www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 15: 505-515 (2015) DOI: 10.4194/1303-2712-v15_2_38

Cryptobenthic Fauna of the Mussel Farm's Collectors

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Received 05 January 2015
Accepted 01 June 2015

Abstract

In this study, cryptobenthic communities of fishes and decapod in underwater caves of Tarkhankut peninsula, underwater caves of southwestern Crimea and mussel's farm in Sebastopol were described. Structure and features of cryptobenthic fauna were considered for mussel's settlements and underwater habitat (caves and grottoes), the study of which is extremely complex and are sketchy and incomplete in the Black Sea. In the cryptobenthic fish community of the mussel fouling two new for Crimea fish species - zebra goby *Zebrus zebrus* and small-headed clingfish *Apletodon dentatus*, were discovered, both of them were previously found only sporadically in the southern part of the Black Sea. For the first time early developmental stage and morphometric characteristics of the Black Sea population of zebra goby were studied, this made it possible to identify the morphological differences between similar species *Zebrus zebrus* and *Millerigobius macrocephalus*. Some morphological features of the Black Sea population *Apletodon dentatus*, which is one of the rarest species of this genus, have been described. Species biodiversity and quantitative relationships in the crypthodentic decapod community was investigated. Adult specimens of two rare species of shrimp (*Lismata seticaudata*, *Alpheus dentipes*), previously known in this area for only a few find plankton larvae were first found in the fauna of decapods of southwestern Crimea. Results from study confirm that it is promisingly investigate the species diversity and abundance of cryptobenthic species fish and decapod in artificial populations of mussel fouling.

Keywords: Black Sea, fish, decapods, cryptobentic, mussel, Gobiidae, *Zebrus zebrus*, *Apletodon dentatus*, *Lismata seticaudata*.

Introduction

In the coastal zone of the Black Sea, like in other seas of the Mediterranean basin and the World ocean in a whole there exists not quite considerable by its species diversity and abundance but extremely interesting and less studied fish group, differing in much masked existence, small size and bottom way of life. They often make conclusion about their being rare, endemic and spread quite locally, as they are known by not numerous local findings. More often such findings concern representatives of the families Blenniidae, Gobiesocidae and Gobiidae (genera *Didogobius*, *Chromogobius*, *Gammogobius*, *Millerigobius*, *Thorogobius*, *Pomatoschistus*, and some species of genus Gobius) (Bogorodsky *et al.*, 2010; Vanhove *et al.*, 2011; Engín and Dalgiç, 2008; Ahnelt *et al.*, 1998; Colombo and Langeneck, 2013; Kovačić *et al.*, 2012). They prefer to inhabit stones and rocks, covered with splits, hollows and surfaces of the underwater caves, or to fix to the lower side of stones or big pebble. Most of them leave their shelters only at the dark time of the full day, excluding fish, inhabiting the half dark zone of the caves; by the way of reproduction all of them are mostly lithophilous. Small size permits them to avoid almost all catching tools and in sum with all above mentioned peculiarities makes them very complex objects for registration. By their way of life such fish species are very close to higher crustacean, most of which adapted completely to habitation conditions making part of the bottom communities, and possibly due to this reason they do not separate as analogous grouping. With distribution of new methods of the studies, including visual investigation of biotops using diving, photo – and video fixation, anesthetic preparations for fish sampling, catches of a number of small crypto benthic species in new for them regions became more often in the Mediterranean basin. Knowledge about areal of settled bottom species, considered before to be narrow local endemics, first of all quite a number of gobies are now quite spread.

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In the Black Sea attention to cryptobenthic species arose in connection with the findings of new alien, or very rare for the regional fish fauna species, mostly from the family Gobiidae.For some of them it is impossible to credibly claim they are recent invasive, or have not been detected previously in connection with the extremely secretive way of life.The analysis of findings in the Black Sea new fish species for the last 15 years has shown that a relatively large and least secretive living *Gobius cruentatus* (red-mouthed goby) and *G. xanthocephalus* (yellow-headed goby) were registered in the first place, the first of them near Turkish shores (Engin *et al.*, 2007) and Crimean shores (Boltachev *et al.*, 2009), the second near Abkhazia (Vasil'eva and Bogorodsky, 2004) and Crimea (Boltachev *et al.*, 2009). At the same period, they marked distribution of an inhabitant of sandy biotops goby *Pomatoschstus bathi* (Vasil'eva and Bogorodsky, 2004; Boltachev *et al.*, 2009).

The further group of findings is connected with investigation of the most hidden habitats, such as underwater caves, grottoes and caverns. One specimen of *Zebrus zebrus*was caught near the Turkish coast (Ordu) in 2007, when hidden habitations were observed using anesthetic (Kovacic and Engin, 2009). Under detailed investigation of the underwater caves in the region of Tarkhankut Peninsula 3 new species were registered (Kovtun, 2013; Kovtun and Manilo, 2013; Kovtun and Karpova, 2014). Two of them – *Gammogobius steinitzi* and *Chromogobiuszebratus* are new for the Black Sea in a whole, the third – *Chromogobiusquadrivittatus*, earlier was observed in small quantities near the Caucasian Coast (Svetovidov, 1964) and single specimen in Varna Gulf (Georgiev, 1961); one specimen was also registered in Odessa Gulf (Hutornoy, 2006). But at present time efforts to find the species in previous habitats near the Caucasian Coast gave no result (Pashkov, 2013); near Bulgarian Coast a single specimen was found in the last years of investigations (Vassilev *et al.*, 2012).

Because the two alien species *Tridentiger trigonocephalus* and *Millerigobius macrocephalus* were found by us in the Sevastopol bay into mussel fouling (between live mussels and in the empty shells) (Boltachev and Karpova, 2012), we assumed that among bivalves cryptobenthic species can also concentrate and create sustainable communities.

At natural substrates near Crimea, mussel inhabitations are mostly in depressive state and are not dense. However, in the mussel farms where mollusks form dense fouling there are suitable conditions for cryptobenthic species existence. We guess that mussels habitation on the farm collectors represent the most accessible model for investigation of separate cryptobenthic species and communities, including fish, crustacean and other bottom hydrobionts.

Targeted research of benthic fauna conducted in underwater caves of Tarkhankut peninsula revealed complex marine organisms, among which there were 9 species of decapod, 15 species of fish, of which 9 species can be attributed to cryptobenthic (*Paradlennius sanguinolentus, Coryphoblenius galerita, Gobius bucchichi, Gobius niger, Gobius cobitis, Lepadogaster lepadogaster,Chromogobius quadrivittatus, Chromogobius zebratus, Gammogobius steinitzi*), and more than 15 species of other animals (Kovtun and Pronin, 2011; Kovtun, 2013; Kovtun and Manilo, 2013; Kovtun and Karpova, 2014). However, in other parts of the Crimean coastal zone nothing special studies of cryptobenthic communities in various hidden habitat were not carried out and all benthic species were considered only in the fauna of rocky habitats in general.

These data were supplemented by our researches in the area of Tarkhankut peninsula and south-western Crimea, where investigations of fauna underwater caves and mussel's farm were carried out, biodiversity of communities and their comparative analysis were made and several new and rare species of marine organisms were identified.

Materials and Methods

Cryiptobenthic fauna was studied in the underwater caves and grottoes Tarkhankut peninsula and south-western Crimea during the summer months of 2011 and 2013. We also investigated mussel collectors in the sea farms in Sevastopol (44°61'8580" N, 33°50'7605"E) and Streletskaya (44°60'6655"N, 33°46'7037"E) bays (Figure 1, Table 1).

Sampling of fish and decapod crustaceans was fulfilled by hands, when covered by molluscs collectors were lifted on vessel board. Samplingwas realized in May 2013 in the Sevastopol bay and in May 2014 in Streletskaya Bay. For further investigations fish was fixed in 4% formaldehyde solution; several specimens of each species were kept inaquarium conditions for learning peculiarities of their behavior. We studied also samples of fish, taken from collectors in the Sevastopol Bay in 2009 and 2010 and preserved in the IBSS collection. During standard biological analysis of fish, we measured general (*TL*) and standard (*SL*) length and mass (*W*). Morphometric characteristics were measured using generally adopted methods (Pravdin, 1966; Miller, 1986). Measurements were conducted with accuracy of 0.1 mm with the help of Verniercaliperand binocular, mass was measured with accuracy of 0.01 g.

In shrimps we determined general length *Lt* (from the end of rostrum to the end of telson), standard length *Lo* (from the end of eye hole to the end of telson), and carapace length *Lc* (from the end of eye hole to the end of cephalotorax) with the help of Vernier caliperswith accuracy of 0.1 mm. To

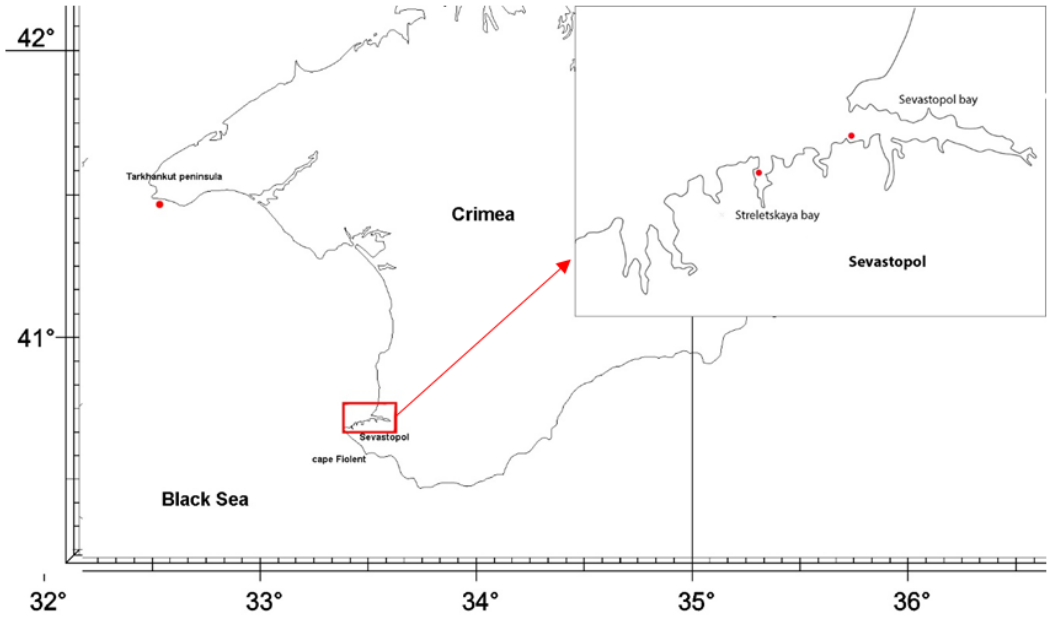


Figure 1. Sampling stations.

Table 1. Cryptobenthic fish fauna in different part of Crimean cxoastal zone – species divercity and the frequency of occurrence

n/n	Species	Tarkhankut peninsula	South-western Crimea	Mussel fouling in Sevastopol bays
Fam. Blenniidae				
1	*Aidablenniussphynx*	C	C	C
2	*Coryphoblenniusgalerita*	C	C	-
3	*Salariapavo*	-	-	C
4	*Parablenniusincognitus*	-	C	M
5	*Parablenniussanguinolentus*	C	C	C
6	*Parablenniuszvonimiri*	M	M	C
Fam. Gobiesocidae				
7	*Apletodondentatus*	V	V	R
8	*Lepadogastercandollii*	R	R	
9	*Lepadogasterlepadogaster*	R	R	R
Fam. Gobiidae				
10	*Chromogobiusquadrivittatus*	R	-	-
11	*Chromogobiuszebratus*	R	-	-
12	*Gammogobiussteinitzi*	R	-	-
13	*Gobiusbucchichi*	C	C	-
14	*Gobiuscobitis*	C	C	-
15	*Gobiuscruentatus*		R	-
16	*Gobiusniger*	C	-	-
17	*Gobiuspaganellus*	C	C	-
18	*Gobiusxanthocephalus*	R	R	-
19	*Millerigobiusmacrocephalus*	-	-	R
20	*Tridentigertrigonocephalus*	-	-	C
21	*Zebruszebrus*	-	-	C
Total		14	11	9
				17

* M – mass; C – common; R – rare; V – very rare; bold - for new species of Crimean ichthyofauna for last 15 years

determine weight characteristics of collected hydrobiological material we used electronic weighs (AXIS – 500, accuracy of 0.001 g). Sex was determined according to presence or absence of appendix masculine. Biological analysis of crabs was conducted according to generally accepted methods (Rodin *et al.*, 1979), which includes measuring of length and width of carapace by Vernier calipers, with accuracy of 0.1 mm, and weighing with accuracy of 0.01 g. Species of decapods measured alive: *Lysmata seticaudata*, *Alpheus dentipes*, *Eriphia verrucosa*, *Pilumnus hirtellus*, *Pachygrapsus marmoratus*, *Macropodia longirostris*. Species of decapods measured after fixation with 96% alcohol: *Palaemon*

elegans, Hippolyte longirostris, Athanas nitescens, Pisidia longimana.

Results and Discussions

The greatest development cryptobenthic fauna off the coast of the Crimea received in areas of Tarkhankut peninsula and Sevastopol, due to the geological features of sedimentary rocks of the coastal zone.

Fish community of cryptobenthic fauna was submitted more than 20 settled benthic species, among which about half were recently discovered, alien (Table 1). The coastal zone of south-western of the Crimea has the greatest biodiversity in the first place due to the more prolonged and regular studies.Approximately equal number of fish species was found us in the natural shelters of rocky substrates (underwater caves and caverns) and among mussel fouling of the farm's collectors, but their species composition differed significantly and Sorensen's coefficient in this case was only 0.3.Out 9 species that we registered among mussels, two species-*Apletodon dentatus* (Facciolà, 1887) and *Zebrus zebrus* (Risso, 1826) were new for the coast of the Crimea. Quite a large species similarity was observed between the communities of underwater caves and grottos in the Tarkhankut peninsula and southwestern Crimea, Sorensen's coefficient reached 0.83. The lowest similarity was recorded between ichthyocenosis of natural habitats of Tarkhankut peninsula and mussel fouling in the southwestern Crimea (Sorensen coefficient of 0.25). In general, gobies dominated by species diversity, but in region of Sevastopol the increase in species diversity of blennies was observed, this trend was even more pronounced in the fauna of mussel fouling, blennies there dominated both the diversity (Figure 2), abundance and biomass (Figure 3). *Parablennius incognitus* was the most numerous among them. Near Crimean shores this species was registered quite recently, at the beginning of XX^{-th}, and at the first period we observed considerable increase in its number, but now it is met in the coastal zone regularly, but singularly (Boltachev *et al.*, 2009; Boltachev and Karpova, 2014). Usual for this region *P. zvonimiri, P. sanguinolentus, Salaria pavo u Aidablennius sphynx* were present in less quantities. *Parablennius incognitus* and *P. zvonimiri* were represented by adult matured specimen, other species

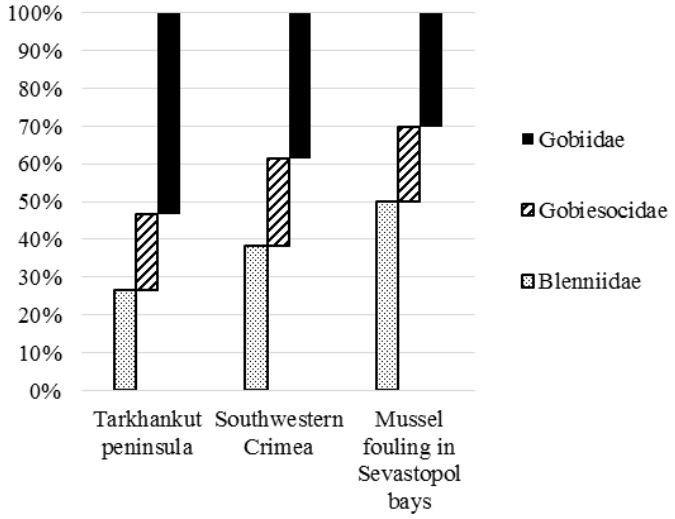


Figure 2. The relative number of species of different families of fish in the cryptobenthic ichthyofauna of the Crimea.

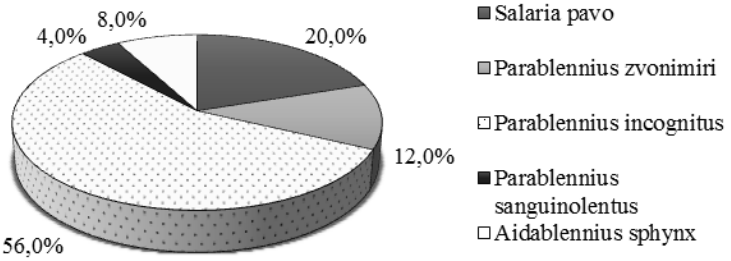


Figure 3. Abundance correlation of different Blenniidae family species on mussel collectors.

were represented mostly by juvenile specimens.

Some morphological, biological and behavioral features both of new fish species we examined in the laboratory.

Zebrus zebrus (Risso, 1826) was represented by 25 specimens. Four of them were caught at collectors in the Sevastopol Bay in 2013, 15 specimens were taken at the mussel farm in the Streletskaya Bay in2014. After these findings this species was also found in samples, collected earlier in 2009 – 2010 in the Sevastopol Bay, where all fishes were primarily attributed to species *Millerigobius macrocephalus* (Boltachev *et al.*, 2009), but comparative analysis revealed among them also 6 exemplars of *Zebrus zebrus*. We conducted biological analysis of 20 exemplars of fish, of which 6 were males with SL 29.2–35.8 mm and W 0.70-1.26 g and 14 females with SL 15.0-33.9 mm and W 0.05-0.78 g. All the main key signs of species according to determining tables (Miller, 1986, Kovacic, 2008) are present: 1) suborbital row of genipores *a* is absent; 2) head and anterodorsal region are naked; 3) anterior dorsal genipores row *g* ends behind or on lateral end of row *o*; 4) all three head canals are present; 5) free upper rays of pectoral fins are well developed.

The body is short, covered with big ctenoid scale. Occiput, front part of the back to the beginning of the first back fin, gill leads and breast are naked. Belly is partially covered with cycloid scale. Head is big, lower part protrudes, mouth oriented a bit up. Mouth is small, curved up. Ends of the upper lip are a bit narrowed. Front nostrils are looking like small tubes, with thin protrusions in the upper part. Head canals anterior and posterior oculoscapular, preopercular with pores σ, λ, κ, ω, α, β, ρ, ρ1, ρ2, γ, δ, ε are present. Rows of sensory papillae: preorbital: r (1), s1 (2), s2 (2), s3 (2), c1 (2), c2 (2), c1 (2), c2 (2); suborbital: no row a, four transverse suborbital rows before, two below longitudinal row b, 1 (6), 2 (5), 3 (7), 4 (7), 5s (4), 5i (5), 6s (4), 6i (7), 7 (4), b (9), d (10); oculoscapular: x1 (9), x2 (2), tr (2), z (9), q (2), y (1), as1 (9), as2 (4), la (4); opercular: ot (11), os (8), oi (5); anterior dorsal: g (6); o (4); n (7), h (6).

General background of the body is yellowish with grey or olive tint, at the sides 6–7 doubled reddish – brown stripes, more or less quite expressed. Head is colored more brightly, general background is reddish-brown, on checks – marmar picture of yellow spots. Yellow stripes go from lower edge of eye down through the mouth corner and from the back edge of eye down through the gill lead. On the nuke behind the eyes there is transversal light or bright-yellow stripe. Fins with going in turn brown and bright uneven wavy stripes, more or less transparent; back fins are more dark and brightly colored, upper edge of the first with yellow trimming, in the second and anal trimming is expressed weaker or is absent. The bases of breast fins are with bright yellow spots, on the base of middle rays there is black spot, lower – yellow one (Figure 4a, Figure 4b) Territorial males change considerably their color (Figure 4 c).

To reveal morphological differences between *Zebrus zebrus* and *Millerigobius macrocephalus* we conducted their comparativemorphometric analysis (Table 2); the results say, that reliable differences are observed only in some proportions of head (interorbital distance and mouth width) and inisthmuswidth.

Zebra goby has discrete way of life, it inhabits coastal biotops of rocks and stones, usually it is in holes and splits of rocks, under stones, in mussels' aggregates, but it can be met on the soft grounds at

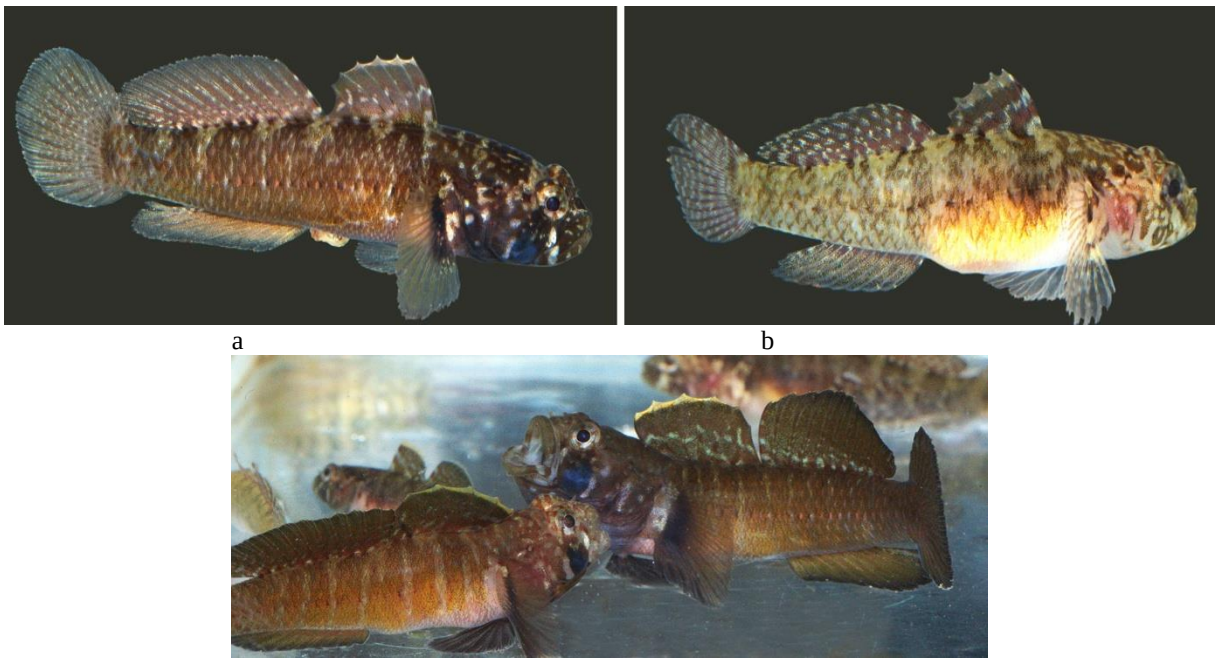


Figure 4. Male (a) and female (b) *Zebrus zebrus.* Territorial males in threatening poses (c).

depths up to 4 m. (Miller, 1986; Bogorodsky *et al.*, 2010). Territorial species, quite aggressive to representatives of its own species and other close in size fish. Living in small aquarium matured males constantly demonstrated to each other endangering poses and changed body color for more bright, brown, with orange tint and thin bright transversal stripes of olive color. Head and front part of the body almost lost marblepicture and were very dark, with blue spots on cheeks, in front and behind of which there were vertical light stripes. But in natural conditions with enough number of shelters these gobies formed inhabitations with high density In collections there were fishes of two size clusters, which possibly corresponds to two age groups (0 + and 1 +).

Pair of fishes, caught on May 28, 2014 and placed to aquarium spawned in several days. Eggs, about 2400 was put by female to the lower and side walls of aquarium, male protected her and aired by movements of the tail and fins. Eggs were of elliptical form with a bit widened upper end, the lower had a bundle of gluing filaments, with which eggs fixed to substrate; its size along long and short axes made correspondingly 1.2 and 0.4 mm. Early stage of embryonic development are shown at Figure 5. Outgoing of larvae with water temperature 24-25°C took place at the sixth day. Larvae of 2.03 mm length, weakly pigmented by a few number of small star-formed melanophores of dark and reddish colors, located at the lower side of the body; after outgoing, they swam actively in pelagial and had no yolk sac.

Apletodon dentatus (Facciolà, 1887) has been

Table 2. Plastic characters of *Millerigobius microcephalus* and *Zebrus zebrus*

	Millerigobius macrocephalus				*Zebrus zebrus*				diff
	M	m	Min	max	M	m	Min	Max	
In % *SL*									
H	21.2	0.68	18.82	23.29	20.8	0.63	17.65	24.02	0.38
h	11.7	0.29	10.84	12.76	11.5	0.22	10.28	12.49	0.68
iH	16.1	1.05	12.79	19.74	16.6	0.44	14.82	18.72	0.46
ih	2.4	0.24	1.72	3.28	4.3	0.67	1.54	7.99	2.63
aD	38.0	0.39	36.86	39.41	32.7	3.11	3.52	37.52	1.71
pD	44.9	0.44	43.89	46.59	45.0	0.55	42.59	49.17	0.18
aP	31.7	0.22	31.00	32.48	32.0	0.36	30.13	33.80	0.75
aV	30.0	0.14	29.60	30.54	30.0	0.64	27.37	35.31	0.08
aA	62.0	0.33	60.74	62.76	60.3	0.60	57.18	63.04	2.50
PV	16.1	0.25	15.40	17.04	13.0	1.21	7.79	17.14	2.55
VA	32.8	0.44	31.38	34.31	31.3	0.90	25.96	36.13	1.45
pl	19.9	0.41	18.53	21.21	20.3	0.34	17.92	21.88	0.70
lD1	17.5	0.61	16.29	19.83	18.2	0.26	16.60	19.49	1.15
hD1	13.3	0.44	11.76	14.63	12.6	0.49	9.32	15.29	1.01
D1-D2	0.0	0.00	0.00	0.00	0.1	0.09	0.00	0.85	1.55
lD2	27.6	0.15	27.14	28.13	28.7	0.39	26.89	30.58	2.66
hD2	16.5	0.82	13.43	18.72	13.5	0.57	10.94	16.87	2.94
lA	20.7	0.47	19.46	22.45	19.7	0.39	17.66	22.07	1.52
hA	12.1	0.30	10.92	12.74	11.9	0.46	8.99	14.08	0.23
lP	24.4	1.76	17.79	28.66	21.7	1.09	15.68	27.34	1.35
lV	20.6	0.15	20.05	21.00	20.6	0.20	20.16	21.40	0.08
lC	20.4	0.27	19.39	21.09	20.0	0.11	19.54	20.25	1.52
c	28.0	0.15	27.65	28.62	27.9	0.52	25.49	30.74	0.36
In % c									
cH	68.4	1.42	64.96	73.72	69.9	1.24	64.51	78.27	0.84
ic	44.2	1.04	41.49	48.06	48.8	1.49	40.46	55.13	2.52
ao	25.0	1.32	19.97	28.01	25.8	1.19	20.38	32.39	0.48
lmx	42.5	1.45	36.93	45.43	41.2	1.22	33.28	46.29	0.68
lmd	41.7	0.61	39.42	43.24	39.9	1.49	31.40	46.32	1.13
o	28.3	0.62	26.13	30.23	25.7	0.87	21.38	31.78	2.44
po	56.2	0.57	54.98	58.41	52.7	1.71	46.15	65.99	1.95
oo	21.3	0.99	18.26	24.77	22.1	0.86	18.22	26.68	0.66
or	46.7	1.18	42.32	49.77	54.2	2.05	43.22	62.69	3.18
io	5.9	0.49	4.36	7.60	8.3	0.61	6.15	13.08	3.03
ho	39.1	1.39	33.82	42.34	41.0	1.07	35.16	48.04	1.08
Ist	13.8	0.28	12.76	14.57	20.7	2.12	11.45	31.97	3.20

* H and h – maximum and minimum depth of the body; iH and ih - maximum and minimum thickness of the body; distances: aD - antedorsal. pD - postdorsal. aP - antepectoral. aV - anteventral. aA - anteanal. PV - pectoventral. VA - ventroanal; pl - caudal peduncle length; lD1 and lD2 - base length of first and second dorsal fin; hD1 and hD2 - depth of first and second dorsal finl; lA - base length of anal fin. hA - anal fin depth; lP - pectoral fin length; lV - ventral fin (sicker) length; lC - caudal fin length; D1– D2 - distance between dorsal fins; c - head length; cH - head depth at occiput; ic - maximum head width; ao - snout length; lmx - upper jaw length; lmd - lower jaw length; o - eye diameter; po - length of postorbital region of head; oo - distance between eye and mouth angle; or - distance between angles of mouth; io - forehead width; and ho - cheek depth; ist – istmus width.

found during investigation of the mussel collectors near the open part of the Streletskaya Bay; on May 19 and 28, 2014 correspondingly 3 and 2 fish specimens with standard length SL 17.2 – 25.8 mm and mass W 0.057 – 0.173 g were caught. Analogous not matured specimen with SL 13.4 mm and W 0.044 g was caught on September 10, 2013 near the shores of Tarkhankut Peninsula (region of cape Maliy Atlesh) in small hole of a big fragment of rock, fouled by macrophytes. Complex features available, according to which fishes belong to the species *Apletodondentatus*: 1) there are well developed caniniform teeth at jaws; 2) the first ray of anal fin is situated under 1 – 2 rays of a dorsal one; 3) there are thickened and pigmented membranes in the anterior part of dorsal and anal fins; 4) distinct anal papillae present; 5) maxilla without a barbel in male; 6) upper jaw with 1–3 incisors; 7) mandibular-canal pores 0. *Apletodon dentatus* described in the Black Sea by singular specimens near Bulgarian shores in the region of Burgas Gulf and Kaliakra Cape as a subspecies *Apletodon dentatusbacescui* (Murgoci, 1940) at the end of 30-ties of the last century (Banarescu, 1964). After a considerable interval, in2000 one exemplar was also caught near Turkish shores (Bat *et al.*, 2006). At present time this fish has valid species status *A. bacescui* in the internet-resources FishBase, Eschmeyer; at the same time a number of researchers attribute it to *A. dentatus* species, pointing, that differences in meristic signs in the Black sea exemplars are extreme deviations in the limits of morphological changeability.

Comparison of not numerous meristic and plastic data on these sub-species from different sources shows that range of changes of majority of them is quite close (Table 3) and covers over some of them and specimens caught by us according to a number of signs occupy intermediate place.

General background of the fish body color is greenish – olive, majority of specimens has marblepicture in reddish-brown spots, less expressed at the tail stem, and light spots. Belly side and head lower part are white. On operculum there are two going aside reddish-brown stripes, separated by white spot of triangular form (Figure 6a). One specimen was green-colored with white points and rosy front part of the snout (Figure 6b). Head lateral-line system with 2 pores in nasal canal, 2 pore in postorbital canal, 3 pores in lacrymal canal, 1 upper and 1 lower pore in preopercular canal, and no open pores in mandibular canal.

Valid species *A. dentatus* is distributed in the Eastern Atlantic from Scottish shores to Canarian Islands, in the Mediterranean Sea mostly in its

Figure 5. Stages of early ontogenesis *Zebrus zebrus*: a –1stday, b – 2nd day, c – 3rd day, d – 4th day, e – 5th day, f, g – larvae, 6th day.

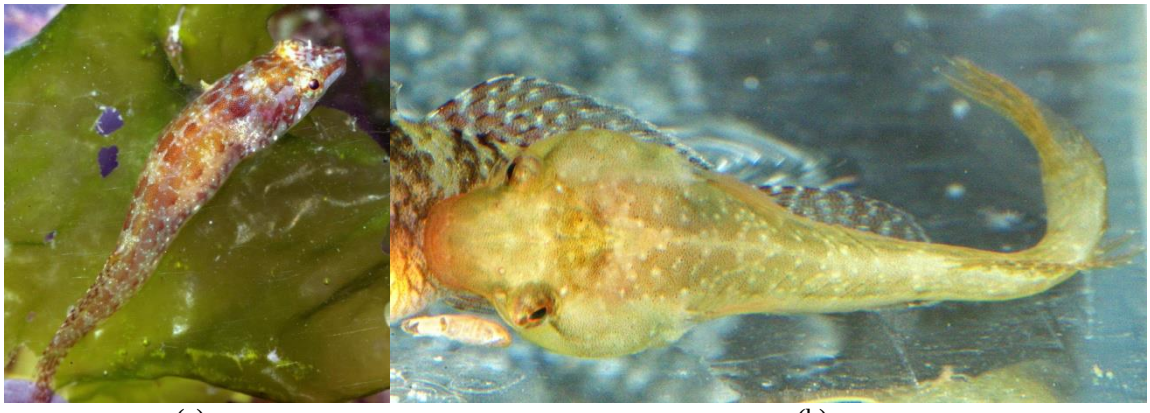
Table 3. Some meristic data and plastic characters (%) taken of *Apletodon dentatus* from literature and our data

	A. dentatus dentatus			*A. dentatus bacescui*			*A. dentatus*	
Source	Briggs, 1986	Brandl *et al.*, 2012	Hofrichter and Patzner, 1997	Briggs, 1986	Banarescu, 1964	Bat *et al.*, 2006	Our data, Sevastopol	Our data, Tarchankut
D	5-6	-		8	8	7	7-8	8
A	5-7	-		7	7	7	6-7	8
P	21-24	-		18	23	21	19	
C	10-11	-		11	-	14	13	
Head length in *SL*	2.5-2.8	2.8-5.3	2.45-2.94	3	-	3.3	2.9-3.3	2.8
Body depth in *SL*	5.5-6.1	-	-	6.5	6.5	-		
Pectoral length in *SL*	3.6-4.6		3.9-4.8	5.5	-	6.2	4.7-5.1	4.9

western and northern parts. In articlesabout the Mediterranean Sea it has been marked that that this species fry is met more often on algae, adults are found on boulders and stones, covered with brown algae (Brandl *et al.*, 2012; Goncçalves *et al.*, 2002). In a whole *A. dentatus* is considered to be one the most rare and small studied among 6 species of *Apletodon*genus (Bilecenoglu and Kaya, 2006; Brandl *et al.*, 2012); there are practically no data on its biology.

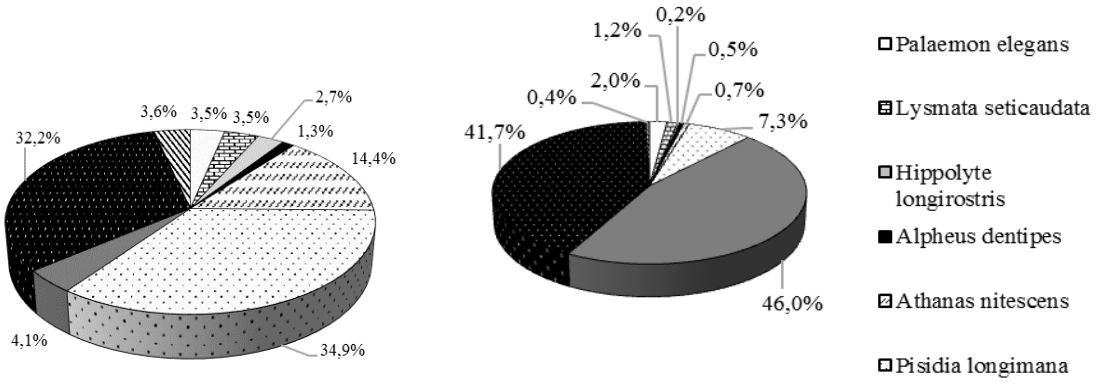
The cryptobenthic fauna of decapod previously in the Black Sea are not described. In studies of the fauna of underwater caves, researchers noted only the typical for the rocky habitats the larger species, as *Lysmata seticaudata*, *Palaemon elegans*, *Palaemon adspersus*, *Pachygrapsus marmoratus*, *Xantho poressa*, *Eriphia verrucosa*, *Pilumnus hirtellus*, *Carcinus maenas* (Kovtun and Pronin, 2011), which are the most typical representatives of common epibenthic fauna. Community of decapod on mussel fouling differed dramatically and was very rich in species diversity and quantity. There were present mainly small and extremely secretive living species. There we constantly registered 9 species of decapods, of which *Pilumnus hirtellus* and *Pisidia longimana* were most abundant (Figure 7a); the greatest contribution into biomass of decapods was made by the biggest of crabs–*Pachygrapsus marmoratus* (Figure 7b). Besides these species, big exemplar of *Eriphia verrucosa* was met singularly.

During investigation of the mussel collectors in Streletskaya Bay the authors also found 8 specimens of less studied shrimp *Alpheus dentipes* Guerin, 1832. Size of the studied specimens of *A. dentipes*was*Lt* 13.0–30.0 mm, *Lo* 12.0–29.5 mm, *Lc* 3.0–7.0 mm, mass *W* 0.092–0.339 g. All specimens of *A. dentipes* were females, four of them had eggs on pleopods, and number of eggs of female with *Lt*23 mm was 602. Body color at the life period – from greenish – grey to brown tints, propodium of the left trunk leg of the first pair –red – brown with bright orange – red dactylus. *A. dentipes* is distributed in the Black and Mediterranean seas, as well as in the Eastern Atlantic from Portugal to the Guinea Gulf and Azores Islands (Kobyakova and Dolgopolskaya, 1969). For the first time in the Black Sea this species was pointed for Sevastopol Bay (Sovinsky, 1882), further on it was mentioned as usual form of the night pelagial in Sukhumi port (Chernyavsky, 1884). For the Caucasian shore of the Black Sea they also mentioned



(a) (b)

Figure 6. Various types of coloration of *Apletodon dentatusbacescui* from Sevastopol's bays.



a) b)

Figure 7. The ratio of different species of decapods in abundance (a) and biomass (b)

catching of adult specimens near Gudauta (Abkhazia) between oyster shells and in the region of Novorossiysk in sea wall fouling (Makarov, 2004). For Bulgarian coast *A. dentipes* is mentioned for Sozopol region (Bulgurkov, 1973), where females with eggs were found in holes of Holocene sediments of the shell limestones and near Romanian shores (Bacesco, 1967). According to our data and findings of previous researchers, A. dentipes is cryptobentic species that is associated with habitats formed by various species of bivalves (*Mytilus*, *Ostrea* etc.) and sometimes found in other very similar habitats. Date of aquatic organisms in the water column is marked only at night shelters.

Also among the bivalves were found 22 specimens extremely rare shrimp *Lysmata seticaudata* (Risso, 1816). Age and sex structure of the investigated individuals: 9 females, 3 of which with eggs on pleopods (*Lt* 19.0-31.0 mm, *Lo* 17.0-28.0 mm, *Lc* 4.0-7.0 mm, *W* 0.094-0.432 g); 7 males (*Lt* 22.0-28.0 mm, *Lo* 18.0-23.0 mm, *Lc* 5.0-7.0 mm, *W* 0.140-0.159 g) and 6 juveniles (*Lt* 17.0-18.0 mm, *Lo* 15.0-16.0 mm, *Lc* 4.0-4.5 mm, *W* 0.062-0.085 g). In the Black Sea known sporadic finds of adult *L. seticaudata* near the coast of Abkhazia (Chernyavskii, 1884), Romania (Bacesco, 1967) and the Crimea-in Sevastopol Bay (Kobyakovaand Dolgopolskaya, 1969) and in underwater caves near Cape Tarkhankut (Kovtun, 2006). Species is represented by the larvae in other findings in the Black Sea (Dolgopolskaya, 1948; Bacesco, 1967; Makarov, 2004). In the underwater caves, this shrimps show exclusively nocturnal activity (Kovtun, 2006). However, there is some evidence about finding this shrimps during the day at a depth of 3-6 meters on the rocks with Cystoseira (Bacesco, 1967). At the given stage of our study it can be assumed that in the Streletskaya Bay the shores of which are composed of lime-stones, shrimp live in small caves, grottoes and caverns, in mussel druses (*Mytilus galloprovincialis*) on this type of collectors, probably populated at the larval stage. Based on available data about frequent findings of larval stages in the plankton (Dolgopolskaya, 1948; Kobyakova and Dolgopolskaya, 1969; Makarov, 2004), it can be assumed that *L. seticaudata* is actually fairly common cryptobenthic species.

Obviously, the spread of crypto benthic species (fish, crustaceans and other aquatic organisms) in the waters Heracleus peninsula (Sevastopol) is confined to the karst-abrasion coastal zone, the folded Miocene limestones Sarmatian tier, which are situated from the Sevastopol bay to the magma rocks off the coast of Cape Fiolent. Similar habitat conditions are also off the coast of Cape Tarkhankut, characterized by an abundance of finds of cryptobenthic species. The close connection of this group with habitats that contain a large number of small and hardly accessible shelters is the reason that they certainly mastered the mussels foulings, where there is a lot of empty mollusk's shells, and close spaces between them. Observations have shown that the maximum number of aquatic organisms are concentrated on the collectors in April-June, during the most active preparation for reproduction, when a survey of 5-10 m collectors can collect dozens of specimens of rare species and a lot of decapods.

Conclusions

The results show that species diversity and abundance of crypto benthic species directly depend on the availability of appropriate habitats in the region, and the probability of detection-the methods used and the regular collection of material. In particular, the study of mussel collectors installed in areas most likely inhabited by crypto- benthic species, can be used as one of the most accessible methods for their detection and study of the biology and ecology at the individual or population level. Application of the method is promising at research mussel collectors, oyster cages mariculture farms; installation of experimental collectors or cages with clams for scientific purposes-to study the dynamics of occupancy crypto benthic species for a long period of observation is quite perspective.

Set the time of introduction of cryptobenthic species (except *Tridentiger trigonocephalus*) is not possible. The abundance of finds in recent years in the Crimea is not evidence of their recent entry into this water area, and reflects the degree of interest in this group of aquatic species and their close study. Researches of the cryptobentic coastal fauna need to be expanded along the coast of the Black Sea in order to obtain real information about the diversity and the transmission characteristics the representatives of this unique group of aquatic organisms.

Acknowledgements

The authors are grateful for owners of marine farms Yuriy Donets, Alexei and Ignat Polyakhov for arranging possibility of regular sampling at the mussel collectors, for Editorial of TrJFAS for possibility to publish materials of the conference FABA–2014 in special issue of the journal.

References

Ahnelt, H., Herler, J., Scsepka, S. and Patzner, R.A. 1998. First records of two rare Mediterranean Gobiidae in the northern Thyrrenian Sea. Cybium, 22(2): 183-186.

Bacescu, M.C. 1967. Decapoda. In: Fauna Republicii Socialiste Romania. Crustacea, 9(4): 1-356 (In Romanian).

Banarescu, P. 1964. The fauna of the popular Republic of Romania. Pisces – Osteichthyes XIII Academici Republicii Populare. Romine Press, Romania, 959 pp. (In Romanian).

Bat, L., Demirci, G.G. and Öztürk, M. 2006. Occurrence of *Apletodon dentatus bacescui* (Murgoci, 1940) (Gobiesocidae) and *Coryphoblennius galerita*

(Linnaeus, 1758) (Blenniidae) at the central Black Sea coast of Turkey. Journal of the Black Sea/Mediterranean Environment, 12: 59-65.

Bilecenoglu, M. and Kaya, M. 2006. The occurrence of *Apletodon incognitus* Hofrichter and Patzner, 1997 (Gobiesocidae) in the Eastern Mediterranean Sea. Acta Ichthyol. Pisc., 36(2): 143-145.

Bogorodsky, S., Kovačić, M., Ozen, O. and Bilecenoglu, M. 2010. Records of two uncommon goby species (*Millerigobius macrocephalus*, *Zebrus zebrus*) from the Aegean Sea. Acta Adriat., 51(2): 217–222.

Boltachev, A.R., Karpova, E.P. and Danilyuk, O. N. 2009. Findings of new and rare fish species in the coastal zone of the Crimea (the Black Sea). J. Ichthyology, 49: 277–291.doi: 10.1134/S0032945209040018

Boltachev, A. and Karpova, E. 2012. Marine fish of Crimean Peninsula. Business-Inform, Simferopol, 224 pp.

Boltachev, A. and Karpova, E. 2014. Faunistic revision of alien fish species in the Black Sea. Russian Journal of Biological Invasions, 5(4): 225-241. doi: 10.1134/S2075111714040018

Brandl, S.J., Wagner, M., Hofrichter, R. and Patzner, R. 2012. First record of the clingfish *Apletodon dentatus* (Gobiesocidae) in the Adriatic Sea and a description of a simple method to collect clingfishes. Bulletin of Fish Biology, 13: 1-2.

Briggs, J.C. 1986. Gobiesocidae. In: P.J.P. Whitehead, M-L. Bauchot, J-C. Hureau, J. Nielsen, E. Tortonese (eds) Fishes of the Northeastern Atlantic and the Mediterranean, 3. UNESCO, Paris: 1351–1359

Bulgurkov, K. 1973. Meeting of *Alpheus dentipes* Guerin (Crustacea-Decapoda) on Bulgarian coast of Black Sea. Izv. of nauch.-study. fishery inst. 12:103-105. (In Bulgarian)

Chernyavskii, B. 1884. Coastal decapods Ponta. Proc. Kharkov. Islands of Naturalists, 13:262.

Colombo, M. and Langeneck, J. 2013. The importance of underwater photography in detecting cryptobenthic species: new in situ records of some gobies (Teleostei: Gobiidae) from Italian Seas with ecological notes. Acta. Adriat., 54(1):101-110.

Dolgopolskaya, M.A. 1948. Materials on the phenology of larval stages Decapoda. Proc. Sevastop. biol. Station, 6: 74-94. (In Russian)

Engin, S. and Dalgıç, G. 2008. First Record of *Chromogobius zebratus* (Gobiidae) for the Mediterranean coast of Turkey. Turkish Journal of Zoology, 32(2): 197-199.

Engin, S., Turan, D. and Kovačić, M. 2007. First Record of the Red Mouthed Goby, *Gobius cruentatus* (Gobiidae), in the Black Sea. Cybrim, 31: 87-88.

Georgiev, J.M. 1961. An unknown goby for Bulgarian ichthiofauna-*Relictogobius kryzanowskii*. Izvestiya. Central. nauchnoizsled. Inst. ribov. and fishing, 1: 141-145.

Goncçalves, E.J., Barbosa, M., Cabral, H.N. and Henriques, M. 2002. Ontogenetic shifts in patterns of microhabitat utilization in the small-headed clingfish, *Apletodon dentatus* (Gobiesocidae). Environmental Biology of Fishes, 63: 333–339. doi: 10.1023/A:1014302319622

Hofrichter, R. and Patzner, R. 1997. A new species of Apletodon from the Mediterranean Sea and the eastern Atlantic with notes on the differentiation between *Apletodon* and *Diplecogaster* species (Pisces: Teleostei: Gobiesociformes: Gobiesocidae). Senckenbergiana Biol., 77(1): 15-22.

Hutornoy, S. 2006. Fish. In: Y.P. Zaytsev, B.G. Alexandrov, G.G. Minicheva (Eds.) The north-western part of the Black Sea: Biology and Ecology. Kiev, Naukova Dumka: 305-313.

Kobyakova, Z.I. and Dolgopolskaya, M.A. 1969. Decapoda. In: M. Boltovskiy (Ed.), Determinant of fauna of the Black and Azov Seas, Kiev, Naukova Dumka, 2: 9-307. (In Russian)

Kovačić, M. 2008. The key for identification of Gobiidae (Pisces: Perciformes) in the Adriatic Sea. Acta Adriat., 49(3): 245-254.

Kovačić, M. and Engin, S. 2009. First record of the zebra goby, *Zebrus zebrus* (Gobiidae), in the Black Sea, International Journal of Ichthyology, Cybium, 33(1): 83-84.

Kovačić, M., Ŝanda, R., Kirinčić, M. and Zanella, D. 2012. Geographic distribution of gobies (Gobiidae) in the Adriatic Sea with thirteen new records for its southern part. Cybium, 36(3): 435-445.

Kovtun, O.A. 2006. New discovery in the Black Sea rare shrimp-*Lysmata seticaudata* (Decapoda, Natantia, Hippolytidae). Zoology Bulletin, 40(6): 469. (In Russian)

Kovtun, O.A. 2013. The new finding of a rare goby *Chromogobius quadrivittatus* (Steindachner, 1863) (Actinopterygii, Perciformes, Gobiidae) in the marine underwater cave peninsula Tarhankut (Black Sea). Marine Ecological Journal, 12(1): 18. (In Russian)

Kovtun, O.A. and Karpova, E.P. 2014. *Chromogobius zebratus* (KolomBatovic, 1891) (Actinopterygii, Perciformes, Gobiidae) from marine underwater cave of Tarhankut peninsula (western Crimea), a species new for the Black Sea. Marine Ecological Journal, 13(1): 72. (In Russian).

Kovtun, O.A. and Manilo, L.D. 2013. Mediterranean fish – *Gammogobius steinitzi* Bath, 1971 (Actinopterygii: Perciformes: Gobiidae) a new representative of the Black Sea ichthyofauna. Acta Ichthyologica et Piscatoria, 43 (4): 307-314. doi: 10.3750/ AIP2013.43.4.08

Kovtun, O.A. and Pronin, K.K. 2011. Morphological and biological characteristics of underwater caves Bungee (peninsula Tarkhankut, Small Atlesh). Caving and karstology, 6: 53-66. (In Russian).

Makarov, Y. 2004. Malacostraca. In: Y. Makarov, Fauna of Ukraine. Kiev, Naukova Dumka, 26(1-2):1-431.

Miller, P.J. 1986. Gobiidae. In: Fishes of the North-eastern Atlantic and the Mediterranean. Volume III. In: P.J.P. Whitehead (Ed.), UNESCO, Paris: 1019-1085.

Pashkov, A.N., Reshetnikov, S.I. and Makhrov, A.A. 2013. On the question of occurrence in the waters of the Krasnodar Territory Chestnut goby *Chromogobius quadrivittatus* (Steindachner, 1863) (Pisces, Gobiidae). MSc thesis. Kerch: YugNIRO.

Pravdin, J.F. 1966. Study Guide fish. Moscow, Food Processing, 376 pp.

Rodin, V.E., Slizkin, A.G. and Myasoedov, V.I. 1979. Study Guide decapods Decapoda Far Eastern seas. Vladivostok, TINRO, 59 pp.

Sovinsky, V.K. 1882. By crustacean fauna of the Black Sea. 1. Some representatives of the family. Caridae, Zap. Kiev. Islands of Naturalists, 6:45-48.

Svetovidov, A.N. 1964. The Fishes of the Black Sea. Nauka Publ. Moscow-Leningrad, 550 pp. (In Russian).

Vanhove, M.P.M., Kovačić, M., Koutsikos, N.E., Zogaris, S., Vardakas, L.E., Huyse, T. and Economou, A.N.

2011. First record of a landlocked population of marine *Millerigobius macrocephalus* (Perciformes: Gobiidae): Observations from a unique spring-fed karstic lake (Lake Vouliagmeni, Greece) and phylogenetic positioning. Zoologischer Anzeiger 250:195-204.

Vasil'eva, E.D. and Bogorodsky, S.V. 2004. Two new species of gobies (Gobiidae) in the ichthyofauna of the Black Sea. Journal of Ichthyology, 44:599-606.

Vassilev, M., Apostolou, A., Velkov, B., Dobrev, D., Zarev, V. 2012. Atlas of the gobies (Gobiidae) in Bulgaria. Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Bulgaria, 112 pp.