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Invertebrate Animals (Metazoa: Invertebrata) of the Atanasovsko Lake, Bulgaria

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Abstract: The role of the Atanasovsko Lake for storage and protection of the specific faunistic diversity, characteristic of the hyper-saline lakes of the Bulgarian seaside is presented. The fauna of the lake and surrounding waters is reviewed, the taxonomic diversity and some zoogeographical and ecological features of the invertebrates are analyzed. The lake system includes from freshwater to hyper-saline basins with fast changing environment. A total of 6 types, 10 classes, 35 orders, 82 families and 157 species are known from the Atanasovsko Lake and the surrounding basins. They include 56 species (35.7%) marine and marine-brackish forms and 101 species (64.3%) brackish-freshwater, freshwater and terrestrial forms, connected with water. For the first time, 23 species in this study are established (12 marine, 1 brackish and 10 freshwater). The marine and marine- brackish species have 4 types of ranges – Cosmopolitan, Atlantic-Indian, Atlantic-Pacific and Atlantic. The Atlantic (66.1%) and Cosmopolitan (23.2%) ranges that include 80% of the species, predominate. Most of the fauna (over 60%) has an Atlantic-Mediterranean origin and represents an impoverished Atlantic-Mediterranean fauna. The freshwater-brackish, freshwater and terrestrial forms, connected with water, that have been established from the Atanasovsko Lake, have 2 main types of ranges – species, distributed in the Palaearctic and beyond it and species, distributed only in the Palaearctic. The representatives of the first type (52.4%) predominate. They are related to the typical marine coastal habitats, optimal for the development of certain species. The second type combines Palaearctic (20.0%), Eurosiberian (9.5%) and Mediterranean (15.2%) taxa. Caspian relicts lack in the Atanasovsko Lake. That is probably related to the specific hydrological regime, technological processes of the salt producing and the highly variable hyper-saline nature of the lake. Of the Pontic species *Chironomus valkanovi* is established. Of the benthic forms *Cerastoderma glaucum* (to 134376 ind/m^2), *Ecrobia ventrosa* (to 19800 ind/m^2), *Abra segmentum* and *Cyprideis torosa* (to 77440 ind/m^2) dominate. *Corophium volutator* is a mass species in all seasons and is one of the most adapted inhabitants of the saltpans. The Cosmopolitan *Acartia clausi* reaches high numbers (to 130000 ind/m^3) as well. Typical for the Atanasovsko Lake are the halobionts *Artemia parthenogenetica* and *Artemia salina* that reach densities up to 3400 ind/l water. The presence of 6 types of foreign immigrants (*Ficopomatus enigmaticus*, *Amphibalanus eburneus*, *Rapana venosa*, *Physella acuta*, *Anadara kagoshimensis* and *Mya arenaria*) is established. Of the invertebrate animals of the Atanasovsko Lake 3 species are included in the Black Sea Red Data Book and 8 species – in the European and IUCN Red Lists.

Key words: Atanasovsko Lake, invertebrates, species composition, zoogeography, invasive alien species

Introduction

The Atanasovsko Lake has an essential role in the preservation and protection of the specific faunistic diversity, distinctive of the hyper-saline lakes of the Bulgarian seaside. The communities of invertebrates in these basins are undergoing major changes related to environmental factors. The fauna of the lake and surrounding basins, taxonomic diversity and some zoogeographical and ecological features of the invertebrate animals are analyzed. Attention is paid to the species that define the functioning of the ecosystems in the protected area. The invasive species and those of conservation interest, established in the lake and its surroundings, are considered. The investigations are focused on the marine, marine-brackish, brackish-freshwater, freshwater and terrestrial forms, connected with water. Representatives of the terrestrial fauna that inhabit the surrounding areas, fall in the area of wetland accidentally and are not related to the typical for the lake system natural habitats, are not scrutinized.

The technological processes of salt producing make an impact on the hydrological regime of the lake and its faunistic diversity. The lake system includes basins with varying salinity (from freshwater to hyper-saline) and fast changing environment. In the spring the salinity is about 5-25 ‰ and during the summer months reaches 150-340 ‰ in some basins. The annual evaporation is about 10 lake volumes (Ivanov et al., 1964). The lake is filled with fresh water from the rivers Azmaka, Vetrenska and some dried up gullies. In some years the salinity of the lake is strongly influenced by the rainfalls and can be significantly reduced. Its lagoon nature, the imported organics and the technological processes of salt producing put the communities to environmental stress.

Literature data

The Bulgarian Black Sea invertebrates had been studied for more than 100 years (Chichkoff, 1907, 1908, 1912). During the last 60 years, the coast is under a drastic anthropogenic impact and large landscape changes. Changes in the cenoses are caused by some invasive species (Cvetkov & Marinov, 1986; Konsulov, 1998; Gomoiu et al., 2002). The published catalogues of the Bulgarian Black Sea fauna have not a systematic character (Valkanov, 1957; Valkanov, Marinov, 1964; Marinov, Golemansky, 1989; Marinov, 1990; Konsulov & Konsulova, 1993). The published generalized studies by Konsulov (1998) and Konsulov & Konsulova (1998) are similar to the works of Marinov (1990) and Konsulov & Konsulova (1993). A part of the names used is out-of-date and needs to be updated. There is a contemporary systematic view for some taxonomic groups, included in the monograph series Fauna of Bulgaria (Polychaeta – Marinov, 1977; Harpacticoida – Apostolov, Marinov, 1988), in survey papers (Mollusca – Wilke, 1996; Hubenov, 2005, 2007a, 2007b) or in dissertations (Nematoda – Stoykov, 1980; Malacostraca – Uzunova, 2006). There is a lack of areographical characteristic of the fauna except some taxa of Polychaeta, Harpacticoida, Malacostraca and Mollusca.

The first data on the invertebrates of the Atanasovsko Lake and the surrounding basins are published by Chichkoff (1909) and Valkanov (1934, 1935, 1936). Later halophilic species of the family Chironomidae are recorded by Cvetkov (1955, 1958) and a research on the meiobenthos was done. In the generalization of the known data until then Vodenicharov (1964) indicated 15 species of invertebrate animals. Naidenow (1967) reported 3 species of Cladocera and Copepoda each, found in the canal around the lake. Some invertebrate animal species have been established by Iankov (1993). In the study related to the first management plan of the protected area, 69 invertebrate species have been established by Andreev (1997, 2003) and Kovachev (1993). In connection with the elaboration of a monitoring plan of the Atanasovsko Lake, Varadinova (2013) reported 46 taxa for the benthos fauna, of which 27 are determined to species.

Weaknesses in the literature data which limit the obtaining of an equivalent information include: different levels of study of the individual taxa; insufficient research of many groups in the corresponding areas; a lack of exact localities for the part of the recorded species; existence of rich synonymy; outdated data; a lack of generalized investigations for most of the groups; significant differences in the number of taxa in the separate areas; unexplored territories; prolonged periods of data accumulation for most regions; predominance in recent years of the ecological studies versus those of the fauna; independent review of the benthos and plankton forms. These weaknesses lead to 5 problems.

- Continuous supplementation of an existing historical list of the fauna. As a result, species diversity in a given area is higher than in reality.
- Incomparability of data in terms of time periods. Data comparisons between two areas very often cover different periods as it is not possible to study all taxonomic groups and territories simultaneously.
- Incomparability of benthos – plankton data. Many studies are look at either benthos only or plankton only, despite the fact that most taxa have both a benthic and planktonic stages.
- Incomplete reporting of anthropogenic influences, successional and landscape changes on the composition of the communities. A number of well-studied brackish basins in the past no longer exist or have changed.
- Prioritization of research in areas under monitoring or environmental protection legislation.

The references present the first record of the taxon and its inclusion in the catalogues and some new or important literature data. Under updating of the names and specifying of the species distribution, some electronic issues are used: Antarctic Invertebrates, CLEMAM (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, NEOBANIS (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, WoRMS (World Register of Marine Species).

Approach, material and methods

The aim of this work is to present the invertebrate fauna of the Atanasovsko Lake as well as to analyze the taxonomic diversity and some zoogeographical and ecological features of the invertebrates of the lake.

The investigations of the Atanasovsko Lake territory for the last 2 centuries are generalized in this work. The works of Caspers (1951), Valkanov (1957), Valkanov, Marinov (1964), Marinov, Golemansky (1989), Marinov (1990), Konsulov & Konsulova (1993, 1998), Konsulov (1998) and Uzunov et al. (1998) have been analysed. Data from new publications, from the previous management plan of the lake (Andreev, 1997, 2003; Kovachev, 1997) and the last monitoring data (Gecheva et al., 2013) are included. All free living water (marine, brackish and freshwater) and the terrestrial invertebrate animals, connected with water, are scrutinized (Table 1). The endoparasitic forms of Plathelminthes, Nematoda and Acanthocephala have not been included. Many authors traditionally regard Protozoa as a part of Animalia. In the catalogues of Valkanov (1957) and Marinov, Golemansky (1989) 7 Protozoa species from the Atanasovsko Lake have been recorded (*Dunaliella salina*, *Monadodendron latypes*, *Rebecca salina*, *Hymenomonas coccolithophora*, *Salpingoeca aggregata*, *Aubignyna perlucida* and *Raphidiophrysopsis sessilis*). Now the protists are accepted as a separate kingdom (Protozoa), equivalent to the animal kingdom (Animalia) and are not considered in this review. Attention is paid to the invasive species and taxa of great conservation significance. The investigations on the plankton and benthos, carried out by I. Pandourski and L. Kenderov, are also included. Additional data were obtained from the exploration of the protected area in September 2014.

The numbers of the stations (Figure 1, Table 1) is the same as in the previous management plan (Minchev, 2003) and the investigations under the monitoring (1-4 in brackets – Gecheva et al., 2013). The habitats in the study territory are under Natura 2000. Two types of natural habitats of the Natura 2000 site Atanasovsko Lake (BG0000270) are not included because they are not represented in the protected area of the managed reserve Atanasovsko Lake.

The areographical categorization of the species is done on the basis of data of their distribution, taken from the literature and the newest electronic issues. The presented ecological data are taken from the Bulgarian literature. Only if there are no data from Bulgaria, foreign data are included for the corresponding species. The conservation value of taxa is determined regarding to their populations inhabiting Bulgaria. For local endemics, 100 % of their populations are localized in Bulgaria, therefore they are given the highest conservation category (world importance). This category also includes regional endemics because of their restricted distribution and species from the IUCN Red List. Taxa of European importance include Black Sea endemics as well as the species from the Bern Convention and Habitats Directive. The relicts and rare taxa (if not listed under other category) form the group of national importance. The species, included in Black Sea Red Data Book (Dumont et al., 1999), European and IUCN Red List are marked.

Abbreviations used

Stations (localities) [numeration according to the previous plan (Figure 1) and the project LIFE11/NAT/BG/000362 in brackets]: **1** – freshwater slowly flowing tributary and pollution; **2** – very slowly flowing freshwater tributary (roundabout canal); **3** – eutrophic marsh, collecting waters from 1 and 2; **4** – canal in the eastern part of the lake, freshwater or saltwater periodically (connection of the salt-producing basins with the sea); **5-11** – salt-producing (most often hyper-saline) basins; **13** – canal in the western part (mainly freshwater); **12**, **12a**, **14**, **15** and **16** – salt-producing basins with a varying degrees of salinity; **17** and **18** – points per canal 4; **(1)** and **(2)** – basin Tolbuhin (about 1000 m distance between the two points); **(3)** - South salt-pan, against the hiding of the Regional Inspectorate of Environment and Water; **(4)** – South salt-pan, to the floodgate of Azmashka River to Rudnik Village

Habitats, classified according to Natura 2000: **I** – Coastal lagoons (1150); **II** – *Salicornia* and other annuals colonizing mud and sand (1310); **III** – Mediterranean salt meadows (1410); **IV** – Pannonic

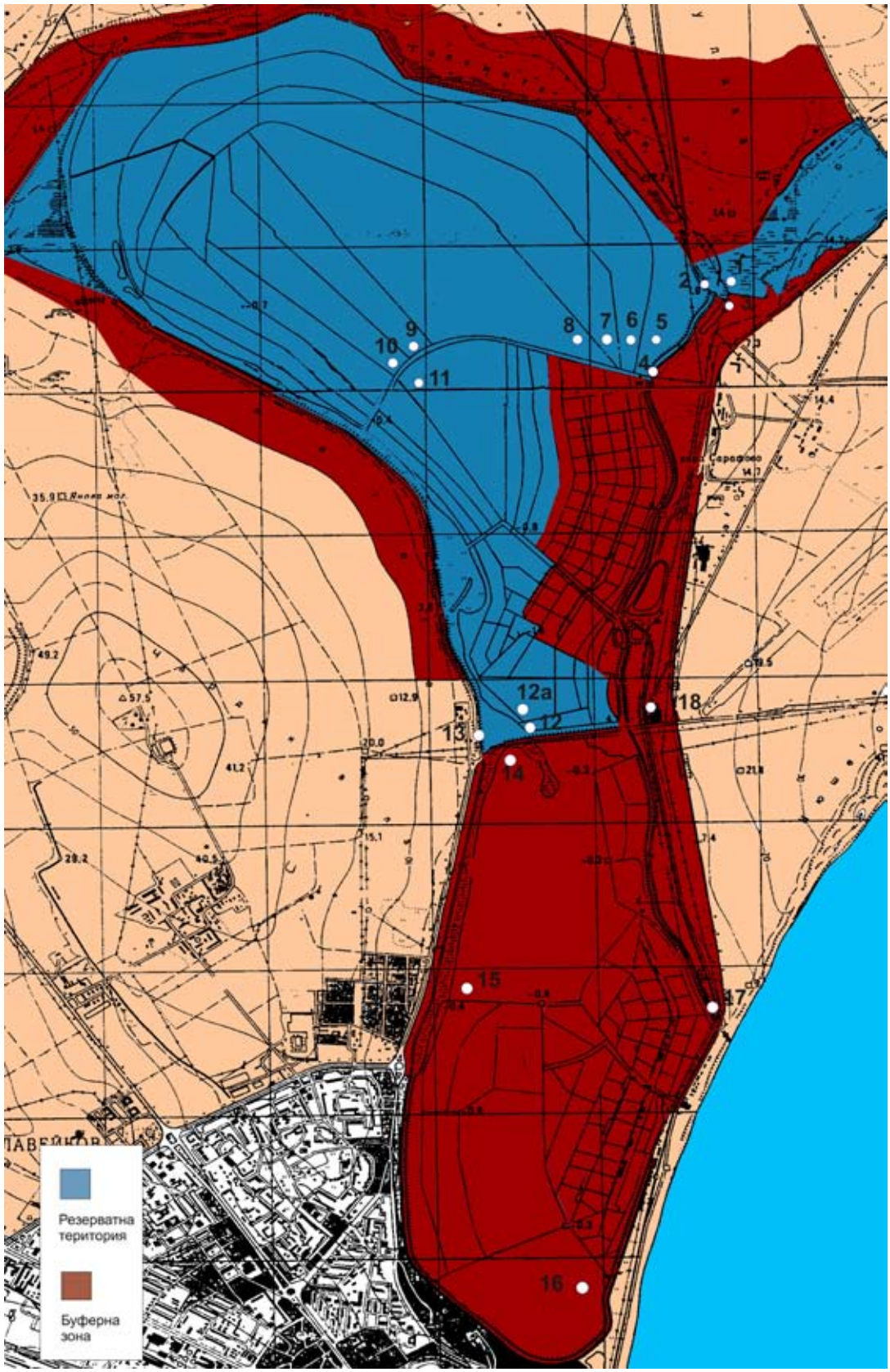

Fig. 1. Stations (localities) from which samples for exploration are taken, as in the previous management plan (Minchev, 2003): **1** – freshwater slowly flowing tributary and pollution; **2** – very slowly flowing freshwater tributary (roundabout canal); **3** – eutrophic marsh, collecting waters from 1 and 2; **4** – canal in the eastern part of the lake, freshwater or saltwater periodically (connection of the salt-producing basins with the sea); **5-11** – salt-producing basins; **13** – canal in the western part (mainly freshwater); **12**, **12a**, **14**, **15** and **16** – salt-producing basins with a varying degrees of salinity; **17** and **18** – points per canal 4

salt steppes and salt marshes (1530); **V** – Embryonic shifting dunes (2110).

Zoogeographical categories (the abbreviations in brackets refer to the freshwater and terrestrial species): **aamip** – Arctic-Atlantic-Mediterranean-Indo-Pacific, **ace** – Arctic-Circumeuropean, **aminp** – Atlantic-Mediterranean-Indo-North Pacific, **aminz** – Atlantic-Mediterranean-Indo-New Zealand, **amip** – Atlantic-Mediterranean-Indo-Pacific, **amiwp** – Atlantic-Mediterranean-Indo-West Pacific, **amnp** – Atlantic-Mediterranean-North Pacific, **amnz** – Atlantic-Mediterranean-New Zealand, **amswp** – Atlantic-Mediterranean-Southwest Pacific, **anam** – Arctic-North Atlantic-Mediterranean, **anamnep** – Arctic-North Atlantic-Mediterranean-Northeast Pacific, **anamnp** – Arctic-North Atlantic-Mediterranean-North Pacific, (**atm**) – Afrotropical-Mediterranean, **bam** – Boreal Atlantic-Mediterranean, **cbm** – Circumboreal-Mediterranean, **ce** – Circumeuropean, **clm** – Celtic-Lusitanian-Mediterranean, **clmm** – Celtic-Lusitanian-Mediterranean-Mauritanian, **cpc** – Celtic-Pontian-Caspian, (**cseeit**) – Central and Southeast European-Iran-Turanian, (**dp**) – Disjunct Palaearctic, (**e**) – European, **eam** – East Atlantic-Mediterranean, **eamp** – **eamrs** – East Atlantic-Mediterranean-Red Sea, (**ean**) – European-Anatolian, (**eca**) – European-Central Asian, **em** (**em**) – East Mediterranean, (**Ep**) – Pontian endemic, **ep** – Aegean-Pontian, (**ewca**) – European-West Central Asian, (**h**) – Holarctic, **ham** – Holatlantic-Mediterranean, (**hn**) – Holarctic-Neotropical, (**hna**) – Holarctic-Neotropical-Australian, (**hno**) – Holarctic-Neotropical-Oriental, (**ho**) – Holarctic-Oriental, (**hoa**) – Holarctic-Oriental-Australian, (**hoes**) – Holoeurosiberian, **hom** (**hom**) – Holomediterranean, (**hop**) – Holopalaearctic, **i** – introduced species (immigrants), **j** – Japanese, **K (k)** – Cosmopolitan, **lm** – Lusitanian-Mediterranean, **m** – Mediterranean, (**mca**) – Mediterranean-Central Asian, **miwp** – Mediterranean-Indo-West Pacific, **mrs** – Mediterranean-Red Sea, (**mwca**) – Mediterranean-West Central Asian, (**na**) – North American, **nam** – North Atlantic-Mediterranean, **namj** – North Atlantic-Mediterranean-Japonic, **namnz** – North Atlantic-Mediterranean-New Zealand, **namswp** – North Atlantic-Mediterranean-Southwest Pacific, **neamj** – Northeast Atlantic-Mediterranean-Japonic, (**nem**) – Northeast Mediterranean, (**nemit**) – Northeast Mediterranean-Iran-Turanian, **nm** (**nm**) – North Mediterranean, (**omca**) – Oriental-Mediterranean-Central Asian, (**omcaa**) – Oriental-Mediterranean-Central Asian-Australian, (**pat**) – Palearctic-Afrotropical, (**pm**) – Pontomediterranean (**po**) – Palearctic-Oriental, (**poa**) – Palearctic-Oriental-Australian, (**ptm**) – Paleotropical-Mediterranean, (**ptmca**) – Paleotropical-Mediterranean-Central Asian, (**ptsp**) – Paleotropical-South Palearctic, **SK (sk)** – Subcosmopolitan, (**sp**) – South Palaearctic, (**tp**) – Transpalaearctic, (**tpo**) – Transpalaearctic-Oriental, (**wces**) – West and Central Eurosiberian, (**wcp**) – West and Central Palaearctic, (**wcpo**) – West and Central Palaearctic-Oriental, (**wes**) – West Eurosiberian, (**wesa**) – West Eurosiberian-Anatolian, (**wp**) – West Palearctic, (**wpo**) – West Palaearctic-Oriental, (**wppt**) – West Palearctic-Paleotropical, **?** – probable category.

Ecological data: **α** – α-mesosaprobic, **α-β** – α-β-mesosaprobic, **β** – β-mesosaprobic, **B** – brackish, **bt** – benthos, **cr** – crenobiont, **DD** – data deficient, **eb** – eurybathic, **eh** – euryhaline, **EN** – endangered, **ep** – epibathic, **epp** – epipelagic, **et** – eurythermal, **eu** – eurybiont, **gw** – ground-water, **ha** – halophilous or halobiont, **is** – invasive species, **L** – freshwater, **l** – littoral zone, **LC** – least concern, **lt** – rocks or lithophilous, **M** – marine, **mb** – mesobathic, **mc** – *Mytilus* cenosis, **p** – plankton, **pe** – pelophilous, **ph** – algae overgrowth or phytophilous, **po** – potamophilous, **pp** – pelagic, **ps** – sand or psammophilous, **r** – rare, **ro** – rocky, **s** – silt, **sep** – stenoepibathic, **sg** – shells and sand with shells, **sl** – sublittoral zone (infra- and circalittoral, subtidal), **slc** – *Cystoseira* sublittoral, **sp** – supralittoral zone (supratidal), **sw** – stagnant water, **T** – terrestrial, **TL** – terrestrial forms connected with water, **tx** - trogloxene, **VU** – vulnerable, **zc** – *Zostera* cenosis, **‰** – limiting freshwater level for marine and salinity level for the freshwater forms, ▪ – Black Sea Red Data Book, ♦ – European and IUCN Red List, **+++** – species established for the first time, **‰** – limiting freshwater level for marine and salinity level for the freshwater forms.

Results and Discussion

A total of 6 types, 10 classes, 35 orders, 82 families and 157 species have been known from the Atanasovsko Lake and the surrounding basins (Table 1). These taxa include 56 species (35.7%) marine and marine-brackish forms and 101 species (64.3%) brackish-freshwater, freshwater and terrestrial forms, connected with water. A small number of supercosmopolitan forms (6-7 species), inhabitants of the freshwater, saline and brackish waters and wet terrestrial habitats are scrutinized to both two categories. For the first time 23 species (12 marine, 1 brackish and 10 freshwater) are established in this study. The types Rotifera, Annelida and Arthropoda

and the classes Eurotatoria, Crustacea and Insecta have a high species composition (over 20 species). These groups comprise the main part of the known taxa. It is supposed that about half of the known species of the protected area are established. There are significant gaps in knowledge of the terrestrial and parasitic groups. In the south part of the Atanasovsko Lake the species and quantitative composition of the communities are poor. Typical for the coastal lakes fauna is the presence of brackish elements. The marine brackish species endure water down to 1 ‰ salinity and the freshwater forms withstand water salinization from 1.5 ‰ to 8 ‰. Many euryhaline sea species also take part in the formation of the coastal basins's fauna, which could vary from marine to freshwater, depending on the water salinity (Valkanov, 1935, 1936; Drensky, 1947; Petrbok, 1947; Kaneva-Abadjieva, 1957, 1976; Zaschev & Angelov, 1959; Mihailova-Neikova, 1961; Kaneva-Abadjieva & Marinov, 1967; Stoykov, 1979, 1980; Маринов, 1990).

Formation of the coastal lakes fauna is connected with the origin of the Black Sea basin itself.[1] Before the last glaciation, a connection with the Caspian basin arose and Caspian interglacial immigrants invaded the Black Sea (Mordukhay-Boltovskoy, 1960; Nevesskaya, 1965; Starobogatov, 1970; Shopov, 1996). Most authors accept these species as Caspian relicts. They are concentrated mainly in the coastal lakes-firths and the mouths of the Black Sea rivers, inhabit the freshwater and brackish basins and usually have Pontian-Caspian or Pontian ranges. According to Mordukhay-Boltovskoy (1960) the evolution of the Caspian fauna gave rise to the origin of eurybiontic oligohaline and freshwater forms, which began to acquire new habitats with their pervasion in Black Sea. Recent data for the distribution of many relict taxa contradict their relict nature – especially their widespread distribution outside the Pontian-Caspian region. The lack of relict forms (leastways those which strongly considered relicts) in the Atanasovsko Lake is probably related to the specific hydrological regime, the technological processes of salt producing and its highly variable hyper lagoon character.

Of Pontian species (Black Sea endemics), *Chironomus valkanovi* is established – halophilous Black Sea species and Bulgarian subendemic, known from the Pomorie Lake and some hyper-saline lakes in Ukraine.

The marine and marine-brackish species have 4 types of ranges (Table 2) – Cosmopolitan, Atlantic-Indian, Atlantic-Pacific and Atlantic. The Atlantic (66.1%) [East- and Northeast Atlantic (23.2%), Holatlantic and North Atlantic (14.3%) and Tropical and Subtropical Atlantic (16.1%)] and Cosmopolitan (23.2%) [предимно Atlantic-Indian-Pacific (16.1%)] areas that comprise 80% of the species, prevail. The main portion of the fauna (over 60 %) has an Atlantic–Mediterranean origin and represents the impoverished Atlantic-Mediterranean fauna. As this fauna was becoming impoverished, many stenobiotic Lusitanian-Mediterranean species were eliminated, so this category is defined by the eurybiontic forms, often distributed along the European coast up to Scotland, North Sea and Scandinavia. Thus an impression is created of the atlantization of this fauna, manifested differently in the various taxonomic groups, benthic and planktonic forms. Usually the atlantization is poorly presented in the planktonic forms. The fauna is composed mainly of widely distributed eurybiontic taxa, some of them with cosmopolitan areas, inhabitants of saline, brackish and fresh waters.

The freshwater-brackish, freshwater and terrestrial forms, connected with water, recorded from the Atanasovsko Lake, are divided into 2 main groups (Table 3) – species, distributed in Palaearctic and beyond it and species distributed in Palaearctic only. The representatives of the first type (52.4%), which are determinant for the zoogeographical categorization of the coastal fauna due to the great

[1] The Upper Miocene Sarmatian Sea (18-30‰, a descendant of Tethys) 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 the Caspian one [Chaudian Sea (12-14‰) and Paleoeuxinian Sea (6-8‰)]. Then, it had been 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 had been severed, and the brackish basin [the New Euxinian Sea (7‰)] originated, where the Mediterranean fauna disappeared. Recently, 7000-8000 years ago, this basin had been again connected with the Mediterranean Sea and its level increased. The marine fauna invaded it and the current Black Sea had been formed (Mischev & Popov, 1978; Shopov, 1993; Dimitrov et al., 1998; Evlogiev, 2009; Studencka & Jasionowski, 2011). There is no unanimity about the zoogeographical status of the Black Sea, which is either considered as independent subregion or is unified with the Mediterranean Sea (and Lusitanean Atlantic subregion): Guryanova (1964), De Lattin (1967), Golikov & Starobogatov (1968, 1972), Starobogatov (1970), Mordukhay-Boltovskogo (1972), Golikov (1982), Nesis (1982), Riedl (1983), Bănărescu (1990), Abbott & Dance (1991), Elder & Pernetta (1991), Bruyne (2003), Hook (2008), Earle & Glover (2009).

Table 1. Faunistic diversity of the invertebrate animals (Metazoa: Invertebrata) of the Atanasovsko Lake and the surrounding basins

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
CNIDARIA					
Anthozoa: Hexacoralia					
Actiniaria					
Sagartiidae					
Actinothoe clavata (Ilmoni, 1830)	7, 17	I, II	clm	M, bt, ep, mc, sg, s	+++
PLATHELMINTHES					
Turbellaria					
Macrostomida					
Macrostomidae					
Macrostomum appendiculatum (O. Fabricius, 1826)	14, 15	I, II	clm	? B-L, 50‰, bt, eh	154, 156
ROTIFERA					
Eurotatoria					
Ploima					
Asplanchnidae					
Asplanchna priodonta Gosse, 1850	2, 3, 4, 7	I, II	? ace, (k)	L, 17.3‰, p, eu, sw	5, 85, 86, 91, 95, 129
Asplanchnopus hyalinus Harring, 1913	12	I, II	(ho)	L, p	+++
Brachionidae					
Brachionus angularis Gosse, 1851	1, 4, 6, 8, 9, 10	I, II	ham, (k)	L-B, 5‰, p, sw	5, 86, 91, 95, 124, 129, 154, 156
Brachionus calyciflorus Pallas, 1776	2, 3, 4, 9, 10	I, II	? ham, (k)	L, 5‰, p, sw	5, 72, 83, 86, 91, 95, 122, 129, 154, 156
Brachionus plicatilis Müller, 1786		I, II	ham, (k)	M-B, 6-20‰, eh, p	46, 47, 83, 94, 154, 156
Brachionus quadridentatus Hermann, 1783	2	I, II	ham, (k)	L, 3-16‰, l, p	5, 91, 95, 122, 124, 154, 156
Brachionus urceolaris Müller, 1773	2, 3, 4, 6, 9, 10	I, II	bam, (k)	L, 4.3-15‰, eh, p	5, 83, 91, 95, 129, 154, 156
Keratella cochlearis (Gosse, 1851)	2, 3, 4, 8, 9, 10	I, II	anamnp, (sk)	L-B, 10-16‰, eh, p, sw	5, 86, 91, 95, 122, 124, 129, 135, 136, 156
Keratella quadrata (Müller, 1786)	2	I, II	ace, (k)	L, 0.5-6‰, p, sw	5, 83, 91, 106, 122, 124, 154, 156
Keratella valga (Ehrenberg, 1834)	4, 11	I, II	lm, (k)	L-B, p, sw	5, 86, 91, 95, 122
Notholca acuminata (Ehrenberg, 1832)	2	I, II	neamj, (pat)	L-B, 0.1-18‰, p, sw	5, 91, 95, 109, 124, 154
Notholca labis Gosse, 1887	9	I, II	neamj, (dp)	L, 25-54‰, p, eh	5, 91, 109
Euchlanidae					
Euchlanis pyriformis Gosse, 1851	2		(e, ? sk)	L, p, sw	5, 91, 109
Synchaetidae					
Synchaeta oblonga Ehrenberg, 1831	2	I, II	bam, (k)	L, 1.8‰, p	5, 91, 109

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Synchaeta pectinata Ehrenberg, 1832	1, 2, 4, 5, 6, 7, 9	I, II	amnz, (sk)	M-B-L, eh, p	5, 91, 95, 124, 136
Synchaeta vorax Rousselet, 1902	1, 2, 4, 5, 6, 7, 8, 9, 10, 11	I, II	clm, (h)	M-B, 12‰, p	5, 154, 91, 105, 46, 83, 84, 128, 135, 160
Polyarthra dolichoptera Idelson, 1925	1, 2, 4, 6, 8, 9, 10	I, II	clm, (k)	L-B, 0.8‰, p, β	5, 154, 91, 95, 124, 129
Ploesoma hudsoni (Imhof, 1891)	8, 10	I, II	clm, (e)	B-L, 24-58‰, p, eh	5, 91, 109
Trichotriidae					
Trichotria pocillum (O. F. Müller 1776)	3	I, II	(h)	L, p	+++
Flosculariida					
Trichosphaeridae					
Filinia longiseta (Ehrenberg, 1834)	10	I, II	clm, (k)	L-B, 0.8-15‰, p, sw	5, 91, 106, 86, 122, 124
Hexarthridae					
Hexarthra mira (Hudson, 1841)	1, 2, 6, 7, 9, 10	I, II	namnz, (k)	M-B-L, p, eh	5, 91, 95, 124
Testudinellidae					
Testudinella patina (Hermann, 1783)	2, 3, 4, 10	I, II	amnz, (k)	M-L, 0.8‰, p-bt, l, s	5, 91, 124
ANNELIDA					
Polychaeta					
Phyllodocida					
Nereididae					
Hediste diversicolor (O. F. Müller, 1776)	(3), 5, 7, 8, 11, 12, 14, 15	I	anam	M, bt, eh-0.5-36‰, eb, s, pe-ps, eu	5, 28, 31, 38, 91, 102, 104, 154, 156, 158
Alitta succinea (Frey & Leuckart, 1847)	4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15	I	amip	M, bt, eh, ep, mc-s-ps	5, 31, 91, 102, 104, 154
Spioniida					
Spionidae					
Polydora limicola Annenkova, 1934	(1, 2)	I			158
Sabellida					
Serpulidae					
Ficopomatus enigmaticus (Fauvel, 1923)	5, 7, 9, 10, 12, 14, 15	I, II	amip, i	M, bt, 0-55‰, ep, is	5, 91, 102, 104, 105, 156
Oligochaeta					
Opistophora					
Criodrilidae					
Criodrilus lacuum Hoffmeister, 1845		I	(eca, ? h)	L, bt	148
Lumbricidae					
Eiseniella tetraedra (Savigny, 1876)	3	I	(h, ? k)	L-TL, bt, tx	5, 91, 148

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Tubificida					
Naididae					
Stylaria lacustris (Linnaeus, 1767)	(4)	I	nam, (hno)	M, bt, 7‰, ps, gw	14, 31, 35, 105, 148, 158
Dero digitata (O. F. Müller, 1773)	(4)	I	(k)	L, bt	148, 158
Aulophorus furcatus (Oken, 1815)	(4)	I			
Nais barbata O. F. Müller, 1773		I	(hoa)	L, bt,	148
Nais elinguis O. F. Müller, 1774		I	aminz, (k)	M-B-L, bt, 18‰, eh, eu, sw-po	31, 34, 35, 105, 148, 154, 156
Nais pseudobtusa Piguet, 1906	(4)	I			158
Tubificidae					
Tubifex tubifex (O. F. Müller, 1774)	1, 3, 4, (4)	I	(k)	M-B-L, bt, eu	5, 91, 148, 158
Limnodrilus hoffmeisteri Claparède, 1862	(4)	I	SK, (k)	M-L, bt, sw, po, α, s	31, 105, 148, 156, 158
Potamothrix hammoniensis (Michaelsen, 1901)	(4)	I	clm, (ho)	M-L, bt, sw, po, pe	92, 148, 158
Hirudinea					
Rhynchobdellida					
Glossiphoniidae					
Helobdella stagnalis (Linnaeus, 1758)	3	I	(h)	L, bt, ph, 1‰	+++
Arhynchobdellida					
Erpobdellidae					
Erpobdella octoculata (Linnaeus, 1758)	4	I	(po)	L, bt, ph, lt, 5-7‰	5, 91, 109
ARTHROPODA					
Crustacea					
Sarsostraca: Anostraca					
Artemiidae					
? *Artemia parthenogenetica* Bowen & Sterling, 1978 [**?** = *Artemia urmiana* Günther, 1899]	6, 7, 8, 9, 10, 11, 12, 12a, 14, 17	I, II	(omcaa, ? mwca)	B, 20-100-340‰, p	55, 147
Artemia salina (Linnaeus, 1758)	6, 7, 8, 9, 10, 11, 12, 12a, 14, 17	I, II	(sp, ? sk)	B, 20-80-340‰, p	3, 5, 33, 38, 43, 55, 150, 156
Phyllopoda: Cladocera					
Sididae					
Penilia avirostris Dana, 1849	1, 4, 5, 6, 7, 8, 9, 11	I	amiwp	M-B-L, p, eh, epp	5, 87, 89, 91, 136, 156
Bosminidae					

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Bosmina longirostris (O. F. Müller, 1776)	4, 5, 6, 9, 10	I	anam, (k)	M-B-L, 1-2‰, p, epp	5, 156, 91, 122, 123, 124
Chydoridae (Eurycercidae)					
Alona rectangula Sars, 1861	2, 4	I	(sk)	B-L, 0.5-6‰, p	5, 91, 121, 123, 124, 154, 156
Chydorus sphaericus (O. F. Müller 1776)	1, 2	I	amswp, (k)	M-B-L, 3‰, p, epp	+++
Daphniidae					
Daphnia pulex (Leydig, 1860)	2, 4, 5	I	(k)	B-L, p, 5-17‰	5, 91, 109, 123, 154, 156
Simocephalus vetulus (O. F. Müller, 1776)	2, 4, 5, 10	I	(sk)	B-L, p, 0.5-2‰	5, 91, 41, 122, 123, 124
Podonidae					
Pleopis polyphaemoides (Leucart, 1859)	1, 4, 5, 6, 7, 8, 9, 10, 11	I, II	amnp	M-B, p, eh	5, 87, 88, 91, 132, 135
Ostracoda: Podocopida					
Cyprididae					
Eucypris inflata (G. O. Sars, 1903)			(mwca)	L-B, bt, eh-150‰	81, 105, 156
Cyprinotus salinus (Brady, 1868)		I	(ean)	M-B-L, bt, 0-20‰	81, 105, 154, 156
Cytherideidae					
Cyprideis torosa (Jones, 1850) [*C. littoralis*]		I	clm, (hat)	M-B-L, bt, ep, 0-30‰, eh, ps, pe, ph	31, 105, 154, 156
Loxoconchidae					
Loxoconcha pontica Klie, 1937		I	clm	M, bt, sep, ph	31, 81, 105, 156
Copepoda: Calanoida					
Paracalanidae					
Paracalanus parvus (Claus, 1863)	5, 6, 7, 8, 11	I	K	M, p, pp, et	5, 38, 88, 91, 132, 156
Temoridae					
Eurytemora velox (Lilljeborg, 1853)	5, 6, 7	I	cpc, (tp)	M-B, p, eh, 0-10‰	5, 154, 156, 91, 124, 130
Centropagidae					
? *Centropages kroyeri* Giesbrecht, 1893	?		amip	M, p	5, 38, 91, 132, 136, 154
Centropages ponticus Karavaev, 1895	1, 5, 6, 7	I	mrs	M, p, ■-EN	50, 79, 87
Diaptomidae					
Arctodiaptomus salinus (Daday, 1885)		I	(po)	L, p, 10‰	37, 38, 123, 156
Pseudodiaptomidae					
Calanipeda aquaedulcis Kritchagin, 1873	1, 4, 5, 6	I	lm, (hom)	B-L, p, eh, et	5, 87, 91, 88, 123, 124, 135, 136, 154, 156
Acartiidae					

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Acartia clausi Giesbrecht, 1889	1, 5, 6, 7, 8, 9, 10, 11	I, II	K, aamip	M, p, 10‰, et	5, 38, 87, 88, 91, 132, 135, 136, 154, 156
Copepoda: Cyclopoida					
Cyclopidae					
Halicyclops rotundipes Kiefer, 1935?		I, II	(nem)	B, p, 0-10‰	123, 154, 156
Macrocyclops albidus (Jurine, 1820)	1	I	(k)	L, p, 0.5-0.8‰	+++
Eucyclops serrulatus (Fischer, 1851)	2, 4	I, II	(sk, ? k)	L, p, 0.5-8‰	5, 91, 106, 121, 122, 124, 154, 156
Acanthocyclops robustus (G. O. Sars, 1863)	2, 3, 4	I, II	(hna, ? sk), i	L, p, is	5, 91, 106, 121, 122, 124
Copepoda: Harpacticoida					
Ameiridae					
Nitokra lacustris (Shmankevich, 1875)		I, II	SK, (pat)	L-B, eh-0-60‰, bt, ps, gw, pe, cr, ph, et	7, 8, 9, 17, 103, 105, 106, 114
Cletodidae					
Cletocamptus retrogressus Schmankevitsch, 1875		I, II	nam, (h)	M-B, 60‰, eu, ps, s	10, , 81, 105, 156
Cirripedia: Thoracica: Balanomorpha					
Balanidae					
Amphibalanus eburneus (Gould, 1841)	5, 6, 7, 9, 10, 17	I	amip, i	M-B, bt-p, 7‰, is, sl	+++
Malacostraca: Amphipoda					
Corophiidae					
Corophium volutator (Pallas, 1766)	4, 7, 8, 9, 10, 11, 12, 14, 15	I	namswp	M, bt, 0.5‰, ep, pe	5, 91, 105, 146, 150, 154
Gammaridae					
Gammarus aequicauda (Martynov, 1931)	5, 6, 7, 8, 9, 11, 12, 14, 15, 17	I	lm	M, eh, bt, ep, ps	27, 95, 150
Gammarus subtypicus Stock, 1966	4, (1), (2,) (3), (4), 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 17	I, II	m, ep, ? em	M, bt, eh-1-50‰, ep, mc, ro, l-sl	5, 31, 33, 38, 91, 105, 131, 150, 154, 156, 158
Talitridae					
Orchestia bottae Milne Edwards, 1840	2, 3	I	clm, ep	M-B-TL, bt, l-sp, eh	+++
Malacostraca: Isopoda					
Asellidae					
Asellus aquaticus (Linnaeus, 1758)	1, 2, 3, (4), 12	I	(h)	L-B, bt, 5‰	5, 91, 154, 156, 158
Idoteidae					
Idotea balthica (Pallas, 1772)	(3), 6, 7, 8, 9, 10, 11, 12, 14, 15, 17, 18	I, II	ham, ? SK	M, bt, ep, ph, l-sl	5, 31, 38, 91, 105, 150, 154, 156, 158
Sphaeromatidae					

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Sphaeroma serratum (Fabricius, 1787)	5, 6, 7, 8, 9, 10, 11, 12, 14, 17, 17	I, II	amiswp	M, bt, ep, l-sl, ps, slc, mc, ro, ph	5, 38, 39, 91, 105, 150, 154, 156
Malacostraca: Decapoda					
Palaemonidae					
Palaemon elegans Rathke, 1837	6, 8, 9, 17	I	eam	M-B, bt, eh, 4-5‰, ep, ph, mc, eu	30, 105, 150, 151,156
Palaemon serratus (Pennant, 1777)	17	I	eamrs	M, bt, ep, r	13, 38, 97, 105
Crangonidae					
Crangon crangon (Linnaeus, 1758)	4, 6, 8, 9	I	ce, ? namj	M, bt (p), eh, eb, ps, s	5, 12, 30, 91, 105, 151
Grapsidae (Varunidae)					
Brachynotus sexdentatus (Risso, 1827)	17	I	hom, lm, clm	M, bt, mb, ps-pe, s, ph	+++
Insecta					
Ephemeroptera					
Baetidae					
Cloeon dipterum (Linnaeus, 1761)	1, 2, 3, 4, (4)	I	(h)	L-TL, bt, ph	5, 91, 101, 109, 158
Caenidae					
Caenis horaria (Linnaeus, 1758)	1, 2, 3, 4	I	(tp)	L-TL, bt, ph	5, 91, 101, 109
Caenis luctuosa (Burmeister, 1839)	2, 4	I	(wcp, ? hoes)	L-TL, bt, ph	5, 91, 109, 101
Caenis robusta Eaton, 1884	1, 2, 3, (4), 12	I	(tp)	L-TL, bt, ph	101, 109,158
Odonata					
Lestidae					
Lestes barbarus (Fabricius, 1798)		I, II, III, IV	(wpo)	L-TL, 13‰	5, 109, 99, 100, 101
Lestes parvidens (Artobolevski, 1929)		I, III, IV	(nemit)	L-TL	99, 100
Lestes virens (Charpentier, 1825)		I, III, IV	(wp)	L-TL	5, 109, 99, 100
Lestes viridis (Vander Linden, 1825)		I, III, IV	(hom)	L-TL, r, ♦-LC	5 109, 100
Platycnemididae					
Platycnemis pennipes (Pallas, 1771)	1, 2, 3, 4	I, III, IV	(wces)	L-TL	+++
Coenagrionidae					
Coenagrion pulchellum (Vander Linden, 1820)		I, III, IV	(wes)	L-TL	5, 24, 98, 99, 100, 101
Enallagma cyathigerum (Charpentier, 1840)		I, III, IV	(h)	L-TL	5, 99, 100, 101
Ischnura elegans (Vander Linden, 1820)	(4)	I, III, IV	(po)	L-TL	5, 158, 55, 109, 98, 99, 100, 101, 110
Ischnura pumilio (Charpentier, 1825)		I, III, IV	(wcp, wcpo)	L-TL	5, 109, 98, 99, 100, 101
Aeshnidae					

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Anax imperator Leach, 1815		I, III, IV	(wppt)	L-TL, ■-NE-DD-VU, ♦-LC	5, 50, 98, 99, 100, 101, 109
Anax parthenope (Selys, 1839)		I, III, IV	(ptsp)	L-TL, r	5, 99, 100, 101, 109
Hemianax ephippiger (Burmeister, 1839)		I, III, IV	(ptm)	L-TL, r	5, 24, 109, 99, 101
Aeshna isoceles (Müller, 1767)		I, III, IV	(hom, ? wp)	L-TL	5, 55, 99, 110, 109
Aeshna mixta Latreille, 1805		I, III, IV	(tpo)	L-TL	5, 98, 100, 101, 110
Libellulidae					
Libellula fulva Müller, 1764		I, III, IV	(wesa)	L-TL, r	5, 99, 100, 101, 109
Orthetrum albistylum (Sélys, 1848)		I, III, IV	(tp)	L-TL	5, 98, 99, 100, 101
Orthetrum cancellatum (Linnaeus, 1758)		I, II, III, IV	(wp)	L-TL, 13‰	5, 24, 98, 99, 100, 101
Crocothemis erythraea (Brullé, 1832)		I, III, IV	(ptmca)	L-TL	5, 100, 101, 102, 110
Sympetrum fonscolombii (Sélys, 1840)		I, III, IV	(ptm, ptsp)	L-TL	5, 99, 100, 101
Sympetrum meridionale (Sélys, 1841)		I, III, IV	(mca, omca)	L-TL	5, 24, 55, 98, 99, 100, 101, 110
Sympetrum pedemontanum (Allioni, 1766)		I, III, IV	(tp, ? dp)	L-TL	99, 100
Sympetrum sanguineum (Müller, 1764)		I, III, IV	(wp)	L-TL	99, 100
Sympetrum striolatum (Charpentier, 1840)		I, III, IV	(tp)	L-TL, eh	5, 55, 98, 99, 100, 101, 110
Sympetrum vulgatum (Linnaeus, 1758)		I, III, IV	(ewca)	L-TL, ♦-LC	99, 100, 101
HETEROPTERA					
Corixidae					
Corixa panzeri Fieber 1848	1, 4	I, II, IV	(hom)	L-TL, sp, eu	+++
Hesperocorixa linnaei (Fieber 1848)	1	I, II, IV	(dp)	L-TL, sp, eu	+++
Sigara mayri (Fieber, 1860)	1, 3, 4, 5	I, II, IV	(em)	L-TL, sp, ha-34‰	+++
Sigara striata (Linnaeus, 1758)	1	I, II, IV	(tp, ? hop)	L-TL, sp, hs-3.4‰	+++
Notonectidae					
Notonecta glauca Linnaeus, 1758	1, 3, 4	I, II, IV	(hes, ? hop)	L-TL, sp, eu	5, 91, 93, 109
Naucoridae					
Ilyocoris cimicoides (Linnaeus, 1758)	1, 3, (4)		(tp)	L-TL, sp, eu	101, 158
Miridae					
Phytocoris insignis Reuter, 1876		II, IV	(e)	T, sp, ha	71, 106
Lygus italicus Wagner, 1950		II, IV	(atm)	T, sp, ha	71, 106
Compsidolon pumilum (Jakovlev, 1876)		II, IV	(hom)	T, sp, ha	71, 106
Saldidae					
Chartoscirta longicornis (Jakovlev, 1882)		II, IV	(pm)	T, sp, ha	71, 106

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Lygaeidae					
Peritrechus meridionalis Puton, 1877		II, IV	(hom)	T, sp, ha	71
Coleoptera					
Dytiscidae					
Hygrotus lernaeus (Schaum, 1857)		I	(hom)	L-TL, ha, sw	62, 80, 156
Hydrophilidae					
Enochrus bicolor (Fabricius, 1792)		I	(hop, ? h)	L-TL, sw, eu	32, 80
Hydraenidae					
Ochthebius marinus (Paykull, 1798)		I	(h)	L-TL, ha, sw, eu, sp	32, 63, 80, 156
Trichoptera					
Hydroptilidae					
Agraylea multipunctata Curtis 1834	(4)	I			158
Diptera					
Chironomidae					
Chironomus aprilinus Meigen, 1818	(1), (2,) (3), (4), 5, 7, 8, 9, 10, 11, 12a, 14, 15, 17	I	(wcp)	M-B-TL, 12‰, l-sp	31, 55, 105, 156, 158
Chironomus plumosus (Linnaeus, 1758)	(4)	I	(hno)	L-TL, 0-9‰, sw, sp	31, 41, 55, 105, 145, 154, 156, 158, 159
Chironomus riparius Meigen, 1804	2, 3, 5, 13, 11, 17, 18	I	(hn)	L-TL, 0-16‰, sw, sp	5, 32, 40, 91, 141, 145, 154, 156, 159
Chironomus salinarius Kieffer, 1915	(3), (4), 5, 6, 7, 8, 9, 10, 11, 12, 12a, 14, 15, 16	I	(wcp)	M-TL, 15-60‰, sw, sp	5, 31, 40, 55, 91, 110, 111, 145, 154, 158, 159
Chironomus valkanovi Michailova, 1974		I	(Ep)	M-TL, 60‰, sw	106, 111, 112, 160
Cryptochironomus defectus (Kieffer, 1913)	(4)	I	(pa)	L-TL, 2‰, sw	40, 141, 156, 158
Glyptotendipes cauliginellus (Kieffer, 1913)	(1, 3)	I	(po)	L-TL, 2‰, sw	40, 55, 141, 159
Polypedilum nubifer (Skuse, 1889)	2, 3	I	(poa)	L-TL, 1.5‰, l, ph	5, 41, 91, 105, 156
Ephydridae					
Ephydra attica Becker, 1896	5, 6, 8, 9, 10, 11, 12a	II, III, IV	(dp, ? mca)	TL, 60‰, sl-l-sp	17, 26, 32, 105
Ephydra bivittata Loew, 1860		II, III, IV	(hom)	TL, l-sp, ha, r	18, 26, 105
Ephydra flavipes (Macquart, 1843)		II, III, IV	(ptm, ? atm)	TL, l-sp, ha	26
Ephydra murina Wirth, 1975	5, 6, 8, 9, 10, 11, 12a	II, III, IV	(cseeit)	TL, 60‰, sl-l-sp	26, 32, 156
Ephydra riparia Fallén, 1813	5, 6, 8, 9, 10, 11, 12a	II, III, IV	(h)	TL, 60-80‰, l	17, 26, 106
Schema acrosticale (Becker, 1903)		II, III, IV	(wp)	TL, ha	26
Glenanthe nigripes Czerny, 1909		II, III, IV	(nm)	TL, ha, r	26, 16, 19, 20, 21, 22, 23, 25, 27
MOLLUSCA					

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Gastropoda					
Sorbeoconcha					
Cerithiidae					
Bittium reticulatum (da Costa, 1778)	5, 17	I	clmm	M, bt, eb, ps, ps-s, pe	+++
Hypsogastropoda					
Hydrobiidae					
Ecrobia ventrosa (Montagu, 1803)	1, 5, 6, 7, 8, 9, 10, 11, 12, 12a, 16, 17, (1), (2), (3), (4)	I	clm	B, bt, eh-60‰, ep-mb, sw, ro, ph, pe, zc	5, 31, 56, 76, 91, 105, 133, 154, 156, 158
Rissoidae					
Rissoa splendida Eichwald, 1830	5, 17	I	m, hom	M, bt, sep, zc, ph, ro	+++
Muricidae					
Rapana venosa (Valenciennes, 1846)	(3), ? 14	I	j, aminp, i	M, bt, mb-eb, eu, is	75, 105, 157
Nassariidae					
Cyclope neritea (Linnaeus, 1758)	(3)	I	lm	M, bt, mb, ps-pe	158
Basommatophora					
Acroloxidae					
Acroloxus lacustris (Linnaeus, 1758)	3	I	(wes, ? hoes)	L, bt, ph, sw, ♦-LC	+++
Planorbidae					
Planorbis carinatus O. F. Müller, 1774	1	I	(wes, ? h)	L, bt, sw, ph, pe, r, ♦-LC	5, 91, 108, 109
Planorbis planorbis (Linnaeus, 1758)	1, 2, (4), 12	I	(h)	L, bt, 2‰, sw, ph, pe, ♦-LC	5, 6, 31, 91, 109, 156, 158
Planorbarius corneus (Linnaeus, 1758)	1	I	(wces)	L, 5‰, sw, po, α-β, ♦-LC	5, 6, 91, 133, 156
Physidae					
Physella acuta (Draparnaud, 1805)	1, 2, 3, 4	I, II	(na, sk, i)	L, bt, eu, pe, ph, po, sw, tx, α-β, is, ♦-LC	5, 6, 56, 91, 108, 110
Bivalvia					
Arcoida					
Arcidae					
Anadara kagoshimensis (Tokunaga, 1906)	6, 14	I, II	miwp, i	M, bt, ep, ps, s, sg, is	+++
Mytiloida					
Mytilidae					
Mytilus galloprovincialis Lamarck, 1819	17	I, II	eamp	M, bt, eb, lt, s, s-ps	+++
Mytilaster lineatus (Gmelin, 1791)	5, 6, 17	I, II	lm	M, bt, 5‰, sep, lt-slc	+++
Ostreoida					

Table 1. Continued

Taxa	Localities (stations)	Habitats	Distribution	Ecological data	References
Pectinidae					
Flexopecten glaber (Linnaeus, 1758)	17	I, II	lm	M, bt, sep, ps, ps-s	‡‡‡
Ostreidae					
Ostrea edulis Linnaeus, 1758	17	I, II	anamnep, i	M, bt, sep, ro, ■-EN, VU	‡‡‡
Veneroida					
Cardiidae					
Cerastoderma glaucum (Poiret, 1789)	(1), (2,) (3), 5, 6, 7, 8, 9, 10, 11, 12, 12a, 16	I, II	clm	M, bt, eh-3.9‰, eb, ps, ps-s, pe	5, 31, 38, 91, 105, 131, 154, 156, 158
Tellinidae					
Tellina tenuis da Costa, 1778		I, II	clm	M, bt, sep, ps, ps-s	31, 38, 105, 156
Semelidae					
Abra segmentum (Récluz, 1843)	(3), 7, 8, 9, 10, 11, 12, 12a, 15, 16	I, II	lm	M, bt, eh-6-60‰, ep, et, pe, ps-s	5, 31, 58, 91, 105, 154, 156, 158
Myoida					
Myidae					
Mya arenaria Linnaeus, 1758	5, 17	I. II	cbm, i	M, bt, ep, ps, ps-s, is	‡‡‡

species diversity, prevail. They are connected with the typical for the sea coasts natural habitats, optimum for the development of their representatives and are poorly presented in the interior. The Cosmopolitan (18.1%), Subcosmopolitan (8.6%) and Holarctic (7.6%) species are the most numerous. The second type (44.8%) combine Palaearctic (20.0%), Eurosiberian (9.5%) and Mediterranean (15.2%) taxa. The Transpalaearctic (6.7%) and Holomediterranean (7.6%) forms are the most numerous. The Mediterranean group is better presented in terrestrial forms and poorly presented in freshwater species. Endemic species have not been found. The specific conditions along the coast do not favor the formation of endemic taxa which often are newly described forms or rare species with unclear distribution.

Of the benthic forms, *Cerastoderma glaucum* [density of 3234 ind/m^2 (maximum – 134376 ind/m^2) and biomass of 338.7 g/m^2 (Cvetkov, 1958)], *Ecrobia ventrosa* [from 6924-10000 ind/m^2 (Gecheva et al., 2013) to 19800 ind/m^2 (Cvetkov, 1958)], *Abra segmentum* and *Cyprideis torosa* [77440 ind/m^2 and biomass 13.9 g/m^2 (Cvetkov, 1958)] are permanent dominants. Along the coast of most basins the shells of *Cerastoderma glaucum* (Celtic-Lusitanian-Mediterranean species) form large aggregations (Fig. 2, 3). There is a lack of the Mediterranean species *Gammarus subtypicus* [698-1863 ind/m^2 (Gecheva et al, 2013)] and *G. aequicauda* [1600 ind/m^2 (Andreev, 1997, 2003; Kovachev, 1993)] in the basins with salinity over 90‰. The species *Corophium volutator* (Atlantic-Pacific) is a mass species in all seasons (lacking in the basins with high salinity) and is one of the most adapted inhabitants of the saltpans. The marine isopods *Idotea balthica* (Atlantic-Mediterranean) and *Sphaeroma serratum* (Atlantic-Indian-Pacific) are persistent species but with limited amounts. High numbers reaches the cosmopolitan *Acartia clausi* [130000 ind/m^3 (Vassilev, 1994)].

The shrimps found in the Atanasovsko Lake – *Crangon crangon* (established in station 4), *Palaemon elegans* and the rare species *Palaemon serratus* (collected in station 17) are not accepted as permanent inhabitants. They are related to the coastal marine communities, rich in macrophytes and probably have entered the lake with the invading marine waters. Shells of several marine molluscs species (*Bittium reticulatum*, *Rissoa splendida*, *Mytilaster lineatus*, *Mytilus galloprovincialis*, *Flexopecten glaber*, *Ostrea edulis* and *Mya arenaria*) are often found in the canal (station 17) through which the water enters from the

Table 2. Zoogeographical characteristic of the marine and marine-brackish fauna of the Atanasovsko Lake

Zoogeographical scheme of the used categories and main taxa	Total	Benthos	Plankton	Marine	Brackish
COSMOPOLITAN TYPE	**13 (23.2)**	**8 (19.5)**	**4 (17.4)**	**11 (22.4)**	**3 (15.8)**
Arctic-Antarctic-Atlantic-Indian-Pacific	**4 (7.1)**	**2 (4.9)**	**2 (8.7)**	**4 (8.2)**	**1 (5.3)**
Cosmopolitan	3	2	1	3	1
Arctic-Atlantic-Mediterranean-Indo-Pacific	1		1	1	
Atlantic-Indian-Pacific	**9 (16.1)**	**7 (17.1)**	**2 (8.7)**	**8 (16.3)**	**2 (10.5)**
Hol- and East Atlantic-Indian-Pacific	**8 (14.3)**	**6 (14.6)**	**2 (8.7)**	**8 (16.3)**	**2 (10.5)**
Atlantic-Mediterranean-Indo-Pacific	4	3	1	4	
Atlantic-Mediterranean-Indo-West Pacific	1		1	1	1
Atlantic-Mediterranean-Indo-Southwest Pacific	1	1		1	
Atlantic-Mediterranean-Indo-New Zealand	1	1		1	1
Atlantic-Mediterranean-Indo-North Pacific	1	1		1	
Tropical and Subtropical Atlantic-Indian-Pacific	**1 (1.8)**	**1 (2.4)**			
Mediterranean-Indo-West Pacific	1	1		1	
ATLANTIC-INDIAN TYPE	**2 (3.6)**	**1 (2.4)**	**1 (4.3)**	**2 (4.1)**	
Atlantic-Indian	**2 (3.6)**	**1 (2.4)**	**1 (4.3)**	**2 (4.1)**	
Tropical and Subtropical Atlantic-Indian	**1 (1.8)**		**1 (4.3)**	**1 (2.0)**	
Mediterranean-Red Sea	1		1	1	
East and Northeast Atlantic-Indian	**1 (1.8)**	**1 (2.4)**		**1 (2.0)**	
East Atlantic-Mediterranean-Red Sea	1	1		1	
ATLANTIC-PACIFIC TYPE	**11 (19.6)**	**5 (12.2)**	**7 (30.4)**	**8 (16.3)**	**6 (31.6)**
Arctic-Antarctic-Atlantic-Pacific	**2 (3.6)**	**1 (2.4)**	**1 (4.3)**	**1 (2.0)**	**1 (5.3)**
Arctic-North Atlantic-Mediterranean-North Pacific	1		1		1
Arctic-North Atlantic-Mediterranean-Northeast Pacific	1	1		1	
Atlantic-Pacific	**9 (16.1)**	**4 (9.7)**	**6 (26.1)**	**7 (12.3)**	**5 (26.3)**
Hol- and North Atlantic-Pacific	**1 (1.8)**		**1 (4.3)**		**1 (5.3)**
Atlantic-Mediterranean-North Pacific	1		1		1
North Atlantic-Pacific	**2 (3.6)**	**1 (2.4)**	**1 (4.3)**	**1 (2.0)**	**1 (5.3)**
Northeast Atlantic-Mediterranean-Japonic	1		1		1
Circumboreal-Mediterranean	1	1		1	
North and South Atlantic-Pacific	**2 (3.6)**	**1 (2.4)**	**1 (4.3)**	**2 (4.1)**	**1 (5.3)**
North Atlantic-Mediterranean-Southwest Pacific	1	1		1	
North Atlantic-Mediterranean-New Zealand	1		1	1	1
Hol- and South Atlantic-Pacific	**3 (5.4)**	**1 (2.4)**	**3 (13.0)**	**3 (6.1)**	**2 (10.5)**
Atlantic-Mediterranean-New Zealand	2	1	2	2	1
Atlantic-Mediterranean-Southwest Pacific	1		1	1	1
East and West Atlantic-Pacific	**1 (1.8)**	**1 (2.4)**		**1 (2.3)**	
East Atlantic-Mediterranean-Pacific	1	1		1	
ATLANTIC TYPE	**37 (66.1)**	**26 (63.4)**	**11 (47.8)**	**27 (55.1)**	**10 (52.6)**
Arctic-Antarctic-Atlantic	**4 (7.1)**	**2 (4.9)**	**2 (8.7)**	**3 (6.1)**	**1 (5.3)**
Arctic-North Atlantic-Mediterranean	2	1	1	2	1
Arctic-Circumeuropean	1		1		
Circumeuropean	1	1		1	
Atlantic	**33 (58.9)**	**24 (58.5)**	**9 (39.1)**	**24 (48.9)**	**9 (47.4)**
Hol- and North Atlantic	**8 (14.3)**	**3 (7.3)**	**5 (21.7)**	**3 (6.1)**	**1 (5.3)**
Holatlantic-Mediterranean	5	1	4	1	
North Atlantic-Mediterranean	2	2		2	1
Boreal Atlantic-Mediterranean	1		1		
Tropical and Subtropical Atlantic	**9 (16.1)**	**7 (17.1)**	**2 (8.7)**	**7 (14.3)**	**3 (15.8)**
Lusitanian-Mediterranean	9	7	2	7	3
East and Northeast Atlantic	**13 (23.2)**	**11 (26.8)**	**2 (8.7)**	**11 (22.4)**	**5 (26.3)**
East Atlantic-Mediterranean	1	1		1	1
Celtic-Lusitanian-Mediterranean-Mauritanian	1	1		1	
Celtic-Lusitanian-Mediterranean	10	9	1	8	3
Celtic-Pontian-Caspian	1		1	1	1
Mediterranean-Pontian-Caspian	**3 (5.4)**	**3 (7.3)**		**3 (6.1)**	
Mediterranean	2	2		2	
Pontian	1	1		1	
Total	**56 (35.7)**	**41 (26.1)**	**23 (15.1)**	**49 (31.2)**	**19 (12.1)**

Table 3. Zoogeographical characteristic of the freshwater-brackish, freshwater and terrestrial fauna

Zoogeographical scheme of the used categories and main taxa	Total	Brackish	Freshwater	Terrestrial
Species distributed in Palaearctic and out of it	**55 (52.4)**	**16 (72.7)**	**49 (53.8)**	**18 (35.3)**
Northern type	**49 (46.7)**	**15 (68.2)**	**45 (49.5)**	**13 (25.5)**
Cosmopolitan	19	8	17	
Subcosmopolitan	9	6	8	
Holarctic-Neotropical-Oriental	1		1	1
Holarctic-Oriental-Australian	1		1	
Holarctic-Neotropical	1		1	1
Holarctic-Oriental	1		1	
Palearctic-Oriental-Australian	1		1	1
Palearctic-Afrotropical	1		1	1
Palearctic-Oriental	4		4	2
West Palearctic-Paleotropical	1		1	1
Transpalaearctic-Oriental	1		1	1
West Palearctic-Oriental	1		1	1
Holarctic	8	1	7	4
South type	**6 (5.7)**	**1 (4.5)**	**4 (4.4)**	**5 (9.8)**
Paleotropical-South Palearctic	1		1	1
Paleotropical-Mediterranean-Central Asian	1		1	1
Paleotropical-Mediterranean	3		2	3
Oriental-Mediterranean-Central Asian-Australian	1	1		
Species with Palaearctic distribution	**47(44.8)**	**5 (22.7)**	**41 (45.1)**	**33 (64.7)**
Palaearctic type	**21 (20.0)**		**19 (20.9)**	**17 (33.3)**
Holopalaearctic	1		1	1
Transpalaearctic	7		7	6
West and Central Palaearctic	4		4	4
West Palaearctic	4		3	4
Disjunct Palaearctic	3		2	1
European-Central Asian	1		1	
European-West Central Asian	1		1	1
Eurosiberian type	**10 (9.5)**	**1 (4.5)**	**11 (12.1)**	**4 (7.8)**
Holoeurosiberian	1		1	1
West and Central Eurosiberian	2		2	
West Eurosiberian-Anatolian	1		1	1
West Eurosiberian	3		3	1
European-Anatolian	1	1	1	
European	3	1	3	1
Mediterranean type	**16 (15.2)**	**4 (18.2)**	**11 (12.1)**	**12 (23.5)**
Mediterranean-Central Asian	1		1	1
Mediterranean-West Central Asian	1	1		
Northeast Mediterranean-Iran-Turanian	1		1	1
Central and Southeast European-Iran-Turanian	1			1
Holomediterranean	8	2	7	6
Atlantomediterranean	1		1	1
North Mediterranean	1			1
East Mediterranean	1		1	
Northeast Mediterranean	1	1		
Pontomediterranean	1		1	1
Pontian endemic	1			
Total	**105 (66.9)**	**22 (14.0)**	**91 (57.9)**	**51 (32.3)**

Fig. 2. Heaps of shells of *Cerastoderma glaucum* along the shores of the basins

Fig. 3. Heaps of shells of *Cerastoderma glaucum* and *Abra segmntum*

sea. The actinia *Actinothoe clavata* is also established in this canal.

Typical for the hyper-saline lakes [such as Atanasovsko Lake – from 30-60‰ to 100-250‰ (Ivanov et al., 1964)] are the halobionts of the genus *Artemia* – *A. parthenogenetica* (South Palaearctic-Oriental) and *Artemia salina* (Subcosmopolitan). In recent years the both species are reported from the Atanasovsko Lake and Pomorie Lake (Triantaphyllidis et al., 1998; Georgiev & Nikolov, 2010). *Artemia* is a problematic genus with an unclear taxonomic status of the part of the species. Some authors impugn the existence of *A. parthenogenetica* (Abatzopoulos et al., 2002; Asem et al., 2010). They accept that these are parthenogenetic populations of different species of the genus *Artemia*. These populations (known as *A. parthenogenetica*) have been established in other continents as well. After DNA analysis Munoz et al. (2010) bring closer the parthenogenetic *Artemia* from the Atanasovsko Lake to *Artemia urmiana* Günther, 1899 (endemic from the Urmia Lake in Iran). Usually *A. salina* develops in the spring and in early summer is displaced from *A. parthenogenetica*. In spring with the increasing of the water's temperature (20-22°C) and salinity (24-26‰), the quantity of *Artemia* increases (to 300-350 ind/l adults and 800-1000 ind/l juveniles) and reaches to 1800 ind/l adults and to 3000 ind/l juvenile forms in summer. It reaches to a high density – 3400 ind/l water (17 g/l) (Andreev, 1997, 2003) which is caused by the abundant phytoplankton blooming. Under the salinity of 250-260‰ *Artemia* maintain life processes (over 170-180‰ they are not propagated) and die under salinity of 340‰ (Caspers, 1952). *Artemia* is important for the salt producing due to the control of the phytoplankton's quantity (obviates the unfavourable effects of the algae *Dunaliella salina* Teodoresco, 1905) and purify the waters in the precrystallizers (Davis, 2000; Georgiev & Nikolov, 2010).

Alien immigrants. 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 at different times. The presence of *Ficopomatus enigmaticus*, *Amphibalanus eburneus*, *Rapana venosa*, *Physella acuta*, *Anadara kagoshimensis* and *Mya arenaria* has been established in the Atanasovsko Lake (Table 4, Figure 4). The invasive species *Rapana venosa*[2], *Anadara kagoshimensis*[3] and *Mya arenaria*[4] have caused significant changes in the Black Sea communities (Cvetkov & Marinov, 1986; Marinov, 1990; Konsulova & Stefanova, 2007; Todorova & Moncheva, 2013). Their populations have a high density in the Burgas Bay in front of the Atanasovsko Lake. According to some experts alive specimens of *Rapana venosa* are not found in the lake. The large number of shells in the northeastern half of the southern part (beside the road) is because of the birds that carry them (to break the shells).

[2] The first specimen of ***Rapana venosa*** in the Bulgarian aquatory was found in 1956 in Varna Bay, near Cape Galata (Kaneva-Abadjieva, 1958). Development of this snail in the rocky sublittoral has a substantial impact on *Mytilus* and *Ostrea*, and in the sand

Table 4. Invasive invertebrate animals, established in the Atanasovsko Lake

Taxa	Finding of the species in Bulgaria	Donor region
Polychaeta		
Ficopomatus enigmaticus (Fauvel, 1923)	1935	Indian Ocean
Crustacea		
Amphibalanus eburneus Gould, 1841	1933	North America
Mollusca		
Rapana venosa (Valenciennes, 1846)	1956	Sea of Japan
Physella acuta (Draparnaud, 1805)	1927	North America
Anadara kagoshimensis (Tokunaga, 1906)	1982	Indian Ocean and Pacific Ocean
Mya arenaria Linnaeus, 1758	1973	Circumboreal

In the same part of the southern lake a relatively high density of *Anadara kagoshimensis*, which has a planktonic larval stage and enters with the inflow of seawater, is observed. This mussel is a eurythermal and euryhaline species that endures very low oxygen concentrations in the water due to the presence of hemoglobin in the haemolimph. Specimens with maximum dimensions are established. The mussel's shells were not found in the reserve but its presence in this part of the lake can be expected. The shells of *Mya arenaria* are established in the reserve (station 5), where the canal ends inside the lake. Probably the planktonic larvae of this mussel also penetrate with the invading seawater.

Conservation significanse. Of the invertebrate species from the Atanasovsko Lake, *Centropages ponticus*, *Anax imperator* and *Ostrea edulis* are included in the Black Sea Red Data Book (Table 5) and belong to the categories endangered (EN) and vulnerable (VU). There are differences in the levels of threat of the species in the separate Black Sea countries (Dumont et al., 1999). *Lestes viridis*, *Anax imperator*, *Sympetrum vulgatum*, *Acroloxus lacustris*, *Planorbis carinatus*, *Planorbis*

sublittoral – on *Chamelea gallina*. The great eurybiontness, high fecundity and lack of competitors allowed this predator to reach mass development in the Black Sea and aroused discussion for eventual measures for a struggle with it. In a single trawling, up to 1500 specimens have been caught, and in some regions between Balchik and Kavarna the entire bottom was covered with Rapa whelks. Very high numbers was observed in Byala, in the region of Cape Cherni Nos (Klissurov, 2008). During the last 20 years, the snail was gathering for food with all possible means. After conquest of the Black Sea the species penetrated the Aegean, Adriatic and Mediterranean Seas, Atlantic coast of France, North Sea, East coast of USA, the mouth of the Rio de la Plata River between Uruguay and Argentina and around New Zealand. The way how the species was transported in the Black Sea is unclear. *R. venosa* is an eurythermal and euryhaline species that develops in the coastal zone on solid substrate and sandy and silty bottom at a depth to 30-40 m. The snail withstands temperature changes (from 0 to 30°C), water pollution and reduced oxygen content. There is a huge fertility (a snail delayed approximately 220000 eggs) which compensates its exploitation by man. It lives about 10 years. There are no precise data on the population of Rapa on the Bulgarian coast (Konsulov & Konsulova, 1993, 1998; Konsulov, 1998).

[3] The first specimens of ***Anadara kagoshimensis*** for the Bulgarian coast were found in 1982 in Varna Bay (Marinov et al., 1983; Kaneva-Abadjieva & Marinov, 1984). Much later, a high density of the species has been found in Burgas Bay (up to 400 specimens/m^2 and biomass 4280 g/m^2). This mussel is a eurythermal and euryhaline species that endures very low oxygen concentrations in the water due to the presence of hemoglobin in the haemolimph. It has a long life cycle and low coefficient of mortality. In a short time, *A. kagoshimensis* became a significant element of psammo- and pelophilous zoocenoses, and started to displace some local species. Thus the „*Chamelea gallina*" group in front of Balchik, Varna and Burgas transforms into „*A. kagoshimensis*" group. The distribution of this species in the Bulgarian part of the Black Sea is restricted from Balchik to the south part of Burgas Bay (Cvetkov & Marinov, 1986; Marinov, 1990; Konsulov, 1998).

[4] ***Mya arenaria*** has been first reported for the Bulgarian coast in the Bay of Burgas in 1973 (Kaneva-Abadjieva, 1974). The mussel inhabits the sandy sublittoral and reaches the wash zone. It has a high ecological plasticity and easy endures variations of the salinity and temperature and oxygen deficiency. It reaches a high density (over 300-400 to 4862 specimens/m^2) in the bays in front of the river mouths. *M. arenaria* is found along the beaches all over the Bulgarian coast but the greatest number of it occurs in front of Durankulak and Albena, in the Varna Bay, Varna Lake, at the influx of the Kamchiya River and Burgas Bay (Stoykov, 1983; Cvetkov & Marinov, 1986; Marinov, 1990). Spawning by eggs thrown straight into the water during the summer months (rarely re-spawning in autumn). From fertilized eggs planktonic larvae develop which 5-6 days after egg hatching convert to mussels. In the 1970s, this mussel is a dominant species in the Romanian coastal zone as 4-5 years after its appearance reaches biomass 16 kg/m^2 and numbers more than 8000 ind/m^2 (Gomoiu & Porumb, 1969). In many areas of the Black Sea shelf *M. arenaria* is a dominant species in new zoocenosis, called her name.

Table 5. Conservation status of the invertebrate animals of the Atanasovsko Lake

Taxa	Black Sea Red Data Book	Ecological data, European and IUCN Red List	Distribution
Centropages ponticus Karavaev, 1895	EN	M, p	Mediterranean-Red Sea
Lestes viridis (Vander Linden, 1825)		L-TL, r, LC	West Palearctic
Anax imperator Leach, 1815	NE, DD, VU	L-TL, LC	West Palearctic-Paleotropical
Sympetrum vulgatum (Linnaeus, 1758)		L-TL, LC	European-West Central Asian
Acroloxus lacustris (Linnaeus, 1758)		L, bt, ph, sw, LC	West Eurosiberian
Planorbis carinatus O. F. Müller, 1774		L, bt, sw, ph, pe, r, LC	West Eurosiberian, ? Holarctic
Planorbis planorbis (Linnaeus, 1758)		L, bt, 2‰, sw, ph, pe, LC	Holarctic
Planorbarius corneus (Linnaeus, 1758)		L, 5‰, sw, po, α-β, LC	West and Central Eurosiberian
Physella acuta (Draparnaud, 1805)		L, bt, pe, tx, α-β, is, LC	Subcosmopolitan, introduced species
Ostrea edulis Linnaeus, 1758	EN, VU	M, bt, sep, ro	North Atlantic-Mediterranean

planorbis, *Planorbarius corneus* and *Physella acuta* belong to the European and IUCN Red Data Lists, from the categories endangered (EN), vulnerable (VU) and least concern (LC). The last category includes the North American invasive species *Physella acuta*, which until recently was considered South European taxon. A total of 8 rare species have been established (*Palaemon serratus*, *Lestes viridis*, *Anax parthenope*, *Hemianax ephippiger*, *Libellula fulva*, *Ephydra bivittata*, *Glenanthe nigripes* and *Planorbis carinatus*). One Black Sea endemic (*Chironomus valkanovi*) has been recorded and relict forms are not known. The two protected areas (maintained reserve and natural monument) are important for the conservation of these species populations along the Bulgarian Black Sea coast.

Fig. 4. Shells of *Ecrobia ventrosa*, *Anadara kagoshimensis* and *Abra segmntum* in the south part of the lake, near the road to Pomorie

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Безгръбначните животни (Metazoa: Invertebrata) на Атанасовското езеро, България

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(Резюме)

Представена е ролята на Атанасовското езеро за съхраняване и опазване на специфичното фаунистично разнообразие, характерно за хиперхалинните езера от българското черноморие. Разгледана е фауната на езерото и околните водоеми, анализирани са таксономичното разнообразие и някои зоогеографски и екологични особености на безгръбначните животни. Технологичните процеси на солодобива влияят на хидрологичния режим на езерото и на фаунистичното му разнообразие. Езерната система включва от сладководни до хиперхалинни басейни с бърза смяна на средата. От Атанасовското езеро и прилежащите му водоеми са известни 6 типа, 10 класа, 35 разреда, 82 семейства и 157 вида. Тези таксони включват 56 вида (35.7%) морски и морско-бракични форми и 101 вида (64.3%) бракично-сладководни, сладководни и сухоземни форми, свързани с водата. За пръв път при настоящото изследване са установени 23 вида (12 морски, 1 бракичен и 10 сладководни). Морските и морско-бракичните видове имат 4 типа ареали – космополитен, атланто-индийски, атланто-пацифичен и атлантически. Преобладават атлантическите (66.1%) и космополитните (23.2%) ареали, които включват 80% от видовете. По-голямата част от фауната (над 60%) има атланто-медитерански произход и представлява обеднена атланто-медитеранска фауна. Сладководно-бракичните, сладководните и сухоземните видове, свързани с водата, установени в Атанасовското езеро, имат 2 основни типа ареали – видове, разпространени в Палеарктика и извън нея и видове, разпространени само в Палеарктика. Преобладават представителите на първия тип (52.4%). Те са свързани с типичните за морските крайбрежия местообитания, оптимални за развитието на определени видове и са застъпен слабо във вътрешността на страната. Вторият тип обединява палеарктични (20.0%), евросибирски (9.5%) и медитерански (15.2%) таксони. В Атанасовското езеро липсват каспийски реликти, което вероятно е свързано със специфичния хидрологичен режим, технологичните процеси при производството на сол и неговия силно променлив хиперхалинен характер. От понтийските видове е установен *Chironomus valkanovi*. От бентосните форми доминанти са *Cerastoderma glaucum* (до 134376 екз./m^2), *Ecrobia ventrosa* (до 19800 екз./m^2), *Abra segmentum* и *Cyprideis torosa* (до 77440 екз./m^2). Покрай бреговете на басейните черупките на *C. glaucum* образуват струпвания. Видът *Corophium volutator* е масов през всички сезони и е един от най-адаптираните обитатели на солниците. Постоянни видове, но с по-ограничени количества, са морските изоподи *Idotea balthica* и *Sphaeroma serratum*. Висока численост (до 130000 екз./m^3) достига и космополитът *Acartia clausi*. Типични за Атанасовското езеро са халобионтите *Artemia parthenogenetica* и *Artemia salina*, които достигат плътност от 3400 екз./l вода. Те имат значение за солодобива тъй като пречистват водите от фитопланктон в предкристализаторите. Установено е присъствие на 6 вида чуждестранни имигранти (*Ficopomatus enigmaticus*, *Amphibalanus eburneus*, *Rapana venosa*, *Physella acuta*, *Anadara kagoshimensis* и *Mya arenaria*). От безгръбначните животни на Атанасовското езеро 3 вида са включени в Червената книга на Черно море и 8 вида – в европейски и IUCN червени регистри.