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Short Communication

New records of endoparasitic helminths in alien invasive fishes from the Carpathian region

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Abstract: Six non-native invasive fish species from the Slovak part of the Tisa River basin, namely *Carassius gibelio*, *Pseudorasbora parva*, *Ameiurus melas, A. nebulosus*, *Lepomis gibbosus*, *Perccottus glenii,* and three gobiid species from the Danube River, namely *Neogobius melanostomus, N. fluviatilis* and *N. kessleri,* were investigated for endohelminth parasites. The expanding Asian cestode *Nippotaenia mogurndae* (syn. *Amurotaenia perccotti*) (Nippotaeniidea) has been introduced to Europe with its invasive host *P. glenii*. Pumpkinseed, *Lepomis gibbosus*, is a new definitive host of *Proteocephalus percae* and it is reported as the second intermediate host of the bothriocephalidean cestode *Triaenophorus nodulosus* in Slovakia.

Key words: non-native fish; *Nippotaenia mogurndae*; new hosts; *Proteocephalus percae*; *Triaenophorus nodulosus*; *Lepomis gibbosus*; biological invasions

Introduction

Invasions by non-indigenous species have been recognized as the second most important threat to global biodiversity after loss of habitats and landscape fragmentation (Allendorf & Lundquist 2003; Park 2004). The economic impact of allochtonous species is a major concern throughout the world (Cowx 1997; Copp et al. 2005; Garcia-Berthou 2007). Management and control of non-indigenous species is perhaps the biggest challenge that conservation biologists will face in the next few decades (Allendorf & Lundquist 2003). The introduction of non-native species into ecosystems may influence the communities by changing species diversity (Mack et al. 2000). Among parasitologists, the applied aspects of parasite invasions, such as the negative effects on economically important hosts, have long been at the centre of interest. Parasites may have more considerable impacts on interactions of native animal communities during invasions than previously acknowledged (Galli et al. 2005; Taraschewski 2006).

During the last century, six non-native fish species were introduced accidentally into the Tisa River basin in Slovakia. Chronologically, goldfish *Carassius gibelio* (L., 1758), brown bullhead *Ameiurus nebulosus* (Le-Sueur, 1819), stone moroko *Pseudorasbora parva* (Temminck et Schlegel, 1842), pumpkinseed *Lepomis gibbosus* (L., 1758), Amur sleeper *Perccottus glenii* Dybowski, 1877 and black bullhead *Ameiurus melas* (Rafinesque, 1820).

Four species of Ponto-Caspian gobies (genus *Neogobius*) have invaded the middle and upper section of the Danube River during the last decade: bighead goby *Neogobius kessleri* (Günther, 1861), racer goby *N. gymnotrachelus* (Kessler, 1857), monkey goby *N. fluviatilis* (Pallas, 1814) and the round goby *N. melanostomus* (Pallas, 1814). The metazoan parasites of *Neogobius* fishes in the Slovak section of the Danube River have been recently investigated by Ondračková et al. (2005).

Data on metazoan parasites of fish in Slovakia were compiled by Moravec (2001), but the first parasitological survey of parasites of fish in the Tisa River basin was carried out by Zachvatkin (1951) and later, parasitological survey of native and introduced species of fish was done (Žitňan 1974; Ergens et al. 1975). However, there is still lack of the information about the parasite fauna of expanding species such as *A. melas* and *P. glenii* in their novel environments. In the present paper, data on the parasite fauna of several non-native fish species are provided.

Material and methods

During the study period (2003–2007), 764 specimens of 6 non-native invasive fish species were collected from sites of various ecological types from the Slovak part of the Tisa River basin (Table 1). The investigation was focused on fish species that were not previously examined in Slovakia, especially *Ameiurus melas* and *Perccottus glenii*.

All fish were caught by electrofishing and transported in aerated tanks of water to the laboratory and examined immediately under dissecting microscope. Collected cestodes and trematodes were fixed in hot 4% formalin. Acanthocephalans were washed in saline, refrigerated for 12 h and then fixed in 70% ethanol. The parasites were identified using identification keys of Ergens & Lom (1970) and Dubinina (1987).

Table 1. Numbers (N) of examined fishes (in systematic order), with minimum – maximum of standard length (SL), sampling site (basin) in Slovakia by biotope* and date of sampling.

Species	N	SL min.–max.	River basin	Biotope*	Date
Carassius gibelio (L., 1758) Cypriniformes: Cyprinidae	43	84–160	Bodrog, Latorica, Ondava, Uh	C, O, Ch, S, BP	2004/V, IX 2005/IV, VII, VIII
Pseudorasbora parva (Temminck et Schlegel, 1842) Cypriniformes: Rasborinae	43	60–75	Bodrog, Uh, Bodva	C, Ch, P	2004/V, X 2005/X
Ameiurus melas (Rafinesque, 1820) Siluriformes: Ictaluridae	111	35–250	Bodrog, Tisa, Latorica, Laborec	C, O, BP	2004/V, VI, VIII, IX, XI 2005/IV, V, VIII 2006/V 2007/IV
Ameiurus nebulosus (LeSueur, 1819) Siluriformes: Ictaluridae	11	100–151	Bodrog, Tisa	C, O	2003/V 2004/VI 2005/IV
Lepomis gibbosus (L., 1758) Perciformes: Centrarchidae	124	40–150	Bodrog, Tisa, Latorica, Ondava, Laborec	C, O, Ch, S, BP	2004/V, VI, VII 2005/IV, V, VII, VIII, X 2006/V 2007/IV
Perccottus glenii Dybowski, 1877 Perciformes: Odontobutidae	432	18–112	Bodrog, Tisa, Latorica, Laborec	C, O, BP	2003/IV, V, VII 2004/IV, V, VI, VII, VIII, IX, XI 2005/IV, VI, VIII, IX, X 2006/IV
Neogobius fluviatilis (Pallas, 1814) Perciformes: Gobiidae	13	43–85	Danube	MS	2004/IX
Neogobius melanostomus (Pallas, 1814) Perciformes: Gobiidae	32	55–96	Danube	MS	2004/IX
Neogobius kessleri (Günther, 1861) Perciformes: Gobiidae	30	76–114	Danube	MS	2004/IX

* Biotope types: O – oxbow; C – canal; Ch – channel; S – stream; MS – main stream; BP – borrow pit; P – pond.

In addition, 75 specimens of gobiid fishes, *Neogobius kessleri*, *N. fluviatilis* and *N. melanostomus* caught in the main stream of Danube River near Štúrovo, were studied for endohelminth parasites (Table 1). After capture, material was preserved in 4% formalin and then delivered to laboratory for examination.

Parasite infection was characterized by prevalence (percentage of fish infected by a given parasite species in a sample) and intensity of infection (minimum and maximum numbers of parasites per infected fish), location and developmental stage.

Results

A total of seven species of endoparasitic helminths have been recorded in nine non-native invasive fish species examined (Table 2). Six of them are native generalists that infected invasive species. One introduced exotic species, the cestode *Nippotaenia mogurndae* Yamaguti et Miyata, 1940 (syn. *Amurotaenia perccotti* Akhmerov, 1941) was observed (Košuthová et al. 2004, 2008).

The findings of the adult cestode *Proteocephalus percae* (Müller, 1780) and cestode plerocercoids of *Triaenophorus nodulosus* (Pallas, 1781) in *Lepomis gibbosus* represent the evidence for establishment of new parasite – host relationships. This non-native fish has been reported as the definitive host of *P. percae* for the first time. It prevailed in the intestine lumen of five fishes from sites in the Bodrog and Latorica River basins. At locality Streda nad Bodrogom, 57% (4/7) of *L. gibbosus* were infected. *Proteocephalus percae* specimens were differentiated from other congeners by scolex morphology and some characters of the strobila – mature proglottides much wider than long, well developed vaginal sphincter (Scholz & Hanzelová 1998). The cestodes found in pumpkinseed were adults with gravid proglottides containing eggs with formed oncospheres. The worms are deposited in collections of the first author.

The plerocercoids of the cestode *T. nodulosus* were detected either as free larvae on the surface of the liver, or encapsulated. The highest prevalence of the cestode (35%) was in the oxbow of the Tisa River at Veľký Kamenec. Gobies served mostly as paratenic host for the acanthocephalan *Pomphorhynchus laevis* (Müller, 1776). This was the most prevalent helminth species in all three gobies. Adult acanthocephalans, *Acanthocephalus anguillae* (Müller, 1780), were present in the lumen of fish intestine with a low prevalence of 2.4% in pumpkinseed and 6.3% in black bullhead. Only three worms of the adult digenean *Asymphylodora* Looss, 1899 were found in one specimen of *P. glenii*. The adult trematode *Nicolla skrjabini* (Ivanitzky, 1928) was abundant in intestine of bighead goby (73%), less in monkey goby (7.7%).

Discussion

The cestode *Nippotaenia mogurndae* has been intro-

Table 2. Prevalence (P) in %, developmental stage (Ds), intensity of infection (Int) minimum – maximum values, date and locality of helminth occurrence in invasive fishes of Slovakia.

Parasite species	Host	Ds	Location	P	Int	River basin	Biotope*	Date
Cestoda Triaenophoridae *Triaenophorus nodulosus*	*L. gibbosus*	plerocercoid	liver tissue	12.1	1–3	Bodrog Tisa	CH, C, O	2005/VII 2005/VIII
Proteocephalidae *Proteocephalus percae*	*L. gibbosus*	adult	intestine	4.0	1–3	Bodrog Latorica	C BP	2005/IV 2007/IV
Nippotaeniidae *Nippotaenia mogurndae*	*P. glenii*	adult	intestine	37.7	1–5	Bodrog Latorica Laborec	C, O, BP O, C, BP O	2003/IV,V 2004/IV,V,VII,IX,XI 2005/IV,X 2006/IV 2004/VI 2005/VII,VIII,IX 2004/VIII
Trematoda Lissorchiidae *Asymphylodora* sp.	*P. glenii*	adult	intestine	0.7	3	Bodrog	C	2003/V
Opecoelidae *Nicolla skrjabini*	*N. kessleri* *N. fluviatilis*	adult	intestine	73.0 7.7	2–25 1–3	Danube	MS	2004/IX
Acanthocephala Echinorhynchidae *Acanthocephalus anguillae*	*L. gibbosus* *A. melas*	adult	intestine	2.4 6.3	1–2 1–2	Ondava Bodrog Latorica	S C BP	2005/VII 2006/V 2007/IV
Pomphorhynchidae *Pomphorhynchus laevis*	*N. kessleri* *N. fluviatilis* *N. melanostomus*	larvae	intestine, abdominal cavity, liver, spleen	100 15.4 93.8	4–30 1–12 3–6	Danube	MS	2004/IX

* For biotope types, see Table 1.

duced to Europe with its invasive fish host *Perccottus glenii* (Košuthová et al. 2004). A total of 163 *P. glenii* from eight sites of different types in the Tisa River basin became infected with *N. mogurndae*. In eastern Slovakia, in the so called Medzibodrožie region, the Amur sleeper has recently rapidly spread with increasing density and the expansion of its cestode corresponds well with the host distribution. There is a statistically significant difference between the prevalence of the cestode in two functional size groups. The prevalence of the cestode increased with the standard length of fish (Košuthová et al. 2008). The further expansion of introduced non-native helminths in Central Europe was confirmed by recent findings in the Vistula and Danube River basins (Ondračková et al. 2007). The non-native parasites *N. mogurndae* and *Gyrodactylus perccotti* Ergens et Yukhimenko, 1973 (Monogenea) dominated in parasites community of *P. glenii* introduced to Poland.

Until now, the only cestode parasites reported from *L. gibbosus* have been plerocercoids of *Proteocephalus ambloplitis* (Leidy, 1887), referred from Buckeye Lake in Ohio (Bangham 1941), Canadian Lakes Ontario and Huron (Dechtiar et al. 1988; McDonald & Margolis 1995), Wisconsin (Amin 1990) and one adult of *Proteocephalus pearsei* La Rue, 1919 found in Buckeye Lake (Bangham 1941).

Two non-native ancyrocephalid monogenean parasites, *Onchocleidus dispar* (Mueller, 1936) and *O. similis* (Mueller, 1936), were introduced to Europe with*L. gibbosus* (Vojtek 1958; Sterud & Jørgensen 2006). Based on previous data, *L. gibbosus* was found to be parasitised by seven species of endohelminths in the territory of former Czechoslovakia (Moravec 2001), but no cestode parasites were previously reported. Since the authors are aware, pumpkinseed, serving as definitive host for cestodes of the genus *Proteocephalus*, is reported from Europe for the first time. Perch is undoubtedly the principal definitive host of *Proteocephalus percae* (Scholz & Hanzelová 1998). It can also be found in predatory fishes such as pike or burbot as in postcyclic hosts after consuming perch. Pumpkinseed was as second intermediate host for *T. nodulosus* reported from Germany (Brinker et al. 2000).

The small number of samples of *A. nebulosus* (11) versus *A. melas* (111) is due to the recent expansion of invasive black bullhead that replaced its close relative, the brown bullhead in Slovakia (Koščo et al. 2005). In Italy, the introduction of the exotic cestode *Corallobothrium parafimbriatum* Befus et Freeman, 1973 with *A. melas* was recorded (Scholz & Cappellaro 1993). The further spreading of the cestode with its fish host to other countries was not recorded. *Acanthocephalus anguillae*, adopted by black bullhead, is the common parasite of native fishes (about 40 species) in Slovakia (Moravec 2001).

The most prevalent helminth species in all three gobies was the acanthocephalan *Pomphorhynchus laevis*. It is a widespread intestinal parasite that uses small fishes as paratenic hosts. The obtained data correspond with the previous study of gobiid fishes from the Danube and Hron rivers in Slovakia (Ondračková et al. 2005).

Generally, the helminth fauna of invasive fish species reported from the new territories is less rich than in their native areas (Drake 2003; Torchin et al. 2003). Introduced animals and plants may escape 75% or more of the parasite and pathogen species from their native range. While they do accumulate novel parasite species from their new location, this number is generally only a fraction of the number lost (Torchin & Mitchell 2004). Transmission of parasites from invading to native species can occur, aiding the invasion process, whilst the 'release' of invaders from the parasite may also facilitate invasions (Torchin et al. 2003; Prenter et al. 2004; Torchin & Mitchell 2004). In conjunction with other biological and physical factors, release from parasites helps explain the increased demographic performance of invasive species, potentially accounting for much of the damage they cause.

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