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Pseudophoxinus iconii, a new species of spring minnow from Central Anatolia (Teleostei: Cyprinidae)

Fahrettin Küçük*, İskender Gülle** and Salim Serkan Güllü*

Pseudophoxinus iconii, a new species, is described from Cihanbeyli (Lake Tuz Basin, Konya, Central Anatolia, Turkey). It differs from other Central Anatolian *Pseudophoxinus* species (*P. anatolicus*, *P. battalgilae*, *P. crassus*, *P. hittitorum*) by the following characters: absence of a keel between the pelvic fin and anus; mouth terminal (upper lip equal to or slightly longer than lower lip); caudal peduncle length 1.6–1.9 times its depth; lateral line complete, with 48–61 perforated scales; 53–63+2–3 scales in lateral series; 13–15 scale rows between lateral line and dorsal-fin origin; 5–7 scale rows between lateral line. *Pseudophoxinus iconii* is presently only known to inhabit Cihanbeyli and Gölyazı canals. It disappeared from another locality due to excessive water abstraction and resulting aridity.

Introduction

Species of the genus *Pseudophoxinus* are often restricted to isolated spring pools and streams in Central Anatolia and the Levant (Küçük et al., 2012). Several studies have investigated the taxonomy and phylogenetic relationships among existing populations of *Pseudophoxinus*. Several authors have underlined the role of past isolated endorheic inland systems of Anatolia on the speciation process of the genus, and suggested the lake basins in central and southwestern Anatolia as the center of origin (Hrbek et al., 2004; Perea et al., 2010; Küçük et al., 2013; Telli & Kence, 2015).

Of the 30 valid *Pseudophoxinus* species, 16 (including the extinct species, *P. handlirschi* from Lake Eğirdir) are strictly endemic to southwestern and Central Anatolia. Five of these species are

found in Central Anatolia (Fig. 1): *P. anatolicus* (Hanko, 1925) from Akgöl, Suğla and Beyşehir lakes; *P. battalgilae* Bogutskaya, 1997 from the Suğla Lake area, Manavgat River Basin, Akgöl Swamp, Çavuşcu Lake and Niğde environs (Kızılcı, Akkaya reservoir and Gümüşler); *P. crassus* (Ladiges, 1960) from İnsuyu Stream; *P. elizavetae* Bogutskaya, Küçük & Atalay, 2006 from Sultansazlığı marshes and *P. hittitorum* Freyhof & Özuluğ, 2010 from Lake Beyşehir and connected streams, along with Bakaran Stream and Derebucak (Freyhof & Özuluğ, 2010; Küçük et al., 2012; Ekmekçi et al., 2015).

Previous molecular studies work has shown that the *Pseudophoxinus* populations around Lake Tuz stand out (Hrbek et al., 2004), necessitating their taxonomical re-classification. In this study, the morphometric data of material obtained

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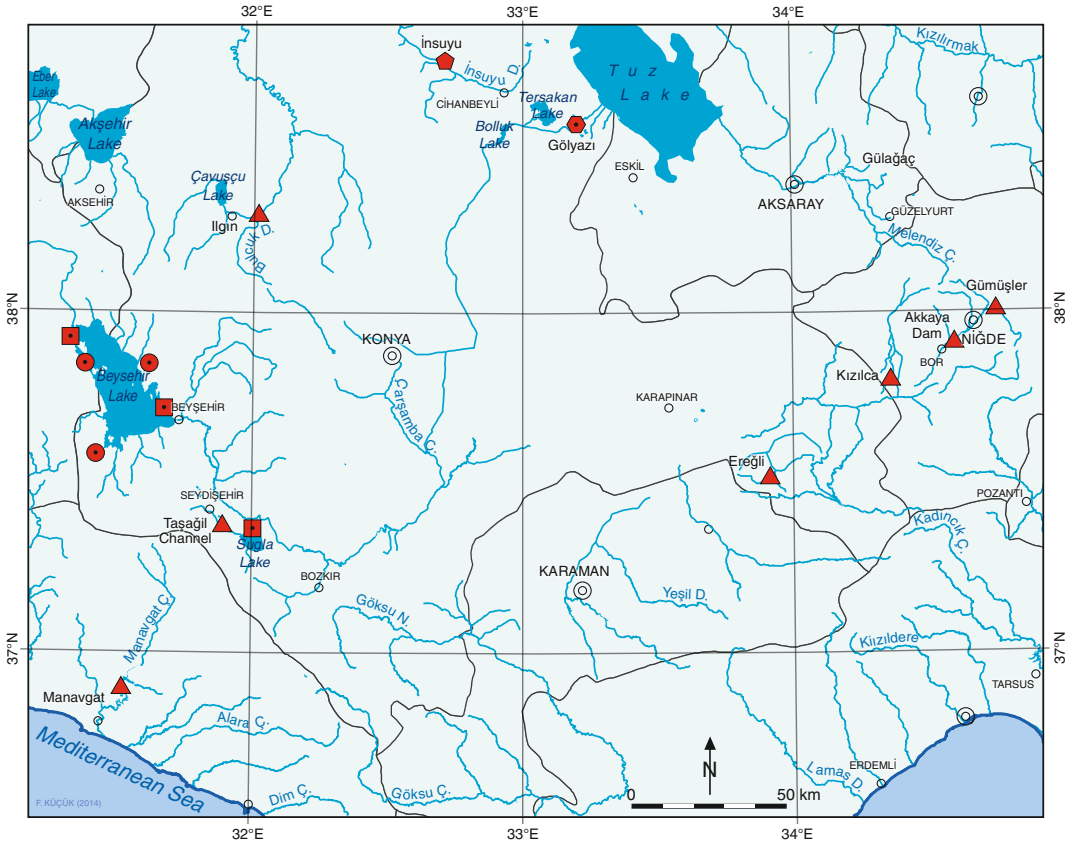


Fig. 1. Localities of Central Anatolian *Pseudophoxinus* species: ◆, *P. iconii*; ▲, *P. battalgilae*; ■, *P. crassus*; ●, *P. anaticus*; and ●, *P. hittitorum*.

from Lake Tuz area (Gölyazı Village, Cihanbeyli, Konya) in 2014 was evaluated and permitted identifying and describing a new species.

Materials and methods

The fish specimens were collected with a pulsed DC electric fish shocker, were sacrificed by over-anesthetization and fixed in 5 % formalin. The samples are deposited at IFC-ESUF, Inland Fishes Collection, Eğirdir Fisheries Faculty of Süleyman Demirel University, Isparta. The counts and measurements were performed as described by Kottelat & Freyhof (2007). All point-to-point measurements were made with a dial caliper and recorded at 0.1 mm precision. Head width 1 is the distance between the anterior eye margins and head width 2 is the head width at the nape; head depth 1 is the head depth through the eye

and head depth 2 is the head depth at the nape. The lateral line scales were counted from the anterior-most scale (the first one to touch the shoulder girdle) to the posterior-most (at the end of the hypural complex); scales in lateral series were counted along the mid-lateral line. Scales on the caudal fin were indicated by '+'; the last two branched dorsal and anal fin rays articulating on a single pterygiophore were counted as '1½'.

Pseudophoxinus iconii, new species

(Figs. 2–3)

Holotype. IFC-ESUF 03-1022, 69.9 mm SL; Turkey: Konya Prov.: Cihanbeyli District: Gölyazı Village, drainage ditches and canals near the village, 38°32.24' N 33°10.89' E, 919 m asl; F. Küçük, İ. Güllü & A. Küçük, 4 Aug 2014.



Fig. 2. *Pseudophoxinus iconii*, IFC-ESUF 03-1022, holotype, 69.9 mm SL; Turkey: Konya Prov.: Gölyazı village.



Fig. 3. *Pseudophoxinus iconii*, IFC-ESUF 03-1026, 63.8 mm SL; Turkey: Konya Prov.: Gölyazı village.

Paratypes. IFC-ESUF 03-1023, 25, 45.7–74.2 mm SL; data same as holotype.

Diagnosis. *Pseudophoxinus iconii* is distinguished from all other *Pseudophoxinus* species in Central Anatolia (*P. anatolicus*, *P. battalgilae*, *P. crassus* and *P. hittitorum*) by the unique combination of the following characters: absence of a keel between pelvic fins and anus; body depth at dorsal-fin origin 29–33 % SL; head length 28–30 % SL, 0.9–1.0 times body depth at dorsal-fin origin; caudal peduncle length 1.6–1.9 times its depth; mouth terminal (upper jaw equal or slightly longer than lower jaw); mostly complete lateral line (in some small specimens ending 3–4 scales in front of the base of the caudal fin), with 48–61 (commonly 53–58) perforated scales and 53–63+2–3 scales in lateral series (commonly 54–59+2–3); 13–15 scale rows between lateral line and origin of dorsal fin; 5–7 scale rows between lateral line and origin of pelvic fin; 10–12 (rarely 13) gill-rakers on the first branchial arch; and pharyngeal teeth 5–5, serrated and hooked at the tip.

Description. See Figures 2–3 for general appearance and Table 1 for morphometric data. Body deep and compressed. Dorsal profile markedly convex, ventral profile less convex than dorsal profile. Dorsal-fin origin situated at vertical through base of pelvic fin. Head long, equal to or slightly shorter than body depth; upper profile significantly convex. Mouth terminal, lower jaw relatively short, quadrate junction positioned vertically through anterior margin of pupil. Corner of mouth not reaching vertical through anterior margin of eye. Eye small, diameter equal to snout length. Snout rounded. Caudal peduncle short, its length 1.6–1.9 times its depth.

Lateral line complete, scales along lateral line 48 (1), 52 (2), 53 (5), 54 (3), 56 (2), 57 (3), 58 (4), 59 (1), 60 (2), 61 (1); 53 (3), 54 (2), 55 (2), 56 (3), 57 (2), 58 (2), 59 (5), 60 (3), 61 (1), 63 (1) + 2–3 scales in lateral series. Scale rows between lateral line and dorsal-fin origin 13–15 (commonly 14); between lateral line and pelvic-fin origin 5–7 (commonly 6–7). Dorsal fin with 3 simple and 7½ branched rays, outer margin straight. Anal fin with 3 simple and 7½ (8) or 8½ (15) branched rays, outer margin



straight or slightly convex. Pectoral fin with 12–13 branched rays, outer margin rounded. Pelvic fin with 7 branched rays, outer margin convex. Caudal fin forked, lobes rounded. Pelvic axillary lobe slightly developed. No keel between pelvic-fin base and anus. Pharyngeal teeth in one row, 5–5, markedly serrated, hooked at tip. 10–12 (rarely 13) short gill-rakers on outer side of first gill arch.

Coloration. In life, body silvery. A longitudinal dark grey stripe in middle of flank from posterior margin of opercle to caudal-fin base; more distinct in posterior part than in anterior part; height slightly greater than eye diameter. In preserved specimens, light brownish on back and upper flank, yellowish on lower flank and belly.

Etymology. The species is named after Iconium, the ancient name of the Konya Province where it lives. A noun in genitive.

Distribution. *Pseudophoxinus iconii* is found in an artificial drainage canal and in a number of spring-fed ditches between Gölyazı village and Cihanbeyli town, to the southwest of Lake Tuz (Fig. 1).

Discussion

Based on the cytochrome-*b* data from the study of Hrbek et al. (2004), the populations of *Pseudophoxinus* species at Beyşehir, Çavuşçu (Ilgın), Akgöl (Ereğli), Kızılca and Akkaya reservoir (Niğde), İnsuyu village (probably Güneşli near Eşmekaya) and Goyöz (erroneous, probably Gölyazı village) are *P. anatolicus*. However, populations from the now dry Güneşli-Eşmekaya Marshes (erroneously given as İnsuyu village, the type locality of *P. crassus*) and Goyöz [Gölyazı village] canal form a distinct sub-clade. According to findings of this study, the latter represents a distinct species and the original *P. anatolicus* is present only in Akgöl (Ereğli), Suğla and Beyşehir lakes.

Table 1. Morphometric data of *Pseudophoxinus iconii* (holotype IFC-ESUF 03-1022, paratypes IFC-ESUF 03-1023, n=25), *P. battalgilae* (IFC-ESUF 03-0962, n=11) and *P. crassus* (IFC-ESUF 03-1028, n=10). Values of holotype of *P. iconii* included in range.

	<i>P. iconii</i>		<i>P. battalgilae</i>	<i>P. crassus</i>
	holotype	paratypes		
Standard length (mm)	69.9	45.7–74.2	40–86	84.4–107.3
In percent of standard length				
Head length	28.6	27.7–29.9(28.6)	24.6–28.2(26.4)	24.8–28.1(26.2)
Body depth at dorsal-fin origin	31.5	29.0–32.9(30.7)	23.8–27.1(25.2)	27.4–30.2(28.5)
Body depth at anal-fin origin	23.0	18.6–23.0(20.6)	17.3–22.6(20.2)	19.7–21.8(20.7)
Predorsal length	53.5	49.6–54.9(53.1)	49.0–53.4(51.6)	50.6–53.0(52.0)
Prepelvic length	52.1	50.0–54.7(53.1)	47.9–53.7(51.0)	52.7–55.9(53.9)
Preanal length	71.4	70.2–74.8(72.0)	67.5–77.3(69.3)	70.4–74.2(71.6)
Distance between pectoral and anal fin origins	44.4	43.8–48.7(45.5)	42.8–51.1(45.5)	46.2–50.9(48.8)
Distance between pectoral and pelvic fin origins	24.6	23.1–29.0(26.1)	24.8–32.0(26.6)	28.4–32.4(30.3)
Distance between pelvic and anal fin origins	20.4	18.0–22.9(20.2)	17.3–20.7(18.3)	18.3–21.2(19.6)
Depth of dorsal fin	22.9	21.6–27.7(23.1)	20.8–24.7(22.8)	19.5–22.9(21.0)
Depth of anal fin	16.3	14.6–19.3(16.2)	13.6–16.8(15.0)	15.0–16.2(15.6)
Length of pectoral fin	18.5	17.0–22.9(19.5)	16.8–19.1(16.2)	16.9–20.9(18.2)
Length of pelvic fin	18.6	15.3–21.4(17.6)	15.3–18.4(16.8)	12.6–17.5(14.9)
Length of caudal peduncle	20.2	17.6–21.1(19.1)	19.9–26.3(22.7)	19.2–21.6(20.3)
Depth of caudal peduncle	11.9	10.3–11.4(10.9)	8.1–10.2(9.30)	12.3–14.0(13.0)
In percent of head length				
Snout length	28	26–29(27.5)	26–28(26.6)	26–30(27.8)
Eye diameter	25	24–30(26.9)	23–27(25.8)	19–24(21.9)
Interorbital distance	30	28–34(31.1)	29–32(30.1)	32–37(35.1)
Head width 1	35	28–35(29.2)	25–30(27.0)	30–36(33.2)
Head width 2	51	48–54(49.4)	43–48(44.5)	53–60(57.5)
Head depth 1	55	52–59(54.6)	52–56(52.4)	54–62(58.2)
Head depth 2	78	73–78(75.3)	68–76(70.9)	75–86(81.3)



The Gölyazı canal system joins Lake Tuz at 5–7 km from its source. This was once a natural channel flowing into Lake Tuz. However, this system, that was composed of numerous radiating ditches and canals, was modified to provide water for irrigational purposes during periods of drought. Compared to the standard freshwater habitat for *Pseudophoxinus*, this habitat is characterized by a higher conductivity (993 $\mu\text{S}/\text{cm}$), salinity (0.7 ppt) and pH (8.7).

In this study, *P. iconii* was compared with all other Central Anatolian species (*P. anatolicus*, *P. battalgilae*, *P. crassus*, *P. elizavetae*, and *P. hittitorum*). *Pseudophoxinus iconii* is distinguished from *P. battalgilae* by the position of the mouth (terminal versus slightly superior), the absence of a keel between pelvic fin and anus (versus slightly marked keel, scaleless for about $\frac{1}{3}$ or $\frac{1}{4}$ of its length), body depth at dorsal-fin origin (29–33 % SL versus 24–27), head length (28–30 % SL versus 25–28), and a shorter caudal peduncle (its length 1.6–1.9 times its depth versus 2.1–2.8). In addition, *P. iconii* has a rounded snout (versus pointed), 13–15 scales between lateral line and dorsal-fin origin (versus 11–13), and 10–12, rarely 13 gill-rakers on the first gill arch (versus 12–15).

Pseudophoxinus iconii is distinguished from *P. anatolicus* and *P. crassus* by having fewer lateral line scales (48–61 versus 82–96 in *P. anatolicus* and 74–80 in *P. crassus*), fewer scales between lateral line and dorsal-fin origin (13–15 versus 25–29 in *P. anatolicus* and 17–21 in *P. crassus*), and fewer scales between lateral line and pelvic-fin origin (5–7 versus 9–10, rarely 11 in *P. anatolicus* and 8–10 in *P. crassus*). *Pseudophoxinus iconii* is further distinguished from *P. anatolicus* by a flexible last simple dorsal fin ray (versus spinous and thickened); and from *P. crassus* by having more gill-rakers on the first gill arch (10–12, rarely 13 versus 8–9).

Pseudophoxinus iconii differs from *P. hittitorum* in the position of the dorsal fin-origin (above pelvic-fin base versus situated posteriorly) and in having fewer lateral line scales (48–61 versus 84–90), fewer scales between lateral line and dorsal-fin origin (13–15 versus 25–29), fewer scales between lateral line and pelvic-fin origin (5–7 versus 9–11), and more gill-rakers on the first gill arch (10–12 versus 6–8).

Pseudophoxinus iconii has a complete lateral line and 7–8½ anal-fin branched rays whereas *P. maeandri*, *P. burduricus*, *P. mehmeti*, *P. ninae* (from Southwestern Anatolia), and *P. elizavetae*

(from Cibik village near Sultansazlığı, Kayseri) have an incomplete lateral line and 6–7½ anal-fin branched rays. *Pseudophoxinus iconii* is distinguished from *P. kervillei* (from Lake Gölbaşı, Asi River drainage) and *P. turani* (from İncesu spring near Hassa, Asi River basin) by its complete lateral line (versus incomplete); more lateral line scales (48–61 versus 4–17 in *P. kervillei*, 12–25 in *P. turani*) and more gill-rakers (10–12 versus 7–8 in *P. kervillei*, 8–11 in *P. turani*).

The habitat of *P. iconii* is located in one of the most arid areas of Turkey, Lake Tuz or Salt Lake Basin. Due to scarcity of surface water and increased water abstraction, the water table has lowered drastically in recent decades. As a result, the ditches serving as a habitat for the fish have regressed considerably, and the population size declined. Excessive water abstraction resulted already in the extirpation of *P. iconii* from the Eşmekaya Marshes (Eskil, Aksaray). The species presently still survives in Gölyazı canals.

Comparison material. All from Turkey: *Pseudophoxinus anatolicus*: IFC-ESUF 03-0959, 8, 121.9–196.8 mm SL; Konya Prov.: Lake Suğla. – IFC-ESUF 03-1014, 14, 199.5–208.5 mm SL; Konya Prov.: Lake Beyşehir.

P. battalgilae: IFC-ESUF 03-0961, 9, 71.8–87.4 mm SL; Antalya Prov.: Manavgat reservoir. – IFC-ESUF 03-0962, 17, 40.0–149.8 mm SL; Konya Prov.: Çarşamba Channel Seydişehir. – IFC-ESUF 03-0964, 10, 28.1–57.8 mm SL; Konya Prov.: Çavuşcu Lake spring. – IFC-ESUF 03-0966, 12, 72.3–84.9 mm SL; Niğde Prov.: Akkaya reservoir. – IFC-ESUF 03-1010, 4, 66.3–73.4 mm SL; Konya Prov.: Tatlıkuyu village near Ereğli.

P. burduricus: IFC-ESUF 03-0971, 17, 39.90–86.69 mm SL; Burdur Prov.: Değirmendere Creek, Karamanlı.

P. crassus: IFC-ESUF 03-0973, 2, 67.3–119.4 mm SL; Niğde Prov.: Kızılarpınarı near Gülağaç. – IFC-ESUF 03-0974, 3, 75.2–79.9 mm SL; Konya Prov.: İnsuyu Village-Cihanbeyli.

P. elizavetae: IFC-ESUF 03-0977, 24, 50.39–100.38 mm SL; Kayseri Prov.: Cibik village.

P. hittitorum: IFC-ESUF 03-0981, 41, 35.98–97.99 mm SL; Konya Prov.: Eflatunpınarı.

P. kervillei: IFC-ESUF 03-0987, 26, 60.7–84.9 mm SL; Hatay Prov.: Lake Gölbaşı, Kırıkhan. – IFC-ESUF 03-0988, 25, 27.4–56.0 mm SL; Hatay Prov.: Meydan village, Samandağ.

P. maeandri: IFC-ESUF 03-0989, 8, 46.70–55.96 mm SL; Denizli Prov.: Işıklı Spring.

P. mehmeti: IFC-ESUF 03-1015, 7, 30.05–74.16 mm SL; Burdur Prov.: Dereköy village.

P. ninae: IFC-ESUF 03-0977, 4, 48.9–67.5 mm SL; Burdur Prov.: Pınargözü, Bucak.

P. turani: IFC-ESUF 03-1003, 20, 52.1–93.4 mm SL; Hatay Prov.: Hassa İncesu Spring.



Fig. 4. *Pseudophoxinus battalgilae*, IFC-ESUF 03-0961, 96.0 mm SL; Turkey: Antalya Prov.: Manavgat reservoir.



Fig. 5. *Pseudophoxinus crassus*, IFC-ESUF 03-1028, 103.2 mm SL; Turkey: Konya Prov.: İnsuyu Stream, Cihanbeyli.

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Cover photograph

Liniparhomaloptera macrostoma (Photograph by Jiahu Lan)
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