Morphological Features Of The Tashkent Riffle Bleak *Alburnus Oblongus* (Teleostei: Leuciscidae) In Chirchik River, Uzbekistan

Turayev, L.G.[1*], Sobirov, J.J.[1], Yuldashov, M.A.[2], Kamilov, B.G.[2]

[1*]Institute of Zoology, Academy of Sciences of the Republic of Uzbekistan
[2]Tashkent State Agrarian University, Uzbekistan

***Corresponding Author**: Turayev, L.G.
*Institute of Zoology, Academy of Sciences of the Republic of Uzbekistan, Email: turayevlaziz089@gmail.com

Abstract.
In 2022, the morphological features of the Tashkent riffle bleak (Alburnus oblongus) from the upper stream of the Chirchik River (Uzbekistan) were studied. The previously abundant species (endemic of the middle Syrdarya) was forced out by invaders from the Chinese fauna from the plain to the foothill zone of the rivers in the second half of the 20th century; the species state became threatening; it was included in the Red Book of Uzbekistan. In the 2000s, the presence of species in the foothill zone of the Chirchik was revealed. Between the total body length and the standard body length, a strong relationship was revealed, which is reliably described by the linear regression equation: SL = 0.85*TL – 1.673 (r = 0.99). A strong positive relationship between the total body weight and the standard body length is characterized by the regression line (W = 0.000012*SL3.0718).

Keywords: Alburnus oblongus, meristic features, plastic features, Chirchik River, Uzbekistan

Introduction

The Tashkent riffle bleak (Alburnus oblongus Bulgakov, 1923) is a small, endemic freshwater fish belonging to the family Leuciscidae. It primarily inhabits the middle reaches of the Syr Darya River and the plains of its major tributaries, namely the Chirchik, Arys, and Angren rivers, within Uzbekistan and Kazakhstan.

Historically, until the 1960s and 1970s, it was a common non-commercial fish found in abundance in the lakes of river floodplains. It played a significant role as one of the predominant species in the polyculture of cyprinids within earthen aquaculture ponds in the Tashkent region (Berg, 1949; Kamilov, 1973). However, in the early 1960s, the introduction of Silver carp (*Hypophthalmichthys molitrix*) and Grass carp (*Ctenopharyngodon idella*) larvae, along with the illegal introduction of other small weedy fish from the Chinese ichthyofauna (Salikhov, Kamilov, 1995; Salikhov et al., 2001; Yuldashov, Kamilov, 2018), resulted in the competitive displacement of the Tashkent riffle bleak. This invasive species from the Chinese fauna proved to be more successful, leading to the endangerment of the Tashkent riffle bleak. Presently, it is listed in the Red Book of Uzbekistan with a "vulnerable, declining 2(VU: D)" status.

The Tashkent Riffle Bleak primarily inhabits shallow areas of rivers and bays with flowing water. However, its population has significantly declined in recent decades. The available data on the biology of the Tashkent Riffle Bleak is limited and primarily pertains to the latter half of the 20th century (Kamilov, 1973; Salikhov et al., 2003). Therefore, the objective of this study was to comprehensively investigate the biological parameters of the Tashkent Riffle Bleak within the upper stream of the Chirchik River.

Material and methods

The study was conducted in the Chirchik basin, which encompasses the rivers flowing from the slopes of the Talas Alatau mountains and its southwestern spurs, irrigating the Tashkent oasis in the Tashkent region of Uzbekistan. The Chirchik River is formed by the confluence of two rivers: Chatkal (the primary component) and Pskem. The total area of the Chirchik basin is approximately 18,061 km², with the Chirchik River itself spanning 155 km in length, and 328 km from the sources of the Chatkal River.
The upper section of the Chirchik River, approximately 30 km in length, features a canyon-like formation, while the lower section widens, losing its distinct relief characteristics. The water supply of the Chirchik River is primarily a mix of snowmelt. The average water flow in the upper reaches of the river is 221 m³/sec. Ice phenomena are observed from November to March. The climate in the Tashkent region is highly continental. Summers are hot, with an average monthly air temperature of around 29°C in July, often reaching daytime temperatures of 35-42°C and occasionally even higher. Winters are relatively cold, with an average monthly temperature of -2°C in January. Water bodies with stagnant water are often covered in ice for up to 1.5 months.
In November 2022, Tashkent riffle bleak samples were collected from the Gazalkent reservoir using a small-mesh seine. The Tashkent riffle bleak species was identified during the research. Water from the reservoir was poured into a plastic

bag (10 L), and a solution of clove oil at a concentration of 0.033 mL/L was prepared (Akvakultura, 2011). 3-5 live fish were placed in the bag, and within 5-6 minutes, they fell asleep. The fish were then carefully straightened out and photographed using a 'Canon' digital camera, with a ruler for scale. Meristic characters were counted, and the fish were subsequently placed in a bag with clean water. Once the fish had awakened and began actively swimming, they were returned alive to the reservoir.

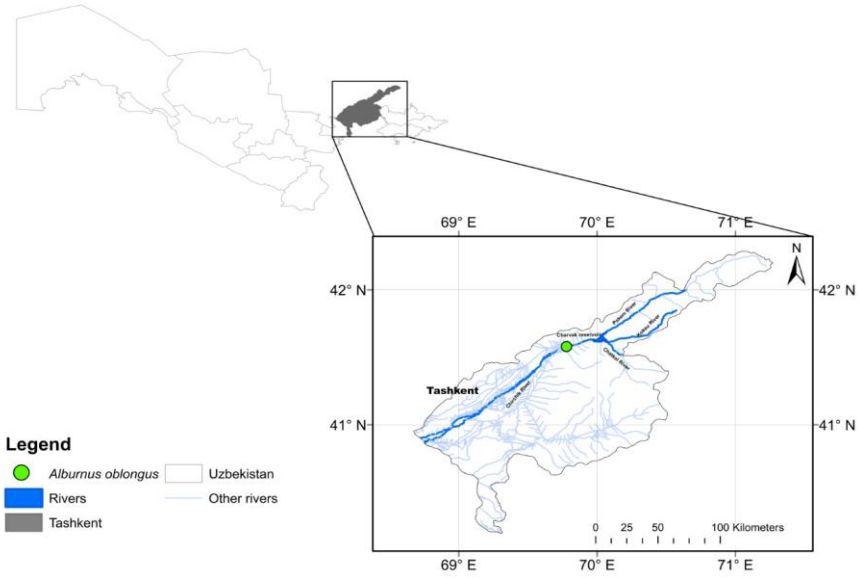

Figure 1. Sampling site of the Tashkent riffle bleak *Alburnus oblongus*

Morphological identification and systematic status of Tashkent riffle bleak were made, using characters given by Berg (1949) and Salikhov et al. (2003). The total length (TL), standard length (without caudal fin, to the end of scale coverlet) (SL) in the nearest 1 mm and body weight (W) in the nearest 1 g were recorded for each fish.

The plastic characteristics of the fish were quantified by measuring digital photographs using the ruler tool in the 'Photoshop' program. The magnification of the photographs was determined, and the measurements were converted into absolute units of length (mm). The measurement scheme for cyprinids by Pravdin (1966) was followed to measure the plastic characteristics. A total of ten landmarks along the perimeter of the fish's body were identified (Fig. 2). Each fish was photographed from a strictly perpendicular angle using a fixed tripod. The distances in a straight line between landmarks were measured using the "truss" protocol, as described by Strauss and Bookstein (1982) and Strauss and Bond (1990). For example, a measurement between landmarks 2 and 4 would be denoted as "2-4". To standardize the plastic feature measurements, the absolute values were converted into percentages of the standard body length. The 'truss-protocol' scheme was implemented using the software programs 'TPS Util 64', 'TPS Dig264', and 'MorphoJ' (Fig. 2). Statistical analyses were conducted to evaluate the data, including the calculation of statistical characters such as the coefficient of variation (Cv, %). In accordance with conventional practice, significance levels were set at $P \leq 0.05$ for all statistical tests.

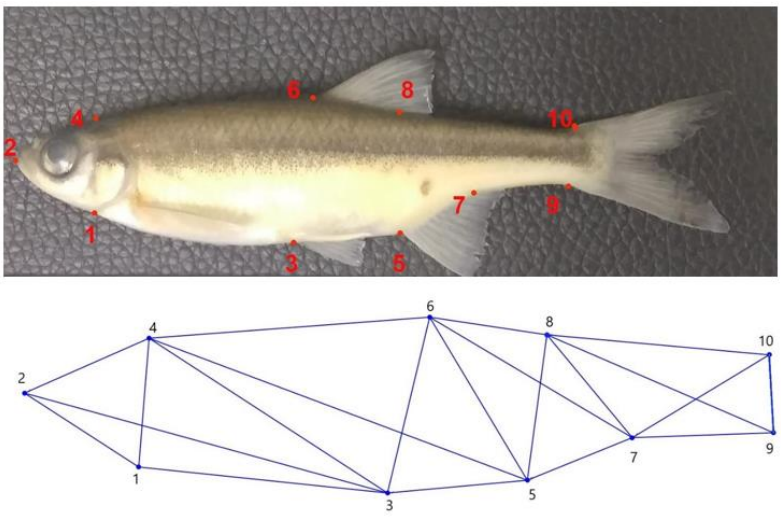

Figure 2. Landmarks and mean 'truss-protocol' for Tashkent riffle bleak, upper stream of the Chirchik River, 2022.

Results

A total of 24 Tashkent riffle bleak specimens were included in our analysis. The samples encompassed fish with a range of total lengths from 30 to 114 mm, standard lengths ranging from 25 to 95 mm, and total weights varying from 0.2 to 12 g. A strong linear relationship was found between the total body length (TL) and the standard body length (SL) of the Tashkent riffle bleak, with a regression equation of SL = 0.85*TL - 1.673 (r = 0.99) (Fig 3).

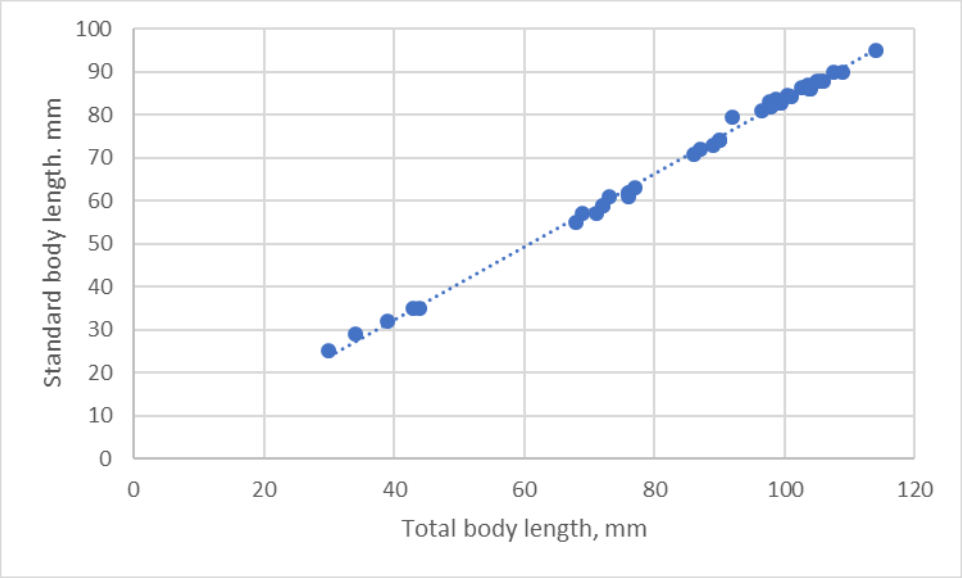

Figure 3. Relationship between total length and standard length of Tashkent riffle bleak, Chirchik River.

The analysis revealed positive relationship between the total body weight and the standard body length of the Tashkent riffle bleak, as demonstrated by the power function regression line: W = 0.000012*SL^3.0718 (Fig 4).

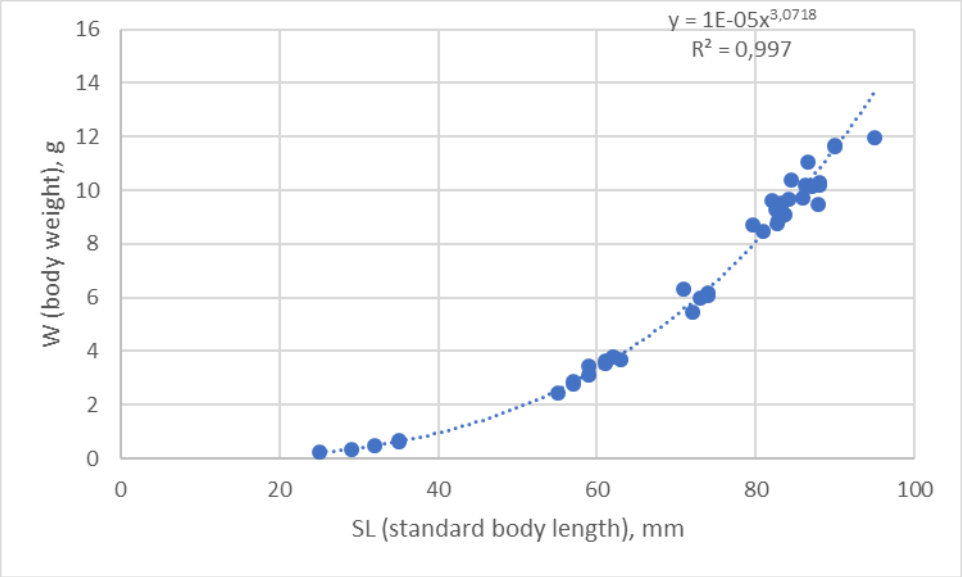

Figure 4. Relationship between the total body weight and standard length of Tashkent riffle bleak.

The meristic counts of the Tashkent riffle bleak were determined as follows: dorsal fin rays III 8-9, anal fin rays III 11-12, and lateral line scales 53-58. Plastic characteristics of the Tashkent riffle bleak, according to the traditional scheme for cyprinids, are presented in Table 1. Indexes for the "truss-protocol" relative to standard body length are shown in Table 2. The sample was divided into two groups based on sexual maturation, with no significant differences in plastic features observed between sexes in both groups.

Table 1. Morphometric characteristics of Tashkent riffle bleak (% of standard length), upper stream of Chirchik River, Uzbekistan

Index	Immature		Matured	
	Min – Max Mean+SD	CV, %	Min – Max Mean+SD	CV, %
Body length	74.7 – 78.5	2,1	74.0 – 79.8 76.8 ± 0.30	1,7
Snout length	76.3 ± 0.73 4.9 – 6,3 5.6 ± 0.23	9,4	3.8 - 7.0 5.8 ± 0.19	13,9
Eye diameter		3,7	6.7 – 8.7 7.4 ± 0.13	7,7
Postorbital length of the head	7.7 – 8.5 8.2 ± 0.14 9.9 – 10.8 10.5 ± 0.16	3,5	9.0 – 11.5 10.4 ± 0.14	5,9
Head length	23.6 – 24.8 24.4 ± 0.24	2,2	19.7 – 26.0 23.5 ± 0.31	5,8
Head height at the back	14.8 – 18.4 16.4 ± 0.65	8,9	15.9 – 18.9 17.0 ± 0.17	4,5
Maximum body height	20.6 – 21.8	2,2	22.2 - 24.7 23.3 ± 0.18	3,3
The smallest body height	21.4 ± 0.21 9.3 – 10.7	6,1	8.5 - 10.1 9.6 + 0.09	4,1
Antedorsal distance	9.9 ± 0.27 49.9 – 53.0 51.7 ± 0.61	2,6	51.1 – 56.1 52.9 ± 0.26	2,1
Postdorsal distance	34.3 – 37.8 36.0 ± 0.63	3,9	31.6 - 35.9 33.6 ± 0.29	3,7
Caudal peduncle length	22.4 – 26.1 24.6 ± 0.60	5,4	20.5 – 24.6 22.4 ± 0.29	5,5
Dorsal- fin base length	11.4 – 17.6 14.7 ± 1.11	16,9	13.0 – 17.5 15.4 ± 0.29	8,2
Dorsal- fin the greatest height	20.1 – 21.6 20.8 ± 0.29	3,1	16.1 - 23.1 19.6 ± 0.37	8,2
Anal- fin base length	10.1 – 16.6 13.6 ± 1.08	17,7	13.0 – 16.8 14.8 ± 0.24	7,2
Anal- fin the greatest height	14.2 – 17.1 15.8 ± 0.50	7,1	12.4 - 16.9 14.2 ± 0.26	8,0
Pectoral- fin length	12.5 – 21.6 17.6 ± 1.52	19,2	14.5 - 22.3 18.4 ± 0.42	10,0
Ventral- fin length	12.6 – 16.0 14.2 ± 0.55	8,7	11.3 - 15.8 13.8 ± 0.27	8,6
Pectoral – pelvic fins distance	18.9 – 24.7 23.1 ± 1.06	10,3	74.0 – 79.8 76.8 ± 0.30	5,6
Ventral – anal fins distance	14.1 – 20.3 16.8 ± 1.05	14,0	3.8 - 7.0 5.8 ± 0.19	8,9

Table 2. Indexes of «truss-protocol» morphological characteristics of Tashkent riffle bleak (% of standard length), upper stream of Chirchik River, Uzbekistan

Index	Immature		Mature	
	Min – Max Mean+SD	CV, %	Min – Max Mean+SD	CV, %
2 - 4	13.0 – 21.0 17.0 ± 1.38	18,3	13.6 – 19.1 16.9 ± 0.37	9,6
4 - 6	31.7 – 38.3 35.7 ± 1.11	7.0	33.7 – 39.5 36.5 ± 0.42	5,1
6 - 8	11.3 – 17.6 14.7 ± 1.12	17,1	13.5 – 17.4 15.5 ± 0.26	7,4
8 - 10	27.4 – 36.0 31.0 ± 1.49	10,8	25.9 – 29.7	3,9
9 - 10	9.7 – 10.9 10.1 ± 0.25	5,5	27.8 ± 0.25 8.6 – 10.5	5,0
7 - 9	15.4 – 23.6 19.5 ± 1.36	15,7	9.9 ± 0.11 13.9 – 20.1 17.4 + 0.37	9,3
5 - 7	12.5 – 16.6 14.1 ± 0.76	12,0	13.5 – 17.1 14.7 ± 0.24	7,1
3 - 5	14.2 – 20.3	13,9	14.2 – 20.4	10,2

	16.8 ± 1.05		17.6 ± 0.41	
2 - 3	44.3 – 49.7 47.6 ± 0.98	4,6	46.6 – 50.5 48.7 ± 0.29	2,6
1 - 2	13.2 – 20.2 16.2 ± 1.23	17.0	15.0 – 18.4 16.8 ± 0.21	5,3
1 - 4	14.3 – 18.0 16.0 ± 0.70	9,8	15.0 – 18.0 16.5 ± 0.15	4,0
1 - 3	25.2 – 37.1 32.5 ± 2.05	14,1	30.7 – 36.2 32.9 ± 0.39	5,2
3 - 4	32.8 – 40.5 36.1 ± 1.30	8,0	34.8 – 40.1 37.1 ± 0.34	4,0
5 - 6	20.9 – 23.6 22.5 ± 0.44	4,4	23.2 – 27.5 24.9 ± 0.22	3,9
7 - 8	16.2 – 18.1 17.2 ± 0.40	5,2	15.3 – 18.1 16.9 ± 0.21	5,3
4 - 5	46.7 – 54.3 50.4 ± 1.27	5,6	50.2 – 55.8 52.1 ± 0.39	3,2
3 - 6	20.6 – 23.6 21.6 ± 0.56	5,8	22.1 – 25.1 23.3 ± 0.22	4,1
6 - 7	26.5 – 31.9 29.6 ± 0.98	7,4	27.6 – 34.1 30.4 ± 0.34	4,8
5 - 8	16.8 – 18.2 17.4 ± 0.24	3,1	17.5 – 20.3 19.0 ± 0.14	3,2
7 - 10	18.2 – 27.1 22.8 ± 1.45	14,3	17.6 – 21.9 19.9 ± 0.30	6,5
8 - 9	29.9 – 36.5 32.9 ± 1.13	7,7	27.4 – 32.8 30.7 ± 0.32	4,6

Discussion

The Tashkent riffle bleak (*A. oblongus*) is an endemic fish species found in the middle stream of the Syr Darya River basin. It was historically abundant in the plain part of the middle Syrdarya and major tributary rivers in the natural state of the Aral Sea basin. With the construction of reservoirs and fish ponds, the species formed large populations and became a common trash fish. However, in the early 1960s, the introduction of silver carp and grass carp larvae, along with accidental introductions of small fish from the Chinese fauna, changed the dynamics. These invasive species possess advantages in reproduction, including parental care, early maturation, portioned maturation, and high fecundity. These traits have likely been shaped by stronger predator pressure and competition in their native habitats in China.

The invasion of competitive species in Uzbekistan negatively impacted the previously widespread Tashkent riffle bleak populations. As a result, the species disappeared from certain river courses and was included in the Red Book of Uzbekistan. Currently, it is classified as "vulnerable, declining 2(VU: D)". The species is now limited to shallow areas and bays with running water, and its numbers have sharply declined in recent decades. However, it has managed to survive and adapt in the foothill zones where the invasive species are not present. Factors such as changes in river flows due to hydro-building, land reclamation measures, and pollution from agricultural runoff pose significant threats to the Tashkent riffle bleak.

The Tashkent riffle bleak is a species with limited available data. Previous studies in Uzbekistan during the mid-20th century reported meristic characteristics, including a dorsal fin formula of D III 8 and an anal fin formula of III 10–11, with 50–54 scales in the lateral line (Berg, 1949). Our current samples exhibit consistent findings, with all fish displaying 3 hard rays and 8-9 soft rays in the dorsal fin, 3 hard rays and 11-12 soft rays in the anal fin, and 53-58 scales in the lateral line. These results suggest relatively low variability in meristic traits within the studied population, corroborating the earlier findings. It is worth noting that the differences observed may be attributed to the limited sample size in Berg's study, which only included a few individuals.

Tashkent riffle bleak was previously observed in the Badam River near the city of Chimkent in Kazakhstan in 1941 (Ryby. 1988). However, there were no further records of its presence in that area during the 20th century. In 1996, the species was rediscovered in the upper reaches of the Arys River, which is a tributary of the Syr Darya, in Kazakhstan. Regarding the plastic characteristics of the Tashkent riffle bleak, indexes such as snout length, pectoral fin length, dorsal fin base length, and anal fin base length exhibited higher variability.

Significant differences were found in 14 out of 19 morphological indexes between immature and sexually mature Tashkent riffle bleak, as determined by t-tests (Table 3). Immature individuals showed higher values in 8 indexes, particularly in eye diameter, postdorsal distance, and caudal peduncle length. Conversely, sexually mature individuals exhibited higher values in 6 indexes, especially in maximum body height. Regarding 'trussprotocol' indexes, significant differences were observed between immature and sexually mature individuals in 16 out of 21 indexes (Table 3). These findings highlight the importance of considering age-related changes in morphometric studies of Tashkent riffle bleak population structure, and the need to compare mature and immature fish separately for population differentiation.

Table 3. Values of Student's t-test of differences in sample mean arithmetic indicators between immature and mature fish (standard t-test = 0.68)

The classic scheme of measurements of cyprinids		The "truss-protocol" indexes	
Indexes	t-value#	Indexes	t-value#
Eye diameter	-4.27	8 -10	-2,08
Postdorsal distance	-3.56	7 - 10	-1,95
Caudal peduncle length	-3.26	8 - 9	-1,89
Anal-fin the greatest height	-2.7	7 - 9	-1,44
Dorsal-fin the greatest height	-2.47	9 - 10	-0,71
Head length	-2.17	1 - 4	0,68
The smallest body height	-1.02	3 - 5	0,7
Ventral-fin length	-0.72	6 - 8	0,72
Snout length	0.84	5 - 7	0,73
Head height at the back	0.88	3 - 4	0,73
Pectoral-pelvic fins distance	0.92	6 - 7	0,82
Anal-fin base length	1.02	2 - 3	1,09
Anterodorsal distance	1.76	4 - 5	1,29
		3 - 6	2,85
		5 - 6	4,79
		5 - 8	5,73
# with negative values of the criterion, the indicator is higher in immature individuals			

Limited information is available regarding the morphological features of Tashkent riffle bleak. To compare the morphology of the studied stock, we examined fish from two other stocks: one from the Akhangaran River (measured in the 1970s) and the other from the Arys River (currently measured). Both stocks consisted of sexually mature individuals, as indicated in the literature. For our analysis, we also selected sexually matured fish (Table 4).

Table 4. Tashkent riffle bleak plastic indexes different tributary rivers of the middle Syr Darya River

	Akhangaran River (n=28)		Arys River (n=16)		Chirchik River (n=19)	
	Mean	STDV	Mean	STDV	Mean	STDV
Snout length	5,5	0,28	6,3	0,6	5,8	0,8
Eye diameter	6,17	1,02	5,6	0,36	7,4	0,6
Postorbital length of the head	-	-	10,1	0,88	10,4	0,6
Head length	22,78	0,54	23,4	0,96	23,5	1,4
Head height at the back	9,43	0,93	15,7	1,08	17,0	0,8
Maximum body height	22,08	2,03	26,2	1,24	23,3	0,8
The smallest body height	8,37	1,86	9,9	0,72	9,6	0,4
Antedorsal distance	51	1,1	54,2	1,04	52,9	1,1
Postdorsal distance	36,92	0,86	34,5	1,4	33,6	1,3
Caudal peduncle length	24,16	0,79	20,4	1,28	22,4	1,2
Dorsal- fin base length	11,25	1,24	12,2	0,88	15,4	1,3
Dorsal- fin the greatest height	19,67	1,34	17,7	1,28	19,6	1,6
Anal- fin base length	12	1,65	14,9	1,12	14,8	1,1
Anal- fin the greatest height	14,75	1,02	14,8	0,76	14,2	1,1
Pectoral- fin length	19,2	1,09	18,7	1,08	18,4	1,8
Ventral- fin length	14,53	1,26	14,5	0,6	13,8	1,2
Pectoral – pelvic fins distance	22,4	0,88	25	1,48	24,1	1,4
Ventral – anal fins distance	18,92	1,02	19,5	0,92	17,4	1,6

The values of Student's tests between the populations of Chirchik and Akhangaran and Chirchik and Arys Rivers are given in Tables 5 and 6.

Table 5. Values of Student's t-test of differences in sample mean arithmetic indicators between stocks of Akhangaran (1970s) and Chirchik (our data) rivers (standard t-test = 0.68)

Index	t-value#
Postdorsal distance	-10,15
Caudal peduncle length	-5,35
Ventral – anal fins distance	-3,67
Ventral- fin length	-2,02
Pectoral- fin length	-1,77
Anal- fin the greatest height	-1,55
Dorsal- fin the greatest height	-0,13
Snout length	1,67
Head length	2,22
Maximum body height	2,86
The smallest body height	3,38
Pectoral – pelvic fins distance	4,93
Eye diameter	5,37
Antedorsal distance	5,56
Anal- fin base length	6,98
Dorsal- fin base length	11,15
Postorbital length of the head	30,57
# with negative values of the criterion, the indicator is higher in Akhangaran river	

Table 6. Values of Student's t-test of differences in sample mean arithmetic indicators between stocks of Aris (Kazakhstan) and Chirchik (our data) rivers (standard t-test = 0.68)

Index	t-value#
Maximum body height	-8,15
Ventral – anal fins distance	-4,87
Antedorsal distance	-3,67
Ventral- fin length	-2,25
Postdorsal distance	-2,07
Snout length	-2,00
Pectoral – pelvic fins distance	-1,78
Anal- fin the greatest height	-1,72
The smallest body height	-1,51
Pectoral- fin length	-0,67
Anal- fin base length	-0,37
Head length	0,27
Postorbital length of the head	0,99
Dorsal- fin the greatest height	3,90
Head height at the back	4,03
Caudal peduncle length	4,75
Dorsal- fin base length	8,82
Eye diameter	11,46
# with negative values of the criterion, the indicator is higher in Akhangaran river	

Significant differences were observed in 17 out of 18 fish traits between the Chirchik and Akhangaran (1970s) population, particularly in plastic traits such as postdorsal distance, dorsal-fin base length, and postorbital length of the head. Similarly, significant differences were found in 17 out of 19 plastic characters between fish from the Arys and Chirchik rivers, with notable variations in maximum body height, dorsal-fin base length, and eye diameter.

It is plausible to suggest that the Tashkent riffle bleak, upon migrating upstream of the Chirchik River where it encounters no competition from invasive species of the Chinese fauna, has undergone adaptation to the conditions of the relatively cold-water zone. This adaptation has likely led to the emergence of a new phenotypic expression of the species' genotype in response to the novel environmental conditions.

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