50
Holarctic-Neotropical-Australian	5	0.98	2	1.16	4	0.96	1	0.50
Holarctic-Afrotropical-Australian	3	0.59	1	0.58	3	0.72		
Holarctic-Oriental-Australian	3	0.59	1	0.58	3	0.72		
Holarctic-Neotropical	5	0.98	3	1.74	5	1.20	1	0.50
Holarctic-Afrotropical	7	1.38	3	1.74	5	1.20	2	0.99
Holarctic-Oriental	8	1.57	2	1.16	7	1.68	4	1.99
Holarctic-Australian	2	0.39	1	0.58	2	0.48		
Palaearctic-Palaeotropical-Australian	3	0.59			3	0.72		
Palaearctic-Afrotropical-Australian	2	0.39			1	0.24	1	0.50
Palaearctic-Oriental-Australian	2	0.39			2	0.48	2	0.99
Palaearctic-Palaeotropical	1	0.20	1	0.58	1	0.24	1	0.50
Palaearctic-Afrotropical	8	1.57	2	1.16	8	1.92	1	0.50
Palaearctic-Oriental	9	1.77	3	1.74	9	2.16	6	2.98
West Palaearctic-Palaeotropical	1	0.20			1	0.24	1	0.50
Transpalaearctic-Oriental	2	0.39			2	0.48	2	0.99
West and Central Palaearctic-Oriental	1	0.20			1	0.24	1	0.50
West Palaearctic-Afrotropical	3	0.59			1	0.24	2	0.99
West Palaearctic-Oriental	2	0.39	1	0.58	2	0.48	2	0.99
Holarctic	68	13.39	17	9.88	63	15.14	23	11.44
European-Australian	1	0.20					1	0.50
South type	14	2.76	1	0.58	9	2.16	11	5.47
Palaeotropical-South Palaearctic	2	0.39			2	0.48	1	0.50
Palaeotropical-Mediterranean-Central Asian	1	0.20			1	0.24	1	0.50
Palaeotropical-Mediterranean	2	0.39			1	0.24	2	0.99
Afrotropical-Mediterranean	3	0.59			1	0.24	2	0.99
Oriental-Mediterranean-Central Asian-Australian	1	0.20	1	0.58				
Oriental-Mediterranean-Central Asian	3	0.59			2	0.48	3	1.49
Oriental-Mediterranean	2	0.39			2	0.48	2	0.99
Species with Palaearctic distribution	205	40.35	45	26.16	145	34.85	127	63.18
Palaearctic type	79	15.55	14	8.14	65	15.62	52	25.87
Holopalaearctic	10	1.97	1	0.58	10	2.40	4	1.99
Transpalaearctic	21	4.13	1	0.58	18	4.33	17	8.46
West and Central Palaearctic	14	2.76	2	1.16	13	3.12	11	5.47

Table 4. Continued

Zoogeographical scheme of the used categories and main taxa	Total		Brackish (rare marine)		Freshwater		Terrestrial	
	number	%	number	%	number	%	number	%
West Palaearctic	18	3.54	2	1.16	14	3.36	10	4.97
Disjunct Palaearctic	2	0.39	1	0.58	1	0.24	1	0.50
Euro-Siberian-Central Asian	1	0.20			1	0.24	1	0.50
European-Central Asian	3	0.59	1	0.58	2	0.48	1	0.50
European-West Central Asian	1	0.20			1	0.24	1	0.50
European-Iran-Turanian	1	0.20	1	0.58	1	0.24		
European-Turanian	2	0.39	1	0.58	1	0.24	1	0.50
European-North African	6	1.18	4	2.32	3	0.72	5	2.49
Euro-Siberian type	55	10.83	12	6.98	48	11.54	18	8.95
Holo-Euro-Siberian	2	0.39	1	0.58	3	0.72	3	1.49
West and Central Euro-Siberian	7	1.38			5	1.20	2	0.99
West Euro-Siberian-Anatolian	2	0.39			2	0.48	1	0.50
West Euro-Siberian	6	1.18			5	1.20	2	0.99
European-Anatolian	1	0.20	1	0.58	1	0.24		
Central and Southeast European-Anatolian	1	0.20	1	0.58	1	0.24		
European	31	6.10	9	5.23	26	6.25	8	3.98
Central and South European	2	0.20			1	0.24	1	0.50
Central and Southeast European	4	0.79			4	0.96	1	0.50
Mediterranean type	71	13.98	19	11.05	32	7.69	57	28.36
Mediterranean-Central Asian	5	0.98	1	0.58	3	0.72	5	2.49
Mediterranean-West Central Asian	3	0.59	2	1.16	2	0.48	2	0.99
North Mediterranean-West Central Asian	1	0.20			1	0.24		
East Mediterranean-Central Asian	1	0.20					1	0.50
Northeast Mediterranean-Iran-Turanian	1	0.20			1	0.24	1	0.50
Central and Southeast European-Iran-Turanian	1	0.20					1	0.50
Central and South European-North African	2	0.39			1	0.24	2	0.99
Holomediterranean	19	3.74	3	1.74	10	2.40	16	7.96
Atlantomediterranean	3	0.59					3	1.49
North Mediterranean	4	0.79			1	0.24	4	1.99
Atlantic-South European	1	0.20	1	0.58			1	0.50
South European	3	0.59	1	0.58	2	0.48	3	1.49
Southeast European-Pontian-Caspian	1	0.20	1	0.58	1	0.24		
Southeast European-Pontian	1	0.20			1	0.24		
Southeast European-Anatolian	1	0.20			1	0.24		
Southeast European	1	0.20					1	0.50
East Mediterranean	4	0.79	2	1.16	3	0.72	4	1.99
Northeast Mediterranean	5	0.98	1	0.58			4	1.99
Pontomediterranean	3	0.59	1	0.58	1	0.24	2	0.99
Pontian endemics	3	0.59	3	1.74			2	0.99
Balkan endemics	2	0.39			1	0.24	1	0.50
Bulgarian endemics	1	0.20	1	0.58	1	0.24		
Regional Bulgarian endemics	4	0.79	2	1.16	1	0.24	4	1.99
Local Bulgarian endemics	1	0.20			1	0.24		
Total	508		172	34.33	416	83.03	201	40.12

Table 5. Alien invertebrate animals, recorded off the Bulgarian Black Sea coast (**Note.** The years in parentheses show finding of the species in Bulgaria, * – invasive species)

Taxa	Year of introduction or finding	Donor region
Coelenterata		
<i>Blackfordia virginica</i> Mayer, 1910	1925 (1935)	North Atlantic and North America
<i>Garveia franciscana</i> (Torrey, 1902)	1933 (1933)	North Atlantic and North America
<i>Rathkea octopunctata</i> (Sars, 1835)	(1957)	Atlantic Ocean and Mediterranean Sea
<i>Diadumene lineata</i> (Verrill, 1869)	(1960)	Northwest Pacific Ocean
Ctenophora		
* <i>Mnemiopsis leidyi</i> Agassiz, 1865	1982 (1986)	Western Atlantic Ocean
* <i>Beroe ovata</i> Bruguère, 1789	1997 (1997)	North Atlantic Ocean
<i>Bolinopsis vitrea</i> (L. Agassiz, 1860)	2010 (2010)	Tropical and Subtropical
Annelida: Polychaeta		
* <i>Ficopomatus enigmaticus</i> (Fauvel, 1923)	1929 (1935)	Indian Ocean
<i>Hesionides arenaria</i> Friedrich, 1937	1950-re (1954)	Pacific Ocean or Atlantic Ocean
<i>Streblospio shrubsolei</i> (Buchanan, 1890)	1957 (1957)	North Atlantic Ocean
<i>Streptosyllis varians</i> Webster & Benedict, 1887	1966 (1966)	North Atlantic or Pacific Ocean
* <i>Polydora cornuta</i> Bosc, 1802	2005 (2008)	North and West Atlantic Ocean
* <i>Dipolydora quadrilobata</i> (Jacobi, 1883)	(1990)	Atlantic Ocean and Pacific Ocean
Arthropoda: Crustacea		
<i>Acartia tonsa</i> Dana, 1849	1976 (2000)	Indian Ocean and Pacific Ocean
<i>Oithona davisae</i> Ferrari F. D. & Orsi, 1984	2001 (2009)	Northwest Pacific Ocean
<i>Triconia minuta</i> (Giesbrecht, 1893 [1892])	(2000)	Indian Ocean and Pacific Ocean
<i>Amphibalanus eburneus</i> (Gould, 1841)	1892 (1933)	North America
* <i>Amphibalanus improvisus</i> (Darwin, 1854)	1844 (1912)	North America
<i>Palaemon macrodactylus</i> Rathbun, 1902	(2009)	Pacific Ocean and Southeast Asia
<i>Rhithropanopeus harrisi</i> (Gould, 1841)	1937 (1934, 1953)	North America
<i>Callinectes sapidus</i> Rathbun, 1896	1967 (1968)	North Atlantic Ocean
<i>Eriocheir sinensis</i> (H. Milne Edwards, 1854)	2006 (2005)	East and Southeast Asia
Mollusca		
<i>Potamopyrgus antipodarum</i> (J. E. Gray, 1843)	1952 (2008)	coast of New Zealand
* <i>Rapana venosa</i> (Valenciennes, 1846)	1946 (1956)	Sea of Japan
<i>Neptunea arthritica</i> (Valenciennes, 1858)	(2000)	Indian Ocean and Pacific Ocean
<i>Corambe obscura</i> (Verrill, 1870)	1980 (1986)	North Atlantic Ocean
<i>Ferrissia fragilis</i> (Tryon, 1862)	(1983)	North America
<i>Physella acuta</i> (Draparnaud, 1805)	(1927)	North America
* <i>Anadara kagoshimensis</i> (Tokunaga, 1906)	1982 (1984)	Indian Ocean and Pacific Ocean
* <i>Mya arenaria</i> Linnaeus, 1758	1966 (1973)	Circumboreal
<i>Teredo navalis</i> Linnaeus, 1758	750-500 B.C.	Atlantic Ocean and Pacific Ocean

not favour the formation of endemic taxa. Those endemics are mainly newly described species or rare species with unclear distribution. The only local endemic (*Hauffenia lucidula* Angelov) is a crenobiontic species of the family Hydrobiidae – 95.5% of the species in this group are freshwater endemic forms.

Alien species. The penetration of invasive alien species via ballast waters and/or as fouling or-

ganisms on ship hulls is one of the greatest threats to the world's oceans. Lists of species, introduced in the Black Sea have been published by several authors (CVETKOV, MARINOV 1986, GOMOIU, SCOLKA 1996, KONSULOV 1998, SHADRIN 2000, ZAITSEV, ÖZTÜRK 2001, GOMOIU *et al.* 2002, MONCHEVA, KAMBURSKA 2002, KAMBURSKA, MONCHEVA 2003, ZAITSEV *et al.* 2004, KONSULOVA, STEFANOVA 2007,

TODOROVA, MONCHEVA 2013). Thirty-one invertebrate species are known from the Bulgarian Black Sea coast, occurring in different periods (Table 5). The most significant changes in the Black Sea communities are caused by 5 species, which are introduced in the last 60 years, namely: *Mnemiopsis leidyi* Agassiz, *Beroe ovata* Bruguière, *Rapana venosa* Valenciennes, *Anadara inaequalis* Bruguière and *Mya arenaria* Linnaeus (CVETKOV, MARINOV 1986, MARINOV 1990, KONSULOVA, STEFANOVA 2007, TODOROVA, MONCHEVA 2013).

Conservation significance of the fauna. A total of 35 species from the Bulgarian Black Sea invertebrates are included in the Black Sea Red Data Book (1 of Porifera, 1 of Cnidaria, 2 of Annelida, 26 of Arthropoda, 4 of Mollusca and 1 of Chordata). Seven of them are included in the European Red List as well. *Pholas dactylus* Linnaeus is included in the international conventions for the European and Mediterranean fauna. There are differences in the levels of threat to the species in the particular Black Sea countries (DUMONT *et al.* 1999). Most of the species belong to the categories Endangered and Vulnerable. Five species have a Pontian-Caspian distribution, five species are Caspian relicts and *Apseudopsis ostroumovi* Bacescu & Carausu is a

Black Sea (Pontian) endemic. The species are most often widely distributed, for example, *Halichondria panicea* Pallas is a cosmopolitan species. Some taxa, included in the Black Sea Red Data Book, have stable populations along the Bulgarian coast and are not threatened at this stage. The Red Data Book of the Republic of Bulgaria includes 8 species of invertebrate animals from the Bulgarian Black Sea (*Hirudo verbana* Carena, *Eriphia verrucosa* Forskål, *Epallage fatime* Charpentier, *Lestes viridis* Vander Linden, *Sympetrum depressiusculum* Sélys, *S. vulgatum* Linnaeus, *Theodoxus pallasii* Lindholm, and *Hauffenia lucidula* Angelov). The species *T. pallasii*, a Pontian-Caspian brackish relict species, is accepted as extinct. Recently, *Carcinus aestuarii* Nardo and *Pholas dactylus* have occurred exceptionally rare. A total of 118 Black Sea endemic species have been found along the Bulgarian coast, of which 12 species are accepted as regional endemics. The local endemics are exceptions among the marine species and usually are newly described taxa with unclear distribution. Some relicts are eurybiotic invasive forms with secondary anthropogenic ranges. A total of 98 rare species have been established. Their number depends on the level of study of the respective groups.

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