

Fish assemblage of the artificial flood protection channel Kupa-Kupa

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Abstract

The objective of this paper is to determine the qualitative and quantitative composition of the fish community, and distribution of native and non-native fishes in the channel Kupa-Kupa. Fish community of the channel Kupa-Kupa was analyzed from September 2017 to September 2019. At eight different locations, 23 species from eight families were found. The dominant species was European bitterling *Rhodeus amarus* which takes up 32.83% of total number of fish caught, while the least represented is Asp *Leuciscus aspius* with one individual. During this research, one endemic fish species was found, as well as two invasive alien species (IAS). Non-native species hold a significant share in the fish community of the channel Kupa-Kupa.

Keywords: fish community, channel Kupa-Kupa, endemic species, non-native species

Introduction

Fishes are appropriate indicators of trends in aquatic biodiversity because their enormous variety reflects a wide range of environmental conditions (Moyle et al., 1992). Fresh waters are experiencing declines in biodiversity far greater than those in the most affected terrestrial ecosystems (Dudgeon et al., 2006). Anthropogenic impacts such as flow regulation, channelization, and bank stabilization, eliminate upstream-downstream linkages and isolate river channels from riparian/floodplain systems and contiguous groundwater aquifers (Ward, 1998). Floods lead to increased resource availability (e.g., food and shelter), with positive effects on the development of the initial stages of fish and on the maintenance of high levels of species diversity (Agostinho et al., 2004a, 2007), allows species dispersal across several plain environments (Thomaz et al., 2007). The life cycle of a fish species, especially its reproduction, depends on the hydrological regime (Vasconcelos et al., 2014). Annual variation in the hydrograph affects species with distinct life history strategies differently, and influences the composition and structure of fish assemblages. Large floods were associated with higher species richness (Agostinho et al., 2004b). Human activities usually shift the balance among fish species, causing the extirpation of many indigenous species and the dominance of a reduced set of often introduced fish species (Balirwa et al., 2003). Croatian freshwater ichthyofauna has been previously researched (Čaleta et al., 2019), as well as the ichthyofauna of one location on the lower course of the Kupa River (Delić et al., 2014). Previous papers on the composition of ichthyofauna in the channel Kupa-Kupa are unknown. The objective of this paper is to determine the qualitative and quantitative composition of the fish community, and distribution of native and non-native fishes in the channel Kupa-Kupa.

Materials and methods

Study area

The beginning of the drainage section of the channel Kupa-Kupa is located on the near vicinity of Karlovac, it was built in 1984 (Mujić, 2016) to protect the area from floods and it is 21.8 km long (Hrvatske vode, 2014). It connects the middle and the lower course of the Kupa River from Mahično to Donja Kupčina. Fishponds Kupa, Crna mlaka

and lake Šumbar are located along the flood channel, and fishpond Pisarovina downstream of the channel. The bottom of the channel varies in substrate. In the very beginning near Mahično the bottom is made of concrete without sediment residue, while in its central part it is muddy. The final third of the channel has a rocky bottom with smaller size rocks. The channel margins are without vegetation and are regularly mowed. Riparian vegetation was found along most of the channel during the two years of research. The vegetation of the bed channel includes common reed, sedge, water lilies and coontails. The regime of floods in the channel Kupa-Kupa is most intense in spring and autumn. The channel is also used for sport fishing purposes.

Fishing samplings

Ichthyofauna samples were collected 11 times, from August 2017 to August 2019, from eight different locations in the channel Kupa-Kupa. The samples from three locations were collected twice (Mahično, mouth of the Bukovac creek and the blue bridge in Rečica), while the samples from other locations were collected once. In result analysis, the results from the locations sampled twice were not summed, but calculated individually for each electrofishing. The sampling locations were marked according to UTM coordinates (WGS84) and were named after the nearest place according to the map: No.1) 45°32'45"N, 15°31'55"E-Mahično, No.2) 45°32'33"N, 15°34'11"E-Topolovka, No.3) 45°32'37"N, 15°35'27"E-Bugarski vrt, No.4) 45°32'44"N, 15°38'23"E-mouth of the Bukovac creek, No.5) 45°32'39"N, 15°39'43"E-blue bridge in Rečica, No.6) 45°32'31"N, 15°42'07"E -Čadinjak, No.7) 45°32'25"N, 15°43'53"E-Dubrave, No.8) 45°31'52"N, 15°47'21"E-mouth of the Kupčina River (Figure 1).



Figure 1. Map of the channel Kupa-Kupa with sampling locations

The samples were collected with a Hans-Grassl IG600 electrofishing device, with a maximum power of 650W of direct current and 1200W of pulsating electric current. The length of the transect of each location was 100 m. The width of the water column channel at sampling sites varied. The maximum width of the sampling channel was at locations No.1) and No.5), where the sampling width was 25 m. In the narrowest part of the channel sampling, the width was 3m, at location No.2). Samplings are done throughout the channel width at all sampling locations. After collecting the samples, the species were determined according to Kottelat and Freyhof (2007) determination key. The determined individuals were classified according to family and origin. The composition of fish community was calculated as a percentage of each species in the total number of fish caught in all fish species. All individuals were placed in an aerated tank with a capacity of 1 hL and transported to JU Aquatika -freshwater aquarium Karlovac for the purpose of the exhibition. MS EXCEL 2016 was used for data analysis.

Results and discussion

In total, 3 567 individuals were collected at eight locations on the channel Kupa-Kupa, from Mahično to Donja Kupčina. Fish from the Cyprinidae family are most numerous in the ichthyofauna of the channel Kupa-Kupa, with 14 species and relative abundance of 79.22% (Figure 2a). From eight families 23 species were identified (Table 1.). The most numerous species were European bitterling *Rhodeus amarus* with 1 171 individuals, followed by Bleak *Alburnus alburnus* with 696 individuals, and the least numerous is Asp *Leuciscus aspius* with one individual.

Table 1. Qualitative and quantitative composition of the fish community of the channel Kupa-Kupa

Taxon	%	Biogeographical status
Cyprinidae		
Bleak <i>Alburnus alburnus</i> (Linnaeus, 1758)	19.51	Native
Asp <i>Leuciscus aspius</i> (Linnaeus, 1758)	0.03	Native
White bream <i>Blicca bjoerkna</i> (Linnaeus, 1758)	0.45	Native
Prussian carp <i>Carassius gibelio</i> (Bloch, 1782)	9.08	Non-native
Common nase <i>Chondrostoma nasus</i> (Linnaeus, 1758)	0.14	Native
Carp <i>Cyprinus carpio</i> Linnaeus, 1758	0.28	Native
Danube gudgeon <i>Gobio obtusirostris</i> Valenciennes, 1842	0.90	Native
Pseudorasbora <i>Pseudorasbora parva</i> (Temminck & Schlegel, 1846)	7.71	IAS (EU)
European bitterling <i>Rhodeus amarus</i> (Bloch, 1782)	32.83	Native
Roach <i>Rutilus rutilus</i> (Linnaeus, 1758)	1.99	Native
Rudd <i>Scardinius erythrophthalmus</i> (Linnaeus, 1758)	0.28	Native
Chub <i>Squalius cephalus</i> (Bonaparte, 1837)	5.21	Native
Tench <i>Tinca tinca</i> (Linnaeus, 1758)	0.59	Native
Vimba bream <i>Vimba vimba</i> (Linnaeus, 1758)	0.20	Native
Cobitidae		
Balkan spined loach <i>Cobitis elongata</i> Heckel & Kner, 1858	0.31	Endemic
Danubian spined loach <i>Cobitis elongatoides</i> Băcescu & Mayer, 1969	8.19	Native
Balkan golden loach <i>Sabanejewia balcanica</i> (Karaman, 1922)	0.11	Native
Centrarchidae		
Pumpkinseed <i>Lepomis gibbosus</i> (Linnaeus, 1758)	6.06	IAS (EU)
Esocidae		
Pike <i>Esox lucius</i> Linnaeus, 1758	1.96	Native
Percidae		
Perch <i>Perca fluviatilis</i> Linnaeus, 1758	1.46	Native
Gobiidae		
Pontian monkey goby <i>Neogobius fluviatilis</i> (Pallas, 1814)	1.43	Non-native
Ictaluridae		
Black bullhead <i>Ameiurus melas</i> (Rafinesque, 1820)	0.93	Non-native
Siluridae		
Catfish <i>Silurus glanis</i> Linnaeus, 1758	0.34	Native

When these results are compared to previous research of the lower course of the Kupa River (Delić et al., 2014), in the channel Kupa-Kupa was recorded six fish species less. Except for Black bullhead *Ameiurus melas*, all other species recorded in the channel Kupa-Kupa were also found in the lower course of the Kupa River (Delić et al., 2014). The Cobitidae family is represented by three species from two genera, including Balkan spined loach *Cobitis elongata* which is an endemic species of the Danube River Basin (Čaleta et al., 2015). This species was found at four locations marked by numbers 1), 5), 6), and 7). Danubian spined loach *Cobitis elongatoides* is the most represented species from this family, and these results are in accordance with previous research of the lower course of the Kupa River

(Delić et al., 2009). At the location No. 5) *C. elongatoides* is the dominant species, and in two samplings conducted at the same location on February 20, 2019 and March 15, 2019 this species took up a relative density of 50% and 66% of the entire fish community. The least represented species from this family is Balkan golden loach *Sabanejewia balcanica* found only at the location No. 5), with only four individuals. All the species from this family were also found in previous research of the lower course of the Kupa River (Delić et al., 2014). It was observed that in colder periods of the year individuals from this species prefer the central part of the channel, while in warmer periods of the year from March to late September most of the population of this family tends to reside in the zone of the riparian vegetation. This type of behaviour could be possible connected with undetermined fractional spawning of this species (Lodi and Malacarne, 1990), and the males from the *Cobitis* genus follow the females into the thick vegetation during spawning season (Bohlen, 2008). Other fish families were represented by one species.

In this research out of the 23 species of fish, 18 species are native, while according to the latest Croatian freshwater fish checklist (Čaleta et al., 2019), Prussian carp *Carassius gibelio*, Pseudorasbora *Pseudorasbora parva*, Pumpkinseed *Lepomis gibbosus*, Pontian monkey goby *Neogobius fluviatilis* and *A. melas* are non-native species. The total number of non-native species is 25,2% of the total number of all species caught in the channel Kupa-Kupa. Species *P. parva* and *L. gibbosus* are on the EU invasive species list (EU 2016/1141, EU 2019/1262) and according to the results of this research, they take up more than 50% of the population of non-native species and 13.8% of the entire fish community of the channel Kupa-Kupa (Figure 2b).

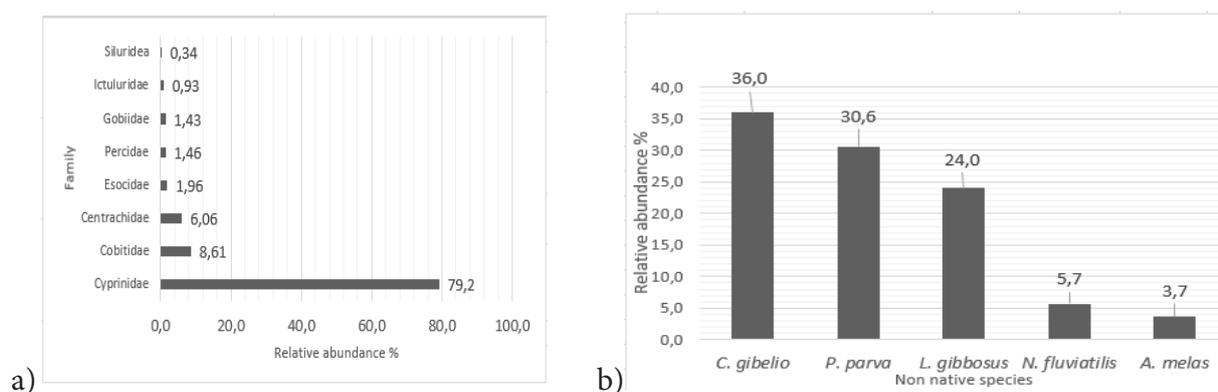


Figure 2. Relative abundance of species with respect to family a), and relative abundance of each non-native species out of the entire population of non-native fish in the channel Kupa-Kupa b)

Among the non-native species, the most represented one is *C. gibelio*, found in all locations, while *N. fluviatilis* inhabits the channel from the location No. 4) to the end of the channel in all locations explored. According to the Jakovlić et al. (2015), the westernmost area of *N. fluviatilis* is in the Korana River in Karlovac and the Kupčina River, approximately two km to the west of location No. 4). The spreading of *N. fluviatilis* to the Kupčina River from the Kupa River was most likely made possible by the channel Kupa-Kupa, because the Kupčina River does not have direct contact with the Kupa River or the Sava River where *N. fluviatilis* was found (Jakovlić et al, 2015). The results of this research confirm the distribution and habitat of *N. fluviatilis* from the location No. 8), to the location No. 4), or less than 9 km from the place where the middle course of the Kupa River flows into the beginning of the channel near Mahično. *A. melas* has the smallest population out of the non-native species, it was recorded only at locations No. 1) and 8). Periodic oscillations were found at the same location in the diversity of species, but also in the abundance of individuals.

Conclusion

Even though it connects the middle and the lower course of the Kupa River, according to its species of ichthyofauna the channel Kupa-Kupa belongs to the lower course of the Kupa River. The ichthyofauna of the channel Kupa-Kupa is richest in species from the Cyprinidae family, and it is also habitat for the endemic species *C. elongata*. Non-native species hold a significant share in the fish community of the channel Kupa-Kupa.

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Sastav riblje zajednice rasteretnog poplavnog kanala Kupa-Kupa

Sažetak

Cilj ovoga rada je utvrditi kvalitativni i kvantitativni sastav ihtiocenoze, te rasprostranjenost autohtonih i alohtonih vrsta riba u kanalu Kupa-Kupa. Analiziran je sastav riblje zajednice od rujna 2017. do rujna 2019., na osam različitih lokacija utvrđeno je 23 vrste riba iz osam porodica. Gavčica *Rhodeus amarus* s 32,83 % od ukupnog broja svih ulovljenih jedinki čini dominantnu vrstu, dok je najmanje zastupljena vrsta bolen *Leuciscus aspius* s jednom ulovljenom jedinkom. Tijekom ovoga istraživanja zabilježena je i jedna endemska vrsta, kao i dvije invazivne strane vrste (IAS). Rezultati ovoga rada pokazuju značajan udio alohtonih vrsta riba u ihtiocenozi kanala Kupa-Kupa.

Ključne riječi: ihtiocenoza, kanala Kupa-Kupa, endemska vrsta, alohtone vrste