

THE INVASIVE ALIEN SPECIES IN THE BLACK SEA COAST OF GEORGIA

Madona VARSHANIDZE *, *Marina MGELADZE* *, *Tsiuri GVARISHVILI* *,
Eteri MIKASHAVIDZE *, *Ramaz MIKELADZE* * and *Paata VADACHKORIA* *

* National Environmental Agency, Fisheries, Aquaculture and Water Biodiversity Department, Batumi, 53 Rustaveli Street, Georgia, GE-6000, ORCID: 0000-0001-9592-9098, varshanidzema@gmail.com; ORCID:0000-0001-8174-3188, email:mari.mgeladze@gmail.com; ORCID:0000-0002-5615-4362, email tsiuri.gvarishvili@gmail.com; ORCID: 0000-0001-5631-7902, eteri.mikashavidze@gmail.com; ORCID: ORCID:0000-0003-2971-5811, rmikeladze@gmail.com; ORCID: 0000-0003-4206-0602, vadach@gmail.com.

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ABSTRACT

The aim of the present paper is to compile a list of the invasive alien species on the Black Sea coast of Georgia. The results have been received from an assessment of data collected from different sources. According to recent data, the greatest number of species (36%) has arrived into the Black Sea from the Mediterranean as a consequence of expanding the natural range or coming through the ballast waters. This proportion has increased with the rising water temperatures of the upper layer. Only a few of these species have become abundant and almost none have reached other seas of the Ponto-Caspian. Among these species are the representatives of micro-, phyto- and zooplankton, demersal plankton, macrophytes, zoobenthos and fish.

RÉSUMÉ: Les espèces exotiques envahissantes de la côte de la mer Noire en Géorgie.

Le but du présent document est de compiler une liste des espèces exotiques envahissantes sur la côte de la mer Noire en Géorgie. Les résultats proviennent d'une évaluation des données agrégées à partir d'un réseau de différentes sources. Selon des données récentes, le plus grand nombre d'espèces (36%) est arrivé dans la mer Noire depuis la Méditerranée à la suite de l'expansion naturelle de l'aire de répartition ou en passant par les eaux de ballast. Cette proportion ne cesse d'augmenter avec la hausse des températures de l'eau de la couche supérieure. Seules quelques-unes de ces espèces sont devenues abondantes et presque aucune n'a atteint les autres mers du Ponto-Caspien. Parmi ces espèces figurent les représentants du micro-, du phyto et du zooplancton, du plancton démersal, des macrophytes, du zoobenthos et des poissons.

REZUMAT: Specii alohtone invasive de pe coasta Mării Negre a Georgiei.

Scopul prezentei lucrări este de a compila o listă a speciilor exotice invazive de pe coasta Mării Negre din Georgia. Rezultatele provin dintr-o evaluare a datelor obținute dintr-o rețea de surse diferite. Conform datelor recente, cel mai mare număr de specii (36%) a ajuns în Marea Neagră dinspre Mediterană ca urmare a extinderii ariei naturale sau a aducerii lor în apele de balast. Această proporție continuă să crească odată cu creșterea temperaturii apei din stratul superior al mării. Doar câteva dintre aceste specii au devenit abundente și aproape niciuna nu a ajuns în alte mări Ponto-Caspice. Printre aceste specii se numără reprezentanții micro, fito și zooplanctonului, planctonului demersal, a macrofitelor, zoobentosului și peștilor.

INTRODUCTION

Invasive alien species (IAS) are one of the great problems of the modern times (Curtean-Bănăduc and Bănăduc, 2008; Skolka and Preda, 2010; Yankova et al., 2013; European Commission, 2016; Anastasiu et al., 2017; Prots and Simpson, 2011; Kohsnud et al., 2013; Popova and Zlatanova, 2017; Radkhah and Eagderi, 2020; Hiz and Aki, 2014; Ghasemi et al., 2014). The increasing number of alien species in the Black Sea since 2000 seems to be related to the climate change as it presumably is connected with a parallel increase in water temperature (Shalovenkov, 2020).

Reliable scientific information and data about the changes in the distribution and abundance of alien species in the Mediterranean and the Black Sea are essential for understanding their ecological and economic impacts, and influence on human health (Öztürk, 2021).

Many alien species are transported daily, around the world (Carlton et al., 1996). The number of alien species in the Black Sea has continually increased (Boltachev and Karpova, 2014). Zaitsev and Mamaev (1997) described 26 alien species from the Black Sea. Subsequently, Zaitsev and Öztürk (2001) recorded that 59 species of alien marine organisms live in the Black Sea, and yet only a few species, such as the sea snail *Rapana venosa* and the comb jelly *Mnemiopsis leidye*, have been well studied in terms of their impact on fisheries (Öztürk, 2021). Other surveys indicated the presence of 156 alien species in the Black Sea, with most of these species coming from the Mediterranean (Shiganova and Öztürk, 2009). The Advisory Group on Conservation of Biological Diversity at the Commission for the Protection of the Black Sea Against Pollution (BSC) has monitored for more than 10 years the appearance of new species in the sea and created a register of alien organisms, which includes 365 marine, brackish, and freshwater species from fungi and unicellular algae to mammals (Aleksandrov et al., 2013). More recently, the intensity of invasion has significantly increased. Especially, since the second half of the twentieth century, a huge number of marine and brackish-water species has been transported daily by ships to the areas of its ports (Shiganova, 2010; Shiganova et al., 2021). According to preliminary estimates, the rate of introduction was about five IAS per year, and registration of at least 85 alien species was predicted by 2020 (Aleksandrov, 2010; Aleksandrov and Shiganova 2018).

Special studies on IAS in the Black Sea region of Georgia have not been conducted so far. The purpose of this article is to compile a list of invasive alien species of the Black Sea coast of Georgia based on the assessment of data collected from various sources.

MATERIAL AND METHODS

The list of alien species occurring over the past few decades on the Black Sea coast of Georgia has been compiled based on a study of original and published data. In total, more than 30 published sources and unpublished data of Georgian experts were reviewed. The taxonomy of marine species is presented according to the World Register of Marine Species (WoRMS).

RESULTS AND DISCUSSION

Over the last few decades, a total of 43 alien species have been recorded in the Black Sea Georgian coast area including phytoplankton (21 species, 49%), zooplankton (two mesozooplankton and two gelatinous/ctenophora species), macrozoobenthos (nine species) and fish (nine species) (Fig. 1, Tabs. 1-4).

Overall, this work provides a comprehensive multidimensional (scientific and bibliometric) view of the invasion of the southeastern Black Sea coast.

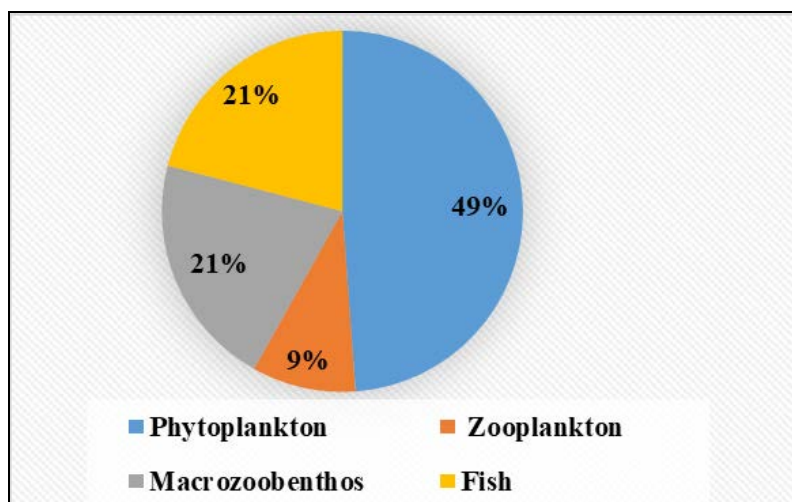


Figure 1: The percentage ratio of the number of alien species of different taxonomic groups on the Black Sea Georgian coast.

The invasive alien phytoplankton species are represented by diatoms and dinophytes in equal numbers. Some of them are quite rare, but many have become quite common species in the Black Sea. The species of the genera *Chaetoceros*, *Gymnodinium*, *Prorocentrum*, *Rhizosolenia*, and *Thalassiosira* are quite common on the Georgian coast (Tab. 1a, b).

Table 1a: Non-native species of phytoplankton in the Black Sea Georgian coast.

	Class	Species
1.	Bacillariophyceae	<i>Cerataulina bergonii</i> Ostefeld, 1903
		<i>Cerataulina pelagica</i> (Cleve) (Hendey, 1937)
2.		<i>Chaetoceros danicus</i> Cleve, 1889
3.		<i>Chaetoceros diversus</i> Cleve 1873
4.		<i>Chaetoceros socialis</i> H. S. Lauder, 1864
5.		<i>Lauderia pumila</i> Castracane, 1886 (<i>Detonula pumila</i> Gran, 1900)
6.		<i>Thalassiothrix mediterranea</i> var. <i>Pacifica</i> Cupp, 1943 (<i>Lioloma pacificum</i> (Cupp) Hasle, 1996)
7.		<i>Rhizosolenia calcar-avis</i> (Schultze 1858) B. G. Sundström, 1986 (<i>Pseudosolenia calcar-avis</i> (Schultze) Sundström, 1986)
8.		<i>Rhizosolenia setigera</i> Brightwell, 1858
9.		<i>Thalassiosira nordenskiöldii</i> Cleve, 1873
10.	<i>Leptocylindrus danicus</i> Cleve, 1889	

Table 1b: Non-native species of phytoplankton in the Black Sea Georgian coast.

	Class	Species
11.	Dinophyceae	<i>Akashiwo sanguinea</i> (K. Hirasaka) G. Hansen and Moestrup, 2000 (<i>Gymnodinium sanguineum</i> Hirasaka, 1924)
12.		<i>Archaeoperidinium minutum</i> (Kofoid) Jørgensen, 1912 (<i>Protooperidinium minutum</i> (Kofoid) Loeblich III, 1970)
13.		<i>Polykrikos geminatus</i> (Schütt) D. Qiu and S. Lin, 2013 (<i>Cochlodinium geminatum</i> (Schütt) Schütt, 1896)
14.		<i>Gymnodinium radiatum</i> Kofoid and Swezy, 1921
15.		<i>Gymnodinium stellatum</i> Hul-burt, 1957
16.		<i>Gymnodinium uberrimum</i> (G. J. Allman) Kofoid and Swezy, 1921
17.		<i>Octactis speculum</i> (Ehrenberg) F. H. Chang, J. M. Grieve and J. E. Sutherland, 2017 (<i>Distephanus speculum</i> f. <i>octonarius</i> (Ehrenberg) S. Locker and E. Martini)
18.		<i>Prorocentrum cordatum</i> (Ostenfeld) J. D. Dodge, 1976
19.		<i>Prorocentrum dentatum</i> Stein, 1883
20.		<i>Scrippsiella acuminata</i> (Ehrenberg) Kretschmann, Elbrächter, Zinssmeister, S. Soehner, Kirsch, Kusber and Gottschling, 2015 (<i>Scrippsiella trochoidea</i> (Stein))
21.	Cryptomonadales	<i>Hillea fusiformis</i> (J. Schiller) J. Schiller, 1925

The presented alien species of zooplankton are distributed throughout the Black Sea. On the Georgian Black Sea coast, they are quite common depending on the season. The thermophilic species of the edible zooplankton *Acartia tonsa* and *Oithona davisae* are dominant in the coastal waters of Georgia in the summer-autumn periods (Kharytonova et al., 2021).

Gelatinous plankton plays an important role in the functioning of the Black Sea marine ecosystems, however in cases of excessive proliferation, this role is negative. Since the 1980s the two invasive alien ctenophore species have invaded the Black Sea. *Mnemiopsis leidyi*, which originates from the Atlantic coast of North and South America, was introduced in 1982 and since then has greatly affected the Black Sea ecosystems (Vinogradov et al., 1989). The invasion by *M. leidyi*, was the most pronounced event that caused cascading effects at higher trophic levels, from a decrease in zooplankton to the collapse of the planktivorous fish and drastic declines among the large pelagic fish and dolphins. Similar effects occurred at lower trophic levels, with a decrease in zooplankton leading to an increase in phytoplankton released from zooplankton grazing pressure, and increases in bacterioplankton, which led to increases in their predators, zooflagellates, and ciliates (Shiganova et al., 2004, 2019, 2021). In 1992, a second ctenophore species, originating from the South Atlantic Ocean, *Beroe ovata* was reported (Konsulov and Kamburska, 1998). Both species have been released with ballast waters into the Black Sea (Ghabooli et al., 2011). The *B. ovata* invasion reduced *M. leidyi* populations and the ecosystem began to recover at all trophic levels (Shiganova et al., 2014, 2018).

Table 2: Invasive alien species of phytoplankton in the Black Sea Georgian coast.

	Class/Order	Species
Mesozooplankton		
1.	Hexanauplia/Calanoida	<i>Acartia (Acanthacartia) tonsa</i> Dana, 1849 (<i>Acartia tonsa</i> Dana, 1849)
2.	Hexanauplia/Cyclopoida	<i>Oithona davisae</i> (Ferrari F. D. and Orsi, 1984)
Macrozooplankton		
3.	Tentaculata/Lobata	<i>Mnemiopsis leidyi</i> (Agassiz, 1865)
4.	Nuda/Beroida	<i>Beroe ovata</i> Bruguière, 1789

Although, the invasive alien species belong to all the taxon and ecological groups, the benthic IAS prevail in the European seas (Streftaris et al., 2005). In 1978-1979 the bivalve mollusk *A. nadara kagoshimensis* which is native to the west Pacific Ocean was recorded for the first time in Georgia, in the benthos of the Chorokhi River mouth, at depths from five to 20 m. At first, some individuals with sizes of 1-2.5 cm were detected, while afterwards bigger individuals (6-8 cm) were found. These bivalves were particularly abundant at Anaklia Town, where the mussel collectors were installed. Currently, this mussel has been widely distributed in the benthos of the Black Sea of Georgia. According to some authors, the reason of its high proliferation is connected to its massive shell and hermetic hooking, which helps the mussel to survive during oxygen deficiency in water (Gogmachadze and Mikashavidze, 2005; Vadachkoria et al., 2020).

In 1929, the polychaeta *Mercierella enigmatica* (*Ficopomatus enigmaticus*) was first recorded from the brackish Paleostomi Lake in Georgia (Annenkova, 1929). Later, the species was found in Gelendzhik Bay near Novorossisk. It is believed that *Mercierella* (*Ficopomatus*) originates in the brackish coastal lakes of India (Micu and Micu, 2004). Until the mid-sixties, it became established in several other brackish and oligohaline locations along the Black Sea coasts (Zaitsev and Öztür, 2001).

Vodyanitsky and Morozova-Vodyanitskaya in the autumn of 1949 discovered a large number of rapana (*Rapana venosa*) on the Gudauta oyster bank, where, according to their observations, it produced huge devastation. For the first time, the rapana was discovered by the VNIRO expedition in the Anapa region of Tuapse, Sochi, Gudauta. At that time there were known cases of finding a rapana from Batumi to the Kerch Strait (Drapkin, 1953).

Table 3: Alien species of macrozoobentos in the Black Sea Georgian coast.

	Phylum	Species
Macrozoobentos		
1.	Polychaeta	<i>Dipolydora quadrilobata</i> (Jacobi, 1883)
2.		<i>Sigambra tentaculata</i> (Treadwell, 1941)
3.		<i>Ficopomatus enigmaticus</i> (Fauvel, 1923)
4.	Mollusca	<i>Mya arenaria</i> Linnaeus, 1758
5.		<i>Anadara kagoshimensis</i> (Tokunaga, 1906)
6.		<i>Rapana venosa</i> (Valenciennes, 1846)
7.	Arthropoda	<i>Amphibalanus improvisus</i> (Darwin, 1854)
8.		<i>Amphibalanus eburneus</i> (Gould, 1841)
9.		<i>Callinectes sapidus</i> (Rathbun, 1896)

According to the recent revisions, the Black Sea ichthyofauna consists of about 190 species and its diversity increases primarily due to the penetration of fish from the Mediterranean Sea (Yankova et al., 2013, 2014; Boltachev and Karpova 2014). There are nine invasive alien fish species in the Georgian waters of the Black Sea. Some authors described the presence of such species as *Sardinella aurita*, *Sarpa salpa*, and *Sparus aurata* at the beginning of the last century (Mayorova, 1951; Svetovidov, 1964). These three species are Mediterranean immigrants which are not considered alien for the Black Sea – it is considered that they extend their range by natural distribution (*). For the last decade, two species of the family Sparidae, salem *Sarpa salpa* and seabream *Sparus aurata*, have increased considerably their abundance along the Georgian and Ukrainean Crimean coasts and passed from the category “rarely found species” to the category “usual species” (Guchmanidze and Boltachev, 2017).

Liza haematocheila is one of the main invaders established, which have the most dramatic impact on species diversity (Erdogan et al., 2010). The species was intentionally introduced into the Azov Sea and Black Sea for aquaculture purposes from the Amur River estuary to the Sea of Japan in 1972-1982 (Ivanov et al., 2017). It is quite common in Georgian waters and of commercial importance.

The first finding of *Parablennius incognitus* (Bath, 1968) in the Black Sea, according to Bogorodskii (2006), was made off the coast of Abkhazia in 2001. This species was also found off the coasts of Turkey and in the Kerch Strait (Vasil’eva, 2007; Yankova et al., 2013).

In recent years, a new species for the ichthyofauna of Georgia, *Lithognathus mormyrus*, has been described (Guchmanidze and Boltachev, 2017). *Lithognathus mormyrus* is widespread and regularly encountered in the Mediterranean Sea, in the eastern Atlantic Ocean from the Bay of Biscay to the Cape of Good Hope, in the south-west part of the Indian Ocean to the south of Mozambique, and in the Red Sea (Marine Species Identification Portal, 2015). In the Black Sea, a specimen of this species was found on the Romanian coast (Stanciu and Ilie, 1980), on the Bulgarian coast in the Gulf of Varna (Vasil’eva, 2007).

Table 4: Alien fish species on in the Black Sea Georgian coast.

	Order	Species
1.	Gobiiformes	<i>Gobius xanthocephalus</i> Heymer and Zander, 1992
2.		<i>Lithognathus mormyrus</i> (Linnaeus, 1758)
3.		<i>Morone saxatilis</i> (Walbaum, 1792)
4.	Blenniiformes	<i>Parablennius incognitus</i> (Bath, 1968)
5.	Mugiliformes	<i>Planiliza haematocheilus</i> (Temminck and Schlegel, 1845) (<i>Liza haematocheila</i> Temminck et Schlegel, 1845 = <i>Mugil soiiuy</i> (Basilewski, 1855)
6.	Gobiiformes	<i>Pomatoschistus bathi</i> Miller, 1982
7.	Clupeiformes	<i>Pomatoschistus bathi</i> Miller, 1982
8.		<i>Sarpa salpa</i> (Linnaeus, 1758)
9.		<i>Sparus aurata</i> Linnaeus, 1758

CONCLUSIONS

The list of alien hidrobionts recorded on the Black Sea coast of Georgia until now includes 43 species. The presented information ensures support to future development of prevention and control measures to tackle the issues of the invasive alien species in the region.

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REFERENCES

1. Alexandrov B. and Shiganova T., 2018 – Non-indigenous species, National Pilot Monitoring Studies and Joint Open Sea Surveys in Georgia, Russian Federation and Ukraine, 2017, Final Scientific Report, November, 247-250.
2. Aleksandrov B., Gomoiu M.-T., Mikashavidze E., Moncheva S., Öztür B. and Shiganova T., 2013 – Nonnative species of the Black Sea, Abstracts book of 4-th Black Sea Scientific Conference Challenges towards good environmental status, 28-31 October, 2013, Constanța, Romania, Constanța, Editura Boldaş, 62-63.
3. Aleksandrov B. G., 2010 – Modern tendencies of the Black Sea biological pollution, *Scientific Notes*, Ternopil University, Biology, 3, 44, 3-5.
4. Anastasiu P., Preda C., Bănăduc D. and Cogălniceanu D., 2017 – Alien species of EU concern in Romania, *Transylvanian Review of Systematical and Ecological Research, The Wetlands Diversity*, 19, 3, 93-106, doi: 10.1515/trser-2017-0024, 93-106.
5. Annenkova N., 1929 – Polychaeta from the relic Paleostomi Lake (the Caucasus) and the rivers connected with it, *Doklady An. SSSR*, 6, 138-140. (in Russian)
6. Bogorodskii, S., 2006 – Discovery of *Parablennius incognitus* (Blenniidae) off the Eastern Coast of the Black Sea, Northern Abkhazia, *Journal of Ichthyology*, 46, 18-24.
7. Boltachev A. R. and Karpova E. P., 2014 – Faunistic revision of alien fish species in the Black Sea, *Russian Journal of Biological Invasions*, 5, 4, 225-240.
8. Carlton J., 1996 – Pattern, process, and prediction in marine invasion ecology, *Biological Conservation*, 78, 97-106.
9. Curtean-Bănăduc A. and Bănăduc D., 2007-2008 – Trophic elements regarding the non-indigenous *Pseudorasbora parva* (Schlegel) 1842 fish species spreading success – Olt River Basin, a case study, *Journal of Biology – Zoology*, 52-53, Edit. Academiei, 33-52.
10. Draffkin E.L., 1953 – New mollusk in the Black Sea, *Priroda*, 92-95. (in Russian)
11. Erdogan N., Duzgunes E., Ogut H. and Kasapoglu N., 2010 – Introduced species and their impact in the Black Sea, CIESM 39th Congress, Venice, Venedik, Italy, 10-14 May, 39, 504.
12. European Commission, 2016 – Commission Implementing Regulation (EU) 2016/1141 of 13th July 2016 adopting a list of invasive alien species of Union concern pursuant to Regulation (EU) No 1143/2014 of the European Parliament and of the Council, *Official Journal of the European Union*, L 189/4, 14 July 2016. (6) (PDF) Alien Species of EU Concern in Romania.
13. Ghabooli S., Shiganova T., Zhan A., Cristescu M., Eghtesadi-Araghi P. and MacIsaac H., 2011 – Multiple introductions and invasion pathways for the invasive ctenophore *Mnemiopsis leidyi* in Eurasia, *Biological Invasions*, 13, 679-690.
14. Ghasemi A. F., Jam A., Taheri M. and Foshtomi M., 2014 – Abundance of the alien spionid *Streblospio gynobranchiata* in relation to sediment composition along the southern coast of the Caspian Sea, *Transylvanian Review of Systematical and Ecological Research*, 16, 2, *The Wetlands Diversity*, 119-126.
15. Gogmachadze T. and Mikashavidze E., 2005 – *Cunearca cornea* (Reeve) – new dominant hydrobiont at the coastal shelf of the Black Sea of Georgia, *News of Biology*, Ivane Javakhishvili Tbilisi State University, 12-14.
16. Guchmanidze A. and Boltachev A., 2017 – Notification of the first sighting of sand steenbras *Lithognathus mormyrus* (Linnaeus, 1758) and modern species diversity of the family Sparidae at the Georgian and Crimean Black Sea coasts, *Journal of Black Sea/Mediterranean Environment*, 23, 1, 48-55.
17. Ivanov P., Nikolov V. and Dzembekova N., 2017 – New data for invasive pilengas mullet species *Liza haematocheila* (Temminck and Schlegel, 1845) along Bulgarian Black Sea coast, *Animal Science*, 56, 2, 231-237.
18. Hiz M. M. and Aki C., 2014 – The nightmare: genetically modified organisms as alien species *Transylvanian Review of Systematical and Ecological Research*, 16.1, *The Wetlands Diversity*, 135-148.

19. Kharytonova Y., Nabokin M., Mgeladze M., Vadachkoria P. and Dyadichko V., 2021 – Current state and long-term changes in the mesozooplankton community of the Ukrainian and Georgian parts of the Black Sea as indicators of its ecological status, *Biosystems Diversity*, 29, 1, 47-58.
20. Kohsnud Z., Kohsnud R. and Ghobeitihab M., 2013 – Effects of the invasive Ctenophore, *Mnemiopsis leidyi* species, on Caspian Sea, *Transylvanian Review of Systematical and Ecological Research*, 15.1, *The Wetlands Diversity*, 117-126.
21. Konsulov A. and Kamburska L., 1998 – Ecological determination of the new Ctenophora – *Beroe ovata* invasion in the Black Sea, *Proceedings of the Institute of Oceanology*, Bulgarian Academy of Sciences, Varna, 195-198.
22. Mayorova A. A., 1951 – Biology and fishing of the Black Sea anchovy, Simferopol, 27. (in Russian)
23. Micu D. and Micu S. A. 2004 – A new type of macrozoobenthic community from the rocky bottoms of the Black Sea, Conference Paper, International Workshop On Black Sea Benthos, 18-23 April, Istanbul, Turkey, 75-88.
24. Popova E. and Zlatanova D., 2017 – The invasive raccoon dog (*Nyctereutes procyonoides*, Gray) – an update of its distribution on the Balkans, *Transylvanian Review of Systematical and Ecological Research*, 19.1, *The Wetlands Diversity*, 77-82.
25. Prots B. and Simpson M., 2011 – Habitats suitability of highly invasive plants species in Ukrainian part of the Upper Tysa basin, *Transylvanian Review of Systematical and Ecological Research*, 11, The Upper Tisa River Basin, 95-108.
26. Radkhah A. R. and Eagderi S., 2020 – Investigation on the global distribution of invasive fish species, convict cichlid *Amatitlania nigrofasciata* (Perciformes, Cichlidae) over the past years with emphasis on Iranian inland waters, *Transylvanian Review of Systematical and Ecological Research*, 22.3, *The Wetlands Diversity*, 45-56.
27. Öztürk B., 2021 – Non-Indigenous species in the Mediterranean and the Black sea, FAO, Rome.
28. Shalovenkov N. N., 2020 – Tendencies of invasion of alien zoobenthic species into the Black Sea, *Russian Journal of Biological Invasions*, 11, 164-171.
29. Shiganova T., Mgeladze M., Teacă A., Kolesnikov M., Aleksandrov B., Dyadichko V., Minicheva G. and Zotov A., 2021 – Non-indigenous species, EMBLAS Report, 170-185.
30. Shiganova T., Mikaelyan A., Moncheva S., Stefanova K., Chasovnikov V., Mosharov S., Mosharova I., Slabakova N., Mavrodieva R., Stefanova E., Zasko D. and Dzhurova B., 2019 – Effect of invasive ctenophores *Mnemiopsis leidyi* and *Beroe ovata* on low trophic webs of the Black Sea ecosystem, *Marine Pollution Bulletin*, 141, 434-447.
31. Shiganova T., Alekseenko E., Moskalenko L. and Nival P., 2018 – Modelling assessment of interactions in the Black Sea of the invasive ctenophores *Mnemiopsis leidyi* and *Beroe ovata*, *Ecological Modelling*, 376, 1-14, doi.org/10.1016/j.ecolmodel.2018.02.008.
32. Shiganova T., Legendre L., Kazmin A. and Nival P., 2014 – Interactions between invasive ctenophores in the Black Sea: assessment of control mechanisms based on long-term observations, *Marine Ecology Progress Series*, 507, 111-123.
33. Shiganova T., 2010 – Biotic Homogenization of Inland Seas of the Ponto-Caspian, *Annual Review of Ecology, Evolution, and Systematics*, 41, 103-126.
34. Shiganova T. and Öztürk B., 2009 – Trend on increasing Mediterranean species arrival into the Black Sea, in Briand F. (ed.) *Climate forcing and its impacts on the Black Sea marine biota*, CIESM Monograph, Monaco, 39, 75-91.
35. Shiganova T. A., Dumont H. J., Mikaelyan A., Glazov D. M., Bulgakova Y. V., Musaeva E. I., Sorokin P. Y., Pautova L. A., 2004 – Interaction between the invading ctenophores *Mnemiopsis leidyi* A. Agassiz and *Beroe ovata* Mayer 1912, and their Influence on the pelagic ecosystem of the northeastern Black Sea, Dumont H., Shiganova T. A., Niermann U. (eds), *The Ctenophore Mnemiopsis leidyi in the Black, Caspian and Mediterranean Seas and Other Aquatic Invasions*, NATO Science Series: IV. Earth and Environmental Sciences, 35, Kluwer Academic Publishers, Dordrecht, 35, 33-70.

36. Skolka M. and Preda C., 2010 – Alien invasive species at the Romanian Black Sea coast – present and perspectives, *Travaux du Muséum National d'Histoire Naturelle Grigore Antipa*, LIII, 443-467. (in Romanian)
37. Stanciu M. and Ilie G., 1980 – *Lithognatus mormyrus*, a new species of Sparidae at the Romanian littoral, Pontus Euxinus, *Studii și Cercetări CSMN-Constanța*, 1, 107-110. (in Romanian)
38. Streftaris N., Zenetos A. and Papathanassiou E., 2005 – Globalisation in marine ecosystems: the story of nonindigenous marine species across European seas, in Gibson R. N., Atkinson R. J. A. and Gordon J. D. M. (eds), *Oceanography and Marine Biology: An Annual Review*, 43, Baton Roca, FL, CRC Taylor & Francis, 419-453.
39. Svetovidov A. N., 1964 – Fishes of the Black Sea, Moscow, Nauk, 552. (in Russian)
40. Vadachkoria P., Tregubov A., Makharadze G., Mikashavidze E. and Varshanidze M., 2020 – Distribution and Quantitative Characteristics of Four Invasive Alien Species off the Black Sea Coast of Georgia, *Acta Zoologica Bulgarica*, 72, 4, 539-544.
41. Vasil'eva E., 2007 – Fishes of the Black Sea. Key to Marine, Brackish-Water, Eurihaline and Anadromous Species with Color Illustrations collected by Bogorodsky S. V., VNIRO Publishing, Moskow, 237. (in Russian)
42. Vinogradov M., Shushkina E., Musaeva E. and Sorokin P., 1989 – Ctenophore *Mnemiopsis leidyi* (A. Agassiz) (Ctenophora: Lobata) – new settlers in the Black Sea, *Oceanology*, 29, 2, 293-298.
43. Yankova M., Pavlov D., Ivanova P., Karpova E., Boltachev A., Bat L., Oral M. and Mgeladze M., 2013 – Annotated check list of the non-native fish species (Pisces) of the Black Sea, *Journal of the Black Sea/Mediterranean Environment*, 19, 2, 247-255.
44. Zaitsev Y. and Mamaev V., 1997 – Marine biological diversity in the Black Sea. A study of change and decline, *Black Sea environmental Series*, 3, New York, United Nations Publications.
45. * <https://hrcak.srce.hr/clanak/289204>