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MORPHOLOGY, AGE AND GROWTH OF EUROPEN BREAM (ABRAMIS BRAMA) IN TUDAKUL RESERVOIR IN UZBEKISTAN

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Abstract:
Modern ststae of invasive european bream (Abramis brama) was studied in Tudakul reservoir (lower stream of Zarafshen River) in 2020-2022. Fins rays formula was D II 9 - 10, A (I) II 24-27;47-54 scalesin lateral lineand 19-21gil rakers were determined. Plastic indexes according to tradinional for cyprinids so as indexes of «truss protocol» are given. A significant difference in the value of a number of plastic indexes was revealed between immature and matured european bream. The ages of the samples ranged between 1 to 5 years, the total length 144.3 – 444.9 mm, the standard lengths 113.3 – 337.0 mm and total weights 27.0 – 845.1 g. The relationship between the total length (TL) and weight (W) was described by $W = 0{,}0436*TL^{2{,}7925}$ (r=0,98). The mean back calculated total length was 13.2 cm at age I; 23.3 cm, II; 30.1 cm, III; 43.4 cm, IV; 44.0 cm.

Keywords: European bream, Abramis brama, fish morphology, age, growth, fecundity, Tudakul reservoir, Uzbekistan

In conditions of water deficiency and strong competition for its use between different water users, methods of using inland water bodies for fish production are promising. The activities are constantly aimed at increasing the fish productivity of water bodies and their rational use. Methods of artificial formation of commercial ichthyofauna due to the introduction of new fish species can be effective. n arid Uzbekistan, located in the Aral Sea basin in Central Asia, natural fish resources are extremely poor and could provide the actual fish productivity of reservoirs at the level of 1-3 kg/ha/year. In this regard, since the second half of the 20th century, the introduction of valuable fish species into local water bodies has been used (Luzanskaya, 1965; Kamilov, 1973; Kamilov, Urchinov, 1995).

The European bream (Abramis brama L.), is a representative of the carp family (Cyprinidae). It is widely distributed in inland plain water bodies of the central and northern parts of Europe, in the basins of the Caspian, Black, Azov Seas. The species was artificially introduced to the basins of the rivers Ob, Irtysh, Yenisei. In the natural state of the Aral Sea basin, the european bream lived in the Aral itself and in the lower reaches of the Amudarya and Syrdarya (Berg, 1949; Kamilov, 1973). Since the 1950s, with the large-scale construction of new irrigation reservoirs in the plain part of the basin, european bream has been introduced into them with aim to increase fish productivity. The european bream was introduced from the population of the Ural River (Russia). In particular, european bream was introduced into the reservoirs of the Zarafshan river basin (the peculiarity of this large river is that its waters are so actively used for irrigation that it does not reach anywhere and dries up in the desert, do not enter the channel of the Amu Darya for many centuries). The bream has found favorable environ-

ments here, began to reproduce, settled in the middle and lower reaches of the river, including the Tudakul reservoir. Since the 1960s-70s, the bream has had the status of an important commercial object in the reservoirs of Zarafshan (Amanov, 1985; Salikhov et al., 2001; Yuldashov, Kamilov, 2018). The biological features of the introduced European bream in the Zarafshan basin were studied mainly until the 1990s; partially in the 2010s, the growth and maturation of the bream of this reservoir was studied under the conditions of using pasture aquaculture technology (Kamilov et al., 2020). The aim of this work was to study the features of the morphology of the European bream of the self-reproducing stock in the Tudakul reservoir at the present time, as well as to assess the current composition of the stock by age, growth.

Site description. Tudakul reservoir (fig. 1) was created for irrigation purposes in the lower reach of Zarafshan River, Uzbekistan (39°51'15"N 64°50'29"E). Climate is temporary and extremely continental. In the region, summer is very hot (average monthly air temperature in July is about 29 ^{o}C, in daytime period with air temperature 35-42^{o}C lasts for 1.5 months). At the same time, winter is rather cold (average monthly air temperature in January is about -2^{o}C, standing water bodies often are covered by ice for 1.5 months). The Tudakul reservoir is very big, it's total area is about 22 000 ha, average depth is about 5 m, maximal depth is 22 m. The main function of the reservoir is irrigation for agriculture. In 2004 - 2015, additionally the reservoir was used as water body with culture based fisheries. Fishery enterprise - tenant of the reservoir has created local hatchery and every autumn reservoir was stocked by culture cyprinids summerlings (silver carp, Hypophthalmichthys molitrix, bighead carp, H. nobilis, common carp, Cyprinus carpio, and grass carp, Ctenopharyngodon idella). The stocking rate was 50-120 summerlings/ha. In that regime commercial fishermen used only seines with large mesh (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 500-1500 tones/year in 2009-2018 years. Since 2017, the new tenant of the reservoir has actually stopped stocking of the reservoir with cyprinids summerlings, stopped using seines, and transferred fish capturing to coastal teams equipped only with gill nets (with mesh 36 - 60 mm). Fish catches from the reservoir have been reduced to 150-300 tons/year. Stocks of local fish found themselves in new conditions.

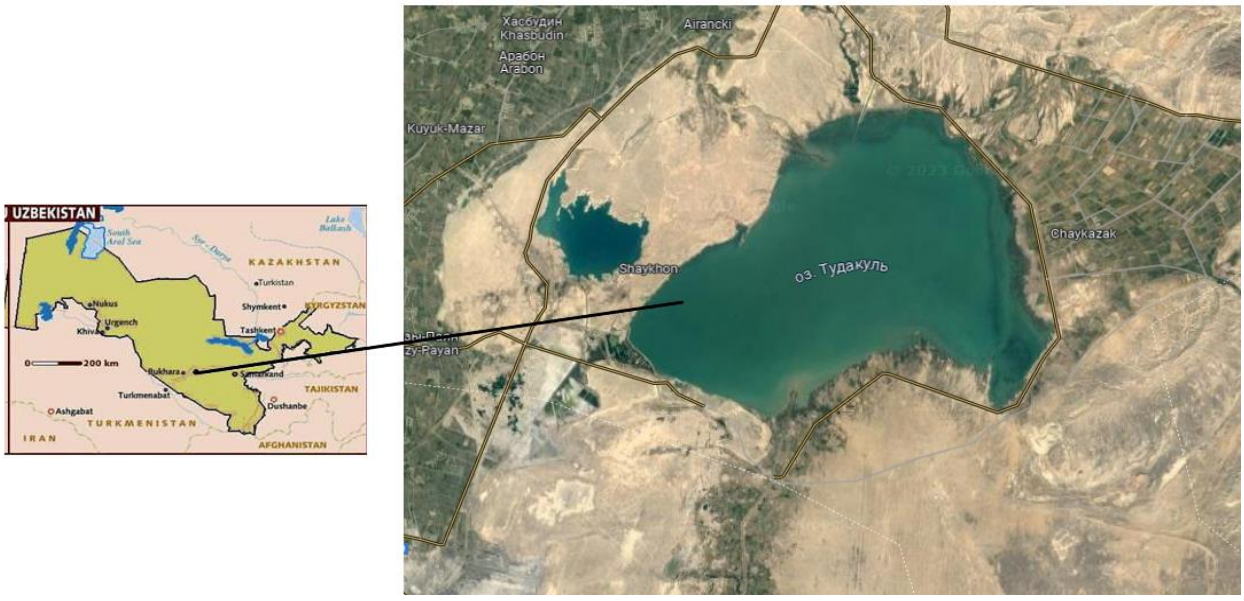

Fig. 1. Tudakul reservoir and it's location in Uzbekistan

Material and Methods

European bream samples were collected from November to April in 2020 – 2021, 2021 – 2022 in the Tudakul reservoir by using gill nets with 16, 24, 32, 36, 40, 50, 60, 70 mm in mesh size. Morphological identification and systematic status of snowtrout were made, using characters given by Ribi … (1988) and Salikhov et al. (2001).

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 andgonads 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.

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

Meristic characters were counted in each fish. Plastic characteristics were measured according to the measurement scheme for cyprinids (Pravdin, 1966). Ten landmarks along the fish body perimeter were identified (Fig. 2). Each fish was photographed at a strict right angle using a fixed tripod. The photographs were used to measure the distances in a straight line between landmarks, i.e. made up the so-called. "truss" protocol (Strauss, Bookstein, 1982; Strauss, Bond, 1990). The sounding lines are specified in the following format: for example, "2–4" indicates a straight line measurement between landmarks 2 and 4. The absolute plastic feature characters were converted into indexes in %% of the standard body length.

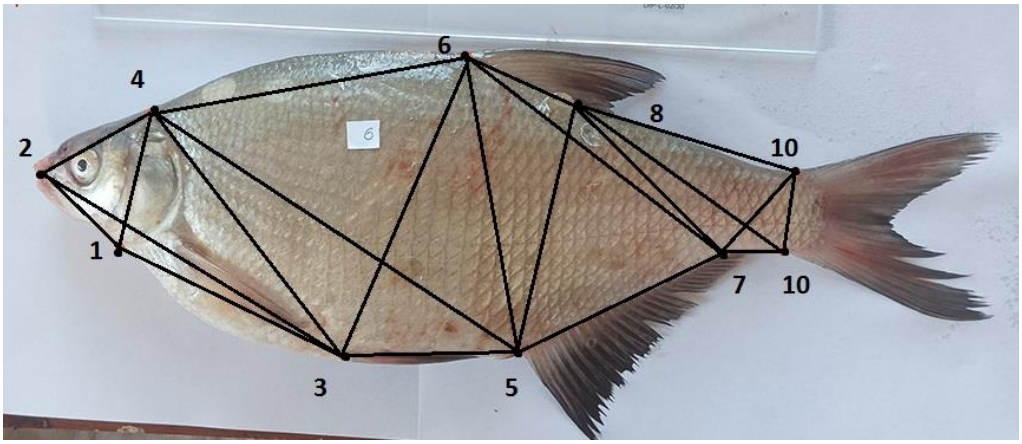

Fig. 2. Landmarks and 'truss-protocol' measurements of european bream from Tudakul reservoir

Results

A total 149 european breams were sampled including 73 females and 76 males; females : males rate was close to 1 : 1. The ages of the samples ranged between 1 to 5 years, the total length 144.3 – 444.9 mm, the standard lengths 113.3 – 337.0 mm and total weights 27.0 – 845.1 g.

European bream has cycloid scales with flat edges. 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 crowdedsclerites. Annuli on scale of immature european bream appears in March and of mature fish appears in May.

A strong positive correlation was found between the standard length and the total body length of the bream ($r_{SL\text{-}W}$ = 0,99), this relationship could be reliably characterized by the regression equation: SL(cm) = 0.8527*TL(cm) - 1,1982.

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. 3) and could be described by equation $W = 0{,}0436*TL^{2{,}7925}$ ($r_{w\text{-}TL}$=0,98). The relation between european bream standard length and total weight could be described by regression: $W\ (g) = 0{,}0108*SL^{3{,}2081}$ ($r_{W\text{-}SL}$=0.95).

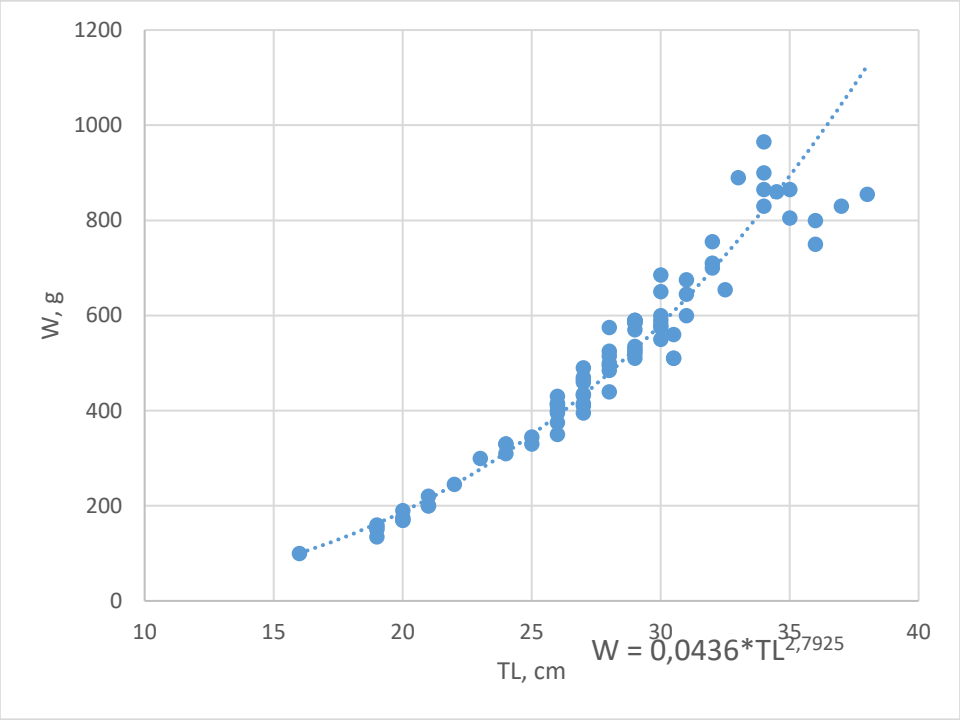

Fig.3. Total length – weight relationship of european bream in Tudakul reservoir, Uzbekistan, 2023

Meristic characters. In european bream, the formula of the rays of the dorsal fin wasdetermined as II 9-10, the formula of the rays of the anal finII 24 – 27. In the lateral line 47–54 (average 50) scales were identified; on the first gill arch there were 19–21 rakers.

Plastic characteristics of european bream according to traditional scheme for cyprinids are shown in Table 1. Indexes for “truss-protocol” in relation to the standard body length are given in table 2. The achievement of the sexual maturation of the european bream occurs when the fish reach a standard body length of about 28 - 30 cm. Based on this, we divided the sample into two groups: immature and matured. Note that no significant difference in plastic features was found between the sexes in both groups, so both sexes were combined in each group.

Table 1.Indexes of plastic morphological characteristics of european bream (%% of standard length), Tudakul reservoir, Uzbekistan, 2023

Index	Immature		Matured	
	Min – Max Mean + S_d	CV, %	Min – Max Mean + S_d	CV, %
Total length	125.9 – 130.3 127.84+ 0.82	1.4	115.7 – 133.5 121.88+ 0.92	3.1
Body length	72.6 – 79.2 77.31+1.19	3.4	77.7 – 85.7 79.86+0.52	2.7
Snout length	5.3 – 5.7 5.41+ 0.08	3.2	3.1 – 5.5 4.41+ 0.14	12.6
Eye diameter	5.8 – 6.8 6.37+ 0.17	5.9	3.6 – 5.1 4.28+ 0.12	11.1
Postorbital length of the head	9.9 – 11.4 10.67+ 0.28	5.8	3.8 – 13.2 10.47+ 0.45	17.9
Head length	20.9 – 22.0 22.30 + 0.36	3.7	16.9 – 22.8 19.25 + 0.34	7.4
Head height at the back	16.4 – 18.8 17.87 + 0.44	5.6	16.8 – 19.8 18.18 + 0.20	4.5
Maximum body height	30.9 – 38.4 35.16+1.39	8.9	36.7 – 42.4 38.66 + 0.36	3.9
The smallest body height	10.0 – 11.5 10.84+ 0.25	5.1	9.7 – 13.0 11.07+ 0.20	7.4
Antedorsal distance	53.1 – 58.5 56.6+ 0.92	3.6	53.9 – 60.8 57.90+ 0.46	3.2
Postdorsal distance	32.8 – 39.3 35.69+1.14	7.2	30.7 – 37.6 34.42+0.53	6.4
Caudal – peduncle length	11.5 – 16.7 14.75+ 0.90	13.7	11.4 – 15.6 13.32+ 0.27	8.4
Dorsal- fin base length	12.4 – 18.9 15.86 + 1.09	15.3	11.8 – 18.7 15.31 + 0.52	14.0
Dorsal- fin the greatest height	25.1 – 28.0 26.53 + 0.52	4.4	21.2 – 29.5 24.40 + 0.58	9.9
Anal- fin base length	23.6 – 30.0 26.63+1.03	8.7	24.4 – 30.4 27.62 +0.36	5.3
Anal- fin the greatest height	17.3 – 18.9 17.83+ 0.29	3.7	12.7 – 18.2 15.97+ 0.36	9.3
Pectoral- fin length	19.1 – 21.8 19.91+ 0.47	5.3	17.1 – 22.3 19.92+ 0.31	6.4
Ventral- fin length	14.2 – 17.1 15.08+ 0.51	7.5	14.1 – 18.1 16.11+ 0.28	7.2
Pectoral – pelvic fins distance	21.3 – 23.0 22.42+ 0.32	3.2	22.2 – 27.4 25.07+ 0.31	5.1
Ventral – anal fins distance	17.2 – 21.4 19.69+ 0.72	8.2	16.6 – 22.8 20.76+ 0.42	8.3

Table2. Indexes of «truss-protocol» morphological characteristics of european bream (%% of standard length), Tudakul reservoir, Uzbekistan

Index	Immature		Matured	
	Min. – Max. Mean+S_d	CV, %	Min. – Max. Mean+S_d	CV, %
2 – 4	16.8 – 19.7 18.33+ 0.52	6.3	15.4 – 19.3 17.38+ 0.24	5.7
4 – 6	37.3 – 41.0 38.76 + 0.66	3.8	37.5 – 44.2 41.22+ 0.45	4.5
6 – 8	12.9 – 20.1 16.51+1.26	17.1	12.6 – 21.0 15.81+0.65	16.9
8 – 10	24.3 – 32.8 28.95+1.59	12.3	23.0 – 32.4 28.30+0.63	9.2
9 – 10	10.2 – 12.2 10.90+ 0.34	6.9	10.3 – 12.6 11.48+ 0.16	5.7
7 – 9	6.3 – 11.0 8.30+ 0.77	20.7	6.5 – 9.6 8.26+ 0.24	12.0
5 – 7	25.3 – 30.2 28.05+ 0.81	6.4	25.7 – 30.4 28.07+ 0.28	4.1
3 – 5	19.3 – 21.4 20.41+ 0.39	4.3	19.2 – 24.1 21.41+ 0.35	6.7
2 – 3	44.3 – 46.8 45.44+ 0.43	2.1	43.3 – 47.2 45.36+ 0.32	2.9
1 – 2	14.8 – 18.4 16.90 + 0.65	8.6	13.3 – 18.0 15.66+ 0.40	10.5
1 – 4	16.4 – 20.0 18.54+ 0.61	7.4	17.3 – 20.3 18.95 + 0.19	4.2
1 – 3	28.1 – 30.1 29.25+ 0.38	2.9	27.16– 32.3 30.28+ 0.33	4.5
3 – 4	35.1 – 37.6 36.35+ 0.52	3.2	36.9 – 41.0 39.07+ 0.29	3.0
5 – 6	35.3 – 37.7 36.83+ 0.42	2.6	36.3 – 40.9 38.96+ 0.30	3.2
7 – 8	23.6 – 30.2 25.83+1.19	10.3	22.9 – 28.4 26.36+0.45	7.0
4 – 5	52.8 – 55.2 54.16 +0.49	2.0	52.3 – 58.6 55.44+0.39	2.9
3 – 6	34.5 – 37.5 35.80 + 0.57	3.5	38.3 – 44.8 35.80 + 0.57	3.9
6 – 7	39.7 – 43.5 41.85+ 0.64	3.4	29.6 – 43.8 40.56+ 0.74	7.6
5 – 8	29.0 – 31.0 30.03+ 0.33	2.4	29.2 – 33.9 32.43+ 0.31	3.9
7 – 10	11.6 – 14.1 13.12+ 0.43	7.3	12.7 – 15.4 14.33+ 0.19	5.6
8 – 9	29.8 – 36.2 32.73+1.04	7.1	27.9 – 35.3 32.70+0.52	6.6

Growth. The determined back-calculated growth of european bream in Tudakul reservoir is given in Table 2.

Table 2. The mean total length determined by back-calculation method according to age groups of european bream (males and females combined)

Age group	N	Back-calculated standard length according age group, cm				
		TL_1	TL_2	TL_3	TL_4	TL_5
1	39	16.5				
2	40	14.8	26.7			
3	38	11.0	21.7	30.3		
4	27	11.3	23.9	34.1	42.1	
5	5	10.8	22.2	31.6	34.9	44.0
MeanTL_i, cm		**13.2**	**23.3**	**30.1**	**43.4**	**44.0**
Annual increment, cm/year		**13.2**	**10.1**	**6.8**	**13.3**	**0.6**

Discussion

The introduction of new promising fish spaces could increase fish productivity of the lentic water body, from one hand. From the other hand, biological invasions are one of the most major issues causing threats to the conservation of local fish fauna biodiversity. In the most cases, introduced species fail to establish new population. The establishment success of an introduced species highly depends on its intrinsic ecological and biological characteristics (e.g. reproduction guild, fecundity, dietary breadth). (Blanchet et al., 2007; Gozlan et al., 2010; etc). During large-scale irrigation construction in the Aral Sea basin, program of artificial commercial fish fauna creation in new reservoirs was developed in Uzbekistan, including the one for Tudakul reservoir (Kamilov, 1973; Yuldashov, Kamilov, 2018).

In Zarafshan River basin (Uzbekistan), one of such invasive species is european bream. The species area includes central and northern part of Europe, basins of Caspian, Black, Azov seas. Bream was introduced to the basins of the rivers Ob, Irtysh, Yenisei (Russia) (Atlas…, 2003) . In the Aral Sea basin the specie lived in the Aral, where he vanished during extremely water salinization in the second half of 20th century. 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 (Kamilov, 1973; Amanov, 1985; Salikhov et al., 2001; Yuldashov, 2018).

In the area of the european bream species, the following mersitic characters are indicated: rays D II-III 6-7 (8) and A II-III 10-17, 43-53 scales in the lateral line, 25 gill rakers on the first gill arch. including in the Ural River (donor reservoir): (Berg, 1949; Atlas…, 2003). Our data show that in the formed population in the environments of Tudakul reservoir (60 years after the introduction) meristic characters are the following: D II 9-10, A (I) II 24-27, in the lateral line 47-54 (average 50) scales, on the first gill arch 19 - 21 rakers.

With regard to plastic characters, there were significant differences between immature and sexually matured individuals. Between immature and sexually mature snowtrouts significant differences in the total length index and in 6 out of 19 morphological indexes according to the traditional scheme for cyprinids were determined. Also, there were significant differences 6_ out of 21 indexes according to 'truss – analysis' protocol (table 3). In this regard, when comparing the morphological characteristics of fish from different populations of european bream, one should compare immature and mature size - age groups separately.

Table 3. Values of Student's "t-test" of significant differences in sample mean arithmetic indicators between immature and mature european bream in Tudakul reservoir (standard t-test = 2.09)

The classic scheme of measurements of cyprinids		The "truss-protocol" indexes	
Indexes	t-value#	Indexes	t-value#
Pectoral – pelvic fins distance	-6.00	3-6.	-7,74
Maximum body height	-2.43	5-8.	-5,30
Dorsal- fin the greatest height	2.71	3-4.	-4,60
Anal- fin the greatest height	4.01	5-6.	-4,12
Total length	4.83	4-6.	-3,09
Head length	6.07	7-10.	-2,57
Snout length	6.44		
# the t-test value with a minus sign indicates that the index in mature fish is greater than that of immature ones.			

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 data provides confidence to fisheries biologists about fish population under environments in different ecosystems or management manipulations. Fish growth can be affected by such factors asannual water temperature rate, fish density in population, food availability and food quality, etc. Our data shows, that in Tudakul reservoir European bream growth increased at the higher rate during first 3 years of age, whereas, during further years, growth rate slowed.

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