

Ecological features of *Cyprinus carpio* (Family: Cyprinidae) in the Aidar-Arnasay system of lakes (Uzbekistan, Jizzakh-Navoi)

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ABSTRACT

The article presents the results of scientific research on the characteristics of growth and reproduction of *Cyprinus carpio*, common in the Aidar-Arnasay lake system. 18 samples aged 2⁺ - 3⁺ were used in this experiment; body length $l=24.0-31.3$ cm (on average, $l=27.3\pm 8.6$ cm), which were collected during 2019-2023. The coordinate points of the sample collection site and the map of the geographic information system are shown. The coefficient of variation of morphometric parameters of individuals from Lake Tuzkan ranged from 3.09 to 18.54 % (6.62 ± 0.74 %). A relationship was found between body length and weight of female individuals ($r=0.426$). In the course of observations of the females fecundity, a correlation was found between individual absolute fecundity and body length ($r=0.256$), as well as between individual absolute fecundity and their body weight ($r=0.438$). It was observed that in the Aidar-Arnasay system of lakes, individuals reach sexual maturity earlier, namely at the age of 2⁺ - 3⁺ years and with a body length of $l=19.5-20.0$ cm. The ratio of the occurrence of males and females in the population was studied. Comparison of ecological characteristics of individuals, such as individual fecundity and the effect of water temperature on spawning, when compared with representatives of this species from other countries.

INTRODUCTION

The Common Carp (*Cyprinus carpio* Linnaeus, 1758) is a widespread fish species in all water bodies of the world. Its natural range includes water bodies of all southern regions of Russia (Kessler, 1860), and the basins of the Black, Caspian, and Aral Seas (Froese & Pauly, 2023). According to Berg (1909), *Cyprinus carpio* is found in all water bodies of China and the Amur River basin. Despite the fact that, according to the calculations of modern scientists, the natural range of *C. carpio* is Eastern Europe and Central Asia, it is considered a native species on all continents except Antarctica (Kloskowski, 2011). Other sources stated that *C. carpio* originates from the waters of Ancient China, entered Europe via the Danube River and that its youngest population was observed to develop in Asia (Flajšhans & Hulata, 2007). Currently, it is distributed in all water bodies of our republic and, simultaneously with other species, is found in rivers, lakes, streams, canals, and reservoirs (Mirabdullaev et al., 2011; Atamuratova, 2021; Kuvatov, 2022; Atamuratova

et al., 2022; Quvatov *et al.*, 2022a, 2022b, 2022c, 2022d; Kuvatov, 2023). Local breeds of *Cyprinus carpio* are bred in the fish farms of our Republic. They are mainly grown in order to meet the needs of the population of the republic for fish products. The main ichthyosaurs of *C. carpio* from natural reservoirs, such as the Aidar-Arnasay system of lakes, the Tudakul Reservoir, and relatively small lakes and reservoirs, according to the planned capture, are allocated for the needs of the population. In the Aidar-Arnasay system of lakes, *C. carpio* ranks first among the main fish species caught (*Sander lucioperca*, *Carassius gibelio*) (Atamuratova *et al.*, 2022). *Cyprinus carpio* differs from other types of fish in its fat content and taste of meat.

Therefore, the study of its biological and ecological features, as well as the control of its current natural state, is one of the urgent tasks and is of great scientific and practical importance.

MATERIALS AND METHODS

Ichthyological materials were collected during the spring, summer, and autumn periods of 2019-2023 from a total of 11 geographical points in the Aidar-Arnasay lake system (Aidar, Arnasay, and Tuzkan lakes) (40°47'36.27"N, 67°38'13.35"E; 40°40'39.40"N, 67°31'53.99"E; 40°32'44.37"N, 67°27'37.09"E; 40°41'6.08"N, 67°20'32.07"E; 40°46'35.46"N, 67°5'10.14"E; 40°55'11.90"N, 67°10'59.54"E; 40°54'32.87"N, 66°51'36.48"E; 41°0'37.84"N, 66°45'46.77"E; 40°56'36.21"N, 66°27'6.43"E; 41°2'31.27"N, 66°11'22.43"E; 40°55'6.13"N, 66°2'37.65"E) using conventional methods (Fig. 1).

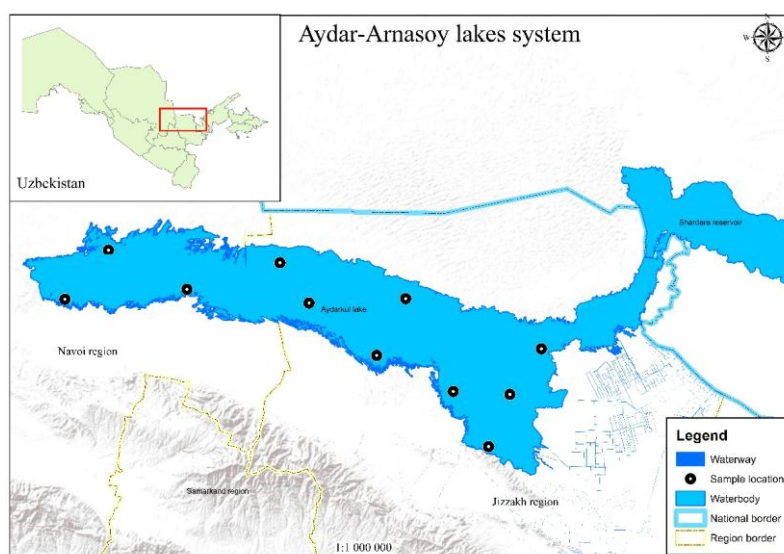


Fig. (1). Points of collection of ichthyological materials

As materials, 18 samples were used at the age of 2+ - 3+ years, length $l=24.0-31.3$ cm (on average, $l=27.3$ cm). After measurements of the samples in the field, they were fixed in special sealed containers in a 4% formalin solution. Due to the small number of ichthyological specimens, the analytical work was carried out in a generalized manner.

Determination of the parameters of fish samples and office work were carried out on the basis of generally accepted methods (Pravdin, 1966). The definition of differences in the correlation between the signs was determined by the method of G.F. Lakin (Lakin, 1990).

RESULTS

Morphometric features:

Meristic signs of carp from Lake Tuzkan: the number of rays on the humeral fins III 17-22, on the anal fin III 5-6, on the pelvic fins I 7-8, on the pectoral fin I 12-15 (average 14), the number of scales on the lateral line amounted to 34-38 pieces. Indicators of plastic signs are presented in **Table (1)**.

Table (1): Indicators of plastic signs of the carp from Lake Tuzkan ($n=10$)

Signs	Min - Max	M±SE	SD	Cv %
<i>l</i> (mm)	24.0-31.3	27.3±8.6	27.3	9.98
Percentage relative to body length (<i>l</i>)				
<i>c</i>	25.9-29.6	27.12±0.39	1.23	4.53
<i>ao</i>	9.2-11.3	10.26±0.22	0.69	6.76
<i>o</i>	3.3-4.2	3.86±0.10	0.31	8.12
<i>po</i>	11.9-14.5	13.15±0.25	0.78	5.96
<i>hc</i>	18.3-20.4	19.47±0.19	0.60	3.09
<i>io</i>	9.6-11.3	10.69±0.17	0.54	5.04
<i>H</i>	30.1-51.3	31.72±0.53	1.67	5.28
<i>h</i>	10.8-21.7	11.99±0.27	0.86	7.15
<i>aD</i>	44.3-51.3	47.52±0.71	2.26	4.75
<i>pD</i>	13.1-21.7	17.21±1.01	3.19	18.54
<i>lca</i>	16.0-20.3	18.66±0.42	1.31	7.04
<i>ID</i>	36.5-40.3	38.51±0.39	1.25	3.24
<i>hD</i>	14.3-18.1	15.82±0.38	1.19	7.51
<i>IA</i>	8.6-10.4	9.27±0.19	0.61	6.55
<i>hA</i>	12.0-18.3	15.04±0.56	1.78	11.85
<i>IP</i>	15.4-18.3	17.37±0.30	0.95	5.46
<i>IV</i>	14.2-17.5	16.11±0.33	1.06	6.57
<i>PV</i>	21.4-25.8	23.14±0.41	1.30	5.62
<i>VA</i>	26.2-30.1	28.67±0.40	1.28	4.46
As a percentage in relation to the length of the head (<i>c</i>)				
<i>ao/c</i>	34.3-42.7	37.96±0.88	2.77	7.29
<i>o/c</i>	11.6-16.2	14.29±0.42	1.32	9.24
<i>po/c</i>	45.1-52.3	48.48±0.80	2.52	5.19
<i>hc/c</i>	67.4-76.5	71.86±0.90	2.83	3.94
<i>io/c</i>	35.7-42.7	39.49±0.72	2.27	5.75

Note: M: is the average indicator of features, SE: is the error of the mean, SD: is the standard deviation, and Cv: is the coefficient of variation. When using morphometric designations, the following generally accepted abbreviations were used: *l* – fish body length (mm), *c* – head length, *ao* – snout length, *o* – eye diameter, *po* – back of the eye, *hc* – head height, *io* – forehead width, *H* – body height, *h* – height of the caudal axis, *aD* – antedorsal distance, *pD* – postdorsal distance, *lca* – length of the caudal axis, *ID* – length of the base of the first dorsal fin, *hD* – height of the first dorsal fin, *IA* – length of the base of the anal fin, *hA* – height of the anal fin, *IP* – length of the pectoral fin, *IV* – length of the pelvic fin, *PV* – distance between the pectoral and ventral fins, *VA* – distance between the pelvic and anal fins, *ao/c* – ratio of snout length to head length, *o/c* – ratio of eye diameter to head length, *po/c* – ratio of the length of the back of the eyes to the length of the head, *hc/c* – ratio of head height to head length, *io/c* – the ratio of the width of the forehead to the length of the head.

As can be seen from **Table (1)**, the coefficient of variation for the carp from Lake Tuzkan varies from 3.09 % to 18.54 % (6.62 % on average). In relation to body length: characters *pD*, *hA* have an average variability, and the remaining characters - *c*, *ao*, *o*, *po*, *hc*, *io*, *H*, *h*, *aD*, *lca*, *lD*, *hD*, *lA*, *lP*, *lV*, *PV* and *VA* are low; and in relation to the length of the head, all characters - *ao/c*, *o/c*, *po/c*, *hc,c*, *io/c* have low variability.

Features of growth and reproduction:

Scientific studies carried out in different parts of the Aidar-Arnasay lake system were carried out on the basis of 2+ - 3+ year old samples of *Cyprinus carpio* with a body length of $l=19.5-31.3$ cm and a weight of 298-380 grams (**Table 2**).

Table (2): Age-size structure of *Cyprinus carpio* in the Aidar-Arnasay system of lakes

Age	<i>l</i> (cm)	<i>W</i> (g)	<i>n</i>
2+	19.5-25.3	298-310	6
3+	26.3-29.5	345-380	12

Note: *l*: is the length of the body of the fish, *W*: is the weight, *n*: is the number of specimens.

Usually, puberty of *Cyprinus carpio* is observed at three or four years of age, but in the conditions of the Aidar-Arnasay system of lakes, puberty of *Cyprinus carpio* occurs at the age of two to three years.

The results of the conducted studies showed that there is a mutual average correlation ($r=0.616$) between the length and weight of the body of the fish (**Fig. 2**).

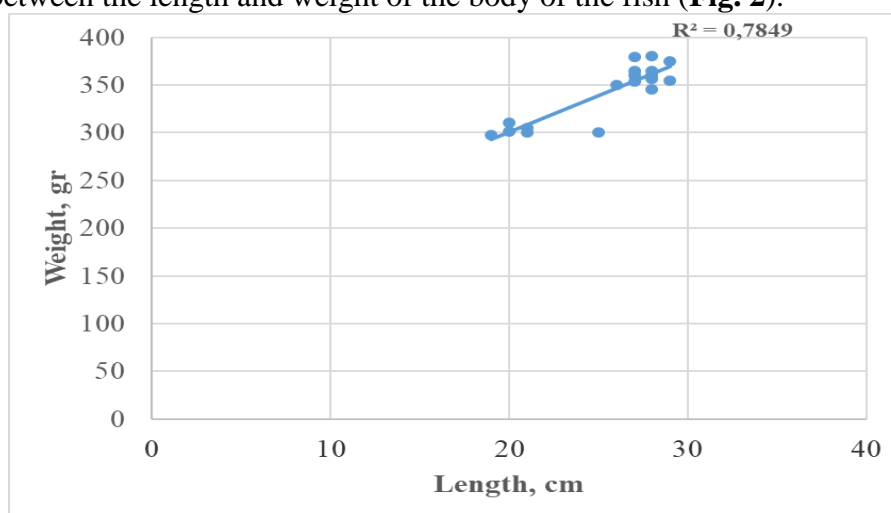


Fig. (2). Correlation of body length and weight of *Cyprinus carpio* from the Aidar-Arnasay system of lakes (correlation is significant at $P<0.01$).

Fecundity:

The fertility rates of *Cyprinus carpio* females in the Aidar-Arnasay system of lakes are shown in **Table (3)**.

Table (3): Reproduction indicators of *Cyprinus carpio* in the Aidar-Arnasay system of lakes

<i>t</i>	<i>l</i> , cm	<i>W</i> , g	<i>C.sm</i> , %	<i>IAF</i>	<i>IRF</i>	<i>n</i>
2+	19.5-25.3	298-310	3.3-6.1	9000-16910	31.6-73.5	6
3+	26.3-29.5	345-380	5.1-6.8	17820-24312	54.8-93.5	12

Note: *l*: is the length of the fish, *W*: is the mass of the fish, *C.sm*: is the degree of sexual maturity, *IAF*: is the individual absolute fecundity, *IRF*: is the individual relative fecundity, and *n*: is the number of samples.

As can be seen from **Table (3)**, the individual absolute fecundity of *Cyprinus carpio* increases depending on the increase in the length and weight of their females. It was found that the body size of *Cyprinus carpio* (body length and weight) is related to its individual absolute fecundity (**Figs. 3 and 4**).

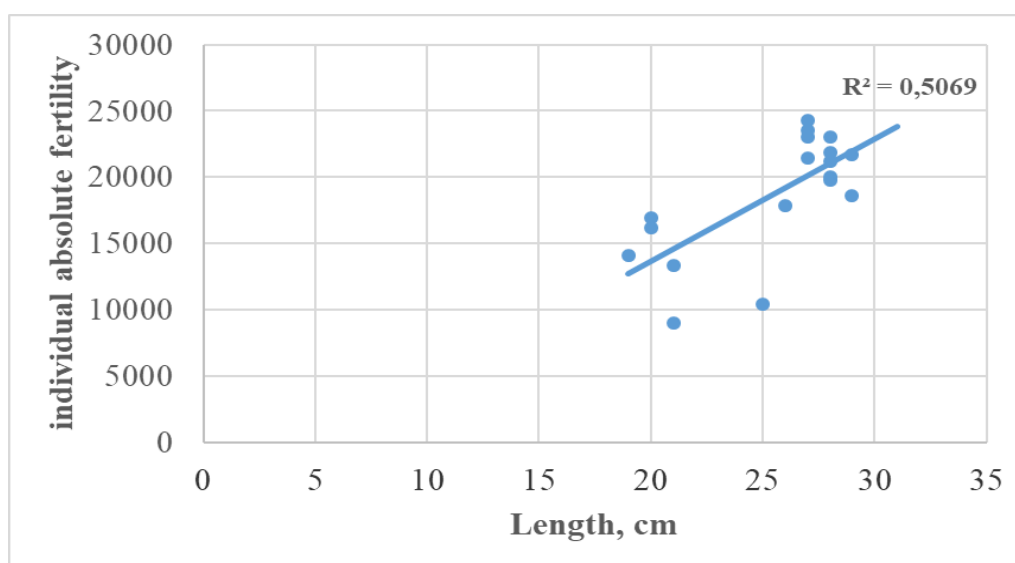


Fig. (3). Relationship between individual absolute fecundity and body length of *Cyprinus carpio* in the Aidar-Arnasay system of lakes. $r=0.256$ (correlation significance level $P<0.01$).

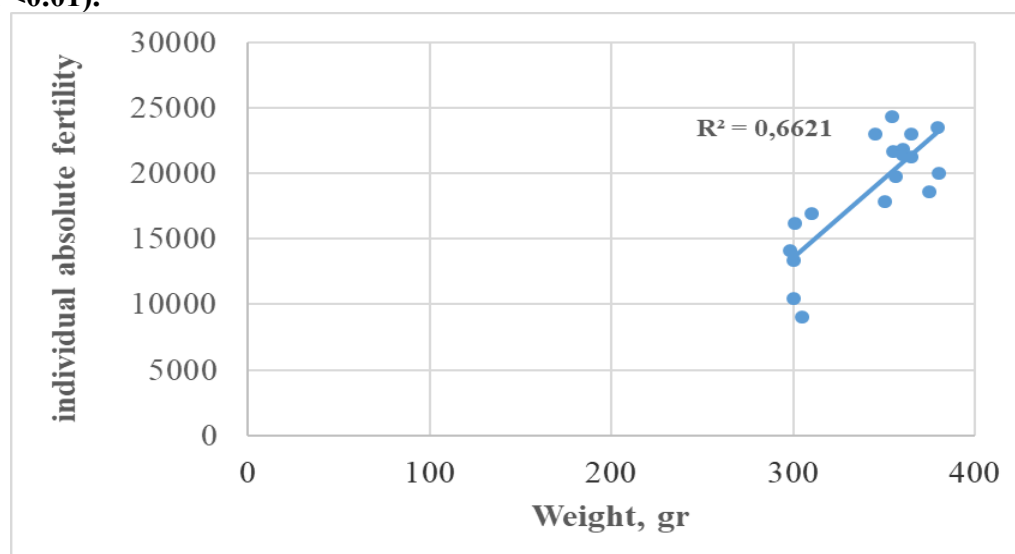


Fig. (4). Relationship between individual absolute fecundity and body weight of *Cyprinus carpio* in the Aidar-Arnasay system of lakes. $r=0.438$ (correlation significance level $P<0.01$).

An analysis of changes between the size and weight of females and age groups showed that in a flock of *Cyprinus carpio*, the most prolific individuals (among 2-3-year-olds) are 3-year-old fish.

DISCUSSION

Since ichthyological samples were collected in different years, the results of data generalization were carried out by years but were not reflected in separate tables. The ratio of males and females in flocks is 1 Male:1 Female. During the study, it was found that *Cyprinus*

carpio females from a sexual point of view mature earlier than individuals from other water bodies, that is, at the age of 2+ and with a body length of 18-19 cm. For example: in the Tuyabuguz reservoir, puberty of *Cyprinus carpio* females occurs at the age of 3-4 years (Atamuratova, 2021). There is information about *Cyprinus carpio* females and their puberty at 3-4 years of age, which are naturally distributed in other water bodies of our republic (Mirabdullaev *et al.*, 2011). The spawning of the female *Cyprinus carpio* begins in April, which is shed in parts (portions). In our scientific observations, various types of eggs were also noted. *Cyprinus carpio* females shed 70-80 % of their eggs on March-April. *Cyprinus carpio* gonodes makeup 10-12 % of the body weight, this figure is 15 % in individuals of water bodies in Russia, 3.1-16.4 % in individuals of water bodies in Japan (10.4 % on average), and 26-38 % in water bodies of India (Sivakumaran *et al.*, 2003). Intensive growth of *Cyprinus carpio* occurs at water temperatures of 23-30°C (Flajšhans & Hulata, 2007). The pH of lake water was measured using litmus paper, which was 7.5-8. This indicator is the optimal environment for *Cyprinus carpio*, it is also mentioned in the literature (pH 6.5-9.0) (Flajšhans & Hulata, 2007). On the average body weight of female *Cyprinus carpio* (W=342 g) accounts for 18 grams of gonads. This rate varies from 100 to 230 grams per W=1000 grams in individuals of this species in European waters (Flajšhans & Hulata, 2007). The average individual absolute fecundity of females is 18687 eggs. This is a good indicator, which indicates the presence of optimal conditions for the growth and reproduction of *Cyprinus carpio* in the Aidar-Arnasay system of lakes. In the Aidar-Arnasai system of lakes, the process of spawning in *Cyprinus carpio* on March-April begins at a water temperature of 15-17°C, in Australia this process occurs at a temperature of 17°C (Sivakumaran *et al.*, 2003). In the world, the optimal temperature for spawning of fish individuals is 18-22°C (Huet, 1975), and in relatively cold waters this process can occur at a temperature of 14°C (Horvath, 1985).

CONCLUSION

Thus *Cyprinus carpio* is well adapted to the conditions of the Aidar-Arnasay Lake system and maintains its population through simple reproduction. No high variability was found in the plastic features of the morphometric parameters of *Cyprinus carpio* individuals from Lake Tuzkan. And in meristic characters, species-specific descriptions were observed. Ecological features, such as puberty at the age of 2+ - 3+, and the individual absolute fecundity of females, on average, about 18687 eggs, is a striking example of the difference between individuals of this species from other water bodies. To date, *Cyprinus carpio* is the main commercial species in the Aidar-Arnasay system of lakes. Studies have shown a correlation between the body length of female individuals and their weight, body weight, and individual absolute fecundity, as well as between body length and individual absolute fecundity. *Cyprinus carpio*, common in the Aidar-Arnasay system of lakes, differs from individuals of the same species common in the basins of other countries in its high sexual productivity, spawning at temperatures optimal for the species (15-17°C), as well as the ratio of occurrence in the population of females and males (M1:F1) that do not go beyond intraspecific optimality.

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CONTRIBUTION OF AUTHORS IN THE ARTICLE

Materials collection and fixation works were done by A. Quvatov, M. Atamuratova, J. Sobirov. Cameral processing, calculation, article formation by A. Quvatov.

CONFLICT OF INTEREST

There were no conflicts between the authors on the collection, sorting, cameral processing, and distribution of the materials.

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