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Research Article

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Influence of the Twilight Period and Different Sampling Methods on Catch of Gobiids (Gobiidae) at Four Locations in the Inshore Parts of the Danube River

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Abstract: The aim of this work was to compare the efficiency of two different methods for fish sampling and to assess the influence of the twilight period on the catch of gobiids along the Danube River in Serbia. The samplings were performed by electrofishing and beach seining in inshore parts of the Danube River with water depth up to 120 cm at four locations: Novi Sad, Belgrade, Tekija, and Prahovo, in October 2012 and September 2013. At each location, the samplings were performed at 17:30, 18:30, 19:30 and 20:30. Totally, 539 gobiids were caught. The highest number of specimens (218) was registered at Tekija, while lower numbers were registered at Belgrade (192) and Prahovo (117), and only 12 specimens were caught at Novi Sad. The catch of the round goby *Neogobius melanostomus* and monkey goby *Neogobius fluviatilis* was more efficient by beach seining than by electrofishing, whereas the catch of the tubenose goby *Proterorhinus semilunaris* was more efficient by electrofishing. Both methods had similar efficiency in catching the bighead goby *Ponticola kessleri* and racer goby *Babka gymnotrachelus*. The species diversity and number of the caught specimens were the highest at 18:30. All five species were recorded at Belgrade, Tekija and Prahovo, while only the monkey goby and racer goby were caught at Novi Sad. The methods used in this study showed good efficiency in catching gobiids, especially at dusk. Even though these methods are difficult to apply in certain habitats, they could be highly relevant in the regular monitoring of gobiids along the inshore parts of rivers.

Key words: Ponto-Caspian gobiids, the Danube River in Serbia, electrofishing, beach seining, influence of twilight period

Introduction

Five gobiids: the monkey goby, *Neogobius fluviatilis,* racer goby, *Babka gymnotrachelus,* bighead goby, *Ponticola kessleri,* round goby, *Neogobius melanostomus,* and tubenose goby, *Proterorhinus semilunaris*, have extended their geographical distribution outside their native range and expanded their area of distribution in Serbia along the rivers Danube, Tisza, Sava and Velika Morava, as well as the entire Danube River Basin. Certain species of gobiids also occur and invade other European rivers (Roche et al. 2013), as well as the inland waters of North America (Kornis et al. 2012).

The wide spectrum of features makes the Ponto-Caspian gobiids successful invasive species: aggressive behaviour, broad range of food, care for the brood, high tolerance to the environmental

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conditions (van Kessel et al. 2016). The rapid increase in the number of specimens in the new habitats may lead to competition for food and space with some native species and to changes in the ecological characteristics of the fish communities, especially in the food chains and trophic structures (Grabowska & Grabowski 2005, Poos et al. 2010).

Further research and understanding of the invasion effects from the Ponto-Caspian gobiids, along with monitoring the changes in inter- and intra-species relations, are important for resolving the issues related to the sampling of these fish in their habitats. The aim of this work was to compare the efficiency of two different methods for fish sampling, as well as the influence of the twilight period on the catch of gobiids along the Danube River in Serbia.

Materials and Methods

Study sites

The samplings were performed at four locations in the Serbian part of the Danube River: Novi Sad (1257 river km), Belgrade (1173 river km), Tekija (956 river km), and Prahovo (862 river km) (Fig. 1). The sampling locations were characterised by the following substrate types: sand at Novi Sad and Belgrade, gravel at Tekija and gravel and rocks at Prahovo.

Sampling

The samplings were performed by electrofishing and beach seining in the inshore parts of the Danube River, with water depth up to 120 cm, from 23 till 26 September and from 8 till 11 October, in 2012 and 2013. At each location, the samplings were performed at 17:30, 18:30, 19:30 and 20:30. Depending on location and substrate, stretches with different length were sampled: 40-55 m with beach seining and 75-120 m with electrofishing. The length of the stretches was 40 m for the beach seining and 120 m for electrofishing at Novi Sad and Belgrade; 55 m for beach seining and 80 m for electrofishing at Tekija; and 55 m for beach seining and 75 m for electrofishing at Prahovo. All surveys were performed by the same equipment, method and sampling team. Catch Per Unit Effort – CPUE (i.e. catch per 100 m of shore) was calculated for each sampling location.

The fish captured were processed quickly in situ, the individuals were identified to species level, counted, and their total length measured to the nearest 1 mm.

Results

Totally, 539 specimens of the five gobiid species (*N. fluviatilis, N. melanostomus, B. gymnotrachelus, P. kessleri* and *P. semilunaris*) were caught.

Fig. 1. Study area

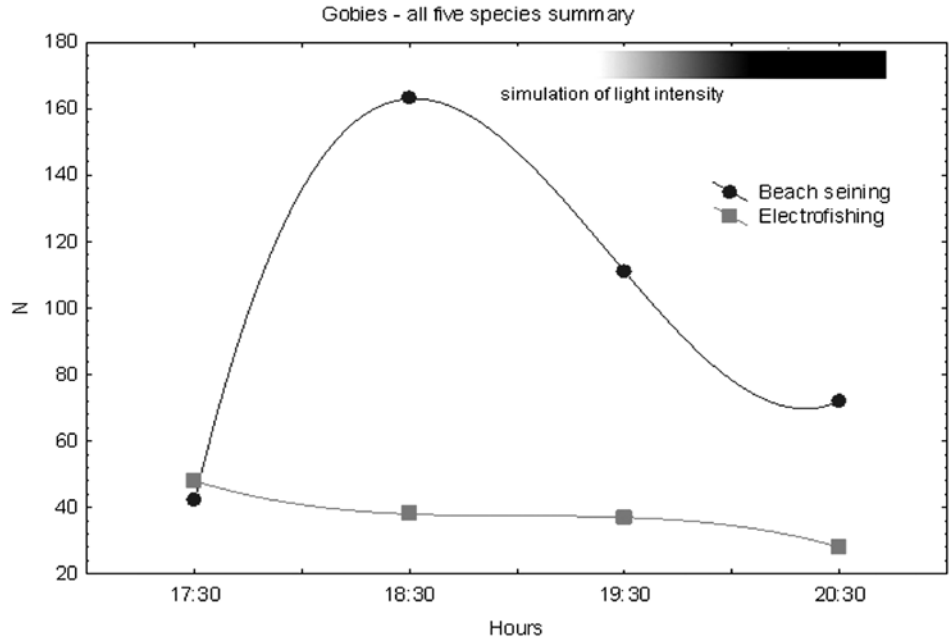

Fig. 2. Summarised catches of five gobiid species at four locations in the Danube River in Serbia, depending on the time of sampling. N – number of specimens

The total length of *N. fluviatilis* was in the range of 28-133 mm, of *N. melanostomus* – from 27 to 58 mm, of *B. gymnotrachelus* – from 45 to 63 mm, of *P. kessleri* from 55 to 162 mm, and of *P. semilunaris* – from 22 to 42 mm. The highest number of specimens (218) was registered at Tekija, while this number was lower at Belgrade (192) and Prahovo (117), and only 12 specimens were caught at Novi Sad. The catch of the round goby and monkey goby was more efficient by beach seining than by electrofishing, while the catch of the tubenose goby was more efficient by electrofishing (Table 1). Both methods showed similar efficiency in catching the bighead goby and racer goby. The species diversity and number of the caught specimens were the highest at 18:30. All five species were recorded at localities Belgrade, Tekija and Prahovo, whereas only the monkey goby and racer goby were caught at Novi Sad.

Figure 2 presents the summarized catches at the four locations for all five gobiid species, depending on the time of sampling. Approximate simulation of light intensity is presented.

There is a noticeable difference in the efficiency of the two different methods of sampling. The electrofishing provided a catch that was significantly smaller in the number of the registered gobiid specimens compared with the beach seining. The lower number of the specimens obtained by the electrofishing (Fig. 2) could be explained by the harder perception of individuals in the conditions of lower intensity of the day-light. On the contrary, the beach seining was not related to the intensity of the day-light. The significant increase in the number of individuals in the twilight period from 18:30 to 19:30 may be assotiated with the local interhabitat migration of the gobiids from the daily shelters and deeper parts of the river to the shallow water, probably connected with feeding.

Discussion

A considerable number of studies in Europe and in the USA and Canada (e.g. Charlebois et al. 2001, Vanderploeg et al. 2002, Phillips et al. 2003, Kornis et al. 2012, Gallardo & Aldridge 2013, Jakšić et al. 2016, Piria et al. 2016), deal with the effects of the introduction of certain gobiid species into local fish communities and ecosystems. A detailed study of these effects requires primarily selection of an appropriate sampling method to determine accurately the population characteristics of certain gobiid species. This selection is also very important in monitoring the invasiveness of gobiid populations.

The gobiids are fish that can be sampled with all standard methods: by electrofishing, gill nets, fyke nets, different types of traps, seining, etc. However, due to the specific way of life of gobiids and certain environmental characteristics, some methods are more

Table 1. The abundance (CPUE) of five gobiids at four locations along the Serbian part of the Danube River caught by beach seining (N) and by electrofishing (E)

Species	Hours	17.30		18.30		19.30		20.30		Total		
	Method / Locality	N	E	N	E	N	E	N	E	N	E	N+E
Monkey goby *Neogobius fluviatilis*	Novi Sad	15		7.5		2.5	0.8			25.0	0.8	25.8
	Belgrade	42.5		237.5	6.7	87.5	2.5	52.5	3.3	420.0	12.5	432.5
	Tekija	14.5	20	27.3	10	65.5	2.5	23.6	2.5	130.9	35.0	165.9
	Prahovo			7.3	5.3	5.5	1.3	1.8	2.7	14.5	9.3	23.8
Round goby *Neogobius melanostomus*	Belgrade			7.5			0.8			7.5	0.8	8.3
	Tekija	7.3	21.3	12.7	1.3	34.5	7.5	32.7	3.8	87.3	33.8	121.1
	Prahovo	5.5	5.3	49.1	4.0	16.4	12.0	18.2	9.3	89.1	30.7	119.8
Bighead goby *Ponticola kessleri*	Belgrade	2.5								2.5		2.5
	Tekija		2.5	3.6	3.8	5.5	1.3		3.8	9.1	11.3	20.4
	Prahovo	3.6		1.8	4.0	1.8	1.3	1.8	2.7	9.1	8.0	17.1
Racer goby *Babka gymnotrachelus*	Novi Sad							2.5		2.5		2.5
	Belgrade					2.5		5		7.5		7.5
	Tekija		7.5	5.5	1.3	5.5	7.5	7.3	1.3	18.2	17.5	35.7
	Prahovo			3.6			0.0	1.8	5.3	5.5	5.3	10.8
Tubenose goby *Proterorhinus semilunaris*	Belgrade	2.5								2.5		2.5
	Tekija		3.8		2.5						6.3	6.3
	Prahovo			1.8	6.7		8.0			1.8	14.7	16.5
Total $n_{tot} = 2038$	*N.f.*	72	20	279.6	22	161	7.1	77.9	8.5	590.4	57.6	648
	N.m.	12.8	26.6	69.3	5.3	50.9	20.3	50.9	13.1	183.9	65.3	249.2
	P.k.	6.1	2.5	5.4	7.8	7.3	2.6	1.8	6.5	20.7	19.3	40
	B.g.	0	7.5	9.1	1.3	8	7.5	16.6	6.6	33.7	22.8	56.5
	P.s.	2.5	3.8	1.8	9.2		8			4.3	21	25.3
										1666	372	2038

suitable and preferable. Thus, for example, Johnson et al. (2005), in the Western Lake Erie, preferred collection of the data about gobiids by angling (by hooks baited with dew worms) from four different dominant substrates (sand, mud, rock, and silt), direct observation (by certified SCUBA diving) and underwater video (remote-operated, underwater colour video system). The efficiency of underwater video is evaluated as 'good' but the method is expensive in comparison with the relatively cheap angling. On the contrary, the different traps and samplers are inexpensive, but their effectiveness is evaluated as 'extremely low'.

Ruetz et al. (2007) studied the fish communities, among which invasive gobiids, in littoral habitats. The authors stated that the most complete results about the species composition and size structure of the fish are obtained by combining electrofishing and small-mesh fyke nets. Polačik et al. (2008) revealed that beach seining and electrofishing are efiicient in catching of gobiids. The same authors stated that *N. fluviatilis* and *N. melanostomus* are caught in the highest abundance by beach seining, which is in accordance with the results obtained in this work. Comparing six methods: seine nets, boat electrofishers, hoop nets, Windermere traps, trap nets, and minnow traps, to study the diversity of fish in the coastal zone of the Detroit River, Lapointe & Corkum (2006) achieved the most complete results by using beach seining. Our results confirm the findings of Lapointe & Corkum (2006), who assumed that with the increase in the sample it is more probably to find more gobiid species, taking the size of the sample as a measure of success.

According to our results, the most numerous samples collected by beach seining were between 18:30 to 19:30 (Fig. 2), which clearly implies that for such a sampling it is very important to define what time of the day it will be done. The electrofishing on gobiids in the Danube River in Hungary is more effective during the night according to Erős et al. (2005). However, Grabowska & Grabowski (2005) found that for the racer goby the period of the highest feeding activity is between 00:00 to

04:00. This indicates that periods of the day-night cycle should be studied considering the single species activity and their catchability with a seine net.

In addition to the time of the day, further restrictions of fishing by seine net relates to the physical characteristics of the habitats. The deeper water and obstacles at the bottom, such as rocks, submerged trees, and aquatic vegetation prevent the efficient use. Seine nets could be successfully applied at depths of 0.3 to 1.5 m and on the bottoms dominated by sand, silt shallow and/or gravel.

In our research, the total number of the individuals from different species caught by electrofishing ranged from 51 in the afternoon to 15 in the night (Fig. 2). This decline in numbers was rather caused by the poorer visibility of the individuals than by decrease in their activity at the time when the samples were taken. Our results in electrofishing correspond, both in terms of size and structure of catches, to the findings of Jakovlić et al. (2015) who investigated the distribution and abundance of Ponto-Caspian gobiids at 23 locations in the Sava River and some tributaries in Croatia. According to that publication, the dominant species were the monkey and round goby, while the bighead goby was recorded in significantly smaller numbers, and the racer goby and tubenose were not registered.

We can conclude that the beach seining is the better and more efficient method than electrofishing for sampling Ponto-Caspian gobiids in shallow coastal sandy-muddy-gravel habitats in large rivers. A favorable period for sampling is at the sunset, between 18:00 and 20:00.

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