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Short communication

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The variability of morphometric and meristic characteristics of Urmia chub, *Petroleuciscus ulanus* (Günther, 1899) in the Mahabd-Chai and Godar-Chai rivers, Lake Urmia basin

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ABSTRACT. In this study, for the first time, we provide morphometric and meristic data on *Petroleuciscus ulanus* from the Lake Urmia basin by comparing them in the populations of the Mahabad-Chai and Godar-Chai rivers. For this purpose, a total of 100 specimens were collected using electrofishing device and cast net during 2014 and 2015. 19 morphometric and 8 meristic traits were measured and counted, respectively. The meristic traits of the two populations showed significant differences in three characters, including branched dorsal and ventral fin rays and lateral line scales ($P < 0.05$). In addition, the morphometric analysis showed significant differences in head length, eye diameter, caudal peduncle length, dorsal fin height and base lengths, pectoral and ventral fin lengths, anal fin base and height lengths ($P < 0.05$). The finding of the current study can help to further studies on the biological features of this endemic species of Iranian inland waters.

Keywords: *Petroleuciscus ulanus*, morphological characteristics, Urmia chub, meristic traits

Introduction

Urmia chub, *Petroleuciscus ulanus* (Günther, 1899) (Cyprinidae) is the sole member of this genus in Iranian inland waters (Bogutskaya, 1996; 2002; Coad and Bogutskaya, 2010; Perea et al., 2010; Esmaeili et al., 2018). This species is recognized by having brown-green dorsum and light silver abdomen, a narrow dark stripe from the eye to end of the lateral line, the heavily pigmented upper part of the operculum, pelvic axillary scale, and gill rakers reaching first or second raker below when appressed. Furthermore, its pharyngeal teeth hooked at tip and strongly serrated, mouth oblique and extends back to behind front margin of eye, lower jaw not or slightly protrudable, upper jaw slightly overlapping lower jaw, gut elongated and S-shape with an anterior loop, and male with tubercles on the pectoral fins and head. It inhabits streams or rivers with a spawning season from April to July. The maximum recorded age and total length are 4 years and 158 mm, respectively. Sex ratio is 1male: 2females, maturity usually attained at two and rarely one year, and absolute fecundity is up to 16,100 eggs. Food mainly includes zooplankton, insects, phytoplankton, filamentous algae, and benthic organisms. The distribution of this monolithic species is the Lake Urmia basin and endemic to the Godar-Chai and Mahabad-Chai rivers (Keivany et al., 2016).

Morphological characteristics such as meristic, morphometric data and the otoliths shape are widely used to identify species and fish populations (Ihssen et al., 1981; Cadrin, 2000). These characteristics are also used to delimit populations, revealing species diversity and classification of fishes (Hossain et al., 2009). Conservation of endemic species is of particular importance and have a priority in their management due to their limited distribution area (Alcma, 1984). *Petroleuciscus ulanus* is endemic to the Lake Urmia basin, and few studies on its biological features have been conducted (Keivany et al., 2016); therefore, it is crucial to study its various biological aspects, including morphological traits. Hence, this work aimed to provide basic morphological data on *P. ulanus* by comparing its morphometric and meristic traits in the two populations of the Godar-Chai and Mahabad-Chai rivers.

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Materials and methods

The sampling was carried out from the Mahabad-Chai (3652´N, 45˚45´E, 66 specimens) and Godar-Chai (37˚ 00´ N, 49˚ 56´E, 34 specimens) rivers, the Lake Urmia basin, west of Iran during 2014 to 2015 (Table 1). Fishes were caught with an electrofishing device and a cast net. After anesthesia, they were fixed into 10% buffered formalin and transferred to the Lab where a total of 19 morphometric and 8 meristic traits (Table 2, Table 3) were measured and counted.

In the PAST software, in order to remove size data from measurements, the allometric method was used as follows: $M_{adj} = M (L_s / L_0)^b$, where M is the original measurement, M_{adj} – the size adjusted measurement, L_0 – the standard length of the fish, L_s – the overall mean of the standard length for all fish from all samples in each analysis, and b was estimated for each character from the observed data as the slope of the regression of log M on log L_0 using all fish in any group (Elliott et al., 1995). The results derived from the allometric method were confirmed by testing the significance of the correlation between transformed variables and standard length (Turan, 1999). Then, data were analyzed for normality distribution using the Kolmogorov-Smirnov test. Parametric and non-parametric morphometric and meristic characters were analyzed using T-test (Independent Samples T-test) and Mann-Whitney, respectively, in SPSS-19 software. After that, data with significant differences were analyzed using principal component analysis (PCA), discriminant function analysis (DFA), and T-test Hoteling using Hoteling's P-value in PAST V2.17b software (Hammer et al., 2001).

Results

Morphometric traits: Kolmogorov-Smirnov test showed snout length, minimum body depth, caudal peduncle length, pectoral-ventral distance, ventral-anal distance, and anal fin height; pre- and post-dorsal fin lengths were parametric ($P > 0.05$). The results of the T-test and Mann-Whitney tests showed significant differences in the head length, eye diameter, caudal peduncle length, dorsal fin base and height lengths, pectoral and ventral fin lengths, anal fin base and height lengths ($P < 0.05$) (Table 2). In the first two PCs, the pectoral fin length was the most effective characteristic to delimit the populations. In addition, DFA/Hotelling's T-test revealed a significant difference between the two populations ($P = 1.19E^{-06}$, $F = 6.10$, Hotelling's $t^2 = 59.87$) (Fig. 1). The PCA results plot is presented in Figure 2, showing the overlap between the populations.

Meristic traits: Meristic traits showed significant differences in three characters, including the branched dorsal fin rays, branched ventral fin rays and the number of the lateral line scales ($P < 0.05$) (Table 3). Unbranched and branched dorsal fin rays were 2-3 and 7-9, respectively. Unbranched and branched anal fin rays counted 3 and 8-11, respectively. In addition, the branched ventral fin rays were 7-8, and the count of the lateral line was 36-44. Outer and inner gill rakers were counted as 12-21 and 15-22, respectively, in both populations.

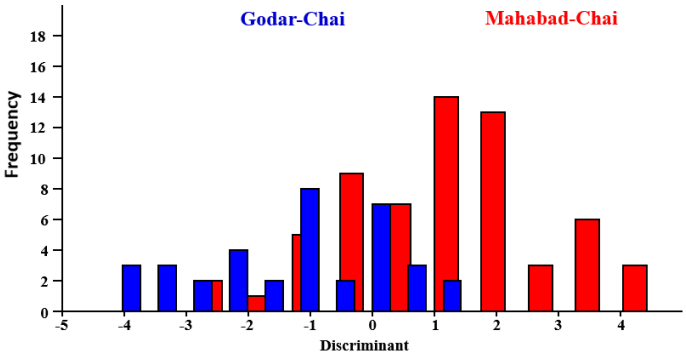

Fig.1. Discriminant function analysis (DFA) of morphometric traits of the *P. ulanus* populations.

Table 1. Different water quality parameters of sampling site of *P. ulanus* (Maleki et al., 1999; Khodaparast et al., 2002)

Parameters	Mahabad-Chai	Godar-Chai
pH	7.83	7.95
Temperature, ˚C	12.75	15.23
O_2, mg/dm^3	8.95	13.98
EC, µs/cm	0.4	0.49
Salinity, ppt	0.14	0.28
Water hardness, mg/ dm^3	150.42	237.8
COD, mgO_2/dm^3	19.26	14.23
Depth, m	0.5-2.5	0.8-1
Width, m	5-15	8-15
Water current	Slow to moderate	Slow to moderate
Floor	Stone	Stone

Note: COD – chemical oxygen demand, mgO_2/dm^3.

Discussion

Morphological studies of fishes can illustrate the effect of environmental factors during their adaptation to their habitat (Zelditch, 2004). The results of the current study showed significant differences between the studied populations of *P. ulanus* in nine morphometric and three meristic characteristics. The major difference was ventral fin length, which can be used to identify these two populations. The observed differences are probably due to the hydrologic features of their habitats e.g., velocity and current patterns that facilities their swimming performance in their specific habitat (Bagarinao, 1981; Swain et al., 2005; Haas et al., 2010; Mahfuj et al., 2019; Styga et al., 2019). According to Kuliev (1997), it is expected to observe differences in meristic traits in fishes in different latitudes; however, due to the almost similar latitude of both populations, little differences in the meristic data were observed. In addition, the meristic characters of fish populations, including fin rays, gill rakers, scales (below, upper or on lateral line), and pharyngeal teeth, are controlled by genetic factors; however, lengths and their ratios in morphometric traits are affected by environmental factors (Brraich and Akhter, 2015; Mouludi-Saleh et al., 2018). Some works have been carried out about the morphometric and meristic traits of other members of the genus *Petroleuciscus* in Turkey (Turan et al., 2018) but no data is available regarding morphological features of *P. ulanus*, which we provided in the current study. In *P. ulanus*, the scales number on the lateral line is 36-44, whereas it is different from those of *P. ninae* (31-36), *P. smyrnaeus* (33-37), *P. kurui* (51-55), *P. borysthenicus* (36-41), and *P. squaliusculus* (40-47) (Turan et al., 2018). Keivany et al. (2016) reported that *P. ulanus* has 2-3 and 7-9 (vs. 2-3 and 7-9 in our study) branched and unbranched dorsal fin rays, 3 and 7-11 (vs. 3 and 8-11 in the current study) branched and unbranched anal fin rays, 7-8 branched (vs. 7-8) ventral fin rays, and 36-45 (vs. 36-44) lateral line scales, respectively, showing that previous reported meristic data are overlapped with the current work.

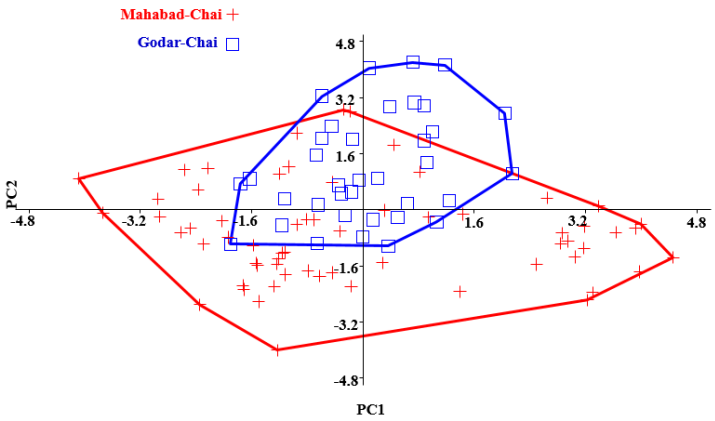

Fig.2. Principal component analysis (PCA) of morphometric traits of the *P. ulanus* populations

Table 2. T-test and Mann-Whitney tests and the mean (± standard deviation) of each morphological trait measured in *P. ulanus* from the Mahabad-Chai and Godar-Chai rivers.

Characters	Mahabad-Chai		Godar-Chai		
	Mean	±SD	Mean	±SD	*p*
Standard length, mm	64.93	0.00	64.93	0.00	-
Head length, mm	16.67	0.91	16 .32	0.58	**0.017**
Head height, mm	11.32	1.31	11.81	0.6	0.397
Snout length, mm	4.1	0.32	4.06	0.4	0.575
Eye diameter, mm	4.19	0.28	4.04	0.27	**0.016**
Inter-orbital width, mm	5.97	1.83	4.86	0.33	0.064
Maximum body depth, mm	17.04	0.82	16.74	1.19	0.151
Minimum body depth, mm	7.11	0.4	7.18	0.36	0.415
Caudal peduncle length, mm	13.19	2.13	14.05	0.92	**0.024**
Dorsal fin base length, mm	8.07	0.5	8.45	0.83	**0.019**
Dorsal fin height, mm	11.94	0.92	12.93	0.67	**0.00**
Pectoral fin length, mm	12.63	1.11	13.61	0.99	**0.00**
Ventral fin length, mm	9.56	0.8	10.04	0.71	**0.006**
Pecto-ventral distance, mm	15.7	0.95	15.87	0.97	0.39
Ventral-anal distance, mm	12.44	0.77	12.35	0.74	0.583
Anal fin height, mm	9.01	0.66	9.43	0.75	**0.006**
Anal fin base length, mm	8.16	0.6	8.72	1.09	**0.007**
Pre-dorsal distance, mm	35.77	1.11	35.49	0.87	0.20
Post-dorsal distance, mm	22.65	0.98	22.83	1.08	0.40

Table 3. Mann-Whitney test, the mean (± standard deviation) and Min-Max of each meristic character counted in *P. ulanus* from Mahabad-Chai and Godar-Chai populations.

Characters	Mahabad-Chai (mean + SD)	Min-Max	Godar-Chai (mean + SD)	Min-Max	*P*
Unbranched dorsal fin rays	2.98 ± 0.125	2-3	3 ± 0.00	-	0.453
Branched dorsal fin rays	8.12 ± 0.33	7-9	7.77 ± 0.42	7-8	**0.000**
Unbranched anal fin rays	3 ± 0.00	-	3 ± 0.00	-	1.000
Branched anal fin rays	9.06 ± 0.61	8-10.5	9.02 ± 0.67	8-11	0.409
Branched ventral fin rays	7.1 ± 0.31	7-8	7.38 ± 0.49	7-8	**0.001**
Lateral line scales	38.62 ± 1.62	36-43	39.47 ± 1.64	36-44	**0.018**
Outer gill rakers	14.32 ± 1.65	12-21	14.11 ± 1.23	12-17	0.885
Inner gill rakers	18.43 ± 1.21	15-21	18.38 ± 1.64	15-22	0.728

In recent years, *Alburnus hohenackeri* has been introduced to the habitats of *P. ulanus*; in their habitats, *P. ulanus* is distinguished by the number of the branched anal fins (7-11 in *P. ulanus* vs. 11-16 in *A. hohenackeri*) and the number of the gill rakers on the first gill arch (12-16 (mod = 14) in *P. ulanus* vs. 19-25 in *A. hohenackeri*) (Keivany et al., 2016).

Conclusions

As a general result, this study provides valid data on morphometric and meristic traits of endemic fish species to Iranian inland waters that can be useful to future studies.

Conflict of interests

The authors declare no conflict of interests.

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