JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

AGE, GROWTH AND MATURATION OF INVASIVE TWOBREAM SPECIES INTRODUCED TO ZARAFSHON RIVER BASIN IN UZBEKISTAN

Kamilov,B.G.[#], Yuldashov, M.A.,J.J.Sobirov, Xalimova N.T

Department of Fisheries, Tashkent State Agrarian University, Tashkent, Uzbekistan.
- corresponding author,bkam58@yandex.ru

Abstract:
A study was carried out at 2013-2014 and 2017-2018 in Tudakul reservoir, Uzbekistan. A total of 278 european bream, *Abramis brama*, and 83 white amur bream, *Parabramis pekinensis,*were sampled. The ages, total lengths and weights of the samples ranged between 1 -5 years, 14 – 50 cm, 30- 1405 g for european bream and 1 - 6 years, 24 - 53.5 cm and 105 - 2138 g for white amur bream, respectively. The relation between the total length (TL) and weight (W) was described by equation$W = 0{,}005*TL^{3{,}2555}$($r_{w\text{-}TL}$=0,98) for european bream and $W = 0{,}005*TL^{3{,}201}$ (r=0,96) for white amur bream. The mean back calculated total length of european bream was 13.5 cm at age I; 28,1 cm, II; 37.95 cm, III; 42.6 cm, IV; 48.6 cm, V; white amur bream - 12.6 cm at age I; 23,3 cm, II; 31.5 cm, III; 37.9 cm, IV; 41.7 cm, V; 44.2 cm, VI. R.Lee's phenomenon was not manifested.All 1-year-old fish were juveniles. Fish of both sexes had gonads at stage II at age II. Males and females reached first maturation at ages III-IV when there total length was 30 – 32 for european bream and 34-35 cm for white amur bream.
Key words: Abramis brama, Parabramis pekinensis, European bream, White amur bream, Growth, Back-calculation, Maturation, Uzbekistan

Introduction

Biological invasions are one of the most major issues causing threats to the conservation of biodiversity. The most, introduced species fail to establish new population. However, the introduction of a non-native species into a novel ecosystem is likely to create an ecological impact if the species is able to successfully establish a self-reproducing population. The establishment success of an introduced species highly depends on its intrinsic ecological and biological characteristics (e.g. reproduction guild, fecundity, dietary breadth). (Ross, 1991; Brown, Moyle, 1997; Zimmerman, Vondracek, 2006; Blanchet et al., 2007; García-Berthou, 2007; Yonekura et al., 2007; Gozlan et al., 2010; etc). In Uzbekistan, in Zarafshon River basin two such invasive species are european bream, *Abramis brama* (Linnaeus, 1758) and white amur bream, *Parabramis pekinensis* (Basilewsky, 1855).

European bream area includes central and northern part of Europe, basins of Caspian, Black, Azov seas. It was introduced to the basins of the rivers Ob, Irtysh, Yenisei (Russia). In the Aral Sea basin subspecies *A.brama orientalisBerg* was determined in the Sea and lower streams of Amudarya and Syrdarya rivers (Kamilov, 1973). In 1950s, european bream from Ural River (Russia) was introduced to Kuyumazar reservoir in the middle stream of basin of Zarafshon River. Bream has found favourable environments, begun natural reproduction and spread in middle and low streams of the river including Tudakul reservoir. Recently species has status of commercial object for fish capturing in all reservoirs in the basin of Zarafshon River (Amanov, 1985; Salikhov et al., 2001; Yuldashov, 2018). In Uzbekistan, european bream biology including growth and maturation were studied before 1980s; there were no studies from the early 1990s.

Since2008, single whiteamurbreamwas found for the first time inscientific catches in lower stream of Zarafshon River, Uzbekistan. Beforethat,specieswasnotmarkedinlocalichthyofauna in the water bodies in that country.Quantityofwhiteamurbreamincreased and since 2014 it isoften foundedin commercial fisheries capturing catches in Tudakul reservoir. There are no any data about biology of that species under conditions of Uzbekistan.

The study of age, growth, maturation and fecundity is essential in fisheries and aquaculture. Theobjective of this work is to study age, growth and maturation of european bream and white amur bream in Tudakul reservoir.

Site description. Tudakulreservoir(fig. 1) wascreated for irrigation purposes inthelowerreachofZarafshonRiver, Uzbekistan (39°51'15"N 64°50'29"E). Summer is hot (average monthly air temperature in July is about 29°C, in daytime often is about 35-42°C). Winter is rather cold (average monthly temperature in January is -2°C, standing water bodies often are covered by ice for 1.5 months). Totalareaofreservoirisabout 22 000 ha, averagedepth is about 5 m, maximaldepth is 22 m. Tudakul reservoir is used as water body with culture based fisheries; reservoir is stocked by culture cyprinids with density 50-120 summerling/ha since 2004. Fishermenusecommercialseineswithlargemesh (70 – 90 mm mesh in wings of seine net) because catch is oriented to large fishes (more than 2 kg). Total fish catch in reservoir was 1000-1500 tones in 2009-2018 years.

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

Materials and methods

Fish samples were collected each 15 days from November 2013 to October 2014 for european bream and from November 2017 to October 2018 for white amur breamin the Tudakul reservoir by using gill nets with 16, 24, 32, 36, 40, 50, 60, 70 mm in mesh size.

The total length (TL),standard length to the end of scale coverlet (SL) in the nearest 1 mm and weight (W) in the nearest 0.1 g were recorded for each fish. Scales (3-4 samples) were taken from 1st row above lateral line under 1st ray of dorsal fin. Scales were cleaned in water and examined under binocular microscope for the age determination. Scales were measured with the aid of a microfiche under magnification 10.0* and growth was back calculated. Sex, stage of maturation were determined by using routine methods for cyprinids (Pravdin, 1966).

The length-weight relationship was determined according to the equation given by Ricker (1975): $W = a*TL^b$, where W = fish weight in grams, TL = total length in centimeters, 'a' and 'b' are constants.

Tissue samples of gonads were fixed in Bouin's solution; paraffin wax sections of 5-7 µm were stained in hematoxilin. Ovarian development was classified into six stages according to Makeeva (1992).

Correlation and regression analyses were done to describe fecundity equations; statistical significance was tested to $p < 0.05$.

Results

European bream.A total 278 european breams were sampled including 126 females and 152 males. Females : males rate was determined as 1 : 1.2. The ages of the samples ranged between 1 to 5 years, the total length 14 – 50 cm, the standard lengths 11.5 – 41.0 cm and weights 30 to 1405 g.

Scale of european bream is cycloid with flat edges. Species belongs to fishes with large scale, 49 – 85 scales in lateral linewere determined in our study.

During the colder months the sclerites (ridges) are crowded together on scales; during the warmer months sclerites are spaced further apart (wide to each other). Annuli (true year mark) are characterized by crowded sclerites. Annuli on scale of immature european bream appears in March and of mature fish appears in May.

Rather often false rings can be found on scales as a result of different unusual events (with growth stop) during vegetation season. False ring are thin, open-ended, visible not around the whole scale, situated in zone of apart sclerites.

The relation between standard length and total length could be described by equation TL = 1,1967*SL + 0,9333 (r_{TL-SL} = 0,99).

Length – weight relationship.There were no significant differences between lengths of the sexes, so all of calculations were made using combined date (female + male).The relation between total length and weight were plotted for combined sexes (fig. 2) and could be described by equation $W = 0{,}005*TL^{3{,}2555}$ (r_{w-TL}=0,98).

Growth. Observed sizes of European bream growth is given in table 1. Back-calculated average growth of european bream different age groups is given in table 2. R. Lee's phenomenon was not manifested.

Maturation.In the first year of fish life, gonads developed slowly. In spring, all one-year-old fish of both sexes had gonads at stage 1. The gonads weighed a few mg and they appeared as colorless to translucent – brown thin threads; it was difficult to select fish by sex. Histologically, nests of oogonia and a few pre-vitellogenetic oocytes were visible.

In spring, all two-year-old females had gonads at stage II (not ripe, developing virgin). European bream were up to 27 cm in standard length and 740 g in weight. Gonads were slightly expanded, become thicker. Gonads easily could be differed by sex. Ovaries were translucent, testes were milky white; their weight was 1.1 – 12.1 g. Pre-vitellogenetic oocytes appeared in ovaries. Testes gonad edges cutting remains sharp, not melted.

Variability of three-year-old females maturation was observed; in spring, gonads of bigger fish (TL more than 27 cm) reached stage IV; eggs (0.61 – 1.39 mm) were yolk-laden and clearly visible to the naked eye. Histologically, numerous advanced vitellogenetic oocytes were present plus pre-vitellogenetic oocytes. But there was part of three-year–old females with gonads at stage II yet (smaller than 27 cm in standard length).

In spring, all three-year-old males had matured (gonads at stage IV).

In spring, all four –year-old females and males were mature and gad gonads at stage IV.

So, first maturation of European bream females in Tudakul reservoir occurs at age III-IV when males and females reach 34-36 cm of total length (30-32 cm in standard length).

White amur bream. A total 83 white amur breams were sampled including 41 females and 42 males. There were no significant differences between lengths of the sexes, so all of calculations were made using combined date (female + male). The agesof the samples ranged between 1 to 6 years, the total lengths24 to 54.1 cm, the standard length 18 to 46.6 cm and weights 105 to 2163 g.

Scale of white amur bream iscycloid. Species belongs to fishes with large scale. During the colder months the sclerites (ridges) are crowded together on scales; during the warmer months sclerites are spaced further apart

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(wide to each other). Annuli (true year mark) are characterized by crowded sclerites. Annuli on scale of immature white amur bream appears in March and of mature fish appears in May.

Length – weight relationship. The relation between total length and weight were plotted for combined sexes (fig. 3) and could be described by equation $W = 0{,}005*TL^{3{,}201}$ ($r_{w\text{-}TL}$=0,96). The relation between standard length and weight could be described by equation $TL = 1{,}107*SL + 2{,}308$ ($r_{TL\text{-}SL}$ = 0,99).

Growth.Back-calculated growth of white amur bream is given in table 3. R. Lee's phenomenon was not manifested.

Maturation. In the first year of fish life, gonads developed slowly. In Spring, all one-year-old fish of both sexes had gonads at stage 1.

In Spring, all two-year-old females had gonads at stage II. In Autumn, three-summer-old (2+) females had ovaries at stage III.

In Spring, all three-year-old females were matured and had ovaries at stage IV.

Variability of two-year-old males maturation was observed; in spring, gonads of bigger fish (TL more than 34 cm) reached stage IV, but main part of two-year–old males had gonads at stage II already. In Spring, all three-year-old males had matured (gonads at stage IV).

So, first maturation of white amur bream occurs at age III when males and females reach 34-36 cm of total length.

4. Discussion

European bream is able to expand its range of distribution by having ecological plasticity, and a high tolerance for unfavourable environmental conditions. Growth and reproduction, which usually indicated as principal factor of invasion success of species could be reason for its strong establishment of new populations. Recently, european bream is commercial fish in Uzbekistan. In natural conditions, bream was absent in the water bodies of Zarafshon River; it was introduced to the basin in 1950s from Ural River, Russia. European bream has found favourable environments in reservoirs and irrigation network in Zarafshon River basin and created self-reproduced populations. Already in 1990s, european bream permanently present in commercial fisheries. In 2003 – 2018, europea n bream annual catches were 68.8 – 400 t in Tudakul reservoir; recently bream is one of the most numerous commercial fish species; total fish catch varied 800 – 1646 t/year, fish productivity was 51 – 74 kg/ha. European bream is popular object in recreational fishing.

The european bream was among the fish the first species for which age estimation techniques were used. Such calcified structure as scale was used (Carlander, 1987). Segerstrale (1932) determined that year zone on scale includes zones of crowded and spaced apart sclerites and annuli are visible as zone of crowded sclerites. Researchers substantiated using of Fraiser-Lee's modification of direct proportional method (Segerstrale, 1932, Dauba, Biro, 1992; Zalachowsli, Wieski , 1998; Treer et al., 2003).

Fish growth study including back-calculation models are important tools in fisheries research and management that are used to determine past lengths and growth from the calcified structure of fishes. Growth and maturation data provides confidence to fisheries biologists about fish population under environments in different ecosystems or management manipulations (Klumb et al., 1999). Fish growth can be affected by such factors as annual water temperature rate, fish density in population, food availability and food quality, etc.(Bonar et al., 1993). Our data shows, that in Tudakul reservoir Bream growth increased at the higher rate during first 3 years of age, whereas, during furtheryears, growth rate slowed due to the first maturation. European bream growth in studied population is very high in compare with other regions of modern species distribution (table 4).

In Uzbekistan European bream reach first maturation at age 3 years in different water bodies (Kamilov, 1973; Amanov, 1985; Salkhov et al., 2001). Our data is well agree with those data. At the same time, european bream in Tudakul reservoir has one of the highest growth rate in Uzbekistan.

White amur bream. Introduction of Chinese herbivorous cyprinid fishes into Uzbekistan water bodies was managed in the early 1960s.Totally 47 alien species were introduced to the water bodies of Uzbekistan including 23 special-purpose and 24 accidental (Kamilov, 1973; Salikhov et al., 2003; Yuldashov, 2018).At that time white amur bream (also a representative of Chinese ichthyofauna) was not noticed in Uzbekistan. But, in 2000s this species was marked firstly in network of Amu-Bukhara channel which takes water from Amudarya River and transfer it to lower stream of Zarafshon River in Uzbekistan.Apparently, individuals of white amur bream accidentally were gotten in those parties of Chinese fishes which were introduced into fish farms in neighboring Turkmenistan (also belonged to the basin of Amudarya River). Species has got acclimatized in Turkmenistan, entered main stream of Amudarya River and passed through Amu-Bukhara channel into network of Lower Zarafshon River including Tudakul reservoir.

Recently, white amur bream stock in Tudakul reservoir includes fish with age up to 6- year-old generation. Species has rather fast growth, reach large size and entered fisheries catches during last several years. Mainly, fish of both sexes mature for the first time at age III years when fish reach 365 – 36 cm in length. One can concludes that there is broodstock of this species and natural reproduction in Tudakul reservoir.

Biology of white amur bream is poorly studied; we could not find data in literature for comparison with data from Tudakul reservoir.

Table 1. Average body size of European bream of different ages in the Tudakul reservoir (above the line – the scatter, below the line 0 the average)

Characteristic	*Age, years*				
	I	*II*	*III*	*IV*	*V*
Total length, cm	14 – 32 22.5	21 – 39 28.6	29 – 47 38.9	40 – 45.5 42.7	40 – 48.5 47.3
Weight, g	30 – 395 127.2	105 – 760 291.7	2985 – 1305 778.4	755 – 1250 1040.1	1140 – 1405 1315
N, samples	92	52	108	23	3

Table 2. The mean calculated (TL, см) determined by back-calculation method according to age group of european bream (males and females combined).

Age group, years	*N, samples*	*Total length, cm*				
		TL_1	TL_2	TL_3	TL_4	TL_5
I	92	13.3				
II	52	13.5	28.6			
III	108	13.5	28.4	38.5		
IV	23	14.5	26.1	35.5	42.8	
V	3	13.8	23.6	32.3	41.1	48.6
Mean length		***13.52***	***28.12***	***37.87***	***42.65***	***48.56***
Mean annual increment		***13.52***	***14.60***	***9.75***	***4.78***	***5.91***

Table 3. The mean calculated (SL, см) determined by back-calculation method according to age group of white amur bream (males and females combined), Tudakul reservoir, Uzbekistan.

Year class	Age group	Number fish	Back-calculated lenth according to age group					
			SL_1	SL_2	SL_3	SL_4	SL_5	SL_6
I	I	17	11,9					
II	II	10	12,4	22,2				
III	III	7	13,9	25,4	31,9			
IV	IV	15	13,7	25,1	33,9	38,9		
V	V	13	12,3	22,5	30,6	37,9	41,6	
VI	VI	3	11,5	21,2	29,8	36,8	41,8	44,2
Mean length			***12,6***	***23,3***	***31,5***	***37,9***	***41,7***	***44,2***
Mean annual increment			***12,6***	***10,7***	***8,3***	***6,3***	***3,9***	***2,4***

Table 4. Growth of European bream in different regions of the range (TL – total body length, SL – standard body length)

Water body	Length	Length at age, cm									Author
		I	II	III	IV	V	VI	VII	VIII	IX	
Lake Dąbie	TL	6.4	11.8	16.9	21.4	25.4	29.1	32.4	35	37.6	Zalachowsli, Wieski,1998
Danube River, Croatia	TL	8.1	13.3	17.6	21.2	24	26.4	28.5	30.5	32.4	Treer et al., 2003
Lake Balaton, Hungary	SL	7.2	11.4	14.9	17.8	22.1	24.2	25.9	27.6	28.8	Dauba, Biro, 1992
Lake Balkhash, Kazakhstan	SL	-	11.1	15.3	18.7	21.6	24.5	26	28	30	Ribi…, 1988
Shardarya reservoir, Kazakhstan	SL	-	17.4	22.5	27.1	30.8	34.4	37.7	39.8	41.4	Ribi…, 1988
Kapchagay	SL	-	16.0	22.8	25.9	27.5	29.5	31.2	33.2	34.5	Ribi …, 1988

ISSN- 2394-5125 VOL 7, ISSUE 08, 2020

reservoir,Kazakhstan											
Tudakul reservoir, Uzbekistan	SL	10.5	22.7	30.9	34.9	39.8					Our data (this study)
	TL	13.5	28.1	37.9	42.7	48.6					

Figure 1. Tudakul reservoir (Zarafshon River basin) in Uzbekistan.

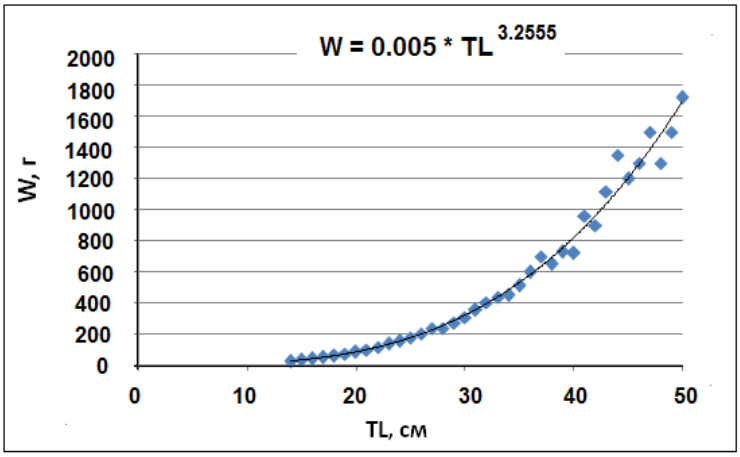

Figure 2. Total length – weight relationship of european bream in Tudakul reservoir, Uzbekistan

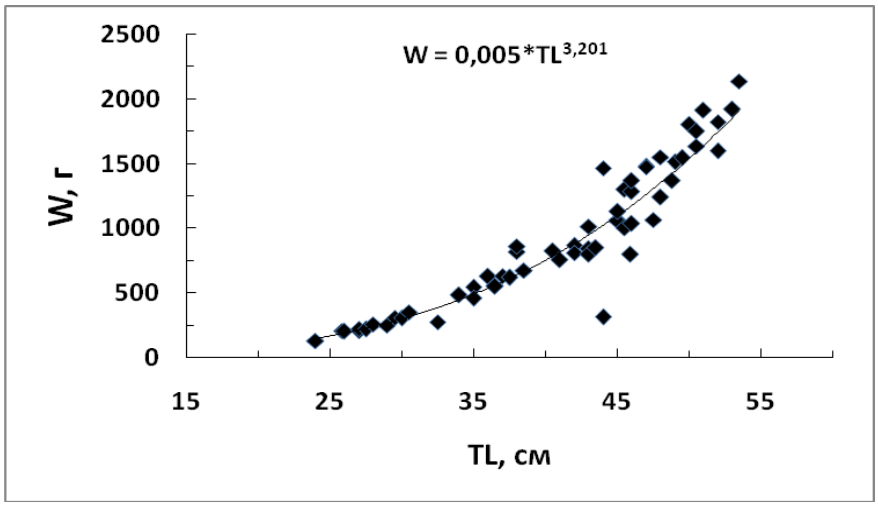

Figure3. Total length – weight relationship of white amur bream in Tudakul reservoir, Uzbekistan.

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