INTERNATIONAL MULTI DISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
eISSN 2394-6334 Impact factor: 8.854 Volume 13, issue 03 (2026)

MORPHO-BIOLOGICAL CHARACTERISTICS OF ACCLIMATIZED SILVER CARP (*HYPOPHTHALMICHTHYS MOLITRIX*) IN THE WATER BODIES OF THE BUKHARA REGION

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Abstract: This article analyzes the morphometric and plastic characteristics, growth rates, and condition factors (Fulton's coefficient) of silver carp (*Hypophthalmichthys molitrix*) acclimatized to the arid climate and unique hydrochemical composition of water bodies in the Bukhara region. Fish samples of various ages obtained from the Tudakul and Shurkul reservoirs, which are characterized by complex hydrochemical profiles, were selected as research objects. Based on statistical data, the article highlights the impact of the hot climate and high water mineralization (salinity) on the body structure and growth dynamics of the fish. Morphometric analyses conducted using the Pravdin methodology revealed the specific ecological plasticity and hydrodynamic adaptation traits of the acclimatized population. The research findings demonstrate that the hot climate and water mineralization levels significantly influence the morphometric indicators and overall productivity of the fish.

Keywords: Bukhara region, acclimatization, morphometry, silver carp (*Hypophthalmichthys molitrix*), , Pravdin method, plastic characteristics.

Introduction

The water bodies of the Bukhara region differ fundamentally from other regions of Uzbekistan due to their extreme hydrological regimes. In this area, the acclimatization of fish is directly dependent on water salinity levels and thermal indicators. The water resources of the Bukhara region (particularly Tudakul, Shurkul, and Zamonbobo) are primarily replenished by the return waters of the Amu Darya and collector-drainage networks. Notably, in the Shurkul reservoir, the concentration of chloride and sulfate salts in the water is high. Mineralization levels vary seasonally between $3\text{--}5 \text{ g/l}$ (and occasionally higher). Such "saline" conditions complicate the process of osmoregulation (salt exchange between the body and water); however, acclimatized species such as grass carp and silver carp have adapted to these conditions over many years. In particular, the ability of these species not only to survive but also to exhibit high biological productivity under such stress is of significant scientific interest.

The lower reaches of the Zarafshan River, the region's main water artery, and its adjacent collector-drainage networks became a large-scale "polygon" for the formation of ichthyofauna starting from the second half of the 20th century. According to historical data, varieties of scaled carp from Ukraine and herbivorous fish from the Far East (grass carp and silver carp), which were introduced to our republic in the 1960s, were crossbred—both naturally and artificially—with local wild carp forms. This process resulted in the emergence of a unique ichthyopopulation adapted to the saline and high-thermal regimes of Bukhara's water bodies.

However, in modern aquaculture, regular monitoring of the current morphological state and biological indicators of these fish is required to improve product quality and implement

systematic breeding programs. Analyzing the body structure, growth coefficients, and the adaptation of fish to environmental factors is crucial not only for theoretical ichthyology but also for enhancing practical fishery productivity.

The objective of this research is to study the morphometric characteristics of one-year-old generations of carp and other phytophagous fish acclimatized to the conditions of the Bukhara region, and to provide a scientific assessment of their biological state under extreme hydrological conditions.

MATERIALS AND METHODS

Study Area and Specimen Collection

The research material was collected on January 27, 2025, from the **Shurkul Reservoir** located in the Bukhara region. This reservoir is a critical water body in the region, primarily replenished during the autumn-winter season via a specialized canal from the Zarafshan River. It was constructed between 1977 and 1980, featuring a total capacity of 170 million m^3, a dam height of 14.5 m^3, and a maximum water discharge capacity of 35 m3.

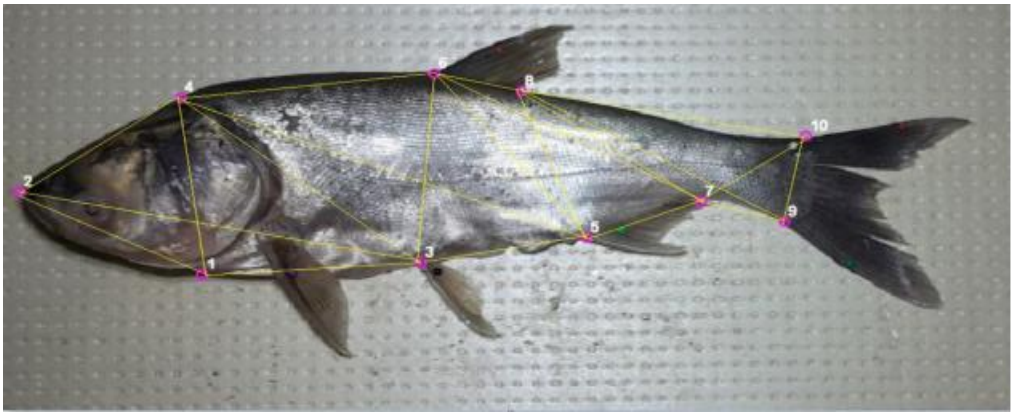
During the sampling period, the following environmental parameters were recorded:

- **Water pH:** 7.8- 8.2
- **Water Temperature:** 4.8- 5.6*C
- **Ambient Air Temperature:** 4.3* C
- A total of 10 silver carp (*Hypophthalmichthys molitrix*) specimens were randomly selected for analysis. Initial measurements included total length (TL cm), standard length (SL, cm), and total body mass (W ,g). The specimens were subsequently preserved in a **7% formalin solution** for laboratory processing.

Morphometric and Digital Analysis

In the laboratory, the fish were positioned laterally with their fins carefully extended. Digital photographs were captured using a camera setup where the optical axis was strictly perpendicular to the plane of the specimen to avoid parallax errors. Plastic characteristics were measured from these digital images using the **Ruler Tool in Adobe Photoshop**.

The morphometric analysis followed the standardized measurement scheme for the *Cyprinidae* family as described by **Pravdin (1966)**. Additionally, a **Truss Network System** was implemented to define the body shape, identifying 10 homologous landmarks along the perimeter of the fish body. Distances were measured as straight lines between these landmarks (e.g., "2-4" denotes the measurement between landmark 2 and landmark 4), following the methodologies of **Strauss and Bookstein (1982)** and **Strauss and Bond (1990)**. All plastic measurements were normalized and calculated as a percentage of the standard body length (% SL).



Rice 1. Landmarks on the body surface of silver carp (*Hypophthalmichthys molitrix*) from the Shurkul Reservoir.

Age and Growth Analysis

The age of the fish was strictly determined using scales collected from a consistent area: specifically, from the first row above the lateral line, directly below the first ray of the dorsal fin. The annual growth rates of the fish were reconstructed using **E. Lea's back-calculation method**. Sexual maturity stages were assessed using a **6-point scale(Nikolskiy)**. Additionally, indicators of **Individual Absolute Fecundity (IAF, thousand eggs)** and **Individual Relative Fecundity (IRF, eggs/g of body weight)** were determined. The numerical data were processed using variational statistics through standard computer software.

RESEARCH METHODOLOGY

The ichthyological methodology developed by **I.F. Pravdin (1966)** was employed to determine the external morphological characteristics of the fish. The following parameters were measured:

- **Total Length (L):** From the tip of the snout to the end of the caudal fin.
- **Smith Length (l):** From the tip of the snout to the fork (middle) of the caudal fin.
- **Body Mass (W):** Measured using an electronic balance with a precision of 0.1 g
- **Plastic and Meristic Traits:** These included body height, head length, eye diameter, the number of rays in the fins, and the scale count.

RESULTS AND DISCUSSION

1. Variability of Morphometric Characteristics

Morphological variations in acclimatized populations serve as primary indicators of environmental adaptation. The analysis of specimens obtained from the Bukhara water bodies indicates shifts in the ratios of body height and head length.

The indices of plastic characteristics for one-year-old fish, based on the **classic measurement scheme for carp (*Cyprinidae*)**, as well as the geometric morphometric traits (according to the **"Truss-Protocol" system**), are presented in **Table 1**.

INDEX	X	S	Sx	Cv, %	Min	Max
TL	30,7	1,36151 1	0,4143868	4,23	28,38	32,939
SL	23,56	1,1252	0,393	4,33	24,45	28,0851
2-4	4,657	0,49321	0,12	8,047	5,316	7,4045
4-6	7,684	0,6631	0,219	7,549	7,737	9,757
6-8	2,13 7	0,32976	0,12	10,559	2,525	3,549
8-10	9, 9	0,474	0,102	4,688	8,468	9,908
9-10	3,6	0,51871	0,14	14,434	2,486	4,295
7-9	3,32	0,44663	0,135	13,87	2,2	4,035
5-7	3,7	0,515	0,24	18,543	2,68	4,95
3-5	6,2	0,73043	0,229	11,285	4,54	6,962
2-3	13,2	0,80923	0,29	6,579	12,28	15, 14
1-2	6,3	0,2307	0,077	3,622	5,94	6,76
1-4	6,27	0,	0,088	4,528	5,75	6,69
1-3	7,3	0,8	0,25	11,194	6,45	9,66
3-4	10,2	0,27	0,088	2,617	9,895	10,765
5-6	8,2	0,5554	0,179	6,792	6,7286	8,793
7-8	2,305	0,338	0,106	11,503	2,144	3,27
4-5	14,52	0,66516	0,19	4,479	13,048	15,14
3-6	7,4	0,39	0,1105	4,771	6,554	8,07
6-7	9,785	0,42291	0,1334	4,391	8,679	10,17
5-8	6,07	0,5286	0,134	9,0108	5,3058	7,07
7-10	4,54	0,5899	0,172	12,367	3,2241	5,1726
8-9	9, 32	0,48547	0,15	5,2169	8,125	9,9468

CONCLUSION

Based on the conducted research and morphometric analysis, the following scientific conclusions were reached:

1. **Ecological Adaptability:** Silver carp (*Hypophthalmichthys molitrix*) demonstrated a high degree of ecological plasticity under the specific arid climate and hydrochemical conditions (high mineralization and thermal regimes) of the Bukhara region. The plastic and cephalic (head) indicators confirm the species' full adaptation to efficiently utilizing the food base within these complex hydrological environments.
2. **Morpho-biological Stability:** Morphometric data indicate that while the acclimatized populations retain their primary species-specific characteristics, they exhibit optimal growth rates relative to local food resources (phytoplankton). Specifically, the development of the branchial (gill) apparatus serves as a crucial biological filter in controlling the eutrophication process of the water bodies.
3. **Fishery Potential:** The rapid growth rate and high fecundity of silver carp have been proven as key factors ensuring the economic efficiency of polyculture fish farming in the Bukhara region. The research results provide a foundation for recommending this species as a primary object for the biological purification (melioration) of water bodies and for enhancing overall productivity.
4. **Practical Significance:** The identified morpho-biological parameters serve as a framework for the future improvement of selection and breeding programs, as well as for developing science-based recommendations for the rational utilization of regional water resources.

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