

The interaction between an introduced fish host and local parasite fauna: *Neogobius kessleri* in the middle Danube River

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Abstract Parasite communities of introduced fish *Neogobius kessleri* Günther (Gobiidae) were studied at five localities in the Slovak section of the Danube River during 2002–2005. Thirty-three metazoan parasite species were identified. All fish were infected with at least two parasite species; most of the parasite species were generalists. At all sampling sites, high susceptibility to local parasites was observed. The parasite community was dominated by three parasite species: glochidia of *Anodonta anatina*, larval or subadult acanthocephalan *Pomphorhynchus laevis*, and larval nematode *Raphidascaris acus*. The infection of both *A. anatina* and *P. laevis* was affected by season and habitat type, with higher abundance in spring and more frequent occurrence of *A. anatina* in side channels and *P. laevis* in main river channels. At both the component and infracommunity levels, a more diverse parasite community was found in side channels. This habitat was dominated by actively transmitted parasites, whilst endoparasites were more abundant in fish from the main river channel. Larval stages of parasites dominated the endoparasite community at all sampling sites. The introduced *N. kessleri* was used as intermediate host for most of the recorded parasites, in some cases also as a paratenic host. Finally, the importance of gobies as suitable hosts for local non-native parasite species (*Anguillicoloides crassus*, *Anodonta woodina*, *Hydrozetes lacustris*) is discussed.

Introduction

In recent decades, the introduction of Ponto-Caspian gobies within Europe has been one of the most impressive fish introductions ever witnessed. In the Danube River, four Ponto-Caspian gobies began to expand upstream of their previously native distributions: Bighead goby, *Neogobius kessleri*, round goby, *Neogobius melanostomus*, monkey goby, *Neogobius fluviatilis* and racer goby, *Neogobius gymnotrachelus* all appeared in the middle Danube since the 1990s (Jurajda et al. 2005; Wiesner 2005). Bighead goby was the first *Neogobius* species recorded in 1996 in the Slovak section of the Danube River (Stráňai 1997), and until 2004, this species had the widest density and distribution among the four *Neogobius* species (Jurajda et al. 2005).

Aquatic introductions are known to be facilitated by a range of factors, including species-specific traits as well as by human activities such as river regulation, the connection of contiguous basins by canals or ballast transport (Grigorovich et al. 2003). In general, most introductions are unsuccessful and only a minority of introduced species establishes stable populations. Several life history traits have been associated with successful invaders, and the success of introduced species may be facilitated also by escapement from the effects of natural predators and parasites (Torchin et al. 2003). According to the parasite/predator escape hypothesis, a host may profit from this favourable situation, attaining higher population densities and greater individual sizes in the colonised areas as compared to conspecifics in their native range (Torchin et al. 2001).

In the present study, the parasite community structure of the bighead goby is reported from five different sites in the Slovak section of the Danube River system where this introduced fish species has reached high densities and is an important component of the local fish community (Jurajda

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et al. 2005). Preliminary results demonstrated a relatively low parasite load in introduced populations compared to native bighead goby populations. Despite the low parasite species richness in introduced populations, parasite community structure of bighead goby indicated the possible importance of this fish species as the intermediate or paratenic host for several local parasites (Ondračková et al. 2005). The importance of gobies as hosts and transmitters of different parasite species has already been described by Zander et al. (1993) in the Baltic Sea. Therefore, this study focuses on the incorporation of a new host into the local host–parasite system.

Materials and methods

During 2002–2005, eight fish samples comprising 261 specimens of *N. kessleri* were collected by electrofishing from five locations in the Slovak section of the Danube River representing two habitat types: (1) side channels, sites named as Bačianske and Bodické and (2) main river channels, sites named as Váh River (near the confluence

with the Danube River), the Old and New channels of the Danube River located near the Gabčíkovo dam (Fig. 1). Side channels are separated from the main channel by the semi-permeable structure composed of the large boulders with some concrete fillings and represent a habitat of backwater (minimum or no current). Main river channels represent a habitat of flowing water. The fish were sampled in spring (April) and autumn (October) in the Bačianske side channel and in both New and Old channels of the Danube River. Only one sample was taken from Bodické side channel (spring) and Váh River (autumn, see Table 1). Live fish were transported to a nearby field station near the village of Gabčíkovo. In the laboratory, all fish were measured (SL - standard length, to the nearest millimetre) and examined under binocular microscope for the presence of metazoan parasites according to standard protocols. Collected parasites were preserved in either 4% formaldehyde (Acanthocephala, Digenea, Cestoda, Bivalvia, Crustacea, Acarina) in a mixture of ammonium picrate and glycerine (Monogenea) or in a mixture of glycerine and alcohol (Nematoda). Parasites were examined using a light microscope (Olympus BX 50) equipped with phase

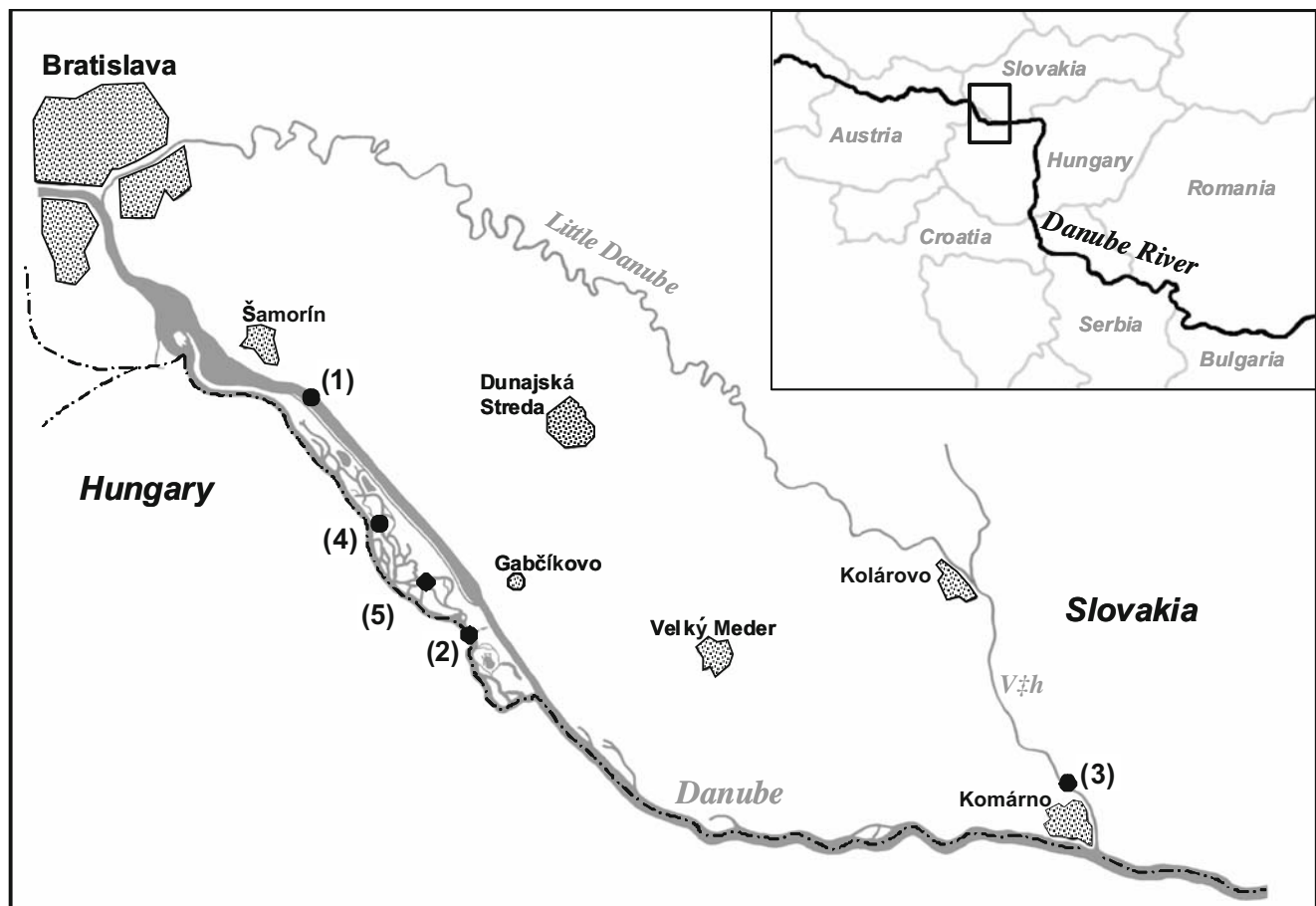


Fig. 1 Map of the study area. 1 Danube River—New channel, 2 Danube River—Old channel, 3 Váh River, 4 Bodické side channel, 5 Bačianske side channel

Table 1 Number of examined fish, standard length (mean, SD, min–max), total prevalence, abundance and mean intensity of parasite infection, component community and mean infracommunity richness and association of fish length (SL) and intensity of parasite infection

	<i>Danube River—New channel</i>		<i>Danube River—Old channel</i>		<i>Váh River</i>	<i>Bodícke side channel</i>	<i>Bačianske side channel</i>	
	Spring	Autumn	Spring	Autumn	Autumn	Spring	Spring	Autumn
<i>N</i>	32	36	20	47	31	17	43	35
SL (mm); mean ± SD	112.7±7.9	101.8±12.5	107.3±21.8	88.0±19.1	101.4±6.7	94.5±30.2	88.0±20.9	88.2±23.5
SL (mm); min–max	89–126	64–120	58–131	46–119	88–114	48–140	57–136	53–140
Total prevalence	100	100	100	100	100	100	100	100
Total abundance	1,703	972	1,572	3,471	3,912	3,248	4,516	1,373
Mean intensity	53.2	27.0	78.6	72.3	126.2	191.1	105.0	39.2
Intensity range (min–max)	23–194	4–127	20–210	3–183	39–234	7–1036	13–610	7–139
Component community richness	12	11	17	15	12	18	23	18
Mean infracommunity richness (min–max)	5.4 (3–9)	3.5 (2–7)	5.5 (3–8)	4.1 (2–7)	3.5 (2–6)	5.2 (2–9)	5.2 (2–9)	4.9 (2–9)
Association of SL and intensity of infection ^a	0.52*	0.17	0.19	0.83**	0.34	0.72*	0.30	0.51*
Association of SL and infracommunity richness ^a	0.46*	0.08	0.04	0.55**	–0.15	0.78**	0.17	0.67**

* $p < 0.01$, ** $p < 0.001$

^a Values represent correlation coefficients of the Pearson correlation test, asterisks indicate the p values

contrast, differential interference contrast (DIC according to Nomarski), measured using Image Analysis Systems (Lucia 5.0) and identified according to Yamaguti (1971), Gussev (1985), Bauer (1987), Moravec (1994) and Niewiadomska (2003).

Parasite community composition was tested for association with habitat type (pooled data for side channels and main river channels) and season (spring and autumn). Autogenic/allogenic species were characterised according to Esch and Fernández (1993). Regarding the mode of transmission, parasite species were separated into two groups: passively transmitted parasites, achieved by the host via ingestion (most of the endoparasites), and actively transmitted parasites, which either penetrate the fish host (larval digenean) or attach the surface of fish host (ectoparasites). Furthermore, we classified endoparasites in respect to their maturity stage, as larval or adult parasites. Larval parasites comprised a group of parasites of which the fish host (*N. kessleri*) served as the intermediate host (denoted as larval IMH). This group included metacercariae of digenean and larval cestodes. The second group comprised parasites of which the fish host served as the paratenic host (denoted as larval PH). This group included subadult *Pomphorhynchus laevis* and encysted larval nematodes *Streptocara crassicauda*, *Raphidascaris acus*, *Eustrongylides excisus* and *Anguillicoloides crassus*.

Parasite infection was characterised according to Bush et al. (1997). Classification of core/satellite species follows Esch and Fernández (1993). For data analyses, all abun-

dance data were $\log(x+1)$ -transformed and all percentage data (proportion of larval parasites in the infracommunity) were $\arcsin(x)$ -transformed. Non-parametric tests were used when data were not normally distributed after transformation. The relationship between parasite abundance and fish length (SL) was tested via Pearson correlations. The Wilcoxon matched pairs test was used to compare parasite abundances or species richness within infra-communities (ecto- vs. endoparasites, larval vs. adult parasites, actively vs. passively transmitted parasites, autogenic vs. allogenic parasites). Analysis of covariance (with fish length as a covariate) was used to compare parasite abundance among the fish samples tested. General linear models factorial analysis of variance (ANOVA) was used for analysis of the effect of habitat and season as categorical variable and fish standard length as continuous variable on abundance of dominant parasite species. Statistical analyses were performed using Statistica 7.0, StatSoft.

Results

All fish were infected with at least two parasite species per fish. Thirty-three metazoan parasite species were observed in total (Table 2). Six parasite taxa occurred at all sampling sites: metacercariae of *Diplostomum* spp. and *Tylodelphys clavata*, adult digenean *Nicolla skrjabini*, larval nematode *R. acus*, acanthocephalan *P. laevis* and glochidia of *Anodonta anatina*. Fish length differed among sampling

Table 2 Prevalence (*P*) and mean abundance (*A*) of metazoan parasites infecting *N. kessleri* in the Slovak stretch of the Danube River

	Danube River - New channel		Danube River - Old channel		Váh River	Bodícke side channel	Bačianske side channel	
	Spring <i>P</i> (<i>A</i>)	Autumn <i>P</i> (<i>A</i>)	Spring <i>P</i> (<i>A</i>)	Autumn <i>P</i> (<i>A</i>)	Autumn <i>P</i> (<i>A</i>)	Spring <i>P</i> (<i>A</i>)	Spring <i>P</i> (<i>A</i>)	Autumn <i>P</i> (<i>A</i>)
Monogenea								
<i>Gyrodactylus proterorhini</i>	75 (6.41)	17 (0.19)	90 (13.25)	2 (0.06)	3 (0.03)		23 (1.04)	3 (0.06)
<i>Gyrodactylus</i> sp. 1						24 (0.35)	2 (0.02)	
<i>Gyrodactylus</i> sp. 2							4 (0.04)	
<i>Gyrodactylus</i> sp. 3							2 (0.02)	
Acanthocephala								
<i>Acanthocephalus lucii</i>							4 (0.19)	9 (0.09)
<i>Pomphorhynchus laevis</i> (SA)	100 (13.69)	94 (7.78)	80 (11.5)	100 (40.68)	100 (37.26)	71 (3.24)	74 (7.89)	26 (3.6)
Cestoda								
<i>Triaenophorus crassus</i> (PL)			15 (0.3)	4 (0.04)		35 (0.94)	23 (0.34)	43 (1.86)
<i>Cestoda</i> sp.			5 (0.05)			12 (0.18)	9 (0.19)	11 (0.43)
Trematoda								
<i>Apatemon cobitidis proterorhini</i> (MTC)	3 (0.03)	3 (0.03)			3 (0.06)	12 (0.12)	4 (0.04)	6 (0.29)
<i>Apophalus donicus</i> (MTC)					3 (0.06)		2 (0.02)	
<i>Bucephalus polymorphus</i> (AD,MTC)					3 (0.03)			3 (0.03)
<i>Diplostomum</i> spp. (MTC)	78 (5.59)	58 (1.97)	40 (1.15)	57 (1.3)	16 (0.16)	94 (15.53)	55 (4.32)	77 (4.49)
<i>Holostephanus cobitidis</i> (MTC)	3 (0.03)			2 (0.02)		24 (1.12)	34 (7.06)	9 (0.20)
<i>Metorchis xanthosomus</i> (MTC)								3 (0.03)
<i>Nicolla skrjabini</i>	41 (0.81)	31 (4.42)	65 (11.20)	45 (1.00)	55 (2.65)	6 (0.82)	2 (0.02)	11 (0.11)
<i>Tylodelphys clavata</i> (MTC)	34 (5.22)	28 (1.89)	5 (1.3)	23 (0.30)	6 (0.10)	12 (0.30)	30 (2.51)	60 (4.71)
<i>Tylodelphys</i> sp. (MTC)			5 (0.85)					
Nematoda								
<i>Anguillicoloides crassus</i> (L3)	13 (0.16)	3 (0.03)	10 (0.10)	2 (0.02)		6 (0.12)	6 (0.06)	20 (0.26)
<i>Camallanus lacustris</i> (AD,L3)					3 (0.03)	6 (0.06)		
<i>Camallanus truncatus</i> (AD)							2 (0.02)	
<i>Eustrongylides excisus</i> (L3)		6 (0.06)					9 (0.09)	9 (0.11)
<i>Pseudocapillaria salvelini</i> (AD)					3 (0.03)			
<i>Pseudocapillaria tomentosa</i> (AD,L4)			10 (0.15)	2 (0.02)		6 (0.06)	12 (0.58)	
<i>Raphidascaris acus</i> (L3)	100 (15.31)	89 (9.33)	95 (16.20)	74 (4.55)	52 (0.87)	65 (11.18)	83 (8.36)	83 (3.66)
<i>Schulmanella petruschewski</i> (L4)						6 (0.24)		
<i>Streptocara crassicauda</i> (L3)	13 (0.28)	3 (0.03)	10 (0.20)	2 (0.20)				3 (0.03)
Bivalvia								
<i>Anodonta anatina</i>	81 (5.59)	19 (1.28)	95 (21.00)	94 (25.62)	100 (85.0)	94 (154.9)	87 (63.26)	94 (19.03)
<i>Anodonta woodiana</i>	3 (0.09)		5 (0.25)	2 (0.11)				
<i>Pseudoanodonta complanata</i>			5 (1.00)					
<i>Unio tumidus</i>			5 (0.05)	6 (0.06)		6 (1.35)		
Acarina								
<i>Hydrozetes lacustris</i>			5 (0.05)					
Crustacea								
<i>Argulus foliaceus</i>						18 (0.24)	2 (0.02)	
<i>Ergasilus sieboldi</i>				4 (0.04)		24 (0.35)	2 (0.02)	20 (0.26)

SA subadult stage, PL plerocercoid, MTC metacercariae, AD adult, L3 third-stage larva, L4 fourth-stage larva

sites [ANOVA; $F_{(7,253)}=9.0$, $p<0.001$], with fish from main river channel sites tending to be larger than fish from side channel sites. A positive association between fish length and both the total parasite abundance ($r=0.38$, $p<0.001$) and infracommunity richness ($r=0.34$, $p<0.001$) was observed. The highest parasite abundance was found in fish from Váh River and Bodícke side channel; the less parasitised fish were observed in autumn samples of Bačianske side channel and the New channel of the Danube River (analysis of covariance, ANCOVA; $F_{(7,252)}=22.3$; $p<0.001$; post hoc Fisher least significant difference (LSD) test]. The species richness in main channel habitat (25 spp.) was insignificantly lower to that of side channels (28 spp.). Mean infracommunity richness was significantly higher in fish from side channels and main channel spring samples as compared to autumn samples of main channel fish [ANCOVA; $F_{(7,252)}=12.4$; $p<0.001$; post hoc Fisher LSD test].

Three parasite species reached prevalence over 50% (core species) in seven (*P. laevis* and *A. anatina*) or eight samples (*R. acus*, see Table 2), and these parasites represented 84% of all specimens in the metazoan parasite community. Glochidia of *A. anatina* and acanthocephalan *P. laevis* reached higher abundances in spring samples, and no effect of season on *R. acus* abundance was found. Whilst *A. anatina* was more abundant in side channels, *P. laevis* dominated in main river channel samples, and this was consistent in both seasons. No effect of habitat type on *R. acus* abundance was found (Table 3).

Nine species of autogenic parasites and 24 species of allogenic parasites occurred in the parasite community of *N. kessleri* (Table 2). Autogenic parasites dominated in both main river channel and side channel habitats independent of season (Wilcoxon pair test, $p<0.001$; Fig. 2a). Regarding actively versus passively transmitted parasites, the abundance of actively transmitted parasites was significantly higher in fish from side channels (*t* tests; $p<0.001$). No differences in parasite abundance between actively and passively transmitted parasites were observed in fish from main river channel habitats (Wilcoxon pair test; $p>0.1$; Fig. 2b).

In general, infracommunity species richness was significantly higher in endoparasites than in ectoparasites in both main river channel and side channel habitats independent of season (*t* test; $p<0.001$). In a similar manner as for infracommunity richness, the abundance of endoparasites was significantly higher, but only in fish both from main river channels (*t* test, $p<0.001$). No differences between ecto- and endoparasite abundance in fish from side channels were affected by high abundance of *A. anatina*; after removing this parasite species from the analysis, significantly higher abundance of endoparasites were also found in side channels (*t* test, $p<0.001$). Among endoparasites, only 6.5% of parasite individuals (belonging to eight

Table 3 Results of GLM factorial ANOVA on the effect of fish length (SL), season (spring and autumn) and habitat (main river channel and side channel) on the abundance of three dominant parasite species infecting *N. kessleri* in the Slovak stretch of the Danube River

	Df	F	p
<i>Anodonta anatina</i>			
SL	1	3.43	0.065
Season	1	20.52	<0.001
Habitat	1	19.04	<0.001
Season × habitat	1	0.06	0.812
Error	256		
<i>Pomphorhynchus laevis</i>			
SL	1	10.83	0.001
Season	1	10.54	0.001
Habitat	1	127.634	<0.001
Season × habitat	1	14.65	<0.001
Error	256		
<i>Raphidascaris acus</i>			
SL	1	67.92	<0.001
Season	1	0.37	0.545
Habitat	1	0.42	0.517
Season × habitat	1	7.50	0.007
Error	256		

species) were found in the adult stage, whilst the rest of the parasites occurred in larval or subadult stages (detailed in Table 2). Within the two groups of larval parasites established, larval IMH comprised 27% and larval PH comprised 73% of the individuals observed. Abundance of larval PH parasites was significantly higher than abundance of larval IMH parasites in main river channel samples (Wilcoxon pair test, $p<0.001$), whereas no difference in spring and dominance of larval IMH parasites in autumn were found in side channels (Wilcoxon pair test, $p<0.05$; Fig. 2c).

Discussion

This study presents an extensive investigation of metazoan parasites infecting *N. kessleri*, one of the most abundant gobies recently introduced into the Middle Danube River. The parasite community of *N. kessleri* reveals surprisingly high species richness (33 species), compared to 17 species found in their native range, the Bulgarian stretch of the Danube River (Ondračková et al. 2006) - the most probable source of introduction - and also compared to four parasite species found in the Hungarian stretch of the Danube River (Molnár 2006) and seven parasite species from the Hron River, a Danube tributary (Ondračková et al. 2005), both

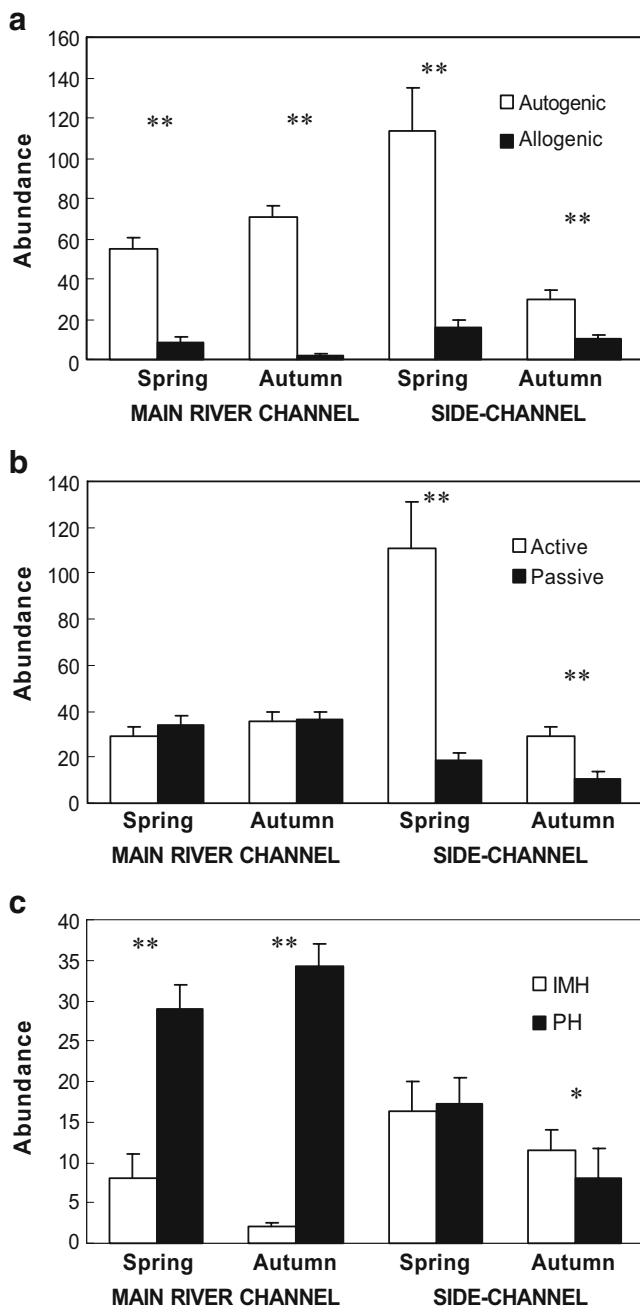


Fig. 2 Abundance of allogenic and autogenic (a), actively and passively transmitted (b) and larval (IMH) and larval (P) (c) parasites in *N. kessleri*. Histograms show mean values and associated standard deviations; asterisks show significant differences of *t* test [on $\log(x+1)$ -transformed data]; * $p < 0.05$; ** $p < 0.001$

non-native areas. All native parasite species with the exception of two parasites (*Proteocephalus* sp. larva, *Pseudochetosoma salmonicola*), both with rare occurrence in the native range (Ondračková et al. 2006), were also found in the non-native range of *N. kessleri* in the present study. However, most of the species found in the Slovak stretch of the Danube River belong to local parasites

(Moravec 2001), and therefore, a possible introduction of parasites from the native area to the Middle Danube is ambiguous and needs further investigation based on molecular analyses of parasites.

Six parasite taxa which were found at all sampling sites - two larval trematodes parasitising fish eyes, *Diplostomum* spp. and *T. clavata*; adult trematode *N. skrjabini*; larval nematode *R. acus*; acanthocephalan *P. laevis* and glochidia of *A. anatina* - infect a wide range of freshwater fishes (see Moravec 2001) and were also found in *N. kessleri* in its native range (Ondračková et al. 2006). Three of these frequently present parasites occurred as core species in the parasite community. Glochidia of *A. anatina* dominated in both habitats, but reached high mean abundances (over 150 glochidia per fish in Bodické side channel) particularly in side channels. High infection parameters of this species affected the proportion of actively and passively transmitted parasites and also the proportion of endo- and ectoparasites, especially in side channels. Unionid mussels exhibited seasonal dynamics in releasing the glochidia; glochidia of *A. anatina* are found on fish during cold months of the year, especially in autumn and spring (Blažek and Gelnar 2006). Therefore, the sampling in late autumn and early spring probably influenced the measure of glochidia occurrence. Consequently, high prevalence and abundance of *A. anatina* glochidia reflected the seasonal dynamics of this species. Nevertheless, high susceptibility of *N. kessleri* to glochidia of *A. anatina* is indisputable.

The acanthocephalan *P. laevis* was the second core parasite species, highly prevalent but with lower mean abundance (maximum 40 individuals per fish in Old channel of the Danube River). Similarly as in its native range, most of the *P. laevis* specimens were found as subadults encysted in a thin wall, located on the surface of the intestine and other internal organs or in the peritoneal cavity. Penetration through the intestine and encystation in the peritoneal cavity of *P. laevis* and some other acanthocephalan species has been described for several small-bodied fish species (Moravec and Scholz 1991; Szekely et al. 1996), and in such cases, infected fish can serve as paratenic hosts. Ponto-Caspian gobies have been reported as common hosts for *P. laevis* in both their native range (Kakacheva-Avramova 1983; Ondračková et al. 2006) and non-native range (Ondračková et al. 2005; Molnár 2006; Kvach and Skóra 2007), and therefore, the high infection rates in the newly colonised range of *N. kessleri* is not surprising.

Whilst gobies were infected with larval *R. acus* only rarely in other studies in the Danube basin - e.g. *Proterorhinus marmoratus* in the South Moravian Reservoir (Koubková and Baruš 2000) and *N. fluviatilis* in Hungarian (Molnár 2006) or *N. kessleri* in the Bulgarian (Ondračková et al. 2006) stretch of Danube - this parasite occurred as a

third core species in the Slovak region of the Danube River, and its prevalence was high in both side channel and main river channel habitats. Similar results were also found for other goby species (*N. fluviatilis* and *N. melanostomus*) introduced into this region, indicating that gobies are suitable intermediate or paratenic hosts for *R. acus* (Ondračková et al. 2005).

Among the parasites with complex life cycles, gobies serve frequently as the second intermediate hosts (Zander et al. 1993). This was also described as a common event for new host-parasite systems in the non-native range of goby distribution when gobies are adopted as new suitable intermediate hosts for local parasites (Camp et al. 1999; Kvach and Skóra 2007; Kvach and Stepień 2008). Moreover, gobies may serve as a paratenic host in the case of larval *P. laevis* located in the abdominal cavity on the surface of various internal organs (see Moravec and Scholz 1991; Székely et al. 1996).

In this study, the majority of parasites infecting *N. kessleri* were found in the larval stage. Although most of the parasite species used *N. kessleri* as the intermediate host, high abundance of extraintestinally located larval/subadult *P. laevis* in main river channel habitats influenced the proportion of parasites in the community in the term of *N. kessleri* as intermediate or paratenic host (Fig. 2c). On the other hand, the abundance of parasites using *N. kessleri* as the intermediate or paratenic host was comparable in side channels because of the high proportion of larval trematodes in the parasite community. The differences in parasite infection between habitats are associated with the presence of the first intermediate hosts for particular parasites: Amphipods were more abundant in lotic waters for *P. laevis* and aquatic snails and more abundant in lentic waters for trematodes. *N. kessleri* inhabits fresh and brackish waters and has a preference for the lower courses of rivers and lakes with perceptible current (Miller 2003). Parasite species richness was higher in *N. kessleri* collected in side channels, and so was the proportion of new parasites for this fish host. Inhabiting an unfamiliar environment and moreover in a new area likely equated to an increased risk of infection with high numbers of new parasites for this fish species.

In terms of parasite colonisation, two categories of fish metazoan parasites are distinguished: autogenic species which mature in fish and allogenic species which mature in vertebrates other than fish and are expected to have a greater colonisation potential than parasites using freshwater fishes as final hosts (Esch and Fernández 1993). In contrast to these expectations, autogenic parasites dominated over allogenic parasites of *N. kessleri* in the Middle Danube. Only a few allogenic species occurred in the parasite community, all having relatively low abundance and prevalence (with the exception of eye flukes), similar to the native range (Ondračková et al. 2006). Low infection by

allogenic species was also found in introduced *N. melanostomus* in Poland (Kvach and Skóra 2007).

Besides the common local parasites, *N. kessleri* was also parasitised by three introduced species: larval nematode *A. crassus*, glochidia of *Anodonta woodiana* and acarinid *Hydrozetes lacustris*. According to Székely (1996), gobiids are suitable paratenic hosts for *A. crassus*. Infection of Ponto-Caspian gobies with this parasite was also documented in introduced populations in Poland (Rokicki and Rolbiecki 2002; Kvach and Skóra 2007). However, relatively low infection parameters found in their fish and in the present study indicate that the importance of gobies in *A. crassus* life cycle is only marginal, and even high abundances of gobies do not seriously affect the infection rate in the definitive host, European eel *Anguilla anguilla*. The Chinese pond mussel (*A. woodiana*) was found outside its native range (Eastern Asia) in several European countries during recent decades. The rapid spread and mass occurrence of this mussel has been reported from several areas in the Danube basin, especially along the Middle Danube (Paunovic et al. 2006). The increased abundance of fertile mussels is reflected in the findings of its glochidia attached to the fish. However, in a similar manner as in *A. crassus*, the infection rate was low and did not represent a significant risk to the local fauna, but the importance of gobies as transmitters of this parasite should be considered. Only one specimen of *H. lacustris*, most probably an accidental finding, was recorded. This parasite sporadically occurs in the Danube River basin (Navrátil 1991); hence, this parasite is assumed to have low importance for the local fish fauna.

In conclusion, *N. kessleri*, a Ponto-Caspian goby which appeared in the Middle Danube in the 1990s (summarised in Jurajda et al. 2005), seems to be a suitable host for a high number of local parasites in its new range. Unusually high species richness and parasite abundances indicate the susceptibility of *N. kessleri* to new parasites, predominantly those with a wide host range and especially in novel habitats such as side channels. On the other hand, no parasite species introduced with the host was recorded, and low abundances of non-native parasites reveal negligible impact on local fauna. The structure of parasite community consisting of a majority of larval parasites indicates the principal importance of introduced gobies as intermediate or paratenic hosts for local Danubean parasite fauna.

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