

# LENGTH-WEIGHT RELATIONSHIPS OF SEVEN POPULATIONS OF ISKANDARIA KUSCHAKEWITSCHI (TELEOSTEI: NEMACHEILIDAE) FROM THE FERGANA VALLEY

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## Abstract

This article presents an ecological analysis of the relationship between length and weight in populations of the Kushakevich stone loach (*Iskandaria kuschakewitschi* (Herzenstein, 1890)) found in the rivers of the Fergana Valley. According to the research findings, the relationship between fish length and weight corresponds to an isometric growth pattern. This result confirms that the fish populations inhabit ecologically favorable river ecosystems in the valley, with low levels of interspecific competition. Additionally, the study reports the first recorded occurrence of *I. kuschakewitschi* in the Kosonsoy River.

**Keywords:** Endemic, length-weight relationship, negative allometric, positive allometric, isometric, Kosonsoy River.

## Introduction

The relationship between fish body weight and length is one of the most extensively studied criteria in fish biology. This length-weight relationship serves as a fundamental biometric parameter for assessing the growth rate, health status, and environmental adaptability of fish [1]. Through these relationships, it is possible to determine whether a fish is growing isometrically or allometrically, as well as to identify ontogenetic changes and biological differences among populations distributed across various regions. Furthermore, length-weight relationships are widely used to monitor the general condition of fish populations, assess their sensitivity to ecological stress, and study their ecological strategies and habitat conditions [2,3]. The Fergana Valley, located in Central Asia, is one of the largest and most hydrologically complex inland water systems. Its numerous rivers and canal networks have fostered a high level of hydrobiological diversity within the region. Such climatic and geomorphological conditions have created a favorable environment for the development and survival of various ecological categories of fish, especially endemic species. One such species is *Iskandaria kuschakewitschi* (Herzenstein, 1890), commonly known as Kushakevich's stone loach, which is found only in the Syr Darya basin and its tributaries. Previous research on the ecological and morphometric status of this species has been limited to a few local water bodies [5,7–10]. While length-weight relationship (LWR) data from the Qoradaryo and Marg'ilonsoy rivers are

available, there is a lack of sufficient information for other rivers and canals [10–11]. Therefore, this article presents the results of a scientific study aimed at determining the length-weight relationship parameters of *I. kuschakewitschi* populations in seven major water bodies of the Fergana Valley, analyzing the differences between them, and assessing the ecological condition of these populations.



**Fig 1:** *Iskandaria kuschakewitschi* from Kasansay River, Fergana Valley

## MATERIALS AND METHODS

The research was conducted during 2024–2025 in various water bodies of the Fergana Valley, including the Qoradaryo, Chortoqsoy, Chodaksoy, Kosonsoy, and Oltiariqsoy rivers, as well as the Greater Fergana (Katta Farg‘ona) and Southern Fergana (Janubiy Farg‘ona) canals. A total of 147 fish specimens ( $n = 147$ ) were collected from selected sites along each river or canal. Sampling was carried out in accordance with standard procedures using hand nets, cast nets, and fish traps.

For each fish, total length ( $L$ ) was measured with a digital caliper to an accuracy of 0.1 mm, and body weight ( $W$ ) was measured with an electronic balance to an accuracy of 0.01 g. A portion of the specimens was fixed in 10% formalin for morphometric analysis and later transferred to 70% ethanol for long-term preservation. All samples were deposited in the collection of the Department of Zoology and General Biology at Fergana State University.

The length-weight relationship (LWR) was estimated using the following equation [3]:

$$W = aL^b$$

Where:

- $W$  is the weight of the fish (g),
- $L$  is the length of the fish (mm),
- $a$  is the intercept of the regression (initial constant),
- $b$  is the regression coefficient (growth exponent).

The parameters were analyzed by applying a log-transformation and fitting a linear regression model using the formula:

$$\log(W) = \log(a) + b \cdot \log(L)$$

Statistical analyses were performed using Microsoft Excel and SPSS software. For each population, the coefficient of determination ( $r^2$ ) was calculated to evaluate the goodness of fit

and reliability of the LWR model. The relationship between body length and mass of the fish was computed based on the formulas described in [13,14].

## RESULTS AND DISCUSSION

In this study, the statistical relationship between length and weight in Iskandaria kuschakewitschi populations inhabiting the Qoradaryo, Chortoqsoy, Oltariqsoy, Chodaksoy rivers and the Greater Fergana and Southern Fergana canals of the Fergana Valley was investigated. A total of 147 specimens were analyzed during the study. According to the results, the correlation coefficient ( $r^2$ ) observed in the fish populations ranged from 0.945 to 0.979, indicating a high level of regression. The "a" values ranged from 0.005 to 0.688, while the "b" values were between 2.687 and 3.423. A b value lower or higher than 3 indicates, respectively, negative or positive allometric growth. The Oltariqsoy population showed a near-isometric, positively allometric growth pattern, while the remaining populations exhibited negative allometric growth.

These differences among populations may be linked to variations in environmental conditions, food availability, trophic levels, and competition intensity in their habitats. In the overall combined model, the values were  $r^2 = 0.953$ ,  $a = 0.0061$ , and  $b = 2.961$ , indicating a growth pattern close to isometric. This suggests that fish populations are living under favorable ecological conditions in the river ecosystems, with environmental factors being near optimal.

**Table 1** presents the LWR parameters for all seven populations, clearly indicating the growth type and statistical fit. Moreover, the first recorded presence of *I. kuschakewitschi* in the Kosonsoy River expands the known distribution range of the species. The Oltariqsoy population did not significantly differ from other populations and exhibited positive allometry, which indicates a stable population in that aquatic habitat.

№	Water Places	N	Total length (mm)		Total weight (g)		a	b	GT	$r^2$
			Min	Max	Min	Max				
1	Kosonsoy	40	4,67	8,89	0,63	4,48	0,007	2,935	-A	0,976
2	Qoradaryo	20	2,92	6,99	0,15	1,75	0,008	2,798	-A	0,945
3	Chodaksoy	17	4,72	8,32	0,72	3,25	0,010	2,687	-A	0,962
4	Chortoqsoy	20	4,29	7,59	0,45	2,15	0,007	2,768	-A	0,969
5	Oltariqsoy	20	3,93	7,28	0,70	4,80	0,005	3,423	I	0,946
6	Great Fergana channel	14	5,13	8,28	0,71	2,73	0,688	2,927	-A	0,979
7	Southern Fergana Channel	16	4,23	8,35	0,43	2,52	0,007	2,855	-A	0,966
	Overall indicators	147	2,92	8,89	0,15	4,48	0,0061	2,961	I	0,953

## DISCUSSION (Continued)

Numerous scientific sources indicate that the expected range for the  $b$  coefficient in length-weight relationships is between 2.5 and 3.5, with the ideal value being 3.0 [3]. The results of this study fall within this expected range, supporting the conclusion that the ecological condition of *Iskandaria kuschakewitschi* populations is stable. A  $b$  value greater than 3 indicates that the fish is gaining weight faster than it is growing in length—i.e., positive allometric growth. Conversely, a  $b$  value lower than 3 suggests that the fish is directing more energy toward length growth rather than weight—i.e., negative allometric growth. This reflects the species' ecological strategy, such as energy allocation toward foraging efficiency or predator avoidance [10,11]. In this study, the overall regression coefficient values were  $r^2 = 0.953$ ,  $a = 0.0061$ , and  $b = 2.961$ , indicating a growth pattern close to isometric. This suggests that *I. kuschakewitschi* populations are living in ecologically favorable conditions within the river ecosystems of the Fergana Valley, likely due to abundant food resources and a low presence of natural predators. Moreover, variations in growth coefficients are influenced by a variety of ecological and biological factors, including habitat characteristics, seasonal variations, degree of sexual maturity, physiological condition of the organism, competition levels, and anthropogenic pressures (e.g., fishing pressure or water quality) [10,11].

## CONCLUSION

*Iskandaria kuschakewitschi*, the Kushakevich stone loach, is widely distributed across rivers in the Fergana Valley and currently maintains stable populations. The study findings indicate that most populations of this species exhibit negative allometric growth, while in some cases, isometric or even positive allometric growth patterns were observed. This suggests variability in sensitivity and adaptive strategies to the environmental conditions of different water bodies. At present, the ecological status of *I. kuschakewitschi* does not appear to be of major concern. However, to ensure long-term stability of its populations, it is important to conduct regular monitoring, broaden the study of its distribution range, and carry out ecological and genetic investigations. Particular attention should be given to populations that are more sensitive to environmental or anthropogenic factors (e.g., Oltiariqsoy population). Comprehensive studies on genetic diversity, feeding spectrum, and seasonal variability are highly recommended for a deeper understanding of the species' ecological dynamics.

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