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The parasite community of gobiid fishes (Actinopterygii: Gobiidae) from the Lower Volga River region

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Abstract: The parasitic fauna in the lower Volga River basin was investigated for four gobiid species: the nonindigenous monkey goby *Neogobius fluviatilis* (Pallas, 1814), the round goby *N. melanostomus* (Pallas, 1814), the Caspian bighead goby *Ponticola gorlap* (Iljin, 1949), and the tubenose goby *Proterorhinus* cf. *semipellucidus* (Kessler, 1877). In total, 19 species of goby parasites were identified, of which two – *Bothriocephalus opsariichthydis* Yamaguti, 1934 and *Nicolla skrjabini* (Iwanitzki, 1928) – appeared to have been introduced from other geographic regions. The monkey goby had significantly fewer parasitic species (6), but relatively high levels of infection, in comparison to the native species. Parasitism of the Caspian bighead goby, which is the only predatory fish among the studied gobies, differed from the others according to the results of discriminant analysis. The parasitic fauna of the tubenose goby more closely resembled those of Caspian Sea gobiids, rather than the Black Sea monkey goby.

Key words: Gobiidae; parasites; Volga River; Caspian Sea; introduced species

Introduction

The Volga River forms part of a northern corridor for exotic invasions, linking the Black and Azov seas with the Caspian Sea via the Azov–Caspian waterway, including the Volga–Don Canal. The system also connects the Baltic and White seas via the Volga–Baltic waterway, including the Volga–Baltic Canal, as well as the Black and Azov seas with the White Sea–Baltic Sea waterway, including the White Sea–Baltic Sea Canal (Panov et al. 2009). The latter canal has served as a source for intersecting invasions, which allowed the Ukrainian brook lamprey *Eudontomyzon mariae* (Berg, 1931), the Black-Sea sprat *Clupeonella cultriventris* (Nordmann, 1840), the monkey goby *Neogobius fluviatilis* (Pallas, 1814) (taxonomy updated following Neilson & Stepien 2009a, 2011), and the Don tadpole-goby *Benthophilus durrelli* Boldyrev & Bogutskaya, 2004 to colonize the Volga River basin (Boldyrev & Bogutskaya 2004, 2007; Slynko et al. 2010). The gorlap goby, also called the Caspian bighead goby, *Ponticola gorlap* (Iljin, 1949) (see Neilson & Stepien 2009a for taxonomy), which was endemic to the Caspian Sea and its associated freshwaters, then invaded the Don River, becoming established and abundant in its lower reaches (Bogutskaya et al. 2004).

The round goby*Neogobius melanostomus* (Pallas, 1814) is closely related to the monkey goby *N. fluviatilis*, which is common in the Lower Volga River and is native to the Black Sea basins (Kottelat & Freyhof 2007), and to the white goby *N. pallasi* (Berg, 1916), which is endemic to the Caspian Sea region (Neilson & Stepien 2011). Molecular genetic analyses reveal that, the modern Lower-Volga population of the round goby contains a mixture of the introduced Don River population and the native Volga River populations (Brown & Stepien 2008).

The tubenose goby, genus *Proterorhinus*, is also common in the Volga-Don region. According to Naseka et al. (2005) the Caspian and Black Sea basins may both be populated with the marine tubenose goby *P. marmoratus* (Pallas, 1814), which is an exclusively marine species (Neilson & Stepien 2009a, 2009b). Kottelat & Freyhof (2007) suggested the name of the Eastern tubenose goby, *P. nasalis* (De Filippi, 1863), which was originally characterized from the Caspian Sea coast of Azerbaijan. Neilson & Stepien (2009b) genetically identified the Volga-Don reaches as containing *P. semipellucidus* (Kessler, 1877), a freshwater species originally described from the mouth of the Karasu River, Iran. They hypothesized that this species is endemic to the freshwaters of the Caspian Sea basin, and to have invaded the Don River (Neilson & Stepien 2009b). Thus, the taxonomic and phylogeographic status of this species may be uncertain.

The parasitic fauna of gobiids has been previously investigated from the southern Caspian Sea (Semenova et al. 2007; Hosseinifard et al. 2011); however, results

Table 1. The number and mean sizes (± standard deviation) of gobies studied.

Fish species		Volgograd	Delta	Total
Neogobius fluviatilis	N	14	–	14
	SL	5.2 ± 0.9	–	5.2 ± 0.9
	TL	6.3 ± 1.0	–	6.3 ± 1.0
Neogobius melanostomus	N	12	18	30
	SL	4.3 ± 0.7	5.4 ± 1.8	4.9 ± 1.5
	TL	5.2 ± 0.8	6.6 ± 2.0	6.1 ± 1.8
Ponticola gorlap	N	2	22	24
	SL	7.1 ± 1.5	7.3 ± 1.8	7.3 ± 1.8
	TL	8.5 ± 1.8	8.8 ± 2.1	8.7 ± 2.1
Proterorhinus cf. *semipellucidus*	N	15	15	30
	SL	3.3 ± 0.8	4.6 ± 0.5	3.9 ± 0.9
	TL	4.2 ± 1.0	5.6 ± 0.5	4.9 ± 1.1

Explanations: N – number of fish individuals studied, SL – standard length in cm, TL – total length in cm.

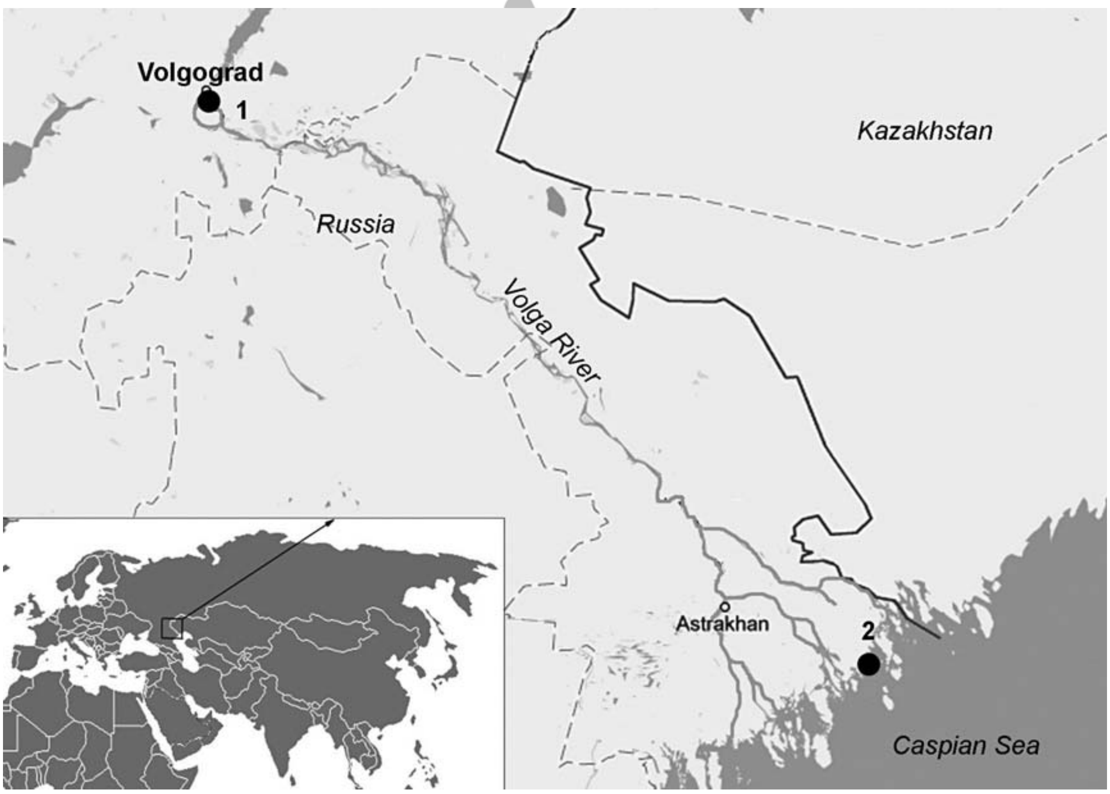

Fig. 1. Map of the investigated area, showing sampling localities (dots): 1 – Volgograd, 2 – Volga Delta region.

from the Lower Volga River are lacking. An important factor underlying successful invasion may be an overall lack of parasites and pathogens during and after the early stages of colonization and establishment, which forms part of the "enemy release hypothesis" (Keane & Crawley 2002). This correspondence to the "enemy release hypothesis" was described by Kvach & Stepien (2008) for invasive gobies (round and tubenose gobies) of the North American Laurentian Great Lakes, which had a low parasite load. Conversely, exotic introductions may introduce new parasites, especially in hosts that are ecologically similar and among waterways that are connected (Mack et al. 2000). Goals of the present study were to describe the parasitic fauna of gobiid fishes inhabiting the lower Volga River region and to compare parasitism in native and non-native species.

Material and methods

In November 2011, 98 individuals of four gobiid fish species (Table 1) were sampled using trawl sat two locations: 1. the Volga River near Volgograd, Russia (48°41′ N 44°30′ E), and 2. the Volga River Delta near the Caspian Sea coast at Obzhorovsky Uchastok (46°14′ N 49°07′ E) (Fig. 1). Nomenclature followed Neilson & Stepien (2009a, b), with the tubenose goby identified as *P. semipellucidus*.

Fish were kept alive in aerated buckets for two days prior to dissection, and individual standard and total lengths (SL, TL) were measured to nearest mm. Fish were

Table 2. Parasitic fauna of gobiids in the lower Volga region.

Parasite species		*Neogobius fluviatilis*	*Neogobius melanostomus*			*Ponticola gorlap*			*Proterorhinus* cf. *semipellucidus*		
Locality		Volgograd	Volgograd	Delta	Total	Volgograd	Delta	Total	Volgograd	Delta	Total
					Microsporidia						
Loma sp.	P	7.1	8.3	5.6	6.7		4.5	4.2		13.3	6.7
	MI	~ 100	3.0	~ 100	~ 51.5		~ 100	~ 100		9.0±1.4	9.0±1.4
	IR	~ 100	3	~ 100	3–~100		~ 100	~ 100		8–10	8–10
	A	7.1	0.3	5.6	3.4		4.5	4.2		1.2	0.6
					Ciliata						
Trichodina domerguei	P			5.6	3.3						
	MI			1.0	1.0						
	IR			1	1						
	A			0.1	0.03						
					Monogenea						
Gyrodactylus proterorhini	P		41.7	27.8	33.3		22.7	20.8	40.0	13.3	26.7
	MI		1.8±0.8	6.8±11.3	4.3±8.0		3.0±3.5	3.0±3.5	2.2±0.8	1.5±0.7	2.0±0.8
	IR		1–3	1–27	1–27		1–9	1–9	1–3	1–2	1–3
	A		0.8	1.9	1.4		0.7	0.6	0.9	0.2	0.5
					Cestoda						
Bothriocephalus opsariichthydis pl	P			5.6	3.3						
	MI			2.0	2.0						
	IR			2	2						
	A			0.1	0.1						
Proteocephalus gobiorum	P						18.2	16.7			
	MI						5.3±6.7	5.3±6.7			
	IR						1–15	1–15			
	A						1.0	0.9			
Triaenophorus crassus pl	P			11.1	6.7						
	MI			1.5±0.7	1.5±0.7						
	IR			1–2	1–2						
	A			0.2	0.1						
					Digenea						
Apatemon gracilis met	P	100.0	75.0	5.6	33.3	2 from 2	77.3	29.2	86.7	100.0	93.3
	MI	27.4±21.2	2.9±1.5	1.0	2.7±1.5	53.0	29.7±25.5	32.2±29.6	15.8±14.1	19.5±12.4	17.8±13.1
	IR	5–73	1–6	1	1–6	6-100	1–71	1–100	1–48	5–42	1–48
	A	27.4	2.2	0.1	0.9	53.0	23.0	25.5	13.7	19.5	16.6
Apharyngostrigea cornu met	P						4.5	4.2			
	MI						1.0	1.0			
	IR						1	1			
	A						0.05	0.04			
Diplostomum sp. met	P	57.1	50.0	27.8	36.7		22.7	20.8		6.7	3.3
	MI	9.0±8.6	6.3±8.4	2.2±1.3	4.5±6.4		2.2±1.6	2.2±1.6		1.0	1.0
	IR	1–21	1–23	1–4	1–23		1–4	1–4		1	1
	A	5.1	3.2	0.6	1.6		0.5	0.5		0.01	0.03

Table 2. (continued)

Parasite species		*Neogobius fluviatilis*	*Neogobius melanostomus*			*Ponticola gorlap*			*Proterorhinus* cf. *semipellucidus*		
Locality		Volgograd	Volgograd	Delta	Total	Volgograd	Delta	Total	Volgograd	Delta	Total
Holostephanus cobitidis met	P	14.3	8.3		3.3					20.0	10.0
	MI	9.5±3.5	3.0		3.0					2.3±1.2	2.3±1.2
	IR	7–12	3		3					1–3	1–3
	A	1.4	0.1		0.1					0.5	0.2
Holostephanus dubinini met	P	71.4	33.3	22.2	26.7	1 from 2	31.8	33.3		46.7	23.3
	MI	6.2±4.0	2.5±3.0	2.0±1.4	2.3±2.2	2.0	7.3±6.9	6.6±6.7		2.9±1.2	2.9±1.2
	IR	1–13	1–7	1–4	1–7	2	2–22	2–22		2–5	2–5
	A	4.4	0.8	0.4	0.6	1.0	2.3	2.2		1.3	0.7
Hysteromorpha triloba met	P		8.3		3.3	1 from 2		4.2		13.3	6.7
	MI		1.0		1.0	1.0		1.0		1.0±0.0	1.0±0.0
	IR		1		1	1		1		1	1
	A		0.1		0.03	0.5		0.04		0.1	0.1
Nicolla skrjabini	P	50.0		22.2	13.3	1 from 2	45.5	45.8	6.7	53.3	30.0
	MI	5.1±5.3		3.5±2.6	3.5±2.6	65.0	6.0±9.5	11.4±20.0	1.0	9.1±6.4	8.2±6.6
	IR	1-14		1–7	1–7	65	1–32	1–65	1	1–20	1–20
	A	2.6		0.8	0.5	32.5	2.7	5.2	0.1	4.9	2.5
Phyllodistomum simile	P		8.3	5.6	6.7		9.1	8.3			
	MI		1.0	1.0	1.0±0.0		32.5±12.0	32.5±12.0			
	IR		1	1	1		24–41	24–41			
	A		0.1	0.1	0.1		3.0	1.4			
Nematoda											
Camallanus lacustris (Zoega, 1776)	P			33.3	20.0		13.6	12.5			
	MI			1.7±1.0	1.7±1.0		2.7±1.5	2.7±1.5			
	IR			1–3	1–3		1–4	1–4			
	A			0.6	0.3		0.4	0.3			
Eustrongylides excisus L3	P			44.4	26.7		40.9	37.5		6.7	3.3
	MI			1.5±1.1	1.5±1.1		3.6±5.5	3.6±5.5		1.0	1.0
	IR			1–4	1–4		1–18	1–18		1	1
	A			0.7	0.4		1.5	1.3		0.1	0.03
Spiroxys contortus L3	P						9.1	8.3			
	MI						1.0±0.0	1.0±0.0			
	IR						1	1			
	A						0.1	0.1			
Acanthocephala											
Pomphorhynchus laevis Müller, 1776	P					1 from 2		4.2	6.7		3.3
	MI					1.0		1.0	2.0		2.0
	IR					1		1	2		2
	A					0.5		0.04	0.1		0.1
Hirudinea											
Piscicola geometra	P									6.7	3.3
	MI									1.0	1.0
	IR									1	1
	A									0.1	0.03

Table 2. (continued)

Parasite species	*Neogobius fluviatilis*	*Neogobius melanostomus*			*Ponticola gorlap*			*Proterorhinus* cf. *semipellucidus*		
Locality	Volgograd	Volgograd	Delta	Total	Volgograd	Delta	Total	Volgograd	Delta	Total
Species richness	6	8	12	14	5	12	14	4	10	11
N fish infected/Total P (%)	14/100	11/91.7	17/94.4	28/93.3	2/100	21/95.5	23/95.8	14/93.9	15/100	29/96.7
N fish uninfected/Percentage	0	1/8.3	1/5.6	2/6.7	0	1/4.5	1/4.2	1/6.7	0	1/3.3

Explanations: P – prevalence (%); MI – mean intensity (m±SD); IR – intensity range; A – abundance; pl – plerocercoid; met – metacercaria; L3 – third-stage larva.

sacrificed and dissected following anesthesia, and mucosa from the skin and gills was examined under light microscopy. The intestine, mesentery, liver, spleen, kidney, eyes, brain, and muscle tissues were pressed between glass microscope slides and examined under stereo microscopy. Smears from the uterine bladder, and gallbladder tissues were examined for microparasites. Trematodes, cestodes, nematodes, and leaches were fixed in hot formalin, and then preserved in 70% alcohol. Larval stages were isolated from cysts before fixation. Trematodes and cestodes were stained in iron acetocarmine (Georgiev et al. 1986), dehydrated in alcohol of different concentration, and mounted in Canada balsam. Acanthocephalans were pressed between glass microscope slides and fixed in 70% alcohol. Acanthocephalans and leaches were mounted in glycerol as a temporary preparation and identified under light microscopy. Monogeneans were mounted in glycerol-amonium-picrate as semi-permanent preparates. Ciliates were prepared as dry smears using Klein's silver nitrate ($AgNO_3$) method (Lom & Dykova 1992). Dry smears of microsporidians were fixed in methanol and stained with Giemsa's stain. All parasites were identified using light microscopy.

Parasitological indices were calculated following Bush et al. (1997), as: prevalence (P, %), intensity (presented as minimum-maximum), mean intensity (MI), and abundance (A). Relative importance of parasites was determined using 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 belong to the parasite infracommunity was evaluated with the Infracommunity Index, ICI, whose highest value was >0.30. The mean infracommunity was characterized as the mean number of parasite species per host individual (Zander 2004).

Statistical analyses were conducted using Statistica for Windows 5.0 (StatSoft Inc.). *T*-tests evaluated infracommunity and abundance parameters; the number of parasites species and the number of individual parasites in each individual host were compared among the gobiid host species. Multivariate and discriminant analyses were employed. Mahalanobis distances were calculated based on the abundance of each parasite species in each host; differences in mean abundances were determined from the coefficients of ratios (CR) (Lobasiuk 2005). A negative CR value meant that the first compared value was greater than the second, and a positive CR value corresponded to the second value being greater than the first; results were significantly different for *t*-test values were >2 (Lobasiuk 2005). The index of Czekanowski-Sørensen, ICS was used to compare the parasite faunas (Czekanowski 1909; Sørensen 1948).

Results

There were 19 parasite taxa found in the studied gobiids (Table 2), including one unidentified microsporidium, one ciliate species, one species of monogenea, three cestode species, eight trematode species, three nematode species, one acanthocephalan species, and one hirudinean species. Two of the round gobies (6.7%), one gorlap goby (4.2%), and one tubenose goby (3.3%) had no parasites.

Species richness varied from 6 parasite species in the invasive monkey goby to 14 species each in both the round and gorlap gobies. Species richness in the Volga Delta zone (18 parasite species) was higher than that near Volgograd (10). Near Volgograd, the round goby had the most species of parasites (8), and the tubenose goby had the fewest (4). In the Delta zone, the round and gorlap gobies had the most (12 species each), and the tubenose goby had 10 species.

Four species played a core role in the parasitic communities of gobies at both localities. So, *Loma* sp. was core in monkey goby, round goby (in delta), and gorlap goby, *Apatemon gracilis* (Rudolphi, 1819) was core in all cases except the round goby in delta, *Holostephanus dubinini* Vojtek & Vojtková, 1968 was core in the monkey goby near Volgograd and in the gorlap goby in delta, also *Nicolla skrjabini* (Iwanitzki, 1928) was core in monkey goby, gorlap goby (both localities), and tubenose goby (in delta). In the Delta region, the trematode *Phyllodistomum simile* Nybelin, 1926 also comprised a core species in the gorlap goby. Also *Diplostomum* sp. was core in the monkey and round gobies near Volgograd.

Seven parasite species occurred in only a single host species; all were in the Delta region (Table 2): *Trichodina domerguei* Wallengren, 1897 on the skin of a round goby, *Bothriocephalus opsariichthydis* Yamaguti, 1934 in the gut of a round goby, *Proteocephalus gobiorum* Dogiel & Bychowsky, 1939 in the gut of the gorlap goby, *Triaenophorus crassus* Forel, 1868 in round goby muscle, *Apharyngostrigea cornu* (Zered, 1800) in gorlap goby muscle, *Spiroxys contortus* (Rudolphi, 1819) in the mesentery of the gorlap goby, and *Piscicola geometra* (L., 1761) on the skin of a tubenose goby.

Discriminant analyses showed significant differences among all host species, except between the round

Table 3. Matrices of similarities: Index of Czekanowski-Sørensen (ICS, %) and Mahalanobis distances (MD) between gobiid species: total for the lower Volga River (A), Volgograd (B), and the Volga Delta region (C). Significant differences ($P < 0.05$) are in bold; "–" not analyzed.

	N. fluviatilis		*N. melanostomus*		*P. gorlap*		*P.* cf. *semipellucidus*	
	ICS	MD	ICS	MD	ICS	MD	ICS	MD
(A) Lower Volga River								
N. fluviatilis	100	0.00						
N. melanostomus	60	**6.10**	100	0.00				
P. gorlap	50	**4.86**	71.4	**5.78**	100	0.00		
P. cf. *semipellucidus*	70.6	**4.71**	72	2.03	72	**3.61**	100	0.00
(B) Volgograd								
N. fluviatilis	100	0.00			–	–		
N. melanostomus	71.4	**8.25**	100	0.00	–	–		
P. cf. *semipellucidus*	40	**8.81**	33.3	3.49	–	–	100	0.00
(C) Volga Delta region								
N. melanostomus	–	–	100	0.00				
P. gorlap	–	–	75	**7.09**	100	0.00		
P. cf. *semipellucidus*	–	–	54.5	5.31	63.6	**6.42**	100	0.00

and tubenose gobies, which had similar parameters of parasitization and faunal composition according to the ICS results (Table 3A). However, overall similarity of the parasitic fauna among most gobiid species was high, with ≥ 50% ICS (Table 3A). The gorlap and monkey gobies were the least similar, also significantly differing according to discriminant analysis.

According to the coefficient of ratios (CR) the monkey goby significantly differed from all other gobiid species: from the round goby in infection by *A. gracilis* (CR = –30.4, $t = 4.66$) and *H. dubinini* (CR = –7.38, $t = 3.16$), from the gorlap goby with *Diplostomum* sp. (CR = –11.17, $t = 2.23$), and from the tubenose goby with *Diplostomum* sp. (CR = –171.33, $t = 2.44$) and *H. dubinini* (CR = –6.61, $t = 3.12$). The tubenose goby also varied from the round goby with infection by *Diplostomum* sp. (CR = –54.33, $t = 2.02$) and *Eustrongylides excisus* Jagerskiold, 1909 (CR = 13.33, $t = 2.27$).

We discerned the same trends near Volgograd, indicated by discriminant analysis. The monkey goby significantly differed from the other studied gobiids (two samples of the gorlap goby from this location were not used in the calculations) with discriminant analysis (Table 3B) and CR: from the round goby by infection with *A. gracilis* (CR = –12.61, $t = 4.42$) and *H. dubinini* (CR = –5.34, $t = 2.74$), and from the tubenose goby by *A. gracilis* (CR = –1.99, $t = 2.02$). CR did not significantly differ between the round and tubenose gobies, where as ICS showed more similarity between the parasitic faunas of round and monkey gobies (Table 3B). Difference between the monkey and tubenose gobies was supported by both the ICS and discriminant analysis: the irrelastion ship was just 40%, and their Mahalanobis distance was the highest among the gobiids studied.

In the Volga Delta, the gorlap goby significantly differed from the round and tubenose gobies in the discriminant analysis (Table 3C). The CR of the round goby differed significantly from the tubenose goby by infected with *E. excisus* (CR = –9.57, $t = 2.68$). ICS showed that all three gobiid species appeared >50% similar (Table 3C).

Comparisons of parasite load showed no significant differences between the Volgograd and Delta sampling locations; their ICS results were 60% similar. For the tubenose goby, their parasitic fauna appeared 43% similar. ICS was not calculated for the gorlap goby due to its low sample size at Volgograd.

The infracommunity composition of gobiid parasites ranged from 0 to 5 species. In general, in the Volgograd region, all goby species shared a common infracommunity except for the invasive monkey goby (Fig. 2). The mean infracommunity of the monkey goby near Volgograd significantly varied from that of the tubenose goby ($t = 3.12$, $P = 0.042$). The round goby moreover differed from the gorlap goby ($t = –2.04$, $P = 0.046$). In the Delta region, most gobies shared a similar infracommunity whereas the tubenose goby (Fig. 2) was dominated by a single species, *A. gracilis* (Table 4). The tubenose goby's infracommunity significantly differed from those of the monkey goby ($t = 2.89$, $P = 0.0059$) and the gorlap goby ($t = 2.7$, $P = 0.0091$).

Discussion

Although discriminant analyses showed significant differences in parasitization among different gobiid species in the Lower Volga River, their Indices of Czekanowski-Sørensen revealed overall similarity (see Table 4). However, the introduced monkey goby was clearly different. Samples of the monkey goby from Volgograd possessed

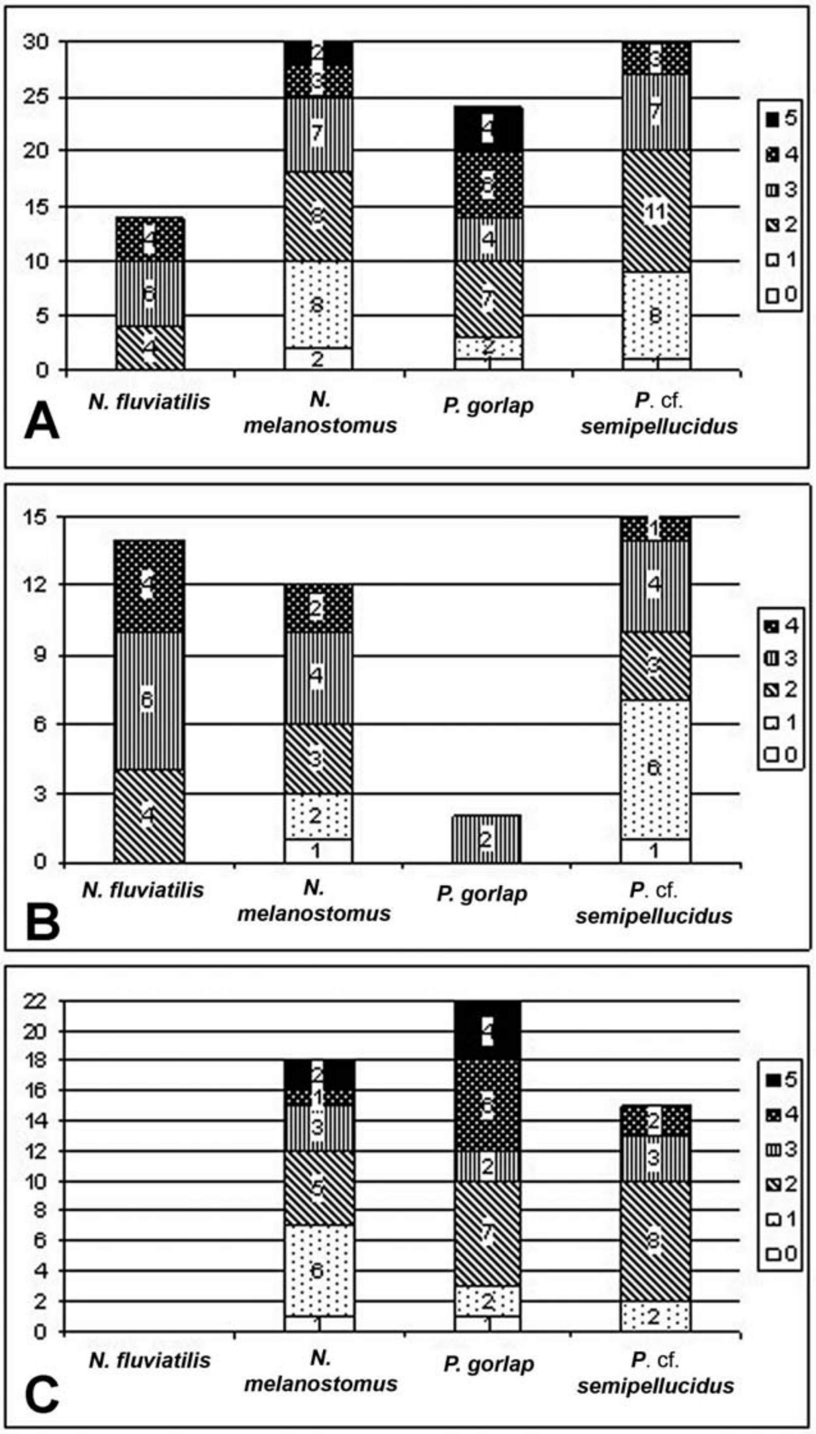

Fig. 2. Infracommunities of goby parasites from the lower Volga River. Total (A), Volgograd (B), Delta region (C). Number of species in infracommunities is indicated in the legend.

lower numbers of parasites (6 species), with higher degrees of parasitization by those. Five of its six parasite species comprised core community species and just one, *Holostephanus cobitidis* Opravilová, 1968, was secondary. The abundance of metacercariae of *A. gracilis* was high at this location. Discriminant analysis and ICS showed a large difference between the monkey and tubenose gobies, with just 40% similarity (see Table 3B). Monkey and gorlap goby parasites had the least similarity (see Table 3A).

The gorlap goby is endemic to the Caspian Sea and its rivers (Kottelat & Freyhof 2007), and is a predatory fish (Tsykhon-Lukanina 1959), which tend to have higher numbers of individual parasites (Valtonen & Julkunen 1995). It differed from the other gobiids studied in discriminant analysis results (see Table 3A, C; Figs 2A, C), but shared similar parasitic fauna with most other gobiids, excepting the monkey goby (50%) (see Table 3A; Fig. 2A).

The round goby has been characterized as ben-

Table 4. The infracommunity index for gobiids. The tendencies to join the infracommunity (ICI > 0.30) are in bold.

Parasite species	*Neogobius fluviatilis*	*Neogobius melanostomus*			*Ponticola gorlap*			*Proterorhinus* cf. *semipellucidus*		
	Volgograd	Volgograd	Delta	Total	Volgograd	Delta	Total	Volgograd	Delta	Total
Loma sp.	0.02	0.04	0.03	0.03		0.02	0.01		0.06	0.03
Trichodina domerguei			0.03	0.01						
Gyrodactylus proterorhini		0.18	0.13	0.15		0.08	0.07	0.21	0.06	0.13
Bothriocephalus opsariichthydis pl			0.03	0.01						
Proteocephalus gobiorum						0.06	0.06			
Triaenophorus crassus pl			0.05	0.03						
Apatemon gracilis met	0.03	**0.32**	0.03	0.15	**0.33**	0.26	0.26	**0.46**	**0.43**	**0.44**
Apharyngostrigea cornu met						0.02	0.01			
Diplostomum sp. met	0.19	0.21	0.13	0.16		0.08	0.07		0.03	0.02
Holostephanus cobitidis met	0.05	0.04		0.01					0.09	0.05
Holostephanus dubinini met	0.24	0.14	0.10	0.12	0.17	0.11	0.11		0.20	0.11
Hysteromorpha triloba met		0.04		0.01	0.17		0.01		0.06	0.03
Nicolla skrjabini	0.17		0.10	0.06	0.17	0.15	0.15	0.29	0.03	0.14
Phyllodistomum simile		0.04	0.03	0.03		0.03	0.03			
Camallanus lacustris			0.15	0.09		0.05	0.04			
Eustrongylides excisus L3			0.21	0.12		0.14	0.13		0.03	0.02
Spiroxys contortus L3						0.03	0.03			
Pomphorhynchus laevis					0.17		0.01	0.04		0.02
Piscicola geometra									0.03	0.02

thophagous (Tsykhon-Lukanina 1959) and is abundant in both the Black and Caspian Sea basins (Kottelat & Freyhof 2007). Its parasite infections differed from those of the introduced monkey goby and the predatory gorlap goby. The round goby's parasitic fauna in the lower Volga River most closely resembled that of the Caspian tubenose goby, indicated by a low Mahalanobis distance (Table 3A; Fig. 2A). The origins of the tubenose goby in the Volga River are unresolved – it may be native or have been introduced from the Azov Sea basin; its parasites more closely resembled those of the Caspian Sea gobiids, rather than the Pontian monkey goby that was introduced from the Sea of Azov basin.

Two non-indigenous parasites to the lower Volga River system, the cestode *B. opsariichthydis* and the trematode *N. skrjabini*, were identified in the gobiids. The former is a parasite that was introduced to Europe (recorded in the Dnieper, Dniester, Danube river basins) from Eastern Asian plantivorous fishes used in aquaculture, such as the grass carp *Ctenopharyngodon idella* (Valenciennes, 1844) and the bighead carp *Hypophthalmichthys nobilis* (Richardson, 1845) (Semenova et al. 2007). In Europe, *B. opsariichthydis* has not been reported in gobiids, but occurs in the round goby from the Volga River Delta zone. In the Caspian basin, *B. opsariichthydis* was reported in the gorlap goby from the Volga Delta (Semenova et al. 2007) and in white goby*N. pallasi* (reported as *Neogobius fluviatilis*) from the Alborz Dam in northern Iran (Hosseinifardet al. 2011). *Nicolla skrjabini* spread to the Caspian basin from the Black Sea basin via its first intermediate host, the Pontian mollusc *Lithoglyphus naticoides* Pfeiffer, 1828 (Zhokhov et al. 2006) following the construction of Volga-Don Canal in 1952 (Pirogov 1972). It belonged to the core group of gobiid parasites in all species except for the round goby.

Two parasitic species specific to gobiids were found in the Lower Volga River: *Gyrodactylus proterorhini* Ergens, 1967 and *P. gobiorum*. The two specialist parasites were not abundant and had a low tendency to join the infracommunity. The monogenean *G. proterorhini* occurred in three species: the round, gorlap, and tubenose gobies and had previously been described from near the south-western Caspian Sea coasts (Semenova et al. 2007). It is distributed widely throughout the Black Sea basin, both in fresh (Kvach 2010; Mühlegger et al. 2010; Ondračková et al. 2010, 2012) and polyhaline waters (Naidenova 1974). According to Naidenova (1974) high infection of gobiids with *G. proterorhini* is typical during spring spawning. Our autumn sampling shows higher infection in comparison to results from the Dniester River delta (Kvach 2010), but lower levels than in the Danube River, where its abundance was 27.2 in spring and 14.5 in autumn (Ondračková et al. 2010). Ondračková et al. (2010) found higher abundance of infection of gobiids with this monogenean in native habitats, than in introduced areas. We found no significant differences in its occurrence between different gobiids species. The cestode *P. gobiorum* is abundant in gobiids in the Black Sea, especially in brackish water estuaries (Kvach 2002a, b), but is rarer in fresh and oligohaline waters (Kvach 2010). The lower Volga River is the type locality for *P. gobiorum* (Dogiel & Bykhovsky 1939), which occurred only in the gorlap goby in higher numbers in the lower Volga system than in the oligohaline Dniester Estuary (Kvach 2010), but lower than in brackishwater lagoons and estuaries (Kvach 2002a, b).

The Caspian Sea, together with the Black Sea, forms the Ponto-Caspian brackishwater zoogeographical region. The introduction of the monkey goby, a native of the Black Sea basin, to similar environments in the Caspian Sea system may have facilitated its establishment. In the lower Volga River system, the Black Sea monkey goby shows a high intensity of infection by many core parasitic species, whose species composition we found differed significantly from that of the round goby despite similarities in their diets (Tsykhon-Lukanina 1959). This finding markedly contrasts to low parasitism in invasive gobies of the Baltic Sea and Great Lakes, which were ballast water introductions that appeared to support the 'enemy release hypothesis' (Kvach & Stepien 2008). In the Volga River, high connectivity among habitats via many canals and links likely led to a more gradual assumption of the native parasite community.

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