Research Article

ACTA ZOOLOGICA BULGARICA
Acta zool. bulg., Suppl. 9, 2017: 73-82

Population Status of Some Alien Species in Varna Bay, Bulgarian Black Sea Coast (2015-2016)

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Abstract: The introduction of alien species is a severe threat to marine environments. Enclosed or semi-enclosed ecosystems, as the Black Sea, seem particularly sensitive to biological invasions. With the increased shipping traffic, aquaculture and trade, the Black Sea has become a major recipient of alien species. A total of 80 species of different eco-functional groups were listed as alien in the Bulgarian Black Sea coastal waters. The aim of our study was to assess the population status of six alien species (four zooplankton, one benthic invertebrate and one fish species) in Varna Bay, the Bulgarian Black Sea coast, in the period 2015-2016. Two copepod alien species played a significant role in the mesozooplankton community structure, with a maximum share of 62% of the overall abundance in spring-summer for *Acartia tonsa* and summer-autumn for *Oithona davisae*. Large aggregates of the ctenophore species *Mnemiopsis leidyi* formed 'hot spots' along the coast during summer with a maximum of 516 ind. m^{-2} in September 2015, followed by high abundance of *Beroe ovata* (107 ind. m^{-2}) in October 2015. The average values of the shell length and total weight of the rapa whelk (*Rapana venosa*) were the lowest on shallow rocky bottom (5.89 cm and 22.27 g, respectively) and the highest at 21 m depth on silty sediments (6.84 cm and 55.13 g, respectively). The biomass of *R. venosa* ranged between 2.16 kg km^{-2} and 19.28 kg km^{-2}, being the highest at sandy locations and the lowest at sandy-silty locations, both sampled by dredge. Fulton's condition factor ranged from 2.33 to 9.20. The catches of the alien redlip mullet (*Liza haematocheila*) in Varna Bay in the studied period were sporadic. According to information about catches for the period 2008-2016 and our observations, the species has become rare along the Bulgarian coast. A drastic reduction in its stock was observed from a maximum catch of 1.923 t in 2009 to 0.075 t in 2016.

Key words: Alien species, ctenophore species, rapa whelk, redlip mullet, Black Sea

Introduction

Introductions of alien marine species have been accelerated in recent decades by the rapid globalisation and increasing trends of trade, travel and transportation (Streftaris & Zenetos 2006, Katsanevakis et al. 2014). Alien marine species may become invasive with severe impact on biodiversity and ecosystem services (Molnar et al. 2008). They may cause ecological, economic and public health impacts globally. The ecological impact includes changes in habitats, communities and food-web functioning. The economic impact ranges from financial losses in fisheries to expenses for industries. The public health impact may arise from the introduction of microbes or toxic algae. Enclosed or semi-enclosed ecosystems, as the Black Sea, seem particularly sensitive to biological invasions. With the increased shipping traffic, aquaculture and trade the Black Sea has become a major recipient of alien species (Alexandrov 2004).

A total of 80 marine and oligohaline species

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of different eco-functional groups were listed as alien in the Bulgarian Black Sea coastal and brackish waters (Moncheva et al. 2013). The list includes 40 phytoplankton species, 4 macrophytes, 8 zooplankton species, 19 benthic invertebrates, and 9 fish. Two of the invasive alien species: *Rapana venosa* (Valenciennes, 1846) and *Mnemiopsis leidyi* A. Agassiz, 1865, were considered with the highest negative impact on the Black Sea ecosystem. Yankova et al. (2013) published a check-list of alien fish species for the Black Sea, including 21 marine as well as freshwater species. In the frame of the project 'East and South European Network for Invasive Alien Species – A tool to support the management of alien species in Bulgaria' (ESENIAS-TOOLS) (2015-2017), a prioritisation of the alien marine species in the Bulgarian Black Sea coastal waters based mainly on the level of environmental impact was conducted and a list of 12 priority alien species was compiled. They included eight marine zooplankton species, three benthic macroinvertebrate and one fish species, among them: the alien copepods: *Acartia tonsa* Dana, 1849, and *Oithona davisae* Ferrari F. D. and Orsi, 1984, the ctenophores: *M. leidyi* and *Beroe ovata* Bruguière, 1789, the rapa whelk *R. venosa*, and the redlip mullet *Liza haematocheila* Temminck & Schlegel, 1845 (Mugilidae).

Acartia tonsa appeared in the Black Sea in the early 1970s and it was supposed that the species replaced the native *Paracartia latisetosa* (Krichagin, 1873), because it occupied the same ecological niche (Gubanova 2000). Some specimens of the cyclopoid copepod *O. davisae* were first found in Sevastopol Bay in December 2001. The species was initially identified as *Oithona brevicornis* (Zagorodnyaya 2002) but recently, the species was re-examined and proved to be *Oithona davisae* (Temnykh & Nishida 2012). The first record of *A. tonsa* in front of the Bulgarian coast was in 2000 (Kamburska 2004), while the occurrence of *O. davisae* was reported in 2009 (Mihneva & Stefanova 2011).

The rapa whelk *R. venosa* was introduced into the Black Sea in 1946 and expanded along the Caucasian and Crimean coasts and to the Sea of Azov within a decade. From 1955 to 1969, its range extended into the north-west Black Sea to the coastlines of Romania, Bulgaria and Turkey. The species has a high ecological fitness as evidenced by its high fecundity, early sexual maturity, longevity, fast growth rate, broad tolerance to salinity, temperatures, water pollution and oxygen deficiency (Zolotarev 1996, Mann & Harding 2003), giving it all the characteristics of a successful invader. Its establishment in the Black Sea appeared to be facilitated by the general lack of competition for the food source and a lack of direct predation on *R. venosa* by predators and an abundance of potential prey species (Zolotarev 1996, ICES 2004). Therefore, the species has become well established in the benthic ecosystem of all Black Sea coastal countries and has exerted significant predatory pressure on the indigenous malacofauna (Mann & Harding 2003). Illegal bottom trawling for harvesting *R. venosa* along the Black Sea shelf has raised ecological concerns with respect to the benthic communities and especially the mussel beds (Knudsen et al. 2010, Ulman et al. 2013).

The native range of the redlip mullet *L. haematocheila* (Mugilidae) covers the estuary of the Amu Darya River and brackish waters of the Sea of Japan (Zaitsev & Öztürk 2001). It was first introduced to the area around the Sea of Azov for fish farming but then migrated to the Black Sea. At the end of the 1980s *L. haematocheila* appeared in the Black Sea (Okomuş & Başçınar 1997). According to Kazanskji & Starushenko (1980) and Gorelov & Esipova (1992), there are no published data on the acclimatisation process of its population in the Black Sea. There are no literature data about the first record of the species along the Bulgarian Black Sea coast. Dobrovolov et al. (2003) first noted its occurrence, based on the genetic identification of all mugilid species, including *L. haematocheila*. According to the authors, the species was present for a long time along the Bulgarian Black Sea coast, but was not

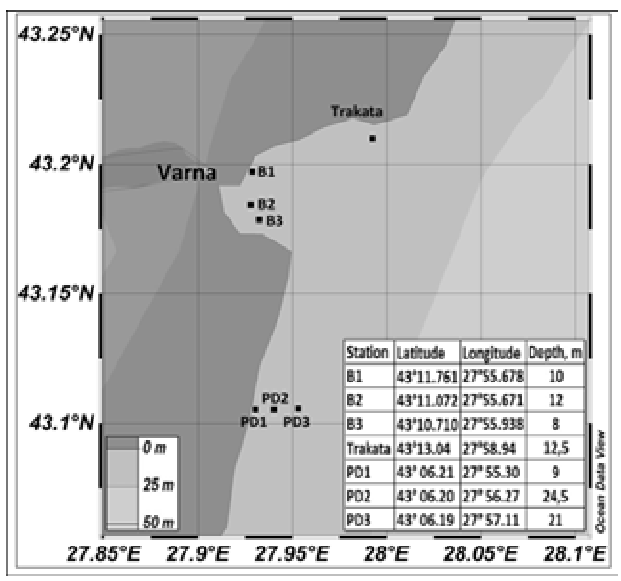


Fig. 1. Map of the sampling area in Varna Bay and the adjacent area. B1, B2, B3 – stations for sampling of zooplankton and benthic macroinvertebrates; PD1, PD2, PD3 – stations for sampling of *Rapana venosa*; Trakata – a station for fish sampling

described and reported for the Bulgarian fish fauna. Beckova & Raikova-Petrova (2011) presented data about the increasing tendency of the catches of *L. haematocheila* during the period 2007-2009 along the Bulgarian Black Sea coast and Varna and Burgas Lakes.

The aim of the present study was to assess the population status of six alien species of different ecological groups: four zooplankton species (*A. tonsa, O. davisae, M. leidyi* and *B. ovata*), one benthic macroinvertebrate (*R. venosa*) and one fish (*L. haematocheila*) in Varna Bay, the Bulgarian Black Sea coast, in the period 2015-2016.

Materials and Methods

The sampling was conducted in Varna Bay and the adjacent area. The zooplankton and benthic macroinvertebrate samples were collected at three stations (B1, B2 and B3), additionally, *Rapana venosa* was collected at three more stations (PD1, PD2 and PD3), while the fish samples were collected at one station (Trakata) (Fig. 1). The sampling was made during the autumn of 2015 (September, October, November) and spring-summer season of 2016 (May, June, July).

The zooplankton sampling was carried out with a Juday net with a mesh size of 150 μm for mesozooplankton (Korshenko & Alexandrov 2012) and a horizontal trawl net with a mesh size of 300 μm for ctenophores (Shiganova et al. 2015). The gelatinous species: *Aurelia aurita* (Linnaeus, 1758), *Pleurobrachia pileus* (O. F. Müller, 1776), *M. leidyi*, and *B. ovata*, were removed, rinsed, measured and counted on board. Subsequently, the samples were preserved in 4% formalin solution buffered to pH 8-8.2 with disodiumtetraborate (borax) (Korshenko & Alexandrov 2012). The zooplankton counts were made under stereomicroscope. All species were identified to species level, except the meroplankton and fish larvae. The species abundance was expressed as a number of specimens per cubic meter and the biomass as mg m^{-3} for mesozooplankton and g m^{-2} for jellyfish. Statistical analyses were performed using the software STATISTICA 7.

The specimens of the alien rapa whelk *R. venosa* were collected at location B3 (Fig. 1) by scuba divers who picked up all individuals within a frame with size 1 m^2 and by dredge hauls from three different locations (PD1, PD2 and PD 3) (Fig. 1), depths and seabeds. A total of 986 specimens were measured and weighted and the sex of each specimen was identified. The shell length (from the apex to the end of the siphonal canal) was measured with a vernier calliper to the nearest 0.01 mm. The total weight and shell-free body weight was measured to the nearest 0.01 g with a balance. The sex of each whelk was identified based on the colour of the gonad and the presence/ absence of penis. The total biomass was estimated and expressed as kg km^{-2}. Two-tailed t-test at significance level of 0.05 was applied to assess whether the differences between the biological parameters were statistically significant. The length-weight relationships were determined using the equation $W=aL^b$ (Le Cren 1951, Pauly 1980, Erkoyuncu 1995). The relationship between the length and the weight was examined by a simple linear regression analysis. Fulton's condition factor was calculated as $K=100(W/L^3)$, where L is the total shell length (cm) and W is the body weight (g) (Le Cren 1951, Erkoyuncu 1995).

As the catches of the alien redlip mullet *L. haematocheila* in Varna Bay in the studied period were sporadic, for the analyses of the species population status we used data on catches from the whole Bulgarian Black Sea coast for the period 2008-2016. Furthermore, data on catches of other mugilid species at the Bulgarian Black Sea coast (2008-2016) and data on catches of *L. haematocheila* from other Black Sea countries (2008-2013) were used for comparison. The data were provided by the Executive Agency of Fisheries and Aquaculture (EAFA), Ministry of Agriculture and Food, Bulgaria; TURKSTAT, Turkey, http://www.turkstat.gov.tr; the Southern Scientific Research Institute of Marine Fisheries and Oceanography (YugNIRO), and the Azov Research Institute of Fisheries (AzNIIRKH), Russia, according to Turkulova et al. (2015).

Results and Discussion

An increasing trend in the population of *O. davisae* was observed with a peak in November 2015, with 22522 ind. m^{-3} (Fig. 2A), the abundance was three-fold higher than the average in the autumn of 2015 (7366±1877 ind. m^{-3} SD). The small copepod made up 60% of the copepod abundance and 31% of the biomass in the late summer-autumn season. *A. tonsa* was characterised with similar presence in abundance and biomass of the copepod assemblage (29% and 23%, respectively) but it occurred mainly in the warm season (spring-summer). The adults appeared in late May when the sea water warmed up to 16°C and rapidly increased to the end of June (9410 ind. m^{-2}) (Fig. 2B). Collectively, the two pelagic copepods represented 55-95% of the copepod population in some areas.

The alien *A. tonsa* is more resistant to pollution

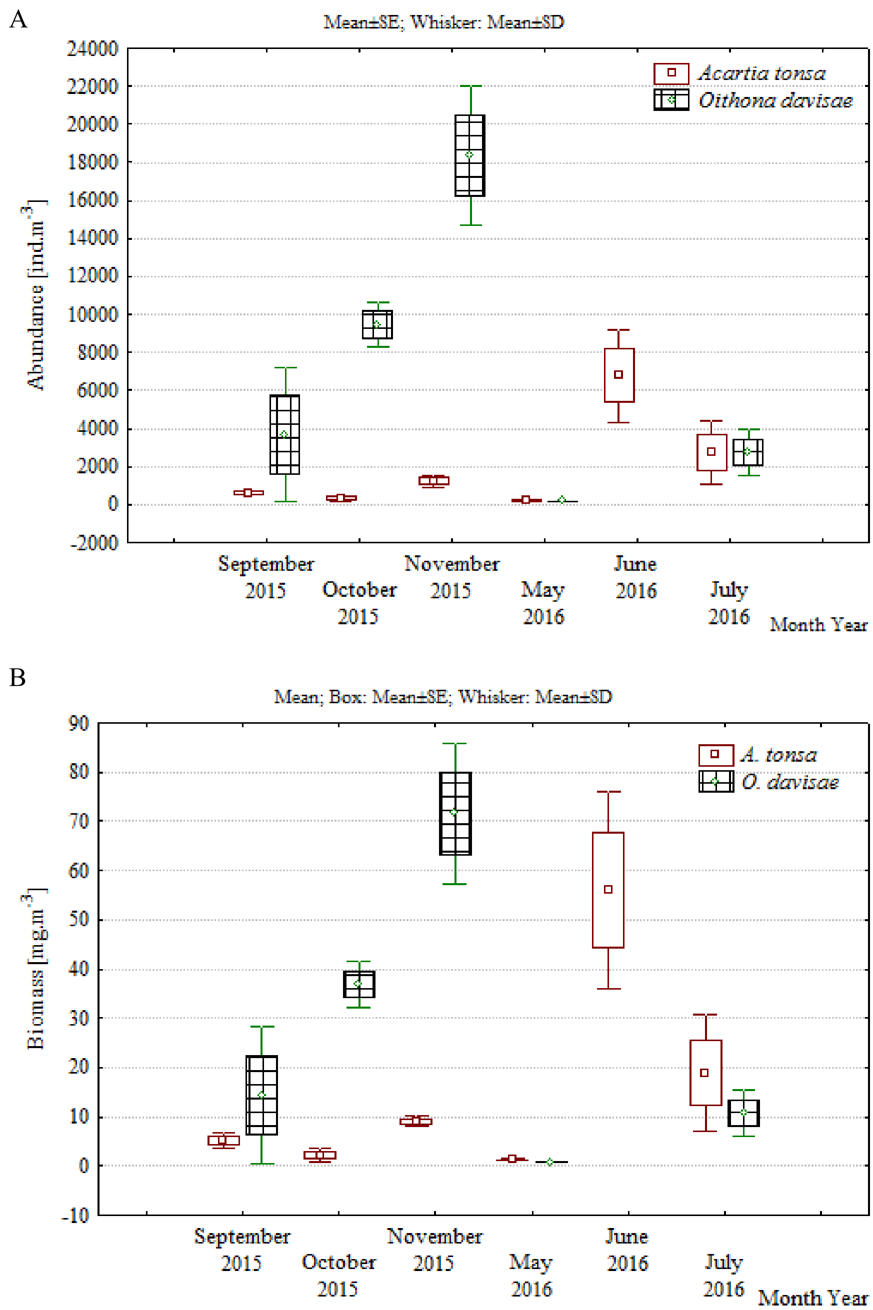


Fig. 2. Box-Whisker Plots of *Acartia tonsa* and *Oithona davisae* abundance (A) and biomass (B) in Varna Bay, the Bulgarian Black Sea coast, for each of the survey months in the period 2015-2016

and eutrophication (Gubanova 2000, 2003). Additionally, *A. tonsa* is tolerant to salinity changes (Jeffries 1962) and produces resting eggs (Zilloux & Gonzales 1972), which are more resistant to adverse environmental conditions. It is considered as a keystone species, which plays an important trophodynamic role in the mixing and cycling of nutrients and energy in marine ecosystems, connecting primary (phytoplankton) and tertiary (planktivorous fish) production (Turner & Tester 1989, Mauchline 1998, Holste & Peck 2005, Miller & Roman 2008). The cyclopoid copepod *O. davisae* inhabits eutrophic embayments (Uye & Sano 1995, Almeda et al. 2010) and feeds on flagellates, dinoflagellates and oligotrichines (Uchima & Hirano 1986). Recently, the phytoplankton community in the Black Sea has shown structural changes and prevalence of small flagellate species (Nesterova et al. 2008), which could be explained with the appearance of this cyclopoid copepod.

The alien ctenophore species *M. leidyi* and *B. ovata* exhibited a typical prey/ predator interaction dynamics. The maximum abundance of *M. leidyi* was observed in September 2015 when it formed

Table 1. Year-to-year variability of abundance and biomass ± SD in alien zooplankton species in Varna Bay, the Bulgarian Black Sea coast, from 2012 to 2016 (National Monitoring Database)

Year	Season	Abundance (ind. m^{-3})		Biomass (mg m^{-3})		Abundance (ind. m^{-2})		Biomass (g m^{-2})	
		Acartia tonsa	Oithona davisae	Acartia tonsa	Oithona davisae	Mnemiopsis leidyi	Beroe ovata	Mnemiopsis leidyi	Beroe ovata
2012	Spring	486.3 ±651.0	0	4.06 ±5.52	0	4.93 ±5.69	0	422.63 ±527.35	0
	Summer	446.7 ±983.1	53.5 ±59.7	5.08 ±6.98	0.21 ±0.23	145.80 ±204.99	26.21 ±37.13	508.38 ±1095.19	17.57 ±36.88
	Autumn	0	100.5	0	0.39	14.74	14.74	3.71	5.54
2013	Spring	1069.5	142.0	7.06	0.55	34.40	0	13.50	0
	Summer	921.0 ±558.9	6382.0 ±4887.2	6.76 ±4.17	24.89 ±19.06	27.03 ±27.45	34.40 ±56.21	5.37 ±7.43	0.58 ±0.9
	Autumn	115.0	4263.5	0.69	16.63	14.74	0	6.35	0
2014	Spring	859.5 ±383.3	110.5 ±9.1	6.72 ±2.26	0.43 ±0.04	0	2.46 ±4.91	0	0.17 ±0.35
	Summer	2504.0 ±3694.7	4200.5 ±4740.9	15.95 ±22.50	16.38 ±18.49	90.92 ±113.89	2.46 ±4.91	43.87 ±58.13	0.11 ±0.22
2015	Summer	622.0 ±129.0	3682.7 ±3551.4	5.29 ±1.58	14.36 ±13.85	509.80 ±442.03	133.67 ±142.19	224.88 ±194.85	25.95 ±42.02
	Autumn	777.3 ±549.0	13908.2 ±5444.8	5.64 ±3.94	54.24 ±21.23	31.90 ±50.25	149.17 ±163.68	24.10 ±38.13	5.23 ±6.45
2016	Spring	3490.8 ±3925.4	60.5 ±93.8	28.63 ±32.61	0.24 ±0.37	543.71 ±782.62	0	453.82 ±453.34	0
	Summer	2756.0 ±1662.1	2755.0 ±1215.8	18.93 ±11.68	10.74 ±4.74	3.74 ±6.49	19.81 ±17.91	4.89 ±8.46	150.52 ±147.78

a large aggregation (516 ind. m^{-2}). The abundance and biomass of *B. ovata* greatly increased from 5 to 577 ind. m^{-2} in October after the peak of *M. leidyi* (Fig. 3A, B). Consequently, the prey abundance diminished sharply during the period of *B. ovata* availability in the bay.

The abundance, distribution range and the magnitude of alien species impact can vary over time. The alien species produce measurable effects on the local community and ecosystem only after attaining a particular level of abundance and when occupying a sufficiently large area (Olenin et al. 2007). Although *A. tonsa* and *O. davisae* have not been harmful for the marine ecosystem and native species populations, their appearance and establishment is a signal of ecosystem changes. The period 2012-2016 was characterised by a relatively stable population development (622 ±141 ind. m^{-3} SD) of *A. tonsa*, while a more pronounced increasing trend was registered for *O. davisae* (Table 1, Fig. 4A).

The introduction of *M. leidyi* in the Black Sea is a typical example of the invasive phenomena. The rapid expansion of the species was clearly one of the causative factors for severe shifts in the ecosystem functioning (Kideys et al. 2005). From 1982 (the first record of *M. leidyi* in Sudak Bay, the coast of Crimea) till 2000, the strength of its impact on the ecosystem changed and passed through several phases: introduction, establishment, expansion and adjustment (Olenin et al. 2010). It formed about 70% of the summer biomass of jellyfish along the Bulgarian coast for the whole period from 1994 to 2015 (Stefanova 2014, National Monitoring Database). Nevertheless, there have been positive signals of a decreasing trend over the last years (Table 1). In many cases, the declines can be directly related to the occurrence of *B. ovata*. The opposite increasing trend of *B. ovata* in the coastal area and the effectiveness of *B. ovata* in controlling the high levels of the voracious plankton consumer *M. leidyi* are presented in Table 1 and Fig. 4B.

The dendrogram produced by the hierarchical clustering of the rapa welk *R. venosa,* using the Bray-Curtis similarity with square-root transformed data on the frequency distribution of shell length, differentiated the samples according to the seabed and depth (Fig. 5). The rocky bottom population was separated from the rest due to the dominance of the small-sized individuals (54.7%) belonging to size class 4-5 cm. The reason could be that the population is subjected to extraction of the large-sized individuals by scuba divers. The two sandy locations were pooled together with 81.8% similarity because of the highest percentage share of 5-6 cm sized individuals – 48.9% from population sampled by divers and 41.5% from population sampled by the dredge (Fig. 5). The

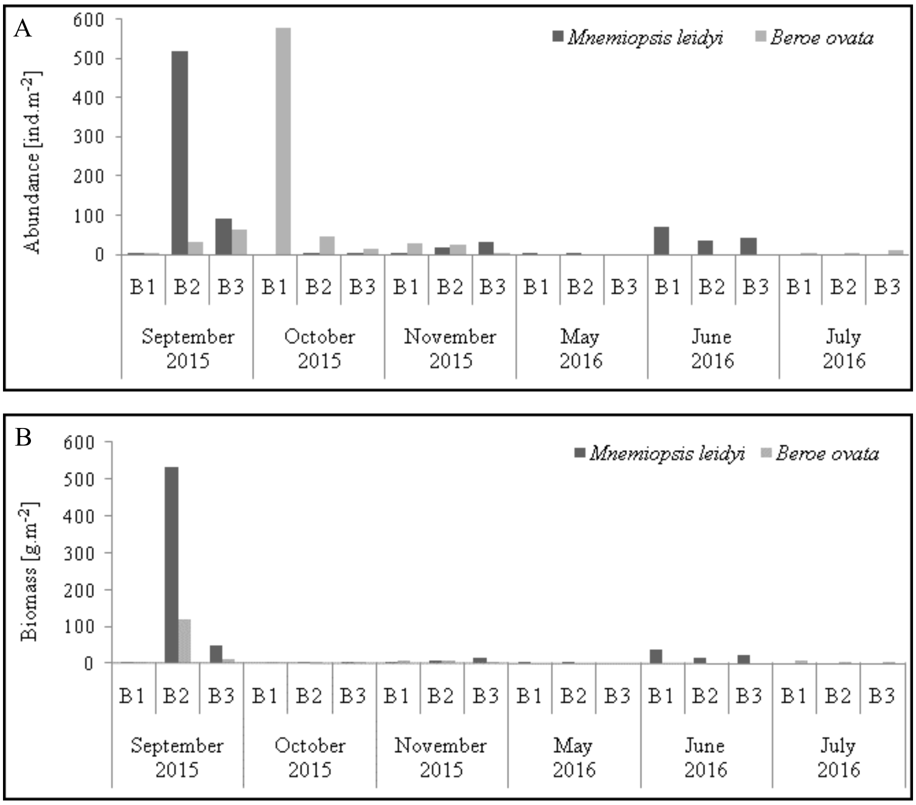


Fig. 3. *Mnemiopsis leidyi* and *Beroe ovata* abundance (A) and biomass (B) in Varna Bay, the Bulgarian Black Sea coast, for each of the survey months in the period 2015-2016

deeper locations were clustered together with 87.1% similarity contributed by the prevalence of larger individuals falling into the size class 6-7 cm (Fig. 6).

The mean shell length of males ranged from 4.68 to 7.42 cm and the total weight from 24.26 to 68.51 g. The females were smaller and lighter than males – the shell length varied from 4.32 to 6.26 cm and the total weight from 19.90 to 44.21 g. The results showed that males were significantly larger and heavier than females (t-test, $P<0.05$) (Table 2).

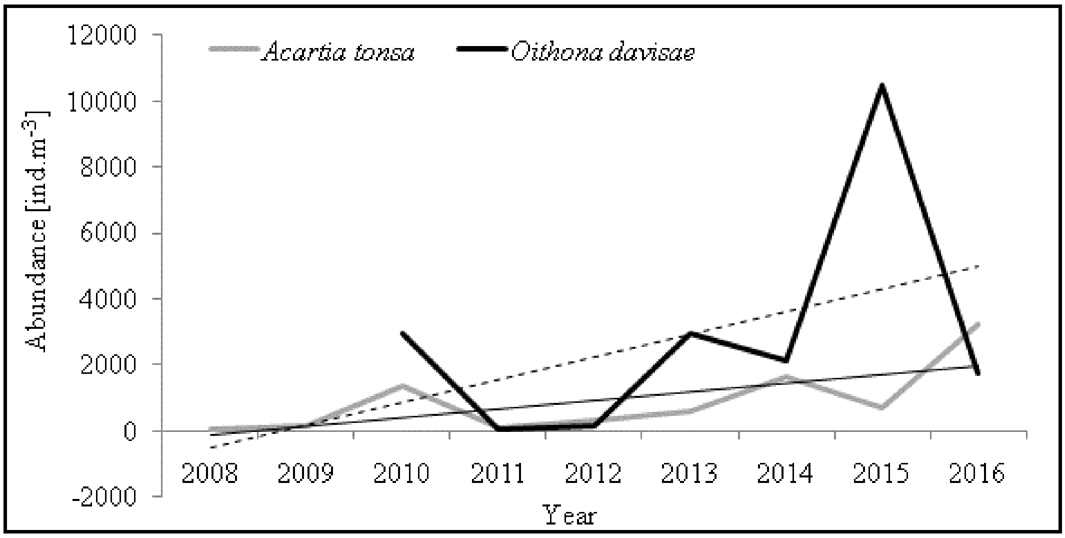
The biomass of *R. venosa* ranged between 2.16 and 19.28 kg km^{-2} and it was the highest on the sandy seabed and the lowest on the sandy-silty seabed, both sampled by dredge (Table 2).

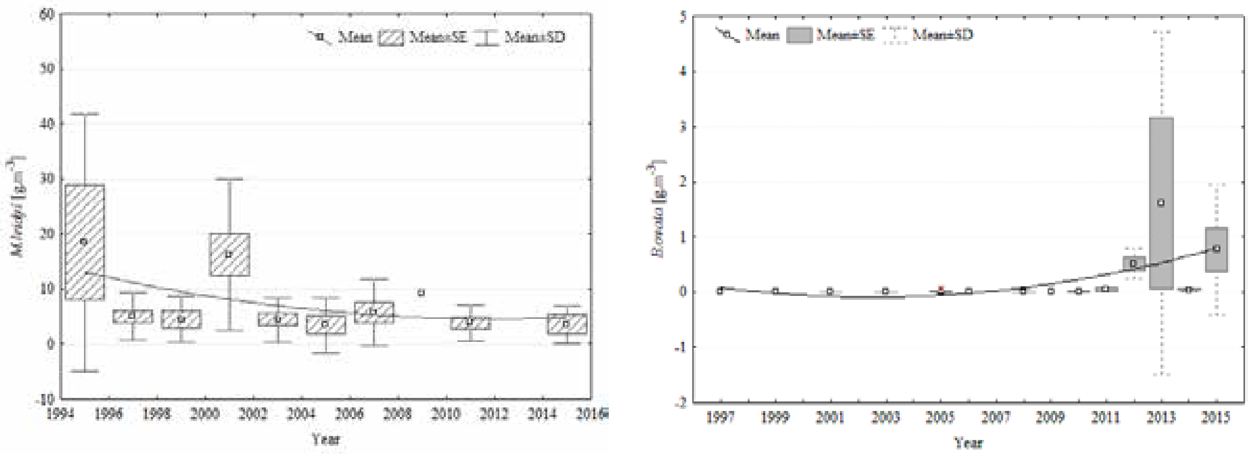
The length-weight relationship was found to be $W=0.189L^{2.933}$ ($R^2=0.936$) for the whole population of *R. venosa*. These results were comparable with the values of b estimated by Aydin et al. (2016) for the Turkish coast of the Black Sea. There were no differences in the values of functional regression coefficient b between males ($W=0.195L^{2.920}$; $R=0.933$) and females ($W=0.191L^{2.920}$; $R=0.933$). Fulton's condition factor varied from 2.33 to 9.20 and the average K of population was 6.26±1.09 SD.

In the period 2014-2016, only two specimens of the redlip mullet *L. haematocheila* were caught in Varna Bay (Trakata station) and analysed on the base of allozyme and morphological data (Ivanova et al. 2017). For the same period, the fish species was found rarely in the catches by gill nets, trap-nets and divers in Varna Lake and along the northern Black Sea coast, according to information (personal communications) by fishermen (Ivanova et al. 2017). The information about the catches of *L. haematocheila* in the Bulgarian Black Sea waters is scarce. Up to 2007 there was lack of data about the catches of the species along our coast. The analysis of data on *L. haematocheila* catches from 2008 to 2016, provided by the Executive Agency of Fisheries and Aquaculture (EAFA), showed that the maximum level of catches (1.923 t) along the Bulgarian Black Sea coast was registered in 2009 (Table 3). A tendency of a progressive decrease after that period is observed and the minimum catch of *L. haematocheila* (0.075 t) was registered in 2016.

The fact that in the last 3-4 years *L. haematocheila* has been rarely presented in the catches along the Bulgarian Black Sea coast, can be explained with the decrease in its stocks in the Sea of Azov and the Black Sea. It was assumed that the main reasons for this trend towards a decrease in the stock of *L. haematocheila* in the Azov Sea, were the permanent intensive fishing pressure (commercial fishing and poaching) and the deterioration of the conditions for natural reproduction

A





B

Fig. 4. Year-to-year variability and trends of alien species populations A) Copepods – upper panel and B) Ctenophores – lower panel (left – *Mnemiopsis leidyi*, right – *Beroe ovata*)

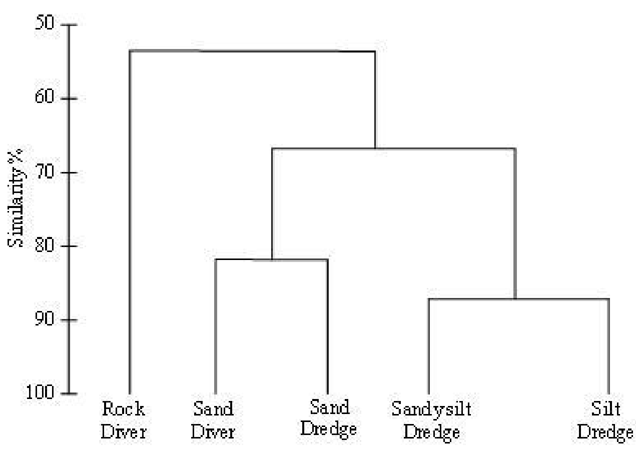


Fig. 5. Dendrogram of hierarchical clustering of frequency distribution data on the shell length of *Rapana venosa* according to the seabed and method of sampling in Varna Bay, the Bulgarian Black Sea coast

of the species in the Azov Sea Basin (Izergin & Demyanenko 2012, Turkulova et al. 2015). As a result from that, a negative trend of the catches of *L. haematocheila* in the Black Sea countries was observed (Table 4). There is no information about the natural reproduction of the species in the Black Sea.

Up to now studies for the assessment of the negative impact of *L. haematocheila* on other representatives of family Mugilidae along the Bulgarian Black Sea coast have not been carried out. According to Erdogan et al. (2010), *L. haematocheila* successfully competes with native mullet species, such as *Mugil cephalus* and *M. auratus,* for food in the Black Sea. The authors assumed that as a result of this competition, the catches of the native mullet species declined from 14,189 to 1,518 tonnes during the period 2000-2008 (Erdogan et al. 2010). However, there is no evidence that the decline of the native fish catches are because

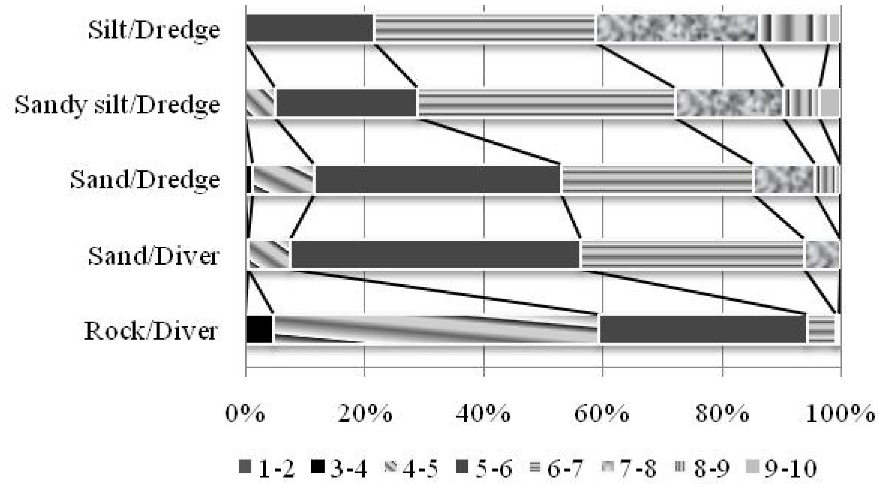


Fig. 6. Frequency distribution of the shell length size classes (cm) of *Rapana venosa* according to the seabed and method of sampling in Varna Bay, the Bulgarian Black Sea coast

Table 2. Mean values of size-weight variables of male and female *Rapana venosa* sampled from different seabed types and by different methods in Varna Bay, the Bulgarian Black Sea coast

Seabed/ Method of sampling	Biomass (kg km^{-2})	Shell length (cm)		Total weight (g)		Body weight (g)	
		Males	Females	Males	Females	Males	Females
Rock/ Diver	6.65	5.05	4.84	24.26	19.90	8.92	6.81
Sand/ Diver	4.87	4.68	4.32	39.07	31.15	15.82	12.10
Sand/ Dredge	19.28	6.27	5.56	47.07	33.08	17.46	11.30
Sandy-silt/ Dredge	2.16	6.81	6.24	53.77	44.21	21.37	16.38
Silt/ Dredge	2.92	7.42	6.26	68.51	41.76	25.73	14.85

Table 3. Catches of mugilid species along the Bulgarian Black Sea coast in tonnes (2008-2016), according to data provided by the Executive Agency of Fisheries and Aquaculture (EAFA), Bulgaria

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mugil cephalus	9.062	10.361	18.724	14.687	24.702	9.03	14.759	10.209	8.703
Liza hematoheila	0.083	1.923	0.332	0.43	0.176	0.063	0.124	0.11	0.075
Liza aurata	2.356	3.267	1.828	2.39	0.947	1.996	2.515	0.865	0.699
Liza saliens	3.151	6.569	8.765	7.509	14.621	10.61	17.008	6.529	4.961

Table 4. Catches of *Liza haematocheila* in some Black Sea countries in tonnes (2008-2013)

Country	2008	2009	2010	2011	2012	2013
Bulgaria	0.083	1.923	0.332	0.43	0.176	0.063
Turkey	3.35	2.987	3.12	2.51	4.01	2.51
Russia	1591.1	2178.8	1018.6	973.4	434.5	372.8
Ukraine	5361.4	7186.7	3825.6	3530.9	1385.6	1258.4

of competition with *L. haematocheila*. It could be because of overfishing or because of the impact of *M. leidyi* on the pelagic food webs. The data on the catches of mugilid species along the Bulgarian Black Sea coast in the period 2008-2016 (Table 3) show that the catches of *L. haematocheila* were negligible in comparison with these of other species, and no influence by the alien *L. haematocheila* on the native species could be deduced.

Conclusions

Our results showed that the alien zooplankton and benthic invertebrate species studied have established and stable populations in Varna Bay. The fish species *L. haematocheila* showed a trend of permanent decrease along the Bulgarian Black Sea coast from 2009 to 2016.

Mnemiopsi leidyi is still a key element in the Black Sea coastal area in summer, although its population has been regulated primarily by *B. ovata*. The alien copepod species *A. tonsa* and *O. davisae* have become an important component of the plankton community structure and are considered to be a suitable prey for the planktivorous fish and the early fish larvae of many species.

The smallest in size individuals of *R. venosa* dominated on the shallow rocky bottom. The sandy locations were characterised by the dominance of 5-6 cm sized specimens, while the deeper locations were distinguished by the prevalence of larger individuals of the size class 6-7 cm. The males showed higher values of all size-weight parameters when compared to females. The biomass of *R. venosa* was the highest on the sandy location and the lowest on the sandy-silty location, both sampled by dredge.

As opposed to the very common occurrence of *L. haematocheila* in the Black Sea in the past, it has become rare along the Bulgarian Black Sea coast currently, a decline which appears to be evident in all Black Sea countries. There is a necessity of constant monitoring of the species in order to assess its actual status and establishment success along the Bulgarian Black Sea coast, as well as its potential impact on the native mugilid species.

Acknowledgements: The study was funded by the Financial Mechanism of the European Economic Area 2009-2014, Programme BG03 'Biodiversity and Ecosystem Services', within the project: East and South European Network for Invasive Alien Species – A tool to support the management of alien species in Bulgaria (ESENIAS-TOOLS, D-33-51/30.06.2015).

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