

Original Article

First record of *Petroleuciscus esfahani* Coad and Bogutskaya, 2010 (Actinopterygii: Cyprinidae) from the Karun River drainage, Persian Gulf basin, Iran

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Abstract: *Petroleuciscus esfahani* Coad and Bogutskaya, 2010 formerly believed to be an endemic species in endorheic Esfahan basin, was recorded for the first time in the exorheic Karun River drainage, Persian Gulf basin, Iran. This new record likely shows overlooking of this species in the Persian Gulf basin. In this study, distribution and possible dispersal mechanisms of this species were discussed and also provides its morphometric and meristic data based on the collected specimens.

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Introduction

The cyprinid genus *Petroleuciscus* currently comprises five species of which 2 are found in Iranian inland waters (Coad, 2017) viz. *P. ulanus* (Günther, 1899) endemic to the Lake Urmia basin in northwestern Iran and *P. esfahani* Coad & Bogutskaya, 2010 endemic to the Esfahan basin in the central of Iran (Jouladeh-Roudbar et al., 2015b). There are three more species in this genus including *P. squaliusculus* (Kessler, 1872) (Syr Darya drainage, Kazakhstan, Kyrgyzstan and Tadjikistan), *P. smyrnaeus* (Boulenger, 1896) (western Turkey i.e. Aegean and Black Sea basin), and *P. borysthenicus* (Kessler, 1859) (Coad and Bogutskaya, 2010).

This genus is distinguished by the small size of adults, the reduced number of vertebrae (modally 34-38 in total, rarely 39 or 40), few sensory cephalic pores (7-10 in the supraorbital canal, 12-19 in the infraorbital canal, and 12-17 in the preoperculo-mandibular canal), a relatively small supraethmoid-mesethmoid block, narrow infraorbitals, and a deep neurocranium with a normally developed interorbital septum (Bogutskaya, 2002).

Petroleuciscus esfahani Coad & Bogutskaya,

2010 was described originally from a stream at Dizaj in the southern Zayandeh River (Esfahan basin) in the central of Iran. The distribution of this species in Iran has been reported only from the Esfahan basin of Iran (Coad and Bogutskaya, 2010; Jouladeh-Roudbar et al., 2015b) and now the present study confirms the presence of this species for the first time in the upper Karun River drainage, Persian Gulf basin.

Materials and Methods

The specimens of *P. esfahani* were collected by electrofishing device from the Beheshtabad River, the upper Karun River drainage, and Khorbeh River, Esfahan basin, Iran in August 2015 (Fig. 1). The collected specimens were preserved into 10% buffered formaldehyde after anesthetizing with 1% clove extract solution. Counts and measurements follow Hubbs and Lagler (1958). The taxonomic key given by Coad and Bogutskaya (2010) and Coad (2017) were used to identify the specimens.

Twenty-nine morphometric characters were measured using digital caliper to the nearest 0.01 mm (Table 1). Standard length (SL) was measured from

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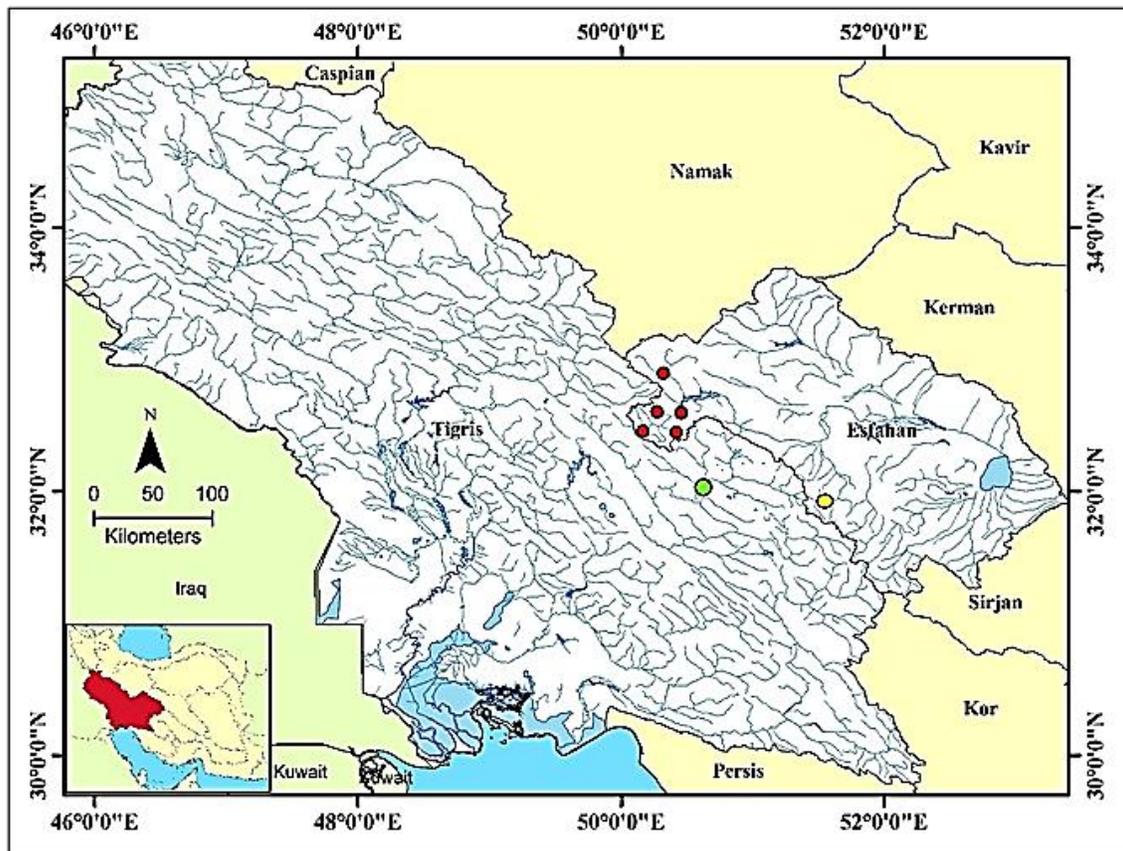


Figure 1. Distribution map of *Petroleuciscus esfahani* (Red circle: Esfahan basin, Green circle: Persian Gulf basin, yellow circle: type locality).

the tip of the upper jaw to the end of the hypural complex, total length (TL) was measured from the tip of the upper jaw to the end of the longest caudal-fin lobe. Head length and interorbital width were measured to their bony margins. The percentage ratios of morphometric characters in relations to standard length (SL) and head length (HL) were calculated. Eight counted meristic characters are presented in Table 2. Fin ray counts separate unbranched and branched rays. The last two branched rays articulated on a last compound pterygiophore in the dorsal and anal fins and are noted as "1½". Mean and standard deviation were calculated without the "½". Lateral-line scale count includes pierced scales, from the first one just behind the supracleithrum to the posteriormost one at the base of the caudal-fin rays (i.e., posterior margin of the hypurals) excluding 1 or 2 scales located on the bases of the caudal-fin rays, total number of lateral-line scales is also provided.

The comparison of the morphometric data

between two populations was assessed using Non-Parametric Multivariate Analysis Of Variance (NPMANOVA) based on the *P*-values (Bonferroni corrected) obtained from permutation test with 1000 replicates in PAST software (version 2.14). An allometric method was used to remove size-dependent variation in morphometric characters using following formula (Elliott et al., 1995): $M_{adj} = M(L_s/L_0)^b$, where M_{adj} is the size adjusted measurement, M the original 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.

Results

Thirty specimens of *P. esfahani* ranged 82.1-131.4 mm in standard length were collected from the Beheshtabad River, upper Karun River drainage (32°01'43.2"N, 50°37'35.3"E) and Khorbeh River,

Table 1. Morphometric data of *Petroleuciscus esfahani* from the Beheshtabad (Tigris drainage) and Khorbeh (Esfahan basin) rivers, Iran (SD=standard deviation; min=minimum; max=maximum).

Characters	Khorbeh River				Beheshtabad River			
	min	max	mean	SD	min	max	mean	SD
Standard length (mm)	82.1	128.1			102.7	131.4		
In percent of standard length								
Body depth maximal	21.6	24.9	23.1	0.9	22.0	25.4	24.0	1.1
Caudal peduncle depth	10.0	11.3	10.5	0.4	10.1	11.6	10.9	0.5
Predorsal length	49.3	53.9	52.1	1.4	52.1	54.7	53.1	0.8
Postdorsal length	47.6	52.5	49.9	1.6	47.1	50.9	48.9	1.0
Prepelvic length	44.8	51.2	48.1	2.0	47.6	51.2	50.0	1.1
Preanal length	62.8	69.0	66.4	1.6	65.6	70.1	68.1	1.4
Caudal peduncle length	21.8	25.7	24.0	1.2	22.1	26.9	23.9	1.3
Dorsal-fin base length	9.4	14.6	12.0	1.5	9.7	12.7	11.0	1.0
Dorsal-fin depth	13.5	17.4	16.1	0.9	14.5	18.4	16.3	1.1
Anal-fin base length	10.6	14.7	12.8	1.3	8.9	13.3	11.9	1.1
Anal-fin depth	10.5	13.2	12.2	1.0	10.0	13.8	12.5	1.0
Pectoral fin length	14.9	18.5	17.1	1.0	15.1	19.0	17.0	1.1
Pelvic fin length	11.3	15.5	13.1	1.2	10.4	14.0	11.9	1.1
Pectoral-pelvic-fin origin distance	23.4	29.8	27.3	1.7	24.8	29.7	27.5	1.4
Pelvic-anal-fin origin distance	16.0	23.3	19.4	1.9	17.2	21.8	19.2	1.4
Body width	11.3	14.0	12.6	0.7	12.0	14.3	13.3	0.6
Caudal peduncle width	2.4	3.3	2.9	0.3	2.7	3.7	3.2	0.3
Head length	19.4	22.1	21.1	0.9	20.3	23.6	22.1	1.0
in percent of head length								
Snout length	15.5	20.4	17.9	1.3	16.6	22.4	18.9	1.5
Eye horizontal diameter	21.2	28.8	24.4	2.1	20.3	24.6	21.8	1.3
Postorbital distance	53.1	62.3	58.1	2.5	57.2	64.8	60.2	2.3
Head depth at nape	74.5	90.6	81.6	4.7	73.4	84.3	79.0	3.1
Head depth at eye	50.4	59.5	54.4	3.2	50.0	55.1	52.3	1.8
Head length at nape	70.0	87.0	77.5	5.1	69.4	81.0	75.3	3.4
Head width	48.5	60.1	53.4	3.4	42.7	55.7	51.4	3.4
Inter orbital	30.8	38.5	34.8	2.1	30.0	38.2	34.1	2.4
Inter nasal	15.8	21.4	18.3	1.7	14.8	19.9	17.1	1.6
Mouth width	23.6	30.2	26.1	1.8	20.0	30.6	24.7	2.6

Table 2. Meristic data of *Petroleuciscus esfahani* from the Beheshtabad (Tigris drainage) and Khorbeh (Esfahan basin) Rivers, Iran (SD=standard deviation; min=minimum; max=maximum).

Characters	Khorbeh River				Beheshtabad River			
	min	max	mean	SD	min	max	mean	SD
Total lateral line scales	49	52	51.1	1.2	48	54	52.1	2.0
Scales between lateral line and Dorsal-fin origin	10	11	10.1	1.0	10	12	11	1.2
Scales between lateral line and anal-fin origin	4	5	4.5	0.5	4	5	4.9	0.1
Anal fin branched rays	10	11	10.3	0.7	10	12	10.5	1.1
Dorsal fin branched rays	8	9	8.2	0.4	9	9	8.2	0
Pectoral fin branched rays	15	16	15.8	0.8	15	17	16	1.0
Pelvic fin branched rays	8	8	8	0	8	8	8	0
Caudal fin branched rays	19	19	19	0	19	19	19	0

Esfahan basin (32°31'08"N, 50°13'42"E). The general body shape of *P. esfahani* from the Beheshtabad and Zayandeh Rivers, and their natural habitats are displayed in Figures 2-4. Other collected species during sampling in the Beheshtabad River were *Turcineomacheilus hafezi*, *Oncorhynchus*

mykis, *Glyptothorax silviae*, *Capoeta coadi*, *Barbus lacerta*, *Chondrostoma regium*, *Carassius gibelio*, *Garra rufa* and *Aphanius vladkovi*.

The body proportions and meristic counts of the collected specimens are shown in Tables 1 and 2 that are in accordance with the original identification key



Figure 2. Lateral view of *Petroleuciscus esfahani*, (above) from the Beheshtabad River (Tigris drainage) and (below) Zayandeh River (Esfahan basin), Iran.



Figure 3. Zayandeh River, natural habitat of *Petroleuciscus esfahani*, Esfahan basin, Iran.

of *P. esfahani* (Coad and Bogutskaya, 2010). We found morphometric and meristic characters of both collected populations of *P. esfahani* largely overlapping (Tables 1, 2). In addition, NPMANOVA showed no significant differences between the Karun and Khorbeh rivers populations in terms of the morphometric characters ($P>0.05$).

Discussion

Petroleuciscus esfahani was known only from two

streams viz. Dizaj (a southern tributary of the Zayandeh River) and Pelasagan (which flows into the northern of the Zayandeh River) in the Esfahan basin (Coad and Bogutskaya, 2010). The Zayandeh River flows from the eastern slopes of the Zagros Mountains to terminate in the salt swamp Gav-Khuni that has been dried during last decade because of demands on water resources in this desert or semi-desert basin (Coad, 2017). The high biodiversity of Iranian inland waters especially those of endorheic



Figure 4. Beheshtabad River, new locality of *Petroleuciscus esfahani*, Tigris drainage, Iran.

basins such as the Esfahan basin is now under severe threats due to anthropogenic activities (hydrological alteration, introduction of exotic species, over-fishing, unusual methods of fishing, rapid sedimentation and land erosion) and natural disturbance (climate change and drought) (Teimori et al., 2016). Hence, this endemic fish similar to other fish species of the Esfahan basin was under stress and treat. Therefore, the presence of this species in the exorheic Persian Gulf basin can decline concerns regarding treats of this endemic species in its type locality.

Petroleuciscus esfahani was not previously recorded from outside of the Esfahan basin, and this study reports new record of this endemic species of the endorheic Esfahan basin in the exorheic Persian Gulf basin. The Esfahan basin is surrounded by the endorheic basins of Namak Lake, Kerman-Na'in, Sirjan, Kor River and the exorheic Persian Gulf basin (Coad, 2017; Jouladeh Roudbar et al., 2015b). The Zayandeh River drainage is main feature of the Esfahan basin and origins from the Zagros Mountains east of the Zardkuh Mountain and flows east for about 300 km to terminate in the swamp Gav-Khuni (Coad, 2017; Jouladeh Roudbar et al., 2015a). The Zayandeh River drainage is connected

to the upper Karun River drainage (which drains to the Persian Gulf) by the Kuhrang Tunnel constructed in 1953 (Jouladeh Roudbar et al., 2015a). There are two possible mechanisms for the presence of *P. esfahani* in both the Esfahan and the upper Karun River drainage; (1) it could have been translocated between basins incidentally via human or by the destruction and reduction of geographical barriers e.g. construction of the Kuhrang Tunnel, and (2) since the Esfahan basin is adjacent to the upper Karun River drainage, it might have been dispersed through the headwater capture which is common in the Zagros Mountains (Oberlander, 1965; Jouladeh Roudbar et al., 2015a).

Finally, *P. esfahani* shows many similarity in terms of morphological characters with those of the genus *Alburnus* and our unpublished molecular data shows that this species is nested within the genus *Alburnus* clade. Therefore, the origin, dispersal direction and taxonomic statue of this species needs a further investigation based on molecular markers for clarification of its possible dispersal mechanism and taxonomic statue.

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چکیده فارسی

اولین گزارش حضور *Petroleuciscus esfahani* Coad and Bogutskaya, 2010 (شعاع بالگان: کپورماهیان) از رودخانه کارون، حوضه آبریز خلیج فارس، ایران

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چکیده:

پیش از این مطالعه اعتقاد بر این بود که گونه بومزاد *Petroleuciscus esfahani* Coad and Bogutskaya, 2010 تنها در حوضه آبریز اصفهان یافت می‌شود. مطالعه حاضر حضور این گونه را برای اولین بار از حوضه رودخانه کارون (ریزآبه به خلیج فارس) گزارش می‌نماید. همچنین مطالعه حاضر اطلاعاتی در ارتباط با پراکنش، ویژگی‌های ریخت‌سنجی و شمارشی این گونه را گزارش و در مورد نحوه انتقال احتمالی آن بحث می‌نماید. **کلمات کلیدی:** رودخانه بهشت‌آباد، پراکنش، خلیج فارس، ایران.