INTRODUCED (NON-NATIVE) FISH SPECIES IN CENTRAL SERBIAN RESERVOIRS

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INTRODUKOVANE RIBLJE VRSTE AKUMULACIJA CENTRALNE SRBIJE

Prošireni abstrakt

U ihtiofauni Republike Srbije je registrovano prisustvo 23 introdukovane (alohthone) vrste iz 11 porodica. Načini i razlozi introdukcija su različiti – akvakulturno gajenje, spontano širenje areala, borba protiv preteranog razvoja makrofita, sportski ribolov i drugi. Posledice introdukcija se, uglavnom, mogu oceniti kao negativne – ugrožavanje autohtone ihtiofaune usled kompeticije za hranu, mrest, unos novih parazita i drugi neželjeni efekti.

Većina naseljava Dunav i neposredne pritoke. Međutim, pojedine vrste su ispoljile visok stepen aklimatizacije na specifične uslove akumulacija i postale su značajni članovi ribljih zajednica.

Hidrografsku mrežu Republike Srbije karakteriše postojanje oko 150 akumulacija različitih namena (vodosnabdevanje, proizvodnja električne energije, melioracija, odbrana od poplava, sportovi na vodi i turizam, ribolov.....). Lociranost u različitim regionima uslovljava varijabilnost ekoloških uslova i diverzitet ihtiofauna.

U radu je dat osvrt na ulogu alohtonih vrsta u ihtiofauni tri akumulacije u slivu Zapadne Morave - Međuvršje na reci Zapadnoj Moravi, Gruža na reci Gruži i Ćelije na reci Rasini. Sve tri akumulacije karakteriše intenzivna eutrofikacija.

Rezultati ihtioloških istraživanja ukazuju na izrazito ciprinidan karakter analiziranih akumulacija. Akumulaciju Međuvršje naseljava 21 vrsta iz 7 porodica (Cyprinidae predstavljaju 90.64% brojnosti i 75.63% biomase), akumulaciju Gruža 19 vrsta iz 6 porodica (Cyprinidae su 80.94% brojnosti, 74.28% biomase) i akumulaciju Ćelije 16 vrsta iz 5 porodica (Cyprinidae su 77.5% brojnosti, 74.5% biomase). Među registrovanim ribljim vrstama, za vodotoke Srbije alohtone su *Carassius gibelio*, *Ctenopharyngodon idella*, *Hypophthalmichtys molitrix*, *Pseudorasbora parva*, *Lepomis gibbosus* i vrste roda *Ameiurus* (*A. nebulosus* i *A. melas*).

Srebrni karaš, babuška (*Carassius gibelio* Bloch 1782) je nakon II svetskog rata unet u vodotoke evropskog dela tadašnjeg SSSR, iz kojih u vodotoke širom Evrope (Holčik, 1991). Od prvog registrovanja u Srbiji, 60-ih godina prošlog veka, evidentirano

je širenje areala i ekspanzija populacione brojnosti u većini akumulacija Srbije. Vrsta preferira pliće vodotoke muljevitog dna, obrasle makrofitskom vegetacijom, sa razvijenim zajednicama planktonskih organizama i makrozoobentosom. Karakteriše je visoka tolerancija na promenljive ekološke uslove, širok trofički spektar i visoka plodnost.

Srebrni karaš je unet u sve tri akumulacije prikom poribljavanja kvalitetnijim vrsta riba, prvenstveno šaranom i somom. Vrsta je pokazala izuzetnu adaptibilnost, što potvrđuje činjenica da je dominantna u analiziranim ekosistemima sa tendencijom hiperprodukcije (posebno u akumulaciji Gruža).

Poznato je da su u populacijama srebrnog karaša koje naseljavaju pojedine ekosisteme nalažene samo ženke (partenogenetsko razmnožavanje). Prisustvo mužjaka ukazuje na mali stepen predatorstva i konkurencije u ishrani (Glaser, 1985). Registrovan je nalaz mužjaka u sve tri analizirane akumulacije. U akumulaciji Međuvršje brojčani odnos ženke : mužjaci iznosi 2.58 : 1, u akumulaciji Gruža 1.63 : 1 (Simović, 2001). Ova činjenica je još jedna potvrda povoljnih uslova za životnu aktivnost vrste u biotopima akumulacija.

Najintenzivniji tempo dužinskog rasta srebrni karaš ostvaruje u akumulaciji Gruža. Opšti ekološki uslovi (mala dubina, termika, visok organski produktivitet i drugi) favorizuju ovaj ekosistem. Omasovljenje vrste u analiziranim akumulacijama negativno utiče na autohtonu ihtiofaunu zbog konkurentskih odnosa sa komercijalno značajnijim ribama, prvenstveno šaranom. Bentofag način ishrane srebrnog karaša može usloviti mobilizaciju teških metala i drugih polutanata iz jezerskog sedimenta i pogoršati kvalitet vode akumulacija koje se koriste za vodosnabdevanje - akumulacije Gruža i Ćelije (Marković i Ivić, 2009).

Amur (*Ctenopharyngodon idella* Vallenciennes 1844) je introdukovan u veći broj akumulacija i kanala Srbije radi suzbijanja makrofitske vegetacije i njom izazvane eutrofikacije (Maletin et al., 1997; 2005). Brojčano prisustvo vrste u analiziranim akumulacijama je neznatno (izuzev u akumulaciji Ćelije). Omasovljenje amura može prouzrokovati smanjenje površina obraslim vodenim biljem na kojima se mreste šaran, linjak, deverika i druge autohtone fitofilne vrste (Janković, 1998). Kao biljojedu vrstu karakteriše je mala iskorišćenost unete hrane tako da deo unetog biljnog materijala biva nesvaren i može usloviti zagađenje vodotoka (Mitrović-Tutundžić i sar., 1996).

Beli tolstolobik (*Hypophthalmichthys molitrix* Valenciennes 1844) je planktofaga vrsta uneta zajedno sa *C.idella* u akumulacije Gruža i Ćelije. Retki nalazi ukazuju na mali uticaj na uspostavljene ekosistemske odnose.

Amurski čebačok, neriba (*Pseudorasbora parva* Temnick and Schlegel 1846) predstavlja invazivnu vrstu koja od prvog registrovanja u Srbiji (1978. godine) ispoljava tendenciju eksplozivnog proširenja areala (Cakić et al., 2004). Nema nikakvog ekonomskog značaja. Zbog kompetitivnih odnosa sa autohtonim vrstama, može pogoršati stanje lokalnih ihtiofauna. U analiziranim akumulacijama pokazuje velike fluktuacije brojnosti, sa tendencijom omasovljenja (posebno izražene u akumulaciji Ćelije).

Sunčica (*Lepomis gibbosus* Linnaeus 1758) ima severnoameričko poreklo. Karakteriše je širok trofički spektar u kome su prisutni, pored faune dna, riblja mlađ i ikra. Pokazuje velike oscilacije u populacionoj brojnosti, posebno ispoljene u akumulaciji Gruža. Poslednjih godina je primećeno opadanje brojnosti u akumulaciji Ćelije - moguća posledica omasovljenja predatorskih vrsta, prvenstveno smuđa.

Američki somići, cverglani (*Ameiurus nebulosus* Lesueur 1819) i **(*Ameiurus melas* Rafinesque 1820)** su vrste severnoameričkog porekla koje se hrane faunom dna, ribljom mlađi i ikrom što može imati negativan uticaj na autohtone ihtiofaune. Prime-

ćena je tendencija omasovljenja u akumulacijama Međuvršje i Gruža. Iako se njihovo prisutvo u šaranskim ribnjacima tretira kao neželjeno, poseduju određena gastronomska svojstva - vrsta *A.melas* se gaji u jednom ribnjaku (Lenhardt et al., 2010).

Najveću ekspanziju populacione brojnosti u ihtiofaunama analiziranih akumulacija ispoljava srebrni karaš *(C.gibelio)*. Vrsta je dominantna sa tendencijom hiperprodukcije (posebno u akumulaciji Gruža). Omasovljenje ove invazivne vrste, kao i prisustvo drugih, ugrožava autohtonu ihtiofaunu i remeti uspostavljene ekološke ravnoteže.

Ključne reči: *alohtone vrste, ihtiofauna, akumulacije, Centralna Srbija*

INTRODUCTION

The ichthyofauna of the Republic of Serbia includes 23 allochthonous (non-native) species belonging to 11 families (Simonović et al.,2010; Lenhardt et al., 2010). Methods of and reasons for fish introductions are diverse – aquaculture, spontaneous range expansion, struggle against excessive macrophyte growth, recreational fishing etc. The consequences of fish introductions tend to be negative - endangerment of native fish species due to competition over food, spawning, introduction of new parasites, and other undesirable effects.

Most non-native species dwell in the Danube and its immediate tributaries. However, some species have exhibited a high degree of acclimation to specific environmental conditions thus becoming important members of fish communities in the reservoirs.

The hydrographic network of the Republic of Serbia comprises about 150 reservoirs used for a variety of purposes (water supply, electrical energy production, land improvement, flood prevention, sports, tourism, recreational fishing). Reservoir locations within different regions involve variability of environmental conditions and ichthyofauna diversity. In addition to very large reservoirs that have a huge impact on the overall economic development of the country, such as Djerdap I-Iron Gates I (area: 235 km^2) and Djerdap II - Iron Gates II (area: 92 km^2), high importance in terms of human populations is also given to medium- and small-sized reservoirs. Such reservoirs in Central Serbia include the following reservoirs in the Zapadna Morava river basin – Međuvršje on the Zapadna Morava River, Gruža on the Gruža River and Ćelije on the Rasina River (Fig. 1).

Figure 1. Locations of the reservoirs analysed: 1 - Međuvršje; 2 - Gruža; 3 – Ćelije

The Međuvršje reservoir is among the oldest reservoirs in Serbia built in 1953 by a 31 m high dam for the purpose of electric power generation. The reservoir is 1.5 km^2 in area and 15.4 x 10^6 m^3 in volume. During more than half a century of its existence, the ecosystem has undergone large changes, primarily reflected in reservoir sedimentation (more than 70% of the original volume) and pronounced eutrophication (Lenhardt et al., 2009).

The Gruža reservoir was created in 1984 to supply water to the City of Kragujevac and surrounding areas. The lake ecosystem (9.34 km^2 in area and 64 x 10^6 m^3 in volume) located in the rural area is characterised by high organic productivity and occasional deterioration of water quality (Ostojić et al., 2007). Nevertheless, the Gruža reservoir biotope is extremely favourable for the development of different hydrobiont communities and high fish fauna production (Marković et al., 2007).

The Ćelije reservoir was formed in 1979 for the original purpose of flood control and land improvement. Since 1984, it has been used for the water supply of Kruševac and surrounding areas. The reservoir (3.35 km^2 in area and 41.1 x 10^6 m^3 in volume) has been affected by torrential watercourses (which cause biotope sedimentation) and municipal wastewaters discharged by communities upstream of the reservoir, which leads to intensive eutrophication of the ecosystem (Milenković-Anđelković et al., 2010).

MATERIAL AND METHODS

The ichthyofaunae of the reservoirs analysed have been occasionally monitored since their creation. This paper provides an overview of results of ichthyological studies

conducted during 2000-2010. The fish fauna situation was analysed using not only research carried out by the present authors but also the available literature, fish catches by recreational fishermen and other relevant data. Determination of caught specimens was performed by standard methods (Vuković and Ivanović, 1971; Simonović, 2006). The presence of individual representatives within fish communities was evaluated using the scale defined by Šorić (1996).

RESULTS AND DISCUSSION

The results of ichthyological studies suggest that the reservoir is inhabited predominantly by cyprinids (Table 1). A total of 21 species belonging to 7 families (with Cyprinidae accounting for 90.64% of the total number and 75.63% of the biomass) were detected in the Međuvršje reservoir, 19 species of 6 families in the Gruža reservoir (Cyprinidae 80.94% of the total number, 74.28% of the biomass), and 16 species of 5 families in the Ćelije reservoir (Cyprinidae making up 77.5% of the total number and 74.5% of the biomass). The fish species non-native to Serbian watercourses include: *Carassius gibelio*, *Ctenopharyngodon idella*, *Hypophthalmichtys molitrix, Pseudorasbora parva*, *Lepomis gibbosus* and the genus *Ameiurus* (*A. nebulosus* and *A. melas*).

Prussian carp (*Carassius gibelio* Bloch 1782)

Carassius gibelio was introduced into the waters of the European part of the then USSR after World War Two and spread thereafter throughout Europe (Holčik, 1991). Since its first record in Serbia during the 1960's, expansion in both the range and population size of this species has been reported for most Serbian reservoirs. *C. gibelio* prefers shallow waters that have muddy bottoms covered with macrophyte vegetation, and host well-developed planktonic communities and macrozoobenthos. This species has a high tolerance to variable environmental conditions, a wide trophic spectrum and high fertility.

C. gibelio was introduced into the three reservoirs during stocking with fish species of higher quality, primarily *Cyprinus carpio* and *Silurus glanis*. The species has exhibited superb adaptabililty, as confirmed by the fact that it predominates the ecosystems analysed (Tab. 1), showing a tendency towards overproduction (particularly in the Gruža reservoir).

C. gibelio is well known for the fact that only females are found among the populations inhabiting some of the ecosystems (parthenogenetic reproduction). Male records in some populations serve as an indication of the absence of predators and food competitors (Glaser, 1985). The three reservoirs analysed were reported to contain male fish (the female : male ratio in Međuvršje and Gruža reservoirs was 2.58 : 1 and 1.63 : 1, respectively) (Simović, 2001). This is another confirmation of the favourability of the environmental conditions on the life activity of this species.

Table 1. Qualitative and semi-quantitative composition of the analysed reservoir ichthyofauna

TAXON	RESERVOIR					
	Međuvršje		Gruža		Ćelije	
	Number	Biomass	Number	Biomass	Number	Biomass
Fam. Cyprinidae						
Alburnus alburnus	ED	SD	D	R	ED	SD
Abramis brama	SD	SD	D	SD	ED	ED
Abramis sapa	SR	SR	-	-	SR	SR
Aspius aspius	SR	R	SR	SR	-	-
Barbus barbus	SR	SR	-	-	-	-
Carassius gibelio *	D	ED	ED	ED	ED	ED
Chondrostoma nasus	R	R	-	-	-	-
Cyprinus carpio	SR	R	SR	SD	R	R
Ctenopharyngodon idella *	SR	SR	SR	SR	SR	R
Hypophthalmichthys molitrix *	-	-	SR	SR	SR	SR
Gobio gobio	SR	SR	SR	SR	SR	SR
Leuciscus cephalus	R	R	SR	SR	-	-
Pseudorasbora parva *	SD	SR	SD	SR	R	SR
Rhodeus sericeus	R	SR	R	SR	-	-
Rutilus rutilus	D	SD	SD	SD	D	D
Tinca tinca	SR	SR	-	-	SR	SR
Fam. Siluridae						
Silurus glanis	SR	D	R	D	SR	R
Fam. Esocidae						
Esox lucius	SR	SD	SR	SD	SR	R
Fam. Percidae						
Perca fluviatilis	SD	SD	SD	SD	R	SD
Gymnocephalus cernuus	-	-	SR	SR	-	-
Sander lucioperca	-	-	SR	R	R	R
Fam. Cobitidae						
Cobitis taenia	SR	SR	-	-	-	-
Fam. Centrarchidae						
Lepomis gibbosus *	R	SR	R	SR	SR	SR
Fam. Ictaluridae						
Ameiurus (Ictalurus) sp. *	SD	R	SD	SD	-	-
Number of families / species	7 / 21		6 / 19		5 / 16	

* non- native (allochthonous) species

ED - eudominant (>20% of total) D – dominant (10-20%) SD – subdominant (4-10%)
R – recedent (1 – 3%) SR – subrecedent (<1%)

C. gibelio has the highest rate of growth in length in the Gruža reservoir (Figure 2). This biotope is favoured by overall environmental conditions (low depth, temperature regime, high organic productivity). The massive spread of this species within the ecosystems tested has an adverse effect on autochthonous ichthyofauna due to competitive relationships with commercially important species, primarily *C.carpio*. Moreover, the bentophagous diet of the species can induce mobilisation of heavy metals and other pollutants from the lake sediment and deterioration of the quality of reservoir water supplied (Gruža and Ćelije) (Marković and Ivić, 2009).

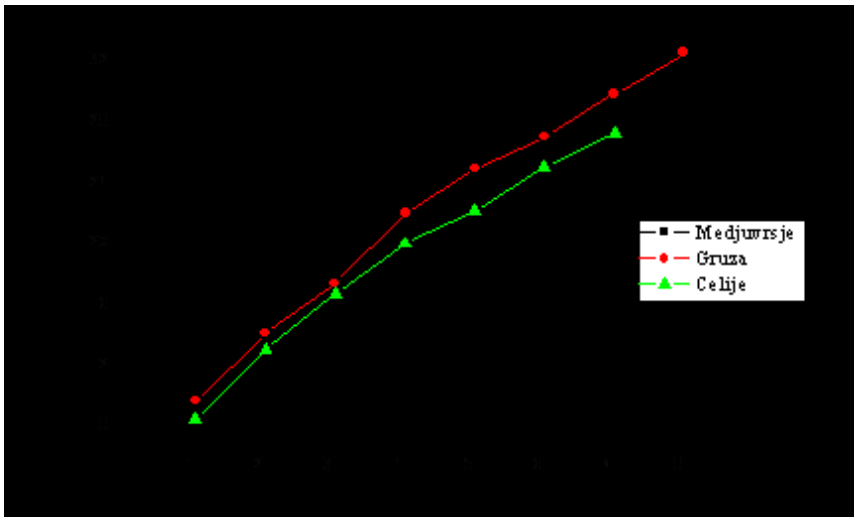

Figure 1. Length growth rate of *Carassius gibelio* in three Central Serbian reservoirs

The **grass carp (*Ctenopharyngodon idella* Vallenciennes 1844)** was introduced into a number of Serbian reservoirs and canals to control macrophyte vegetation and eutrophication (Maletin et al., 1997; 2005). The species presence is low in all the reservoirs excepting, to some extent, the Ćelije reservoir. It can lead to a reduction in areas covered with aqueous plants where *C.carpio, Tinca tinca, Abramis brama* and other autochthonous phytophilous species spawn (Janković, 1998). Being a herbivore, *C. idella* is characterised by low feed conversion efficiency, with most of the plant material ingested remaining undigested and, hence, likely to cause pollution of the water course (Mitrović-Tutundžić et al., 1996).

The **silver carp (*Hypophthalmichthys molitrix* Valenciennes 1844)** is a planktophagous species introduced into the Gruža and Ćelije reservoirs along with *C.idella*. Rare findings of the species suggest a low impact on established ecosystem relationships.

The **stone morocco, topmouth gudgeon (*Pseudorasbora parva* Temnick and Schlegel 1846)** is a highly invasive species that has shown an explosive range expansion tendency since its first record in Serbia in 1978 (Cakić et al., 2004). It has no economic importance. It can deteriorate local ichthyofauna situation due to its competitive relationship with autochthonous species. It exhibits high fluctuations in total number in the reservoirs analysed, tending towards a massive increase in its abundance (particularly in the Ćelije reservoir).

The **pumpkinseed (*Lepomis gibbosus* Linnaeus 1758)** is a North American species that shows a wide trophic spectrum involving fish fry and spawn along with the bottom fauna. It shows high oscillations in population numbers, notably in the Gruža reservoir. A decrease in its numbers has been observed in the Ćelije reservoir in the last years – a possible consequence of the massive spread of predators, *Sander lucioperca* in particular.

The **brown bullhead (*Ameiurus nebulosus* Lesueur 1819)** and the **black bullhead (*Ameiurus melas* Rafinesque 1820)** are North American species. Feeding on bottom fauna, fish fry and spawn induces an adverse effect on autochthonous ichthyofaunae.

Although their presence in carp fishponds is recognised as undesirable, these species have specific gastronomic properties (*A. melas* being farmed in one fishpond)(Lenhardt et al., 2010).

CONCLUSIONS

The ichthyofauna of the Republic of Serbia includes 23 allochthonous (non-native) species belonging to 11 families. Most non-native species inhabit the Danube and its immediate tributaries. Some species have shown a high degree of acclimation to specific environmental conditions thus becoming important members of fish communities in the reservoirs.

This study evaluates the importance of introduced fish species in the ichthyofauna of three major Central Serbian reservoirs (Međuvršje, Gruža and Ćelije). The highest expansion in population size has been exhibited by *Carassius gibelio*. This species predominates the reservoirs tested, showing a tendency towards overproduction (particularly in the Gruža reservoir). The massive spread of this invasive species within the ecosystems, along with the presence of other species, has led to endangerment of the autochthonous ichthyofauna and disturbance of the ecological balance.

ACKNOWLEDGMENT

This study has been supported by the Ministry of Education and Science, Republic of Serbia (Grant No. 31011).

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