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Communities of metazoan parasites of two fishes of the *Proterorhinus* genus (Actinopterygii: Gobiidae)

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Summary

Metazoan parasite communities of two gobiids, *Proterorhinus marmoratus* and *P. semilunaris*, which are common small-sized fishes native for the Black Sea basin, were studied. The parasite component community of *P. marmoratus* is represented by 11 species (one monogenean, one cestode, five digeneans, two nematodes, and two acanthocephalans). *P. semilunaris* had 5 species (one monogenean, one cestode, one digenean, one nematode, and one acanthocephalan). *Acanthocephaloides propinquus* has a great tendency to join the infracommunity. The differences between the parasite component communities of two *Proterorhinus* gobies are explained by different quality of habitats and available intermediate hosts. The component community of parasites of *P. marmoratus* is formed by brackish-water and marine parasite species, and that of *P. semilunaris* consists of limnetic parasite species. The euryhaline *G. proterorhini* is the only parasite species found in both *P. marmoratus* and *P. semilunaris*. In both species of gobiids, the main abundant parasite species (*A. propinquus* in *P. marmoratus* and *Nicolla skrjabini* in *P. semilunaris*) infest the host by feeding on crustaceans.

Keywords: *Proterorhinus*, Gobiidae, Parasite community, Black Sea, Dniester River

Introduction

The gobiids of *Proterorhinus* genus are common small-sized fishes of the Ponto-Caspian basin. This genus is represented by five species: *Proterorhinus marmoratus* (Pallas, 1814), *P. nasalis* (Filippi, 1863), *P. semipellucidus* Kessler, 1863, *P. semilunaris* Heckel, 1837, *P. tataricus* Freyhof and Naseka, 2007 (Stepien & Tumeo, 2006; Freyhof & Naseka, 2007; Neilson & Stepien, 2009). Two of these species inhabit the brackish waters of the Black Sea (*P. marmoratus*) and the southern Caspian Sea (*P. nasalis*). The western freshwater tubenose goby *P. semilunaris* is native to the fresh waters of the Black Sea basin and the Maritza and Struma rivers draining the Aegean Sea (Stepien & Tumeo, 2006; Kottelat & Freyhof, 2007), but are mentioned as non-indigenous in the upper streams of the Danube river (Harka, 1990; Erős *et al*., 2005; Prášek & Jurajda, 2005), the Dnieper river (Pinchuk *et al*., 1985; Rizevsky *et al*., 2007), the Rhine-Main River system (North Sea basin) (Reinartz & Hilbrich, 2000; Freyhof, 2003; Copp *et al*., 2005, Manné & Poulet, 2008), the Vistula River (Grabowska *et al*., 2008), and the Laurentian Great Lakes (Jude *et al*., 1992).

Extensive data has been published on the parasites of *P. marmoratus* in the Sevastopol Bay (Naidenova, 1974; Gaevskaya & Dmitrieva, 1997), the North-Western Black Sea (Chernyshenko, 1960, 1966; Machkevsky *et al*., 1990; Kvach, 2005), and the Bulgarian coastal Lake Beloslavsko (Margaritov, 1960). However, the parasites of *P. semilunaris* in native habitats are studied only in the lower and middle Danube River (Chiriac & Udrescu, 1957; Vojtek, 1964; Ergens, 1962, 1967) and in the small rivers of the northern coast of the Sea of Azov (Chaplina & Antsyshkina, 1961). *P. semilunaris* was long considered a junior synonym of *P. marmoratus* (Berg, 1949; Smirnov, 1986), but was resurrected by Stepien and Tumeo (2006). Therefore, no comparative studies were made.

So, in view of the invasive status of *P. semilunaris* and its similarity with *P. marmoratus*, the objective of this study was to compare the communities of metazoan parasites of these two gobiids in their native habitats of the North-Western Black Sea region (then NWBS).

Material and Methods

The fish were caught by deep-net (100 cm × 50 cm; 5 mm mesh size) in the summer period of 2004 – 2006 at 7 localities in 5 water bodies: Tyligul Estuary, Hryhorivsky Estuary, Gulf of Odessa, Sukhyi Estuary, and Dniester

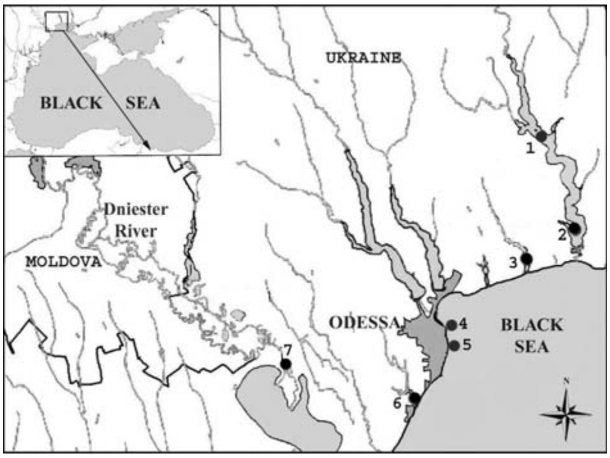

Fig. 1. Schematic map of the investigation area. Black circles: sampling localities

River Delta (Fig. 1; Table 1). During the analysis the localities ##1, 2 (Tyligul Estuary) and ##4, 5 (Gulf of Odessa) were grouped according to the water body they were taken from (Table 1). In total, 113 gobies (98 ind. of *P. marmaratus* and 15 ind. of *P. semilunaris*) were examined for parasites (Table 1). The standard length (SL, cm) of individual fish was measured first.

Parasitological terminology follows Bush *et al*. (1997) and Zander (1998). The prevalence (P, %), intensity (presented as intensity range, IR), mean intensity (MI), and abundance (A) were calculated according to Bush *et al*. (1997). The importance of parasites is judged by an altered core-/satellite concept according to their abundance: >2 = core species, 0.6 – 2 = secondary species; 0.2 – 0.6 = satellite species; and <0.2 = rare species (Zander *et al*., 2000). The tendency to join the infracommunity was evaluated according to the Infracommunity Index, ICI (Zander, 2004):

$$ICI = \frac{Mij}{Nj \times Ij},$$

where *Mij* was the ratio (number) of multiple infected hosts *j* with parasite *i* and other parasites, *Nj* was the ratio (numbers) of infected hosts *j*, and *Ij* was the mean of parasite species in host *j* (= mean infracommunity). The great tendency to join the community was determined by the ICI level more then 0.30 (Zander, 2004).

To compare the parasite faunas the Index of Czekanowski-Sørensen, ICS (Czekanowski, 1909; Sørensen, 1948), was used:

$$ICS = \frac{2c}{a+b} \times 100\%,$$

where *a* was the number of parasite species found in host A, *b* was the number of parasite species found in host B, and *c* was the number of parasite species infecting both hosts.

Abbreviations of names of parasite larval stages were used as follows: pl - pleurocercoid, met - metacercaria, L3 - third stage larval, ca - cystacanth.

Results

P. marmoratus was found in brackish-water localities: Tyligul, Hryhorivsky, Sukhyi estuaries, and the Gulf of Odessa, but *P. semilunaris* occurred only in the Dniester River delta (Table 1). The metazoan parasite component community of *P. marmoratus* is represented by 11 species, including one monogenean, one cestode, five digeneans, two nematodes, and two acanthocephalans (Table 2). Only one species, the monogenean *Gyrodactylus proterorhini* Ergens, 1967, occurred in both gobiids. Aside from this monogenean, the parasite component community of *P. semilunaris* was comprised of another four species (Table 2). The similarity between the metazoan parasite fauna of *P. marmoratus* and *P. semilunaris* (ICS) was 12.5 %.

The analysis of importance of parasites follows the scale of Zander *et al*. (2000) which shows that there are five core species in the parasite component community of *P. marmoratus*: *Cryptocotyle concavum* (Creplin, 1825) was a core species in all localities of occurrence (except the Gulf of Odessa), *C. lingua* (Creplin, 1825) in all localities, *Timoniella imbutiforme* (Molin, 1859) was a core species only in the Hryhorivsky Estuary, and *Acanthocephaloides propinquus* (Dujardin, 1845) in all localities (except the Hryhorivsky Estuary) (Table 2). The only secondary spe-

Table 1. The sampling localities and number of sampled gobiids of two *Proterorhinus* species

Host species	*Proterorhinus marmoratus*				*P. semilunaris*
Name of water bodies	Tyligul Estuary	Hryhorivsky Estuary	Gulf of Odessa	Sukhyi Estuary	Dniester River
Number of localities according to Fig. 1	1, 2	3	4, 5	6	7
Coordinates	46°53′ N 31°03′ E; 46°41′ N 31°09′ E	46°37′ N 31°00′ E	46°28′ N 31°45′ E; 46°26′ N 31°46′ E	46°19′ N 31°40′ E	46°27′ N 31°11′ E
Number of fish hosts	12	5	46	35	15
Standard length, cm (m±SD)	5.0 ± 3.1	5.8 ± 0.8	4.6 ± 0.6	5.0 ± 0.9	3.1 ± 0.8
Number of infected hosts	8 (66.7%)	5	40 (87.0%)	30 (85.7%)	11 (73.3%)
Number of uninfected hosts	4 (33.3%)	0	6 (13.0%)	5 (14.3%)	4 (26.7%)

cies was *A. propinquus* in the Hryhorivsky Estuary. The monogenean *G. proterorhini* (in the Sukhyi Estuary and the Gulf of Odessa), metacercariae of *C. concavum* (in the Gulf of Odessa), nematode *Dichelyne minutus* (Rudolphi, 1819) (in the Gulf of Odessa and the Hryhorivsky Estuary), and acanthocephalan *Telosentis exiguus* (von Linstow, 1901) (in the Sukhyi Estuary) were satellite species. In some water bodies *T. imbutiforme* (Tyligul Estuary), *D. minutus* (estuaries Tyligul and Sukhyi), and *T. exiguus* (Sukhyi Estuary) were rare. The cestode *Proteocephalus gobiorum* Dogiel et Bychowsky, 1939, digeneans *Magnibursatus skrjabini* (Vlasenko, 1931) and *Pygidiopsis genata* Looss, 1907, and the nematode *Streptocara crassicauda* (Creplin, 1829) (in the Gulf of Odessa) also were rare parasites of *P. marmoratus* at all localities of their occurrence. In *P. semilunaris*, only the digenean *Nicolla skrjabini* (Iwanitzky 1928) was a core species in its component community, while other species were rare (Table 2).

In both host species the single ectoparasite (*G. proterorhini*) was found, being located on fins and skin (Table 3). The *Cryptocotyle* metacercariae encysted in skin and fins were rather abundant in *P. marmoratus*, but were absent in *P. semilunaris* (Table 3). Two species, *A. propinquus* and *T. exiguus*, were found in three microhabitats (stomach, intestine, and cloaca) with the highest number of *A. propinquus* in the cloaca, and *T. exiguus* in the intestine. The digenean *N. skrjabini* was also found in all three microhabitats being most abundant in the intestine of *P. semilunaris* (Table 3).

The parasite infracommunity of *P. marmoratus* is composed of one to six species. The fish infected with one parasite species made up 33.7 %; in most cases they were

Table 2. The component communities of two *Proterorhinus* species in the North-Western Black Sea and the Dniester River

Host species		*Proterorhinus marmoratus*				*P. semilunaris*
Localities		Tyligul Estuary	Hryhorivsky Estuary	Gulf of Odessa	Sukhyi Estuary	Dniester River
1		2	3	4	5	6
MONOGENEA						
Gyrodactylus	P			10.9	22.9	6.7
proterorhini	IR			1 – 3	1 – 3	1
	MI			1.4 ± 0.9	1.5 ± 0.8	1.0
	A			0.2	0.3	0.1
CESTODA						
Triaenophorus	P					6.7
crassus pl	IR					1
	MI					1.0
	A					0.1
Proteocephalus	P	8.3			2.9	
gobiorum	IR	1			1	
	MI	1.0			1	
	A	0.1			0.03	
DIGENEA						
Cryptocotyle	P	41.7	3 from 5	15.2	28.6	
concavum met	IR	1 – 20	1 – 208	1 – 9	1 – 54	
	MI	7.8 ± 9.0	86.3 ± 108.2	3.3 ± 3.2	12.5 ± 20.2	
	A	3.3	51.8	0.5	3.6	
C. lingua met	P	16.7	2 from 5	34.8	11.4	
	IR	15 – 20	53 – 201	1 – 24	2 – 52	
	MI	17.5 ± 3.5	127.0 ± 104.7	6.4 ± 6.0	27.0 ± 27.2	
	A	2.9	50.8	2.2	3.1	
Magnibursatus	P			2.2	8.6	
skrjabini	IR			1	1	
	MI			1.0	1.0 ± 0.0	
	A			0.02	0.1	
Nicolla	P					73.3
skrjabini	IR					1 – 9
	MI					3.7 ± 2.5
	A					2.7
Pygidiopsis	P			2.2		
genata met	IR			6		
	MI			6.0		
	A			0.1		
Timoniella	P	8.3	1 from 5			
imbutiforme met	IR	1	51			
	MI	1.0	51.0			
	A	0.1	10.2			

Table 2. (*continued*)

1		2	3	4	5	6
NEMATODA						
Dichelyne	P	8.3	1 from 5	23.9	8.6	
minutus	IR	1	1	1 – 5	1 – 2	
	MI	1.0	1.0	1.6 ± 1.2	1.3 ± 0.6	
	A	0.1	0.2	0.4	0.1	
Eustrongylides	P					6.7
excisus L3	IR					1
	MI					1.0
	A					0.1
Streptocara	P			8.7		
crassicauda L3	IR			1 – 2		
	MI			1.3 ± 0.5		
	A			0.1		
ACANTHOCEPHALA						
Acanthocephaloides	P	58.3	4 from 5	45.7	77.1	
propinquus	IR	1 – 13	1 – 4	1 – 32	1 – 49	
	MI	3.6 ± 4.4	1.8 ± 1.5	8.8 ± 8.4	10.1 ± 12.1	
	A	2.1	1.4	4.0	7.8	
Acanthocephalus lucii	P					6.7
	IR					1
	MI					1.0
	A					0.1
Telosentis	P			4.3	17.1	
exiguus	IR			1	1 – 3	
	MI			1.0 ± 0.0	1.7 ± 1.0	
	A			0.04	0.3	
Species number		6	5	9	8	5

Look “Material and Methods” for abbreviations.

infected with *A. propinquus*. The gobies infected with two parasites species made up 31.6 %, three parasites species – 12.2 %, and four – 4.1 %. Five and six parasite species occurred in only one goby individual each (1.0 % of examined *P. marmoratus*). Most of the examined *P. semilunaris* (9 from 15 individuals or 60.0 %) were infected with only one parasite species, *N. skrjabini*. The infracommunity of one gobiid individual (6.7 %) was composed by two parasite species, *G. proterorhini* and *N. skrjabini*, located in different microhabitats. The infracommunity of another gobiid individual harbored four parasite species, *Triaenophorus crassus* Forel, 1868, *N. skrjabini*, *Eustrongylides excisus* Jägerskiöld, 1909, and *Acanthocephalus lucii* (Müller, 1776), two of which (*T. crassus*, *E. excisus*) were located in muscles, and the remaining two species (*N. skrjabini*, *A. lucii*) in the digestive tract.

According to the Infracommunity Index (ICI), *A. propinquus* in the Sukhyi Estuary has the great tendency to join the community (Table 4). In other localities *A. propinquus* also shows high levels of this index.

Discussion

The species richness in the metazoan parasite fauna of *P. marmoratus* is similar to the data of previous investigations in the NWBS (11 species) (Chernyshenko, 1960, 1966; Machkevsky *et al*., 1990; Kvach, 2005). We found 8 parasite species, which were reported earlier (in comparing to the literature data ICS = 72.7 %) and three species occurred first: *G. proterorhini*, *M. skrjabini*, and *S. crassicauda*. The species richness is similar to that in the Sevastopol Bay (11 species) (Naidenova, 1974; Gaevskaya & Dmitrieva, 1997), but the species composition was much different in our data (ICS = 27.3 %): only three species, *G. proterorhini*, *C. concavum*, and *M. skrjabini*, were recorded in both NWBS and Sevastopol Bay. According to the data of Margaritov (1960), in Bulgarian brackish-water Lake Beloslavsko, *P. marmoratus* infected with only one metazoan parasite species, *Piscicola geometra* L., 1758, which not found by us.

The literature data about the parasites of *P. semilunaris* in its native habitats are scarce (Table 5). In small rivers of the northern coast of the Sea of Azov two species, the digenean *Plagioporus skrjabini* Koval, 1951 and glochidiae of unionids, were found (Chaplina & Antsyshkina, 1961). Another two parasite species, the monogenean *G. proterorhini* (sometime quoted as *G. medius* Kathariner, 1893 or *G. arcuatus* Bychowsky, 1933) and metacercariae of *A. cobitidis proterorhini*, were reported in the *P. semilunaris* original range in the Danube River (lower and middle stream) (Chiriac & Udrescu, 1957; Vojtek, 1964; Ergens, 1962, 1967). The similarity between the Dniester River and the Danube River (ICS) was 28.6 % (see Table 5). In contrast, the parasite fauna of the invasive *P. semilunaris* in non-native habitats, such as the Morava River and Lake St. Clair (North America), have been investigated rather extensively (Muzzall *et al*., 1995; Pronin *et al*., 1997; Koubková & Baruš, 2000; Kvach & Stepien, 2008) (Table 5). The maximum species richness of the metazoan parasite fauna of the invasive *P. semilunaris* in the Morava River (Czech Republic) is 13 species (Koubková & Baruš, 2000). The data about *P. semilunaris* parasites in the Dniester River do not consist of any of the same species as in the Great Lakes, but the similarity with the Morava River basin is very low (ICS = 11.1 %) (Koubková & Baruš, 2000; Kvach & Stepien, 2008).

Table 3. Occurrence of metazoan parasites in different microhabitats of two *Proterorhinus* species (P/MI/A)

Microhabitat	Host species	*Proterorhinus marmoratus*				*P. semilunaris*
	Localities	Tyligul Estuary	Hryhorivsky Estuary	Gulf of Odessa	Sukhyi Estuary	Dniester River
1	2	3	4	5	6	7
	ECTOPARASITES					
Skin and fins	*Gyrodactylus proterorhini*			10.9/1.4/0.2	22.9/1.5/0.3	6.7/1.0/0.1
	Species number	0	0	1	1	1
	ENDOPARASITES					
Skin and fins	*Cryptocotyle concavum* met	41.7/7.8/3.3	60.0/86.3/51.8	15.2/3.3/0.5	28.6/12.5/3.6	
	C. lingua met	16.7/17.5/2.9	40.0/127.0/50.8	34.8/6.4/2.2	11.4/27.0/3.1	
	Species number	2	2	2	2	0
Muscles	*Triaenophorus crassus* pl					6.7/1.0/0.1
	Timoniella imbutiforme met	8.3/1.0/0.1				
	Eustrongylides excisus L3					6.7/1.0/0.1
	Species number	1	0	0	0	2
Mesentery	*Pygidiopsis genata* met			2.2/6.0/0.1		
	Streptocara crassicauda L3			8.7/1.3/0.1		
	Species number	0	0	2	0	0
Stomach	*Magnibursatus skrjabini*			2.2/1.0/0.02	8.6/1.0/0.1	
	Nicolla skrjabini					6.7/1.0/0.1
	Acanthocephaloides propinquus			2.2/1.0/0.02	5.7/1.5/0.1	
	Telosentis exiguus				5.7/2.5/0.1	
	Species number	0	0	2	3	1
Intestine	*Proteocephalus gobiorum*	8.3/1.0/0.1			2.9/1.0/0.03	
	Cryptocotyle concavum met		20.0/10.0/2.0			
	Nicolla skrjabini					73.3/3.3/2.4
	Timoniella imbutiforme met		20.0/51.0/10.2			
	Dichelyne minutus	8.3/1.0/0.1	20.0/1.0/0.2	23.9/1.6/0.4	5.7/1.5/0.1	
	Acanthocephaloides propinquus	16.7/3.0/0.5		6.5/2.7/0.2	11.4/7.8/0.9	
	Telosentis exiguus			2.3/1.0/0.02	11.4/1.0/0.1	
	Species number	3	3	3	4	1
Cloaca	*Nicolla skrjabini*					20.0/1.3/0.3
	Dichelyne minutus				2.9/1.0/0.03	
	Acanthocephaloides propinquus	41.7/3.8/1.6	80.0/1.8/1.4	41.3/9.3/3.8	77.1/10.1/7.8	
	Acanthocephalus lucii					6.7/1.0/0.1
	Telosentis exiguus			2.3/1.0/0.02	2.9/1.0/0.03	
	Species number	1	1	2	3	2

Table 4. Infracommunity index. Bold: the great tendency to join the infracommunity

Host species	*Proterorhinus marmoratus*				*P. semilunaris*
Locality	Tyligul Estuary	Hryhorivsky Estuary	Gulf of Odessa	Sukhyi Estuary	Dniester River
Gyrodactylus proterorhini			0.03	0.11	0.07
Triaenophorus crassus pl					0.07
Proteocephalus gobiorum	0.06			0.02	
Cryptocotyle concavum met	0.24	0.20	0.07	0.16	
C. lingua met	0.12	0.13	0.17	0.06	
Magnibursatus skrjabini			0.01	0.05	
Nicolla skrjabini					0.13
Pygidiopsis genata met			0.01		
Timoniella imbutiforme met	0.06	0.07			
Dichelyne minutus	0.06	0.07	0.09	0.05	
Eustrongylides excisus L3					0.07
Streptocara crassicauda L3			0.03		
Acanthocephaloides propinquus	0.24	0.20	0.22	**0.31**	
Acanthocephalus lucii					0.07
Telosentis exiguus			0.02	0.10	

Digeneans are the most numerous parasites in the gobiid guild community in the northwestern Black Sea (Kvach, 2005). However, in *P. semilunaris* they are represented by a single species, *N. skrjabini*, which is also the only core species in its parasite fauna. The remaining four species (*G. proterorhini*, *T. crassus*, *E. excisus*, *A. lucii*) parasitizing *P. semilunaris* occurred in a single specimen each.

The monogenean *G. proterorhini* is a specific parasite of goby guild in the Black Sea basin. In the NWBS it had never before been reported. It is now mentioned as a rare species both in the sea and the Dniester River (Table 2). Another specialist parasite of goby guild in the Ponto-Caspian region is *P. gobiorum*. In the estuaries of the Black Sea this species is the most abundant in the grass goby, *Zosterisessor ophiocephalus* (Pallas, 1814) (Kvach, 2005). It is now also registered in *P. marmoratus*. Both specialists (*G. proterorhini* and *P. gobiorum*) have a low tendency to join the infracommunity in *Proterorhinus* fishes (Table 4). The ICI was highest for generalists like *A. propinquus* and *C. concavum* (in *P. semilunaris* the generalist trematode *N. skrjabini* attained the highest value of this index), which infest great number of hosts in the Black Sea basin. The high value of ICI for the generalist parasites shows the possibility of these hosts to engage in parasitic systems in new habitats. So, these gobiids play the important role in the realization of the parasites life cycles.

The most abundant parasites of both *Proterorhinus* species are parasites of the digestive tract. In *P. marmoratus* it was the acanthocephalan *A. propinquus* (most abundant in the cloaca), but in *P. semilunaris* it was the digenean *N. skrjabini* (Table 3). The source of infestation by these parasites were benthic organisms, which play the role of dietary items for the gobiids. The hosts of *A. propinquus* cystacanths are caprellid amphipods and isopods *Idothea balthica basteri* (de Buron and Chauvet, 2003; Belofastova, 2007). The hosts of metacercariae of *N. skrjabini* are also gammarids (Stenko, 1976). Crustaceans are the main pray item of the tubenose goby (Smirnov, 1986). Thus, in both species of gobiids, the main abundant parasite species infest the host as the host feeds on crustaceans.

Besides the typical parasites of the digestive tract of fish, free metacercariae (without cysts) of *C. concavum* (10 sp.) and *T. imbutiforme* (51 sp.) occurred in the intestine of a goby from the Hryhorivsky Estuary (Table 3). A specimen of the marbled goby, *Pomatoschistus marmoratus* (Risso, 1810), was found in the digestive tract of this individual fish. It should be a source of occasional infestation of the tubenose goby with digeneans.

The parthenogenesis stages (sporocysts and rediae) of *C. concavum* develop in mudsnails of the *Hydrobia* genus (Zander *et al*., 1993). The gastropod *Hydrobia acuta* is one of the most abundant species in the Gulf of Odessa (Butenko, 2000) and it is also present in all brackish waters of the NWBS (Losovskaya *et al*., 2006). The cercariae actively penetrate through the skin of fishes (Naidenova, 1974); therefore the lithophilous *P. marmoratus* is easily invaded by cercariae.

The differences between the parasite component communities of two *Proterorhinus* gobies are induced by the habiting in different environmental conditions. The salinity of the most of water bodies where *P. marmoratus* caught is ranged from 10 ‰ in spring to 17 ‰ in summer (V. V. Adobovsky, P. C.), however, in the Tyligul Estuary it was 16 – 19 ‰, and in some bays was up to 21 ‰. In the Dniester River where *P. semilunaris* were caught the water is fresh. The parasite community of *P. marmoratus* consists of mostly (63.6 %) brackish-water species (*P. gobiorum*, *C. concavum*, *M. skrjabini*, *P. genata*, *T. imbutiforme*, *D. minutus*, *T. exiguus*). Two marine (*C. lingua*, *A. propinquus*) and two euryhaline (*G. proterorhini*, *S. crassicauda*) species make up just 18.2 % of the parasite community. The 1st intermediate hosts of *C. concavum*, *T. imbutiforme*, and *C. lingua* are brackish-water *Hydrobia* mollusks (Maillard, 1975; Zander *et al*., 1993), which are absent in fresh waters. The life cycles of acanthocephalans are connected to marine and brackish-water amphipods (Dezfuli, 1989; de Buron & Chauvet, 2003; Belofastova, 2007), and the life cycle of *D. minutus* to brackish-water polychaetes (Køie, 2001). Also, among the other 1st intermediate hosts of *S. crassicauda* are brackish-water gammarids (Moravec, 1994). Thus, the life cycles of metazoan parasites of *P. marmoratus* connect this fish to the brackish-water benthic community.

The euryhaline *G. proterorhini* previously was found in various gobiids in the polyhaline waters of the Black Sea, such as the Crimean near-shores (Naidenova, 1974), and in the fresh waters of the Danube River drainage (Chiriac & Udrescu, 1957; Ergens, 1962, 1967; Koubková & Baruš, 2000; Ondračková *et al*., 2005). All other parasites found in *P. semilunaris* are limnetic and are typical for many fish species in European fresh waters. In addition, species such as *N. skrjabini*, *E. excisus*, and *A. lucii*, were noted in gobiids in brackish waters of the NWBS (Kvach, 2005), but they are absent in *P. marmoratus*.

Table 5. Metazoan parasite of *Proterorhinus semilunaris* in native and non-indigenous waters according to different authors ([1] – current data; [2] – Chaplina and Antsyshkina, 1961; [3] – Chiriac and Udrescu, 1957; Vojtek, 1964; Ergens, 1962; 1967; [4] – Koubková and Baruš, 2000; [5] – Muzzall *et al*., 1995; Pronin *et al*., 1997; Kvach and Stepien, 2008)

Locality	Native			Non-indigenous	
	Dniester River[1]	Small rivers of northern Azov coast[2]	Lower and Middle Danube River basin[3]	Morava River[4]	Lake St. Clair[5]
1	2	3	4	5	7
MONOGENEA					
Gyrodactylus proterorhini	+		+		
CESTODA					
Proteocephalus sp.				+	+
Triaenophorus crassus pl	+				
DIGENEA					
Apatemon cobitidis proterorhini met			+	+	
Diplostomum spathaceum met				+	
Nicolla skrjabini	+				
Plagioporus skrjabini		+			
Tylodelphys clavata met				+	
NEMATODA					
Anguillicola crassus L3				+	
Camallanus lacustris				+	
Eustrongylides excisus L3	+				
Philometra ovata L3				+	
Pseudocapillaria tomentosa				+	
Raphidascaris acus L3				+	+
Spiroxys contortus L3					+
ACANTHOCEPHALA					
Acanthocephalus lucii	+			+	
A. anguillae				+	
Leptorhynchoides thecatus					+
Neoechynorhynchus sp. ca					+
Southwellina hispida ca					+
MOLLUSCA					
Glochidium sp.		+		+	
CRUSTACEA					
Argulus foliaceus				+	
Species number	5	2	2	13	6

Look material and methods for abbreviations.

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