



Comparative Morphometry of the Species *Schizothorax eurystomus* (Cypriniformes: Cyprinidae) Distributed in the Kashkadarya River Basin, Uzbekistan

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ABSTRACT

This article presents the findings of a comparative morphometric analysis of *Schizothorax eurystomus* Kessler, 1872, a species widely distributed in the Kashkadarya River. The study compares morphometric traits of individuals from this river with those of the same species inhabiting other water bodies within the Republic. A total of 26 specimens, ranging in length from 90 to 199mm, were collected from the Kashkadarya River. These included fish of varying ages and sizes, allowing for a comprehensive analysis. The specimens were fixed in 10% formalin in field conditions for preservation. For comparative purposes, additional data were collected from 14 specimens (101–308mm) from the Chirchik River and 40 specimens (82–255mm) from the Akhangaran River. Morphometric and meristic characteristics were analyzed across all samples. The results revealed significant differences in specimens from the Kashkadarya River, particularly in structures associated with the locomotor system. Statistical significance of group differences was assessed using the T-test at a 5% level of confidence ($r \leq 0.05$).

INTRODUCTION

Schizothorax eurystomus Kessler, 1872 is distributed in the mountainous and foothill regions of the Amudarya (Kashkadarya, Surkhandarya), Syrdarya (Naryn, Karadarya, Chirchik, Akhangaran), and Zarafshan rivers (Berg, 1949; Nikolsky, 1938; Turdakov, 1963; Amanov, 1985; Ergasheva, 1997; Mirzayev, 1998, 2000). The species is widely found in the Syrdarya River basin (Salikhov, 1990; Mirzayev, 1998, 2000; Quvatov, 2021, 2022). A high variability (Nikolsky, 1938; Amanov, 1985; Mirzayev, 1998) has been recorded in *Schizothorax eurystomus* associated with age. According to Nikolsky (1938), as *Schizothorax eurystomus* ages, increases are observed in caudal peduncle length, postorbital distance, and pectoral to ventral fin distance, while decreases occur in eye diameter, greatest and least body depth, and the base lengths of

pectoral and pelvic fins. **Mirzayev (1998)** noted that with increasing age and body length, the body depth, postdorsal distance, distance between the pectoral and pelvic fins, and forehead width tend to increase, while the head length and depth, eye diameter, the length of paired fins, and the base length of the pelvic fins tend to decrease. In addition, *Schizothorax eurystomus* is found from the upper to lower sections of the Chirchik and Akhangaran rivers, as well as in the Chorvoq and Tuyabugiz reservoirs. There is a lack of detailed information in the literature on the morphological characteristics of *Schizothorax eurystomus* (**Kamilov, 1973; Salikhov, 1990**). Scientific research on the ecological, morphological, and morphometric characteristics of *Schizothorax eurystomus* from the Kashkadarya River has not been conducted over the past 20-30 years. This article presents the results of scientific research on the ecological, morphological, and morphometric characteristics of *Schizothorax eurystomus* distributed in the Kashkadarya River. It also includes a comparative analysis of the morphometric characteristics of specimens from the Kashkadarya River with those from the Chirchik and Akhangaran Rivers.

MATERIALS AND METHODS

The material consisted of 26 specimens collected from the upper reaches of the Kashkadarya River during 2022-2024 using ichthyological methods at the following coordinates: 38°35'22"N, 66°45'39"E; 39°01'12"N, 67°16'32"E and 39°01'34"N, 67°23'29"E. A map of the locations, where ichthyological specimens were collected, is presented in Fig. (1).



Fig. 1. Ichthyological specimens collected from the upper reaches of the Kashkadarya River, with its geo information system map presented

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Additionally, 40 specimens of *Schizothorax eurystomus* were collected from the upper and middle reaches of the Akhangaran River during 2018–2019, at the following coordinates: 40°58'1.79"N, 69°19'20.67"E and 40°57'46.28"N, 70°01'27.93"E. Furthermore, 14 specimens were obtained from the middle and lower reaches of the Chirchik River during 2019–2020 at the coordinates 41°23'22.33"N, 69°32'15.66"E.

Morphometric measurements were taken using standard methodologies, with the following commonly accepted abbreviations (**Pravdin, 1966**):

- **l** – total body length, mm
- **c** – head length
- **ao** – snout length
- **o** – eye diameter
- **po** – postorbital distance
- **hc** – head height
- **io** – interorbital width (forehead width)
- **H** – body depth
- **h** – caudal peduncle depth
- **aD** – predorsal distance
- **pD** – postdorsal distance
- **lca** – caudal peduncle length
- **ID** – base length of the dorsal fin
- **hD** – height of the dorsal fin
- **IA** – base length 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 pelvic fins
- **VA** – distance between the pelvic and anal fins

All statistical analyses were performed using the Statistica 10.0 software package (StatSoft, USA), following the procedures outlined by G.F. Lakin (**Lakin, 1990**).

RESULTS AND DISCUSSION

According to **Berg (1949)**, the meristic characteristics of *Schizothorax eurystomus* are described as follows: the number of rays in the dorsal fin is IV 7-9 (average 8); the number of rays in the anal fin is III 5; the number of scales along the lateral line is 90-105; the number of gill rakers on the outer (first) gill arch is 10-17 (and 15-21 on the inner side).

The meristic characteristics of *Schizothorax eurystomus* from the Chirchik and Akhangaran rivers in Tashkent region are as follows: the number of rays in the dorsal fin is II-III 8-10; the number of rays in the anal fin is II-III 5-6; the number of rays in the

pectoral fin is I 16-19; the number of rays in the pelvic fin is I-II 7-9; the number of scales along the lateral line is 88-102; the number of gill rakers on the outer (first) gill arch is 14-18; the number of teeth on the first unbranched hard ray of the dorsal fin is 14-23 (paired); the number of abdominal vertebrae is 24-25; the number of caudal vertebrae is 18-19 (Quvatov *et al.*, 2021; Quvatov, 2022).

In our scientific studies, the meristic characteristics of *Schizothorax eurystomus* from the Kashkadarya River are as follows: the number of rays in the dorsal fin is II(3)-III 7-9; the number of rays in the anal fin is II-III 6; the number of rays in the pectoral fin is I 15-18 (average 17); the number of rays in the pelvic fin is I-II(2) 8, with 7(1)-9(1); the number of scales along the lateral line is 90-103 (average 95.8); the number of gill rakers on the outer (first) gill arch is 13-19 (average 14.4); the number of teeth on the first unbranched hard ray of the dorsal fin is 13-24 (paired); the number of abdominal vertebrae is 24-25; the number of caudal vertebrae is 18-19.

The morphometric description of *Schizothorax eurystomus* from the Kashkadarya, Chirchik, and Akhangaran Rivers is presented in Tables (1, 2, and 3).

Table 1. Plastic characteristics of *Schizothorax eurystomus* from the Kashkadarya River (n=26)

Characteristics	Min-Max	M±m	σ	Cv, %
<i>l</i> , mm	90-199	152.3±6.8	34.8	22.9
Percentage relative to body length (<i>l</i>)				
<i>C</i>	16.8-23.9	19.8±0.4	2.0	10.2
<i>Ao</i>	6.18-9.63	6.9±0.1	0.8	11.1
<i>O</i>	2.8-5.6	3.8±0.2	0.8	22.1
<i>Po</i>	8.9-13.3	10.1±0.2	1.1	10.5
<i>Hc</i>	11.8-15.0	13.2±0.2	1.0	7.6
<i>Io</i>	5.6-7.8	6.6±0.1	0.5	7.6
<i>H</i>	18.0-21.4	19.4±0.2	0.8	4.3
<i>H</i>	8.3-10.1	9.4±0.1	0.5	4.8
<i>aD</i>	36.0-42.8	40.3±0.3	1.7	4.1
<i>pD</i>	27.8-37.1	32.9±0.5	2.7	8.2
<i>Lca</i>	14.4-20.6	17.8±0.4	1.8	10.1
<i>lD</i>	9.0-11.9	10.3±0.1	0.8	7.3
<i>hD</i>	13.1-17.8	15.5±0.2	1.1	7.1
<i>lA</i>	5.0-7.1	6.0±0.1	0.5	8.7
<i>hA</i>	12.1-16.1	13.9±0.2	1.0	7.1
<i>lP</i>	13.4-23.3	15.4±0.4	1.8	11.8
<i>lV</i>	11.3-14.7	12.9±0.2	0.9	7.3

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<i>PV</i>	17.4-25.0	20.8±0.4	1.8	8.6
<i>VA</i>	13.7-19.0	16.4±0.3	1.3	7.8
Percentage relative to head length (<i>c</i>)				
<i>ao/c</i>	30.4-41.9	35.0±0.5	2.4	7.0
<i>o/c</i>	15.8-22.2	18.4±0.4	1.8	10.0
<i>po/c</i>	46.2-58.1	51.2±0.5	2.7	5.3
<i>hc/c</i>	60.9-74.2	67.5±0.7	3.5	5.1
<i>io/c</i>	26.1-38.7	33.6±0.5	2.7	8.1

Note: M – the mean value of the characteristics, m – the standard error, σ - the standard deviation, and Cv – the coefficient of variation.

Table 2. Plastic traits indicators of *Schizothorax eurystomus* distributed in the water basins of the Chirchik River (n=14)

Characteristics	Min-Max	M±m	σ	Cv, %
<i>l, mm</i>	101-308	199.5±13.2	49.5	24.8
Percentage relative to body length (<i>l</i>)				
<i>C</i>	20.1-24.8	21.9±0.4	1.5	6.9
<i>Ao</i>	7.6-9.3	8.4±0.1	0.5	6.0
<i>O</i>	3.0-5.1	4.2±0.2	0.7	16.3
<i>Po</i>	10.5-13.2	11.5±0.2	0.8	7.2
<i>Hc</i>	13.8-16.3	14.9±0.2	0.6	4.3
<i>Io</i>	7.1-9.1	8.2±0.1	0.5	6.0
<i>H</i>	20.6-24.2	22.1±0.3	1.2	5.7
<i>H</i>	10.2-13.2	11.6±0.2	0.8	7.2
<i>aD</i>	46.7-50.3	48.3±0.3	1.1	2.2
<i>pD</i>	32.0-45.3	40.2±1.1	4.2	10.4
<i>Lca</i>	20.2-22.3	21.1±0.1	0.5	2.6
<i>lD</i>	11.5-15.2	13.7±0.2	0.9	6.7
<i>hD</i>	15.0-20.1	18.5±0.5	1.9	10.4
<i>lA</i>	6.5-9.2	7.6±0.2	0.7	9.1
<i>hA</i>	14.0-19.1	17.3±0.4	1.6	9.1
<i>lP</i>	4.0-20.2	16.4±1.4	5.4	32.6
<i>lV</i>	5.0-17.9	15.2±1.2	4.4	29.1
<i>PV</i>	26.1-51.2	29.7±1.7	6.2	20.8
<i>VA</i>	20.9-26.1	23.3±0.4	1.5	6.5
Percentage relative to head length (<i>c</i>)				
<i>ao/c</i>	30.6-45.3	38.6±1.1	4.1	10.7

<i>o/c</i>	14.3-23.5	19.0±0.8	2.9	15.2
<i>po/c</i>	42.3-65.2	53.1±1.5	5.7	10.8
<i>hc/c</i>	59.3-76.8	68.5±1.5	5.5	8.1
<i>io/c</i>	33.8-42.4	37.7±0.7	2.5	6.5

Note: M – the mean value of the characteristics, m – the standard error, σ - the standard deviation, and Cv – the coefficient of variation.

Table 3. Plastic traits indicators of *Schizothorax eurystomus* distributed in the water basins of the Akhangaran River (n = 40)

Characteristics	Min-Max	M±m	σ	Cv, %
<i>l, mm</i>	82-255	161.0±7.9	49.9	31.0
Percentage relative to body length (<i>l</i>)				
<i>c</i>	21.6-25.6	23.4±0.2	1.0	4.3
<i>ao</i>	6.3-10.1	8.4±0.1	0.8	9.4
<i>o</i>	2.5-6.1	3.9±0.1	0.7	17.8
<i>po</i>	10.6-12.8	11.9±0.1	0.5	4.3
<i>hc</i>	12.5-17.0	14.3±0.2	1.0	7.3
<i>io</i>	6.8-10.8	8.2±0.1	0.7	9.1
<i>H</i>	18.0-25.9	22.4±0.3	2.1	9.4
<i>h</i>	9.0-11.7	10.6±0.1	0.6	5.8
<i>aD</i>	45.5-52.7	50.2±0.3	1.6	3.2
<i>pD</i>	28.0-39.7	33.2±0.4	2.4	7.1
<i>lca</i>	17.2-23.2	20.1±0.2	1.5	7.3
<i>lD</i>	9.9-14.4	12.3±0.1	0.9	7.6
<i>hD</i>	10.6-19.5	16.2±0.3	1.7	10.7
<i>lA</i>	6.1-8.1	7.2±0.1	0.5	6.6
<i>hA</i>	4.7-19.8	16.1±0.4	2.6	15.9
<i>lP</i>	3.5-20.8	16.1±0.4	0.3	7.2
<i>lV</i>	4.0-17.5	15.7±0.4	0.4	8.3
<i>PV</i>	25.9-32.9	29.4±0.2	1.5	5.1
<i>VA</i>	20.9-25.9	23.6±0.2	1.2	5.2
Percentage relative to head length (<i>c</i>)				
<i>ao/c</i>	27.9-40.1	35.9±0.5	2.9	8.1
<i>o/c</i>	10.9-23.8	16.5±0.4	2.6	15.6
<i>po/c</i>	47.5-54.8	51.1±0.3	1.9	3.7
<i>hc/c</i>	57.1-70.4	61.3±0.5	3.0	4.9
<i>io/c</i>	28.6-46.3	34.2±0.5	3.3	9.6

Note: M – the mean value of the characteristics, m – the standard error, σ - the standard deviation, and Cv – the coefficient of variation.

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As can be seen from the tables above, the coefficient of variation of *Schizothorax eurystomus* in the Kashkadarya River ranges from 4.1 to 22.1% (average 8.4%). Among these: the trait *o* – shows high variability; the traits *c*, *ao*, *po*, *lca*, and *IP* show moderate variability; while the remaining traits exhibit low variability.

The coefficient of variation of *Schizothorax eurystomus* distributed in the water basins of the Chirchik River ranges from 2.2 to 32.6% (average 10.4%). Among these: the traits *IP*, *IV*, and *PV* show high variability; the traits *o*, *pD*, *hD*, *ao/c*, *o/c*, and *po/c* show moderate variability; while the remaining traits exhibit low variability.

In the water basins of the Akhangaran River (Tuyabuguz Reservoir), the coefficient of variation ranges from 3.2 to 17.8% (average 8.6%). Among these, the traits *o*, *hD*, *hA*, and *o/c* show moderate variability, while the remaining traits exhibit low variability (Quvatov *et al.*, 2021). The comparative morphometric analysis of *Schizothorax eurystomus* distributed in the Kashkadarya, Chirchik, and Akhangaran Rivers (Tuyabuguz Reservoir) is presented in Table (4).

Table 4. Comparative analysis of *Schizothorax eurystomus* in the basins of the Kashkadarya, Chirchik, and Akhangaran rivers

Characteristics	Kashkadarya River (I) n – 26	Akhangaran River (II) n – 40	Chirchik River (III) n – 14	Tst		
				I-III	I-II	II-III
<i>SL, mm</i>	152.3±6.8	132.1±7.3	199.5±13.2	*3.17	0.83	*4.84
<i>c</i>	19.8±0.4	23.6±0.2	21.9±0.4	*3.76	*8.53	*4.30
<i>ao</i>	6.9±0.1	8.4±0.2	8.4±0.1	*7.27	*7.44	0.01
<i>o</i>	3.8±0.2	4.2±0.1	4.2±0.2	1.84	0.52	0.002
<i>po</i>	10.1±0.2	12.2±0.1	11.5±0.2	*4.54	*7.74	*3.36
<i>hc</i>	13.2±0.2	14.7±0.2	14.9±0.2	*6.55	*4.20	0.52
<i>io</i>	6.6±0.1	7.8±0.1	8.2±0.1	*9.65	*10.82	2.45
<i>H</i>	19.4±0.2	23.5±0.3	22.1±0.3	*7.56	*8.16	2.63
<i>h</i>	9.4±0.1	10.7±0.1	11.6±0.2	*9.35	*8.79	*3.76
<i>aD</i>	40.3±0.3	50.6±0.3	48.3±0.3	*17.99	*23.65	*5.00
<i>pD</i>	32.9±0.5	33.3±0.6	40.2±1.1	*5.88	0.46	*6.18
<i>lca</i>	17.8±0.4	19.5±0.3	21.1±0.1	*8.74	*5.40	*3.89
<i>ID</i>	10.3±0.1	12.2±0.2	13.7±0.2	*11.83	*9.44	*4.15
<i>hD</i>	15.5±0.2	16.0±0.4	18.5±0.5	*5.43	2.03	*3.89
<i>lA</i>	6.0±0.1	7.2±0.1	7.6±0.2	*7.57	*9.52	2.11
<i>hA</i>	13.9±0.2	15.2±0.5	17.3±0.4	*7.22	*4.83	2.75
<i>IP</i>	15.4±0.4	17.6±0.5	16.4±1.4	0.67	1.96	*5.01
<i>IV</i>	12.9±0.2	16.1±0.4	15.2±1.2	1.93	*14.93	*4.12
<i>PV</i>	20.8±0.4	29.5±0.3	29.7±1.7	*5.25	*20.22	0.15
<i>VA</i>	16.4±0.3	23.2±0.2	23.3±0.4	*14.52	*22.65	0.22
<i>ao/c</i>	35.0±0.5	35.4±0.7	38.6±1.1	*3.01	1.36	2.57
<i>o/c</i>	18.4±0.4	17.6±0.5	19.0±0.8	0.70	*3.50	1.57
<i>po/c</i>	51.2±0.5	51.5±0.4	53.1±1.5	1.17	0.16	1.31

<i>hc/c</i>	67.5±0.7	62.2±0.7	68.5±1.5	0.61	*7.43	*4.39
<i>io/c</i>	33.6±0.5	32.9±0.5	37.7±0.7	*4.80	0.80	*5.63

Note: The difference between groups (Tst) is significant at the 5% level ($t \leq 0.05$).

A comparative analysis of morphometric traits among *Schizothorax eurystomus* populations from the Kashkadarya, Chirchik, and Akhangaran Rivers revealed several interpopulation differences.

When comparing specimens from the Kashkadarya and Chirchik rivers, significant differences were observed in the following traits: *c* (head length), *ao* (snout length), *po* (postorbital distance), *hc* (head height), *io* (interorbital width), *H* (body depth), *h* (caudal peduncle depth), *aD* (predorsal distance), *pD* (postdorsal distance), *lca* (caudal peduncle length), *ID* (base length of dorsal fin), *hD* (height of dorsal fin), *IA* (base length of anal fin), *hA* (height of anal fin), *PV* (distance between pectoral and pelvic fins), *VA* (distance between pelvic and anal fins), as well as in the ratios *ao/c* and *io/c*.

Specimens from the Kashkadarya and Akhangaran rivers differed in the traits: *c*, *ao*, *po*, *hc*, *io*, *H*, *h*, *aD*, *lca*, *ID*, *IA*, *hA*, *IV* (length of pelvic fin), *PV*, *VA*, and in the ratios *o/c* and *hc/c*.

In comparing specimens from the Akhangaran and Chirchik rivers, differences were found in the following traits:

c, *po*, *h*, *aD*, *pD*, *lca*, *ID*, *hD*, *IP* (length of pectoral fin), *IV*, and in the ratios *hc/c* and *io/c*.

These variations highlight region-specific morphological adaptations likely influenced by ecological and hydrological differences among the river systems (Quvatov *et al.*, 2021).

CONCLUSION

No significant differences were observed in the meristic traits of *Schizothorax eurystomus* specimens from the Kashkadarya River when compared with those from the rivers of the Tashkent region. However, differences were noted when compared to the historical data provided by L.S. Berg.

Among the plastic (morphometric) traits in specimens from the Kashkadarya River, eye diameter (*o*) showed the highest degree of variability. In specimens from the Chirchik River, the traits *IP* (pectoral fin length), *IV* (pelvic fin length), and *PV* (distance between pectoral and pelvic fins) exhibited high variability; traits such as *o*, *pD* (postdorsal distance), *hD* (dorsal fin height), and the ratios *ao/c*, *o/c*, and *po/c* showed moderate variability, while the remaining traits showed low variability.

In contrast, specimens from the Akhangaran River (including the Tuyabuguz Reservoir) displayed moderate variability in traits such as *o*, *hD*, *hA* (anal fin height), and the ratio *o/c*, with all other traits exhibiting low variability.

A comparative analysis of morphometric traits among populations from the Kashkadarya, Chirchik, and Akhangaran Rivers revealed significant differences in overall body length and the structure of the locomotor system. However, no statistically

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significant differences were found between the populations of the Chirchik and Akhangaran Rivers.

These interpopulation differences are likely the result of varying topographical features, ecological conditions, and hydrological regimes specific to each river system. Specimens from the Chirchik River were characterized by a more elongated body, smaller head, taller and longer caudal peduncle, larger unpaired fins, and smaller paired fins compared to those from the Akhangaran River and Tuyabuguz Reservoir. These variations are presumed to reflect adaptations to the distinct hydrological conditions of their respective habitats.

Recommendation:

The historical background, potential endemism, and ecological distinctions among the *Schizothorax eurystomus* populations in different river systems of the Republic underscore the need for continued morphological and ecological research on this species. Such studies are essential for understanding population dynamics, conservation status, and adaptive responses to environmental variability.

AUTHORS CONTRIBUTION

The collection of ichthyological materials, morphological and morphometric analyses, and manuscript preparation were carried out by A.Q. Quvatov and O.Kh. Ubaydullayev. The co-authors J.B. Almardanov, Z.U. Narboev, and Kh.M. Rakhimova provided technical assistance and financial support for the study.

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