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ADAPTATION AND REPRODUCTIVE STATUS OF PRUSSIAN CARP (*CARASSIUS GIBELIO*), CONSIDERED INVASIVE IN UZBEKISTAN, IN THE TUDAKUL RESERVOIR

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Abstract: This article examines the adaptation of the invasive silver crucian carp (*Carassius gibelio*) to the Tudakul Reservoir, its importance in fisheries, and its introduction into the territory of Uzbekistan with the aim of developing ichthyofauna. The study investigates its life cycle, reproductive characteristics, fecundity level, feeding environment, and adaptability to external environmental factors. It is established that silver crucian carp, an invasive species in the Zarafshan River basin, has successfully formed reproducing populations in the Tudakul Reservoir and has acquired considerable commercial fishing importance. The article also highlights the importance of sustainable fishing practices and the formation of fish stocks in fisheries management. This study may serve as a useful source for researchers interested in fisheries and ichthyology in Uzbekistan.

Keywords: Silver crucian carp (*Carassius gibelio*), regression equation, rheophilic fish, limnophilic fish, fecundity level, population, family Cyprinidae, Kamchatka, Sakhalin, Lena River, Yenisei River, Ob River, Irtysh River, Black Sea, Tudakul Reservoir.

INTRODUCTION

Today, we live in an era when ensuring food security for the world's population, preserving biodiversity, and making efficient use of natural resources have become increasingly pressing issues. To address these challenges and ensure the rational use of water resources, particular attention is being paid to research aimed at increasing the fish productivity of water bodies, including the artificial formation of fish communities intended for commercial fishing. The next stage in increasing the productivity of water bodies involves the application of pasture aquaculture technologies. In a number of developed countries in Europe and North America, considerable importance is attached to breeding commercial fish species, primarily for recreational fisheries. In other developing countries, research aimed at cultivating fish species harvested from water bodies to meet the needs of the population is of significant scientific and practical importance.

One of the fish species particularly suitable for such purposes due to its adaptability and high reproductive capacity is the silver crucian carp. The silver crucian carp (*Carassius gibelio* (Bloch, 1782)) belongs to the family Cyprinidae. It occurs in freshwater rivers of the Pacific basin in Asian countries such as China and Japan, as well as on the islands of Taiwan and Hainan and in the Amur

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River in Russia. Over several centuries, humans have contributed to the expansion of this species westward across Eurasia, including into France and eastern Spain, as well as into various regions such as Kamchatka and Sakhalin. In the north, it is distributed throughout the basins of the Lena, Yenisei, and Ob rivers. In the south, it inhabits the Black Irtysh River basin, the northern part of the Altai region, and the Black Sea and Aral Sea basins [1, 3, 6].

Until the early 1960s, within the Aral Sea basin, the silver crucian carp was found only in the Aral Sea itself and in the lower reaches of the Amu Darya and Syr Darya rivers near their confluence with the sea. However, as the water level of the Aral Sea declined and its salinity increased, this fish species, like many others, disappeared from the area.

During the period of large-scale irrigation construction in Uzbekistan, lentic-type water bodies, including reservoirs and lakes formed by groundwater accumulation, emerged in the lowland sections of major river basins. As previously noted, in order to ensure the efficient utilization of these water resources, their commercial fish communities were developed through the introduction of new fish species of commercial value, including species that had not previously inhabited the region. In the 1950s, silver crucian carp was introduced into pond fish farms in the Tashkent region from the Savvino fish farm in the Moscow region, where the species had originally been brought from the Amur River [2, 4, 5, 7]. Subsequently, through the transfer of fry of other cyprinid species raised in pond fish farms to various water bodies across the republic, silver crucian carp also spread throughout Uzbekistan, including the Tudakul Reservoir in the lower reaches of the Zarafshan River.

Silver crucian carp has successfully adapted to favorable environmental conditions in almost all natural water bodies and artificial ponds located in the lowland regions of Uzbekistan and has begun reproducing naturally. Since the 1970s and 1980s, it has become one of the commercially important fish species, including in the Tudakul Reservoir [8, 9, 10].

During our scientific research, the reproductive characteristics of silver crucian carp were analyzed. It should be noted that the study focused on specimens from populations inhabiting the Tudakul Reservoir, which are considerably affected by commercial fishing activities. The fish specimens were caught by fishermen using gillnets. Fishing teams operated in different parts of the reservoir, thereby covering its entire area.

RESEARCH METHODOLOGY

The study was aimed at investigating the reproductive biology of the silver crucian carp (*Carassius gibelio* Bloch, 1782) population inhabiting the Tudakul Reservoir. Fish samples were collected from various designated locations within the reservoir during 2022–2023 using standard ichthyological methods. The total body length and weight of each specimen were measured, while age was determined based on scale analysis. The sexual maturity of female fish was assessed through macroscopic examination of their gonads, and the stages of gonadal development were determined in accordance with established ichthyological methodologies. The collected data were subjected to statistical analysis, and the results were expressed as mean values and standard errors ($M \pm m$).

The spawning season of silver crucian carp began on April 27 and continued for approximately two weeks in May. Areas near the shoreline covered with submerged vegetation served as spawning

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grounds. The depth of these spawning sites ranged from 40 cm to 1.5 m. The first and second spawning periods of silver crucian carp coincided with the spawning season of common carp (*Cyprinus carpio*). In spring, the spawning of white bream was also observed. This indicates a partial overlap in the reproductive periods of these fish species in the Tudakul Reservoir.

At the end of March, when the gonads of female silver crucian carp in the Tudakul Reservoir had reached stage IV of sexual maturity, their absolute fecundity was determined. This indicator ranged from 12,200 to 101,200 eggs. Larger female specimens demonstrated higher fecundity values. The positive relationship between absolute fecundity (AF, thousand eggs) and body length was described by the following regression equation:

AF (thousand eggs) = 6.42 × SL (cm) − 106.65; (r = 0.59)

(Figure 1).

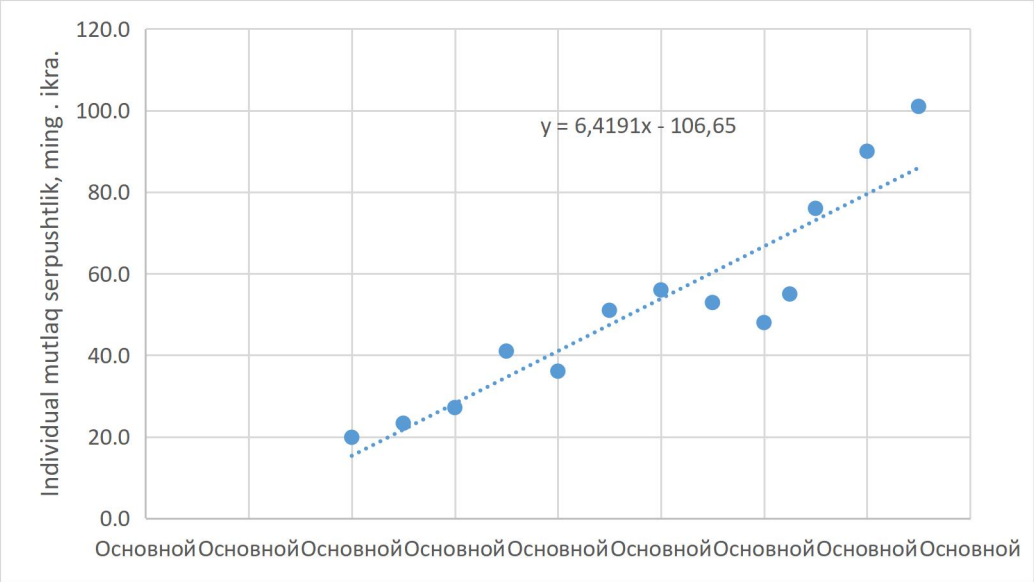


Figure 1. A positive relationship was established between the individual absolute fecundity of silver crucian carp in the Tudakul Reservoir and its standard body length: AF = 6.42 × SL − 106.65 (r = 0.59).

The individual relative fecundity of female silver crucian carp ranged from 78 to 132 eggs per gram of body weight. It should be noted that this indicator varied independently of fish body length, particularly standard length (r = 0.08).

In mid-April, the gonadosomatic index (GSI) of female silver crucian carp ranged from 7.8% to 21%.

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The diameter of sexually mature oocytes in the gonads at the beginning of April was 1.01 ± 0.06 mm. This parameter exhibited relatively low variability (Cv = 9.1%) and showed a weak relationship with fish body length (r = 0.38).

Analysis and Results

In spring, the gonads of female fish at stage IV of sexual maturity were weighed with an accuracy of 0.1 g. A 1 g subsample was then measured with an accuracy of 0.01 g and fixed in a 4% formalin solution. Under laboratory conditions, the number of oocytes in each sample was determined using a Bogorov counting chamber. The absolute fecundity of the fish (AF, thousand eggs) was calculated by extrapolating the number of oocytes in the subsample to the total gonad weight.

Individual relative fecundity (RF, eggs/g) was determined by dividing the absolute fecundity value by the body weight of the fish excluding its internal organs (Figure 2).



Figure 2. Determination of the number of oocytes in the sample using a Bogorov counting chamber under laboratory conditions.

The counting data were processed using generally accepted computer software and methods of variation statistics. One-way analysis, correlation analysis, and regression analysis were applied. The significance level for all calculations was set at p = 0.05. Correlation and regression analyses were performed using the Excel package of Microsoft Office.

CONCLUSIONS AND RECOMMENDATIONS

Silver crucian carp, an invasive species in the Zarafshan River basin, has successfully established reproducing populations in the Tudakul Reservoir and has become an important commercially harvested fish species.

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The species reaches sexual maturity at the age of two years. Its individual absolute fecundity ranges from 12,200 to 101,200 eggs, while its relative fecundity amounts to 78–132 eggs per gram of body weight.

It is necessary to restore genuine pasture aquaculture practices in the Tudakul Reservoir. Such an approach would not only increase the harvesting volume of pasture aquaculture species but also create opportunities to increase the commercial catch of native ichthyofaunal species.

Strict compliance with fishing bans during the spawning period of native fish species, particularly in April and May, is essential for preserving fish populations and ensuring the sustainable use of aquatic biological resources.

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