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A CONTRIBUTION TO THE DATA ON TENCH (*TINCA TINCA* L., CYPRINIDAE, PISCES) DISTRIBUTION IN SERBIA

ABSTRACT: The studies on the ichthyofauna of Serbia that have been conducted so far indicate the sporadic tench (*Tinca tinca* L.) presence in typical habitats. The hydroenvironmental conditions necessary for the survival of this fish species are highly variable and, generally, are more favourable in the northern part of the country (the Vojvodina Province). Although the tench presence has been registered at over 30 sites, there is a tendency of a decrease in population abundance. This is due to the reduction of the surface area of the macrophyte-covered flood zones induced by the damming and regulation of rivers, high water level fluctuations, and water amount reduction in the majority of watercourses, a massive increase in the number of allochthonous phytofagous species, reservoir sediment deposition, water quality deterioration and other factors. The tench conservation status in Serbia is officially designated as Low Risk — Least Concern. It may be transferred to a higher category if the tendency towards deterioration of survival conditions for the species should continue.

KEY WORDS: distribution, endangerment, protection, Serbia, tench

INTRODUCTION

Anthropogenic activities have dramatically sped up the process of succession of species which is induced by the evolutionary changes in a number of existing biocenoses. The aquatic environment and its hydrobionts, particularly the fish, have been subjected to severe changes. Apart from the global effect being primarily manifested through the deterioration of environmental survival conditions, the ichthyofauna of certain regions has been substantially altered by the introduction and translocation of certain species that are frequent causes of disturbances in the established equilibria. The ichthyofauna of Serbia has also experienced dramatic changes over the last decades.

The Republic of Serbia (its surface area being 88 361 km^2) is situated in the central part of the Balkan Peninsula. A part of the territory located north

of the Danube (2783 km long, 588 km in Serbia) and the Sava (945 km, 206 km in Serbia) rivers, the Vojvodina Province (21 506 km^2), is characterised by lowlands and a wide range of slow-flowing and stagnant water bodies. The highlands dominating Central Serbia (3/4 of the state territory) are distinguished by the wealth of torrential rivers, rivulets, springs, and upland reservoirs. Larger rivers in this part of Serbia include the Zapadna Morava (308 km), the Južna Morava (295 km), the Ibar (272 km) and the Drina (346 km, 220 km in Serbia). A number of lakes (the most famous of them being Palić and Ludoš) and 85 reservoirs, the Đerdap-dam I (surface area 253 km^2) being the largest, contribute to the wealth of water in Serbia. Most river courses in Serbia flow directly or indirectly (from more than 97% of the territory) into the Danube (the Black Sea Basin), the waters from less than 3% of the state territory flowing into the Aegean and Adriatic Seas (Anonymous 2003).

The overall deterioration tendency of the water quality of most water courses in Serbia has been observed in Serbia over recent decades, as reflected by eutrophication and chemical, radioactive and other types of pollution (Ostojić et al., 2005; Bogdanović, 2006; Marković and Lenhardt, 2007).

The high variability of environmental conditions has induced high diversity of icthyofauna, including a permanent or occasional presence of 94 species from 26 families and a pronounced predominance of the representatives of the Cyprinidae family (50 species) (Simonović and Nikolić, 1997; Karadžić and Mijović, 2007). The diversity of the ichthyofauna has been increased by a large number of non-native species — a total of 22 from 10 families (Lenhardt et al., 2006; Simonović, 2006). The introduction of these species into the water courses of Serbia started in the 1930s and it was intensified in the second half of the 20th century (Holčik, 1991), exhibiting a tendency of the continuous expansion (Maletin et al., 1997; Cakić et al., 2004; Simonović et al., 2006).

The tench (*Tinca tinca* L.) is a cyprinid species of Euro-Siberian origin widely distributed in the watercourses throughout Europe, including the Balkan Peninsula (Wheeler, 1978; Simonović, 2006). Although globally studied, the tench has not been fully explored in Serbia. Although the first record of the species in the ichthyofauna of Serbia was made in the 1860s (Pančić, 1860), later publications, mostly handbooks, provide only general information on the morphology, ecology and breeding of this species (Vuković and Ivanović, 1971; Bojčić et al., 1982; Hristić and Bunjevac, 1991; Ćirković et al., 2002). More intensified research on the ichthyofauna of Serbia's watercourses conducted in 1990s revealed the presence of tench in the Danube and tributary rivers (Hegediš et al., 1992; Janković et al., 1994; Marković and Simović, 1994; Maletin et al., 1996). The results of the above analyses suggest a low percentage of the species (generally accounting for less than 1% of the individual abundance and biomass of local ichthyofauna).

MATERIALS AND METHODS

The little information available on the ecology of the species has motivated the authors to engage in this study. Some data on tench distribution have been provided by the Fishery Improvement Programmes for certain regions in Serbia. The study has been particularly focused on registering tench habitats larger than 0.1 km^2 in still and slow-flowing waters. These biotopes are typical for this species (W r i g h t and G i l e s, 1991; G o n z a l e s et al., 2000). The study is a short review of both the current state of tench populations in certain regions of Serbia and the degree of habitat endangerment.

RESULTS AND DISCUSSION

Tench in Serbian open waters

The presence of tench has been registered at more than 30 sites throughout Serbia (Fig. 1, Tab. 1), the majority of them being in the Vojvodina Province (1—21), a part of the Pannonian Basin located in Serbia. The dense hydrographic network of this part of the country includes various types of water bodies (rivers, rivulets, flood zones, pools and bogs, canals, lakes and reservoirs).

Tab. 1 — Main characteristics of tench (*Tinca tinca*) habitats in Serbia

Item	Ecosystem	Area	Biotope	Main purpose of use
(1)	Palić Lake	5.6 km^2	natural	recreation, tourism
(2)	Ludoš Lake	3.6 km^2	natural	irrigation, protected area
(3)	Čik Canal	95 km long	artificial	irrigation, part of DTD Canal
(4)(5)	Vrbas—Bezdan Canal	90 km long	artificial	irrigation, part of DTD Canal
(6)	Odžaci—Sombor Canal	13 km long	artificial	irrigation, part of DTD Canal
(7)(8)	Kosančić—Mali Stapar Canal	21 km long	artificial	irrigation, part of DTD Canal
(9)	Bački Petrovac—Karavukovo Canal	52 km long	artificial	irrigation, part of DTD Canal
(10)(11)	Banatska Palanka—Novi Bečej Canal	147 km	artificial	irrigation, part of DTD Canal
(12)	Kikinda Canal	50 km	artificial	irrigation, part of DTD Canal
(13)	Jegrička River—Canal	65 km	semi-natural	irrigation, angling
(14)	Zobnatica Reservoir	2.5 km^2	artificial	Irrigation, recreation
(15)	Mt. Fruška Gora Reservoirs	≈ 1.2 km^2	artificial	irrigation, recreation
(16)	Borkovac Reservoir	0.7 km^2	artificial	irrigation, recreational fishing
(17)	Bela Crkva Lakes	1 km^2	artificial	recreation, angling
(18)	Carska Bara Bog	11 km^2	natural	special nature reservation
(19)	Kovilj — Petrovaradin Marshes	5.5 km^2	natural	special nature reservation
(20)	Obedska Bara Bog	7 km^2	natural	special nature reservation
(21)	Pančevački Rit Swamp	400 km^2	natural	irrigation

(22)	Zasavica Bog	11.5 km^2	natural	special nature reservation
(23)	Sava Lake	0.8 km^2	artificial	water supply, recreation
(24)	Silver Lake	4 km^2	artificial	recreation, angling
(25)	Đerdap-dam I Reservoir	253 km^2	artificial	hydroelectric production
(26)	Đerdap-dam II Reservoir	92 km^2	artificial	hydroelectric production
(27)	Perućac Reservoir	12.4 km^2	artificial	hydroelectric production
(28)	Međuvršje Resevoir	1.5 km^2	artificial	hydroelectric production
(29)	Ćelije Reservoir	3.4 km^2	artificial	water supply
(30)	Batlava Reservoir	3.3 km^2	artificial	water supply
(31)	Brestovac Reservoir	0.8 km^2	artificial	water supply
(32)	Krupac Lake	0.4 km^2	natural	water supply
(33)	Vlasina Reservoir	16 km^2	semi-natural	hydroelectric production

Record of the presence of tench in the northernmost parts of Serbia was made in Palić (1) and Ludoš lakes (2) of Aeolian origin. The lakes are located between the Danube and Tisa rivers next to the state border with Hungary (Fig. 1). Lake Palić is an important tourist destination in this part of Europe. The depth of 3—4 m, mean water t° of about 10°C, the muddy bottom, and the dense macrophyte vegetation cover make the above ecosystem a favourable habitat for this species. Until the 1960s, the ichthyofauna of the lake was characterised by markedly excessive production of carp (*Cyprinus carpio*) — making up 98% of the total ichthyofauna biomass. However, the lake experienced environmental catastrophe towards the end of the1960s. Drastic deterioration of the lake water quality induced by permanent waste water discharges from the city of Subotica (8 km away) and other populated areas as well as from agricultural sources led to large-scale death of fish (the essential reason being high silt concentrations of H_2S) in 1971 (Maletin et al., 1998a). Over the period 1971—1976, lake restoration (emptying of the lake, silt removal and refilling) and stocking were performed. This resulted in the establishment of a dynamic equilibrium. Apart from the Asian herbivore, primarily the grass carp (*Ctenophayngodon idella*), in the period 1976—1982, the tench was also introduced at the rate of 60—100 kg/year. This induced a moderate increase in the species abundance followed by a decrease in its number as early as in the 1990s due to the deterioration of ambient conditions (Đukić et al., 1991). Currently, the lake ecosystem is characterised by low numbers of the tench (accounting for about 1% of the total fish catch). Lake Ludoš is located in an urban area 12 km away from the town of Subotica. It is supplied with water through the Ludoš-Lake canal that receives purified water from Lake Palić and the Kereš Brook. It is surrounded by farms that use its water for irrigation. This shallow lake (with an average depth of 1m) and its surroundings marked by diverse habitats — a swamp, a meadow and a steppe (the total area of 5.93 km^2), were included in the Ramsar List of Wetlands of International Importance in 1977 (Ramsar Sites Database, 2008). Notwithstanding protection measures, the intensified eutrophication of the ecosystem (Bogdanović, 2006) and a decrease in the number of fish, primarily of the *C. carpio* and the tench, have been observed in recent years.

Most tench records (3—13) have been made in the Danube-Tisa-Danube (DTD) Hydrosystem canal network. It is a unique system of canals and dams intended for the irrigation and quality improvement of arable areas, the impro-

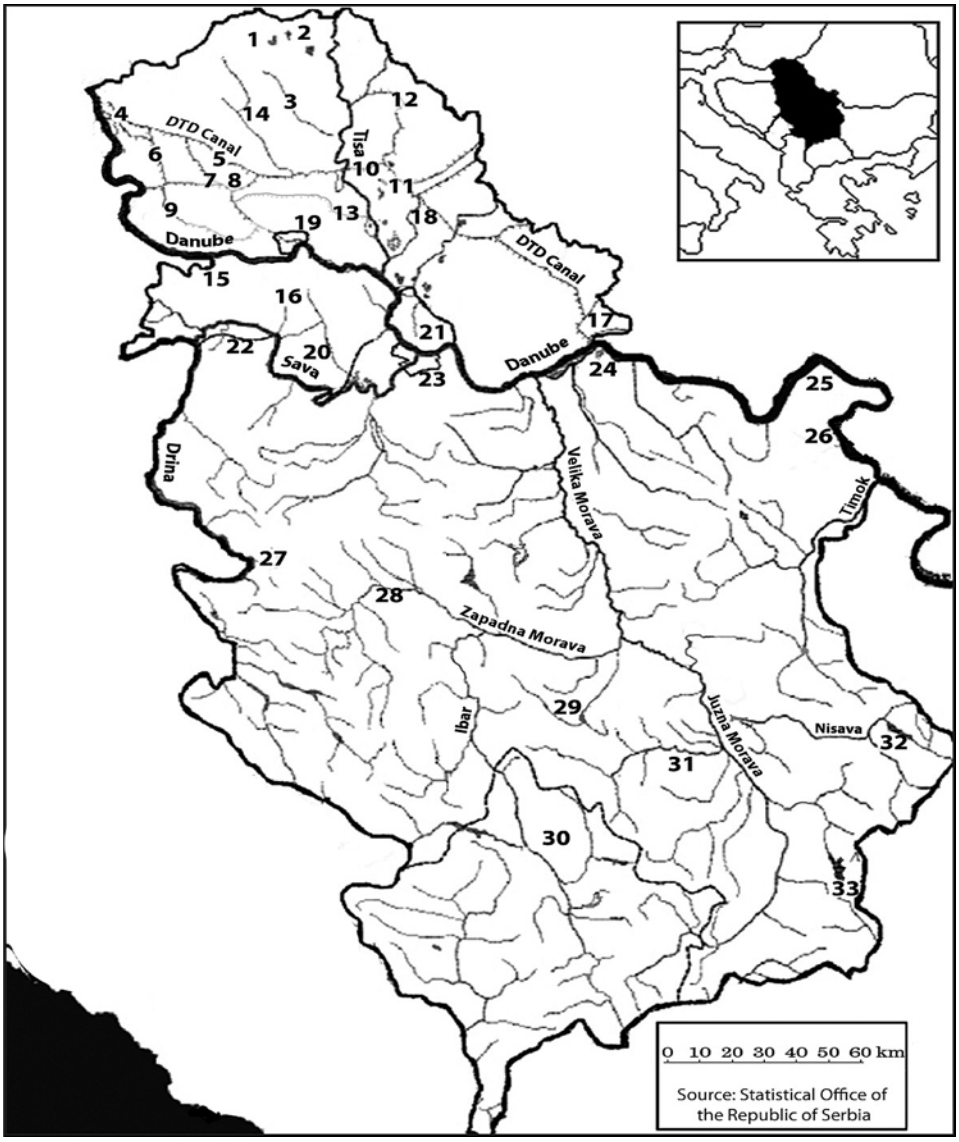

Fig. 1 — Current distribution of tench (*Tinca tinca*) in Serbia

1) Palić Lake, 2) Ludoš Lake, 3) Svetićevo, 4) Šebeš Fok 5) Crvenka, 6) Odžaci, 7) Ruski Krstur, 8) Kruščić, 9) Karavukovo, 10) Novi Bečej, 11) Melenci, 12) Novo Miloševo, 13) Temerin, 14) Zobnatica Reservoir, 15) Fruška Gora Reservoirs, 16) Borkovac Reservoir, 17) Bela Crkva Lakes, 18) Carska Bara Bog, 19) Kovilj—Petrovaradin Marshes, 20) Obedska Bara Bog, 21) Pančevački Rit Swamp, 22) Zasavica Bog, 23) Sava Lake, 24) Silver Lake, 25) Đerdap-dam I Reservoir, 26) Đerdap-dam II Reservoir, 27) Perućac Reservoir, 28) Međuvršje Reservoir, 29) Ćelije Reservoir, 30) Batlava Reservoir, 31) Brestovac Reservoir, 32) Krupac Lake, 33) Vlasina Reservoir

vement of water supply, the evacuation of waste waters and the development of fisheries (S t a n k o v i ć, 2000). The main canal is 248 km long, the whole system encompassing 700 km of secondary canals and about 10 000 km of accessory channels. The total surface area of the soil covered by the Hydrosystem is 12 700 km^2. The DTD system construction in the 1947—1997 period resulted in a drastic reduction of the flood zones. Despite the drainage of large wetland areas, ambient conditions have been preserved in certain parts of the canal network enabling tench survival.

The profiles (3), (5), (6), (9), (10), (11) and (12) showed variations in the individual (0.23—4.2%) and biomass (0.05%—2.5%) presence of the tench in the total ichthyofauna catch (M a l e t i n et al., 2005; M a l e t i n et al., 2006). Higher abundance of the tench has been registered in the Bezdan profile near Šebeš Fok (4) — 7% of individual fish and 13% of the biomass, in the Ruski Krstur (7) — 15% and 20% and in the Kruščić profile (8) — 18% and 24%, respectively (M a l e t i n et al., 2007). The high tench abundance at these sites is due to a low degree of devastation of habitats and rich macrophyte vegetation providing the species with favourable survival conditions. The profiles (7) and (8) are located in the Kosančić — Mali Stapar Canal ecosystem where the first record of female largemouth bass (*Micropterus salmoides*) in the watercourses of Serbia has been made (M a l e t i n et al., 1997). The massive increase in largemouth bass has not affected the total tench population. However, the introduction of grass carp (*Ctenopharyngodon idella*) aimed at preventing the expansion of macrophyte vegetation (M a l e t i n et al., 2007a) can cause disturbance of the overall environmental conditions in the above habitats and tench endangerment.

As regards the ichthyofauna of the Temerin profile (13) of the Jegrička River (Canal), the individual and biomass presence of the tench was 2.69% and 1.01%, respectively. The Jegrička is the longest artificial watercourse in Vojvodina turned by hydromelioration into a canal and linked within the DTD Hydrosystem. The last 15 km of the watercourse have been converted into a fish pond, stocked with quality fish fry and protected as a Nature Park. This habitat meets the requirements essential for the massive increase in the presence of limnophilous fish species such as tench (Š i p o š et al., 2007).

Individual tench records have been made in a number of reservoirs in Vojvodina including Zobnatica on the Krivaja River (14) and those on the southern slopes of Mt. Fruška Gora (15) — Moharač (67 ha), Šot (33 ha) and Bruja (15 ha). Frequent recreational fishing destinations in Vojvodina also include the Borkovac Reservoir (16) made by the damming of the Borkovac Brook in 1971. Continuous stocking in the 1980s led to increases in the carp and tench populations (record was made of individual fish mass exceeding 1.2 kg). Recreational fishermen are also attracted to the reservoirs located within and surrounding Bela Crkva, a town near the Romanian border (17). The above lakes (7 in all) were formed by being filled with ground water following gravel exploitation. Potential reasons for the decrease in tench numbers in the microreservoirs include excessive catch and *C. idella* introduction.

The reduction in the tench distribution area in Vojvodina resulted primarily from river regulations and wetland drainage. Hence the high importance of

the sites (18), (19) and (20) that are considered as refuge for this and other endangered species.

Carska Bara (18) is one of the largest Serbian bogs, located 17 km southwest of the town of Zrenjanin at the confluence of the Begej River into the Tisa. Its superb biodiversity (particularly of the ornithofauna composed of 240 registered species) was the reason for the inclusion of the region, the surface area thereof being 17.67 km^2, in the Ramsar List (Ramsar Sites Database, 2008) in 1996. Notwithstanding the overall favourable environmental conditions, individual tench presence in the fish fund has been extremely low (0.37—0.74% of the total ichthyofauna comprising 24 species) (Kostić and Maletin, 1992). Recent studies do not report any increases in the total population of the species. Possible reasons include considerable fluctuations in the water level induced by low precipitation and global warming as well as the massive presence of the bird colonies of herons (*Ardea* sp.) and cormorants (*Phalacrocorax* sp.), major fish predators.

A low individual tench presence is also characteristic of Kovilj-Petrovaradin Marshes (19), complex wetlands and forests, located in the inundation area of the middle course of the Danube River, near the City of Novi Sad. The region (its surface area being 48.4 km^2) has been proclaimed Special Nature Reserve by the Decree of the Government of the Republic of Serbia (The Official Gazette of the Republic of Serbia, 27/98) due to the biota diversity enhanced by the 46 fish species making up the ichthyofauna of the region. Intensive traffic on the Novi Sad — Belgrade highway passing through the above region is a major factor endangering the autochthonous habitat.

The flood zone of the Sava River, 40 km west of Belgrade, is the site of the Obedska Bara (20), a large swampy forest area stretching along the Sava River (a truncated meander of the Sava). Initial protection measures for this region were taken as early as in 1874. This authentic complex of diverse aquatic and terrestrial biocenoses (the surface area being 175 km^2) was included in the Ramsar List (in 1977). Irrespective of the protection measures, constant expansion of surrounding agricultural areas and water level fluctuations have caused a drastic reduction in the abundance of tench which accounted for 7% of the total catch of ichthyofauna in the 1980s (Budakov et al., 1983).

The high environmental adaptability of tench to deteriorated hydrochemical survival conditions has been confirmed by the fish presence recorded in the Pančevački Rit Swamp (21). Its large wetlands (having a surface area of 399.9 km^2) located on the right bank of the Danube in a broader area of the city of Belgrade had been incessantly flooded until World War II. Thereafter, they were partially drained and converted for the most part into fertile land being currently managed by the PKB, the largest Serbian agricultural company. Crude wastewaters were being discharged into the swap by the company, resulting in the pollution of the ecosystem and, hence, the extinction of many living organisms. Tench presence was recorded in a number of bogs, the major ones including Veliko Blato (2 km^2) and Reva Bog (0.4 km^2). The latter is greatly affected by industrial waste waters from Krnjača settlement. The ichthyological research of the ecosystem conducted in July 1991 revealed the presence of 7 fish species, including the tench, despite the concentration of dissolved oxygen

being as low as 0.77 mgdm^{-3} (M a s l i ć et al., 1992). This finding is a confirmation of tench tolerance to unfavourable oxygen conditions (A l a b a s t e r and L l o y d, 1980).

Central Serbia is characterised by few tench habitats registered (22—33). The hydrographic network of this part of the country is more diverse, the survival conditions being variable and generally more unfavourable. Zasavica Bog (22) is the most important tench habitat in Serbia distinguished for its preserved ambient conditions. Located in the north-western part of Serbia (Mačva region) in the flood plain of the Sava River, it is among major wildlife refuges in this part of the Balkans. The entire region (its surface area being 19.13 km^2) includes a number of bogs interconnected with canals and marsh systems with fragments of flooded meadows and forests. Zasavica Bog is protected as a Special Nature Reserve and has been included in the Ramsar List due to the high biodiversity of the entire region. The broader public became familiar with this portion of preserved nature in 2004 when the European beaver (*Castor fiber*) was reintroduced into the ecosystem after more than 100 years of its disappearance. The fish assembly composed of 23 species is particularly renowned for the presence of the mudminnow (*Umbra krameri*), a fish species classified, globally, as vulnerable (VU) (IUCN 2006) and, at national level, as critically endangered (CR) (S i m i ć et al., 2007). The individual tench proportion in the total fish fund at certain sites ranges from 3.93—25.0%, the tench biomass percentage being 6.91—17.30% (M a l e t i n et al., 2001). Despite the strict protection regime employed, the protected ecosystems have been endangered in the last years by the expansion of agricultural activities in the surrounding region.

The majority of other sites where the tench has been registered are characterised by negligible tench population (generally < 1% of the individual number and biomass of local ichthyofaunas). This tendency has been also recorded in popular tourist destinations in Serbia — the Sava Lake (23) on the Sava River (the area of Belgrade) and Silver Lake or Srebrno Jezero (24) along the Danube banks (near Veliko Gradište).

A low presence of tench has also been found in major Serbian hydroelectric reservoirs, the Đerdap — Dam I (25) and Đerdap Dam II (26) on the Danube River. The construction of Đerdap I dam in 1970 at the 943rd km of the river course and of Đerdap II dam in 1984 at the 863rd km, the elevation of the Danube water level by 20 m and accompanying consequences had an enormous effect on the qualitative and quantitative structure of the ichthyofauna comprising 53 species of 13 families (D i m o v i ć and H e g e d i š, 2002). The constructed dam is a barrier to the anadromous migrations of five acipenserid (fam. Acipenseridae) and two herring (fam. Clupeidae) species. Conversely, there has been an increase in the numbers of bream (*Abramis brama*), Asian herbivore — *C. idella*, silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*Arystichthys nobilis*) (L e n h a r d t et al., 2004). The registered decrease in the abundance of commercially important species, such as the *C. carpio* and the tench, has been primarily induced by the depth increase leading to a drastic reduction in the surface area of the littoral zone. Moreover, the

massive increase of *C. idella* population could contribute to the reduction in the spawning areas for phytophile fish (J a n k o v i ć, 1998).

For recreational fishing purposes, the tench has been introduced into a number of reservoirs, including Perućica on the Drina (27), Međuvršje on the Zapadna Morava (28), Ćelije on the Rasina (29), Batlava on the Batlava (30), Brestovac (31) on the Pusta Reka River, among others. The total tench population in the stated ecosystems is negligible. In terms of a potential massive increase in tench population, of particular interest are the eutrophic reservoirs Međuvršje and Ćelije (located in the Zapadna Morava River Basin).

The Međuvršje reservoir is situated in the Ovčar Kablar Gorge area being protected as an Area of Superb Natural Quality (The Official Gazette of the Republic of Serbia, 5/2000). The reservoir is one of the oldest Serbian reservoirs formed in 1953 by the construction of a 31 m high dam. This resulted in the formation of a 9.3 km long lake, its maximum width being 272 m and maximum depth 12 m, the total volume amounting to 15.4 x 10^6 m^3. As much as 70% of the initial volume has been deposited with river sediments over time (L e n h a r d t et al., 2009). The shallowing of the reservoir and the nutrient inflow have favoured the development of plankton communities and the abundance of macrophytic vegetation. The fish fauna is composed of 20 species of 7 families, the bleak (*Alburnus alburnus*) being the predominating one (M a r k o v i ć et al., 2007). The tench was first introduced into this ecosystem through fish stocking in 1956. Although the stockings continued (the last one being conducted in 1999 by the introduction of 100 kg of fry), the species population did not increase abundantly — the catches made in the period 2002—2006 showed that its percentage was as low as 0.27% and 0.41% of the individual and biomass level, respectively. It was induced not only by excessive catch, practiced even in the period of spawning, but also by permanent sediment deposition at spawning spots. Additionally, high variations in the water level caused by the Međuvršje hydroelectric power works led to the destruction of the roes of tench and other phytophylous species. The latest Fishery Improvement Programme for the period 2007—2011 envisages, apart from the regulation of HE power station activities, full prohibition of recreational fishing of tench over a 5-year period and the stocking of waters with fish fry (a total of 729 kg). The above measures, coupled with strict catch control measures, should contribute to a massive increase in the species population.

The Ćelije Reservoir, its volume being 41x$10^6$$m^3$, was formed in 1979. It is specifically used for the supply of the town of Kruševac and surrounding populated areas with potable water. The lake banks have numerous bays suitable for the development of macrophyte vegetation. The fish assembly includes 17 species of 4 families, the bleak, and the goldfish (*Carassius gibelio*) predominating (S i m o v i ć and M a r k o v i ć, 1997). Occasional tench presence has been registered (there was no record of its presence in the catch of recreational fishermen in some years). This is likely due to the massive increase in the population of pike-perch (*Sander lucioperca*), being introduced in the last decade. The reservoir has been stocked with different fish species, including the tench, on several occasions. However, the common stand in recent years has been that the tench, as a bentophagous species, should not be intro-

duced into the reservoirs used for the water supply of inhabitants. The living activities of the species being performed at the biotope bottom can lead to the mobilisation of heavy metals and other pollutants from the sediments into the water. Considering the tench abundance in this type of reservoirs in Serbia, this is quite unlikely to happen. As opposed to this, some researchers suggest that the tench introduction into eutrophic ecosystems can contribute to water quality improvement, given the fact that the mineralisation process is accelerated and that the transition of some nutrients from sediments is prevented by the tench trophic activities (M i c h a e l s, 1988). This fact, apart from the promotion of angling diversity, is the reason for the tench introduction into some carp ponds and reservoirs in Turkey (I n n a l and E r k ' a k a n, 2006).

There are just a few autochthonous habitats in eastern and southern parts of Serbia. The tench is abundant in the Nišava River (southern Serbia), upstream of the city of Niš, particularly in the part of the river course passing through the Sićevac Gorge. Although the Nišava ecosystem is not a typical habitat of the species (a relatively rapid flow and stony-gravelly bottom), shallower and slower flowing parts of the river are inhabited by tench. Lake Krupac (32), a small natural lake characterised by high tench abundance, is located in this region. Being 1.5 km long, max. 200 m wide, having a silty bottom and abounding in aquatic plants, the lake is characterised by numerous populations of tench (> 10% of the individual ichthyofauna number), rudd (*Scardinius erythrophtalmus*), roach (*Rutilus rutilus*), and, frequently, pike (*Esox lucius*). The Lake catchment, used for the water supply of the town of Pirot, coupled with the low amount of precipitations in recent years, have induced both a drastic decrease in the water level and shallowing.

The Vlasina reservoir (33) is a tench habitat located at the highest altitude in Serbia (1213 m a.s.l.) (Fig. 2). By the construction of the Vlasina dam in 1949, the peat bog was converted into a 9 km long reservoir, of 3.5 km maximum width and 22 m depth, the total volume being 168 x 10^6 m^3. The specific character of this ecosystem has been created by floating islands (the largest one having the area of 8 ha) being moved around with the wind. The aquatoria of the reservoir and the surrounding ground (the surface area of 32.09 km^2) were included in the Ramsar List in 2007. The ichthyofauna of the reservoir includes 16 species of 5 families. Excluding the autochthonous species, the brown trout (*Salmo trutta m. fario*) and the Balkan barbel (*Barbus peloponnesius*), other species have been translocated from other waters of the Balkans. Apart from the perch (*Perca fluviatilis*) and *C. gibelio*, the tench is an abundant member of the ichthyofauna assemblage. A single sampling showed that the tench accounted for 22% of individual and 12% of the biomass percentage in the total ichthyofauna (M a l e t i n et al., 1998b). The tench is a stable member of the fish community into which it had been introduced through stockings conducted in 1968, 1971 and 1991 (S t a n k o v i ć, 2000). Notwithstanding the protection measures and the organised fish guarding network employed, the ecosystems of the protected area in the last years have been endangered by the expansion of tourism and accompanying adverse activities (urbanisation, traffic, emission of different types of wastes).

Fig. 2 — Vlasina Reservoir — tench habitat at the highest altitude in Serbia

Tench in Serbian aquaculture

Up until the 1960s, the tench was the second most widespread of the cyprinid fish species in Serbia, right after the carp. The highest and long-lasting production was practised in fish ponds Ečka, Novi Kneževac and Srpski Miletić. For example, in the period 1977—1981, tench proportion in the total amount of sold fish in the then Yugoslavia ranged from 0.25—0.60% (B o j č i ć et al., 1982). The cyprinid fish species market in Serbia exhibits seasonal variations — the highest consumption being recorded during Saint Nicholas festive and fasting days (favouring fish of 2.5 kg or more).

The intensification of production led to changes in the fish pond preparation technique, which is followed by soil cultivation. Furthermore, the increased fish population density induced a decline in tench production. The drop in tench production resulted from the introduction of competitive herbivorous fish species, their feeding habits disrupting the tench environment. The common tench population of 5—10%, as compared to carp, was replaced by the substantial growth rate of Asian herbivores in polycultures. The indigested food excreted by carp as feces was previously used by tench and then by new consumers, the newly introduced Asian fish complex. Macrophyte vegetation, necessary for tench spawning, became food for herbivorous species.

CONCLUSION

The tench (*T. tinca*) is an insufficiently studied species of the Serbian ichthyofauna, irrespective of the global concerns and implemented introductions throughout the world. The hydroenvironmental conditions in a great number of aquatic biotopes enable the survival of the species. However, the tench population is generally a small one. The basic reasons include changes in ambient conditions and decreases in wetland surface area. The river course damming and flood zone reduction have contributed to the disappearance of the species from several natural habitats. Translocations, primarily into reservoirs, have not generally resulted in successful acclimatisation and massive abundance of the species, due to a number of abiotic and biotic factors including the competitiveness with the representatives of autochthonous ichthyofauna. The introduction of Asian herbivores to reduce the expansion of the macrophyte vegetation might have induced deterioration of spawning and feeding conditions for the phytophilous species concerned.

This study was not aimed at registering all tench-inhabited sites in Serbia, the reason being a great number of microhabitats of this cyprinid. They include, in Vojvodina, parts of the DTD Hydrosystem canal network, numerous microreservoirs, as well as dead waters (or „mrtvaja" as called in Serbia) in the catchment area of the Tisa, Begej, Tamiš and Karaš rivers. Furthermore, the study has not covered reservoirs in Central Serbia where the tench has been introduced for recreational fishing purposes as there have been no valid data on its successful acclimatisation. Additionally, the study has not registered several other sport angling fishponds formed in the last years where, apart from the carp and Asian herbivores, the tench has also been introduced. It has been also impossible to register numerous pools formed after gravel exploitation in the valleys of the Drina, Sava, Južna and Velika Morava rivers, where tench has been reported.

The conservation status of the species both in Serbia and globally is classified in the category of LR/lc (Lower Risk/least concern) (IUCN 2006). Despite the relatively wide distribution of the species in Serbia, the risk degree estimate related to the species necessitates a more detailed assessment of all relevant indicators of survival conditions (habitat alteration, population growth, exploitation rate, pollution etc.). The conservation status can be transferred into a higher category unless thorough protection measures be taken on national level.

Considering the above, the Ministry of Science of the Republic of Serbia has approved a project entitled „Reintroduction and Repopulation of Tench (*Tinca tinca*) into Fishpond Systems and Open Waters" to be implemented by experts from several university institutions in Serbia. The project envisages the introduction of high-quality spawners from a fishpond of a country with highly developed tench production. The individual fish shall be bred in the Mošorin fishpond near Novi Sad for artificial spawning purposes. The fish fry obtained shall be introduced into other fishponds and open waters. The above measures, along with more rigid protection of current habitats, should enable the recovery and increase in the tench population in Serbia.

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ПРИЛОГ ПОДАЦИМА О РАСПРОСТРАЊЕЊУ ЛИЊАКА (*TINCA TINCA* L., CYPRINIDAE, PISCES) У СРБИЈИ

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Резиме

Испитивања ихтиофауне Србије која су до сада извршена указују на спорадично присуство лињака (*Tinca tinca* L.) у типичним стаништима. Хидроеколошки услови непходни за опстанак ове рибље врсте веома су променљиви и, генерално, повољнији у северним крајевима земље (Војводина). Иако је присуство лињака регистровано на више од 30 локација, постоји тенденција смањивања популационе бројности. Разлог за то су смањење површине плавних зона обраслих макрофитском вегетацијом настало услед преграђивања и регулисања речних токова, велика варирања водостаја и смањење количине воде у већини водотокова, омасовљење алохтоних фитофагних врста, таложење наноса у акумулацијама, погоршање квалитета воде и други чиниоци. Степен угрожености лињака у Србији званично је означен као статус Ниског ризика — Најмања угроженост. Овај статус може прећи у вишу категорију уколико се настави тенденција погоршања услова опстанка врсте.