



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

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*Pseudophoxinus hittitorum*, new species, is described from Lake Beyşehir basin, Central Anatolia. It is distinguished from other Anatolian *Pseudophoxinus* by a complete lateral line with 84-94 + 1-2 scales, the absence of an epidermal lateral stripe, the dorsal-fin origin behind vertical through the pelvic-fin origin and a flexible last simple dorsal-fin ray.

### Introduction

Spring minnows of the cyprinid genus *Pseudophoxinus* are distributed from Central Anatolia east to Azerbaijan and south to Israel. Most species have very small distribution areas and are often restricted to a few streams or springs making them one of the most challenging group of fishes for conservation in the strongly impacted Middle East landscape. The diversity of spring minnows was much underestimated by last century ichthyologists such as Karaman (1972) who included all species in *Phoxinellus* and most were just subspecies of *P. zeregi*. Reviews by Krupp (1985), Bogutskaya (1992) and Krupp (1992) improved the knowledge by recognizing most of Karaman's subspecies as valid species and described two additional new species. Bogutskaya (1992) also placed all Asian and all European *Phoxinellus* distributed south of Neretva River

(Dalmatia) in *Pseudophoxinus* and restricted *Phoxinellus* to Europe. Freyhof et al. (2006) then restricted *Phoxinellus* to four Dalmatian species only and Kottelat & Freyhof (2007b) restricted *Pseudophoxinus* to Asia. It should be mentioned, that there are three additional, very poorly known species from North Africa (*P. callensis*, *P. chaignoni*, *P. punicus*) (Kraiem, 1983) not discussed by Freyhof et al. (2006) and Kottelat & Freyhof (2007b) because Collares-Pereira (1983) already speculated that they are not related to *Phoxinellus* or *Pseudophoxinus*. Since eight new species of *Pseudophoxinus* have been described from Anatolia (Bogutskaya, 1997; Freyhof & Özuluğ, 2006, 2009a-b; Bogutskaya et al., 2006; Küçük, 2007) and here we present the description of an additional unnamed Anatolian *Pseudophoxinus*. With 25 species recognized in Asia, *Pseudophoxinus* is one of the most species-rich genera in the Middle East.

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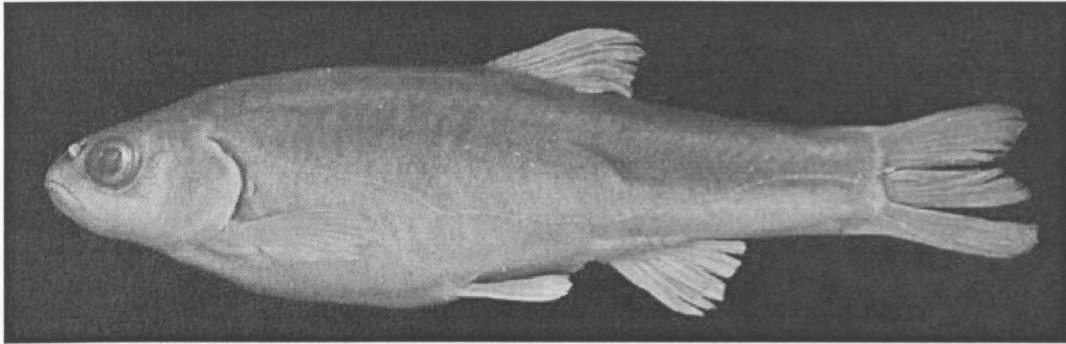


Fig. 1. *Pseudophoxinus hittitorum*, IUSHM 37970-608, holotype, 75.7 mm SL; Turkey: Eflatunpınar.

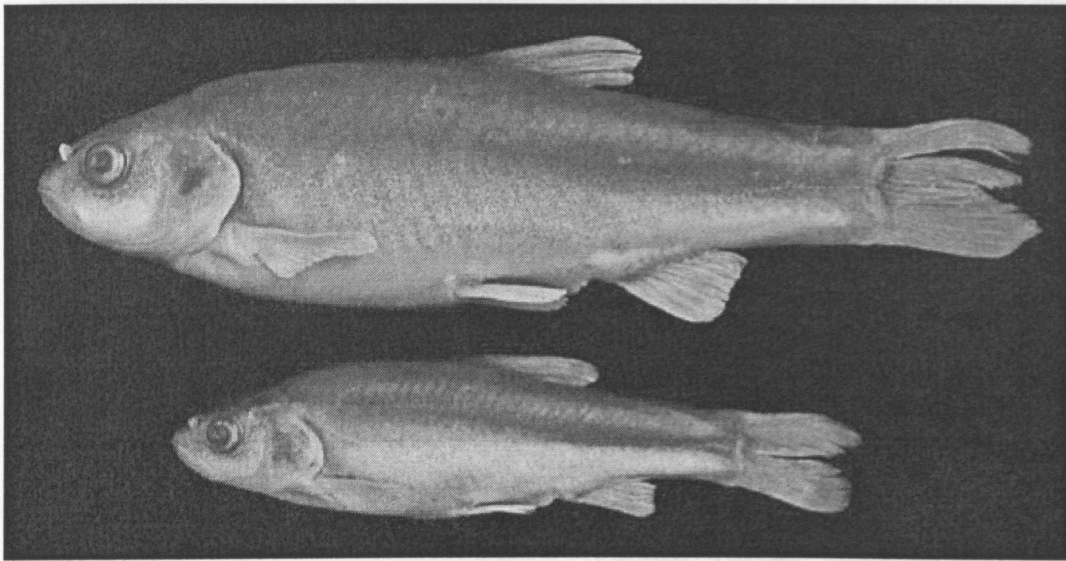


Fig. 2. *Pseudophoxinus hittitorum*, IUSHM 37970-609, paratypes, 57.3, 82.9 mm SL; Turkey: Eflatunpınar.

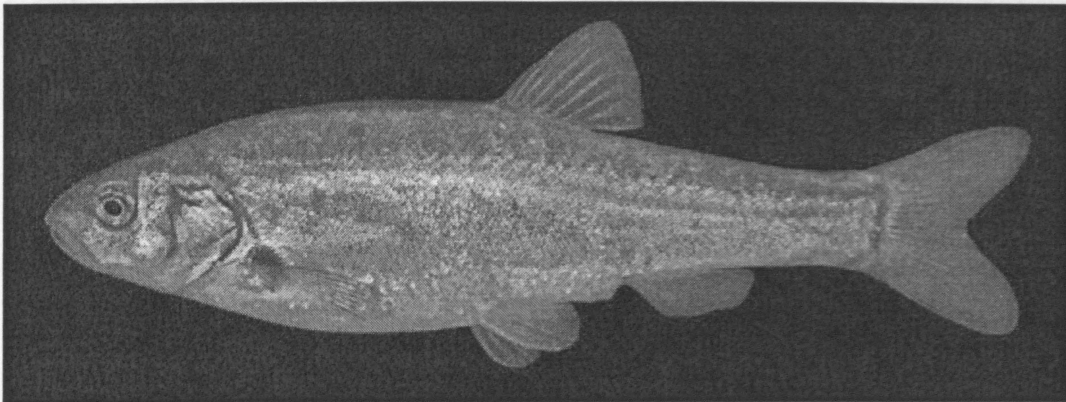


Fig. 3. *Pseudophoxinus hittitorum*, about 90 mm SL; Turkey: Eflatunpınar, collected with holotype. Anal fin malformed.



### Material and methods

All fish were preserved in 5 % formaldehyde. Measurements were made with dial caliper and recorded to 0.1 mm. All measurements are made point to point, never by projections. Methods for counts and measurements follow Kottelat & Freyhof (2007a). Standard length (SL) is measured from the tip of the upper lip to the end of the hypural complex. The length of the caudal peduncle is measured from behind the base of the last anal-fin ray to the end of the hypural complex, at mid-height of the caudal-fin base. Lateral line scales are counted from the anteriormost scale (the first one to touch the shoulder girdle) to the last scale at the end of the hypural complex. Scales on the caudal fin itself are indicated by "+". Gill rakers are counted on the outer margin of the anterior gill arch. The last two branched rays articulating on a single pterygiophore in the dorsal and anal fins are noted as "1½". The holotype is included in the calculation of means and SD in Table 1.

Abbreviations used: SL, standard length; HL, lateral head length; FSJF, Fischsammlung J. Freyhof, Berlin; IUSHM, Istanbul University, Science Faculty, Hydrobiology Museum, İstanbul; HUIC, Department of Biology, Hacettepe University, Ankara; ZHM, Zoologisches Institut der Universität Hamburg. We use the Evolutionary Species Concept; see Mayden (2002) for a discussion and hierarchy of Species Concepts.

### *Pseudophoxinus hittitorum*, new species (Figs. 1-3)

**Holotype.** IUSHM 37970-608, 75.7 mm SL; Turkey: Konya prov.: Spring Eflatunpınar at Sadıkhacı, 37°49.51'N 31°40.46'E; M. Özuluğ & J. Freyhof, 26 June 2008.

**Paratypes.** IUSHM 37970-609, 10, 66-95 mm SL; FSJF 2599, 5, 76-104 mm SL; same data as holotype; – IUSHM 37970-493, 18, 47-88 mm SL; FSJF 2310, 20, 37-98 mm SL; same locality as holotype; M. Özuluğ & J. Freyhof, 5 Nov 2007.

**Additional material.** HUIC uncat., 2, 78.1 mm, 81.1 mm SL, Turkey: Konya prov.: Bakaran stream at road from Akşehir to Beyşehir.

**Diagnosis.** *Pseudophoxinus hittitorum* is distinguished from all other species of *Pseudophoxinus* in Asia by the combination of: lateral line complete, reaching to caudal-fin base; 84-94 + 1-2 scales along lateral line; 6-8 short gill rakers; 26½-30½ scales between lateral line and dorsal-fin origin; 9½-12½ scales between lateral line and pelvic-fin origin; last simple dorsal-fin ray flexible; upper lip projecting beyond tip of lower lip; pelvic fin short, not reaching to anus; no epidermal black stripe; and dorsal-fin origin behind vertical of pelvic-fin origin.

**Description.** See Figures 1-3 for general appearance and Table 1 for morphometric data of holotype and 20 paratypes. Medium sized, and elongated species with short and roundish head. Greatest body depth at about middle between nape and dorsal-fin origin, decreasing towards caudal-fin base. Dorsal and ventral body profile slightly convex. Body and caudal peduncle compressed. Head profile straight or convex, head length 0.9-1.1 times in body depth. Back humped behind nape in larger individuals, profile of predorsal body slightly convex. Snout slightly pointed its length 1.5-1.8 times in postorbital length. Ventral head profile with conspicuous angle at articulation of lower jaw in large individuals. Mouth terminal, uppermost point of cleft at level of center of eye or slightly below, rostral cap not covering upper lip, lips smooth and thick, upper lip projecting beyond tip of lower lip. Eye diameter 2.1-2.7 times in head depth at eye, 1.5-1.8 times in interorbital width. Caudal peduncle 1.4-1.8 times longer than deep. Pelvic-fin origin in front of dorsal-fin origin. Pectoral fin reaching to about 60-80 % to pelvic-fin origin. Pelvic fin short, not reaching anus. No pelvic axillary lobe. Margin of dorsal and anal fins straight to slightly concave. Caudal fin forked, lobes rounded, upper lobe slightly longer than lower one. Largest recorded specimen 93.9 mm SL.

Dorsal fin with 3 simple and 5½ (1), 7½ (13) branched rays. Anal fin with 3 simple and 6½ (5), 7½ (10) branched rays. Caudal fin with 10+9 principal and 9+8 branched rays. Pectoral fin with 13-14 branched rays and pelvic fin 7 branched rays. Body covered by completely embedded, overlapping, very thin scales. No keel or scaleless area between posterior pelvic-fin base and anus. Ventral body in front of anus slightly elevated. Scales along lateral line 84+1 (1), 86+2 (1), 87+2 (1),



**Remarks.** *Pseudophoxinus hittitorum* belongs to a group of species with more than 70 scales in lateral series and a complete lateral line (*P. caralis*, *P. crassus*, *P. anatolicus*, *P. handlirschi*, *P. fahrettini*). Hrbek et al. (2004) examined *P. crassus*, *P. fahrettini* (as *P. handlirschi*) and *P. hittitorum* (as *P. battalgili*) and found them most closely related to each other. They found this group of species to be quite distinct from *P. anatolicus*, but unpublished data (I. Doadrio, pers. comm.) suggest that fishes identified by Hrbek et al. (2004) as *P. anatolicus* represent *P. battalgili* and that the real *P. anatolicus* is also closely related to *P. crassus*, *P. fahrettini* and *P. hittitorum*.

*Pseudophoxinus hittitorum* is distinguished from *P. caralis*, *P. crassus* and *P. anatolicus* by the dorsal-fin origin situated clearly behind vertical of pelvic-fin origin (vs. above), a lower position of the lateral line, which is situated at about the horizontal of the pectoral-fin origin (vs. clearly above) and a short pelvic fin not reaching to anus in both sexes (vs. reaching or overlapping at least in males). It is further distinguished from *P. crassus* by having  $26\frac{1}{2}$ - $30\frac{1}{2}$  scales between lateral line and dorsal-fin origin (vs. 17-20),  $9\frac{1}{2}$ - $12\frac{1}{2}$  scales between lateral line and pelvic-fin origin (vs. 9-10). *Pseudophoxinus hittitorum* is further distinguished from *P. anatolicus* and *P. caralis* by a flexible last simple dorsal-fin ray (vs. spinous and thickened) and from *P. caralis* by having 3-4 gill rakers on lower gill arch (vs. 10).

*Pseudophoxinus hittitorum* is immediately distinguished from *P. handlirschi* by the upper lip projecting beyond the tip of the lower lip (vs. lower lip projecting beyond tip of upper lip) and by having 6-8 total gill rakers (vs. 14-17) and from *P. fahrettini* by the absence of a prominent black stripe between eye and caudal-fin base (vs. presence), by having 6-8 total gill rakers on first gill arch (vs. 12-14) and 84-94 + 1-2 lateral line scales (vs. 74-85 + 3-4).

*Pseudophoxinus hittitorum* has smaller scales than all the remaining species of *Pseudophoxinus* in Anatolia and the Levant by having 84-94 + 1-2 lateral line scales (vs. 38-45 + 2-3 in *P. alii*, 52-64 + 2 in *P. antalyae*, 55-64 + 3 in *P. battalgili*, 48-56 + 2-3 in *P. drusensis*, 51-54 + 2-3 in *P. egridiri*, 57-65 + 3 in *P. elizavetae*, 54-64 + 2-3 in *P. evliyae*, 43-49 + 2-3 in *P. firati*, 26-33 + 2-3 in *P. hasani*, 44-52 + 2-3 in *P. libani*, 41-46 + 3 in *P. maeandri*, 60-65 + 2 in *P. maeandricus*, 44-54 + 2-3 in *P. ninae*, 34-44 + 2-3 in *P. kervillei*, 36-49 + 2-3 in *P. syriacus*, 55-62 + 2-3 in *P. zeregi*, 38-46 + 2-3 in *P. zekayi*). *Pseudophoxinus*

*hittitorum* is further distinguished from all these species except *P. battalgili*, *P. maeandricus* and *P. zekayi* by a complete lateral line (vs. incomplete).

*Pseudophoxinus hittitorum* was identified as *P. battalgili* by Hrbek et al. (2004). It is distinguished from *P. battalgili* by having 84-94 + 1-2 lateral line scales (vs. 55-64 + 3), a plain body coloration (vs. a prominent black stripe) and the absence of a ventral keel between the pelvic-fin base and the anus (vs. presence). Unpublished data (I. Doadrio, pers. comm.) confirmed that individuals collected by us in Eflatunpınar show the same cytochromeB DNA patterns as fishes collected by Hrbek et al. (2004) from this place, confirming that *P. hittitorum* is the species they identified as *P. battalgili*.

**Comparative material.** *Pseudophoxinus alii*: IUSHM 36900-174, 13, 27-34 mm SL; Turkey: Antalya prov.: stream Ilıca at Ilıca, 36°49.50'N 31°21.18' E.

*P. anatolicus*: ZMH 2485, 1, 86 mm SL, Ereğli. – ZMH 1083, 2, 125.4, 127.5 mm SL; Turkey: Lake Beyşehir. – IUSHM 37000-195, 1, 100 mm SL; FSJF 2354, 7, 96-185 mm SL; Turkey: Konya prov.: stream at Kireli, at road from Şarkikaraağaç to Beyşehir, 37°50.73'N 31°36.94' E. – IUSHM 37000-256, 8, 198-240 mm SL; Turkey: Konya prov.: Lake Beyşehir at Kiyakdede.

*P. antalyae*: ZMH 2445, paratypes, 10, 49.6-63.7 mm SL; Turkey: Antalya prov.: Kırkgöz. – IUSHM 37100-210, 16, 44-82 mm SL; Antalya prov.: Spring Kırkgöz, 37°06.59'N 30°34.83' E.

*P. atropatena*: FSJF 2631, 5, 43-67 mm SL; Azerbaijan: Qabala prov.: spring in village Chukhur-Qabala draining to Turian-chay river, 40°53.34'N 47°41.07' E.

*P. battalgili*: ZMH 8861, holotype, 58 mm SL; ZMH 6634, 2, paratypes, 39.0, 50.7 mm SL; Turkey: Lake Beyşehir. – IUSHM 37200-202, 20, 37-60 mm SL; Turkey: Niğde prov.: reservoir northeast of Gümüşler, 38°00.76'N 34°46.00' E. – IUSHM 37200-225, 23, 39-51 mm SL; Turkey: Aksaray prov.: small pool in former Lake Büğüt 2 km north of Eşmekaya, 38°16.59'N 33°26.20' E.

*P. caralis*: ZMH 1082, syntype, 86 mm SL, Turkey: Lake Beyşehir.

*P. crassus*: Turkey: IUSHM 31600-930, 5, 55-79 mm SL; Turkey: Konya prov.: stream İnsuyu about 1 km downstream of Pınarbaşı, 38°43.23'N 32°43.49' E. – IUSHM 31600-331, 30, 42-74 mm SL; Turkey: Konya prov.: stream north of Sarı Yayla, draining to former Lake Samsam, 39°07.13'N 32°45.55' E.

*P. drusensis*: FSJF 2700, 26, 32-87 mm SL; Syria: Nahr al Tammasiyyar near Magsoofa, 33°17'37" N 35°38' 14" E.

*P. egridiri*: IUSHM 37300-224, 26, 29-61 mm SL Turkey: Isparta prov.: Spring Karaot at shore of Lake Eğirdir, about 4 km north of Yenice village, 38°08.09'N 30°54.44' E.



89+1 (3), 90+1 (3), 90+2 (2), 91+2 (1), 92+1 (2), 94+1 (1). Lateral line complete, not slanted upwards at vertical of posterior anal-fin base or anterior caudal peduncle, reaching to caudal-fin base. Often interrupted on caudal peduncle. 26½-30½ scales between lateral line and dorsal-fin origin, 9½-12½ scales between lateral line and pelvic-fin origin. About 52-60 circumpeduncular scales, irregularly set and deeply embedded. Pharyngeal teeth in one row, 5-5, slightly serrated, hooked at tip. Gill rakers short and thick, 3-4 on upper arch, 3-4 on lower arch, 6 (1), 7 (2), 8 (3) total gill rakers in outer side of first gill arch. Preoperculummandibular and infraorbital sensory canals disconnected. Length of pelvic fin almost reaching anus in males, reaching only to about 70-80 % of distance between pelvic-fin origin and anus in females.

**Coloration.** In life, body yellowish, back pale grey. Lateral body with individual silvery scales. Fin membranes hyaline, rays dusty. No external

stripe along lateral midline in life and preserved individuals.

In preserved specimens, an inner axial stripe present. Numerous isolated, minute, epidermal black spots on body below lateral midline. Body below a line from lower pectoral-fin base to lowermost caudal peduncle without black spots. Fin membranes pale grey, rays dusty.

**Distribution.** *Pseudophoxinus hittitorum* was collected in two tributaries of Lake Beyşehir, a spring at Eflatunpınar east of the lake and in Bakaran stream draining from south to the lake.

**Etymology.** The species is named for the Hittites, an ancient Anatolian culture (about 1750-1180 BC). At at Eflatun Pınar, which is the type locality of *P. hittitorum*, a Hittite monument (most likely from the second half of 13th century) was built to honor one of the ancient Hittite gods.

**Table 1.** Morphometric data of *Pseudophoxinus hittitorum* (holotype IUSHM 37970-608, paratypes IUSHM 37970-609; FSJF 2310, n=19).

	holotype	paratypes			
		min	max	mean	SD
Standard length (mm)	75.7	78.2	57.3	95.0	
<b>In percent of standard length</b>					
Head length	25.0	24.1	27.6	26.1	1.0
Body depth at dorsal-fin origin	27.3	24.7	30.5	27.2	1.7
Body width at dorsal-fin origin	16.2	13.6	17.5	15.5	1.3
Predorsal length	54.7	54.6	58.9	56.3	1.3
Postdorsal length	37.7	35.8	39.3	37.4	0.9
Prepelvic length	50.8	49.7	55.3	52.4	1.3
Preanal length	68.7	68.7	74.8	71.4	1.4
Distance between pectoral and pelvic-fin origins	26.8	25.0	29.3	26.9	1.1
Distance between pelvic and anal-fin origins	19.5	19.1	21.2	20.1	0.8
Depth of caudal peduncle	12.8	11.2	14.8	12.9	1.1
Length of caudal peduncle	22.7	19.6	23.7	21.4	1.0
Dorsal-fin depth	19.2	17.0	22.3	19.2	1.5
Anal-fin base length	14.3	13.4	16.5	14.7	1.0
Pectoral fin length	17.2	16.6	19.7	17.8	0.9
Pelvic fin length	14.8	12.0	15.3	13.7	1.0
<b>In percent of head length</b>					
Head depth at nape	73.5	72.8	69.4	77.0	2.1
Head depth at eye	53.9	54.2	52.2	58.4	1.6
Snout length	31.5	31.2	29.1	33.0	1.2
Eye diameter	24.4	22.9	20.3	26.4	1.8
Postorbital distance	52.7	51.3	47.1	54.9	2.0
Maximum head width	59.9	56.3	50.6	62.7	4.0
Interorbital width	36.7	37.1	34.6	39.7	1.5



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Received 29 May 2009  
Revised 21 January 2010  
Accepted 21 January 2010



*P. elizavetae*: IUSHM 37400-220, 13, 71-79 mm SL; Turkey: Kayseri prov.: Spring Soysallı west of Develi, 38°23.41' N 35°21.94' E.

*P. evliyae*: IUSHM 37960-310, 20, 35.3-87.5 mm SL; Turkey: Antalya prov.: Small field canal south of Kırkpınar, north of Kızılcaadağ, 37°08.36' N 29°55.08' E.

*P. fahrettini*: IUSHM 37970-514, 20, 68-105 mm SL; Turkey: Isparta prov. stream at Bağlılı, 37°45.82' N 31°02.01' E.

*P. firati*: IUSHM 37600-229, 20, 33-57 mm SL; Turkey: Sivas prov.: Spring south of Yazıurdu, uppermost part of Tohma river about 30 km west of Gürün, 38°47.86' N 36°55.08' E.

*P. handlirschi*: IUSHM 36600-117, 5, 82.0-95.3 mm SL; Turkey: Isparta prov.: Lake Eğirdir.

*P. hasani*: SMF 24565, paratypes, 6, 35.9-57.8 mm SL; Syria: Nahr Marqiya. – FSJF 2709, 31, 25-56 mm SL; Syria: Nahr al Marqiya at road bridge, 35°01'50" N 35°54'18" E.

*P. kervillei*: IUSHM 37700-237, 15, 42-59 mm SL; FSJF 2391, 19, 39-68 mm SL; Turkey: Hatay prov.: Asi at Sinanlı, 36°05.85' N 36°04.71' E. – FSJF 2641, 26, 26-66 mm SL; Syria: Asi north of Ain al Zarqa, 35°56'40" N 36°24'09" E. – FSJF 2642, 1, 66 mm SL; Syria: Asi at Qbaybat, about 10 km south of Hama, 34°57'27" N 36°47'07" E. – FSJF 2643, 15, 25-70 mm SL; Syria: Spring south of Qala'at al Jarras, 35°19'49" N 36°18'38" E. – FSJF 2644, 13, 39-72 mm SL; Syria: Asi at Al Qusayr, 24°30' 31" N 36°32'20" E. – FSJF 2645, 4, 44-47 mm SL; Syria: Spring Al Fawwar north of Mashta Bayth Darwish, 35°32'00" N 36°15'10" E. – FSJF 2646, 1, 44 mm SL; Syria: Asi at Shayzar, 35°16'18" N 36°33'46" E. – FSJF 2647, 5, 29-54, Syria: Nahr al Barid at Nahr al Barid, 35°18'08" N 36°20'43" E.

*P. meandri*: FSJF 1872, 5, 30.0-43.1 mm SL; Turkey: Denizli prov.: Spring running to Lake Işıklı at Işıklı, 38°19.29' N 29°51.07' E.

*P. maeandricus*: ZMH 1077, holotype, 76.1 mm SL; ZMH 1078, paratypes, 3, 46.9-53.6 mm SL; Turkey: Denizli prov.: upper waters of Great Menderes near Işıklı.

*P. ninae*: IUSHM 33900-928, 18, 28-64 mm SL; Turkey: Burdur prov.: stream Onaç north of Bucak on main road to Burdur, 37°30.76' N 30°32.46' E. – IUSHM 37980-604, 40, 27-47 mm SL; Turkey: Burdur prov. stream in Düger behind Mosque, 37°34.83' N 30°01.65' E.

*P. syriacus*: SMF 23692, 10, 40.8-63.3 mm SL; Syria: Judaidat al-Wadi, Nahr al Barada valley, 33°34' N 36°11' E. – FSJF 2651, 32, 31-68 mm SL; Syria: Spring of Nahr al Barada north-west of Damaskus, 33°40'31" N 36°03'20" E.

*P. zeregi*: NMW 51068, 3, syntypes, 51.7-55.8 mm SL; Syria: Aleppo. – IUSHM 37800-239, 9, 46-58 mm SL; Turkey: Hatay prov.: Büyük Karaçay at Karaçay, 36°08.13' N 36°02.53' E. – FSJF 2734, 1, 57 mm SL; Syria: Nahr al Marqiya at road bridge, 35°01'50" N 35°54'18" E. – FSJF 2741, 6, 40-62 mm SL; Syria: stream Azak, a headwater of Abou Noah, 34°57'37" N 35°58'33" E. – FSJF 2746, 4, 40-58 mm SL; Syria: Afrin below reservoir north of Afrin, 36°37'02" N 36°51'39" E. – FSJF 2749, 5, 30-51 mm

SL; Syria: Nahr al Barid at Nahr al Barid, 35°18'08" N 36°20'43" W.

*P. zekayi*: IUSHM 36700-161, 16, 35-78 mm SL; Adıyaman prov.: river connecting Lakes Gölbaşı and Azaplı south of Gölbaşı, 37°47.42' N 37°37.58' E. – IUSHM 36700-155, 23, 62-98 mm SL; Kahramanmaraş prov.: Spring Çöçelli north of Çöçelli, 37°16.87' N 37°07.49' E. – IUSHM 36700-243, 22, 33-94 mm SL; Kahramanmaraş prov.: Spring Evri south-west of Çöçelli, 37°15.97' N 37°06.11' E.

### Acknowledgments

We are pleased to thank Füsün Erk'akan (HUIC), Ralf Thiel (ZMH) for allowing JF to examine materials. We also thank Cem Dalyan and Özcan Gaygusuz (İstanbul) as well as Nisreen Alwan, Kai Borkenhagen, and Florian Wicker (Senkenberg) for help during fieldwork, Ignacio Doadrio (Madrid) for making unpublished molecular results available to us.

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