Review of the genus *Garra* Hamilton, 1822 in Iran with description of a new species: a morpho-molecular approach (Teleostei: Cyprinidae)

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Abstract: The Iranian species of the genus *Garra* are reviewed, and diagnoses are presented for all recognized species. *Garra gymnothorax*, *G. lorestanensis*, *G. mondica*, *G. nudiventris*, *G. persica*, *G. rossica*, *G. rufa*, *G. typhlops* and *G. variabilis* are considered valid. *Discognathus crenulatus* Heckel, 1847 is considered as a synonym of *G. rufa*. One new species is described, *Garra amirhosseini* from the Tigris River drainage in Iran distinguished from its congeners by having 7½ branched dorsal-fin rays, breast and belly with very small scales which are fully covered by a thick epidermal layer, and 9+8 branched caudal-fin rays. *Garra amirhosseini* is also distinguished from all other of congeners in the Persian Gulf basin except a species without a mental disc, *G. elegans*, by having two fixed, diagnostic nucleotide substitutions in the mtDNA COI barcode region. Maximum Likelihood based estimation of the phylogenetic relationships placed the sequenced fishes into 16 groups which showed between 0.62% (*Garra amirhosseini* vs. *Garra elegans*) and 17.6% (*Garra variabilis* vs. *Garra barreimiae*) K2P sequence divergence in their COI barcode region.

Keywords: *Garra amirhosseini* sp. n., Barcode region, Phylogenetic relationships, Middle East, Persian Gulf.

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Introduction
With 126 valid species, the genus *Garra* Hamilton, 1822 is one of the most diverse genera of the Labeoninae, and has a widespread distribution ranging from East Asia to Africa (Froese & Pauly 2016; Sayyadzadeh et al. 2015; Mousavi-Sabet & Eagderi 2016). In the western Palearctic, there are three *Garra* species groups, *G. variabilis* group, *G. tibanica* group and *G. rufa* group (Hamidan et al. 2014). The first group comprises *Garra variabilis* and *G. kalati* which are distributed in the Mediterranean and Persian Gulf basins with no record of *G. kalati* from Iran. The second group comprises *G. tibanica*, *G. smarti*, *G. buettikeri* and *G. dunsirei* from the Arabian Peninsula with no Iranian records. The *Garra rufa* group includes very diverse species distributed in the great Persian Gulf basin (Euphrates, Tigris, Persis, and Hormuz) and endorheic Lake Maharlu which once was connected to the Persian Gulf basin through the Paleo-Kor River (see Esmaeili et al. 2010, 2015a, b). Since the first revision of the genus *Garra* by Menon (1964), more than 10 new species have been described of which some were based on the squamation pattern, including *Garra mondica* in
the Garra rufa group described from the Mond River drainage in Iran (Sayyadzadeh et al. 2015). In this study, all Garra populations in Iran were analyzed for their morphological characters, squamation pattern, and sequenced for COI barcode region. We describe another new species in the Garra rufa group based on squamation pattern and some other morphological and molecular characters from a hot spring in the Tigris River drainage of Iran. A key to identification of species of the genus Garra is given.

**Material and Methods**

After anesthesia, fishes were fixed in 5% formaldehyde and later stored in 70% ethanol. Measurements were made with digital calipers and recorded to the nearest 0.1 mm. All measurements are made point to point, never by projections. Methods for counts and measurements follow Kottelat and Freyhof (2007). The terminology of the snout morphology and the oromandibular structures follow Stiassny & Getahun (2007) and Nebeshwar & Vishwanath (2013). Standard length (SL) is measured from the tip of the snout to the end of the last scales on the body in lateral line. The length of the caudal peduncle is measured from the insertion of the last anal-fin ray to the end 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". The holotype is included in the calculation of means and SD.

**Abbreviations**: SL, standard length; HL, lateral head length; K2P, Kimura 2-parameter. Collection codes: CMNFI, Canadian Museum of Nature, Ottawa; FSJF, Fischsammlung J. Freyhof, Berlin; NMW, Naturhistorisches Museum Wien, Vienna; ZIN, Laboratory of Ichthyology, Zoological Institute, Russian Academy of Sciences, St. Petersburg; ZM-CBSU, Zoological Museum of Shiraz University, Collection of Biology Department, Shiraz; ZMUC, Zoological Museum, University of Copenhagen.

**DNA extraction and PCR**: Genomic DNA was extracted using Macherey and Nagel NucleoSpin® Tissue kits following the manufacturer’s protocol on an Eppendorf EpMotion® pipetting-roboter with vacuum manifold. The standard vertebrate DNA barcode region of the COI (cytochrome c oxidase subunit 1) was amplified using a M13 tailed primer cocktail including FishF2_t1 (5’TGTAAAACGACGGCCAGTCAACCAACAAAGACATTGGCAC), FishR2_t1 (5’CAGGAAACAGCTATGACACCTCAGGGTGTCCGAA), VF2_t1 (5’TGTAAAACGACGGCCAGTTCAACCAACCACCACAAAGACATTGGCAC) and FR1d_t1 (5’CAGGAACAGCTATGACACCTCAGGGTGTCCGAA) (Ivanova et al. 2007). Sequencing of the ExoSAP-IT (USB) purified PCR product in both directions was conducted at Macrogen Europe Laboratories with forward sequencing primer M13F (5’GTAAAACGACGGCCAGTCAACCAACAAAGACATTGGCAC) and reverse sequencing primer M13R-pUC (5’CAGGAACAGCTATGACACCTCAGGGTGTCCGAA) (Ivanova et al. 2007). Sequencing of the ExoSAP-IT (USB) purified PCR product in both directions was conducted at Macrogen Europe Laboratories with forward sequencing primer M13F (5’GTAAAACGACGGCCAGTCAACCAACAAAGACATTGGCAC) and reverse sequencing primer M13R-pUC (5’CAGGAACAGCTATGACACCTCAGGGTGTCCGAA).

**Molecular data analysis**: Data processing and sequence assembly was done in Geneious Biomatters (2013) and the ClustalW algorithm (Higgins & Sharp 1988) was used to create a DNA sequence alignment. Modeltest (Posada & Crandall 1998), implemented in the MEGA 6 software (Tamura et al. 2011), was used to determine the most appropriate sequence evolution model for the given data, treating gaps and missing data with the partial deletion option under 95% site coverage cutoff. We generated maximum likelihood phylogenetic trees with 10,000 bootstrap replicates in RaxML software 7.2.5 (Stamatakis 2006) under the GTR+G+I model of nucleotide substitution, with CAT approximation of rate heterogeneity and fast bootstrap to explore species phylogenetic affinities. Bayesian analyses of nucleotide sequences were run with the parallel version of MrBayes 3.1.2 (Ronquist & Huelsenbeck 2003) on a Linux cluster with one processor assigned to each Markov chain under the most generalizing model (GTR+G+I) because overparametrization apparently does not negatively affect Bayesian analyses (Huelsenbeck & Ranala 2004). Each Bayesian analysis comprised two simultaneous runs of four Metropolis-coupled
Markov-chains at the default temperature (0.2). Analyses were terminated after the chains converged significantly, as indicated by the average standard deviation of split frequencies <0.01. We used the sequences of Iranian populations of *G. rufa* and all individuals of *G. persica*, *G. rossica*, *G. cf. gymnothorax* and *G. mondica* given in Sayyadzadeh et al. (2015) and also *G. amirhosseini* (in this study). In order to better understand the phylogenetic position of the studied species, we include records from the NCBI Genbank for *G. barreimiae*, *G. cf. longipinnis*, *G. jordanica*, *G. ghorensis*, *G. rufa*, *G. typhlops*, *G. variabilis* and *G. widdowsoni*.

Screening for diagnostic nucleotide substitutions was performed manually from the resulting sequence alignment. Estimates of evolutionary divergence over sequence pairs between species were conducted in Mega6 (Tamura et al. 2013). Analyses were conducted using the Kimura 2-parameter model (Kimura 1980). The rate variation among sites was modelled with a gamma distribution (shape parameter=1). Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated.

**Results**

We included COI barcode sequences for a total of 94 *Garra* individuals. Maximum Likelihood estimation of phylogenetic relationships based on mitochondrial COI barcode region place the sequenced fishes into 16 groups (Fig. 1), which show between 0.62% (*G. elegans* vs. *G. amirhosseini*) and 17.6% (*G. variabilis* vs. *G. barreimiae*) K2P sequence divergence in their COI barcode region. *Garra nudiventris*, *G. rossica* and *G. variabilis* are related and form a group well-separated from the other analysed species. *Garra amirhosseini*, *G. elegans*, *G. persica*, *G. rufa* and *G. widdowsoni*, form a separate monophyletic group. Table 1 lists the diagnostic nucleotide substitutions found in the 647 base pairs long mtDNA COI barcode region. Table 2 lists the average estimates of the evolutionary divergence between the *Garra* species recognized here as number of base substitutions per site.

**Key to species of *Garra* in Iran:**

1a – Subterranean species, body whitish or pink; eye absent ................................................. 2

1b – Epigean species, body brown or grey, usually mottled; eye fully developed ................................................. 3

2a – Mental disc absent; body naked ................................................. *G. typhlops*

2b – Mental disc present; body naked or scaled .... 4

3a – Mental disc absent .......... *G. elegans*

3b – Mental disc present ................................................. 5

4a – Body naked ..................... *G. lorestanensis*

4b – Body fully covered by scales or scales restricted to lateral midline ............... *G. widdowsoni*

5a – One (two short in some populations) pair of barbels ............................................. 6

5b – Two pairs of barbels ............................................. 7

6a – Predorsal mid-line region, breast and belly naked ............................................. *G. nudiventris*

6b – Predorsal mid-line region, breast and belly fully covered by scales or embedded scales ............. 8

7a – 8+8 branched caudal-fin rays .......... *G. persica*

7b – 9+8 branched caudal-fin rays .............. 9

8a – Head length shorter than caudal peduncle length and pectoral fin length .............. *G. variabilis*

8b – Head length longer than caudal peduncle length and pectoral fin length .............. *G. rossica*

9a – 7½ branched dorsal-fin rays, breast and belly naked or with very small scales covered by a thickish epidermal layer ................. 10

9b – Mostly 8½ branched dorsal-fin rays, breast naked or covered by both embedded and fully scales, belly usually covered by scales ......................... 11

10a – Mid-dorsal area in front of the dorsal-fin origin naked; breast, anterior belly naked ...... *G. mondica*

10b – Mid-dorsal area in front of the dorsal-fin origin always covered by embedded scales; breast and belly with very small scales covered by a thick epidermal layer ................. *G. amirhosseini*

11a – Breast naked (in Bashar population with hidden scales) .............. *G. gymnothorax*

11b – Breast partly covered by scales .......... *G. rufa*
Fig. 1. Maximum Likelihood (ML) estimation of the phylogenetic relationships based on the mitochondrial COI barcode region. Nucleotide positions with less than 95% site coverage were eliminated before analysis. Numbers of major nodes indicate bootstrap values from the Maximum Likelihood-, from 1000 pseudo-replicates followed by Bayesian posterior probabilities.
Table 1. Diagnostic nucleotide substitutions found in mtDNA COI barcode region of Garra species.

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<tr>
<th>Nucleotide position relative to Oryzias latipes complete mitochondrial genome (AP004421)</th>
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<tr>
<td>Nucleotide position</td>
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<td>G. widowsoni</td>
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<td>Garra sp. Kol</td>
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Genus Garra Hamilton, 1822

Type species: Cyprinus (Garra) lamta Hamilton, 1822 by subsequent designation of Bleeker (1863: 192).

Type locality: Behar Province and Rapti River, Gorakhpur District, Uttar Pradesh, India.

Diagnosis: Among cyprinids Garra is phylogenetically all ally diagnosed by the following combination of apomorphic features: lower lip expanded posteriorly to form either an ovoid or circular callous pad or sectorial disc; vomero-palatine organ either vestigial or fully recessed; pectoral fins with the first two or more rays prominent and often unbranched; supraethmoid wider than long in dorsal aspect; and
Garra amirhosseini sp. n. (Figs. 2-10)

Holotype: ZM-CBSU H1216, 67.3mm SL; Iran: Ilam prov.: Sartang-e-Bijar hot spring at Mehran, Tigris River drainage, 33°46’16.3”N 45°56’17.2”E; G. Sayyadzadeh and A. Mansouri, 26 Oct 2015.

Paratypes: All from Iran. ZM-CBSU H1217, 6, 46-66mm SL; same data as holotype; ZM-CBSU J2791, 22, 40-60mm SL; Iran: Ilam prov.: Sartang-e-Bijar hot spring at Mehran, Tigris River drainage, 33°46’19.1”N 45°56’19.0”E; H.R. Esmaeili and M. Masoudi, 13 Sep. 2012.


Diagnosis: Garra amirhosseini sp. n. is distinguished from all other species of Garra in the rivers flowing to the Persian Gulf by having the breast and belly with very small scales which are fully covered by a thick epidermal layer (vs. naked breast in G. gymnothorax, naked breast and belly in G. mondica or vs. fully covered by normal scales without any covering layer). Garra amirhosseini is further distinguished from G. mondica by having a predorsal mid-line which is fully covered by scales or embedded scales (vs. naked or with 2-4 embedded scales at front of dorsal fin origin in a few individuals). Garra amirhosseini is further distinguished from G. rufa and G. gymnothorax by having usually 7½ branched dorsal-fin rays (vs.

Table 2. Estimates of evolutionary divergence (%) over sequence pairs between species found in the COI barcode region of Garra species studied.


cleithrum narrow and anteriorly elongate. In addition, the following combination of features distinguish Garra from other members of the labeonin subtribe Garraina: pharyngeal teeth in three rows, 2,4,5–5,4,2; dorsal fin with either 10 or 11 branched rays, inserted slightly in advance of pelvic fins; anal fin with 8-9 branched rays, situated well behind pelvic fins; diploid chromosome number 50 (see Stiassny & Getahun 2007).

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usually 8½). Garra amirhosseini is distinguished from all the congers included in this study except a species without mental disc G. elegans (vs. having mental disc in G. amirhosseini) by two fixed, diagnostic nucleotide substitutions, and a K2P nearest-neighbor distance of 0.62% to G. elegans.

Beside the breast and belly with very small scales fully covered by a thick epidermal layer, Garra amirhosseini is also distinguished from G. persica by having usually 9+8 caudal-fin rays (vs. usually 8+8). Garra amirhosseini is distinguished from G. rossica by having a fully developed mental disc (vs. reduced) and 16-20 total gill rakers on the first branchial arch (vs. 13-15), from G. variabilis by having a fully developed mental disc (vs. reduced) and two pairs of barbels (vs. one) and from G. typhlops and G. widdowsoni by having well-developed eyes and a brown and silvery colour pattern (vs. absence).

**Description:** General appearance of body is shown in Figures 2-10, and morphometric data are given in Table 3. Body elongated, moderately compressed laterally, more compressed in region of caudal peduncle. Dorsal head profile rising gently, flat or slightly convex, more or less continuous with dorsal body profile to nape or about middle between nape and dorsal-fin origin. Ventral profile more or less straight to anal-fin origin. Head moderately large and depressed, with slightly convex or flat interorbital distance; height at nape less than head length; width at nape greater or about equal to depth at nape. Snout
roundish; transverse lobe with 6-18 tubercles, demarcated posteriorly by a slightly shallow transverse groove in some individuals, no transverse groove in others. Proboscis covered with small or medium sized tubercles, largest on anterior margin of proboscis. Proboscis not, or only slightly, elevated from depressed rostral surface. Lateral surface of snout covered by small-sized tubercles reaching to anterior eye margin in some individuals, or to posterior nostril in others. Depressed rostral surface always without tubercles, anterior arm of depressed rostral surface not reaching to base of rostral barbel, clearly separating transverse lobe from lateral surface in large specimens. No groove between transverse lobe and lateral surface in some individuals. No head tubercles in juveniles and in a few adults. Eye placed dorso-laterally in anterior half or about mid-region of head. Barbels in two pairs; rostral barbel antero-laterally located, shorter or about equal to eye diameter; maxillary barbel at corner of mouth, shorter than rostral barbel. Well-developed disc with free lateral and posterior margins; which is heavily papillate with batteries of fleshy papillae arrayed around the periphery of the whole disc. Rostral cap well-developed, fimbriate, papillate on ventral surface. Upper lip present as a thin band of papillae arranged in two ridges. Upper jaw almost or completely covered by rostral cap. Disc elliptical, shorter than wide and narrower than head width through base of maxillary barbel; papillae on anterior

Fig.3. Garra amirhosseini, ZM-CBSU H1217, H1219, H1220, paratypes, a, 66.4mm SL, b, 58.9mm SL, and c, 54.9mm SL; Iran: hot Spring Sartang-e Bijar.
fold of same size, regularly arranged; groove between antero-median fold and central callous-pad
narrow and deep, papillae on inner half of whole
length of latero-posterior flap coarsely arranged;
anterior marginal surface of central callous pad
without or with sparsely arranged small papillae;
posterior margin of latero-posterior flap extending
vertical to middle of eye (Figs. 6-7).

Dorsal fin with 3 simple and 7½ branched rays,
last simple ray slightly shorter than head length;
distal margin concave; origin closer to snout tip than
to caudal-fin base; inserted anterior to vertical from
pelvic-fin origin; first branched ray longest; tip of last
branched ray reaching vertical to anus. Pectoral fin
with 1 simple and 12-13 branched rays, reaching to
a point 3-4 scales anterior to pelvic-fin origin, length
shorter or slightly equal to head length. Pelvic fin
with 1 simple and 7-8 branched rays, reaching to
anus, origin closer to anal-fin origin than to pectoral-fin origin, inserted below second or third branched
dorsal-fin ray. Anal fin short, with 3 simple and 5½
branched rays; first branched ray longest; distal
margin straight or slightly concave; origin closer to
pelvic-fin origin than to caudal-fin base. Anus 2-3
scales in front of anal-fin origin. Caudal fin forked
with 9+8 branched rays; tip of lobes pointed. Total
gill rakers on the first branchial arch 16-20 [16(5),
17(7), 18(2), 19(-), 20(1)]. Lateral line complete,
with 33-36 [33(4), 34(3), 35(4), 36(4)] scales on body
and 2-3 scales on caudal-fin base. Transverse scale
rows above lateral line 3½-4½; between lateral line
and pelvic-fin origin 3½ and between lateral line and
anal-fin origin 3½. Circumpeduncular scale rows 13-
14. Usually, 17-19 scales on predorsal midline
between dorsal-fin origin and nape which are deeply
embedded in many individuals and are uncountable.
Scales on flank regularly arranged. Chest and belly with very small scales which are fully covered by a thick epidermal layer. One short axillary scale at base of pelvic fin in some individuals, and 5-7, usually 5, scales between posteriormost pelvic-fin base and anus, embedded in skin in some individuals.

**Coloration:** In ethanol: Head, dorsum and flank dark gray. Single or groups of dark scales on flank. A very faint, irregularly-shaped mid-lateral stripe restricted to posterior flank or absent in some individuals. Mouth, chest and abdomen yellowish white. A wide black or dark brown bar at posteriormost caudal peduncle, faded in some individuals, bold, and 2-3 scales wide in others. Bar reaching dorsal midline in most individuals, not reaching ventral midline. A small black blotch at anteriormost lateral line. Lateral line pores cream whitish. Fins hyaline with irregularly set black spots on rays, darker and numerous in dorsal and caudal fins, or rays partly dusty grey or black. Base of last 2-6 branched dorsal-fin rays with a black spot more prominent in rays 3-5, hyaline in others. In life: Fins hyaline with black spots. Head grey. Flank scales dark grey with individual or groups of pale grey scales forming a mottled pattern; whitish or pale grey on ventral flank and belly. Iris silvery orange. A pale blue dot at anteriormost lateral line, forming a faded patch reaching down to upper pectoral-fin base in some individuals.

**Distribution:** Garra amirhosseini was found in a hot spring in the Tigris River drainage in Iran, the Sartang-e-Bijar Spring (Figs. 11, 31), which is situated about 70km north-west of Ilam.

**Etymology:** The species is named for Amirhossein son of the first author.

**Remarks:** Garra amirhosseini occurs in the Tigris.
River drainage in Iran with *G. rufa* and *G. gymnothorax*, while *G. rufa* is widespread, it has not been found in sympatry with *G. amirhosseini* which has been recorded from a hot spring only. Berg (1949) described *G. rufa gymnothorax* from the Iranian Karun drainage, a tributary of the lowermost Tigris, distinguishing *G. r. gymnothorax* from *G. r. rufa* by its naked breast (vs. scaled). Alexander Naseka (Dolsko) examined syntypes (ZIN 13214–15) of this nominal species for us (Fig. 12), and these fishes have indeed a naked breast as described by Berg (1949). Coad (1991) treated *G. r. gymnothorax* as a synonym of *G. rufa*. Our molecular data suggest that fishes from the Karun River drainage might represent a distinct species, as they form a separate molecular group, well differentiated from *G. rufa* (Fig. 1: *G. gymnothorax*). Within the Tigris River drainage in Iran, *Garra amirhosseini* is distinguished from the other two species by having the breast and belly with very small scales which are fully covered by a thick epidermal layer (vs. fully covered by normal scales without any covering layer in *G. rufa* or naked breast in *G. gymnothorax*) and by usually 7½ branched dorsal-fin rays (vs. 8½). In our molecular tree, the nearest group to *Garra amirhosseini*, is *G. elegans* which is also known from the Tigris River drainage. *Garra amirhosseini* is distinguished from *G. elegans* by having mental disc (vs. mental disc absent). *Garra amirhosseini*, is distinguished from *G. mondica* by having breast and belly covered with small scales (vs. naked), a predorsal midline which is fully covered by scales or
embedded scales (vs. naked or with 2-4 embedded scales at front of dorsal fin origin in few individuals). *Garra amirhosseini* differs from all the subterranean members of the genus *Garra* (*G. lorestanensis, G. typhlops and G. widdowsoni*) by presence of eyes and pigment (vs. lacking pigment and eyes).

**Garra gymnothorax** (Berg, 1949)

(Figs. 12-13)

**Material examined:** The syntypes of *Garra rufa gymnothorax* are in the Zoological Institute, St. Petersburg (ZIN 13214), there being 6 fish in the catalogue and 6 in the jar although Berg (1949) lists 7 in his description. They measure 30.5-44.9mm standard length. The date in Berg (1949) is 6.VI.1904 while in the catalogue it is 4.III.1904 and in the jar 24.III.1904, variations not accountable by old and new styles of dating (13 days apart). A further collection listed by Berg (1949), (ZIN 24435), is not listed as type material in the text nor in the jar but the catalogue suggests that they are (Eschmeyer et al. (2016) list these 10 fish as syntypes). ZIN 24354 is from "Ziaret-Seid-Hasan, Mesopotamiya". The type series may be only ZIN 13214 as in the text.
Fig. 10. Live specimen of *Garra amirhosseini*, ZM-CBSU H1216, holotype, 67.3mm SL; Iran: hot Spring Sartang-e Bijar.

Fig. 11. Hot Spring Sartang-e Bijar, type locality of *Garra amirhosseini*.
Eschmeyer et al. (1996) list ZIN 13215, 17 fish, and ZIN 24436, 3 fish, as syntypes. Eschmeyer et al. (2016) give syntypes as ZIN 13214-15 (6, 6+), 24429 (1), 24435-36 (10, 3). ZM-CBSU H1225, 11, 45-72 mm SL; Iran: Khuzestan prov.: Helayjan River at Izeh, Tigris River drainage, 31°47'04.8''N 49°47'36.2''E; H.R. Esmaeili and M. Razbanian, 21 Dec 2015. ZM-CBSU H1514, 12, 45-75 mm SL; Iran: Kohkiloye and Boyerahmad prov.: Bashar River at Lema village, Yasouj city, Tigris River drainage, 31°02'25.7''N 51°13'03.6''E; R. Khaefi, 10 Jul 2010.

Diagnosis: Garra gymnothorax is distinguished from all other species of Garra in Iran by a combination of characters, none of them unique. The breast is naked or with embedded scales in one population (vs. covered by scales in G. rufa), belly and predorsal mid-dorsal line covered by scales (vs. naked in G. mondica), eye placed in posterior half of head (vs. slightly in anterior half in G. amirhosseini), usually 8½ branched dorsal-fin rays (vs. 7½ in G. amirhosseini and G. mondica) and usually 9+8 caudal-fin rays (vs. usually 8+8 in G. persica). Garra gymnothorax is distinguished from G. rossica by having a fully developed mental disc (vs. weak-developed) and 17-23 total gill rakers on the first branchial arch (vs. 13-15), from G. variabilis by having a fully developed mental disc (vs. weak-


<table>
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<th>Holotype</th>
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<th>SD</th>
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</table>
developed) and two pairs of barbels (vs. one) and from *G. typhlops* and *G. widdowsoni* by having well-developed eyes and a brown and silvery colour pattern (vs. absence).

It is distinguished from all the congeners included in this study by four fixed, diagnostic nucleotide substitutions, and a K2P nearest-neighbor distance of 4.81% to *G. typhlops*.

**Description:** General appearance of body is shown in Figures 12-13, and morphometric data are given in Table 4. Body elongated, moderately compressed laterally, more compressed in region of caudal peduncle. Dorsal head profile rising gently, flat or slightly convex, more or less continuous with dorsal body profile to nape or about middle between nape and dorsal-fin origin. Ventral profile more or less

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*Fig.12. Garra rufa gymnothorax. ZIN 13214, syntypes, 29.4–ca. 45mm SL.*
Fig. 13. Live specimen of *Garra gymnothorax*, ZM-CBSU H1224, 65.4mm SL; Iran: Helayjan River.

Table 4. Morphometric data of *Garra gymnothorax*, ZM-CBSU H1223-H1235, B962, B964, (n=15); *Garra rufa*, ZM-CBSU H1526-H1529, J101, J104, J107, J122, (n=8).

<table>
<thead>
<tr>
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<th>G. rufa</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
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<tr>
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<td>Head length</td>
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<td>Predorsal length</td>
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<td>Preanal length</td>
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<td>Prepelvic length</td>
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<td>Depth of caudal peduncle</td>
<td>11.3</td>
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<tr>
<td>Length of caudal peduncle</td>
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<td>21.4</td>
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<td><strong>In percent of head length</strong></td>
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<td>Head depth</td>
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<td>Eye diameter</td>
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<td>Maximum head width</td>
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<td>Rostral barbel</td>
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<td>19.1</td>
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<tr>
<td>Maxillary barbel</td>
<td>6.3</td>
<td>14.8</td>
</tr>
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</table>
straight to anal-fin origin. Head moderately large and depressed, with slightly convex or flat interorbital distance; height at nape less than head length; width at nape greater or about equal to depth at nape. Eye placed dorso-laterally in posterior half of head. Barbels in two pairs; rostral barbel antero-laterally located, shorter or about equal to eye diameter; maxillary barbel at corner of mouth, shorter than rostral barbel. Well-developed disc with free lateral and posterior margins; which is heavily papillate with batteries of fleshy papillae arrayed around the periphery of the whole disc. Rostral cap well-developed, fimbriate, papillate on ventral surface. Upper lip present, as a thin band of papillae arranged in two ridges. Upper jaw almost or completely covered by rostral cap. Disc elliptical, shorter than wide and narrower than head width through base of maxillary barbel.

Dorsal fin with 3 simple and 7½-8½ [7½(5), 8½(38)] branched rays, distal margin concave; origin closer to snout tip than to caudal-fin base; inserted anterior to vertical from pelvic-fin origin; first branched ray longest, tip of last branched ray reaching vertical to anus. Pectoral fin with 1 simple and 12-13 branched rays, reaching to a point 3-4 scales anterior to pelvic-fin origin, length shorter or slightly equal to head length. Pelvic fin with 1 simple and 7-8 branched rays, reaching to anus, origin closer to anal-fin origin than to pectoral-fin origin, inserted below second or third branched dorsal-fin ray. Anal fin short, with 3 simple and 5½ branched rays; first branched ray longest; distal margin straight or slightly concave; origin closer to pelvic-fin origin than to caudal-fin base. Anus 3-4 scales in front of anal-fin origin. Caudal fin forked with 9+8 branched rays; tip of lobes pointed. Total gill rakers on the first branchial arch 17-23 [17(4), 18(11), 19(10), 20(8), 21(3), 22(1), 23(4)]. Lateral line complete, with 32-37 [32(6), 33(7), 34(8), 35(3), 36(3), 37(8)] scales with 2-3 of them situated on caudal fin base.

Fig.14. Natural habitat of *G. gymnothorax*, Iran: Helayjan River.
Transverse scale rows above lateral line 3½-4½; between lateral line and pelvic-fin origin 2½-3½. Circumpeduncular scale rows 12-13. Usually, 10-12 scales on predorsal midline at front of dorsal-fin origin. Scales on flank regularly arranged. Chest naked and in one population with hidden scales, belly covered by scales. One short axillary scale at base of pelvic fin in some individuals, and 4-7, usually 5, scales between posteriormost pelvic-fin base and anus.

**Distribution:** *Garra gymnothorax* is known from Karun River system in the Helayjan River at Izeh, Balarud River at Andimeshk and Bashar River at Yasouj (Figs. 14, 31).

**Remark:** See *G. amirhosseini*.

*Garra lorestanensis* Mousavi-Sabet & Eagderi, 2016 (Fig. 15)

**Material examined:** Listed in Mousavi-Sabet & Eagderi (2016).

**Diagnosis:** *Garra lorestanensis* is distinguished from its congeners by lacking pigment and eyes (vs. presence in all epigean species), having mental disc (vs. absence in *G. typhlops*) and naked body (body fully covered by scales or scales restricted to lateral midline in *G. widdowsoni*).

**Description:** See Figure 15 for general appearance, Table 1 page 48 for morphometric data of holotype and 5 paratypes (see Mousavi-Sabet & Eagderi 2016). Relatively stout species with wide head, moderately compressed laterally, more compressed posteriorly especially in caudal peduncle region. Body deepest at or slightly in front of dorsal-fin base, depth decreasing towards caudal-fin base. Greatest body width at or slightly behind of pectoral-fin base, body almost equally wide until dorsal-fin origin. Head relatively large, and deeply depressed. Dorsal head profile rising gently from the tip of snout, slightly convex, sharply continuous with dorsal body profile from about middle between tip of snout and nape to about middle between nape and dorsal-fin origin. Ventral profile slightly concave in pectoral-pelvic contour, and more or less straight from pelvic to anal-fin origin. Caudal peduncle relatively shallow (caudal peduncle depth 9.5-11.5% SL). Caudal peduncle length 1.4-1.8 times longer than its depth. Lateral line complete, with 28-35 pores. Body naked. Pharyngeal teeth in three rows with a formula of 3,4,5-5,4,3 in three studied specimens. 10-12 total gill rakers on the first branchial arch, in five studied specimens. Snout roundish; transverse lobe with sparsely small tubercles, shallow transverse groove between transverse lobe and proboscis in larger specimens, no obvious transverse groove in small individuals. Proboscis with sparsely small sized tubercles. Proboscis not (commonly in small individuals) or only slightly (in larger specimens) elevated from depressed rostral surface. Scattered small-sized tubercles on lateral surface of snout reaching to posterior nostril in larger specimens. Depressed rostral surface normally without tubercles, anterior arm of depressed rostral surface not reaching to base of rostral barbel, separating transverse lobe from lateral surface. Commonly no obvious groove between transverse lobe and lateral surface. No obvious head tubercles in small individuals. Mouth surrounded by two pairs of barbels; rostral barbel antero-laterally located, maxillary barbel at corner of mouth, shorter than rostral barbel. Rostral cap poorly developed, fimbriate, papillate on ventral surface. Upper lip present, upper jaw almost covered by rostral cap. Disc elliptical, longer than wide and narrower than head width through roots of maxillary barbel; papillae on antero-median fold; well-developed groove between antero-median fold and central callous-pad narrow and deep, scattered small sized papillae on latero-posterior flap; surface of central callous pad with sparsely arranged small papillae. Dorsal fin with 3 simple and 7½ (4) or 8½ (2) branched rays. Anterior dorsal-fin origin located mid dorsum, or slightly posterior. Pelvic fin with 1 simple and 6-7 branched rays. Pelvic-fin origin behind a vertical of dorsal-fin origin, about a vertical of mid dorsal-fin base. Pectoral fin with 1 simple and 13-14 branched rays. Pectoral fin reaching approximately 55-60% of distance from pectoral-fin

**Distribution:** *Garra lorestanensis* is known from the Loven Cave, the natural outlet of a subterranean limestone system of the Zagros Mountains in the Abe Sirum or Ab-e Serum Valley near Tang-e Haft railway station, the Tigris River drainage, the Persian Gulf basin, Lorestan Province, southwestern Iran (Figs. 16, 31).

**Remark:** See page 51 in Mousavi-Sabet & Eagderi 2016.
Garra mondica Sayyadzadeh, Esmaeili & Freyhof 2015
(Fig. 17)


Diagnosis: Garra mondica is distinguished from all other species of Garra in the rivers flowing to the Persian Gulf south of the Tigris by having a naked breast and anterior belly (vs. fully covered by scales) and a naked mid-dorsal area in front of the dorsal-fin origin or dorsal midline with only few, usually embedded scales. The naked mid-dorsal area seems to be a unique character state of this species within its comparison group including the species of the Euphrates and Tigris drainages. A naked breast and anterior belly is also found in some populations of G. rufa. Garra mondica is further distinguished from G. rufa by having usually 7½ branched dorsal-fin rays (vs. usually 8½). Garra mondica is distinguished from all the congeners included in this study by 2 fixed, diagnostic nucleotide substitutions and a K2P nearest-neighbor distance of 3.9% to G. rufa (Table 2). Besides the naked breast, anterior belly and predorsal back, G. mondica is also distinguished from G. persica by having usually 9+8 caudal-fin rays (vs. usually 8+8). Garra mondica is distinguished from G. rossica by having a fully-developed mental disc (vs. reduced) and 18-23 total gill rakers on the first branchial arch (vs. 11-15), from G. variabilis by having a fully developed mental disc (vs. reduced) and two pairs of barbels (vs. one) and from G. lorestanensis, G. typhlops and G. widdowsoni by having well-developed eyes and a brown or grey, usually mottled colour pattern (vs. absence of colour pattern).

Description: See Figure 17 for general appearance. Body elongated, moderately compressed laterally, more compressed in region of caudal peduncle. Dorsal head profile rising gently, slightly convex, more or less continuous with dorsal body profile to nape or about middle between nape and dorsal-fin origin. Ventral profile more or less straight to anal-fin origin. Head moderately large and depressed, with slightly convex or flat interorbital space; height at nape less than head length; width at nape greater or about equal to depth at nape. Snout roundish; transverse lobe with 11-21 tubercles, demarcated posteriorly by a shallow transverse groove in some individuals, no transverse groove in others. Proboscis covered with small or medium sized tubercles, largest on anterior margin of proboscis. Proboscis not or only slightly elevated from depressed rostral surface. Lateral surface of snout covered by small to medium sized tubercles reaching to anterior eye margin in some individuals, or to posterior nostril in others. Depressed rostral surface always without tubercles (Figs. 18, 29).

Distribution: Garra mondica is found in two small
springs in the Mond River drainage in Iran, the Konar Siyah Spring (Figs. 18, 31), which is situated 20km south-west of Firouzabad and the Tang-e-Mohr Spring, which is situated about 10km south of Mohr.

**Remarks:** See Sayyadzadeh et al. (2015).

**Garra nudiventris** (Berg, 1905)

(Fig. 19)

**Material examined:** The types for the var. *nudiventris* are in ZIN 11113, listed by Berg (1905) as 2 fish from Schivar (see Eschmeyer et al. 2016), by Berg (1949) as being 4 fish, not numbered in the ZIN catalogue and with 5 fish in the jar (45.6-66.2mm SL). ZIN 11113 appears to have been renumbered in part as 11703 and 11708 according to Berg (1949). ZIN 11708 is listed in Berg (1949) as 13 specimens and 11703 seems to be also 13 specimens. The type localities for var. *nudiventris* are for ZIN 11113 "Shivar, north of Nikh (Nekh), north-east Kerman, basin of L. Hamun, 23 VI 1896, N. Zarudnyi", for ZIN 11708 "Podaghi, north-north-east of Bazman, eastern Kerman, 6 VII 1898, N. Zarudnyi" and 11703 is probably "Neizar in Seistan, N. Zarudnyi" according to Berg (1949) (the catalogue number 11703 does not appear under the description of materials in Berg (1949), possibly omitted in error, and it is deduced here that it should have preceded the locality cited). ZM-CBSU H1500, 6, 40-54mm SL; Iran: Khorasan prov.: Kalat-e-Baba Qanat at Birjand, Lut drainage basin, 32°49’33.7"N 59°15’29.2"E. H.R. Esmaeili, G. Sayyadzadeh, A. Gholamifard, R. Zamanian Nejad, S. Mirghyasi, S. Ghasemian and B. Parisi, 30 Aug 2011.

**Diagnosis:** *Garra nudiventris* is distinguished from all other species of *Garra* in Iran except *G. mondica* by having the predorsal mid-line region and belly naked (vs. fully covered by scales). It is distinguished from all other species of *Garra* in Iran except some populations of *G. rossica* by having one pair of barbels (vs. two pairs) and the lowest total gill rakers on the first arch (10-11 vs. 13-24). It is also distinguished from *G. gymnothorax* and *G. rufa* by having 7½ branched dorsal-fin rays (vs. usually 8½ branched dorsal-fin rays). It is distinguished from *G. persica* by having usually 9+8 caudal-fin rays (vs. usually 8+8), and from *G. typhlops* and *G. widdowsoni* by having well-developed eyes and a brown and silvery colour pattern (vs. absence).
It is distinguished from all the congeners included in this study except *G. rossica* by 11 fixed, diagnostic nucleotide substitutions, and a K2P nearest-neighbor distance of 0.75% to *G. rossica*.

**Description:** General appearance of body is shown in Figure 19 and morphometric data are given in Table 5. Body elongated, moderately compressed laterally, more compressed in region of caudal peduncle.
Dorsal head profile rising gently, flat or slightly convex, more or less continuous with dorsal body profile to nape or about middle between nape and dorsal-fin origin. Ventral profile more or less straight to anal-fin origin. Head moderately large and depressed, with slightly convex or flat interorbital distance; height at nape less than head length; width at nape greater or about equal to depth at nape. Eye placed dorso-laterally in anterior half of head. Barbels in one maxillary pair. Disc weak-developed with free lateral and posterior margins, slightly papillate. Rostral cap developed, fimbriate, papillate on ventral surface. Upper jaw almost or completely covered by rostral cap. Disc triangular, shorter than wide and narrower than head width through base of maxillary barbel.

Dorsal fin with 3 simple and 7½ branched rays, distal margin straight, in some specimens slightly concave; origin slightly closer to caudal-fin base than to snout tip or equal from both ends; inserted anterior to vertical from pelvic-fin origin; first branched ray longest, tip of last branched ray not reaching vertical to anus. Pectoral fin with 1 simple and 12-13 branched rays, reaching to a point 9-11 scales anterior to pelvic-fin origin, length shorter than head length. Pelvic fin with 1 simple and 7 branched rays, reaching to anus, origin closer to anal-fin origin than to pectoral-fin origin, inserted below second or third branched dorsal-fin ray. Anal fin short, with 3 simple and 5½ branched rays; first branched ray longest; distal margin straight or slightly concave; origin closer to pelvic-fin origin than to caudal-fin base. Anus 3-4 scales in front of anal-fin origin. Caudal fin forked with 9+8 branched rays; tip of lobes pointed. Total gill rakers on the first branchial arch 10-11. Lateral line complete, with 36-39 scales which 2-3 of them situated on caudal fin base. Transverse scale rows above lateral line 6½-7½; between lateral line and pelvic-fin origin 5½-6½. Circumpeduncular scale rows 16-18. Predorsal midline at front of
dorsal-fin origin naked. Scales on flank regularly arranged. Chest and belly naked. One very short axillary scale at base of pelvic fin in some individuals, and 9-11 scales between posteriormost pelvic-fin base and anus that in some specimens are embedded and uncountable. There is a lateral dark strip on lateral line of body.

**Distribution:** *Garra nudiventris* is known from Lut drainage basin at Kalat-e-Baba Qanat (Figs. 20, 31).

**Remarks:** *Discognathus rossicus* var. *nudiventris* Berg, 1905 was described from "Schiwar" in Iran for specimens with a naked abdomen, thoracic region and groove on the back anteriorly. The distribution of these specimens overlaps with that of the type in Southern Iran (from Sistan) and Southern Baluchistan. Berg (1949) later placed them as an infraspecies.

*Garra rossica* (Nikol'skii, 1900)

(Fig. 21)

**Material examined:** The syntypes of *Discognathus rossicus* are in the Zoological Institute, St. Petersburg (ZIN 10365), the type locality in Latin on page 239 being "Flum. Tedschent in prov. Transcasp. Zarudnyi. 1892 (4)" while on p. 240 are the localities "Habitat in flumine Tedshent in provincia Transcaspienti, nec noc in Persia orientale ad Kirmanum orientale" (Nikol'skii 1900), and confirmed by BWC. However, there were 3 fish in the jar (45.0-54.5mm SL) although 4 are listed in the catalogue and in the type description. Berg (1905) lists 3 fish but in Berg (1949) lists only 2. Other materials listed by Nikol'skii (1900) from eastern Iran and Kerman (ZIN 11113, 11703, 11704, 11705, 11708) are apparently not types of *rossicus* although Berg (1949) indicates that 11704 ("Neizar in Seistano") and 11705 ("Ljabeb in Seistano") are part of the type series from Iran. Eschmeyer et al. (2016) also list ZIN 10665 (4) as part of the type series, perhaps a misprint for ZIN 10365. Eschmeyer et al. (2016) list ZIN 10365 [not 10665] (4, now 3), 11113 (6), 11703-05 (6+, 6, 6), 11708 (6) as syntypes. ZM-CBSU J2762, 12, 49-85mm SL; Iran: Sistan and Baluchistan prov.: Irandegan River at Irandegan, 27°53'22.9"N 61°05'35.9"E; F. Irandegani, 27 Dec 2011. ZM-CBSU H1506, 8, 31-52mm SL; Iran: Khorasan e Razavi prov.: Khiaban Qanat at Taibad, Bejestan drainage basin, 34°44'10.1"N 60°34'29.7"E; H. R. Esmaeili, G. Sayyadzadeh, A. Gholamifard, R. Zamanian Nejad, S. Mirghyasi, S. Ghasemian and B. Parsi, 28 Aug 2011.

**Diagnosis:** *Garra rossica* is distinguished from all other species of *Garra* in Iran except *G. nudiventris* by having the weak developed mental disc (vs. well-developed), one or two short barbels (vs. two large) and low total gill rakers (11-15 vs. 17-24). It is distinguished from *G. nudiventris* by having predorsal mid-line region and belly fully covered by scales (vs. naked). It is also distinguished from *G. gymnothorax* and *G. rufa* by having 7½ branched

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**Fig. 21.** Live specimen of *Garra rossica*, ZM-CBSU N168, 41.9mm SL; Iran: Irandegan River.
dorsal-fin rays (vs. usually 8½). It is distinguished from *G. persica* by having usually 9+8 caudal-fin rays (vs. usually 8+8), and from *G. typhlops* and *G. widdowsoni* by having well-developed eyes and a brown and silvery colour pattern (vs. absence).

It is distinguished from all the congeners included in this study except *G. nudiventris* by 11 fixed, diagnostic nucleotide substitutions, and a K2P nearest-neighbor distance of 0.75% to *G. nudiventris*.

**Description:** General appearance of body is shown in Figure 21, and morphometric data are given in Table 5. Body elongated, moderately compressed laterally, more compressed in region of caudal peduncle. Dorsal head profile rising gently, flat or slightly convex, more or less continuous with dorsal body profile to nape. Ventral profile more or less straight to anal-fin origin. Head moderately large and depressed, with flat or slightly convex interorbital distance; height at nape less than head length; width at nape greater or about equal to depth at nape. Eye placed dorso-laterally in slightly anterior half of head. Barbels in two short pairs and in one population in one maxillary pair. Disc weak-developed with free lateral and posterior margins; slightly papillate. Rostral cap developed, fimbriate, papillate on ventral surface. Upper jaw almost or completely covered by rostral cap. Disc elliptical, slightly shorter than wide and narrower than head width through base of maxillary barbel.

Dorsal fin with 3 simple and 7½ branched rays, distal margin straight, in some specimens slightly concave; origin slightly closer to snout tip than to caudal-fin base ends; inserted anterior to vertical from pelvic-fin origin; first branched ray longest, tip of last branched ray reaching vertical to anus. Pectoral fin with 1 simple and 12-13 branched rays,
reaching to a point 5-8 scales anterior to pelvic-fin origin, length shorter than head length. Pelvic fin with 1 simple and 7 branched rays, reaching to anus, origin closer to anal-fin origin than to pectoral-fin origin, inserted below second or third branched dorsal-fin ray. Anal fin short, with 3 simple and 5½ branched rays; first branched ray longest; distal margin straight or slightly concave; origin closer to pelvic-fin origin than to caudal-fin base. Anus 2-3 scales in front of anal-fin origin. Caudal fin forked with 9+8 branched rays; tip of lobes pointed. Total gill rakers on the first branchial arch 11-15. Lateral line complete, with 35-39 scales which 2-3 of them situated on caudal fin base. Transverse scale rows above lateral line 5½-6½; between lateral line and pelvic-fin origin 4½-5½. Circumpeduncular scale rows 15-18. Usually, 13-17 scales on predorsal midline at front of dorsal-fin origin. Scales on flank regularly arranged. Chest and midline of belly covered by embedded scales. One very short axillary scale at base of pelvic fin in some individuals, and 5-9, scales between posteriormost pelvic-fin base and anus.

**Distribution:** *Garra rossica* is known from Jaz-Murian and Kavir drainage basin (Figs. 22, 31).

**Remarks:** See material examined and diagnosis.

*Garra rufa* (Heckel, 1843)

(Fig. 23)

**Material examined:** The types of *Discognathus rufus* are from "Aleppo" according to Heckel (1843). The syntypes of *Discognathus rufus* (Fig. 24) according to Krupp (1985c) are in the Naturhistorisches Museum Wien under NMW 53240, 8 specimens, 59-108mm SL; from Aleppo and 1 syntype is in the Senckenberg Museum Frankfurt under SMF 553 (formerly NMW), 103mm SL; and also from Aleppo. The catalogue in Vienna lists 6 specimens. One specimen from NMW 53240, 112.3mm SL; was designated as the lectotype and 7 fish, 60.2-97.5mm SL; as paralectotypes by F. Krupp, 29 October 1984, and published in Krupp and Schneider (1989). ZM-CBSU J101, 22, 41-106mm SL; Iran: Kohgilooeyh and Booyerahmad prov.: K hersan River at Pataveh, Tigris River drainage, 30°55'04.14"N 51°17'16.14"E; G. Sayyadzadeh, R. Zamanian Nejad, S. Mirghiyasi and S. Ghasemian, 04 March 2011. ZM-CBSU H1526, 20, 54.7-84.7mm SL; Iran: Illam prov.: Doirej River at Abdanan, Tigris River drainage, 32°39'13.0"N 47°32'37.7"E; H.R. Esmaeili and S. Vatandoust, 11 Sep 2012.

**Diagnosis:** *Garra rufa* is distinguished from all other species of *Garra* in Iran except *Garra gymnothorax* by having usually 8½ branched dorsal-fin rays (vs. 7½). It is distinguished from *G. gymnothorax* by the breast fully covered by scales or embedded in some populations (vs. naked). Belly and predorsal mid-dorsal line covered by scales (vs. naked in *G. mondica*), eye placed in posterior half of head (vs. slightly in anterior half in *G. amirhosseini*), usually 9+8 caudal-fin rays (vs. usually 8+8 in *G. persica*), a fully developed mental disc and two pairs of barbels (vs. weak-developed and one pair in *G. rossica*, *G. nudiventris* and *G. variabilis*), 20-24 total gill rakers on the first branchial arch (vs. 10-15 in *G. rossica* and *G. nudiventris*). It is distinguished from *G. typhlops* and *G. widdowsoni* by having well-developed eyes and a brown and silvery colour pattern (vs. absence).

It is distinguished from all the congeners included in this study by one fixed, diagnostic nucleotide substitutions, and a K2P nearest-neighbor distance of 2.45% to *G. rufa*.

**Description:** General appearance of body is shown in Figure 23, and morphometric data are given in Table 4. Body elongated, moderately compressed laterally, more compressed in region of caudal peduncle. Dorsal head profile rising gently, flat or slightly convex, more or less continuous with dorsal body profile to nape or about middle between nape and dorsal-fin origin. Ventral profile more or less straight to anal-fin origin. Head moderately large and depressed, with slightly convex or flat interorbital height; height at nape less than head length; width at nape greater or about equal to depth at nape. Eye placed dorso-laterally in posterior half of head.
Barbels in two pairs; rostral barbel antero-laterally located, shorter or about equal to eye diameter; maxillary barbel at corner of mouth, shorter than rostral barbel. Well-developed disc with free lateral and posterior margins; which is heavily papillate with batteries of fleshy papillae arrayed around the periphery of the whole disc. Rostral cap well-developed, fimbriate, papillate on ventral surface. Upper lip present, as a thin band of papillae arranged in two ridges. Upper jaw almost or completely covered by rostral cap. Disc elliptical, shorter than wide and narrower than head width through base of maxillary barbel.

Dorsal fin with 3 simple and usually 8½ branched rays, distal margin concave; origin closer to snout tip than to caudal-fin base; inserted anterior to vertical from pelvic-fin origin; first branched ray longest, tip of last branched ray reaching vertical to anus. Pectoral fin with 1 simple and 12-13 branched rays, reaching to a point 4-5 scales anterior to pelvic-fin origin, length shorter or slightly equal to head length. Pelvic fin with 1 simple and 7-8 branched rays, reaching to anus, origin closer to anal-fin origin than to pectoral-fin origin, inserted below second or third branched dorsal-fin ray. Anal fin short, with 3 simple and 5½ branched rays; first branched ray longest; distal margin straight or slightly concave; origin closer to pelvic-fin origin than to caudal-fin base. Anus 3-4 scales in front of anal-fin origin. Caudal fin forked with 9+8 branched rays; tip of lobes pointed. Total gill rakers on the first branchial arch 20-24. Lateral line complete, with 32-38 scales which 2-3 of them situated on caudal fin base. Transverse scale rows above lateral line 4½; between lateral line and pelvic-fin origin 3½. Circumpeduncular scale rows 13-16. Usually, 11-14 scales on predorsal midline at front of dorsal-fin origin. Scales on flank regularly arranged. Chest with embedded scales, belly covered by scales. One short axillary scale at base of pelvic fin in some individuals, and 4-7, scales between posteriormost pelvic-fin base and anus.

**Distribution:** Garra rufa is known from Tigris River, Maharlu and Persis drainage basins (Fig. 25, 31).

**Remarks:** The syntypes of Discognathus crenulatus Heckel, 1847, a synonym of G. rufa, are in the Naturhistorisches Museum Wien under NMW 53236 (14 specimens) from the Qarah Aqaj River and 53237 (6) from Sa’di’s tomb measuring 33-79mm SL; (Kähsbauer, 1964). The 14 specimens under NMW 53236 measure 24.0-75.9mm SL; and 7 (not 6) specimens under NMW 53237 measure 35.4-56.6mm SL;: Neither the record of Kähsbauer (1964) nor data from jars on the shelves accord with the catalogue in Vienna which gives 10 or 8 and 6 or 5 specimens respectively for these two syntype localities.
Fig. 24. *Discogathus crenulatus* NMW-53327_Syntypes_1-7_WEB.
**Garra persica** Berg, 1913
(Fig. 26)

**Material examined:** The syntype specimens are in the Zoological Institute, St. Petersburg under catalogue numbers ZISP 11707 (6 specimens from the "River Bampur in Eastern Persia. N. Zarudnyi 1898, 15-27.VII") and 11706 (1 specimen from "Kiabad in Zirkuh (Eastern Khorassan). N. Zarudnyi 1898, 3.V") according to Berg (1914) where the original description is founded on these fish, implying all are types. The latter is also given as "settlement Kiabad between Zirkuh Province and Sistan" in the catalogue (this locality may be at or near Kuh-e Ziri at 32°48'N, 59°50'E according to Coad (1981c)). These dates are old style and corrected to new in Berg (1949) (27.VII-8.VIII and 15.V, respectively). In St. Petersburg under ZISP 11707 there are 10 fish 24.0-46.5mm SL; and ZISP 11706 is not listed as a type in the catalogue nor in Berg (1949). Berg (1949) lists 10 fish in 11707 too. These specimens were formerly identified as *Discognathus lamta* by Nikol'skii (1899) who lists 1 fish in 11706 and 6 in 11707. Three syntypes are in the Zoological Survey of India, Calcutta (ZSI F11101/1) listed under *Garra rufa obtusa* and received from the Zoological Institute, St. Petersburg, Russia on exchange (Menon & Yazdani 1968). There are more apparent types available than those listed by Berg (1914). ZM-CBSU 10200, 30, 34-56mm SL; Iran: Fars prov.: Rasoul River at Goud e Gaz, Kol River drainage, 27°17'28.8"N 54°29'20.7"E; H.R. Esmaeili and A. Teimori, 27 Jan 2008.

**Diagnosis:** *Garra persica* is distinguished from all other species of *Garra* in Iran by having usually 8+8 caudal-fin rays (vs. usually 9+8). It is distinguished from *G. rufa* and *G. gymnothorax* by having usually 6½-7½ branched dorsal-fin rays (vs. 8½), from *G. rossica*, *G. nudiventris* and *G. variabilis* by having a fully developed mental disc and two pairs of barbels (vs. weak-developed and one pair), from *G. mondica*
by having belly and predorsal mid-dorsal line covered by scales (vs. naked). It is also distinguished from *G. typhlops* and *G. widdowsoni* by having well-developed eyes and a brown and silvery colour pattern (vs. absence).

It is distinguished from all the congeners included in this study except a blind species *G. typhlops* (vs. well-developed eye in *G. persica*) by one fixed, diagnostic nucleotide substitutions, and a K2P nearest-neighbor distance of 2.45% to *G. rufa*.

**Description:** General appearance of body is shown in Figure 26. Body elongated, moderately compressed laterally, more compressed in region of caudal peduncle. Dorsal head profile rising gently, flat or slightly convex, more or less continuous with dorsal body profile to nape or about middle between nape and dorsal-fin origin. Ventral profile more or less straight to anal-fin origin. Head moderately large and depressed, with slightly convex or flat interorbital distance; height at nape less than head length; width at nape greater or about equal to depth at nape. Eye placed dorso-laterally in posterior half of head. Barbels in two pairs; rostral barbel antero-laterally located, shorter or about equal to eye diameter; maxillary barbel at corner of mouth, shorter than rostral barbel. Well-developed disc with free lateral and posterior margins; heavily papillate with batteries of fleshy papillae arrayed around the periphery of the whole disc. Disc elliptical, shorter than wide and narrower than head width through base of maxillary barbel. Rostral cap well-developed, fimbriate, papillate on ventral surface. Upper lip present, as a thin band of papillae arranged in two ridges. Upper jaw almost or completely covered by rostral cap.

Dorsal fin with 3 simple and 6½-7½ branched rays, distal margin concave; origin closer to snout tip than to caudal-fin base or equal between two ends in some specimens; inserted anterior to vertical from pelvic-fin origin; first branched ray longest, tip of last branched ray reaching vertical to anus. Pectoral fin with 1 simple and 12-13 branched rays, reaching to a point 5-7 scales anterior to pelvic-fin origin, length shorter than head length. Pelvic fin with 1 simple and 7-8 branched rays, reaching to anus, origin closer to anal-fin origin than to pectoral-fin origin, inserted below second or third branched dorsal-fin ray. Anal fin short, with 3 simple and 5½ branched rays; first branched ray longest; distal margin straight or slightly concave; origin closer to pelvic-fin origin than to caudal-fin base. Anus 2-3 scales in front of anal-fin origin. Caudal fin forked with 8+8 branched rays; tip of lobes pointed. Total gill rakers on the first branchial arch 17-19. Lateral line complete, with 32-37 scales which 2-3 of them situated on caudal fin base. Transverse scale rows above lateral line 4½; between lateral line and pelvic-fin origin 4½. Circumpeduncular scale rows 14-16. Usually, 14-17 scales on predorsal midline at front of dorsal-fin origin. Scales on flank regularly arranged. Chest with
embedded scales, belly covered by scales. One short axillary scale at base of pelvic fin in some individuals, and 5-7, scales between posteriormost pelvic-fin base and anus.

**Distribution:** *Garra persica* is known from Rudan and Kol River drainage basins and also Shour, Bampour and Karvandar Rivers (Figs. 27, 31).

**Remark:** See material examined and diagnosis.

*Garra typhlops* (Bruun & Kaiser, 1944)  
(Fig. 28)

**Material examined:** Holotype. ZMUC P 26475, 46.5 mm TL and 38.5 mm SL; Iran: Lorestan prov.: from a flood resurgence at Kaaje-Ru, valley of Ab-i-Serum, a tributary of Dez River, Karun River drainage, 33°04’39”N 48°35’33”E. Paratypes. ZMUC P 26476, 26477, 26478, 26480 measure 19.5-42.0 mm total length and 16.5-34.5 mm SL; according to Bruun & Kaiser (1948). CMNFI 2007-0124, 6, 27.3-42.2 mm SL; type locality as above. CMNFI 2008-0177, 1, 30.4 mm SL; type locality as above.

**Diagnosis:** *Garra typhlops* is one of two subterranean species in Iran, distinguished from all other *Garra* species in Iran except *G. lorestanensis* by absence of eyes and a depigmented body. It is also distinguished from *G. lorestanensis* by absence of mental disc (vs. having mental disc).

**Description:** General appearance of body is shown in Figure 28. The body is compressed and the head somewhat flattened. Body deepest in front of dorsal-fin base, depth decreasing towards caudal-fin base. Greatest body width at or slightly behind of pectoral-fin base, body almost equally wide until dorsal-fin origin. Dorsal head profile rising gently from the tip of snout, slightly convex, sharply continuous with dorsal body profile from about middle between tip of
snout and nape to about middle between nape and dorsal-fin origin. Ventral profile slightly concave in pectoral-pelvic contour, and more or less straight from pelvic to anal-fin origin. Caudal peduncle relatively shallow. There are two pairs of barbels, one pair at the mouth corners and one about half way along the upper lip. The upper lip has a feebly crenulated edge. The mouth is subterminal and horseshoe-shaped. Mental disc is absent. There is no visible trace of eyes in most fish. The skin has a few rows of scales behind the pectoral fin base, although some individuals may have more flank scales. There are about 32 myomeres along the flank. A lateral line is present. The dorsal fin with 3 simple and 7-8 branched rays, the anal fin 3 simple and 4-5 branched rays, the pectoral fin 14-17 branched rays and the pelvic fin 5-7 branched rays. Pharyngeal teeth in 3 rows, 1 to 3 in the outer row, 3 to 4 in the middle row and 3-5 in the inner row. Gill rakers very short, not reaching the adjacent raker when appressed and numbering 10-13 in total. Total vertebrae 34-36 (commonly 34). Gut s-shaped. Preorbital bones that enclose the infraorbital canal absent, the posterior pharyngeal process of the basioccipital is broad and directed vertically with lateral ridges, haemal spine of the fourth fused vertebra of the Weberian apparatus narrow, well-developed PU2 of the caudal skeleton with a long neural spine.

**Distribution:** The Iranian cave barb’s original locality is a water cave, the natural outlet of a subterranean limestone system in the Zagros Mountains. The stream below the cave locality is the 'Ab–e Sirum’, a tributary of the Dez River, in Lorestan province. The Dez flows into the Karun River which drains to the head of the Persian Gulf. The cave is located at 33°04’ 39"N and 48°35’33"E. (Figs. 29, 31).

**Remarks:** It was described in the genus *Iranocypris* Bruun & Kaiser, 1944. The species was suggested to be related to the genus *Barbus* by Bruun & Kaiser (1944), a view that was subsequently rejected by Saadati (1977). Coad (2011) proposed that the species may be related to the genus *Garra* Hamilton, 1822. Hashemzadeh Segherloo et al. (2012) provided the first molecular evidence of the species phylogeny based on the cytochrome c oxidase subunit I (COI) gene, which indicated that the species is phylogenetically close to the genus *Garra*. More recently, Farashi et al. (2014) examined phylogenetic relationships of the cave fish with other species of the family Cyprinidae based on the mitochondrial cytochrome b gene. Their results show that *I. typhlops* is monophyletic and is sister taxon of a cluster formed by *Garra rufa* (Heckel, 1843) and *Garra barreimiae* (Fowler & Steinitz 1956) within a clade that includes other species of the genus *Garra* and recommended that *I. typhlops* should be transferred to the genus *Garra* Hamilton, 1822. Sayyadzadeh et al. (2015) approved the view of Farashi et al. (2014) and transferred *Iranocypris* to the genus *Garra*. Two sympatric forms were reported within the *I. typhlops* group (Sargeran et al. 2008). They are morphologically distinguished by the
presence/absence of a mental disc on the ventral surface of the head, considering as *G. lorestanensis* and *G. typhlops* by Mousavi-Sabet & Eagderi (2016), respectively. *Garra typhlops* is distinguished from the subterranean *G. lorestanensis* (Figs. 15, 28) which is sympatrically found in the same locality, by absence of mental disc (vs. presence of mental disc; Figs. 15, 28), smaller intestine, and bipartite swimbladder (vs. longer intestine and either a single chambered or bipartite swimbladder in *G. lorestanensis*), which was previously reported too by Sargeran et al. (2008). *Garra typhlops* can be osteologically distinguished from *G. lorestanensis* by absent of preorbital bones that enclose the infraorbial canal (vs. reduced in *G. lorestanensis*); the posterior pharyngeal process of the basioccipital is directed vertically with lateral ridges (vs. broad directing horizontally with a vertical ridge on its ventral face in *G. lorestanensis*), commonly 34 vertebrae in *G. typhlops* (vs. commonly 35 vertebra in *G. lorestanensis*), narrow
haemal spine of the fourth fused vertebra of the Weberian apparatus in *G. typhlops* (vs. wide in *G. lorestanensis*); PU2 of the caudal skeleton is well-developed with a long neural spine (vs. small PU2 with a short neural spine in *G. lorestanensis*).

*Garra typhlops* is easily distinguished from its sympatric subterranean loach, *Paracobitis smithi* (Fig. 30) by having two pairs of barbels (vs. three pairs), and absence of adipose keel (vs. presence of a weak adipose keel).

**Comparative materials:** *Garra gymnothorax*: ZIN 13214, 7 syntypes, 39-57 mm SL; Iran: Kulikhan, Karun River system, H. Zarudnyy, 6 June 1904.

*Garra cf. gymnothorax*: FSJF 2198, 19, 40-94 mm SL; Iran: Kohkeloyeh va Boyraknam prov.: Bashar River 20 km northeast of Yasooj, 30°44'9.12"N 51°29'31.32"E. FSJF 2209, 9, 66-129 mm SL; Iran: Chaharmahal Bakhtiari prov.: Stream Sangan at Sangan, 31°15'41.52"N 51°17'9.00"E.

*Garra lorestanensis* CMNFI 2007-0124, 2, 27.0-31.6 mm SL; type locality.

*Garra nudiventris*: CMNFI 2007-0025, 8, 36.6-47.1 mm SL; Khorasan, qanat south of Birjand, ca. 32°24'N, ca. 59°49'E. – CMNFI 2007-0026, 19, 36.3-62.9 mm SL; Khorasan, qanat at Shusf, 31°48'N, 60°01'E. CMNFI 2007-0027, 13, 31.4-60.7 mm SL;
Khorasan, qanat at Khvansharaf, 31°34'N, 60°06'E. CMNFI 2007-0028, 13, 36.3-58.9mm SL; Khorasan, qanat at Khunik-e Pa'in, 31°28'N, 60°06'E. CMNFI 2008-0197, 1, 73.6mm SL; South Khorasan, Birjand qanats, 32°52'N, 59°12'E. CMNFI 2008-0199, 1, 73.1mm SL; South Khorasan, Birjand qanats, 32°52'N, 59°12'E. CMNFI 2008-0200, 1, 70.7mm SL; South Khorasan, Birjand qanats, 32°52'N, 59°12'E.

Garra persica. FSJF 2218, 20, 50-83mm SL; Iran: Hormuzgan prov.: River Rodan about 6 km northeast of Rodan, 27°28'53.70"N 57°15'53.70"E. FSJF 397, 20, 35-50mm SL; Iran: Sistan & Baluchestan prov.: Karvander River at bridge north of Karvander, 27°51'18"N 60°46'03"E. ZM-CBSU 10200, 30, 34-56mm SL; Iran: Fars prov.: Rasool River at God e Gaz village, 27°17'28.8"N 54°29'20.7"E. CMNFI 1979-0138, 1, 25.7mm SL; Fars-Hormozgan border, stream in Rasul River drainage (ca. 27°32'N, ca. 54°58'30"E). CMNFI 1979-0139, 1, 30.6mm SL; Fars-Hormozgan border, stream in Rasul River drainage (ca. 27°25'30"N, ca. 54°59'E). CMNFI 1979-0144, 1, 27.3mm SL; Hormozgan, Minab River at Minab (27°09'30"N, 57°04'E). CMNFI 1979-0145, 4, 14.8-25.4mm SL; Hormozgan, Geru River south of Minab (26°55'N, 57°01'30"E). CMNFI 1979-0149, 7, 29.0-49.4mm SL; Hormozgan, stream north of Bandar Abbas (27°36'N, 56°14'E). CMNFI 1979-0152, 1, 62.2mm SL; Hormozgan, Shur River drainage (28°09'N, 55°43'E). CMNFI 1979-0178, 23, 25.1-66.9mm SL; Hormozgan, Sarzeh River drainage (27°36'N, 56°15'E). CMNFI 1979-0180, 1, 42.7mm SL; Hormozgan, stream 3km east of Essin (27°19'N, 56°17'30"E). CMNFI 1979-0181, 1, 44.0mm SL; Hormozgan, Kul River (27°17'30"N, 56°03'30"E). CMNFI 1979-0186, 8, 30.2-64.6mm SL; Hormozgan, stream and pools at Sar Khun (ca. 27°24'30"N, ca. 56°25'E). CMNFI 1979-0187, 9, 32.1-57.9mm SL; Hormozgan, stream and pools at Sar Khun (27°23'30"N, 56°26'E). CMNFI 1979-0312, 10, 26.6-35.6mm SL; Baluchestan, dam on Bampur River (27°11'N, 60°36'E). CMNFI 1979-0315, 1, 23.8mm SL; Baluchestan, Bampur River 2km north of Karvandar (27°51'N, 60°46'E). CMNFI 1979-0324, 1, 29.6mm SL; Baluchestan, Bampur River at Sa'idabad (27°11'N, 60°22'E). CMNFI 1979-0329, 2, 25.4-30.8mm SL; Baluchestan, stream at Zaminbandan (27°02'N, 61°20'E). CMNFI 1979-0411, 1, 60.4mm SL; Hormozgan, Minab River (27°24'N, 57°12'E). CMNFI 1979-0412, 9, 22.9-39.3mm SL; Hormozgan, spring at Saras (27°30'N, 57°34'E). CMNFI 1979-0416, 39, 15.1-46.8mm SL; Hormozgan, Ab Garm-e Ganow (ca. 27°26'N, ca. 56°20'E); CMNFI 2007-0051, 10, 29.5-43.7mm SL; Hormozgan, upper Kol River basin (28°19'N, 55°55'E). CMNFI 2007-0055, 5, 30.9-44.6mm SL; Hormozgan, Minab River basin (27°47'N, 57°12'E); CMNFI 2007-0056, 2, 32.1-54.2mm SL; Kerman, qanat at Kahnuj (27°58'N, 57°45'E). CMNFI 2007-0058, 7, 36.7-51.7mm SL; Fars, headwaters of Gowdar River (ca. 27°24'N, ca. 54°16'E). CMNFI 2008-0142, 1, ?mm SL; Hormozgan, Jaghin River (27°12'N, 57°25'E).

Garra rufa. Qweik drainage: NMW 53240, lectotype (101mm SL) and 7 paralectotypes of D. rufus, 59-101mm SL; Syria: Aleppo; T. Kotschy, 1842. NMW 53238, syntypes of D. obtusus, 2, 43-134mm SL; Syria: Aleppo; T. Kotschy, 1842. Euphrates and Tigris drainage: NMW 53257, 6 syntypes of D. obtusus, 31-104mm SL; Iraq: Mossul; T. Kotschy, 1842. NMW 53236-37, syntypes of D. crenulatus, 4, 56-74mm SL; Iran: Qarah Aqaj River. FSJF 2238, 22, 55-101mm SL; Iran: Fars prov.: Spring Pirbanoo about 10km south of Shiraz, 29°31'8.10"N 52°27'55.98"E. FSJF 2549, 8, 43-82mm SL; Turkey: Adiyaman prov.: stream Egrı south of Adiyaman, a tributary to Atatürk reservoir, 37°44'30.00"N 38°20'6.48"E. FSJF 2588, 5, 58-65mm SL; Turkey: Adiyaman prov.: stream Çakal, 13km west of Adiyaman, a tributary to Atatürk reservoir, 37°44'30.00"N 38°20'6.48"E. FSJF 2588, 5, 58-65mm SL; Turkey: Adiyaman prov.: stream Ambar at road to Silvan, 25km east of
Garra typhlops: CMNFI 2007-0124, 6, 27.3-42.2mm SL; type locality. CMNFI 2008-0176, 1, 31.2mm SL; type locality. CMNFI 2008-0177, 1, 30.4mm SL; type locality.

Material used for molecular study: Garra barreimiae. FSJF DNA-2488; UAE: Wadi Shawkah, in Emirate of Ras Al-Khaimah, 25°05’54”N 56°06’33”E (GenBank accession numbers: KM214685, KM214738, KM214758, KM214779). FSJF DNA-2489; UAE: Wadi Wurayah in Emirate of Al-Fujaira, 25°23’54”N 56°16’10”E (GenBank accession numbers: KM214734, KM214767, KM214783).


Garra cf. longipinnis: FSJF DNA-2493; Oman: Al-Saïq Platte at Jabal al Akhdar, 23°02’00”N 57°28’00”E (GenBank accession numbers: KM214752, KM214756).

Garra ghorensis: FSJF DNA-1193; Jordan: Spring at Ghor al Hadithah, 31°17’47”N 35°32’33”E (GenBank accession numbers: KJ553478, KJ553508, KJ553520). – FSJF DNA-1225; Jordan: stream below Afra hot spring, 30°57’56”N 35°40’56”E (GenBank accession number: KJ553401). FSJF DNA-2495; Jordan: Wadi Burbaita at the upper part of Wadi Al-Hassa, 30°59’01”N 35°40’11”E (GenBank accession numbers:


Garra variabilis: FSJF DNA-1159; Syria: Nahr al Barid at Nahr al Barid, 35°18'08"N 36°20'43"E
(GenBank accession numbers: KJ553391, KJ553567) FSJF DNA-1168; Syria: Orontes at Shayzar, 35°16'18"N 36°33'46"E (GenBank accession numbers: KJ553422, KJ553524).

Garra widdowsoni: FSJF DNA-2301; Iraq: cavern 25 feet below ground, 6 miles north of Haditha, 34°4'0.00"N 42°23'60.00"E (GenBank accession numbers: KM214769, KM214795).

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References


بازنگری جنس 1822 Garra Hamilton, در ایران، همراه با توصیف یک گونه جدید: رویکرد ریختی-مولکولی (ماهیان استخوانی عالی: کپور ماهیان)

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چکیده: گونه‌های مختلف جنس Garra در ایران مورد بازبینی قرار گرفته و برای تمامی گونه‌های مشخص شده ویژگی تشخیصی آنها G. rufa, G. persica, G. nudiventris, G. mondica, G. lorestanensis, G. gymnothorax, G. variabilis و G. typhlops هم نام گونه Discognathus crenulatus Heckel, 1847 در نظر گرفته شد. به این ترتیب یک گونه جدید از حوزه آبریز تیپرس در ایران توصیف شد. این گونه از دیگر گونه‌های هم جنس خود در داشتن ویژگی‌های زیر قابل تشخیص می‌باشد: تعداد 7 شعاع نرم در باله پشتی، فلسفه بسیار ریز در ناحیه سینه و شکم که بطور کامل توسط یک لایه پلاستیکی پوشانده می‌شوند و تعداد 408 شعاع نرم در باله دمی. همچنین از تمامی گونه‌های هم جنس خود در حوزه خلیج فارس، به جز یک گونه فاقد دیسک، در G. elegans، G. amirhosseini از داشتن تعداد دو جابجای توکلیوئید تشخیصی در زن سیتوکروم اپیدرومی می‌باشد. برآورد بیشترین درستنمایی G. variabilis vs. Garra barreimiae (amirhosseini vs. Garra elegans) و بیشترین آن 16 درصد (امامی، خوشنویسی، خارمی، خلیج فارس).

کلمات کلیدی: Garra amirhosseini, توصیف یک گونه، رویکرد ریختی-مولکولی، اختلافات، خلیج فارس.