Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2023; 11(2): 01-08

Received: 03-11-2022
Accepted: 05-12-2022

NJ Mustafayev
Azerbaijan State Agrarian University, Ganja, Azerbaijan

Sh. R Ibrahimov
Azerbaijan State Agrarian University, Ganja, Azerbaijan

NM Hasanov
Azerbaijan State Agrarian University, Ganja, Azerbaijan

Sh. A Veliyev
Azerbaijan State Agrarian University, Ganja, Azerbaijan

Kh M Safarov
Azerbaijan State Agrarian University, Ganja, Azerbaijan

GK Ismayilov
Azerbaijan State Agrarian University, Ganja, Azerbaijan

TS Khudiyeva
Azerbaijan State Agrarian University, Ganja, Azerbaijan

LI Mammadova
Azerbaijan State Agrarian University, Ganja, Azerbaijan

GB Mustafayeva
Azerbaijan State Agrarian University, Ganja, Azerbaijan

Corresponding Author:
NJ Mustafayev
Azerbaijan State Agrarian University, Ganja, Azerbaijan

Biological characteristics of main commercial fish of the shamkir reservoir

NJ Mustafayev, Sh. R Ibrahimov, NM Hasanov, Sh. A Veliyev, Kh. M Safarov, GK Ismayilov, TS Khudiyeva, LI Mammadova and GB Mustafayeva

DOI: https://doi.org/10.22271/j.ento.2023.v11.i2b.9163

Abstract
In 2019-2022, an ichthyological study of six species of the main commercial fish was carried out at the Shamkir reservoir on the Kura River. Studies have shown that the ratio of males and females among the main fish species caught in this reservoir was approximately 1:1 for bream (*Abramis brama orientalis*), zander (*Sander lucioperca*) and carp (*Cyprinus carpio*), 2:3 for Prussian carp (*Carassius auratus gibelio*), 5:4 for Caspian roach (*Rutilus caspicus*), and 3:2 for Danubian bleak (*Chalcalburnus chalcoides*). In all fish species, the difference between the body weight of males and females without viscera was greater than the difference between their total body weight, which was due to the presence of eggs in females. For the same reason, the fullness according to Fulton of males and females more differs, than fullness according to Clark. Comparition of the different age groups shows that the growth speed of lenth and mass of the carp and zander were higher than of the rest fish. The growth rate of roach and Danubian bleak was the lowest compared to other fish.

Keywords: Caspian roach, danubian bleak, bream, carp, prussian carp, zander

1. Introduction
The Shamkir Reservoir (41°03'23.8"N 45°48'34.0"E – 40°56'25.0"N 46°10'43.5"E) was created in 1982 as a result of the construction of a dam on the middle course of the Kura River. Its length is 40 km, width is 3 km on average, maximum depth was 70 m, water surface area is 115.95 km^2, total volume is 2677 mln. m^3, useful volume 1425 mln, m^3 [16, 10]. Apart from the Kura river, another two rivers – Zayamchay and Shamkirchay flows here from the southwest. Many of the fish living in the middle reaches of the Kura River can be found in the reservoir. According to literature data [3, 4], 19 species of fish were recorded here in 1985-1990, 16 species in 2001-2005, and 27 species during the period of our research. Among them, the 6 species mentioned below are commercially important: Caspian roach – *Rutilus caspicus* (Jakovlev, 1870), Danubian bleak – *Chalcalburnus chalcoides* (Güldenstädt, 1772), oriental bream – *Abramis brama orientalis* Berg, 1949, common carp – *Cyprinus carpio* Linnaeus, 1758, Prussian carp – *Carassius auratus* gibelio Bloch, 1782, and zander – *Sander lucioperca* (Linnaeus, 1758). In different years 14.0-45.6 t of bream, 1.7-10.7 t of roach, 1.4-11.5 t of zander, 0.2-7.9 t of Prussian carp, 0.4-5. 3 t of carp and 0.25-2.6 t of Danubian bleak were caught in the reservoir. Until our research, there was information about the fries of some of these fish in the literature [2]. However, despite the fact that these fishes were well studied in a number of another water bodies of Azerbaijan [12, 13, 14, 15] and the great importance of this reservoir for fisheries, the biological characteristics of the commercial fishes here were very poorly studied [8, 20, 9, 11].
In connection with the above, the purpose of this article is to show and analyze information on the biological characteristics of the main commercial fish of the Shamkir reservoir.

2. Material and Methods
In various seasons of 2019-2022, 297 roachs, 292 Danubian bleaks, 511 breams, 274 carps, 303 Prusian carps, 370 zanders were caught from some points of the Shamkir reservoir, mainly using set and drag nets and studied by us (Fig. 1). In addition, some fish for study were also taken from the fishing brigades operating in the reservoir. Laboratory studies were carried out

at the "Technology of fish products production" department of the Azerbaijan State Agrarian University. Collection and processing of materials was carried out on the basis of generally accepted ichthyological methods [18, 21, 7, 19].

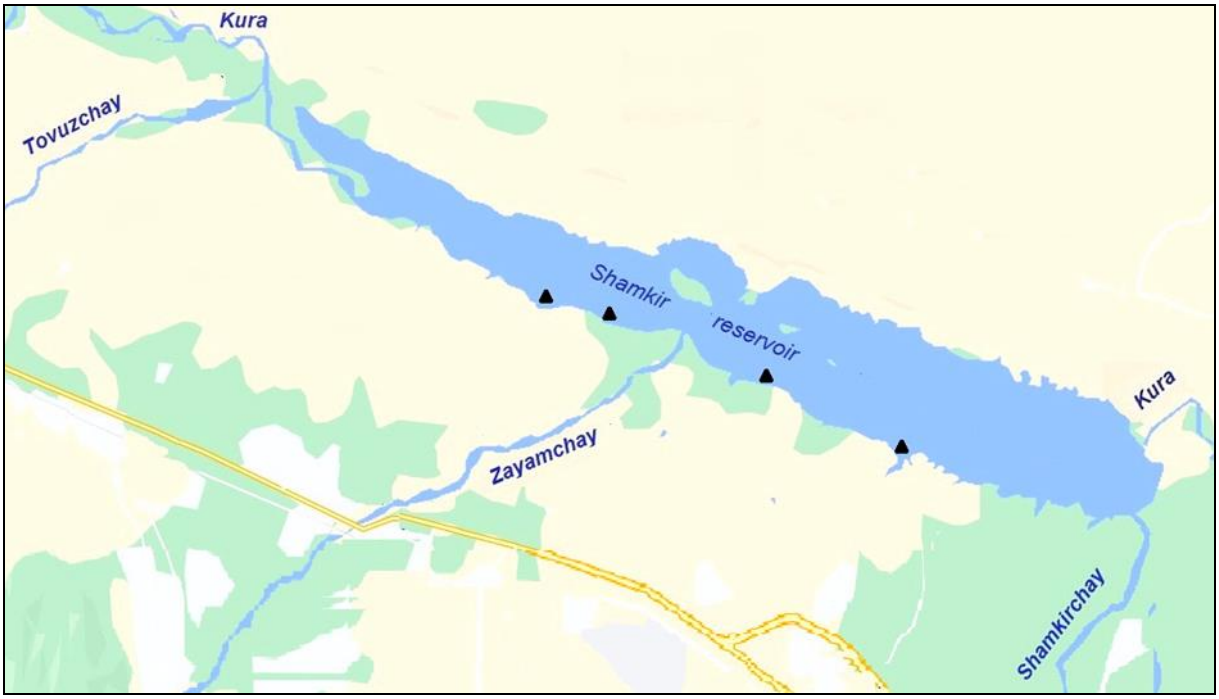

Fig 1: Map of the area of our research (▲ - the fishing points)

The identification of species of the caught fish was determined according to the relevant literature sources [1, 5, 6]. The sex of each fish was identidicated, the total and standard length of the body, and the total mass and mass without viscera were measured. To determine the age of the fish, the annual rings on the scales taken from the part between the dorsal fin and the lateral line organ were counted under a microscope.

The coefficients of fullness of fish according to Fulton and Clark were determined using the following formulas:

$$F = \frac{W \cdot 100}{SL^3}$$

and

$$C = \frac{W_1 \cdot 100}{SL^3}$$

Here
F – coefficient of fullness according to Fulton;
C – coefficient of fullness according to Clark;
W – total mass of fish;
W_1 – mass of fish without viscera;
SL – standard length of fish.

All morphometric characteristics were processed by the variation-statistical method [17], the arithmetic mean number by the variation lines using the following formula:

$$M = \frac{\Sigma vp}{n}$$

Here
M – average arithmetic number;
Σ – plural sign;
v – variation row;
p – the number of fish in each variation row;
n – the total number of fish.

For determination the difference between the biological indicators of male and female fish in a percentage we offer the following formula:

$(P_f\text{-}P_m) : (P_{f+}P_m) \times 100\%$.
here
P_f – the indicator of females
P_m – the corresponding indicator of males.

If there was no difference between the indicators of female and male fish (Pd-Pe=0), the result obtained was 0%, if the indicators of females were higher than those of males, the result was expressed as a positive percentage, if the indicators of males were higher than those of females, it was expressed as a negative percentage.

3. Results and Discussion

Caspian roach

162 of the 297 specimens of roach obtained from the Shamkir reservoir were male and 135 were female, that was, the ratio of the number of males to the number of females was approximately 5:4. The total length of the fish body was 18.2-33.7 (on average 28.47±0.41) cm, the standard length was 15.8-28.3 (23.89±0.39) cm, the total mass was 89.0-447.8 (268.42±18.53) g, body mass without viscera 74.0-386.7 (219.57±16.28) g, Fulton coefficient 1.78-2.45 (2.18± 0.02), the Clark coefficient 1.67-2.15 (1.93±0.02). The biological indicators of males and females of roach, differences between them are given in table 1.

Table 1: Biological indicators of males and females of roach in the Shamkir reservoir, fluctuations (on average)

Indicators	Males	Females	Difference, %
Toral length of body, cm	18.2-30.9 (25.84±0.43)	19.3-33.7 (31.05±0.45)	9.2
Standart length of body, cm	15.8-26.5 (20.28±0.51)	16.2-28.3 (26.48±0.43)	12.9
Total mass of body, g	89.0-312.7 (203.18±19.41)	98.7-447.8 (318.72±19.57)	27.7
Mass of body without viscera, g	74.0-243.8 (163.48±18.72)	82.9-386.7 (236.82±17.48)	21.2
Fulton coefficient	1.78-2.24 (2.16±0.03)	1.85-2.45 (2.19±0.03)	0.7
Clark coefficient	1.67-2.09 (1.92±0.03)	1.71-2.15 (1.94±0.02)	0.5

The table shows certain differences were observed between the biological indicators of male and female fish. The indicators of female fish for all characteristics were higher than those of males. When we compare the percentages of the differences in the indicators of male and female fish, it can be seen that the difference in the standard length of the body (12.9%) was greater than the difference in the total length of the body (9.2%). When measuring the total body length, the caudal fin was also taken into account, but it was not taken into account in the standard body length, This means that males have a longer caudal fin relative to body length than females.

The total body mass of females was also higher than that of males. When we compare the percentages of the differences in the body mass indicators between male and female fish, it can be seen that the difference in total body mass of males and females (27.7%) was more than the difference in body mass without internal organs (21.2%). This was probably due to the fact that the ratio of the mass of the spawn of female fish to their total body mass before reproduction was greater than the ratio of the mass of the testes to total body mass of males.

All the fish studied were sexually mature. They were distributed by age groups as follows: 2-year-olds – 92 specimens (30.9% of all fish); 3-year-olds – 103 units (34.7%); 4-year-olds – 62 specimens (20.8%); 5-year-olds – 24 specimens (8.2%); 6-year-olds – 16 specimens (5.4%). As it can be seen, two- and three-year-old specimens maked up the main mass of fish, i.e. 65.6%. The small share of 4-6-year-old specimens in fishing indicates that there was a strong pressure of excessive fishing on the population.

The biological indicators of the roach by age were as follows: in 2-year-old fish the total length of the body was 18.2-21.7 (20.38±0.29) cm, the standard length of the body was 15.8-18.4 (17.43±0. 21) cm, full body mass 89.0-125.9 (108.87±2.96) g, body mass without viscera 74.0-109.2 (97.27±2.91) g, fullness coefficients according to Fulton 1.85-2.31 (2.14±0.04), according to Clark 1.72-2.05 (1.89±0.03); in 3-year-olds the total length of the body was 20.2-24.3 (22.87±0.31) cm, the standard length of the body was 16.9-20.1 (18.97±0.26) cm, the total mass of the body was 112.5-171.8 (141.27±5.46) g, body mass without viscera 93.4-148.1 (114.65±4.89) g, fullness coefficients according to Fulton 1.90-2.35 (2.19±0.03), according to Clark 1.81-2.13 (1.98±0.04); in 4-year-olds the total length of the body was 22.4-28.1 (25.43±0.42) cm, the standard length of the body was 18.1-23.4 (20.31±0.47) cm, the total mass of the body was 145.5-264.2 (191.27±8.96) g, body mass without viscera 117.3-212.5 (159.53±8.26) g, fullness coefficients according to Fulton 1.95-2.45 (2.18±0.04), according to Clark 1.63-2.07 (1.92±0.05); in 5-year-olds the total length of the body was 26.5-30.6 (28.11±0.43) cm, the standard length of the body was 21.3-26.2 (23.29±0.47) cm, full mass 212.4-372.3 (266.56±15.47) g, body mass without viscera 178.1-324.5 (223.58±12.86) g, fullness coefficients according to Fulton 1.82-2.29 (2.18±0.04), according to Clark 1.78-2.15 (1.94±0.03); in 6-year-olds the total length of the body was 29.3-33.7 (31.05±0.45 cm), the standard length of the body was 24.5-28.3 (26.48±0.43) cm, the total mass of the body was 298.5 -447.8 (318.72±19.57) g, body mass without viscera 254.3-386.7 (276.82±17.48) g, fullness coefficients according to Fulton 1.71-2.26 (2.16±0.03), according to Clark 1.68-2.12 (1.91±0.02).

Danubian bleak

292 of the 176 specimens of this fish obtained from the Shamkir reservoir were male and 116 were female, that was, the ratio of the number of males to the number of females was approximately 3:2. The total length of the fish body was 16.2-29.7 (on average 21.92±0.48) cm, the standard length was 13.4-25.8 (19.34±0.42) cm, the total mass was 39.5-249.7 (128.76±5.98) g, body mass without viscera 29.8-223.5 (103.57±4.97) g, Fulton coefficient 1.12-1.69 (1.27±0.02), the Clark coefficient 0.92-1.41 (1.18±0.02). The biological indicators of males and females of Danubian bleak, differences between them are given in table 2.

Table 2: Biological indicators of males and females of Dabube bleak in the Shamkir reservoir, fluctuations (on average)

Indicators	Males	Females	Difference, %
Toral lenth of body, cm	16.2-25.1 (21.45±0.53)	17.1-29.7 (22.34±0.56)	4.1
Standart lenth of body, cm	13.4-21.7 (18.67±0.45)	14.6-25.8 (19.92±0.49)	6.5
Total mass of body, g	39.5-178.6 (108.6±2.89)	61.3-249.7 (153.4±3.72)	17.4
Mass of body without viscera, g	29.8-129.3 (79±2.21)	50.74-223.5 (86±2.81	4.2
Fulton coefficient	1.12-1.64 (1.25±0.04)	1.14-1.69 (1.29±0.03)	1.7
Clark coefficient	0.94-1.41 (1.19±0.03)	0.92-1.39 (1.18±0.03)	-0.5

The table shows certain differences were observed between the biological indicators of male and female fish. The indicators of females for all characteristics, except of Clark coefficient, were higher than those of males. When we compare the percentages of the differences in the indicators of male and female fish, it can be seen that the difference in the standard length of the body (6.5%) was greater than the difference in the total length of the body (17.4%). When measuring the total body length, the caudal fin was also taken into account, but it was not taken into account in the standard body length. It means that in male fish the caudal fin makes up a relatively larger part of the body length. The difference between males and females in terms of body condition according to Clark shown in the table with a minus sign. This

was because this indicator in males was higher than in females.

The age of the studied fish varied between 2-4 years. All fish had reached sexual maturity. They were distributed by age groups as follows: 2-year-olds – 87 specimens (29.8% of all fish); 3-year-olds – 143 specimens (48.9%); 4-year-olds – 62 specimens (21.3%). The small share of 4-year-old specimens in fishing, and the fact that 5-year-old specimens were not caught at all, indicates that there was a strong pressure of excessive fishing on the population.

The biological indicators of the Danubian bleak by age were as follows: in 2-year-old fish, the total length of the body was 16.2-20.3 (18.58±0.54) cm, the standard length of the body was 13.4-17.5 (15.74±0.48) cm, full body mass 39.5-90.2 (65.82±4.56) g, body mass without viscera 29.8-75.6 (58.73±4.23) g, fullness coefficients according to Fulton 1.17-1.69 (1.25±0.03), according to Clark 0.94-1.38 (1.18±0.02); in 3-year-olds, the total length of the body was 19.1-24.3 (21.94±0.47) cm, the standard length of the body was 74.5-152.3 (118.73±4.87) cm, the total mass of the body was 74.5-152.3 (118.73±4.87) g, body mass without viscera 62.4-118.7 (94.59±4.09) g, fullness coefficients according to Fulton 1.12-1.68 (1.28±0.02), according to Clark 0.92-1.35 (1.19±0.03); in 4-year-olds, the total length of the body was 23.1-29.7 (25.84±0.44) cm, the standard length of the body was 19.6-25.8 (22.96±0.51) cm, the total mass of the body was 121.5-249.7 (194.63±5.42) g, body mass without viscera 105.3-223.5 (167.81±5.32) g, fullness coefficients according to Fulton 1.15-1.69 (1.27±0.03), according to Clark 0.94-1.41 (1.19±0.02).

Oriental bream

268 of the 511 specimens of bream obtained from the Shamkir reservoir were male and 243 were female, that was, the ratio of the number of males to the number of females was approximately 1:1. The total length of the fish body was 20.1-46.3 (32.45±1.26) cm, the standard length was 16.3-38.6 (28.43±0.96) cm, the total body mass was 74.6-1350.4 (462.46±91.42) g, body mass without viscera 65.2-1162.8 (354.46±92.57) g, Fulton coefficient 1.79-2.49 (2.11±0.03), the Clark coefficient 1.54-2.19 (1.82±0.03). The biological indicators of males and females of bream, differences between them are given in table 3.

Table 3: Biological indicators of males and females of bream in the Shamkir reservoir, fluctuations (on average)

Indicators	Males	Females	Difference, %
Toral lenth of body, cm	20.1-40.5 (31.87±0.94)	22.1-46.3 (34.46±0.98)	7.9
Standart lenth of body, cm	16.3-33.6 (25.36±0.87)	17.6-38.6 (28.24±0.85)	10.1
Total mass of body, g	74.6-824.6 (442.57±7.46)	127.0-1350.4 (724.13±8.37)	27.9
Mass of body without viscera, g	65.2-734.5 (387.46±7.97)	98.2-1162.3 (639.71±8.46)	22.3
Fulton coefficient	1.79-2.21 (2.08±0.04)	1.88-2.49 (2.13±0.03)	2.4
Clark coefficient	1.59-2.07 (1.80±0.03)	1.54-2.19 (1.83±0.03)	1.7

The age of the studied fish varied between 2-6 years. All fish had reached sexual maturity. They were distributed by age groups as follows: 2-year-olds – 97 specimens (19.0% of all fish); 3-year-olds – 198 specimens (38.8%); 4-year-olds – 102 specimens (19.9%); 5-year-olds – 73 specimens (14.2%); 6-year-olds – 41 specimens (8.1%). As it can be seen, two- and three-year-old specimens made up the main mass of fish, i.e. 65.6%. The small share of 5- and 6-year-old specimens shows that there was a strong pressure of excessive fishing on the population.

The biological indicators of the bleak by age were as follows: in 2-year-old fish the total length of the body was 20.1-24.7 (22.57±0.31) cm, the standard length of the body was 16.3-19.2 (17.89±0.27) cm, full body mass 74.6-169.7 (121.34±3.52) g, body mass without viscera 65.2-143.8 (102.18±3.34) g, fullness coefficients according to Fulton 1.79-2.28 (2.06±0.03), according to Clark 1.54-1.97 (1.73±0.02); in 3-year-olds the total length of the body was 23.7-27.9 (25.81±0.35) cm, the standard length of the body was 18.5-22.7 (20.68±0.32) cm, the total mass of the body was 148.5-239.4 (198.59±4.83) g, body mass without viscera 127.6-201.5 (166.91±4.34) g, fullness coefficients according to Fulton 1.89-2.32 (2.10±0.02), according to Clark 1.68-1.98 (1.81±0.03); in 4-year-olds the total length of the body was 27.5-34.1 (29.86±0.32) cm, the standard length of the body was 21.2-27.9 (23.97±0.36) cm, the total mass of the body was 213.5-534.6 (367.89±12.46) g, body mass without viscera 196.7-463.8 (294.53±10.27) g, fullness coefficients according to Fulton 1.96-2.36 (2.15±0.03), according to Clark 1.71-2.08 (1.84±0.02); in 5-year-olds the total length of the body was 31.3-42.4 (36.89±0.42) cm, the standard length of the body was 25.6-35.1 (30.82±0.44) cm, full mass 381.7-984.6 (582.41±26.48) g, body mass without viscera 347.5-882.4 (502.13±24.48) g, fullness coefficients according to Fulton 2.05-2.43 (2.16±0.04), according to Clark 1.79-2.18 (1.87±0.03); in 6-year-olds the total length of the body was 39.8-46.3 (42.81±0.56) cm, the standard length of the body was 34.0-38.6 (36.89±0.52) cm, the total mass of the body was 897.6-1350.4 (1028.53±62.47) g, body mass without viscera 803.2-1162.8 (912.87±55.47) g, fullness coefficients according to Fulton 2.01-2.49 (2.19±0.04), according to Clark 1.82-2.19 (1.89±0.03).

Common carp

141 of the 274 specimens of carp obtained from the Shamkir reservoir were male and 133 were female, that was, the ratio of the number of males to the number of females was approximately 1:1. The total length of the fish body was 22.8-63.8 (43.94±1.52) cm, the standard length was 18.9-55.8 (36.74±1.28) cm, the total body mass was 223.5-3357.1 (991.67±164.57) g, body mass without viscera 132.8-2972.6 (806.94±138.73) g, Fulton coefficient 1.72-2.39 (2.08±0.03), the Clark coefficient 1.48-2.07 (1.74±0.02). The biological indicators of males and females of carp, differences between them are given in table 4.

Table 4: Biological indicators of males and females of carp in the Shamkir reservoir, fluctuations (on average)

Indicators	Males	Females	Difference, %
Toral lenth of body, cm	22.8-54.2 (39.87±1.46)	30.6-63.8 (46.57±1.64)	15.3
Standart lenth of body, cm	18.9-47.2 (33.24±1.25)	25.1-55.8 (39.51±1.38)	17.1
Total mass of body, g	223.5-2158.3 (867.59±15.28)	287.0-3357.1 (1083.92±17.46)	21.8
Mass of body without viscera, g	132.8-1867.5 (734.26±13.97)	243.1-2972.6 (879.51±14.59)	18.1
Fulton coefficient	1.72-2.11 (2.05±0.03)	176-2.39 (2.11±0.04)	2.9
Clark coefficient	1.48-1.93 (1.73±0.02)	1.49-2.07 (1.75±0.02	1.2

All the fish involved in the study were sexually mature fish and their age ranged from 2 to 6 years. They were distributed by age groups as follows: 2-year-olds – 51 specimens (18.6% of all fish); 3-year-olds – 109 specimens (39.7%); 4-year-olds – 53 specimens (19.7%); 5-year-olds – 39 specimens (13.9%); 6-year-olds – 22 specimens (8.1%). As it can be seen, two- and three-year-old specimens made up the main mass of fish i.e. 65.6%. The small share of 5- and 6-year-old specimens shows that there was a strong pressure of excessive fishing on the population.

The biological indicators of carp by age were as follows: in 2-year-old fish the total length of the body was 22.8-31.5 (24.14±0.42) cm, the standard length of the body was 18.9-26.3 (22.68±0.37) cm, full body mass 163.5-310.6 (223.57±14.53) g, body mass without viscera 132.8-273.4 (179.46±12.53) g, fullness coefficients according to Fulton 11.72-2.44 (2.08±0.04), according to Clark 1.50-2.11 (1.75±0.03); in 3-year-olds the total length of the body was 29.6-41.5 (35.91±0.52) cm, the standard length of the body was 24.5-36.8 (30.46±0.43) cm, the total mass of the body was 285.1-1108.6 (539.62±38.46) g, body mass without viscera 246.8-946.7 (462.39±32.14) g, fullness coefficients according to Fulton 1.78-2.31 (2.12±0.03), according to Clark 1.53-2.07 (1.76±0.02); in 4-year-olds the total length of the body was 41.3-48.2 (44.49±0.39) cm, the standard length of the body was 35.2-41.9 (38.67±0.41) cm, the total mass of the body was 826.9-1489.6 (993.73±56.43) g, body mass without viscera 716.2-1248.3 (854.89±49.89) g, fullness coefficients according to Fulton 1.81-2.28 (2.14±0.03), according to Clark 1.59-2.04 (1.75±0.03); in 5-year-olds the total length of the body was 47.1-55.4 (50.62±0.44) cm, the standard length of the body was 40.8-48.2 (43.61±0.32) cm, full mass of the body 1297.5-2358.5 (1894.24±98.76) g, body mass without viscera 1108.6-2092.7 (1624.43±81.24) g, fullness coefficients according to Fulton 1.86-2.34 (2.13±0.02), according to Clark 1.54-1.98 (1.73±0.02); in 6-year-olds the total length of the body was 54.2-63.8 (58.97±0.51) cm, the standard length of the body was 47.2-55.8 (51.43±0.47) cm, the total mass of the body was 2158.3-3357.1 (2589.63±108.43) g, body mass without viscera 1867.5-2972.6 (2234.26±92.39) g, fullness coefficients according to Fulton 1.75-2.39 (2.15±0.02) according to Clark 1.48-2.03 (1.71±0.02).

Prussian carp

124 of the 303 specimens of this fish obtained from the Shamkir reservoir were male and 179 were female, that was, the ratio of the number of males to the number of females was approximately 2:3. The total length of the fish body was 20.3-46.9 (29.73±1.87) cm, the standard length was 16.5-39.2 (24.91±1.62) cm, the total body mass was 159.8-2083.4 (518.63±129.43) g, body mass without viscera 112.3-1781.3 (447.51±112.76) g, Fulton coefficient 2.24-4.41 (3.24±0.05), the Clark coefficient 1.94-3.83 (2.51±0.05). The biological indicators of males and females of Rrussian carp, differences between them are given in table 5.

Table 5: Biological indicators of males and females of Prusian carp the Shamkir reservoir, fluctuations (on average)

Indicators	Males	Females	Difference %
Toral lenth of body, cm	20.3-36.4 (28.07±1.53)	20.6-46.9 (31.32±1.92)	10.9
Standart lenth of body, cm	16.5-29.9 (23.46±1.81)	16.9-39.2 (25.83±1.96)	9.5
Total mass of body, g	159.8-1237.48 (389.45±18.53)	169.3-2083.4 (669.31±22.57)	53.9
Mass of body without viscera, g	112.3-1046.6 (331.15±15.34)	119.3-1781.3 (549.38±18.29)	45.8
Fulton coefficient	2.24-4.08 (3.18±0.04)	2.29-4.41 (3.27±0.05)	3.7
Clark coefficient	1.96-3.72 (2.43±0.03)	1.94-3.83 (2.62±0.04)	2.6

The age of the studied fish varied between 2-6 years. All fish had reached sexual maturity. They were distributed by age groups as follows: 2-year-olds – 54 specimens (17.8% of all fish); 3-year-olds – 129 specimens (42.6%); 4-year-olds – 81 specimens (26.7%); 5-year-olds – 23 specimens (7.6%); 6-year-olds – 16 specimens (5.3%). The small share of 5- and 6-year-old specimens shows that there was a strong pressure of excessive fishing on the population.

The biological indicators of Prussian carp by age were as follows: in 2-year-old fish the total length of the body was 20.3-26.8 (23.54±0.38) cm, the standard length of the body was 16.5-21.8 (18.92±0.34) cm, full body mass 159.8-280.5 (219.63±16.27) g, body mass without viscera 112.3-219.3 (171.26±8.47) g, fullness coefficients according to Fulton 2.38-4.29 (3.18±0.05), according to Clark 2.12-3.79 (2.41±0.04); in 3-year-olds. the total length of the body was 23.1-31.9 (27.65±0.41) cm, the standard length of the body was 19.6-26.7 (22.47±0.39) cm, the total mass of the body was 217.6-473.6 (334.42±9.71) g, body mass without viscera 181.3-382.4 (291.32±15.12) g, fullness coefficients according to Fulton 1.78-2.31 (2.12±0.03), according to 1.98-3.51 (2.52±0.04); in 4-year-olds the total length of the body was 28.3-34.9 (31.86±0.35) cm, the standard length of the body was 23.7-28.4 (26.27±0.33) cm, the total mass of the body was 395.2-905.4 (639.71±12.73) g, body mass without viscera 321.6-783.1 (550.19±23.45) g, fullness coefficients according to Fulton 2.37-4.41 (3.21±0.04), according to Clark 2.03-3.83 (2.50±0.04); in 5-year-olds the total length of the body was 32.6-39.6 (36.54±0.32) cm, the standard length of the body was 26.8-33.2 (30.17±0.33) cm, full mass of the body 689.4-1286.0 (926.48±27.36) g, body mass without viscera 539.7-1018.5 (789.41±14.83) g, fullness coefficients according to Fulton 2.24-4.32 (3.29±0.05), according to Clark 1.94-3.72 (2.49±0.04); in 6-year-olds the total length of the body was

35.8-46.9 (41.79±0.43) cm, the standard length of the body was 29.3-39.2 (34.51±0.41) cm, the total mass of the body was 2158.3-3357.1 (2589.63±128.43) g, body mass without viscera 735.9-1781.3 (1109.51±89.63) g, fullness coefficients according to Fulton 2.27-4.17 (3.28±0.04), according to Clark 1.98-3.68 (2.43±0.03).

Zander

182 of the 370 specimens of zander obtained from the Shamkir reservoir were male and 188 were female, that was, the ratio of the number of males to the number of females was approximately 1:1. The total length of the fish body was 29.7-66.3 (43.26±0.94) cm, the standard length was 24.1-56.9 (37.13±0.87) cm, the total body mass was 171.6-2243.5 (489.27±117.39) g, body mass without viscera 144.3-1941.2 (362.81±107.26) g, Fulton coefficient 0.85-1.52 (1.19±0.03), the Clark coefficient 0.75-1.19 (0.95±0.03). The biological indicators of males and females of zander, differences between them are given in table 6.

Table 6: Biological indicators of males and females of zander in the Shamkir reservoir, fluctuations (on average)

Indicators	Males	Females	Difference, %
Toral lenth of body, cm	29.7-58.1 (42.11±1.02)	30.6-66.3 (44.84±1.08)	6.3
Standart lenth of body, cm	24.1-49.7 (36.78±0.96)	24.6-56.9 (38.41±1.05)	4.4
Total mass of body, g	171.6-1734.8 (372.11±10.54)	189.2-2243.5 (591.38±12.18)	44.8
Mass of body without viscera, g	144.3-1492.7 (289.72±11.27)	165.9-1941.2 (413.32±11.64)	34.1
Fulton coefficient	0.91-1.27 (1.16±0.03)	0.85-1.52 (1.21±0.04)	4.2
Clark coefficient	0.75-1.16 (0.96±0.03)	0.75-1.19 (0.94±0.04)	2.1

All the fish involved in the study were sexually mature and their age ranged from 2 to 6 years. They were distributed by age groups as follows: 2-year-olds – 61 specimens (16.5% of all fish); 3-year-olds – 152 specimens (41.1%); 4-year-olds – 97 specimens (26.2%); 5-year-olds – 41 specimens (11.1%); 6-year-olds – 19 specimens (5.1%). The small share of 5- and 6-year-old specimens shows that there was a strong pressure of excessive fishing on the population.

The biological indicators of Prussian karp by age were as follows: in 2-year-old fish the total length of the body was 29.7-35.2 (32.81±0.43) cm, the standard length of the body was 24.1-28.7 (27.02±0.36) cm, full body mass 171.6-279.3 (231.42±21.47) g, body mass without viscera 144.3-214.8 (183.56±19.32) g, fullness coefficients according to Fulton 1.02-1.23 (1.12±0.02), according to Clark 0.78-1.06 (0.92±0.02); in 3-year-olds the total length of the body was 33.8-47.1 (41.26±0.65) cm, the standard length of the body was 27.9-39.3 (33.26±0.57) cm, the total mass of the body was 273.2-568.9 (419.57±15.62) g, body mass without viscera 212.6-473.3 (347.81±14.12) g, fullness coefficients according to Fulton 0.94-1.29 (1.17±0.03), according to Clark 0.76-1.08 (0.93±0.03); in 4-year-olds the total length of the body was 46.8-50.9 (48.21±0.31) cm, the standard length of the body was 38.2-43.9 (41.13±0.28) cm, the total mass of the body was 498.3-1163.8 (763.42±78.61) g, body mass without viscera 438.4-916.9 (611.34±69.71) g, fullness coefficients according to Fulton 0.85-1.41 (1.23±0.03), according to Clark 0.75-1.12 (0.96±0.02); in 5-year-olds the total length of the body was 49.2-57.9 (53.67±0.41) cm, the standard length of the body was 41.5-49.3 (44.95±0.39) cm, full mass of the body 935.7-1612.8 (1194.57±28.41) g, body mass without viscera 791.7-1293.5 (932.69±91.27) g, fullness coefficients according to Fulton 0.97-1.38 (1.22±0.02), according to Clark 0.81-1.15 (0.96±0.02); in 6-year-olds the total length of the body was 57.1-66.3 (62.42±0.51) cm, the standard length of the body was 48.7-56.9 (53.97±0.48) cm, the total mass of the body was 1573.4-2243.5 (1713.42±32.51) g, body mass without viscera 1312.0-1941.2 (1481.33±17.46) g, fullness coefficients according to Fulton 1.11-1.52 (1.24±0.03) according to Clark 0.95-1.19 (0.98±0.02).

In order to compare the growth rate of the studied fish in terms of body length, Fig. 2 shows a graph showing the average length of fish of different ages. From the information here, it can be seen that 2-year-old fish of all species, except for zander, differ relatively little in terms of average indicators of total body length (18.58-24.14 cm). Only the zander was much larger than these fish at 2 years of age (32.81 cm). As the age of the fish increases, zander and especially carp grow more rapidly and are significantly ahead of other fish in size.

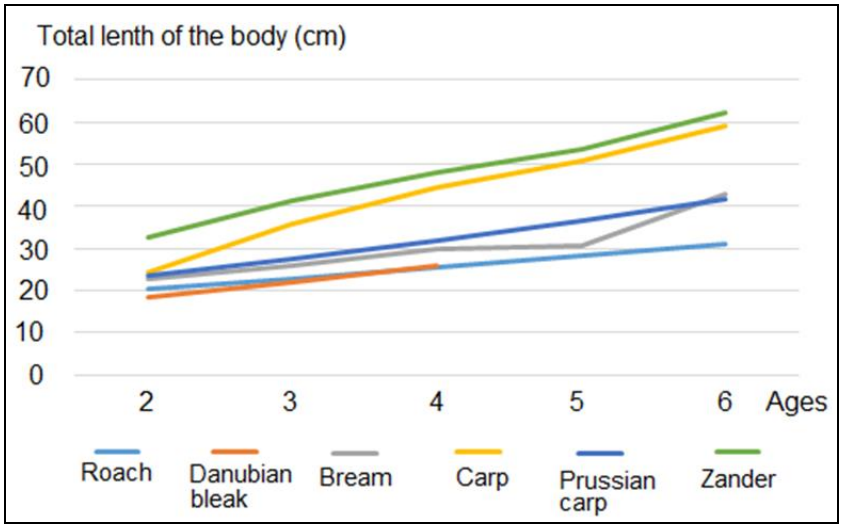

Fig 1: The rate of linear growth of commercial fish of the Shamkir reservoir.

This regularity manifests itself even more prominently in growth of the body mass of fish. As can be seen from Fig. 3, at the age of 2, fish that differ little in terms of mass differ more as they age. After 4 years of age, carp started to grow faster especially rapidly and became much larger than other fish. It was followed by their growth rate, zander, Prussian carp and bream were coming. By the speed of growth of body mass roach and Danubian bleak much behind them.

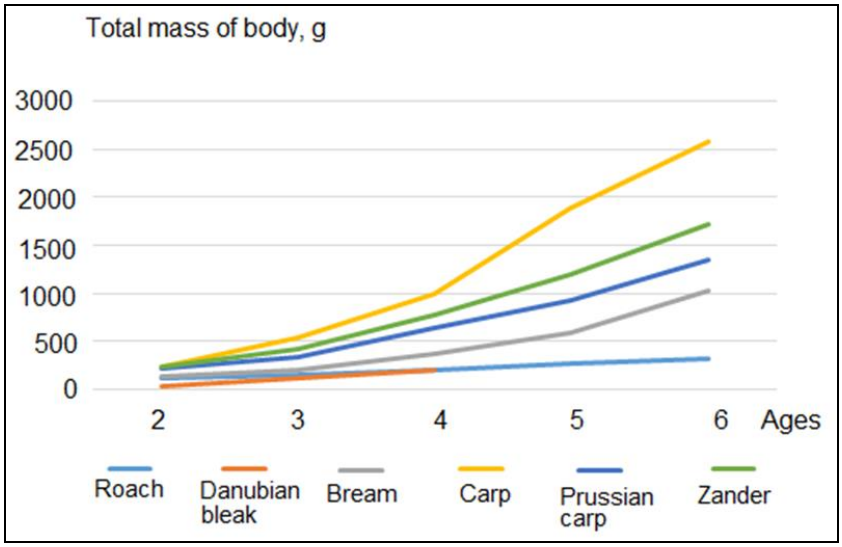

Fig 3: The growth rate of body mass of commercial fish of the Shamkir reservoir.

4. Conclusion

Ichthyological studies carried out in Shamkir reservoir showed that, among the main commercial fishes caught in this water basinthe ratio of males to females was approximately 1:1 for bream, carp and zander, 2:3 for Prussian carp, 5:4 for roach and 3:2 for Danubian bleak. In all fish species, the difference between the body mass without entrels of males and females was greater than the difference between their total body mass, which was due to the presence of eggs in females. For the same reason, the fullness males and females by Fulton more differ than their fullness by Clark. Among the studied fish greatly prevailed 3-year-olds, there were very few representatives of older age groups, which indicates that the fishing pressing in the reservoir was too high. Comparing the length and mass of fish of different age groups was shown that the rate of carp and zander growth among the studied fish species was higher than the others species. The growth rate of roach and Danubian bleak was the lowest compared to other fish.

References

1. Abdurrahmanov YA. Fauna of Azerbaijan. Fishes. Baku: Azerb. SSR EA; c1966. p. 223.
2. Aliyeva SI, Guliyev ZM. Factors affecting the stock of fries of carp, bream and zander in the Shamkir reservoir. Proceedings of the Institute of Zoology of ANAS. 2011;29:107-111.
3. Bagirova Sh. M, Asgarova Kh. M, Aghayarova AE. Ichthyofauna of Shamkir and Yenikend reservoirs. Biology of Kura range reservoirs, Baku: Elm; c2010. p. 147-224.
4. Biology of the Shamkir reservoir. Edited by A.H. Gasimov, Baku: Printing house of AzTU; c1997. p. 207.
5. Bogutskaya NG, Kiyashko PV, Naseka AM, Orlova MI. Key to fish and invertebrates of the Caspian Sea. Volume 1. SPb-M.: Association of scientific publications KMK; c2013. p. 543.
6. Bogutskaya NG, Naseka AM. Catalog of cyclostomes and fish. M.: Association of Scientific Publications KMK; c2004. p. 389.
7. Chugunova NI. Guide to the study of the age and growth of fish. M: Publishing House of the Academy of Sciences of the USSR; c1958. p. 164.
8. Ibrahimov Sh. R, Mustafayev NJ. Current status of Azerbaijan ichthyofauna. Proceedings of the Zoological Institute. 2015;33(2):58-68.
9. Kuljanishvili T, Mumladze L, Japoshvili B, *et al*. The first unified inventory of non-native fishes of the South Caucasian countries Azerbaijan, Armenia, and Georgia // Knowledge and Management of Aquatic Ecosystems. 2021;422(32):1-16.
10. Mamedov VM. Hydrological features of Kura range reservoirs. Biology of Kura range reservoirs. Baku: Sada; c2010. p. 15-22.
11. Mustafaev NJ. Patterns of the distribution of cyclostomes and fish in the inland waters of Azerbaijan // Proceedings of the Institute of Zoology. 2015;34(1):68-87.
12. Mustafayev NC. Biological and morphophysiological characteristics of marine and freshwater populations of bream (*Abramis brama orientalis* Berg) and roach (*Rutilus rutilus caspicus* Jakowlew) // News of ANAS, Series of Biological Sciences. 2010;1-2:147-152.
13. Mustafayev NC. Biological and morphophysiological characteristics of sea and freshwater populations of Caspian shemaya (*Chalcalburnus chalcoides* Güldenstadt, 1722). Proceedings of the Azerbaijan Society of Zoologists. 2008;1:533-538.
14. Mustafayev NJ. Biological characteristics of fresh water and marine populations of bream (*Abramis brama orientalis* Berg). Materials of the scientific conference of postgraduate students of ANAS, Baku: Elm; c2008. p. 160-163.
15. Mustafayev NJ. Biological features of marine and fresh water populations of Caspian roach (*Rutilus rutilus caspicus n. kurensis* Berg). Materials of the scientific-practical conference on "Academician Hasan Aliyev and ecological science in Azerbaijan". Baku: Çashioğlu; c2007. p. 199-201.

16. National Atlas of the Republic of Azerbaijan. Baku: State Land and Mapping Committee; c2014. p. 444.
17. Plokhinsky N.A. Mathematical methods in biology. M: MSU; c1978. p. 264.
18. Pravdin IF. Guide to the study of fish. Moscow: Pishchepromizdat; c1966. p. 376.
19. Romanov VI, Petlina AP, Babkina IB. Methods for the study of freshwater fish. Tomsk; c2012. p. 252.
20. Yusifov EF, Alekperov İ. Kh, İbrahimov Sh. R, *et al*. About the Biological Diversity of Inland Water Ecosystems in Azerbaijan // Proceedings of ANAS (Biological and Medical Sciences). 2017;72(3):74-91.
21. Zinovyev EA, Mandritsa SA. Methods for the study of freshwater fish. Perm; c2003. p. 113.