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Research Article

Species Composition and Distribution of the Mussels (Mollusca: Bivalvia) in the Bulgarian Sector of the Black Sea

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Abstract: A total of 11 orders, 22 families, 45 genera and 48 species of mussels are known from the Bulgarian aquatory of the Black Sea. They are divided into 23 zoogeographical categories. The predominant part of them are Atlantic-Mediterranean elements (30 species or 62.5%). In the Bulgarian shelf there are from eight to 12 biocenoses and a large number of groups, which are characterised by specific types of mussels. The belts of *Mytilus galloprovincialis* and *Modiolula phaseolina* are typical of the Black Sea. Biogenic reefs built by *Ostrea edulis* but without living forms have been established. Four alien species are recorded, of which two are invasive. Nineteen species (39.6%) have a conservation value.

Key words: Bivalvia, Bulgaria, species composition, distribution, conservation

Introduction

The first data on the molluscs from the Bulgarian Black Sea were reported by Chichkoff (1912). After the World War II, Kaneva-Abadjieva (1957, 1958, 1960a, 1960b, 1960c, 1962, 1968, 1974, 1976) worked on the marine molluscs. Contributions to the study of molluscs are made by researchers who have published monographs and catalogues of the Bulgarian fauna: Valkanov (1935, 1936, 1957), Valkanov & Marinov (1964, 1978), Marinov (1979, 1990), Marinov & Golemansky (1989), Konsulov & Konsulova (1993, 1998) and Konsulov (1998). The hydrobiological research of the Black Sea are important for the study of mussels (Borcea 1931, Paspaleff 1933, Caspers 1951, 1952, Kaneva-Abadjieva & Marinov 1960a, 1960b, 1965, 1966, 1967, 1977, 1984, Marinov & Stoykov 1982, 1995, Marinov et al. 1983, Todorova 2005, 2011, 2015, 2017, Todorova et al. 2008a, 2008b, 2009, 2022, Konsulova et al. 2010, Todorova & Panayotova 2011, 2015, Todorova & Moncheva 2013, Todorova & Milkova 2017). These data have been published in articles which are not specifically focusing on mussels.

Four introduced species are known from the Bulgarian Black Sea coast – *Anadara kagoshimensis* (Tokunaga, 1906) (Marinov et al. 1983; Kaneva-Abadjieva & Marinov 1984); *Arcuatula senhousia* (W. H. Benson, 1842) (Todorova in Chartosia et al. 2018); *Magallana gigas* (Thunberg, 1793) (Mitov et al. 2020) and *Mya arenaria* Linnaeus, 1758 (Kaneva-Abadjieva 1974) as *A. senhousia* and *M. gigas* have been established in the recent years (Chartosia et al. 2018; Mitov et al. 2020). Nineteen species of mussels have conservation value and are included in the international conventions and Red Lists (Dumont et al. 1999, Todorova et al. 2008a, 2008b, 2022, Todorova 2011, 2015, Todorova & Panayotova 2011, 2015, Todorova & Milkova 2017). They are vulnerable to anthropogenic impact and invasive forms. Their populations are decreasing so their condition is a subject of increased inter-

est. During the last 80 years, the coastal basins have been exposed to anthropogenic impacts. Now some of them do not exist in their original form. They are drained, converted into dams, bays or are partially preserved.

The faunistic composition of the Bulgarian marine molluscs is known exhaustively. Long-term hydrobiological research obtained data on molluscs' distribution in the marine ecosystems and coastal basins. Despite the complete characteristic of the zoobenthos of the Bulgarian sector of the Black Sea, an essential omission is the lack of a generalised faunistic work on marine molluscs. Less explored are the southernmost parts of the coast and the coastal zone with a depth of less than 10 m, in which the oceanographic ships do not enter. Some of the coastal basins have been studied for a long time and current data of their fauna are missing.

The aim of the work is to present the taxonomic diversity of the sea mussels, to update data of their distribution and to analyse some zoogeographical, ecological and conservation features of the species.

Materials and Methods

This review includes material from the collections and published data. The information about species taken from the collections of the National Museum of Natural History and the Institute of Biodiversity and Ecosystem Research is included; material provided by hydrobiologists, personal collections of the author from the last 30 years and published data (1912-2024) that refer to Bulgaria.

For the marine species, the depth to which they are established in the Bulgarian Black Sea is given. Species, for which there are no data from the Bulgarian coast, data from other regions of the sea are presented. When information in the Bulgarian literature differs significantly from the one, reported for other parts of the sea, the respective foreign data for the Black Sea are presented.

The zoogeographical categorisation of species is done on the basis of data of their distribution, taken from the literature and the newest electronic issues. 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 Lusitanean subregion). The zoogeographical scheme used here is based on the works of Guryanova (1964), Nevesskaya (1965), De Lattin (1967), Starobogatov (1970), Mordukhay-Boltovskogo (1972), Golikov (1982), Nesis (1982), Riedl (1983), Abbott & Dance (1991), Elder & Pernetta (1991), Bruyne (2003), Kantor & Sysoev (2005), Hook (2008), Earle & Glover (2009). Zoogeographical analysis for the taxa categorisation was used. This method allows obtaining data information about species complexes with different zoogeographical characteristics based on the published data regarding species distribution and results of the faunistic research. These complexes contain zoogeographical information about the taxonomic groups which, combined with the origin of the ranges, determines the zoogeographical character of the fauna.

The first record of taxa and more important literature data are given in the quoted references. Attention is paied to publications in which exact localities of the species are given. Under updating of the names and specifying of the species distribution, some electronic issues have been 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 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), OBIS (Ocean Biogeographic Information System), WoRMS (World Register of Marine Species), MolluscaBase eds.

The rare species and taxa, included in the Black Sea Red Data Book (Dumont et al. 1999), Black Sea Zoobenthost List IUCN Criteria, Barcelona Convention, SPA/BD Protocol (Annex II – 1999, 2017), Bern Convention and Bucharest Convention are marked.

The localities of the species are presented under Abbreviations. The coastal brackish basins are included. For each species are given: 1) recent scientific name; 2) synonyms and names under which it is reported for Bulgaria; 3) distribution in the Bulgarian Black Sea aquatory; 4) depth at which it was established; 5) areographical characteristic; 6) brief ecological data; 7) conservation status; 8) literature sources. For introduced taxa, the natural range is indicated first, followed by the secondary (anthropogenic range). The invasive species are marked. The depths are in parentheses to distinguish them from the localities numbers.

Abbreviations used

Taxa: **[ ]** – names and synonyms, under which the species are recorded for Bulgaria.

Distribution: **1–29** – Localities in the Black Sea; **32–54** – Localities along the coast; **58–96** – Coastal basins; Dash before the figure (-7, -12) indicates the latter as maximum depth, dash after the figure (7-, 12-) indicates the latter as minimum depth; **?** – uncertain data or lack of data, * – outdated information and significantly altered habitat versus the time of collection of the material.

Localities of the species: * – highly altered habitat to the time of collection of the material; **[ ]** – old geographical names and old data, before 1957.

Sea localities: 1 – Durankulak [Blatnitsa] (Durankulak north – Durankulak Lake – Krapets); **2** – Shabla (Shabla Lake – Shabla Tuzla – Cape Shabla); **3** – Cape Kaliakra (Rusalka – Bolata – Cape Kaliakra); **4** – Kavarna (Cape Chairburun – Cape Chirakman – Cape Kalkanburun); **5** – Balchik (Balchik Tuzla – Balchik); **6** – Batova (Albena – Kranevo); **7** – Varna (Golden Sands – Evksinograd – Varna – Cape Galata – Pasha Dere River); **8** – Kamchiya (Cape Ilandzhik – Camping Ray – Kamchiya River – Shkorpilovtsi); **9** – Byala (Cape Cherni – Byala – Dvoynitsa River – Obzor); **10** – Cape Emine (Irakli – Cape Emine – Cocketrice sandy bank); **11** – Nesebar (Elenite – Sunny Beach – Nesebar – Ravda); **12** – Pomorie (Aheloy – Pomorie – Camping Evropa – Cape Lahna); **13** – Burgas (Saraphovo – Burgas – Kraymorie – Park Rosenets – Cape Chukalya); **14** – Sveta Anastasiya Island [Bolshevik Island]; **15** – Chernomorets (Cape Atiya – Chernomorets – Cape Chervenka [Cape Hrisotira]); **16** – Sozopol (Camping Gradina – Sozopol – Kavatsite – Dyuni); **17** – Cape Maslen Nos (Alepu Marsh – Ropotamo River – C. Maslen Nos – Stomoplo Marsh); **18** – Primorsko (Stomoplo Marsh – Primorsko – Dyavolska Reka River); **19** – Kiten [Urdoviza] (International Youth Centre – Kiten – Karaagach River – Lozenets); **20** – Tsarevo [Michurin, Vasiliko] (Cape Arapya – Tsarevo – Varvara); **21** – Ahtopol (Varvara – Achtopol – Veleka River); **22** – Sinemorets (Sinemorets – Silistar River – Rezovo); **23** – *Zostera* overgrowths (0–6 m); **24** – Rocky sublittoral, *Cystoseira* and other algae, *Mytilus* (from 0.5–1 m to 15–25 m); **25** – Sandy sublittoral (1–25 m); clean sand – to 17 m, with *Branchiostoma* – to 20 m; **26** – Coastal silt (from 15–20 m to 30–40 m); dominated by *Melinna* – to 25–30 m; **27** – *Mytilus* silt (from 15–20 m to 60–80 m); **28** – *Phaseolina* silt (from 65 m to 140–180 m); **29** – Black Sea, pelagic in front of the Bulgarian coast.

Localities along the sea coast: **32** – Lithotelms, Shabla – Cape Kaliakra, Varna; **33** – Lithotelms, Ravda, Sozopol – Cape Maslen Nos; **34** – Basins of Varna Aquarium; **35** – Subterranean (ground) waters of sandy beach, interstitial, mesopsamal; **36** – Sunny Beach, coastal zone, sand bottom and floating algae; **37** – Arkutino, coastal zone; **38** – Camping (Residence) Perla, coastal zone, sand bottom and floating algae; **39** – Kiten, coastal zone, sand bottom and floating algae; **40** – Lozenets, coastal zone; **41** – Small saltwater marshes along the coast; **42** – Small freshwater marshes along the coast; **43** – Mouths of small streams; **44** – Temporary salty puddles and floods around the coastal basins; **45** – Rocks along the entire coast, rocky supralittoral; **46** – Algae washed ashore along the coast, supralittoral; **47** – Salty soils around coastal basins; **48** – Terrestrial coastal zone with halophilic plants (to 50–100 m from the sea); **49** – Sea coastal zone; littoral (medio- or pseudolittoral); **50** – Rocky littoral (medio- or pseudolittoral, enteromorpha zone); **51** – Sandy littoral (medio- or pseudolittoral); **52** – Sandy supralittoral; **53** – Springs and wells with brackish water along the coast, Durakulak – Cape Kaliakra; **54** – Springs along the coast, Sozopol – Cape Maslen Nos.

Coastal basins (lakes, swamps, firths and river floods): **58** – Durankulak [Blatnitsa] Lake: [0–5‰, 3.4 km^2, depth 4 m], 1–4‰, average salinity 2‰; **59** – Ezerets Lake: [1–2‰, average salinity 1.6‰], 0.58–0.79‰, 0.72 km^2, depth 9.0 m; **60** – Shabla Lake: [0.1–2‰, 0.6–1.6‰], 0.52–0.60‰, 0.79 km^2, depth 9.5 m; **61** – *Schabla Tuzla: [10–30‰], 22–200‰, 0.19 km^2, depth 0.6 m; **62** – Nanevska Tuzla [Tauk Liman]: 1–90‰ (often about 20‰) 0.10 km^2, depth 0.3 m; **63** – *Bolata River Mouth: 0.1‰; **64** – *Balchik Tuzla: [80–150‰], 35–160‰, 0.14 km^2, depth 0.5–0.8 m; **65** – Batova River Mouth and Swamp: 0.03–6‰, depth 0.5–1 m; **66** – *Golden Sands Marshes: [0–60‰]; **67** – *Sindel [Sultanlar] Swamp: [0‰]; **68** – *Beloslav [Devnya, Gebedzhe] Lake: 0.1–15.6‰, 3.90 km^2, depth 3.5 m, sea canal 1923; **69** – *Varna Lake: [5–14‰], 6.5–8–16.8‰, 17.40 km^2, depth 19 m, sea canals 1909, 1976; **70** – Pasha Dere [Chatal Dere, Novata Voda] River Mouth: [0–7‰]; **71** – Kamchiya River Mouth Swamps: [0.4–0.7‰], average 0.1‰; **72** – Fandakliyska Reka [Shkorpilova] River Mouth: [0.1‰]; **73** – *Dvoynitsa [Cherta, Suha Kamchiya] River Mouth; **74** – *Hadzhiyska River Mouth [Nesebar Marsh]: [1–10‰]; **75** – Aheloy River Mouth; **76** – Pomorie Lake: 30–70 to 140‰, 8.50 km^2, depth 1.4 m; **77** – Atanasovsko Lake: 1–250‰, average 50–60‰, 16.90 km^2, depth 0.3–0.8 m; **78** – *Burgas [Vaya] Lake: [9–20‰], 1.8–45‰, average 10.6‰, 27.60 km^2, depth 1.3 m; **79** – *Mandra Dam [Mandra Lake to 1963]: [0.1–12‰, max. 30‰, 14.00 km^2, depth 1.1–5 m]; **80** – Uzungeren-Poda Complex: 0.1–32‰, 3.12 km^2; **81** – Tsiganski Skelet Marsh [Chengene Skele Marsh]: [7–20‰]; **82** – Alepu Marsh: 4–11–27‰ (usually 3.5–7.2‰), 0.14 km^2, depth 0.6–1 m; **83** – Arkutino Marsh: 0.1–1‰, 0.03 km^2, depth 0.5 m; **84** – Ropotamo River Mouth: 5–15‰; **85** – Stomoplo Marsh: [2–25‰], 1.5–4‰, 6–14‰, 0.06 km^2, depth 0.5 m; **86** – *Dyavolsko Blato Swamp: [1–20‰], 6–14‰, 0.80 km^2, depth 1 m; **87** – *Dyavolska Reka River Mouth: depth 4 m; **88** – Karaagachka Reka [Kitenska, Oryashka] River Mouth and Swamp: [5–15‰]; **89** – Tsarevska Reka [Michurinska (small)] River: [3‰]; **90** – Izgrevsko Dere [Michurinska Reka (great)] River: [5–10‰]; **91** – Puddles and mouths of streams between Tsarevo and Ahtopol; **92** – Veleka River Mouth: [0–0.5‰]; **93** – Butamyata [Potamyata] River Mouth: [12‰]; **94** – Silistar River Mouth: [5–15‰]; **95** – Rezovska Reka [Rezvaya] River Mouth: [0–1.45‰]; **96** – Black Sea coastal lakes and swamps.

Areographical categories: **amep** – Atlantic-Mediterranean-East Pacific, **ami** – Atlantic-Mediterranean-Indian, **amip** – Atlantic-Mediterranean-Indo-Pacific, **amrs** – Atlantic-Mediterranean-Red Sea, **anamnep** – Arctic-North Atlantic-Mediterranean-Northeast Pacific, **anamp** – Arctic-North Atlantic-Mediterranean-Pacific, **bam** – Boreal Atlantic-Mediterranean, **cbm** – Circumboreal-Mediterranean, **ce** – Circumeuropean, **clm** – Celtic-Lusitanian-Mediterranean, **clmm** – Celtic-Lusitanian-Mediterranean-Mauritanian, **eam** – East Atlantic-Mediterranean, **eami** – East Atlantic-Mediterranean-Indian, **eamiswp** – East Atlantic-Mediterranean-Indo-Southwest Pacific, **eamp** – East Atlantic-Mediterranean-Pacific, **eamrs** – East Atlantic-Mediterranean-Red Sea, **i** – introduced species (immigrants), **iwp** – Indo-West Pacific, **lm** – Lusitanian-Mediterranean, **lmi** – Lusitanian-Mediterranean-Indian, **lmm** – Lusitanian-Mediterranean-Mauritanian, **lmmg** – Lusitanian-Mediterranean-Mauritanian-Guinean, **m** – Mediterranean, **miwp** – Mediterranean-Indo-West Pacific, **mp** – Mediterranean-Pontian; **nam** – North

Atlantic-Mediterranean, **namnei** – North Atlantic-Mediterranean-Northeast Indian, **namnep** – North Atlantic-Mediterranean-Northeast Pacific, **nwp** – Northwest Pacific, **pc** – Ponto-Caspian, **Rc** – Caspian relict, **Sf** – subfossil, **sk** – Subcosmopolitan, **+** – species known only from shells, **?** – probable category.

Ecological data: **ar** – argillophilous, **B** – brackish, **bt** – benthos, **cs** – coastal silt, **eb** – eurybathic, **eh** – euryhaline, **ep** – epibathic, **epi** – epibiont, **et** – eurythermal, **eu** – eurybiont, **ha** – halophilous or halobiont, **hb** – hypobathic, **is** – invasive species, **L** – freshwater, **l** – littoral zone (medio-, pseudolittoral, intertidal), **lr** – rocky littoral, **ls** – sandy littoral, **lt** – rocks or lithophilous, **M** – marine, **mb** – mesobathic, **mc** – *Mytilus* cenosis, **ms** – *Mytilus* silt, **p** – plankton, **pe** – pelophilous, **ph** – algae overgrowth or phytophilous, **phc** – *Phyllophora* coenosis, **phs** – *Phaseolina* silt, **ps** – sand or psammophilous, **rh** – rhithrophilous, **ro** – rocky, **s** – silt, **sb** – stenobathic, **sep** – stenoepibathic, **sg** – shells and sand with shells, **shb** – stenohypobathic, **sl** – sublittoral zone (infra- and circalittoral, subtidal), **slc** – *Cystoseira* sublittoral, **slr** – rocky sublittoral, **sls** – sandy sublittoral, **sp** – supralittoral zone (supratidal), **spr** – rocky supralittoral, **sps** – sandy supralittoral, **th** – thermophile, **zc** – *Zostera* cenosis, **‰** – limiting freshwater level for marine and salinity level for the freshwater forms.

Conservation status: **■** – Black Sea Red Data Book; **BA** – Barcelona Convention, SPA/BD Protocol (Annex II – 1999, 2017), Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean; **BC** – Bern Convention (II, III); **BSZL** – Black Sea Zoobenthost List IUCN Criteria; **BU** – Bucharest Convention; **r** – rare.

Results

A total of 11 orders, 22 families, 45 genera and 48 mussel species are known from the Bulgarian Black Sea. Only the order Cardiida has a high species composition (15 species). The rest orders include from one to nine species. The genera comprise from one to three species. Only *Donax* and *Abra* include more than one species.

Subclass PTERIOMORPHIA

Order Arcida

Family Noetiidae

***Striarca lactea* (Linnaeus, 1758)** [*Arca lactea* Linnaeus, 1758; *Arcopsis lactea* (Linnaeus, 1758); *S.* (*Galactella*) *lactea* (Linnaeus, 1758)] – 7, 16, 24; (-20 m); eami, Sf, +; M, bt, ep, lt, r; BU-II; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a; Hubenov 2005b, 2007a, 2007b, 2015.

Arcidae

***Anadara kagoshimensis* (Tokunaga, 1906)** [*Anadara* sp.; *A. inaequivalvis* (Bruguière, 1789); *Cunearca cornea* (Reeve, 1844); *Scapharca inaequivalvis* (Bruguière, 1789)] – 3, 6, 7, 12, 13, 25, 26, 69, 76, 77; (-25, -40 m); miwp, i; M, is, changes communities, bt, ep, ps, s, sg; Marinov et al. 1983, 1989; Kaneva-Abadjieva & Marinov 1984; Nguen Suan Li 1984; Cvetkov & Marinov 1986; Marinov & Golemahsky 1989; Marinov 1990; Zaprjanov 1992; Konsulov & Konsulova 1993, 1998; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Prodanov et al. 2001; Hubenov 2005b, 2007a, 2007b, 2009, 2015; Todorova 2005; Revkov et al. 2008; Todorova et al. 2008a, 2008b; Trayanova 2008; Stoykov & Uzunova 1999; Konsulova et al. 2010; Todorova & Panayotova 2011, 2015; Trayanova et al. 2011; Todorova & Moncheva 2013; Hubenov et al. 2015; Kalcheva et al. 2015; Băncilă et al. 2022.

Order Mytilida

Family Mytilidae

***Mytilaster lineatus* (Gmelin, 1791)** [*M. lineatus pontica*; *M. minimus* (Poli, 1795); *M. monterosatoi* Milachewitch, 1916] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 68, 69, 76, 77; (0–30, 50 m); lm; M (B–5‰), bt, sep, lt-slc; Chichkoff 1912; Borcea 1931; Paspalev 1933; Caspers 1951; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Mihailova-Neikova 1961; Valkanov & Marinov 1964; Kaneva-Abadjieva & Marinov 1966; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Marinov & Stoykov 1995; Stoykov 1996; Trayanova 2008; Todorova et al. 2008a, 2008b; Todorova & Panayotova 2011, 2015; Todorova & Moncheva 2013; Hubenov et al. 2015; Kalcheva et al. 2015; Vidinova et al. 2016; Kalcheva 2018, 2019.

***Mytilus galloprovincialis* Lamarck, 1819** [*M. edulis galloprovincialis* Lamarck, 1819] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 27, 68, 69, 76, 77; (0–80 m); eamp; M, bt, eb, lt, mc, s, s-ps; Chichkoff 1912; Borcea 1931; Paspalev 1933; Valkanov 1936, 1957; Caspers 1951; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Konsulov 1998; Stoykov & Uzunova 1999; Prodanov et al. 2001; Trayanova 2003, 2008; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005, 2011, 2015; Revkov et al. 2008; Todorova et al. 2008a, 2008b; Georgiev & Nikolov 2010; Konsulova et al. 2010; Nikolov et al. 2010; Todorova & Panayotova 2011, 2015; Todorova & Moncheva 2013; Hubenov et al. 2015; Kalcheva et al. 2015; Kalcheva 2018, 2019; Petrova et al. 2023.

***Modiolus adriaticus* Lamarck, 1819** [*Modiola adriatica* Lamarck, 1819; *Gibbomodiola adriatica* (Lamarck, 1819)] – 7, 11, 13, 16, 25, 26; (20–36, 75 m); lm, ? clm; M, bt, mb, pe, s-ps; Chichkoff 1912; Valkanov 1957; Kaneva-Abadjieva 1960a, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov 1990; Stoykov 1996; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova et al. 2008b; Trayanova 2008; Konsulova et al. 2010; Todorova & Moncheva 2013.

***Modiolula phaseolina* (Philippi, 1844)** [*Modiola phaseolina* Philippi, 1844; *Modiolus phaseolinus* Philippi, 1844] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 28; (-23, 75–140 m); clmm; M, bt, shb, pe, phs; Zernov 1913; Borcea 1931; Valkanov 1957; Kaneva-Abadjieva 1960a, 1962; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Revkov et al. 2008; Trayanova 2008; Todorova & Moncheva 2013.

Arcuatula senhousia (W. H. Benson, 1842) – 12, 13, 16; (11–12, 0–7 m); iwp, sk i; M, bt, ep, sg; Todorova in Chartosia et al. 2018. Probable invasive species.

Order Pectinida

Family Pectinidae

***Flexopecten glaber* (Linnaeus, 1758)** [*F. glaber ponticus* (Bucquoy, Dautzenberg & Dollfus, 1889); *Chlamys glabra* (Linnaeus, 1758); *Pecten glaber var. pontica* Bucquoy, Dautzenberg & Dollfus, 1898; *P. pontica* Bucquoy, Dautzenberg &

Dollfus, 1898] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 76, 77; (3–40, 70 m); lm; M, bt, sep, ps, ps-s; BU-II; Chichkoff 1912; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov 1990; Deltchev et al. 1993, 1998; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Hubenov et al. 2015; Kalcheva et al. 2015; Todorova et al. 2022.

Family Anomiidae

***Anomia ephippium* Linnaeus, 1758** – 7; (-30 m); amep; M, bt, ep, ro; BU-II; Caspers 1951a; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b; Deltchev et al. 1993, 1998; Hubenov 2005b, 2007a, 2007b, 2015.

Order Ostreida

Family Ostreidae

***Ostrea edulis* Linnaeus, 1758** [*O. lamellosa* Brocchi, 1814; *O. taurica* Siemaschko, 1847; *O. sublamellosa* Milaschewitsch, 1916] – 3, 5, 7, 12, 16, 17, 24, 76, 77; (7–20, 65 m); anamnep, i, anamp; M, bt, sep, ro; r, ■, BU-II, BSZL; Chichkoff 1912; Borcea 1931; Paspalev 1933; Caspers 1951; Kaneva-Abadjieva 1960a, 1960b, 1962; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Dumont et al. 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova et al. 2008a, 2009; Todorova & Panayotova 2011, 2015; Todorova & Moncheva 2013; Hubenov et al. 2015; Kalcheva et al. 2015.

***Magallana gigas* (Thunberg, 1793)** [*Crassostrea gigas* (Thunberg, 1793); *Ostrea gigas* Thunberg, 1793] – 4, 7, 13, 15, 16, 17, 19; (0–7 m); nwp, sk, i; M, B, bt, ep, ro; Mitov et al. 2020; Băncilă et al. 2022.

Subclass HETEROCONCHIA

Order Lucinida

Family Lucinidae

***Lucinella divaricata* (Linnaeus, 1758)** [*Divaricella divaricata* (Linnaeus, 1758); *Lucina commutata* Philippi, 1836; *Tellina divaricata* Linnaeus, 1758] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 69; (5–27 m, -30 m); clm; M, bt, ep, ps, ps-s; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005, 2015; Todorova et al. 2008a, 2008b; Trayanova 2008.

***Loripes orbiculatus* Poli, 1795** [*L. lacteus* (Linnaeus, 1758) sensu Poli, 1791; *L. lucinalis* (Lamarck, 1818); *Lucina leucoma* W. Turton, 1822; *Tellina lactea* Linnaeus, 1758] – 3, 7, 11, 16, 17, 20, 25, 76; (-25 m); clmm; M, bt, sep, ps, zc; BSZL; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Stoykov & Uzunova 1999; Todorova 2005, 2015; Todorova et al. 2008a, 2008b; Kalcheva et al. 2015.

Order Galeommatida

Family Lasaeidae

***Hemilepton nitidum* (W. Turton, 1822)** [*Kellia compressa* Milaschewitsch, 1909; *Erycina nitida*; *Lepton nitidum* W. Turton, 1822] – 25, *69, 84; (0–25, 34 m); clm; M, bt, ps, epmb; Kaneva-Abadjieva 1957; Wilke 1995; Hubenov 2005b, 2007a, 2007b, 2015.

***Kellia suborbicularis* (Montagu, 1803)** [? *Hemilepton nitidum* (W. Turton, 1822)] – 69; (2 m); namnep; M, bt, eb, ps; Todorova et al. 2008b; Hubenov 2015.

***Kurtiella bidentata* (Montagu, 1803)** [*Mysella bidentata* (Montagu, 1803)] – 16, 17; (-50 m); eam; M, bt, sg, eb, ro; Wilke 1995; Hubenov 2005b, 2007a, 2007b, 2015.

Order Cardiida

Family Cardiidae

***Acanthocardia paucicostata* (G. B. Sowerby, 1834)** [*Cardium paucicostatum var. impedita* Milaschewitsch, 1909; *C. paucicostatum* G. B. Sowerby, 1834] – 3, 7, 13, 16, 17, 25, 26, 27, 69; (20–78 m, 15–100 m); lm; M, bt, mb-eb, pe, sg; Chichkoff 1912; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Todorova et al. 2008b; Trayanova 2008.

***Cerastoderma glaucum* (Poiret, 1789)** [*C. edule* (Linnaeus, 1758); *Cardium edule* Linnaeus, 1758; *C. clodiense* Brocchi, 1814; *C. lamarckii* Reeve, 1845] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 27, 68, *69, 76, 77, *78; (-80 m); clm; M, bt, eh-3.9‰, eb, ps, ps-s, pe; Chichkoff 1912; Borcea 1931; Paspalev 1933; Valkanov 1936, 1957; Caspers 1951, 1952; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Mihailova-Neikova 1961; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Stoykov & Uzunova 1999; Nikula & Väinölä 2003; Hubenov 2005b, 2007a, 2007b, 2015; Marinov & Stoykov 1995; Stoykov 1996; Vassilev & Konsulov 1998; Todorova 2005; Todorova et al. 2008a, 2008b; Trayanova 2008; Georgiev & Nikolov 2010; Konsulova et al. 2010; Todorova & Panayotova 2011, 2015; Hubenov et al. 2015; Kalcheva et al. 2015; Valchev et al. 2015; Traykov & Ivanov 2015; Vidinova et al. 2016; Kalcheva 2017, 2018, 2019.

***Parvicardium exiguum* (Gmelin, 1791)** [*Cardium exiguum* Gmelin, 1791] – 3, 7, 13, 16, 25, 27, 69; (10–120 m); clm; M, bt, eb, ps, ps-s, pe; Chichkoff 1912; Borcea 1931; Caspers 1951a; Valkanov 1957; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Todorova et al. 2008b; Trayanova 2008; Konsulova et al. 2010; Todorova & Moncheva 2013.

***Papillicardium papillosum* (Poli, 1791)** [*Cardium fasciatum* Gmelin, 1791; *Cardium simile* Milaschewitsch, 1909] – 3, 7, 17, 25, 27, 28; (10–30 m, 100 m); lmm; M, bt, eb, pe, pe-ps; Borcea 1931; Caspers 1951; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Valkanov 1957; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015.

***Monodacna colorata* (Eichwald, 1829)** [*Hypanis colorata* (Eichwald, 1829); *Didacna*] – 3, 7, 25, 26, 27, 28; (13–148 m); pc, Rc, Sf, + [Black Sea Basin endemic (20th century), now invasive in the Caspian Sea Basin]; M, B, bt, ps-pe, s, eb; Borcea 1926, 1937; Caspers 1951; Kaneva-Abadjieva 1957, 1960a; Valkanov 1957; Marinov 1990; Deltchev et al. 1993, 1998; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Gogaladze et al. 2021.

***Hypanis plicata* (Eichwald, 1829)** [*H. plicata relicta* (Milaschewitch, 1916); *Adacna relicta* Milaschewitsch, 1916] – 3, 27, 28; (35–92 m); pc, Rc, Sf, + [Pontian-Caspian endemic]; B,

bt, pe, ar, s-ps, eb; BSZL; Borcea 1937; Valkanov 1957; Kaneva-Abadjieva 1968a; Marinov 1990; Konsulov & Konsulova 1993, 1998; Deltchev et al. 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Gogaladze et al. 2021.

Family Tellinidae

***Gastrana fragilis* (Linnaeus, 1758)** [*Tellina fragilis* Linnaeus, 1758; *Psammobia*] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25; (-36 m); clm; M, bt, ep, ar, ar-ps, sg; BSZL; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Trayanova 2008.

***Moerella donacina* (Linnaeus, 1758)** [*Tellina donacina* Linnaeus, 1758; *Angulus donacinus* (Linnaeus, 1758)] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26; (-20, 30 m); clmm; M, bt, sep, ps-pe; r, BU-II, BSZL; Chichkoff 1912; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015.

***Fabulina fabula* (Gmelin, 1791)** [*Tellina fabula* Gmelin, 1791; *T. fabula* var. *propinqua* Milaschewitsch, 1916; *Angulus fabula* (Gmelin, 1791); *Moerella*] – 7, 25; (-10, 40 m); clm; M, bt, ep, ps, ps-s; BU-II; BSZL; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015.

***Macomangulus tenuis* (da Costa, 1778)** [*Tellina tenuis* da Costa, 1778; *T. exigua* Poli, 1791; *Angulus exiguus* (da Costa, 1778); *A. tenuis* (da Costa, 1778); *Moerella*] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 77, *79; (0.2–24 m); nam; M, bt, sep, ps, ps-s; Chichkoff 1912; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005, 2011, 2015; Trayanova 2008; Todorova et al. 2008a, 2008b; Todorova & Panayotova 2011, 2015; Trayanova et al. 2011; Todorova & Moncheva 2013; Hubenov et al. 2015.

Family Donacidae

***Donax trunculus* Linnaeus, 1758** [*D. julianae* Krynicky, 1837; *D. trunculus julianae* Krynicky, 1837] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 76; (2–15 m); clm; M, bt, sep, ps; BSZL; Chichkoff 1912; Borcea 1931; Paspalev 1933; Caspers 1951; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Konsulov & Konsulova 1993, 1998; Marinov 1990; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova et al. 2008a, 2008b; Todorova & Moncheva 2013; Todorova & Panayotova 2011, 2015; Kalcheva et al. 2015; Todorova 2021; Alexandrova et al. 2022, 2024; Merdzhanova et al. 2024; Peycheva et al. 2024.

***Donax semistriatus* Poli, 1795** [*Donax fabagella* Lamarck, 1818; *Donax venustus* Poli, 1795] – 16, 25; 10–15, 20; (65- m); lm; M, bt, ep, ps; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015.

Family Semelidae

***Abra alba* (W. Wood, 1802)** [*A. alba occitanica* Récluz, 1843; *A. alba* var. *pontica* Milaschewitsch, 1916; *Syndesmya alba* (W. Wood, 1802); *Syndosmya occitanica* Récluz in Chenu, 1844] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 26, 27, 28, 69; (15–118 m, -135, 170 m); clmm; M, bt, eb, pe, phs; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Todorova et al. 2008b; Trayanova 2008; Todorova & Moncheva 2013.

***Abra prismatica* (Montagu, 1808)** [*A. fragilis* Risso, 1826; *A. milachewichi* Nevesskaja, 1963; *A. nitida* (O. F. Müller, 1776); *Syndesmya fragilis* (Risso, 1826); *S. fragilis* Milaschewitsch, 1916] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 26, 27, 69; (15–90 m); clm; M, bt, eb, pe, s-ps; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Todorova et al. 2008b; Trayanova 2008.

***Abra segmentum* (Récluz, 1843)** [*A. ovata* (Philippi, 1836); *Erycina ovata* Philippi, 1836; *Syndesmya ovata* (Philippi, 1836); *Syndosmya segmentum* Récluz, 1843] – 7, 13, 23, 26, *66, 68, *69, 76, 77, *79, 85, *86; (-15, 40); lm; M, bt, eh-6-60‰, ep, et, pe, ps-s; Chichkoff 1912; Valkanov 1936, 1957; Caspers 1951; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Mihailova-Neikova 1961; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Vassilev & Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005, 2011, 2015; Todorova et al. 2008b; Trayanova 2008; Georgiev & Nikolov 2010; Hubenov et al. 2015; Kalcheva et al. 2015; Valchev et al. 2015; Vidinova et al. 2016; Kalcheva 2018, 2019.

Order Venerida

Family Mactridae

***Spisula subtruncata* (da Costa, 1778)** [*Mactra subtruncata* var. *triangula* Renieri, 1804; *M. triangula* Brocchi, 1814] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 27, 28, 69, 76; (14–92 m, 5–140 m); clmm; M, bt, eb, pe, ps-s, sg; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Trayanova 2008; Kalcheva et al. 2015.

Family Mesodesmatidae

***Donacilla cornea* (Poli, 1795)** [*Mesodesma cornea* (Poli, 1795)] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 51, 76; (0.2, -2 m); lm; M, bt, sep, ps; ■, BU-II, BSZL; Valkanov 1957; Kaneva-Abadjieva 1960a, 1962; Valkanov & Marinov 1964; Konsulov & Konsulova 1993, 1998; Marinov 1990; Konsulov 1998; Dumont et al. 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005, 2011, 2015; Todorova et al. 2008a, 2008b; Todorova & Moncheva 2013; Kalcheva et al. 2015.

Family Veneridae

***Gouldia minima* (Montagu, 1803)** [*Circe minima* (Montagu, 1803); *Venus minima* Montagu, 1803] – 5, 16, 25, 26, 27; (-25, 70 m); clmm; M, bt, eb, ps-pe, mc; Chichkoff 1912; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva

1957, 1960a, 1960b; 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Todorova & Moncheva 2013.

***Pitar rudis* (Poli, 1795)** [*Meretrix rudis* var. *ochropicta* Krynicki, 1837; *Venus ochropicta* Krynicki, 1837; *Cytherea rudis* (Poli, 1795)] – 3, 7, 13, 16, 17, 25, 26, 27; (11–40 m, 200 m); lmmg; M, bt, mb, ps-pe, sg; BSZL; Chichkoff 1912; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Todorova et al. 2008b; Trayanova 2008.

***Irus irus* (Linnaeus, 1758)** [*Venerupis irus* (Linnaeus, 1758)] – 3, 7, 24; (0–10 m); eamiswp; M, bt, sep, lt, slr; BU-II, BSZL; Borcea 1931; Paspalev 1933; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Konsulov & Konsulova 1993, 1998; Marinov 1990; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015.

***Chamelea gallina* (Linnaeus, 1758)** [*Venus gallina* Linnaeus, 1758; *Chione gallina corrugatula* (Krynicki, 1837)] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 69, 76; (11–14 m, -30, 90 m); ce; M, bt, mb, ps, s-ps, sg; Chichkoff 1912; Borcea 1931; Paspalev 1933; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1957, 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005, 2021; Revkov et al. 2008; Trayanova 2008; Todorova et al. 2008a, 2008b; Konsulova et al. 2010; Todorova & Panayotova 2011, 2015; Trayanova et al. 2011; Todorova & Moncheva 2013; Kalcheva et al. 2015; Kalcheva 2018, 2019; Peycheva et al. 2024.

***Polititapes aureus* (Gmelin, 1791)** [*Paphia aurea* (Gmelin, 1791); *Polititapes petalina* (Lamarck, 1818); *Venus petalina* Lamarck, 1818; *Tapes aureus var. rugata* Bucquoy, Dautzenberg & Dollfus, 1893; *T. rugatus* Bucquoy, Dautzenberg & Dollfus, 1893; *T. discrepans* Milaschewitsch, 1916; *T. lineatus* Milaschewitsch, 1916; *T. proclivis* Milaschewitsch, 1916] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 27, 76; (11–60 m, 2–65 m); ce; M, bt, mb, ps-pe, s; BU-II; BSZL; Chichkoff 1912; Borcea 1931; Paspalev 1933; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova et al. 2008b; Kalcheva et al. 2015.

***Petricola lithophaga* (Retzius, 1788)** – 7, 11, 12, 13, 24; (-10, 26 m); lmi; M, bt, sep, lt; BU-II, BSZL; Chichkoff 1912; Borcea 1931; Paspalev 1933; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Todorova et al. 2008a; Todorova & Panayotova 2011, 2015; Todorova & Moncheva 2013.

Order Adapedonta

Family Solenidae

***Solen marginatus* Pulteney, 1799** [*S. vagina* Linnaeus, 1758 *sensu* Pennant, 1777; *S. marginatus* var. *pontica* Milaschewitsch, 1916] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 76; (0–10 m); clmm; M, bt, sep, ps; r, ■, BU-II; BSZL; Chichkoff 1912; Paspalev 1933; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Dumont et al. 1999; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2011, 2015; Kalcheva et al. 2015.

Order Myida

Family Dreissenidae

***Dreissena grimmi* Andrusov, 1890** [*D.* (*Pontodreissena*) *rostriformis distincta* Andrusov, 1897; *D. distincta* Andrusov, 1897; *D. rostriformis* (Deshayes, 1838)] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 27, 28; (36–148 m, 50–200 m); pc, Rc, Sf, +; B, bt, mb-eb; Kaneva-Abadjieva 1960a, 1968a; Kaneva-Abadjieva & Marinov 1960b; Valkanov & Marinov 1964; Marinov 1990; Deltchev et al. 1993, 1998; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005a, 2005b, 2007a, 2007b, 2015.

Family Myidae

***Mya arenaria* Linnaeus, 1758** [*M. truncata* Linnaeus, 1758] – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 25, 26, 68, 69, 76, 77; (0.30–12 m); cbm, i; M, is, changes communities, bt, ep, ps, ps-s; Kaneva-Abadjieva 1974; Marinov & Stoykov 1982; Stoykov 1983; Marinov et al. 1983; Cvetkov & Marinov 1986; Marinov & Golemansky 1989; Marinov 1990; Konsulov & Konsulova 1993, 1998; Marinov & Stoykov 1995; Stoykov 1996; Konsulov 1998; Stoykov & Uzunova 1999; Prodanov et al. 2001; Hubenov 2005b, 2007a, 2007b, 2009, 2015; Todorova 2005; Revkov et al. 2008; Trayanova 2008; Todorova et al. 2008a, 2008b; Todorova & Panayotova 2011, 2015; Todorova & Moncheva 2013; Hubenov et al. 2015; Kalcheva et al. 2015; Vidinova et al. 2016; Băncilă et al. 2022.

Family Corbulidae

***Lentidium mediterraneum* (O. G. Costa, 1829)** [*Corbulomya maeotica* Milaschewitsch, 1908; *Corbula mediterranea* O. G. Costa, 1830] – 7, 25, 69; (10–12 m); m; M, bt, sep, ps, ps-s; Borcea 1931; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Kaneva-Abadjieva & Marinov 1966; Marinov et al. 1983; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova 2005; Trayanova 2008; Todorova et al. 2008a, 2008b; Trayanova et al. 2011; Todorova & Moncheva 2013; Todorova & Panayotova 2015.

Family Pholadidae

***Pholas dactylus* Linnaeus, 1758** – 5, 7, 10, 11, 12, 13, 24, 76; (-15 m); amrs; M, bt, sep, lt; r, BA-II – SPA/BD Protocol (Annex II – 1999, 2017), BC-II, BU-II, BSZL; Chichkoff 1912; Borcea 1931; Paspalev 1933; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b, 1962; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova et al. 2008a, 2008b; Todorova & Panayotova 2011, 2015; Todorova & Moncheva 2013; Kalcheva et al. 2015.

***Barnea candida* (Linnaeus, 1758)** [*B. candida pontica* Milaschewitsch, 1916; *Pholas candidus* Linnaeus, 1758] – 7, 24; (-15 m); namni; M, bt, ep, lt, eh; r, BU-II; Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova et al. 2008b; Todorova & Panayotova 2011, 2015; Todorova & Moncheva 2013.

Family Teredinidae

***Teredo navalis* Linnaeus, 1758** – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 69; (-70 m); amip, i, k; M, bt, ep-mb, c, is; Chichkoff 1912; Borcea 1931; Paspalev 1933; Valkanov 1936; Caspers 1951; Kaneva-Abadjieva 1960a, 1960b, 1962; Marinov 1990; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2009, 2015; Trayanova 2008.

***Nototeredo norvagica* (Spengler, 1792)** [*Teredo utriculus* Gmelin, 1791(nomen dubium)] – 10, 17; (-70 m); nam; M, bt, ep-mb; Bulgurkov 1963; Marinov & Golemansky 1989; Hubenov 2005b, 2007a, 2007b, 2015.

Order Anomalodesmata

Family Thraciidae

***Thracia phaseolina* (Lamarck, 1818)** [*T. papyracea* (Poli, 1791)] – 7, 25; (0.2–22 m); nam; M, bt, ep, ps, ps-pe; r, Caspers 1951; Valkanov 1957; Kaneva-Abadjieva 1960a, 1960b; Marinov 1990; Deltchev et al. 1993, 1998; Konsulov & Konsulova 1993, 1998; Konsulov 1998; Hubenov 2005b, 2007a, 2007b, 2015; Todorova et al. 2008b.

Discussion

The Bulgarian fauna comprises 52.7% of the known 91 species of mussels from the Black and Azov Seas. The species composition varies depending on whether the authors consider only marine and marine-brackish forms or include freshwater-brackish and freshwater forms from the coastal brackish basins. *Monodacna colorata*, *Hypanis plicata* and *Dreissena grimmi* are subfossils for the Bulgarian Black Sea coast. Only shells are found of them. High numbers of living forms are represented in the basins of the Ponto-Caspian brackish region of Russia and Ukraine (Starobogatov 1970). Shells of *Pecten jacobaeus* (Linnaeus, 1758) and *P. maximus* (Linnaeus, 1758) have been established by Caspers (1951) in the Varna Bay. These species are not found by other authors in the Black Sea (Valkanov 1957a, Kaneva-Abadjieva 1960, Skarlato & Starobogatov 1972). The shells are believed to have been thrown from the ships.

Most mussels have been established throughout the Bulgarian Black Sea coast. Species, which are distributed either in the northern or in the southern part of the coast are mostly rare forms and taxa as *Kurtiella bidentata* and *Hemilepton nitidum*, reported in the last 30 years for the Bulgarian fauna (Wilke 1995). In most cases, the species distribution is related to the level of study of the corresponding coastal region. Three areas of good research are outlined under juxtaposition of the found species within the localities. Firstly are the vicinities of Varna where the investigations of the Black Sea began a centure ago. The popular resort centers Nesebar, Pomorie, Burgas and Sozopol form an area of good research. Owing to Bulgarian and Romanian specialists, the region of Kaliakra Cape is also well studied. The rich species composition of the lakes Varna and Beloslav has changed after the connection with the sea (1909 and 1923) and their transformation into ports (after 1976). The fauna of the lakes Burgas (anthropogenic impact after 1960) and Mandra (dam since 1963) became considerably poor.

The Black Sea below the depths of 180–200 m is enriched with released H_2S, which makes the real deep-sea life impossible. The groups of epi-, meso- and eurybathic species are presented (Table 1).

The most numerous are the **Stenoepibathic** species (57.4%), to which most mussels belong. Constantly found in the shallow coastal zone (to 5–10 m), the shells of which are presented along the shore are *Ostrea edulis*, *Macomangulus tenuis*, *Donacilla cornea* (for the surf zone), *Solen marginatus*, *Donax trunculus*, *Irus irus*, *Lentidium mediterraneum* and *Pholas dactylus*. Some stenoepibathic forms *Anadara kagoshimensis*, *Ostrea edulis*, *Lucinella divaricata*, *Loripes orbiculatus*, *Moerella donacina*, *Donax semistriatus* and *Gouldia minima* reach the depth of 15–30 m and approach to the mesobathic forms. An intermediate niche, closer to the mesobathic forms, is occupied by *Flexopecten glaber* and some representatives of the family Veneridae (*Pitar rudis* and *Chamelea gallina*), which reach higher depths.

The **Mesobathic** (17.0%) species reach the depth over 40 m in the Black Sea. Typical mesobathic species are *Modiolus adriaticus*, *Acanthocardia paucicostata* and *Polititapes aureus*. Some taxa as *Teredo navalis* and *Nototeredo norvagica* could be considered stenomesobathic forms as well.

The group of **Eurybathic** (23.4%) species includes a number of common Black Sea species as *Mytilus galloprovincialis*, *Cerastoderma glaucum*, *Parvicardium exiguum* and *Spisula subtruncata*. The species *Abra alba*, *A. prismatica*, etc, belong to this group and although not so widespread, are often found in both little and great depths. Most eurybathic forms reach the depth of 80–110 m as *Parvicardium exiguum* and *Abra alba* reach the great depths – to 120 and 135 m.

Typical **Stenohypobathic** species is only *Modiolula phaseolina*, found from 62 to 140 m (rarely could be found at smaller depth – 25 m) and usually reach higher density at depth of 110–115 m.

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 Tethys) gave rise to the Pontian Sea-Lake, from which two separate basins were formed later, the Black Sea and the Caspian Sea.

Table 1. Distribution of the marine Bivalvia from the Bulgarian Black Sea coast.

Zoogeographical scheme of the used categories	Number, %	Categories according to depth			
		Epibathic	Mesobathic	Eurybathic	Hypobathic
Cosmopolitan type	**5 (10.4)**				
Subcosmopolitan	2 (4.2)	2			
Atlantic-Mediterranean-Indo-Pacific	1 (2.1)	(1)	1		
East Atlantic-Mediterranean-Indo-Southwest Pacific	1 (2.1)	1			
Mediterranean-Indo-West Pacific	1 (2.1)	1			
Atlantic-Indian type	**4 (8.3)**				
East Atlantic-Mediterranean-Indian	1 (2.1)	1			
North Atlantic-Mediterranean-North Indian	1 (2.1)	1			
Lusitanian-Mediterranean-Indian	1 (2.1)	1			
Atlantic-Mediterranean-Red Sea	1 (2.1)	1			
Atlantic-Pacific type	**5 (10.4)**				
Arctic-North Atlantic-Mediterranean-Northeast Pacific	1 (2.1)	1			
Atlantic-Mediterranean-East Pacific	1 (2.1)	1			
East Atlantic-Mediterranean-Pacific	1 (2.1)			1	
North Atlantic-Mediterranean-Northeast Pacific	1 (2.1)			1	
Circumboreal-Mediterranean	1 (2.1)	1			
Atlantic type	**34 (70.8)**				
North Atlantic-Mediterranean	3 (6.2)	2 (1)	1		
East Atlantic-Mediterranean	1 (2.1)			1	
Celtic-Lusitanian-Mediterranean-Mauritanian	7 (14.6)	3		3	1
Lusitanian-Mediterranean-Mauritanian-Guinean	1 (2.1)		1		
Lusitanian-Mediterranean-Mauritanian	1 (2.1)			1	
Circumeuropean	2 (4.2)		2		
Celtic-Lusitanian-Mediterranean	8 (16.7)	4 (1)	1	3	
Lusitanian-Mediterranean	7 (14.6)	5	1 (1)	1	
Mediterranean-Pontian	1 (2.1)	1			
Ponto-Caspian	3 (6.2)	2	1	(1)	
Total	**48**	**28 (58.3)**	**8 (16.7)**	**11 (22.9)**	**1 (2.1)**

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).

Before the last glaciation, a connection with the Caspian Basin arose (via Manych Channel) and Caspian interglacial immigrants invaded the Black Sea (Nevesskaya 1965; Starobogatov 1970; Shopov 1996). Most authors accept these species as Caspian relicts (known also as Sarmatian, Pontian, Pontian-Caspian or autochthonous faunistic elements). They are concentrated mainly in the coastal lakes-firths and the mouths of the Black Sea rivers and inhabit the freshwater and brackish basins. Part of them are subfossils for the sea itself (Gogaladze et al. 2021). The Caspian relicts usually have Pontian or Ponto-Caspian ranges. Some of them have entered the river systems of Central and Western Europe (spread to other continents) where they are considered invasive species. 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 the Black Sea. The "relicts" *Dreissena polymorpha* (Pallas, 1771) and *D. bugensis* (Andrusov, 1897) – one of the most invasive recent mollusc, are a typical example. Recent data for the distribution of many relict taxa (mainly in the latest electronic editions) contradict their relict nature. It has been established that these taxa are widespread outside the Ponto-Caspian region. These may be invasive relict forms (a small number of species) or species with uncleared distribution, accepted as relicts. The main portion of the Caspian relicts includes benthic brackish forms.

The mussels are divided into 23 zoogeographical categories, combined into four groups (Table 1). The number of forms with Cosmopolitan, Atlantic-Pacific and Atlantic-Indian type of distribution (14 species in total or 29.2%) is considerably smaller than the forms of the Atlantic type (34 species or 70.8%). The main portion of the species (31 species or 64.6%) has an Atlantic-Mediterranean origin and represents the impoverished Atlantic-Mediterranean fauna (Hubenov 2007a, 2007b, 2015). As this fauna was becoming impoverished, the stenobiotic Lusitanian-Mediterranean species were eliminated, so this category is currently defined by the eurybiontic forms, often distributed along the European coast up to Scotland and Scandinavia. Thus, an impression is created of the atlantisation of this fauna. Twenty-three species (47.9%) have a Mediterranean-Lusitanian-Scandinavian distribution. Some boreal forms, as *Anomia ephippium*, *Mya arenaria*, etc., are also included in these species. There are five Mediterranean species (10.4%). Four alien taxa are known: *Anadara kagoshimensis* (Indo-Malayan), *Arcuatula senhousia* (Indo-West Pacific), *Magallana gigas* (Northwest-Pacific) and *Mya arenaria* (circumboreal) introduced in the last 50 years. Some authors (Hayward et al. 1996) consider *Teredo navalis* to be a Mediterranean-Lusitanian invasive species with a cosmopolitan recent distribution. There are contradictory data on the distribution of *Pitar rudis* (Lusitanian-Mediterranean-Mauritanian-Guinean) and *Striarca lactea* (East Atlantic-Mediterranean-Indian) – Nordsieck (1969), Skarlato & Starobogatov (1972), Hayward et al. (1996). The complex of endemics (3 species or 6.2%) is represented by Ponto-Caspian subfossil relicts (*Monodacna colorata*, *Hypanis plicata* and *Dreissena grimmi*). There are no data on the Black Sea endemic species in the recent malacological literature, of which there have been more in the old literature (Kaneva-Abadjieva 1960). Many endemics are brought to synonyms or downgraded to subspecies today. Eight species of Bivalvia have endemic subspecies.

Typical for the Black Sea is the almost continuous zone at depth from 40 to 140 m, composed from *Mytilus galloprovincialis* (to 70 m) and *Modiolula phaseolina* (70–140 m). The species *M. galloprovincialis* is not developed in such quantity anywhere else as in Black Sea (Valkanov &. Marinov 1978). As a result of the *Rapana venosa* (Valenciennes, 1846) predatory pressure, the communities of *M. galloprovincialis* located at depths less than 25–30 m are fragmented (Todorova 2005; Petrova et al. 2023; Todorova et al. 2023). *Spisula subtruncata* is a characteristic species for the soft silt bottom where it can be found to depths of 100 m. It has two maximums of the density and biomass (at 40 m and 60–65 m) and is the third mussel according its distribution along the Bulgarian coast (Marinov 1990). *Abra alba* has the widest range of distribution: from 5 to 135 m depth and a lot of maximums of the density and biomass, of which the ones at 95 and 105 m are the best exhibited (Kaneva-Abadjieva 1962). *Chamelea galina* is most abundant between 15 and 30 m depth. The distribution of the molluscs' biomass along the Bulgarian coast shows that the regions where it does not exceed 50 g/m^2 (Marinov 1990). dominate. In many regions northern of the Kamchiya River, the biomass is over 50 g/m^2. In the south half of the Bulgarian shelf, higher biomass is converged until the 50 m isobath, whereas in the northern half it reaches to the 70–80 m isobath. In all cases when the biomass is higher than 500 g/m^2, the reason is mainly *Mytilus galloprovincialis* (Marinov 1990). Near Tsarevo a biomass to 3354 g/m2 is established, near Pomorie – 2694 g/m2, near Bourgas – 3790 g/m2 (Marinov 1990; Stoykov & Uzunova 1999). The higher biomass (200–500 g/m^2) between th 50 and 100 m isobath is mainly due to *Modiolula phaseolinus*. In south direction,n between these isobaths, the species is poorly represented, wherefore the average biomass is often below 50 g/m^2 (Marinov 1990). The data presented are referred to the sublittoral bottom, located below the 10 m isobath. Between the shore and this isobath the molluscs are also of great importance for the formation of the zoobenthos biomass and mostly for the phyto- and psammophilous species. In the overgrown with algae localities these are *Mytilaster lineatus* and the gastropods *Tricolia pullus* and *Rissoa splendida*, the biomass of which reach to a few hundred g/m^2. In the sandy bottom the biomass is formed mostly of *Donacilla*

cornea, *Donax trunculus*, *Moerella tenuis*, *Chamelea galina*, *Lentidium mediterraneum*, etc. (Marinov 1990).

Three main zones are established in the Bulgarian Black Sea coast – **supralittoral**, **mediolittoral** (littoral, pseudolittoral) and **sublittoral** (infralittoral, circalittoral) . In these zones, 12 biocenoses and a great number of series are differentiated, which are characterised by a specific species composition (Kaneva-Abadjieva 1960, 1962, Valkanov & Marinov 1978, Marinov 1990, Konsulov & Konsulova 1993, 1998, Todorova 2005, 2011, 2015, 2017, Revkov et al. 2008, Todorova et al. 2008a, 2008b, 2022, Konsulova et al. 2010, Todorova & Panayotova 2011, 2015). Thirty-two biotopes have been localised as national habitats (Todorova & Moncheva 2013; Todorova & Milkova 2017). Recently, biogenic reefs built by *Ostrea edulis* "ostrak" have been established (Todorova et al. 2008a, 2009).

Rocky supralittoral: Two species of Gastropoda (*Melarhaphe neritoides* and *Myosotella myosotis*) are characteristic. Representatives from Bivalvia are not presented.

Rocky mediolittoral: The presence of *Mytilaster lineatus* and *Mytilus galloprovincialis* is constantly observed (Kaneva-Abadjieva 1962; Valkanov &. Marinov 1978; Todorova 2011, 2015).

Sandy mediolittoral: A very typical and abundant species is *Donacilla cornea*, the maximum density of which reaches 9800 ind/m^2 at Alepu. A comparatively high density is established at Stomoplo (6000 ind/m^2) and Ahtopol (2000 ind/m^2) (Valkanov &. Marinov 1978; Marinov 1990; Konsulov 1998; Konsulov & Konsulova 1993, 1998).

Cystoseira overgrowths: An exceptionally rich biocenosis, connected to the algae *Cystoseira barbata* and *C. crinita* that develop on the rocky bottom from 0.5 to 20 m of depth. Eight mollusc species develop on the thallus of the algae. The most common mussels are *Mytilaster lineatus* (overgrows the base of the thallus) and *Mytilus galloprovincialis*. The average density of the macro- and meiobenthos is 709424 ind/m2, the average biomass – 20.9 g/kg algae. The maximum density reaches 1040000 ind/m2, and the biomass – 400 g/m2 (Kaneva-Abadjieva & Marinov, 1977; Marinov, 1990). The density and biomass are highest in spring and summer. The biomass is formed mainly from *Mytilaster* and *Mytilus*.

Rocky sublittoral: This biocenosis spreads in depth from 0.5 to 30 m. A total of 36 species of molluscs have been found here, of which the most common are the mussels *Mytilus galloprovincialis* and *Mytilaster lineatus*. The karst and mergel rocks are pierced by the holes of *Petricola lithophaga*, *Pholas dactylus* and *Barnea candida* (Marinov 1990, Konsulov 1998, Konsulov & Konsulova 1998). Inhabitants of the rocky bottom are *Ostrea edulis* (living forms are not established (Todorova et al. 2008a, 2009) and *Magallana gigas* (Mitov et al. 2020).

Sandy sublittoral: It extends from 0 to 17–20 m depth. A total of 30 species of molluscs has been established here, of which the most common are *Chamelea gallina*, *Lucinella divaricata* and *Abra alba*. The average density of the molluscs is 398 ind/m^2, as it is the highest for *Lentidium mediterraneum* (168 ind./m^2), *Ch. gallina* (65 ind/m^2) and *L. divaricata* (60 ind/m^2) (Kaneva-Abadjieva & Marinov 1966; Marinov 1990). The molluscs comprise 92.7% of the average biomass in the zoocenosis (126.5 g/m^2): it is the highest for *Ch. gallina* (89.9 g/m^2) and *Polititapes aureus* (9.6 g/m^2) (Valkanov et al. 1978; Marinov 1990). The maximum biomass is established for *Ch. Gallina*: from 1542 to 1787 g/m^2 (density about 2700 ind/m^2) (Kaneva-Abadjieva et Marinov 1966, Marinov 1990) and maximum density – for *L. mediterraneum*: from 5380 to 21000 ind/m^2 (Valkanov et al. 1978, Marinov 1990). Typical psammophilous forms are *Loripes orbiculatus*, *Solen marginatus*, *Moerella donacina*, *Macomangulus tenuis*, *Fabulina fabula*, *Donax trunculus* and *Gouldia minima*. The invasive immigrants *Anadara kagoshimensis* (to 4282 g/m2) and *Mya arenaria* (to 4596 g/m2, 4862 ind/m2) are also represented here (Marinov 1990; Todorova & Panayotova 2011, 2015).

Coastal silt: It extends from 15–20 to 30–40 m. A total of 25 species of molluscs has been established; of them *Lucinella divaricata*, *Spisula subtruncata*, *Abra alba*, *A. prismatica*, *Gouldia minima*, *Chamelea gallina* and *Polititapes aureus* are the most common. At greater depths *Acanthocardia paucicostata*, *S. subtruncata*, *A. prismatica* and *Pitar rudis* predominate. *Donacilla cornea subtruncata* and *Ch. Gallina* have the highest density. *Chamelea gallina* (to 56.1 g/m^2) and *P. aureus* (to 84.7 g/m^2) have the highest biomass. The molluscs comprise from 72.1 to 77.9% of the biomass in the zoocenosis (Marinov 1990).

Mytilus silt: It begins to the north of Cape Kaliakra from the depth of 45 m and reaches the depth of about 70 m; at the Cape Emine – 80 m. The width of this zone varies from 2–3 miles to 10–15 miles. Ahead of Burgas Bay the zone is the widest and begins from the depth of 15–20 m. A total of 17 species

Table 2. Conservation significance of Bivalvia from the Bulgarian Black Sea coast.

Taxa	Ecological data, IUCN and European category, BSZL, BU-II, Black Sea Red Data Book	Distribution (area and depth)
Striarca lactea (Linnaeus, 1758)	M, bt, ep, lt, r; BU-II	(-20 m); eami, Sf, +
Modiolus adriaticus Lamarck, 1819	M, bt, mb, pe, s-ps, BU-II	(20-36, 75 m); lm, ?clm
Flexopecten glaber (Linnaeus, 1758)	M, bt, ep, ps, ps-s; BU-II	(3-40, 70 m); lm
Anomia ephippium Linnaeus, 1758	M, bt, ep, ro; BU-II	(-30 m); amep
Ostrea edulis Linnaeus, 1758	M, bt, sep, ro, r, BU-II, BSZL, ■ – EN, VU	(7-20, 65 m); anamnep
Loripes orbiculatus Poli, 1795	M, bt, sep, ps, zc; BSZL	(-25 m); clmm
Hypanis plicata (Eichwald, 1829)	B, bt, pe, ar, s-ps, eb; BSZL	(35-92 m); pc, Rc, Sf, +
Gastrana fragilis (Linnaeus, 1758)	M, bt, ep, ar, ar-ps, sg; BSZL	(-36 m); clm
Moerella donacina (Linnaeus, 1758)	M, bt, sep, ps-pe; r, BU-II, BSZL	(-20, 30 m); clmm
Fabulina fabula (Gmelin, 1791)	M, bt, ep, ps, ps-s; BU-II; BSZL	(-10, 40 m); clm
Donax trunculus Linnaeus, 1758	M, bt, sep, ps; BSZL	(2-15 m); clm
Donacilla cornea (Poli, 1795)	M, bt, sep, ps, BU-II, BSZL, ■ – EN	(0.2, -2 m); lm
Pitar rudis (Poli, 1795)	M, bt, mb, ps-pe, sg; BSZL	(11-40-200 m); lmmg
Irus irus (Linnaeus, 1758)	M, bt, sep, lt, slr; BU-II, BSZL	(0-10 m); eamiswp
Polititapes aureus (Gmelin, 1791)	M, bt, mb, ps-pe, s; BU-II; BSZL	(11-60 m, 2-65 m); ce
Petricola lithophaga (Retzius, 1788)	M, bt, sep, lt; BU-II, BSZL	(-10, 26 m); lmi
Solen marginatus Pulteney, 1799	M, bt, sep, ps, r, BU-II; BSZL, ■ – EN	(0-10 m); clmm
Pholas dactylus Linnaeus, 1758	M, bt, sep, lt; r, BA-II – SPA/BD (Annex II – 1999, 2017), BC-II, BU-II, BSZL	(-15 m); amrs
Barnea candida (Linnaeus, 1758)	M, bt, ep, lt, eh; r, BU-II	(-15 m); namni

of molluscs has been established. The main dominant is *Mytilus galloprovincialis*, whose maximum biomas in some places reaches from 3354 to 5900 g/m^2 (Kaneva-Abadjieva 1962, Marinov et Stoykov 1995). The biomass of *M. galloprovincialis* shows three maximums, of which the maximum at 45 m depth is the biggest. *Spisula subtruncata*, *Abra alba* and *Polititapes aureus* have a very high density. The biomass of the zoocenosis is formed mainly by the molluscs (94.3%). *Mytilus galloprovincialis* alone gives 63.6% from the biomass. However, as a result of its patchy distribution, the coefficient of permanency of this species is only 25.6%, followed by *S. subtruncata* with the coefficient of permanency 79.2% but with a twice lower biomass (Valkanov & Marinov, 1978; Marinov, 1990; Konsulov & Konsulova, 1993, 1998; Konsulov, 1998).

Phaseolina silt: This zone extends from 60–65 m to 184 m of depth. In the southern region, due to the larger slope of the bottom, the zone is narrower. A total of ten species of molluscs has been established. Of Gastropoda, *Trophonopsis muricata* is the only representative. This conspicuous predator feeds on the mussels with thinner shells, such as *Modiolula phaseolina*, *Parvicardium exiguum*, *Papillicardium papillosum*, *Spisula subtruncata*, *Abra alba* and *A. prismatica*. *Modiolula phaseolina* is a dominant species, with the coefficient of permanency from 22.2% (south of Kamchiya River) to 96.5% (in the north). Its density and biomass show many peaks, of which the density maximum (4963 ind/m^2) is at 110 m of depth and the biomass maximum (389 g/m^2) – at 65 m (Kaneva-Abadjieva & Marinov 1960). This species was recorded at the depth of 55 m in front of Cape Kaliakra, with a density up to 13040 ind/m^2 and biomass up to 995.6 g/m^2 (Marinov & Stoykov 1995). Molluscs comprise 86.5% of the whole biomass, while *M. phaseolina* alone forms 79.9% (Marinov 1990).

Invasive Species. Significant changes in the Black Sea communities have caused two species introduced in the last 50 years: *Anadara kagoshimensis* and *Mya arenaria*.

The first specimens of *A. kagoshimensis* for the Bulgarian coast were found in 1982 in Varna Bay (Marinov et al. 1983, Kaneva-Abadjieva & Marinov 1984; Nguen Suan Li 1984). Much later, a high density of the species has been found in Burgas Bay (up to 400 ind/m^2 and biomass of 4280 g/m^2) (Marinov 1990). 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 the 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).

Mya arenaria was first reported for the Bulgarian coast in the Bay of Burgas in 1973 (Kaneva-Abadjieva 1974). This mussel inhabits the sandy sublittoral and reaches the surf 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 ind/m^2) in the bays in front of the river mouths (Marinov 1990; Todorova & Panayotova 2011, 2015). *Mya 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 is through eggs being thrown straight into the water during the summer months. From fertilised eggs, planktonic larvae develop and convert to mussels in 5-6 days after hatching. In many areas of the Black Sea shelf *M. arenaria* was a dominant species in new zoocenosis, called after her name.

Resourse Species. In 1978 a decline in the population of *Mytilus galloprovincialis* was detected, although the harvesting was gradually halted (Marinov 1978, 1990; Konsulov & Konsulova 1993, 1998). The main reasons for mass mortalities appear to have been the eutrophication and destruction of natural mussel fields by trawling and predatory pressure from *Rapana venosa*. A decrease in the predatory pressure in deeper waters and stopping of trawling has resulted in a progressive restoration of mussel resources. In 1990s, the commercial farming of *M. galloprovincialis* on artificial substrata was mostly near the town of Sozopol, where the harvest had reached 150 tons per year (Konsulov & Konsulova 1993, 1998; Konsulov 1998). In 2009, the harvest reached 812 t/y. Today the number of mussel farms is 17; the farm near Kavarna alone has the capacity of 2000 t per year. There is an interest in the exploitation of the populations of *Mya arenaria* and *Chamelea gallina* (Konsulova & Stefanova, 2007).

Conservation Significance is confirmed for 19 species (39.6%) of mussels (Table 2): Three species are included in the Black Sea Red Data Book; 14 species – in the Black Sea Zoobenthost List IUCN Criteria and 13 species – in the Bucharest Convention; *Pholas dactylus* is a rare species with a high degree of protection, which is included in all European, Mediterranean and Black Sea fauna conventions [Barcelona Convention, SPA/BD Protocol (Annex II – 1999, 2017), Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean; Bern Convention (Annex II); Black Sea Zoobenthost List IUCN Criteria and Bucharest Convention]. The number of rare taxa is seven. There are differences in the levels of threat of the species in the separate Black Sea countries (Dumont et al. 1999). In Bulgaria, the Kaliakra Reserve and protected area Sand Bank Koketrays are marine protected areas. These include 0.2% of the territorial waters of Bulgaria, 0.1% of the shelf zone to 100 m depth and 0.2% of the protected areas of the country (Todorova et al. 2008a).

Conclusion

A total of 48 species of mussels, divided into 11 orders and 22 families, are known from the Bulgarian Black Sea. They comprise 52.7% of the taxa established in the Black Sea and Azov Sea and 64.0% of the Bulgarian mussels. The order Cardiida (15 species) is the most numerous. Larger families represented by each species each are Cardiidae and Veneridae. Three species are subfossils for the Bulgarian Black Sea coast. Most mussels are found throughout the territory of the Bulgarian Black Sea coast. The species found in one of the two parts of the coast (north or south) are rare forms and their distribution is related to the level of exploration of the respective region. The mussels are divided into 23 zoogeographical categories, combined into four groups. The number of forms with Cosmopolitan, Atlantic-Pacific and Atlantic-Indian type of distribution (14 species total – 29.2%) is considerably smaller than the forms of the Atlantic type (34 species – 70.8%). Most of the species (31 species – 64.6%) have an Atlantic-Mediterranean origin. The Mediterranean species are five (10.4%). Four alien species have been established, of which two species are invasive. The complex of endemics (three species – 6.2%) is represented by the Pontian-Caspian subfossil relicts. In the Bulgarian shelf, 12 biocenoses and a large number of groups are distinguished, which are characterised by specific types of mussels. Typical of the Black Sea is the zone at a depth of 40 to 140 m, composed of *Mytilus galloprovincialis* (to 70 m) and *Modiolula phaseolina* (70–140 m). Biogenic reefs built by *Ostrea edulis* but without living forms have been established. Nineteen species have a conservation value – 39.6%. *Mytilus galloprovincialis* is cultivated by 17 mussel farms, some of which have a capacity of 2000 t per year.

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References

Abbott R. & Dance R. 1991. Compendium of Seashells. London, Charles Letts & Co. 411 p.

Alexandrova A., Ignatova-Ivanova T., Bachvarova D., Toschkova S., Doichinov A., Ibryamova S. & Chipev N. 2022. Pilot Screening and Assessment of Microplastic Bioaccumulation in Wedge Clams *Donax trunculus* Linnaeus, 1758 (Bivalvia) from the Bulgarian Black Sea Coast. Acta Zoologica Bulgarica 74 (4): 569–577.

Alexandrova A., Ignatova-Ivanova T., Ibryamova S., Georgieva S., Stancheva M., Peteva Z., Georgieva A., Tsvetanova E., Miloshev G., Ivanov P. & Chipev N. 2024. Stress ecology of wedge clams *Donax trunculus* Linnaeus, 1758 from sandy habitats of the Bulgarian Black Sea coast. Acta zoologica bulgarica, Supplement 18: 17-25.

Băncilă R., Skolka M., Ivanova P., Surugiu V., Stefanova K., Todorova V. & Zenetos A. 2022. Alien species of the Romanian and Bulgarian Black Sea coast: state Of knowledge, uncertainties, and needs for future research. Aquatic Invasions 17 (3): 353–373, https://doi.org/10.3391/ai.2022.17.3.02

Biserkov V. & Golemanski V. (Eds.). 2011. Red Data Book of the Republic of Bulgaria. Digital edition. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water.

Biserkov V. & Golemanski V. (Eds.). 2015. Red Data Book of the Republic of Bulgaria. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water, 1–3, ISBN 978-954-9746-20-4 (BAS).

Borcea I. 1926. Note sur les moules et sur les faciès ou biocénoses à moules de la région littorale roumaine de la Mer Noire. Annales scientifiques de l'Université de Jassy 14: 129–139.

Borcea I. 1931. Nouvelles contributions à l'étude dela faune bentique dans la Mer Noire près du littoral roumain. – Annales scientifiques de l'Université de Jassy 16: 655–750.

Borcea I. 1937. Les résultats de l'expédition de recherches dans la Mer Noire du 28 août – l septembre 1935. Annales scientifiques de l'Université de Jassy 23: 1–26.

Bruyne R. 2003. The complete encyclopedia of shells. Lisse, Rebo. 336 p.

Bulgurkov K. 1963. Faunistic findings of Crustacea and Mollusca along the western coast of the Black Sea. Bulletin de l'Institut central de recherche scientifique de pisciculture et de pêcherie (Varna) 3: 265–267. (in Bulgarian).

Caspers H. 1951. Quantitative Untersuchungen über die Bodentierwelt des Schwarzen Meeres im bulgarischen Küstenbereich. Archiv für Hydrobiologie 45 (1–2): 1–192.

Caspers H. 1952. Untersuchungen über die Tierwelt von Meeressalinen an der bulgarischen Küste des Schwarzen Meeres. Zoologischer Anzeiger 148 (5/8): 243–259.

Chartosia N., Anastasiadis D., Bazairi H., Crocetta F., Deidun A., Despalatović M., Di Martino V., Dimitriou N., Dragičević B., Dulčić J., Durucan F., Hasbek D., Ketsilis-Rinis V., Kleitou P., Lipej L., Macali A., Marchini A., Ousselam M., Piraino S., Stancanelli B., Theodosiou M., Tiralongo F., Todorova V., Trkov D., & Yapici S. 2018. New Mediterranean Biodiversity Records (July 2018). Mediterranean Marine Science 19 (2): 398–415. https://doi.org/10.12681/mms.18099

Chichkoff G. 1912. Contribution à l'étude de la faune de la Mer Noire. Animaux récoltés sur les côtes bulgares. Archives de zoologie expérimentale et générale, 5e sér. 10 (2): 29–39.

Cvetkov L. & Marinov T. 1986. Faunistic enrichment of the Black Sea and changes in its benthic ecosystems. Hydrobiology (Sofia) 27: 3–20 (in Russian).

Deltshev C., Andreev S., Blagoev G., Golemansky V., Milojkova G., Peneva V., Dobrev D., Todorov M. & Hubenov Z. 1993. Invertebrates (Non Insecta) in Bulgaria (Protozoa, Nematoda, Oligochaeta, Mollusca, Crustacea, Myriapoda, Araneae, Acari). In: Sakalian M. (Ed.). Bulgaria's biological diversity: Conservation status and Needs Assessment. 1. Sofia, 149–244. (in Bulgarian).

Deltshev C., Andreev S., Blagoev G., Golemansky V., Milojkova G., Peneva V., Dobrev D., Todorov M. & Hubenov Z. 1998. Invertebrates (Non Insecta) in Bulgaria. In: Meine C. (Ed.). Bulgaria's biological diversity: Conservation status and Needs Assessment. Washington-Sofia, Pensoft, 109–161.

Dimitrov P., Michova E. & Peichev V. 1998. Palaeooceanological reconstruction in the West Back sea part during the Quaternary. Institute of Oceanology 2: 127–139. (in Bulgarian).

Dumont H., Mamaev V. & Zaitsev Y. 1999 (Eds.): Black Sea Red Data Book. New York, UNOPS. 413 p.

Earle S. & Glover L. 2009. Ocean an illustrated atlas. Washington, National Geographic. 352 p.

Elder D. & Pernetta J. 1991. The Random House atlas of the oceans. IUCN, New York, Random House. 200 p.

Evlogiev Y. 2009. Pliocene surface and high Quaternary terraces in the Batova River valley, Northeast Bulgaria. Review of the Bulgarian Geological Society 70 (1–3): 91–101. (in Bulgarian).

Georgiev B. & Nikolov P. 2010. Invertebrates in the Pomorie Wetland. In: Collection with reports Pomorie Lake region (Protected Site "Pomorie Lake", Ramsar Site, NATURA 2000 sites "Pomorie" BG 0000620 and "Pomorie Lake" BG 0000152), 72–87. (in Bulgarian).

Gogaladze A., Son M., Lattuada M., Anistratenko V., Syomin V., Pavel A., Popa O., Popa L., ter Poorten J.-J., Biesmeijer J., Raes N., Wilke T., Trichkova T., Hubenov Z., Vinarski M., Anistratenko O., Alexenko T. & Wesselingh F. 2021. Decline of unique Pontocaspian biodiversity in the Black Sea Basin: A review. Ecology and Evolution 2021: 1–25. doi:10.1002/ece3.8022

Golikov A. 1982. On principles of regionalization and unification of terminology in marine biogeography. In: Kusakin O. (Ed.): Marine Biogeography, Its Subject, Methods, and Principles of Regionalization. Moscow, Nauka, 94–98 (in Russian).

Gomoiu M.-T., B. Alexandrov, N. Shadrin & Y. Zaitsev. 2002. The Black Sea – a recipient, donor and transit area for alien species. In: Geppäkaki E., S. Gellasch and S. Olonin (Eds.): Invasive aquatic species of Europe. Distribution, impacts and management. Dordrecht, Kluwer Academic publishers, 341–350.

Guryanova Ye. 1964. Zoogeographic regionalization of the benthic fauna of the World Ocean. In: Physico-geographical Atlas of the World, Moscow, Map 68 B, 291–292. (in Russian).

Hayward P., Nelson-Smith T. & Shields Ch. 1996. Sea Shore of Britain and Europe. London, Collins. 352 p.

Hook P. 2008. A concise guide to the seashore. Melbourne, Parragon. 256 p.

Hubenov Z. 2005a. *Dreissena* (Bivalvia: Dreissenidae) – systematics, autochthonous and anthropogenic areas. Acta Zoologica Bulgarica 57 (3): 259–268.

Hubenov Z. 2005b. Malacofaunistic diversity of Bulgaria. In: Petrova, A. (Ed.): Current state of Bulgarian biodiversity – prblems and perspectives. Sofia, Bulgarian Bioplatform, Drakon, 199–246. (In Bulgarian).

Hubenov Z. 2007a. Fauna and zoogeography of marine, freshwater, and terrestrial mollusks (Mollusca) in Bulgaria. – In: Fet V. & Popov A. (Eds.): Biogeorraphy and ecology of Bulgaria. Springer, Dodrecht, 141–198.

Hubenov Z. 2007b. Faunistic review, distribution and zoogeographical characteristic of the bulgarian Black Sea mollusks (Mollusca: Polyplacophora, Gastropoda et Bivalvia). Annuaire de l'Université de Sofia "Kliment Ohridski", Faculté de Biologie 96/98 (1 – Zoology): 17–38.

Hubenov Z. 2009. Bezgrabnachni zhivotni – nashestvenitsi po balgarskoto Chernomorie [Invertebrates – invaders along the Bulgarian Black Sea coast]. Bulletin National Oceanographic Commission 6: 24–27.

Hubenov Z. 2015. Species composition of the free living multucellular invertebrate animals (Metazoa: Invertebrata) from the Bulgarian sector of the Black Sea and the coastal brackish basins. Historia naturalis bulgarica 21: 49–168.

Hubenov Z., Kenderov L. & Pandourski I. 2015. Invertebrate Animals (Metazoa: Invertebrata) of the Atanasovsko Lake, Bulgaria. Historia naturalis bulgarica 22: 43–69.

Kalcheva S. 2017. Shell size and population density of *Cerastoderma glaucum* Poiret 1789 (Mollusca: Bivalvia) in „Pomorie Lake" (Black Sea coast, Bulgaria). ZooNotes 105: 1–4.

Kalcheva S. 2018. Ecological study of bentic mollusks in Pomorie Lake Protected Area. Ph.D. thesis, Stara Zagora, Trakia University, Faculti of Agriculture, Departmant of Biology and aquaculture. 177 p. (in Bulgarian).

Kalcheva S. 2019. Ecological study of bentic mollusks in Pomorie Lake Protected Area. Dissertation abstract, Ph.D. thesis, Stara Zagora, Trakia University, Faculti of Agriculture, Departmant of Biology and aquaculture. 36 p. (in Bulgarian).

Kalcheva S., Georgiev D. & Georgiev D. 2015. Malacofauna (Gastropoda and Bivalvia) of the "Pomoriysko ezero" protected area: preliminary results. Journal of BioScience and Biotechnology, Faculty of Biology, Plovdiv University (Special edition / Online Section "Biodiversity & Ecology", Second National Youth Conference "Biological sciences for a better future", Plovdiv, October 30-31, 2015), 281–183.

Kaneva-Abadjieva V. 1957. Mollusca and Malacostraca im Varnasee. Arbeiten aus der Biologischen Meeresstation in Varna, Bulgarien 19: 127–154. (in Bulgarian).

Kaneva-Abadjieva V. 1958. A new harmful snail on our coast of Black Sea. Nature (Sofia) 7(3): 89–91. (in Bulgarian).

Kaneva-Abadjieva V. 1960a. Materials to the study of the mollusc fauna in the Back Sea at the Bulgarian shores. Travaux de l'Institut de recherches scientifiques sur la pêche et les industries s'y rattachant (Varna) 2: 149–172. (in Bulgarian).

Kaneva-Abadjieva V. 1960b. Researches on zoobenthos of the Bay of Varna in respect of Mollusca and Malacostraca. Travaux de l'Institut de recherches scientifiques sur la pêche et les industries s'y rattachant (Varna) 2: 173–194. (in Bulgarian).

Kaneva-Abadjieva V. 1960c. Higher crustaceans in mussel overgrowths in the gulf of Varna. Bulletin de l'Institut zoologique de l'Academie des sciences de Bulgarie 9: 399–403. (in Bulgarian).

Kaneva-Abadjieva V. 1962. Répartition des mollusques de la Mer Noire dans les eaux littorales bulgares. Bulletin de l'Institut central de recherche scientifique de pisciculture et de pêcherie (Varna) 2: 67–79. (in Bulgarian).

Kaneva-Abadjieva V. 1968. Distribution des mollusques subfossiles devant le littoral bulgare de la Mer Noire. Report. Comité internationale Mer Méditerranée 19 (2) : 213–215.

Kaneva-Abadjieva V. 1974. A new mussel species for our Black Sea Coast. Nature (Sofia) 23 (2): 64–65. (in Bulgarian).

Kaneva-Abadjieva V. 1976. On the alimentary zoobenthos dynamics in Bourgas Lake and Mandra Dam during the 1967–1974 period. Proceedings Institute of Fisheries (Varna) 14: 43–56. (in Bulgarian).

Kaneva-Abadjieva V. & Marinov T. 1960a. Nourriture de quelques poissons benthophaques. Travaux de l'Institut de recherches scientifiques sur la pêche et les industries s'y rattachant (Varna) 2: 41–72. (in Bulgarian).

Kaneva-Abadjieva V. & Marinov T. 1960b. Zoobenthos distribution in the Bulgarian Black Sea area. Arbeiten des Zentralen Forschungsinstitutes für Fischzucht und Fischerei Varna 3: 117–166. (in Bulgarian).

Kaneva-Abadjieva V. & Marinov T. 1965. Fouling organisms along the Bulgarian Black Sea Coast. Proceedings of the Research Institute of Fisheries and Oceanography (Varna) 6: 137–145. (in Bulgarian).

Kaneva-Abadjieva V. & Marinov T. 1966. Distribution of the zoobenthos in the sand biocoenosis of the Bulgarian Black Sea coast. Proceedings of the Research Institute of Fisheries and Oceanography (Varna) 7: 69–95. (in Bulgarian).

Kaneva-Abadjieva V. & Marinov T. 1967. Dynamics of the zoobenthos in the lakes along the Bulgarian Black Sea coast in the 1964–1966 period. Proceedings of the Research Institute of Fisheries and Oceanography (Varna) 8: 177–194. (in Bulgarian).

Kaneva-Abadjieva V. & Marinov T. 1977. The zoobenthos in the cystozyr fouling biocenosis. Hydrobiology, 6: 76–88. (in Bulgarian).

Kaneva-Abadjieva V. & Marinov T. 1984. A new mollusk species for the Black Sea, *Cunearca cornea* (Reeve). Nature (Sofia), 33(5): 63–64. (in Bulgarian).

Kantor Yu. & Sysoev A. 2005. Catalogue of Mollusks of Russia and Adjacent Countries. Moscow. KMK Scientific Press. 627 p. (in Russian).

Kobelt W. 1897-1898. Studien zur Zoogeographie 1. Die Fauna der palaearktischen Region. Wiesbaden, 344 p.

Konsulov A. 1998. Black Sea Biological Diversity (Bulgaria). Black Sea Environmental programme. Series. 5. Istanbul, UN Publications. 131 p.

Konsulov A. & Konsulova T. 1993. Biodiversity of the Black Sea benthos and plankton. In: Sakalian M. (ed.): The National Biological Diversity Conservation Strategy. 1.

Biodiversity Support Program, Sofia, Pensoft, 473–514. (in Bulgarian).

Konsulov A. & Konsulova T. 1998. Biological diversity of the Black Sea zoobenthos and zooplankton. – In: Meine C. (ed.): Bulgaria's Biological Diversity: Conservation Status and Needs Assessment. 1/2. Biodiversity Support Program, Washington, Pensoft, 319–346.

Konsulova T., K. Stefanova. 2007. Black Sea Species. In: Evaluation of the alien for the Bulgarian fauna species and measures to reduce their impact on natural ecosystems and native species. National Report, Ministry of Environment and Water of Bulgaria.

Konsulova T., Trayanova A. & Todorova V. 2010. Sand bank Koketrays – a Case Study on the Effect of Marine Protected Area Designation as a Key Approach to Black Sea Biodiversity and Habitats Conservation (2010). Acta Zoologica Bulgarica 62 (1): 89–97.

Lattin G. de. 1967. Grundriss der Zoogeographie. Hochschullehrbücher für Biologie. Band 12. Jena, VEB Gustav Fischer Verlag. 602 p.

Marinov T. 1978. Estestveni zapasi ot chernata mida v balgarskiya shelf na Cherno more [Natural stocks of the black mussel in the Bulgarian shelf of the Black Sea]. Ribno stopanstvo 5: 4-5. (in Bulgarian).

Marinov T. 1979. Composition, ecology and economic importance of zoobenthos in the Bulgarian Black Sea shelf. Dr. Sci. thesis, Sofia, Bulgarian Academy of Sciences. 414 p. (in Bulgarian).

Marinov T. 1990. The Zoobenthos from the Bulgarian Sector of the Black Sea. Sofia, Publishing House of the Bulgarian Academy of Sciences. 195 p. (in Bulgarian).

Marinov T. & Golemansky V. 1989. Second suplement to the catalogue of the Bulgarian Black Sea fauna. Acta Zoologica Bulgarica 37: 3–34. (in Bulgarian).

Marinov T. & Stoykov S. 1982. Findings of sand gaper (*Mya arenaria*) in front of the Bulgarian Black Sea coast. Bulletin of the National Oceanographic Committee 3: 9–16. (in Bulgarian).

Marinov T. & Stoykov S. 1995. Zoobenthos distribution in Bulgarian continental shelf of the Black Sea. Proceedings of the Institute of Fisheries (Varna) 23: 119–137. (in Bulgarian).

Marinov T. & Stoykov S. 1982. Findings of sand gaper (*Mya arenaria*) in front of the Bulgarian Black Sea coast. Bulletin of the National Oceanographic Committee 3: 9–16. (in Bulgarian).

Marinov T., Stoykov S. & M'Barek M. 1983. The zoobenthos of the sublittoral and muddy bottom of bay of Varna. Proceedings of the Institute of Fisheries (Varna), 20: 109–133. (in Bulgarian).

Merdzhanova A., Panayotova V., Peycheva K., Stancheva R., Dobreva D., Makedonski L., Petrova-Pavlova E. & Mihneva V. 2024. *Donax trunculus* L., 1758 (Bivalvia: Donacidae) from Bulgarian Waters of the Black Sea as a sustainable source of macronutrients. Acta zoologica bulgarica, Supplement 18: 27-32.

Mihailova-Neikova M. 1961. Hydrobiological research of the Mandra Lake with regard to its importance as a fishing ground. Annuaire de l'Université de Sofia, Faculté de Biologie, Géologie et Géographie 53 (1 – Zoology): 57–123. (in Bulgarian).

Mischev K. & Popov V. 1978. Morphographische Charakteristik des Schwarzmeerbeckens. In: The Black Sea. Varna, G. Bakalov, 36–46. (in Bulgarian).

Mitov P., Uzunova S., Kenderov L., Dimov S. & Yanachkov P. 2020. Pacific oyster invasion along Bulgarian Black Sea coast. Poster – Kliment's Days 2020, Faculty of Biology, Sofia University.

Mordukhay–Boltovskogo F. 1960. The Caspian Fauna in the Azov–Black Sea Basin. Moscow & Leningrad, Publishing House of the Academy of Sciences of the USSR. 288 p. (in Russian).

Mordukhay–Boltovskogo F. 1972. General characteristic of the fauna of the Black and Azov Seas. In: Mordukhay–Boltovskogo F. (Ed.): The Key for the Fauna of the Black and Azov Seas. 3. Kiev, Naukova dumka, 316–324. (in Russian).

Nesis K. 1982. Zoogeographical position of the Mediterranean Sea. In: Kusakin O. (ed.): Marine Biogeography, Its Subject, Methods, and Principles of Regionalization. Moscow, Science, 270–299. (in Russian).

Nevesskaya L. 1965. Poznechetvertichnye dvustvorchatye mollyuski Chernogo morya ih sistematika i ekologiya. Moskva, Nauka. 391 p. (in Russian).

Nguen Suan Li. 1984. Qualitative composition and quantitative distribution of zoobenthos in the Bourgas Bay. Ph.D. thesis, Sofia, Bulgarian Academy of Sciences. 177 p. (in Bulgarian).

Nikula R. & Väinölä R. 2003. Phylogeography of *Cerastoderma glaucum* (Bivalvia: Cardiidae) across Europe: a major break in the Eastern Mediterranean. Marine Biology 143:339–350.

Nikolov G., Atanasov A., Georgiev D. & Raichev E. 2010. Analysis of the plankton in the area around the cape Maslen Nos, Bulgaria: Possibilities for cultivation of mediterranean mussels (*Mytilus galloprovincialis*). Ecologia Balkanika 2: 15–18.

Nordsieck F. 1969. Die europäischen Meeresmuscheln (Bivalvia). Stuttgart, G. Fischer. 253 p.

Paspalev G. 1933. Hydrobiologische Untersuchungen über den Golf von Varna. Arbeiten aus der Biologischen Meeresstation in Varna 2: 1–18.

Petrova E., Mihneva V., Stoykov S., Klisarova D., Uzunova S., Dineva S. & Gerszhikov D. 2023. Environmental status and dynamics of shellfish resources – veined rapa whelkand black mussel in the Western Blsck Sea during 2015-2016. Proceedings of the Institute of Fishing Resources 28: 7-24.

Peycheva K., Panayotova V., Merdzhanova A., Stancheva R., Dobreva D., Makedonski L., Petrova-Pavlova E. & Mihneva V. 2024. Trace elements risk assessment for consumption of the bivalve species *Chamelea gallina* (L., 1758) (Veneridae) and *Donax trunculus* L., 1758 (Donacidae) along the Black Sea coastline of Bulgaria. Acta zoologica bulgarica, Supplement 18: 33-40.

Prodanov K., Moncheva S., Konsulov A., Kamburska L., Konsulova Ts. & Dencheva K. 2001. Recent ecosystem trends along the Bulgarian Black Sea coast. Proceedings of the Institute of Oceanology 3: 110–127.

Revkov N., Abaza V., Dumitrache C., Todorova V., Konsulova T., Mickashavidze E., Vershanidze M., Sezgin M., Ozturk B., Chikina M. & Kucheruk N. 2008. The state of zoobenthos. T. Oguz (ed.): BSC, 2008. State of the Environment of the Black Sea (2001–2006/7). Istanbul, Publications of the Commission on the Protection of the Black Sea Against Pollution (BSC) 2008–3, 273–320.

Riedl R. 1983. Fauna und Flora des Mittelmeeres. Hamburg, P. Parey. 836 p.

Shopov V. 1993. Stratigraphy of the Quaternary of Bulgarian Black Sea shelf sediments. Review of the Bulgarian Geological Society 54 (1): 83–97. (in Bulgarian).

Shopov V. 1996. Quaternary chroostratigraphy of Bulgaria. Review of the Bulgarian Geological Society 57 (3): 37–42. (in Bulgarian).

Skarlato O. & Starobogatov Y. 1972. Class of Bivalve Mollusks – Bivalvia. – In: Mordukhay-Boltovskogo F. (Ed.): The Key for the Fauna of the Black and Azov Seas. 3. Kiev, Naukova dumka, 178–249. (in Russian).

Starobogatov Y. 1970. Fauna of Mollusks and Zoogeographic Regionalization of the Continental Water Bodies of the World. Leningrad, Science. 372 p. (in Russian).

Stoykov S. 1983. Preliminary data on age and growth of the Soft Clam, *Mya arenaria* L., of the Bulgarian coast. Proceedings of the Institute of Fisheries (Varna) 20: 161–167. (in Bulgarian).

Stoykov S. 1996. Investigation on macrozoobenthos in the shelf along the Bulgarian Black Sea coast during the period 1995–1996. Proceedings of the Institute of Fisheries (Varna), 24: 117–123. (in Bulgarian).

Stoykov S., Uzunova S. 1999. Dynamics of macrozoobenthos from the Bourgas Bay (Bulgarian Black Sea coast) during the period 1993–1995. Proceedings of the Institute of Fisheries (Varna), 25: 153–154. [349]

Studencka B. & Jasionowski M. 2011. Bivalves from the Middle Miocene reefs of Poland and Ukraine: A new approach to Badenian/Sarmatian boundary in the Paratethys. Acta geologica polonica 61 (1): 79–114.

Todorova V. 2005. Environmental status of zoobenthos communities of sublittoral sediments of the continental shelf in the northwestern part of the Black Sea and in front of the Bulgarian coast. Ph.D. thesis, Sofia, Bulgarian Academy of Sciences. 206 p. (in Bulgarian).

Todorova V. 2011. Black mussels and / or barnacle communities on mediolittoral rocks. Littoral sands and muddy sands. Underwater „meadows" of sea grasses. In: Red Data Book of the Republic of Bulgaria. Digital edition. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water.

Todorova V. 2015. Black mussels and / or barnacle communities on mediolittoral rocks. Littoral sands and muddy sands. Underwater „meadows" of sea grasses. In: Red Data Book of the Republic of Bulgaria. 3. Natural habitats. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water, 44–47, 51–52.

Todorova V. 2017. Zoobenthic indicators for assessment of sandy bottom habitats. In: Todorova V. and Milkova T. (Eds). Final project report „Investigations on the State of the Marine Environment and Improving Monitoring Programs developed under MSFD (ISMEIMP)", IO-BAS and BSBD-Varna, 2017, ISBN:978-619-7244-02-1, pp. 23–47.

Todorova V. (Ed.). 2021. Black Sea monitoring and assessment guideline. ANEMONE Deliverable 1.3, CD Press, 190 p. ISBN 978-606-528-527-9.

Todorova V., Micu D., Panayotova M. and Konsulova T. 2008a. Marine Protected Areas in Bulgaria – Present and Prospects. Varna, HelixPres. 20 p. (in Bulgarian).

Todorova V., Trayanova A. & Konsulova T. 2008b. Biological monitoring of coastal marine waters and lakes – benthic invertebrate fauna. Report. Varna, Institute of Oceanology, Bulgarian Academy of Sciences, 46 p. [Online: http://www.bsbd.org/UserFiles/Report_zoobenthos_final%20]

Todorova V., Micu D. & Klisurov L. 2009. Unique oyster reefs discovered in the Bulgarian Black Sea. Comptes rendus de l'Académie bulgare des Sciences 62 (7): 871–874.

Todorova V. & Milkova T. 2017 (Eds.). Investigations on the State of the Marine Environment and Improving Monitoring Programs developed under MSFD. Institute of Oceanology, Bulgarian Academy of Sciences. 595 p. ISBN 978-619-7244-03-8. (in Bulgarian).

Todorova V. & Moncheva S. 2013 (Eds.). Parvonachalna otsenka na sastoyanieto na morskata okolna sreda [Initial assessment of the state of the marine environment]. Institute of Oceanology, Bulgarian Academy of Sciences, 493 p.

Todorova V. & Panayotova M. 2011. Infralittoral rocks and other hard substrates. *Cystoseira* spp. on exposed to waves infralittoral bedrock and boulders. Sublittoral sands. Sublittoral mussel beds on sediments. In: Red Data Book of the Republic of Bulgaria. Digital edition. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water.

Todorova V. & Panayotova M. 2015. Infralittoral rocks and other hard substrates. *Cystoseira* spp. on exposed to waves infralittoral bedrock and boulders. Sublittoral sands. Sublittoral mussel beds on sediments. In: Red Data Book of the Republic of Bulgaria. 3. Natural habitats. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water, 54–58, 60–63.

Todorova V., Panayotova M., Bekova R. & Prodanov B. 2022. Recovery of *Flexopecten glaber* (Linnaeus, 1758) (Bivalvia: Pectinidae) in the Bulgarian Black Sea Waters: Recent Distribution, Population Characteristics and Future Perspectives for Protection and Commercial Utilisation. Acta Zoologica Bulgarica 74 (3): 437–444.

Todorova V., Panayotova M. & Doncheva V. 2023. Distribution and impact on benthic habitats of the non-native invasive species *Rapana venosa* in the Bulgarian Black-Sea. In: Trichkova T., Kalcheva H., Tomov R., Vladimirov V. & Tyufekchieva V. (Eds.). Book of Abstracts. Joint ESENIAS and DIAS Scientific Conference 2023 and 12th ESENIAS workshop, 11–14 October 2023, Varna, IBER-BAS, ESENIAS, DIAS, p. 66.

Trayanova A. 2003. Ecological status of mscrozoobenthic communities in Beloslav and Varna Lakes during the autumn of 1999. Proceedings of the Institute of Oceanology (Varna) 4: 140–148.

Trayanova A. 2008. Ecological status of zoobenthos from sediments of Beloslav Lake, Varna Lake and Varna Bay. Ph.D. thesis, Sofia, Bulgarian Academy of Sciences, 200 p. (in Bulgarian).

Trayanova A., Todorova V., Konsulova T., Shtereva G., Hristova O.& Dzhurova B. 2011. Ecological State of Varna Bay in Summer 2009 according to Benthic Invertebrate Fauna. Acta Zoologica Bulgarica 63 (3): 277–288.

Traykov I. & Ivanov P. 2015. Estuaries (16C2). In: Red Data Book of the Republic of Bulgaria. 3. Natural habitats. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water, pp. 104–106.

Valchev V., Vassilev V. & Georgiev V. 2015. Submerged macrophytic communities in hypersaline water bodies. – In: Red Data Book of the Republic of Bulgaria. 3. Natural

habitats. Sofia, Bulgarian Academy of Sciences & Ministry of Environment and Water, pp. 52–54.

Valkanov A. 1935. Notizen über die Brackwässer Bulgariens. I. Annuaire de l'Université de Sofia. Faculté physico-mathématique 31 (3): 249–303 (in Bulgarian).

Valkanov A. 1936. Notizen über die Brackwässer Bulgariens. II. Versuch einer hydrographischen und biologischen Erforschung derselben. Annuaire de l'Université de Sofia. Faculté physico-mathématique 32 (3): 209–341 (in Bulgarian).

Valkanov A. 1957. Katalog unserer Schwarzmeerfauna. Arbeiten aus der Biologischen Meeresstation in Varna 19: 1–62 (in Bulgarian).

Valkanov A. & Marinov T. 1964. Nachtrag zum Katalog der Bulgarischen Schwarzmeerfauna. Bulletin de l'Institut de zoologie et musée 17: 51–59 (in Bulgarian).

Valkanov A. & Marinov T. 1978. Zoobenthos. In: Valkanov A., Ch. Marinov, Ch. Danov and P. Vladev (Eds.): The Black Sea. Varna, G. Bakalov, 181–190 (in Bulgarian).

Valkanov A., Petrova V., Roshdestvenski A., Marinov T. & Naidenov V. 1978. Black Sea lakes. In: Valkanov A., Marinov Ch., Danov Ch. & Vladev P. (Eds.): The Black Sea. Varna, G. Bakalov, 262–283 (in Bulgarian).

Vassilev V. & Konsulov A. 1998. Zooplankton in the lake Pomoriysko – compositiom, dynamics, trophic interactions and secondary assimilation. Proceedings of the Institute of Oceanology 2: 146–153 (in Bulgarian).

Vidinova Y., Tyufekchieva V., Varadinova E., Stoichev S., Kenderov L., Dedov I. & Uzunov Y. 2016. Taxonomic list of benthic Macroinvertebrate communities of inland standing water bodies in Bulgaria. Acta Zoologica Bulgarica 68 (2): 147–158.

Wilke T. 1995. *Hemilepton nitidum* (Turton, 1822) and *Mysella bidentata* (Montagu, 1803), two bivalve species new for the Bulgarian Black Sea coast. Proceedings of the Institute of Fisheries – Varna, 23: 138–147.

Zernov S. 1913. On the question of life in the Balack sea. Zap. Imp. Akad. Nauk, S.-Peterb. 32 (1): 299 p. (in Russian).

Zapryanov L. 1992. Morfologichna harakteristika na midata *Scapharca inaeqvivalvis* (Brugiere, 1789) (Bivalvia, Anadaridae) ot Cherno more [Morphological characteristics of the clam *Scapharca inaeqvivalvis* (Brugiere, 1789) (Bivalvia, Anadaridae) from the Black Sea]. Izvestiya na Narodniya muzey – Varna 28 (43): 361–365.

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