

Aquatic Invasions Records

First record of round goby, *Neogobius melanostomus* (Pallas, 1814) in the Sava River, Croatia

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Abstract

In June 2011, 34 specimens of round goby (*Neogobius melanostomus*) were caught at three different locations in the Sava River in Croatia, which is a first record of this invasive species in Danube tributaries in Croatia. Size, structure and condition of populations indicate that the species is well adjusted to its new habitat and that further range expansions are highly likely.

Key words: round goby, Sava River, Croatia, invasive species

Introduction

Recently, expansion of two species of Ponto-Caspian gobies has been reported in the Croatian part of the Sava River: bighead goby *Ponticola kessleri* (Günther 1861; Neilson and Stepien 2009) and monkey goby *Neogobius fluviatilis* (Pallas, 1814) (Čaleta 2007; Piria et al. 2011).

Round goby is a species with a broad and flexible diet (Diggins et al. 2002; Corkum et al. 2004; Copp et al. 2008; Polačik et al. 2009), aggressive behaviour, tolerance of a wide range of environmental factors, early sexual maturation (L'avrinčikova and Kováč 2007), an ability to spawn several times a year (Kulikova and Fandeeva 1975; Moiseyeva and Rudenko 1978; Moiseyeva et al. 1983; Stammer and Corkum 2005) and male parental care that facilitates successful recruitment (Sapota 2004). Native to Azov, Black and Caspian Sea basins (Kottelat and Freyhof 2007), during the last several decades it has been rapidly spreading throughout most of the Europe (Jurajda et al. 2005; Ojaveer 2006; Czugała and Woźniczka 2010), and,

probably via ballast water, even reached North America (Great Lakes) (Charlebois et al. 2001).

Compared to several other Ponto-Caspian gobies, the round goby invasion of the upper parts of Danube basin was reported relatively late (Harka and Biro 2007). In 1997, its presence was observed in Serbia around Prahovo (downstream from the Sava River) (Simonović and Nikolić 1996; Simonović et al. 1998). Several years later, its presence was reported around Vienna, Austria (Wiesner et al. 2000), while in 2001, it was found near Budapest (Guti et al. 2003). Though both latter reports are upstream from the Sava, in the light of possible discontinuous range expansion of Ponto-Caspian gobies (Jurajda et al. 2005; Harka and Biro 2007; Borchherding et al. 2011), it is unclear whether it was present in the relatively short (137 km) stretch of the Danube in the far-eastern part of Croatia, that acts as a border with Serbia, before the reported findings (Mustafić 2005; Polačik et al. 2008; Francová et al. 2011) (Appendix 1). As yet, no findings were reported in any other locality in Croatia.

Figure 1. Location of the sampling area.



Figure 2. A typical *Neogobius melanostomus* specimen, with clearly visible black spot on dorsal fin, caught in the Sava River (30th June 2011, photo by T. Tomljanović).



Materials and methods

Round goby specimens were caught on 30th June 2011, during a regular fish survey, in the littoral part of the Sava by electric fishing (Hans Grassl EL 63 II, 220/440 V, 17.8/8.9 A) at three locations: Račinovci (N44°51'15.3", E18°57'45.7") - 8 specimens; Županja (N45°04'27.6", E18°41'15.5") - 5 specimens; Babina Greda (N45°05'36.5", E18°32'18.5") - 21 specimens (Figure 1). In total, 34 specimens were caught

and immediately frozen at -20°C. Round goby often shared habitat with monkey goby, but unlike the latter, which was mostly caught on sandy bottom, it was usually caught in the vicinity of boulders (ca. 1.4 m depth).

Its identification was performed based on the following morphological characteristics: a large black spot on the posterior part of first dorsal fin; nape scale coverage; pelvic-disc fraenum with small rounded lobes and length less than 1/6 of width at base; first branched ray of second dorsal

about as long as the penultimate ray (Kottelat and Freyhof 2007; Froese and Pauly 2011). A typical sample is shown in Figure 2.

Results and discussion

Total length (L_t) of the sampled specimens was in the range from 4.5 to 9.7 cm, while weight (W) was from 0.89 to 12.5 g. Condition factor (CF), calculated as $WL_t^{-3}100$, was 1.17. The length-weight relationship is expressed as $W=aL_t^b$ (Ricker 1975), where relationship parameter values were: $a=0.0058$ and $b=3.38$ (95% confidence limits 3.283-3.477). Correlation coefficient was $r^2=0.993$ ($p<0.01$). In comparison, b value of L-W relationship of round goby specimens from its native range in Turkey (where L_t was from 6.8 to 18.4 cm) varied from 2.87 to 3.27 (Tarkan et al. 2006), indicating a high positive allometry of Croatian specimens and, indirectly, their high successfulness in adapting to new habitat.

The presence of round goby in locations up to 125 km away from the confluence of Sava and Danube, the number of specimens caught, the presence of several different size-classes and L-W relationship all suggest that round goby has established a stable and well-adapted populations in this part of the Sava River. As yet, it is uncertain how far it has spread further upstream and whether it has entered other reaches of the Sava. As the morphologically, biologically and genetically closely related species monkey goby (Neilson and Stepien 2009) has already spread as far as the middle reaches of the Kupa River (Piria et al. 2011), and given the high invasiveness of round goby (Corkum et al. 2004; Jurajda et al. 2005), its further range expansion is highly probable.

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References

- Adáamek Z, Andreji J, Gallardo JM (2007) Food Habits of Four Bottom-Dwelling Gobiid Species at the Confluence of the Danube and Hron Rivers (South Slovakia). *International Review of Hydrobiology* 92 (4–5): 554–563, <http://dx.doi.org/10.1002/iroh.200510998>
- Borcherding J, Staas S, Krüger S, Ondračková M, Šlapanský L, Jurajda P (2011) Non-native Gobiid species in the lower River Rhine (Germany): recent range extensions and densities. *Journal of Applied Ichthyology* 27(1): 153–155, <http://dx.doi.org/10.1111/j.1439-0426.2010.01662.x>
- Charlebois PM, Corkum LD, Jude DJ, Knight C (2001) The round goby (*Neogobius melanostomus*) invasion: Current research and future needs. *Journal of Great Lakes Research* 27(3): 263–266, [http://dx.doi.org/10.1016/S0380-1330\(01\)70641-7](http://dx.doi.org/10.1016/S0380-1330(01)70641-7)
- Copp GH, Kováč V, Zwiemüller I, Dias A, Nascimento M, Balázová M (2008) Preliminary study of dietary interactions between invading Ponto-Caspian gobies and some native fish species in the River Danube near Bratislava (Slovakia). *Aquatic Invasions* 3: 193–200, <http://dx.doi.org/10.3391/ai.2008.3.2.10>
- Corkum LD, Sapota MR, Skora KE (2004) The round goby, *Neogobius melanostomus*, a fish invader on both sides of the Atlantic Ocean. *Biological Invasions* 6: 173–181, <http://dx.doi.org/10.1023/B:BINV.0000022136.43502.db>
- Czugała A, Woźniczka A (2010) The River Odra estuary - another Baltic Sea area colonized by the round goby *Neogobius melanostomus* Pallas, 1811. *Aquatic Invasions* 5 (Supplement 1): S61–S65, <http://dx.doi.org/10.3391/ai.2010.5.S1.014>
- Čaleta M (2007) Ekološke značajke ihtiofaune nizinskog dijela rijeke Save (Ecological characteristic of the ichthyofauna of the Sava River lowlands). PhD Thesis, Faculty of Science, University of Zagreb, 232 pp
- Diggins TP, Kaur J, Chakraborti RK, DePinto JV (2002) Diet choice by the exotic round goby (*Neogobius melanostomus*) as influenced by prey motility and environmental complexity. *Journal of Great Lakes Research* 28: 411–420, [http://dx.doi.org/10.1016/S0380-1330\(02\)70594-7](http://dx.doi.org/10.1016/S0380-1330(02)70594-7)
- Erős T, Sevcsik A, Tóth B (2005) Abundance and night-time habitat use patterns of Ponto-Caspian gobiid species (Pisces, Gobiidae) in the littoral zone of the River Danube, Hungary. *Journal of Applied Ichthyology* 21: 350–357, <http://dx.doi.org/10.1111/j.1439-0426.2005.00689.x>
- Francová K, Ondračková M, Polačik M, Jurajda P (2011) Parasite fauna of native and non-native populations of *Neogobius melanostomus* (Pallas, 1814) (Gobiidae) in the longitudinal profile of the Danube River. *Journal of Applied Ichthyology* 27: 879–886, <http://dx.doi.org/10.1111/j.1439-0426.2010.01582.x>
- Froese R, Pauly D (eds) (2011) FishBase. <http://www.fishbase.org> (accessed July 2011)
- Günther A (1861) Catalogue of the acanthopterygian fishes in the collection of the British Museum. Gobiidae, Discoboli, Pediculati, Blenniidae, Labyrinthici, Mugilidae, Notacanthi. London: British Museum 3: i-xxv 1-586 i-x
- Guti G, Erős T, Szalóky Z, Tóth B (2003) Round goby, *Neogobius melanostomus* (Pallas, 1811) in the Hungarian section of the Danube. *Halászat* 96 (3): 116–119
- Harka Á, Biró P (2007) New patterns in Danubian distribution of Ponto-Caspian gobies — a result of global climatic change and/or canalization? *Electronic Journal of Ichthyology* 1: 1–14
- Jurajda P, Černý J, Polačik, Valová z, Janáč M, Blažek R, Ondračková (2005) The recent distribution and abundance of non-native *Neogobius* fishes in the Slovak section of the River Danube. *Journal of Applied Ichthyology* 21: 319–323, <http://dx.doi.org/10.1111/j.1439-0426.2005.00688.x>
- Kottelat M, Freyhof J (2007) Handbook of European freshwater fishes. Publications Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany, 646 pp
- Kulikova NI, VN Fandeeva (1975) On intermittent spawning of the round goby (*Gobius melanostomus* Pallas) from the Azov Sea. *Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Morskogo Rybnogo Khozyaystva I Okeanografii* 96: 18–27
- L'avrinčikova M, Kováč V (2007) Invasive round goby *Neogobius melanostomus* from the Danube mature at small size. *Journal of Applied Ichthyology* 23(3): 276–278, <http://dx.doi.org/10.1111/j.1439-0426.2007.00851.x>

- L'avrinčikova M, Kováč V, Katina S (2005) Ontogenic variability in external morphology of round goby *Neogobius melanostomus* from Middle Danube, Slovakia. *Journal of Applied Ichthyology* 21: 328–334, <http://dx.doi.org/10.1111/j.1439-0426.2005.00677.x>
- Lenhardt M, Markovic G, Hegedis A, Maletin S, Cirkovic M, Markovic Z (2010) Non native and translocated fish species in Serbia and their impact on the native ichthyofauna. *Reviews in Fish Biology and Fisheries* 21(3): 407–421, <http://dx.doi.org/10.1007/s11160-010-9180-8>
- Lusk S, Lusková V, Hanel L (2010) alien fish species in the Czech Republic and their impact on the native fish fauna. *Folia Zoologica* 59 (1): 57–72
- Moiseyeva EB (1983) The development of the gonads of the round goby, *Neogobius melanostomus* (Gobiidae), during the embryonic period. *Voprosy Ikhtiologii* 23: 64–74
- Moiseyeva YB, Rudenko VI (1978) Spawning of round goby *Gobius melanostomus* Pallas in aquaria during winter. *Voprosy Ikhtiologii* 4: 777–779
- Mustafić P (2005) Indeks biotičkog integriteta riblje zajednice velikih rijeka Hrvatske. (Index of biotic integrity of the fish community in the large Croatian rivers). PhD Thesis, Faculty of Science, University of Zagreb, 185 pp
- Neilson ME, Stepien CA (2009) Escape from the Ponto-Caspian: Evolution and biogeography of an endemic goby species flock (Benthophilinae: Gobiidae: Teleostei). *Molecular Phylogenetics and Evolution* 52(1): 84–102, <http://dx.doi.org/10.1016/j.ympev.2008.12.023>
- Ojaveer H (2006) The round goby *Neogobius melanostomus* is colonising the NE Baltic Sea. *Aquatic Invasions* 1: 44–45, <http://dx.doi.org/10.3391/ai.2006.1.1.11>
- Ondračková M, Dávidová M, Pečínková, Blažek R, Gelnar M, Valová Z, Černý J, Jurajda P (2005) Metazoan parasites of *Neogobius* fishes in the Slovak section of the River Danube. *Journal of Applied Ichthyology* 21: 345–349, <http://dx.doi.org/10.1111/j.1439-0426.2005.00682.x>
- Pallas PS (1814) Zoographia Rossa-Asiatica, sistens omnium animalium in extenso Imperio Rossico et adjacentibus maribus observatorum recensionem, domicilia, mores, et descriptiones anatomem atque icones plurimorum. Vol. 3. Petropoli: Academia Scientiarum, 422 pp
- Piria M, Treer T, Tomljanović T, Šprem N, Matulić D, Aničić I, Safner R (2011) First record of monkey goby, *Neogobius fluviatilis* (Pallas, 1814) in the barbel zone of the Sava River, Croatia. *Journal of Applied Ichthyology* 27: 1383–1384, <http://dx.doi.org/10.1111/j.1439-0426.2011.01800.x>
- Polačik M, Janáč M, Jurajda P, Adamek Z, Ondrackova M, Trichkova T, Vassilev M (2009) Invasive gobies in the Danube: invasion success facilitated by availability and selection of superior food resources. *Ecology of Freshwater Fish* 18(4): 640–649, <http://dx.doi.org/10.1111/j.1600-0633.2009.00383.x>
- Polačik M, Janáč M, Trichkova T, Vassilev M, Keckeis H, Jurajda P (2008) The distribution and abundance of the *Neogobius* fishes in their native range (Bulgaria) with notes on the non-native range in the Danube River. *Large Rivers* 18 (1-2): 193–208
- Ricker WE (1975) Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada* 191: 382
- Sapota MR (2004) The round goby (*Neogobius melanostomus*) in the Gulf of Gdańsk – a species introduction into the Baltic Sea. *Hydrobiologia* 514: 219–224, <http://dx.doi.org/10.1023/B:hydr.0000018221.28439.ae>
- Simonović P, Valković B, Paunović M (1998) Round goby *Neogobius melanostomus*, a new Ponto-Caspian element for Yugoslavia. *Folia Zoologica* (Brno) 47(4): 305–312
- Simonović PD, Nikolic VP (1996) Freshwater fish of Serbia: an annotated check list with some faunistic and zoogeographical considerations. *Bios* (Macedonia, Greece) 4: 137–156
- Stammler KL, Corkum LD (2005) Assessment of fish size and intraspecific interactions in round gobies, *Neogobius melanostomus*. *Environmental Biology of Fishes* 73: 117–123, <http://dx.doi.org/10.1007/s10641-004-5562-x>
- Stráňai I, Andreji J (2004) The first report of round goby, *Neogobius melanostomus* (Pisces, Gobiidae) in the waters of Slovakia. *Folia Zoologica* 53(3): 335–338
- Tarkan AS, Gaygusuz Ö, Acipinar H, Gürsoy Ç, Özuluğ M (2006) Length-weight relationship of fishes from the Marmara region (NW-Turkey). *Journal of Applied Ichthyology* 22(4): 271–273, <http://dx.doi.org/10.1111/j.1439-0426.2006.00711.x>
- Višnjić-Jeftić Z, Hegediš M (2004) New data of the distribution of the gobies (gen. *Neogobius*, fam Gobiidae) in Serbian course of the Danube River. In: Proceedings of XI European Congress of Ichthyology, Tallin. Toomas Saat (ed), Abstract volume, Tallin, 5–9 September 2003, p. 76
- Wiesner C, Spolwind R, Waidbacher H, Guttman S, Doblinger A (2000) Erstnachweis der Schwatzmundgrundel *Neogobius melanostomus* (Pallas, 1814) in Österreich. *Österreichs Fischerei* 53: 330–331

Appendix 1. Records of round goby in the Danube River basin.

Record No.	Country	Location		Records coordinates	Record date	No. specimens	Reference		
		River	Point						
1	Serbia	Danube	Prahovo	861	44°18'38"	22°33'05"	1997	13	Simonović et al. 1998
2	Austria	Danube	Vienna	1917	48°10'06"	16°29'26"	2000	-	Wiesner et al. 2000
3	Serbia	Danube	Tekija-Banatska Palanka	956-1076	44°41'-44°49'	22°24'-21°20'	2001	-	Višnjić-Jeftić and Hegediš 2004
4	Hungary	Danube	Göd	1670	47°41'	19°07'	2001	4	Guti et al. 2003
5	Austria	Danube	Wolfsthal – Krems Hafen	1873-1999	48°08'34"-48°24'12"	17°01'16"-15°38'14"	2002	26	Wiesner 2005
6	Slovakia	Hron	-	0.82	47°49'	18°43'	2003	1	Stráňai and Andreji 2004
7	Slovakia	Danube	Štúrovo	1720	47°47'	18°43'	2003	3	Stráňai and Andreji 2004
8	Hungary	Danube	Budapest	-	47°49'	19°00'	2003	-	Harka and Biro 2007
9	Hungary	Danube	Göd- Dömös	1668-1708	47°41'-47°46'	19°07'-18°54'	2003	61	Guti et al. 2003
10	Slovakia	Danube	Gabčíkovo	1821	47°52'	17°32'	2003	7	Ondračková et al. 2005

First record of round goby in the Sava River

Appendix 1 (continued).

Record No.	Country	Location		Records coordinates			Record date	No. specimens	Reference
		River	Point	rkm	Latitude, N	Longitude, E			
11	Slovakia	Hron	-	0.50	47°49'	18°43'	2003		Adamek et al. 2007
12	Slovakia	Danube	Štúrovo	1720	47°47'	18°43'	2003	5	Adamek et al. 2007
13	Slovakia	Danube	Čunovo- Karloveské side arm	1851-1873	47°59'-48°08'	17°22'-17°03'	2003-2004	184	L'avrinčíkova et al. 2005
14	Croatia	Danube	Dalj	1355	45°28'58"	18 °59'20"	2004	1	Mustafić 2005
15	Slovakia	Danube	Chl'aba - Bratislava	1706 - 1873-	47°49'-48°08'	18°49'-17°06'	2004		Jurajda et al. 2005
16	Slovakia	Vah	Komárno - Kava	3 - 8	47°46'-47°48'	18°08'-18°03'	2004		Jurajda et al. 2005
17	Slovakia	Hron	Kamenice nad Hronom	6	47°49'	18°42'	2004	575	Jurajda et al. 2005
18	Slovakia	Ipel'	Chl'aba	3	47°49'	18°49'	2004		Jurajda et al. 2005
19	Hungary	Danube	-	-	46°10'-47°44'	18°55'-17°49'	2004	916	Erős et al. 2005
20	Slovakia	Danube	Čunovo	1845-1851	48°01'-47°59'	17°13'-17°22'	2004	33	Copp et al. 2008
21	Slovakia	Danube	Čunovo- Karloveské side arm	1851-1873	47°59'-48°08'	17°22'-17°03'	2004-2005	109	L'avrinčíkova and Kováč 2007
22	Croatia	Danube	Batina	1423	45°51'11"	18 °51'14"	2005	4	Polačik et al. 2008
23	Croatia	Danube	-	1327-1423	43°33'	18°55'	2005-2006	3	Francova et al. 2011
24	Austria	Danube	Vienna	1900 - 1902	48°21'	16°14'	2005-2006	40	Polačik et al. 2009
25	Czech Republic	Confluence Morava and Dyje	-	-	48°37'	16°56'	2008	-	Lusk et al. 2010
26	Croatia	Sava	Račinovci	207	44°51'15.3"	18°57'45.7"	2011	8	Present study
27	Croatia	Sava	Županja	261	45°04'27.6"	18°41'15.5"	2011	5	Present study
28	Croatia	Sava	Babina Greda	302	45°05'36.5"	18°32'18.5"	2011	21	Present study