

Oxynoemacheilus chaboras, a new loach species from the Euphrates drainage in Türkiye (Teleostei, Nemacheilidae)

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<https://zoobank.org/31342190-DE9E-42A9-AF83-AD5AE4F0C7D1>

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Academic editor: Nicolas Hubert ♦ Received 13 January 2024 ♦ Accepted 28 March 2024 ♦ Published 26 April 2024

Abstract

Oxynoemacheilus chaboras, new species, from the stream Beyazsu in the Euphrates drainage, belongs to the *O. persa* species group, being closely related to *O. shehabi* from the Orontes, *O. sarus* from the Seyhan and Ceyhan, *O. euphraticus* from the Euphrates and Tigris, *O. karunensis* from the Karkheh, and *O. persa* from Central Iran. The new species is distinguished from others in the *O. persa* group by having 8–9 pores in the supraorbital canal, two distinct black blotches at the caudal-fin base, a rudimentary and shallow pelvic axillary lobe, 6–10 irregularly shaped bars on the flank, and a deep head, body, and caudal peduncle. *Oxynoemacheilus chaboras* sp. nov. is most closely related to *O. euphraticus*, from which it is differentiated by a mean uncorrected *p*-distance of 3.24% (min. 3.09%) in its COI barcode gene.

Key Words

Cypriniformes, Cytochrome c oxidase subunit I, freshwater fish, taxonomy, Western Asia

Introduction

The genus *Oxynoemacheilus* Bănărescu & Nalbant, 1966, with 63 recognised species, is the most speciose genus of freshwater fishes in the western Palaearctic (Yoğurtçuoğlu et al. 2022). The hotspot of species richness of *Oxynoemacheilus* is Mesopotamia and the adjacent Levant, where there are 21 species of the genus only in the Tigris-Euphrates drainage. This high species richness can be attributed to several factors such as the unique hydrological conditions, diverse habitat types, and historical biogeographical processes of the region. Seven species are endemic to the Euphrates drainage, and 11 are endemic to the Tigris drainage (Freyhof et al. 2021, 2022). But additional species of *Oxynoemacheilus* are still being discovered in this region, as vast areas especially in Iraq and Syria remain unexplored.

There are many tributaries to the upper and middle Euphrates. One of these rivers is the Khabur that has few springs in Türkiye, but mostly flows in Syria. The stream Beyazsu, located in the Turkish Mardin province, is one of the headwater streams in the Khabour drainage. It flows into Syria after crossing the border at the city of Nusaybin, only 17.5 km below its source, the spring Beyazsu (Canpolat and Bozdoğan 2019). This karstic spring has much water throughout the year and its average annual flow rate is approximately 3.8 m³/sec. (Canpolat and Bozdoğan 2019).

Until now, only Turan et al. (2014) seems to have studied the fishes of the Beyazsu and reported the presence of *Alburnus caeruleus* Heckel, 1843, *Alburnus sellal* Heckel, 1843 (as *Alburnus mossulensis* Heckel, 1843), *Barbus lacerta* Heckel, 1843, *Capoeta damascina* (Valenciennes, 1842) (as *Capoeta umbla* (Heckel, 1843)), *Garra rufa* (Heckel, 1843), and an unidentified species of genus

Oxynoemacheilus. These authors described *Alburnoides emineae* Turan, Kaya, Ekmekçi & Doğan, 2014 as a new species from the stream Beyazsu, indicating its unique fauna. Here we examine the *Oxynoemacheilus* population from the Beyazsu in detail to test if they might represent an undescribed species.

Materials and methods

The care of experimental animals was consistent with the Republic of Türkiye's animal welfare laws, guidelines, and policies. After anaesthesia, fishes were fixed in 5% formalin and stored in 70% ethanol, fin clips directly fixed in 99% ethanol. Measurements were made with a dial calliper, recorded to 0.1 mm, from a precise point-to-point approach, never by projections. Methods for counts and measurements followed Kottelat and Freyhof (2007), structures of the suborbital groove and the adipose crest followed Freyhof et al. (2019), and nomenclature of head pores followed Kottelat (1990). Standard length is measured from the tip of the snout to the posterior extremity of the hypural complex. The length of the caudal peduncle is measured from behind the base of the last anal-fin ray to the posterior extremity of the hypural complex, at mid-height of the caudal-fin base. The last two branched rays articulating on a single pterygiophore in the dorsal and anal fins are counted as "1½". Simple rays of dorsal- and anal-fins are not counted as they are deeply embedded.

Morphological data for *Oxynoemacheilus zagrosensis* Kamangar, Prokofiev, Ghaderi & Nalbant, 2014 are taken from Kamangar et al. (2014) and its position in the *Oxy-noemacheilus persa* (Heckel, 1847) group follow Freyhof and Geiger (2021).

Abbreviations used

SL, standard length; **HL**, head length; Collection codes: **FFR**, Recep Tayyip Erdogan University Zoology Collection of the Faculty of Fisheries, Rize; **FSJF**, Fischsammlung J. Freyhof, Berlin, Germany. **IUSHM**, Istanbul University, Faculty of Science, Hydrobiology Museum, Istanbul; **NMW**, Natural History Museum Vienna; **ZFMK-ICH**, Zoological Research Museum Alexander Koenig, Ichthyology Collection, Bonn; **ZMH**, Zoologisches Museum Hamburg, Hamburg.

DNA extraction, PCR and sequencing

Genomic DNA extraction of *Oxynoemacheilus* specimens was performed according to the application protocol recommended by the manufacturer using the DNeasy Blood & Tissue Kit (Qiagen, Hilden, Germany). Amplification of the barcode region of the cytochrome c oxidase subunit 1 (COI) gene of vertebrate mitochondrial DNA was performed according to Bektaş et al. (2022)'s thermocycler

conditions of which PCR protocol (4 min. first denaturation at 94 °C, followed by 30 cycles of denaturing for 30 s at 94 °C, annealing for 30 s at 61 °C, extending for 1 min. at 72 °C and final extension for 7 min. at 72 °C) using forward FishF1 (5'-TCAACCAACCACAAAGACATTGGCAC-3'; Ward et al. 2005) and reverse FishR1 (5'-TAGACTTCTGGGTGGCCAAAGAATCA-3'; Ward et al. 2005) primers were used for amplification. PCR products were purified using the QIAquick PCR Purification Kit (Qiagen, Hilden, Germany) and bidirectional sequencing of PCR products was performed with an ABI PRISM 3730×1 Genetic Analyser using a Big-Dye Terminator 3.1 cycle sequencing ready reaction kit (Applied Biosystem) at Macrogen Europe. The obtained sequences were deposited in NCBI's GenBank with the accession numbers between **OR689585–OR689588**.

Molecular analysis

Oxynoemacheilus species distributed in the Euphrates and all other species, except *O. zagrosensis*, of the *O. persa* species group, as well as all other species known from the Euphrates drainage, were included in our dataset (Fig. 1). References to the sequences downloaded from Genbank are as follows: Geiger et al. (2014); Esmaeili et al. (2014); Freyhof et al. (2016); Sayyadzadeh and Esmaeili (2020); Kaya et al. (2020); Freyhof and Geiger (2021); Bektaş et al. (2022); Freyhof et al. (2022). The chromatograms of raw COI sequences obtained after sequencing were examined with the Bioedit 7.2.5 (Hall, 1999) program and the detected errors were manually edited. Base composition, and distinctive and diagnostic nucleotide positions were determined with the MEGA version X (Kumar et al. 2018) programme. The mean inter-species genetic distance values of *Oxynoemacheilus* were calculated in MEGA X according to the uncorrected *p*-distance model (Srivathsan and Meier 2012).

Phylogenetic relationships among *Oxynoemacheilus* species were estimated using Maximum Likelihood (ML; Felsenstein 1981) algorithm in MEGA X programme, and Bayesian analysis (BI) in MrBayes v3.2.1 programme (Ronquist et al. 2012). For ML and BI analyses, the best-fit evolution models were determined according to Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) in the jModeltest 0.1.1 (Posada 2008). The ML tree was generated with 1000 bootstrap replicates using the GTR+G model that was selected by the lowest AIC score. The BI tree was generated implementing the GTR+G model that was selected by the lowest BIC score. The BI analyses were run for 5 million generations, sampling every 1000 generations. A conservative 25% of the trees were discarded as burn-in based on Bayesian analysis. No further software was used for checking the runs' convergence. Visualization of the BI tree was performed by iTOL (Interactive Tree of Life; <https://itol.embl.de/>), a web-based software.



Figure 1. Maximum Likelihood (ML) phylogenetic tree was reconstructed based on the COI-Barcode gene. ML and BI methods resulted in generally similar topologies with minor differences, and therefore only the ML tree is shown. The bootstrap values of ML and posterior probability values of BI are indicated on nodes (ML/BI). The bootstrap percentage values (BP) $\geq 50\%$ from ML analysis and Bayesian posterior probabilities (PP) ≥ 0.50 are shown on the nodes.

Results

Sequence characteristic and phylogenetic reconstruction

Molecular analysis was conducted with four newly-generated DNA barcodes (see Genetic material section) and in addition already published data from NCBI GenBank. The average nucleotide frequency of four sequences of *O. chaboras* were A = 22.0%, T = 30.2%, C = 28.2% and G = 19.7%, and the nucleotide composition was A-T (52.2%) rich. Although the phylogenetic tree topologies reconstructed by both ML and BI methods indicated some minor differences from each other, they were generally compatible. In both topologies, some of the internal branches corresponding to the phylogenetic relationships between species, were weakly supported (Fig. 1).

The members of the *O. persa* species group (as defined by Freyhof and Geiger 2021) are distributed in two subclades with strong support according to the BI (PP: 0.96; Fig. 1) and ML (BP: 77%; Fig. 1) results. The first subclade includes *O. chaboras*, *Oxynoemacheilus shehabi* Freyhof & Geiger, 2021, *Oxynoemacheilus euphraticus* (Bănărescu & Nalbant, 1964), *O. persa*, *Oxynoemacheilus sarus* Freyhof, Yoğurtcuoğlu & Kaya, 2021 and *Oxynoemacheilus karunensis* Freyhof, 2016, while the second sub-clade includes *Oxynoemacheilus argyrogramma* (Heckel, 1847), *Oxynoemacheilus kentritensis* Freyhof, Kaya & Turan, 2017, *Oxynoemacheilus zarzianus* Freyhof & Geiger, 2017, *Oxynoemacheilus hanae* Freyhof & Abdullah, 2017, *Oxynoemacheilus kurdistanicus* Kaman-gar, Prokofiev, Ghaderi & Nalbant, 2014, *Oxynoemacheilus marunensis* Sayyadzadeh & Esmaeili, 2020, *O. zagrosensis* and *O. chomanicus*. *Oxynoemacheilus chaboras* clusters as the sister species of the first sub-clade with weak support (BP: less than 50%; PP: 0.54; Fig. 1). *Oxy-noemacheilus chaboras* is distinguished from *O. euphraticus*, *O. shehabi*, *O. persa*, *O. sarus* and *O. karunensis* by 19, 23, 23, 27 and 29 diagnostic base positions, respectively. It is genetically most similar to *O. euphraticus* with a mean uncorrected *p*-distance value of 3.24% (minimum 3.09% – maximum 3.58%). It is distinguished from *O. shehabi*, *O. persa*, *O. sarus* and *O. karunensis* by mean 3.82% (min. 3.74%), 3.82% (min. 3.74%), 4.88% (min. 4.39%) and 5.20% (min. 4.88%), respectively. Table 1 displays the mean pairwise genetic distance results for each species.

Oxynoemacheilus chaboras sp. nov.

<https://zoobank.org/A8C6E729-44C3-4B5C-9FCE-4A1906C9CDBE>

Figs 2–4

Type material. Holotype. FFR 15646, 53 mm SL; Türkiye: Mardin prov.: stream Beyazsu 14 km north of Nusaybin, 37.1989, 41.3076.

Paratypes. FFR 1428, 11, 46–60 mm SL: same data as holotype. — FFR 15633, 2, 40–51 mm SL; FSJF 4116,

4, 46–55; Türkiye: Mardin prov.: stream Beyazsu 12 km north of Nusaybin, 37.1730, 41.2690.

Genetic material. FFR DNA-Oxy378, 379, 380, 381; same data as holotype (GenBank accession numbers: **OR689585, OR689586, OR689587, OR689588**).

Diagnosis. *Oxynoemacheilus araxensis*, *O. argyrogramma*, *Oxynoemacheilus arsanius* Freyhof, Kaya, Turan & Geiger, 2019, *Oxynoemacheilus bergianus* (Derjavin, 1934), *O. euphraticus*, *Oxynoemacheilus kaynaki* Erk'akan, Özeren & Nalbant, 2008, *Oxynoemacheilus muefti* Freyhof, Kaya, Turan & Geiger, 2019, *Oxy-noemacheilus paucilepis* (Erk'akan, Nalbant & Özeren, 2007), and *Oxynoemacheilus tigris* (Heckel, 1843) are other species of *Oxynoemacheilus* known from the Euphrates drainage (Fig. 5). *Oxynoemacheilus chaboras*, is distinguished from these by a combination of characters, none of them unique to the species.

Oxynoemacheilus chaboras belongs to a group of species (*O. argyrogramma*, *O. chaboras*, *O. euphraticus*) having two bold, black, round or comma-shaped blotches on the caudal-fin base (vs. absent in *Oxy-noemacheilus araxensis*, *O. arsanius*, *O. bergianus*, *O. kaynaki*, *O. muefti*, *O. paucilepis*, and *O. tigris*). Furthermore, male *O. chaboras* have a suborbital groove (as in *O. araxensis* and *O. bergianus* vs. absent in *O. arsanius*, *O. kaynaki*, *O. muefti*, *O. paucilepis*, and *O. tigris*).

Oxynoemacheilus chaboras is further distinguished from *O. araxensis* by having a forked caudal fin (vs. slightly emarginate), and it is further distinguished from *O. bergianus* by having a forked caudal fin (shortest middle caudal-fin ray is 57–70% of longest ray of the upper caudal-fin lobe, vs. deeply emarginated, 70–84), and a deeper caudal peduncle (depth 1.4–1.7 times in its length vs. 1.7–3.5).

Oxynoemacheilus chaboras is distinguished from *O. argyrogramma* and *O. euphraticus* by possessing a mid-lateral series of blotches (vs. marbled or mottled pattern in *O. argyrogramma*), without a mottling pattern above or below the blotches in front of dorsal-fin base (vs. irregularly mottled or marbled in *O. euphraticus*), and having no, or a very short, incision in the upper lip (vs. a deep median incision in *O. euphraticus*). It is further distinguished from *O. euphraticus* by having a deeper caudal peduncle (caudal-peduncle depth 1.4–1.7 times in its length vs. 2.0–2.8).

Description. See Figs 2–4 for general appearance and Table 2 for morphometric data. Small-sized and slender species. Body deepest at dorsal fin origin or slightly anterior of it. Body width greatest at pectoral-fin base. Section of head roundish, flattened on ventral surface, straight or slightly convex in interorbital space, convex on snout. Snout blunt. Caudal peduncle compressed laterally, 1.4–1.7 times longer than deep. Pelvic axillary lobe shallow and fully attached to flank. Pelvic-fin origin below second or third branched dorsal-fin ray. Anal-fin origin located in front of vertical of midline between dorsal and caudal-fin origins. Pectoral fin reaching to approximately 72–99% of distance from pectoral-fin origin to pelvic-fin origin. Pelvic

Table 1. The interspecies genetic distances calculated by the uncorrected *p*-distance model for the *Oxynoemacheilus* species of Euphrates-Tigris and other *O. persa* species group.

Species	1	2	3	4	5	6	7	8	9	10
1 <i>O. chaboras</i>										
2 <i>O. euphraticus</i>	0.0324									
3 <i>O. shehabi</i>	0.0382	0.0300								
4 <i>O. persa</i>	0.0382	0.0265	0.0423							
5 <i>O. marunensis</i>	0.0455	0.0340	0.0431	0.0431						
6 <i>O. hanae</i>	0.0455	0.0349	0.0374	0.0439	0.0285					
7 <i>O. kurdistanicus</i>	0.0463	0.0366	0.0455	0.0512	0.0268	0.0301				
8 <i>O. kentrutensis</i>	0.0472	0.0356	0.0415	0.0480	0.0390	0.0366	0.0415			
9 <i>O. zagrosensis</i>	0.0488	0.0323	0.0480	0.0480	0.0260	0.0268	0.0220	0.0374		
10 <i>O. sarus</i>	0.0488	0.0358	0.0415	0.0431	0.0520	0.0480	0.0545	0.0504	0.0537	
11 <i>O. argyrogramma</i>	0.0507	0.0406	0.0509	0.0472	0.0388	0.0390	0.0388	0.0480	0.0363	0.0604
12 <i>O. zarzianus</i>	0.0512	0.0395	0.0488	0.0423	0.0325	0.0341	0.0390	0.0415	0.0350	0.0545
13 <i>O. chomanicus</i>	0.0512	0.0332	0.0455	0.0488	0.0268	0.0309	0.0260	0.0415	0.0187	0.0545
14 <i>O. karunensis</i>	0.0520	0.0414	0.0488	0.0374	0.0593	0.0537	0.0577	0.0577	0.0569	0.0472
15 <i>O. araxensis</i>	0.0772	0.0706	0.0764	0.0732	0.0854	0.0829	0.0837	0.0724	0.0854	0.0732
16 <i>O. kaynaki</i>	0.0789	0.0683	0.0715	0.0764	0.0772	0.0780	0.0780	0.0756	0.0732	0.0894
17 <i>O. arsaniasus</i>	0.0821	0.0716	0.0715	0.0780	0.0756	0.0764	0.0748	0.0740	0.0691	0.0854
18 <i>O. tigris</i>	0.0821	0.0688	0.0699	0.0748	0.0789	0.0780	0.0846	0.0724	0.0780	0.0813
19 <i>O. muefifi</i>	0.0894	0.0796	0.0821	0.0846	0.0862	0.0854	0.0878	0.0813	0.0756	0.0967
20 <i>O. paucilepis</i>	0.1024	0.0948	0.0878	0.0976	0.0951	0.0959	0.0935	0.0870	0.0927	0.0967
21 <i>O. bergianus</i>	0.1122	0.1156	0.1220	0.1122	0.1228	0.1171	0.1146	0.1098	0.1146	0.1179
	11	12	13	14	15	16	17	18	19	20
1 <i>O. chaboras</i>										
2 <i>O. euphraticus</i>										
3 <i>O. shehabi</i>										
4 <i>O. persa</i>										
5 <i>O. marunensis</i>										
6 <i>O. hanae</i>										
7 <i>O. kurdistanicus</i>										
8 <i>O. kentrutensis</i>										
9 <i>O. zagrosensis</i>										
10 <i>O. sarus</i>										
11 <i>O. argyrogramma</i>										
12 <i>O. zarzianus</i>	0.0455									
13 <i>O. chomanicus</i>	0.0390	0.0358								
14 <i>O. karunensis</i>	0.0515	0.0650	0.0537							
15 <i>O. araxensis</i>	0.0808	0.0748	0.0862	0.0862						
16 <i>O. kaynaki</i>	0.0705	0.0748	0.0683	0.0902	0.0878					
17 <i>O. arsaniasus</i>	0.0721	0.0732	0.0683	0.0902	0.0846	0.0228				
18 <i>O. tigris</i>	0.0770	0.0732	0.0715	0.0894	0.0862	0.0423	0.0488			
19 <i>O. muefifi</i>	0.0851	0.0813	0.0829	0.1024	0.0967	0.0220	0.0358	0.0512		
20 <i>O. paucilepis</i>	0.0981	0.0992	0.0943	0.1008	0.0878	0.0992	0.0959	0.0943	0.1033	
21 <i>O. bergianus</i>	0.1187	0.1203	0.1106	0.1163	0.1057	0.1098	0.1114	0.1203	0.1154	0.1008

fin reaching to genital papillae, rarely to anus; not reaching vertical of tip of last dorsal-fin ray. Anus about 40–70% of an eye diameter anterior to anal-fin origin. Anal fin not reaching caudal-fin base. No dorsal or ventral adipose crest on caudal peduncle. Largest known individual 60 mm SL.

Dorsal fin with 9½–10½ branched rays, outer margin straight or slightly concave. Anal fin with 5½ branched rays, outer margin straight. Pectoral fin with 9–11 branched rays, outer margin straight or slightly convex, tip pointed in male. Pelvic fin with 6 branched rays, outer margin straight or slightly convex. Caudal fin forked with (8+8)9+8 branched rays, lobes pointed. Flank and back covered by cycloid scales. Chest and belly without scales. Lateral line complete, terminating between origin of hypural complex and caudal fin base. Anterior nostril opening at end of a low, ovoid, flap-like tube. Posterior tip of anterior nostril overlapping posterior nostril when

folded backwards. One central pore and one lateral pore on each side of supratemporal head canal, 3(4) + 9–10 pores in infraorbital canal, 8–9 pores in supraorbital canal, and 9–10 pores in mandibular canal. A suborbital groove in male. Mouth small, arched. Lips thick without furrows, lower lip thicker than upper lip. A median interruption in lower lip. Upper lip without median incision, rarely with a very small and short median incision. *Processus denticiformis* narrow and rounded. Lower jaw rounded, without median notch. Barbels long; inner rostral barbel reaching base of maxillary barbel, outer reaching to vertical of posterior of anterior eye margin. Maxillary barbel reaching or almost reaching to vertical of posterior eye-margin.

Coloration. Body with yellowish or cream background and dark-brown pattern in live and preserved individuals. Preserved individuals with a dark-grey, narrow inner-axial stripe, absent in life. Dorsal head and upper



Figure 2. *Oxynoemacheilus chaboras*, FFR 15646, holotype, 53 mm SL; Türkiye: stream Beyazsu.

part of cheek brown, with marbled pattern. Ventral surface of head yellowish without pattern. Flank with 6–10 dark-brown bars or blotches, as much as, or thicker than, interspaces. Bars and blotches irregularly shaped and set, generally vertically elongated, sometimes oval, or horizontally elongated, usually extending to mid-dorsal saddles and meeting contra laterals. Back with 1–3 predorsal saddles, one saddle at dorsal-fin origin and one at posterior dorsal-fin base, and 3 saddles behind dorsal fin, as much as or thicker than interspaces. One dark-brown or black blotch at lower caudal-fin base, a second, much smaller blotch at uppermost caudal-fin base, both distinct in both live and preserved individuals. Dorsal, caudal and pectoral fins with many, small brown blotches on rays. These blotches forming 2–3 narrow bands on dorsal, and 3–5 on caudal. Pectoral, anal and pelvic fins hyaline, sometimes with a few dark-brown blotches on rays.

Distribution. The species known from the stream Beyazsu in the Euphrates drainage (Figs 6, 7).

Etymology. The species is named *Chaboras*, an ancient Greek name of the Khabur (Χαβώρας), as it was

first documented by Ptolemy and Pliny the Elder ichthyofauna. A noun in genitive, indeclinable.

Discussion

Following our molecular analysis, *Oxynoemacheilus chaboras* belongs to the *O. persa* species group as defined by Freyhof and Geiger (2021). Within the *O. persa* species group, *O. chaboras* belongs to a group of species (*O. argyrogramma*, *O. euphraticus*, *O. hanae*, *O. karunensis*, *O. kurdistanicus*, *O. marunensis*, *O. persa*, *O. sarus*, and *O. shehabi*) that have a deeply emarginate or forked caudal fin (vs. slightly emarginate or truncate in *O. chomanicus*, *O. kentritensis*, *O. zagrosensis*, and *O. zarzianus*) and in which the male has a suborbital groove (vs. absent in *O. chomanicus*, *O. kentritensis*, *O. zagrosensis*, and *O. zarzianus*).

Oxynoemacheilus chaboras is most closely related to *O. shehabi* from the upper Orontes, *O. sarus* from the Seyhan and Ceyhan, *O. euphraticus* from the Euphrates and

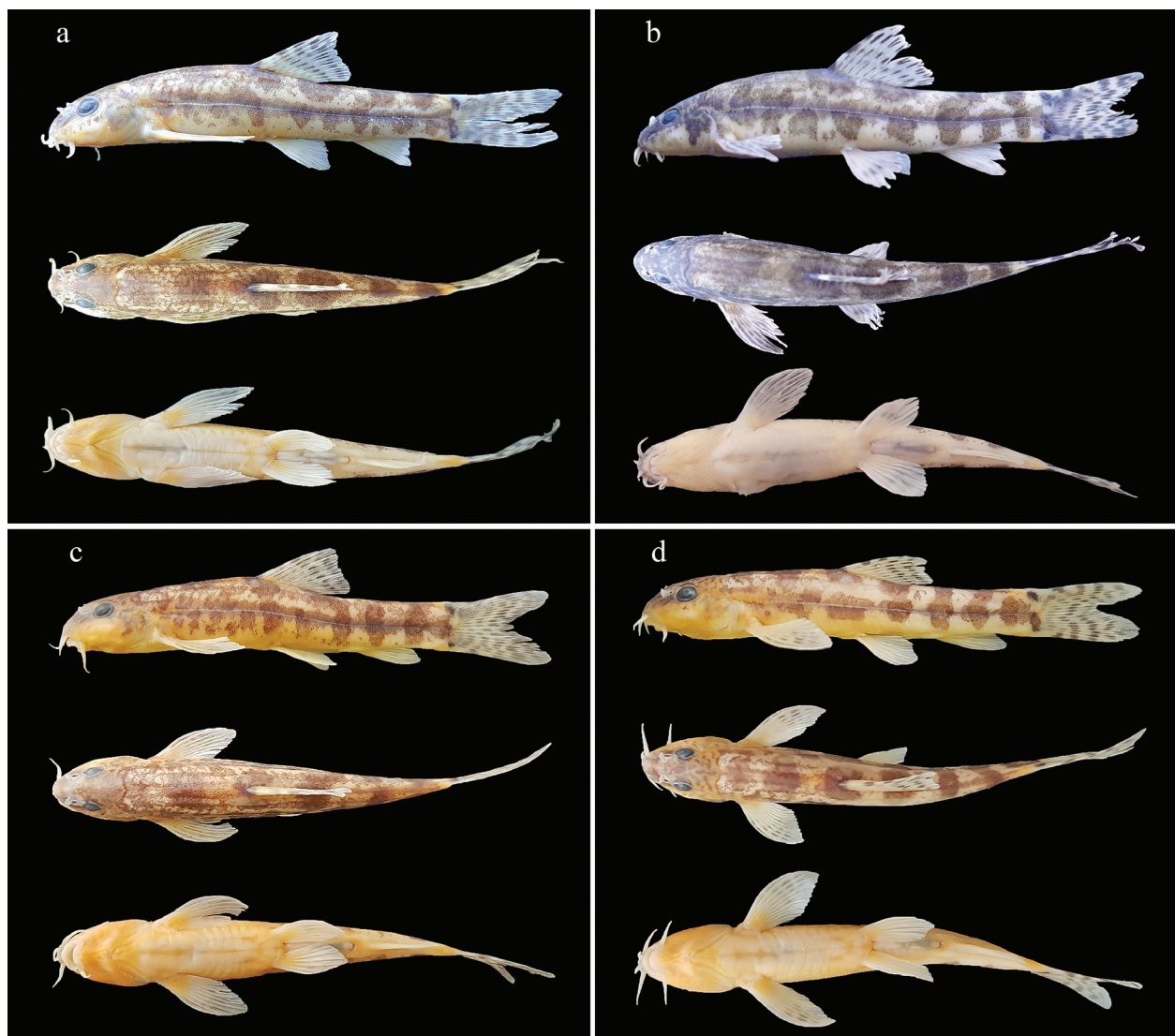


Figure 3. *Oxynoemacheilus chaboras*, paratypes, stream Beyazsu. **a.** FFR 1428, 50 mm SL; **b.** FFR 15633, 51 mm SL; **c.** FFR 1428, 50 mm SL; **d.** FFR 1428, 49 mm SL.



Figure 4. *Oxynoemacheilus chaboras*, FFR 15633, paratype, 51 mm SL; Türkiye: stream Beyazsu.

Tigris, *O. karunensis* from the Karkheh, and *O. persa* from Central Iran. *Oxynoemacheilus argyrogramma*, *O. hanae*, *O. kurdistanicus*, *O. marunensis* are placed in a second cluster of species within the *O. persa* species group and are not closely related. While all these species are well-supported in

our molecular analysis (Table 1), their phylogenetic relationships are poorly supported in our phylogenetic tree (Fig. 1).

Oxynoemacheilus chaboras is distinguished from *O. shehabi* and *O. sarus* by possessing 8–9 pores in the supraorbital canal (vs. 5–7), a rudimentary and shallow

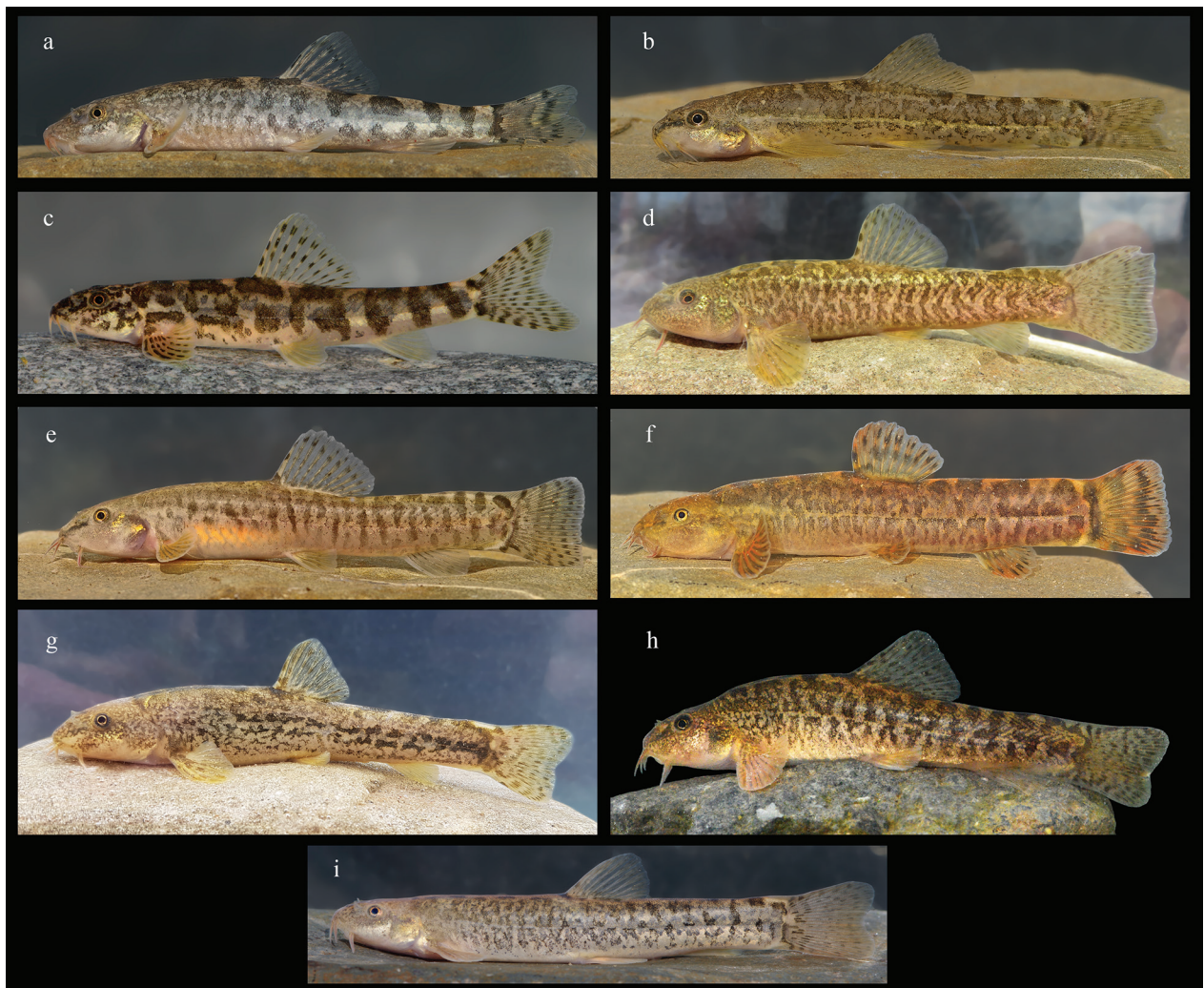


Figure 5. *Oxynoemacheilus* species in the Euphrates drainages: **a.** *O. bergianus*, stream Sason, 61 mm SL; **b.** *O. argyrogramma*, stream Sünnepe, 50 mm SL; **c.** *O. euphraticus*, Great Zap River, 55 mm SL; **d.** *O. muefti*, Murat River, 69 mm SL; **e.** *O. tigris*, stream Sünnepe, 55 mm SL; **f.** *O. kaynaki*, Göksu River, 68 mm SL; **g.** *O. paucilepis*, stream Balıklıtohma, 70 mm SL; **h.** *O. arsaniasus*, stream Kaleli, 90 mm SL; **i.** *O. araxensis*, stream Arkaçaylılar, 71 mm SL.

pelvic axillary lobe fully attached to the body (vs. well-developed with a free tip), a deeper body (body depth at dorsal fin origin 17–22% SL vs. 14–17 in *O. shehabii*), deeper caudal peduncle (10–12% SL vs. 8–9 in *O. shehabii*), deeper head (head depth at eye 51–60% HL vs. 44–51 in *O. sarus*) and a longer anal fin (anal-fin height 18–22% SL vs. 16–19 in *O. sarus*). It is distinguished from *O. hanae* by lacking isolated patches of dark-brown spots or blotches on the lower part of the flank (vs. present) and possessing two distinct black blotches at the caudal-fin base (vs. usually absent or very small, overlaid by a chevron shaped bar).

The new species is distinguished from *O. karunensis* and *O. persa* by lacking the dense mottling in the interspaces between the blotches on the flank in almost all individuals (vs. very dense mottling in all individuals), possessing a deeper caudal peduncle (caudal peduncle depth 1.4–1.7 times in its length vs. 1.7–3.1 in *O. karunensis*), and two distinct black blotches at the caudal-fin base (vs. two very large blotches, usually fused to an irregularly shaped bar in *O. persa*).

We were not able to compare *O. chaboras* to *O. marunensis* as we had no materials available. We noted that the description of this species by Sayyadzadeh and Esmaeili (2020) is solely based on juvenile individuals. This limitation made it impossible to make definitive statements about the adult colour pattern and some other character states of *O. marunensis*. *Oxynoemacheilus chaboras* is distinguished from *O. marunensis*, based on Sayyadzadeh and Esmaeili (2020), by possessing a deeper body (body depth at dorsal-fin origin 17–22% mm SL vs. 14–18), a narrower interorbital width (18–24% mm HL vs. 23–31), and 9+8 branched caudal-fin rays (vs. 8+7 or 8+8). It should be noted that *O. marunensis* is only distantly related to *O. chaboras*. The mean genetic distance between these species is 4.55%.

Oxynoemacheilus chaboras is distinguished from *O. kurdistanicus* by possessing no, or rarely, a very short incision in the upper lip (vs. usually a deep, rarely a shallow median incision), and a series of mid-lateral blotches disconnected from the saddles on the back below the

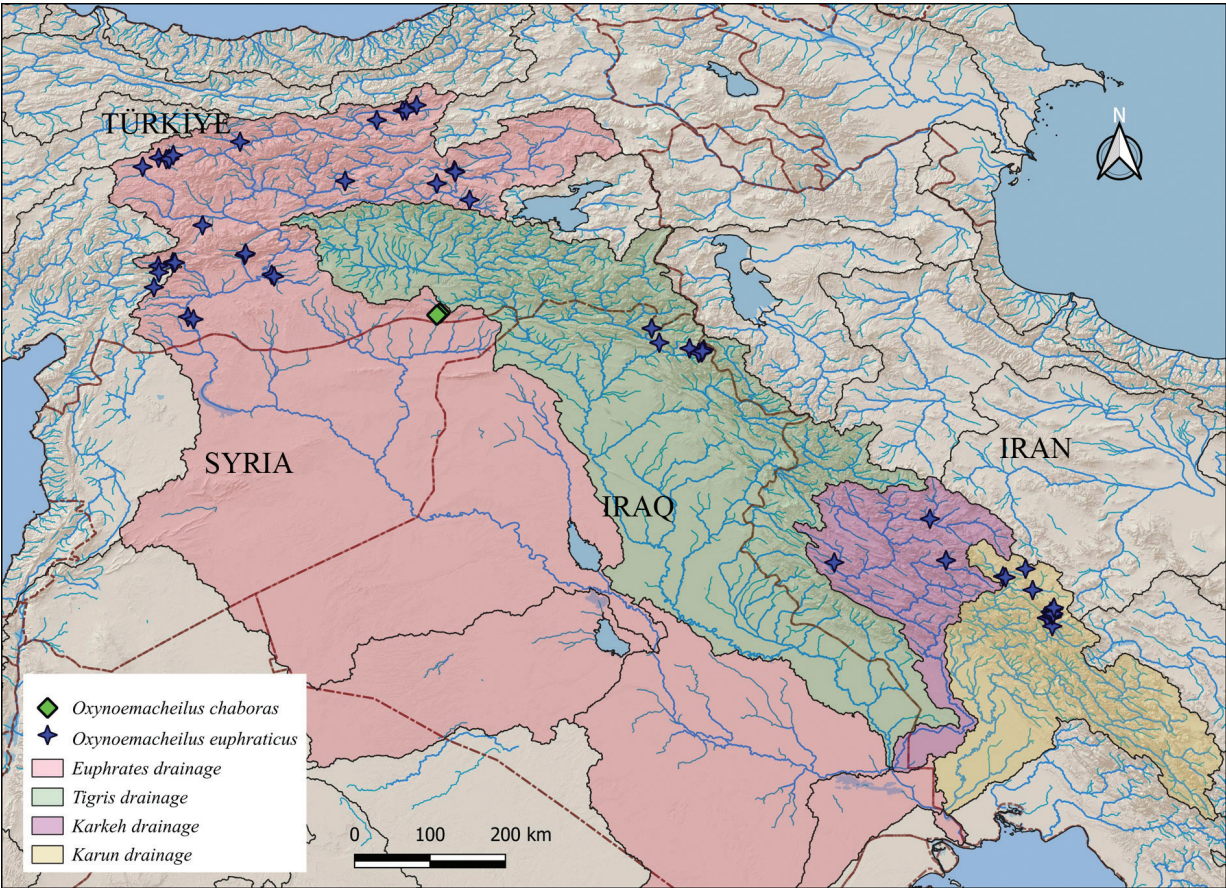


Figure 6. Distribution map of *Oxynoemacheilus chaboras* and *O. euphraticus*.

Table 2. Morphometric data of *Oxynoemacheilus chaboras* (holotype FFR 15646 and paratypes FFR 1428, n = 11).

	Holotype	min	max	mean	SD
Standard length (mm)	53	46	60	51.9	4.0
In percent of standard length					
Head length	24.2	23.0	25.0	24.1	0.6
Body depth at dorsal-fin origin	18.4	17.4	21.8	18.8	1.2
Predorsal length	50.9	47.4	51.1	49.7	1.2
Postdorsal length	35.8	33.8	37.4	35.5	1.2
Prepelvic length	51.2	49.6	55.5	52.1	1.2
Preanal length	72.7	72.7	78.7	75.7	1.8
Distance between pectoral and pelvic-fin origins	30.1	26.2	30.6	28.4	1.6
Distance between pelvic and anal-fin origins	21.4	21.4	25.2	22.8	1.0
Distance between vent and anal-fin origin	3.0	2.1	3.7	2.9	0.5
Dorsal-fin height	22.7	19.9	24.3	22.4	1.2
Anal-fin height	18.9	15.8	19.2	17.9	1.0
Pectoral-fin length	24.1	21.8	26.7	24.2	1.7
Pelvic-fin length	18.7	16.5	19.3	18.1	0.8
Length of caudal peduncle	19.8	16.9	19.8	18.2	0.9
Depth of caudal peduncle	11.9	10.2	12.2	11.6	0.5
In percent of head length					
Head depth at eye	51	51	60	53.9	3.3
Maximum head width	59	59	66	63.2	2.6
Snout length	40	39	44	41.4	1.8
Eye diameter	19	19	23	20.6	1.4
Postorbital distance	45	40	50	45.2	2.7
Interorbital width	21	18	24	21.6	2.3
Length of inner rostral barbel	30	20	30	24.7	2.5
Length of outer rostral barbel	41	34	44	38.5	3.2
Length of maxillary barbel	40	33	44	39.6	3.3

dorsal-fin origin (vs. bars connected to saddles in most, but not all individuals). All *O. kurdistanicus* examined have a pattern of bars on flank, while most *O. chaboras* have a series of mid-lateral blotches usually narrowly connected to saddles. In *O. chaboras*, this pattern is usually formed by two wide and dark elements (blotch and saddle) connected by a narrower and paler field of pigments while in *O. kurdistanicus* (and *O. euphraticus* and *O. marunensis*), bars are usually (not always) regularly shaped and not wider along the lateral midline.

Comparative materials

Oxynoemacheilus araxensis ZMH 4827, holotype, 61 mm SL; ZMH 4826, paratypes, 5, 36–50 mm SL; ZMH 5951, paratypes, 4, 44–64 mm SL; Türkiye: Erzurum prov.: Kandili Karasu, Euphrates drainage.—FFR 1354, 11, 66–90 mm SL Türkiye: Erzurum prov.: stream Sırlı at Ilıca 40.2130°N, 41.0699°E.—FFR 1451, 2, 68–75 mm SL; Türkiye: Erzurum prov.: stream Ağarcık at Ilıca, 40.2460°N, 41.0710°E.—FFR 1468, 12, 53–70 mm SL; Türkiye: Erzurum prov.: stream Baş about 1 km west of Çayköy, 39.9470°N, 40.8040°E.—FSJF 3440, 6, 42–71 mm SL; Türkiye: Erzurum prov.: stream Arkaçayırılar at Paşayurdu, 39.9833°N, 40.9920°E.

Oxynoemacheilus argyrogramma FFR 15516, 26, 37–49 mm SL; Türkiye: Kilis prov.: stream Sünnepe at



Figure 7. Type locality of *Oxynoemacheilus chaboras*.

northeastern Küplüce, 36.7640°N, 37.2540°E.—FFR 1574, 14, 41–62 mm; FFR 1448, 11, 37–48 mm SL; Türkiye: Gaziantep prov.: stream Merziman about 3 km south of Yavuzeli, 37.2910°N, 37.5730°E.

Oxynoemacheilus arsaniasus FFR 15531, paratypes, 5, 36–54 mm SL; Türkiye: Muş prov.: stream Kaynarca at Tepe, 39.1070°N, 41.4920°E.—FFR 1449, 1, 49 mm SL; Türkiye: Muş prov.: stream Kaynarca about 3 km southeast Tepe, 39.0680°N, 41.5290°E.—FSJF 4019, 12, 46–97 mm SL; Türkiye: Bitlis prov.: Reservoir of stream Karasu in Kaleli, 38.5537°N, 42.0257°E.

Oxynoemacheilus bergianus FFR 1577, 19, 54–62 mm SL; Türkiye: Samsun prov.: stream Soruk 20 km east of Vezirköprü, 41.1189°N, 35.2269°E.—FFR 15561, 9, 35–69 mm SL; Türkiye: Kayseri prov.: stream Sarnaz a drainage of stream Zamantı at Taşçı, 38.1953°N, 35.7805°E.—FSJF 2983, 15, 38–77 mm SL; Türkiye: Kayseri prov.: stream Zamantı at Pınarbaşı, 38.7366°N, 36.4131°E.—FFR 1457, 11, 64–72 mm SL; Türkiye: Malatya prov.: stream Sultansuyu 8 km east of Akçadağ, 38.3388°N, 38.0620°E.—FFR 1467, 28, 54–64 mm SL; Türkiye: Erzurum prov.: stream Baş 10 km east of Aşkale, 39.9478°N, 40.8040°E.—FFR 15506, 25, 33–59 mm SL; Türkiye: Ağrı prov.: Murat River 17 km west of Taşlıçay, 39.6785°N, 43.1887°E.

Oxynoemacheilus chomanicus FSJF 3644, 5, 33–61 mm SL; Iraq: Choman River at Alut, 35.9563°N, 45.6155°E.

Oxynoemacheilus euphraticus FFR 1434, 1, 56 mm SL; Türkiye: Sivas prov.: Euphrates at İliç, 39.4850°N, 38.5850°E.—FFR 1471, 25, 27–63 mm SL; Türkiye: Sivas prov.: stream Kangal about 1 km west of Çetinkaya, 39.2560°N, 37.6250°E.—FFR15520, 14, 41–57 mm SL; Malatya prov.: stream Sultan Suyu about 7 km east of Akçadağ, 38.3390°N, 38.0620°E.—FFR 15508, 13, 53–70 mm SL; Türkiye: Adıyaman prov.: stream Göksu at Düzbağ, 37.7950°N, 37.4710°E.

Additional distribution records

Own data: 39.9124°N, 40.8540°E. 39.9094°N, 40.8028°E. 36.943333°N, 44.19533°E. 39.2516°N, 37.6189°E. 38.9500°N, 40.0166°E. 38.9166°N, 41.2666°E. 39.2515°N, 37.6189°E. 39.2515°N, 37.6189°E. 39.2515°N, 37.6189°E. 39.2515°N, 37.6189°E. 38.9167°N, 41.2667°E. 39.3013°N, 37.6743°E. 37.8370°N, 37.6848°E. 39.1439°N, 37.2571°E. 39.2516°N, 37.6189°E. 36.9433°N, 44.1953°E. 37.7950°N, 37.4705°E. 37.8444°N, 37.6702°E. 37.6500°N, 39.0500°E. 37.0666°N, 37.9500°E. 39.9833°N, 40.9920°E. 36.7484°N, 44.2997°E. 36.9433°N, 44.1953°E. 36.6164°N, 44.8781°E. 36.6106°N, 44.8381°E. Saygun et al. (2021): 37.8369°N, 37.6848°E. 39.0956°N, 41.5054°E. 39.4850°N, 38.5850°E. 39.2561°N, 37.6251°E. 39.2463°N, 37.5807°E. 37.9409°N, 38.6470°E. 37.8391°N, 37.6977°E. 37.7052°N, 37.4790°E. 37.5021°N, 37.4108°E. Çiçek et al. (2022): 39.7800°N, 40.4486°E. Rakıcı et al. (2020): 39.0741°N, 41.5195°E. 38.6928°N, 41.7142°E. 39.2672°N, 37.4748°E. 38.3471°N, 38.0737°E. 37.8392°N, 37.6766°E. 37.9635°N, 38.6624°E. Krupp (1985): 37.1006°N, 37.8758°E. 37.6742°N, 39.0158°E. Jouladeh Roudbar et al. (2016): 33.1382°N, 49.6788°E. 33.1182°N, 49.6676°E. 33.7846°N, 48.2068°E. 33.7820°N, 48.2080°E. 33.5507°N, 49.0207°E. 33.0108°N, 49.6478°E. 33.0674°N, 49.6500°E. 33.0559°N, 49.6701°E. 32.9988°N, 49.5823°E. 33.7543°N, 46.6847°E. 34.3478°N, 47.9885°E. Zare-Shahraki et al. (2022): 33.5647°N, 48.9855°E. 33.3783°N, 49.3888°E. 33.0819°N, 49.6319°E. 33.0570°N, 49.6668°E. 32.8860°N, 49.6560°E. 32.9997°N, 49.5888°E. 33.0322°N, 49.6564°E. Musa and Abdulrahman (2023): 36.6705°N, 44.71154°E. 36.6553°N, 44.9055°E. 36.6325°N, 44.8884°E.

Oxynoemacheilus hanae ZFMK 103020, holotype, 57 mm SL; FSJF 3359, paratypes, 22, 46–61 mm SL; Iraq: stream Zalm south of Taparezina, 35.3064°N, 45.9705°E.—FSJF 3641, 63, 34–61 mm SL; Iraq: stream Zalm south of Taparezina, 35.3064°N, 45.9705°E.

Oxynoemacheilus karunensis FSJF 3525, 8, 33–55 mm SL; Iran: Hamadan prov.: Gamasiab River at Do Ab, 47.9167°N, 34.3724°E.—FSJF 3523, 6, 34–51 mm SL; Iran: Hamadan prov.: Haram Abad River at Ashmizan, 34.1105°N, 48.8704°E.—FSJF 3524, 7, 37–53 mm SL; Hamadan prov.: Dehno stream about 2 km south-west of Nahavand, 48.3532°N, 34.1691°E.—FSJF 3526, 2, 30–40 mm SL; Iran: Hamadan prov.: Gamasiab River at Chesme Mahi, 34.3382°N, 48.0324°E.—SMF IR7, 3, 36–44 mm SL; Iran: Khozestan prov.: Marun River near Behbahan, 30.6567°N, 50.1883°E.

Oxynoemacheilus kentritensis FFR 1566, holotype, 67 mm SL; Türkiye: FFR 01403, paratypes, 3, 57–68 mm SL; Bitlis prov.: stream Kesan about 1 km south of Güntepe, 38.3566°N, 42.6275°E.—FSJF

- 3645, paratypes, 3, 65–79 mm SL; Türkiye: Bitlis prov.: stream Horozdere east of Hizan, 38.2447°N, 42.4791°E.—FSJF 3646, paratypes, 2, 68–70 mm SL; Türkiye: Bitlis prov.: stream Oraniz about 1 km east of Dönertaş, 38.3141°N, 42.5655°E.
- Oxynoemacheilus kurdistanicus*** FSJF 3369, 28, 40–61 mm SL; Iraq: Nalparez River, 35.5707°N, 45.8630°E.—FSJF 3347, 25, 50–62 mm SL; Iraq: stream north-west of Saburawa, a tributary of Tabin River, 35.8336°N, 45.1044°E.—FSJF 3353, 9, 40–61 mm SL; Iraq: stream KunaMassi in Sevanja, 35.7892°N, 45.4030°E.—FSJF 3373, 54, 35–62 mm SL; Iraq: stream Suraw near Suraw village, 35.7626°N, 45.9848°E.—FSJF 3643, 15, 36–62 mm SL; Iraq: Choman River at Alut, 35.9564°N, 45.6155°E.
- Oxynoemacheilus muefti*** FFR 15507, paratypes, 2, 29–45 mm SL; Ağrı prov.: Türkiye: Murat River at Ballıbostan; 39.6780°N, 43.1890°E.—FFR 1432, 7, 42–63 mm SL, Ağrı prov.: Türkiye: Murat River at Taşlıçay; 39.6460°N, 43.3670°E.—FSJF 3444, 4, 33–46 mm SL; Türkiye: Ağrı prov.: Murat River at Ballıbostan, 12 km east of Ağrı, 39.6789°N, 43.1896°E.—FSJF 2556, 3, 45–47 mm SL; Türkiye: Adıyaman prov.: stream Eğri south of Adıyaman, tributary to Atatürk Reservoir, 37.7417°N, 38.3351°E.—IUSHM 2019-1410, 3, 37–68 mm SL; Türkiye: Ağrı prov.: stream near Sarıköy, 16 km west of Eleşkirt, 39.8016°N, 42.4816°E.—IUSHM 2019-1411, 3, 43–52 mm SL; Türkiye: Ağrı prov.: Murat River at Balıbostan, 12 km east of Ağrı, 39.6789°N, 43.1896°E.
- Oxynoemacheilus paucilepis*** FFR15510, 10, 34–73 mm SL; Türkiye: Sivas prov.: stream Balıklıtohma about 3 km south of Kocakurt, 39.1440°N, 37.2570°E.—FFR15521, 15, 41–76 mm SL; Türkiye: Sivas prov.: stream Balıklıtohma at Kuruayşe, 39.2070°N, 37.2010°E.—FSJF 2852, 50, 24–39 mm SL; Türkiye: Sivas prov.: stream Tersakan about 15 km southwest of Kangal, 39.1439°N, 37.2571°E.
- Oxynoemacheilus persa*** NMW 48567, holotype, 50 mm SL; Iran: spring at Persepolis.—FSJF 3214 (earlier IZA 7826), 25 paratypes of *O. farsicus*, 34–56 mm SL; Iran: Fars prov.: Shur River at Dasht-e-Arzhan, a tributary of Mond River.—FSJF 2245, 44, 31–65 mm SL; Iran: Fars prov.: Kor River about 73 km north of Shiraz, 30.1936°N, 52.4657°E.
- Oxynoemacheilus sarus*** FFR 15585, holotype, 52.5 mm SL; FFR 15522, paratypes, 4, 39–54 mm SL; Türkiye: Adana prov.: lower stream Çakıt, south of Salbaş, 37.1031°N, 35.1094°E.—FSJF 2327, paratypes, 10, 32–49 mm SL; Türkiye: Adana prov.: lower stream Çakıt, south of Salbaş, 37.0961°N, 35.1170°E.—FSJF 2377, paratypes, 2, 48–49 mm SL; Türkiye: Adana prov.: stream Körkün at Karakuyu, 37.1529°N, 35.1606°E.—FFR 15586, 3, 47–51 mm SL; Türkiye: Kahramanmaraş Prov.: stream Aksu at 8 km northeast of Pazarcık, 37.5390°N, 37.3480°E.—FSJF 2567, 1, 48 mm SL; Türkiye: Adıyaman prov.: stream Çelik at road south of Gölbaşı, 37.6239°N, 37.5034°E.

Oxynoemacheilus shehabi ZFMK ICH 124181, holotype, 46.3 mm SL; ZFMK ICH-125126-28, paratypes, 3, 41.5–47.6 mm SL; Syria: Orontes at Al Qusayr, 34.5086°N, 36.5389°E.

Oxynoemacheilus zarzianus FSJF 3352, 28, 39–69 mm SL; Iraq: stream Kunamasi in Sevanja, 35.7892°N, 45.4030°E.—FSJF 3348, 16, 46–68 mm SL; Iraq: stream in Merga village, 36.0515°N, 45.0945°E.—FSJF 3651, 18, 54–75 mm SL; Iraq: stream Kunamasi in Kunamasi, 35.7967°N, 45.4136°E.—FSJF 3372, 30, 43–71 mm SL; Iraq: stream Suraw near Suraw village, 35.7626°N, 45.9848°E.

Acknowledgments

Authors would like to thank Fadil Kaya (Bitlis) for his help during the fieldwork. We also thank Müfit Özüluğ (IUSHM), Anja Palandacic (NMW), Serkan Wesel (ZFMK-ICH), and Ralf Thiel (ZMH) for allowing JF to examine materials under their care. Because the second author contributed to this manuscript at Bournemouth University, we would like to thank Bournemouth University for providing their facilities, and TÜBİTAK BİDEB (2219 Program) which supported her with one-year scholarships during her post-doc research at United Kingdom.

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