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Garra surinbinnani, a new species of labeonine from the Mae Khlong basin of Thailand (Teleostei: Cyprinidae)

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Garra surinbinnani, new species, is described from the Mae Khlong basin of western Thailand. It is the fourth species of *Garra* known from the basin and occurs syntopically with the other three species in fast-flowing rocky riffles. Within the Mae Khlong basin, it is most similar to *G. fuliginosa* from which it differs most obviously in having a bilobed (vs. trilobed) proboscis on the snout and 12–13 (vs. 15–16) circumpeduncular scales. *Garra surinbinnani* is readily distinguished from other species of *Garra* with a proboscis in Southeast Asia – *G. notata* and *G. salweenica* in the Salween basin, and *G. cyrano* in the Mekong basin – in having 12–13 (vs. 15–16) circumpeduncular scales, and from all species of *Garra* outside Southeast Asia with a bilobed proboscis and 12–13 circumpeduncular scales by having 28–31 (vs. 34 or more) lateral-line scales.

Introduction

With ca. 170 species (Fricke et al., 2019), *Garra* is one of the most diverse genera of fishes in the world. The genus ranges from western Africa to China, north to Turkey and Afghanistan, and south to Borneo. Most species of *Garra* live in fast-flowing, upland streams (Zhang & Chen, 2002), and many of the species are confined to small geographic areas; e.g. Kullander & Fang (2004) documented the presence of seven species in Rakhine State, Myanmar, none of which is known to occur elsewhere, and Tamang et al. (2019) reported 18 species in the Brahmaputra River drainage of Arunachal Pradesh State in northeastern India.

Tongnunui et al. (2016) recorded three species of *Garra* from the Mae Khlong basin in western Thailand: *G. cambodgiensis*, *G. fuliginosa*, and *Garra* species. The last species, which apparently is endemic to the Mae Khlong basin, was described soon thereafter by Kangrang et al. (2016) as *G. fluviatilis*. Recent collections in the basin have included a fourth species, previously confused with *G. fuliginosa*. Like *G. fuliginosa*, it has a proboscis and a transverse lobe on the snout but otherwise is easily distinguishable from *G. fuliginosa* and all other species of *Garra*. The new species is described herein.

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Materials and methods

Measurements were taken to the nearest 0.1 mm using digital calipers. Morphometric data are expressed as percentages of standard length (SL) or of head length (HL). Measurements follow Hubbs & Lagler (1958) except for body depth, which was measured at the dorsal-fin origin, and prepectoral, prepelvic, and preanal lengths, which were taken from the anterior tip of the snout to the origin of each fin. Total ray counts are given for paired fins, branched ray counts are given for unpaired fins. The last branched ray of the dorsal and anal fins, sharing a pterygiophore with the penultimate ray, is given as ½. Numbers of scales between dorsal-fin origin and lateral line, and between lateral line and anal-fin origin, are numbers of whole scales. Number of scales between the anus and anal fin is the number of fully exposed scales. Measurements and counts were taken from the left side whenever possible. Vertebral counts were made on micro-computed tomography scans, with the first caudal vertebra with its hemal spine posterior to the anterior-most anal-fin pterygiophore; counts of abdominal vertebrae include the Weberian complex (n = 4 vertebrae), and counts of caudal vertebrae include the urostyle complex (n = 1 vertebra). Descriptions of the snout follow Nebeshwar & Vishwanath (2017). Data on *G. arunachalensis*, *G. chindwinensis*, *G. motuoensis*, and *G. yajiangensis* were taken from Gong et al. (2018), Nebeshwar & Vishwanath (2013), Premananda et al. (2017), and Yu et al. (2016). Abbreviations for institutional collections are: ANSP, Academy of Natural Sciences of Drexel University, Philadelphia; THNHM, Thailand Natural History Museum, National Science Museum, Pathum Thani; UF, University of Florida, Florida Museum of Natural History, Gainesville; and ZRC, Zoological Research Collection, Lee Kong Chian Natural History Museum, Singapore.

Photographs of live and preserved specimens were taken with a Canon 7D camera. All images of live specimens were taken immediately after capture. Figures were edited using Adobe Photoshop CC 2018. Computed tomography scans of *G. surinbinnani* were generated using a Phoenix v|tome|x M scanner (GE Measurement & Control, Boston, USA) at the University of Florida's Nanoscale Research Facility. X-ray data were processed using datos|x software v. 2.3 and segmented and visualized using VG StudioMax v. 3 (Volume Graphics, Heidelberg, Germany). The scan data are freely available for download at MorphoSource (https:\\morphosource.org). Maps were produced using ArcMap 10.5 in ArcGIS.

Table 1. Specimens included in the molecular phylogeny and their associated GenBank accession numbers and GenSeq assignments.

Species	Catalog no	Tissue no	COI	RAG1	GenSeq
Garra cambodgiensis	UF 170343	2007-1142	MK902673	MK902692	genseq-4
G. cambodgiensis	UF 183816	2012-0144	MK902674	MK902693	genseq-4
G. cambodgiensis	UF 237398	2015-0426	MK902675	MK902694	genseq-4
G. surinbinnani	UF 191337	ICH-01557	MK902676	MK902695	genseq-3
G. surinbinnani	UF 192073	ICH-02853	MK902677	MK902696	genseq-3
G. surinbinnani	UF 192195	ICH-02620	MK902678	MK902697	genseq-3
G. fasciacauda	UF 185133	2012-0696	MK902679	MK902698	genseq-4
G. fluviatilis	UF 176452	2009-0598	MK902680	MK902699	genseq-3
G. fluviatilis	UF 181134	2011-0190	MK902681	MK902700	genseq-3
G. fuliginosa	UF 170307	2007-1187	MK902682	MK902701	genseq-4
G. fuliginosa	UF 183401	2012-0342	MK902683	MK902702	genseq-4
G. fuliginosa	UF 188288	ICH-00097	MK902684	MK902703	genseq-4
G. fuliginosa	UF 191353	ICH-01617	MK902685	MK902704	genseq-4
G. fuliginosa	UF 191849	ICH-02911	MK902686	MK902705	genseq-4
G. notata	UF 192116	ICH-02881	MK902687	MK902706	genseq-4
G. salweenica	UF 183869	2012-0249	MK902688	MK902707	genseq-4
Barbonymus gonionotus	UF 161762	2005-0841	MK902689	MK902708	genseq-4
Cirrhinus microlepis	UF 190978	ICH-01238	MK902690	MK902709	genseq-4
Opsarius signicaudus	UF 192165	ICH-02833	MK902691	MK902710	genseq-4

Fig. 1. *Garra surinbinnani,* THNHM-F0015381, holotype, 58.3 mm SL; Thailand: Kanchanaburi Province: Ulong Creek.

Phylogenetic analyses included molecular data (Table 1) from Southeast Asian species of *Garra* that have a proboscis or occur in the Mae Khlong basin. *Garra fasciacauda* was included to test hypothesized relationships of *G. cambodgiensis* (Yang et al., 2012; Sun et al., 2018). GenSeq designations were assigned following Chakrabarty et al. (2013). Outgroups were *Barbonymus gonionotus*, *Cirrhinus microlepis*, and *Opsarius signicaudus*.

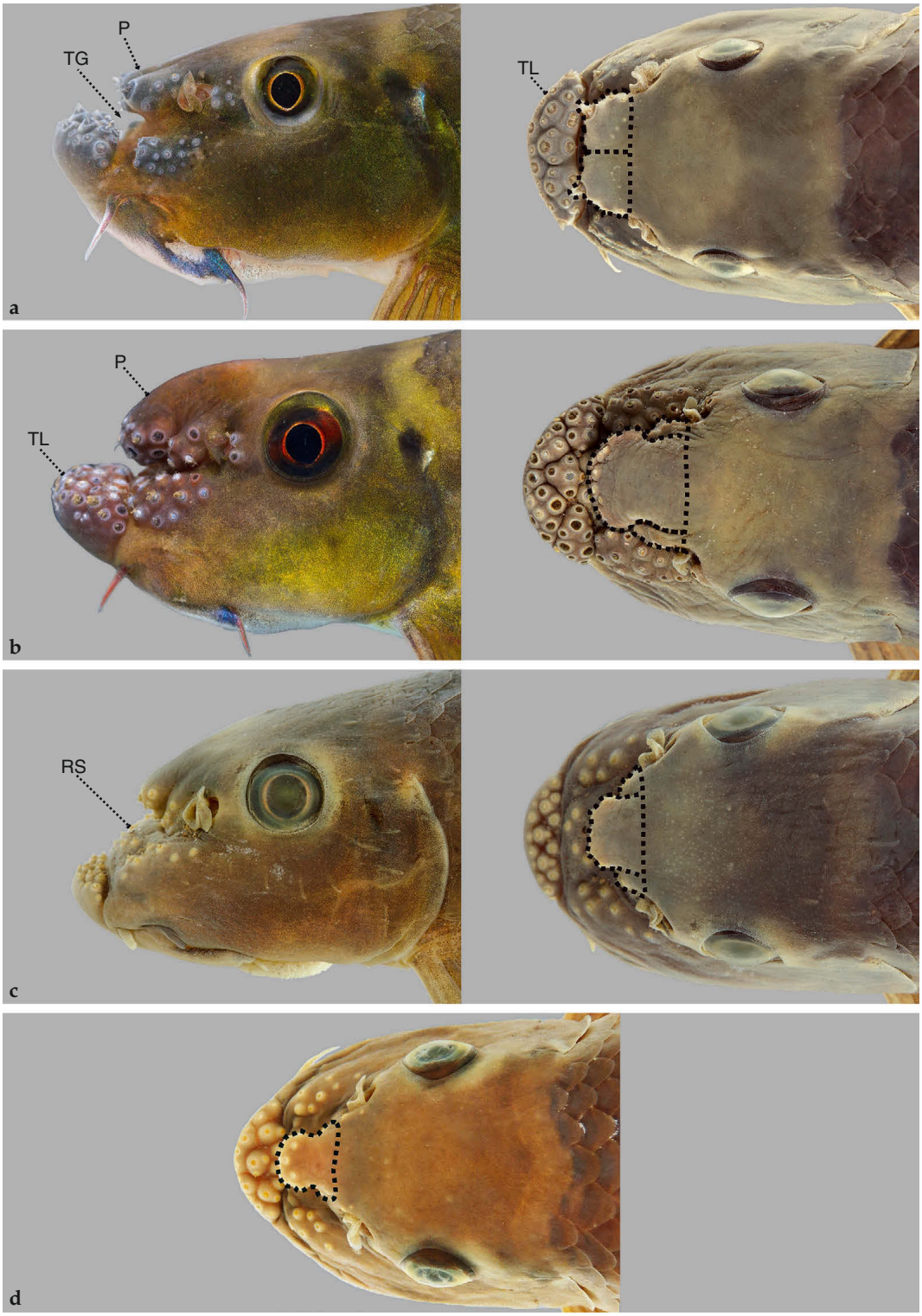
DNA was extracted from tissue samples using the QIAamp DNA mini kit (Qiagen). Mitochondrial cytochrome oxidase (COI) and nuclear recombination activating (RAG1) genes were amplified by polymerase chain reaction (PCR) and sequenced using the following primers: FISH-BCL 5'-TCAACYAATCAYAAAGATATYGGCAC-3', FISH-BCH 5'-ACTTCYGGGTGRCCRAARAATCA-3' (Baldwin et al., 2009), RAG1-F 5'-AGCTGTAGTCAGTAYCACAARATG-3' (Quenouille et al., 2004), and RAG-RV1 5'-TCCTGRAAGATYTTGTAGAA-3' (Šlechtová et al., 2007). PCR was conducted using 25 µL solutions containing 1 µL each primer at 10 mM; 0.25 µL MyTaq Red polymerase and 4 µL buffer (Bioline Reagents); and 2 µL DNA template. Thermocycling parameters followed Liu et al. (2012). Purification and bidirectional Sanger sequencing were performed by Eurofins Genomics.

Chromatograms were assembled and edited with Geneious 8.1.9. Alignment and concatenation of the two gene loci were implemented with Mesquite 3.5 (Maddison & Maddison, 2018) using Clustal W 2.1 (Larkin et al., 2007). Uncorrected p-distances were averaged for COI with MEGA 7.0.26 (Kumar et al., 2016). Partitioning and phylogenetic analyses were carried out on the concatenated two-gene dataset using the high performance cluster (HiPerGator) at the University of Florida. Partitions and the model of nucleotide substitution were selected with PartitionFinder 2.1.1 (Lanfear et al., 2016) using linked branch lengths, the corrected Akaike information criterion, and a greedy search algorithm (Lanfear et al., 2012). Maximum likelihood (ML) analysis and bootstrapping were conducted with RAxML 8.2.10 (Stamatakis, 2014) using complete random starting trees, the default rapid hill-climbing algorithm, 100 independent tree searches, and 500 bootstrap replicates, as determined by the autoMRE convergence criterion. Bayesian inference (BI) analysis was conducted with MrBayes 3.2.6 (Ronquist et al., 2012) using two independent runs of four chains and 20 million generations, sampling trees every 1000 generations and discarding the first 25 % as burn-in.

Garra surinbinnani, new species
(Fig. 1, Tables 2–3)

Holotype. THNHM-F0015381, 58.3 mm SL; Thailand: Khwae Noi basin: Kanchanaburi Province: Ulong Creek at Vale Resort on Rt. 323, Thong Pha Phum District, 14°45'32"N 98°38'49"E; S. Tongnunui, D. Boonwun, Z. S. Randall, D. A. Boyd, R. J. Thoni and L. M. Page, 23 Jan 2018.

Paratypes. UF 192068, 5, 47.9–61.5 mm SL; same data as holotype. – UF 183335, 7, 42.1–54.0 mm SL; ANSP 205735, 2, 49.8–51.2 mm SL; and ZRC 60823, 2, 46.8–48.2 mm SL; Thailand: Khwae Noi basin: Kanchanaburi Province: Khayeng River SW


P
TG
TL
a
P
TL
b
RS
c
d

◁ **Fig. 2.** Lateral and dorsal views of the head of: **a,** *G. surinbinnani* with bilobed proboscis, UF 192384, 117.4 mm SL; **b,** *G. fuliginosa* with trilobed proboscis, UF 237392, 116.2 mm SL; **c,** *G. salweenica* with trilobed proboscis, UF 183853, 101.7 mm SL; **d,** dorsal view of the head of *G. cyrano* with unilobed proboscis, ZRC 45303, holotype, 89.7 mm SL. P, proboscis; TG, transverse groove; TL, transverse lobe; RS, rostral surface.

of Khayeng Creek off Rt. 3272, Thong Pha Phum District, 14°38'54" N 98°34'45" E; R. Plongsesthee, R. A. Singer, Z. P. Martin and Z. S. Randall, 31 Dec 2011. – UF 192195, 1, 101.7 mm SL; Thailand: Khwae Yai basin: Tak Province: Mae Khlong Yai Creek 6.5 km S of Ban Mae Khlong Noi [village] on Rt. 1090, Umphang District, 16°19'01" N 98°59'42" E; L. M. Page, Z. S. Randall, S. Tongnunui, D. A. Boyd and D. Boonwun, 8 Jan 2018.

Additional material (non-types). Thailand: Mae Khlong basin: Kanchanaburi Province: UF 176420, 1, 34.7 mm SL; Khayeng Creek at Rt. 3272, Thong Pha Phum District, 14°39'35" N 98°32'01" E; W. Tangjitjaroen, 3 Jan 2010. – UF 181152, 1, 116.6 mm SL; Ban Huai Paousa [Paousa Creek village], Thong Pha Phum District, 14°36'22" N 98°28'14" E; R. Plongsesthee et al., 26 Apr 2011. – UF 188715, 1, 106.0 mm SL; Khayeng River at Rt. 3272, Thong Pha Phum District, 14°39'00" N 98°34'31" E; W. Beamish, 7 Mar 2002. – UF 188777, 2, 36.4–112.9 mm SL; Khayeng River 4 km SSW of Ban Pracham Mai [village], Thong Pha Phum District, 14°33'22" N 98°34'19" E; W. Beamish, 13 Nov 2002. – UF 188783, 3, 52.9–102.7 mm SL; same data as UF 188715. – UF 191308, 1, 42.3 mm SL; Malai River 2 km N of river mouth at Vajiralongkorn reservoir, Sangkhla Buri District, 15°08'06" N 98°22'10" E; J. M. Pfeiffer et al., 7 Jan 2017. – UF 191337, 18, 34.6–49.5 mm SL; Pracham Mai River at Rt. 3272, Thong Pha Phum District, 14°39'34" N 98°32'02" E; T. Thanikkul et al., 6 Jan 2017. – UF 191510, 1, 32.2 mm SL; Lamun River at Rt. 3199, Si Sawat District, 14°34'04" N 99°12'14" E; K. Seha et al., 12 Jan 2017. – UF 191768, 5, 31.9–40.8 mm SL; Mae Nam Noi Creek, Sai Yok District, 14°25'39" N 98°50'10" E; L. M. Page et al., 24 Jan 2018. – UF 191868, 7, 45.3–56.2 mm SL; same locality data as UF 191337; Z. S. Randall et al., 22 Jan 2018. – UF 192366, 1, 44.5 mm SL; Khayeng River at FWFCC/SEAECO station, Thong Pha Phum District, 14°37'38" N 98°34'19" E; S. Tongnunui et al., 19 Dec 2018. – UF 192384, 1, 117.4 mm SL; and UF 192406, 1, 82.4 mm SL; Song Thai River behind Maharaja field station in Thung Yai Wildlife Sanctuary, Thong Pha Phum District, 15°12'39" N 98°51'16" E; J. Liao et al., 13–16 Dec 2018. – UF 192531, 2, 36.0–40.0 mm SL; Li Chia River at Rt. 323, Thong Pha Phum District, 15°04'13" N 98°33'46" E; D. A. Boyd et al., 7 Jan 2017. – UF 237393, 2, 34.8–36.6 mm SL; Phachi River approx. 2 miles W of Dan Makham Tia, Dan Makham Tia District, 13°51'21" N 99°22'48" E; P. Nithirojpakdee et al., 26 Jan 2015. – UF 237394, 2, 35.0–43.1 mm SL; same locality data as UF 191337; 28 Jan 2015. – UF 237396, 2, 45.0–47.9 mm SL; Song Karia River at Rt. 323, Sangkhla Buri District, 15°13'23" N 98°26'47" E; L. M. Page et al., 29 Jan 2015. Tak Province: UF 191801, 3, 85.2–127.9 mm SL; Nam Khiao Creek on Rt. 1090, Umphang District, 16°17'16" N 98°59'46" E; D. Boonwun et al., 8 Jan 2018. – UF 191925, 1, 46.5 mm SL; Khwae Yai River at Ban Mae Khlong Kee [village] on Rt. 1090, Umphang District, 16°13'43" N 98°55'29" E; Z. S. Randall et al., 11 Jan 2018. – UF 192073, 2, 39.2–41.1 mm SL; Khwae Yai River at confluence with Umphang Creek, Umphang District, 16°01'21" N 98°51'09" E; S. Tongnunui et al., 10 Jan 2018.

Fig. 3. Mouth of *Garra surinbinnani*, UF 181152, 116.6 mm SL.

Diagnosis. *Garra surinbinnani* is distinguished from all other species of *Garra* by the combination of a more-or-less rectangular (viewed dorsally), bilobed proboscis on the snout (Fig. 2), a large transverse lobe separated from the rest of the snout by a deep transverse groove, 12–13 circumpeduncular scales, and 28–31 lateral-line scales.

Description. Morphometric data in Table 2, meristic data in Table 3, shape and color in Figures 1–5. Body elongate, more or less rounded anteriorly, compressed posteriorly; dorsal profile arched to dorsal-fin origin, then tapering to caudal peduncle; ventral profile straight to caudal peduncle, then slightly concave. Head depressed, slightly wider than long (Fig. 2). Tip of snout broadly rounded when viewed dorsally. Transverse lobe large with 3 rows of large tubercles on dorsum,

lobe separated from rest of snout by deep transverse groove. Small to large tubercles on side of snout anterior to nostrils; small tubercles on head posterior to nostrils. Depressed rostral surface of snout exposed only in small individuals, without tubercles; areas lateral to rostral surface with tubercles. Proboscis large, more-or-less rectangular with a medial cleft and one large tubercle at each anterior corner, 1–2 smaller tubercles between large tubercles on large individuals. Proboscis in contact with or separated ventrally from snout by narrow space in juveniles, well separated from snout in largest individuals. Eye small, dorsolateral, near middle of head longitudinally.

Two pairs of barbels; rostral barbel shorter than eye diameter; maxillary barbel at corner of

Table 2. Morphometric data for *Garra surinbinnani* (ANSP 205735; UF 181152, 183335, 188715, 188777, 188783, 191337, 237393, 237394, 237396; ZRC 60823) and *G. fuliginosa* (UF 170307, 183401, 188869, 191353, 191764, 183401).

	G. surinbinnani n = 32			*G. fuliginosa* n = 16		
	range	mean	SD	range	mean	SD
Standard length (mm)	35.0–116.6	53.4	–	34.6–154.4	71.2	–
In percent of standard length						
Head length	19.7–27.1	24.3	1.80	22.2–32.0	26.5	2.47
Head width	15.6–22.5	19.6	1.34	17.8–20.4	19.1	0.73
Snout length	9.5–13.4	11.6	0.98	12.2–14.7	13.5	0.86
Eye diameter	4.2–6.7	5.4	0.67	4.8–7.3	6.1	0.77
Interorbital width	9.1–12.5	10.7	0.63	9.3–11.3	10.2	0.52
Pectoral fin length	16.1–26.8	20.5	2.78	17.7–23.4	20.4	1.65
Pelvic fin length	15.6–22.5	17.9	1.40	17.3–23.0	19.8	1.62
Pre-pelvic fin length	47.6–56.8	52.4	2.27	49.9–56.6	54.2	1.89
Pre-dorsal length	43.6–50.9	47.3	1.68	41.5–51.6	46.6	2.73
Pre-anal fin length	74.5–83.5	78.8	2.43	75.8–83.3	80.4	2.03
Body depth	20.0–32.2	24.1	1.95	23.9–27.1	25.4	1.04
Caudal-peduncle depth	11.8–14.5	13.1	0.69	11.8–14.0	13.2	0.73
Caudal-peduncle length	9.7–17.6	13.7	2.30	9.5–15.4	12.4	1.59
In percent of head length						
Head width	60–98	80.9	7.8	62–82	72.6	5.7
Snout length	39–59	48.0	4.4	43–58	51.4	4.7
Gape width	28–63	44.8	8.3	35–60	51.6	6.7
Eye diameter	17–33	22.4	3.2	20–28	23.2	1.9
Interorbital width	35–57	44.1	4.4	33–43	38.7	2.9

Table 3. Meristic data for *Garra surinbinnani* and *G. fuliginosa*. Specimens same as in Table 2.

	G. surinbinnani n = 32		*G. fuliginosa* n = 16	
	range	mode	range	mode
Anal rays	5½–5½	5½	5½–6½	5½
Caudal rays	17	17	17	17
Dorsal rays	8½–9½	8½	8½–8½	8½
Pectoral rays	11–17	13–14	13–14	13
Pelvic rays	7–10	9	8–9	9
Lateral-line scales	28–31	29–30	29–30	30
Lateral-line pores on caudal fin	2–4	3	2–4	3
Predorsal scales	8–10	9	9	9
Scales from lateral line to dorsal-fin origin	4–5	4	3–4	4
Scales from lateral line to anal-fin origin	3–4	3	3–4	3
Scales between anus and anal fin	3–5	4	3–5	4
Circumpeduncular scales	12–13	12	15–16	15

Fig. 4. Lateral views of: **a,** *Garra surinbinnani,* UF 192195, paratype, 101.7 mm SL; **b,** *G. fuliginosa,* UF 237392, 116.2 mm SL; **c,** *G. salweenica,* UF 183853, 101.7 mm SL.

mouth (Fig. 3), shorter than rostral barbel. Rostral cap well developed, crenulated, with wide papillate margin; separated from upper jaw by deep groove. No upper lip; upper jaw covered by rostral cap; papillose fold in corner of mouth. Lower lip an elliptical disc, shorter than wide; anterior margin a crescentic fold of skin covered by small papillae; fold anteriorly separated from lower jaw by deep groove, posteriorly separately from central callous pad by shallow groove; lateral and posterior margins of central pad papillate and free; posterior margin of disc posterior to eye.

Dorsal fin with 2–3 simple and 8½–9½ (modally 8½) branched rays; distal margin concave; origin closer to snout tip than to caudal-fin base, far in front of pelvic-fin origin. Anal fin with 5½ branched rays; distal margin straight to concave; tip not extending to base of caudal fin; origin

Fig. 5. Lateral views of juveniles of: **a,** *Garra surinbinnani*, UF 237393, 36.6 mm SL; **b,** *G. fuliginosa*, UF 191353, 43.6 mm SL; **c,** *G. salweenica*, UF 183853, 44.4 mm SL; **d,** *G. fluviatilis*, UF 191270, 37.8 mm SL.

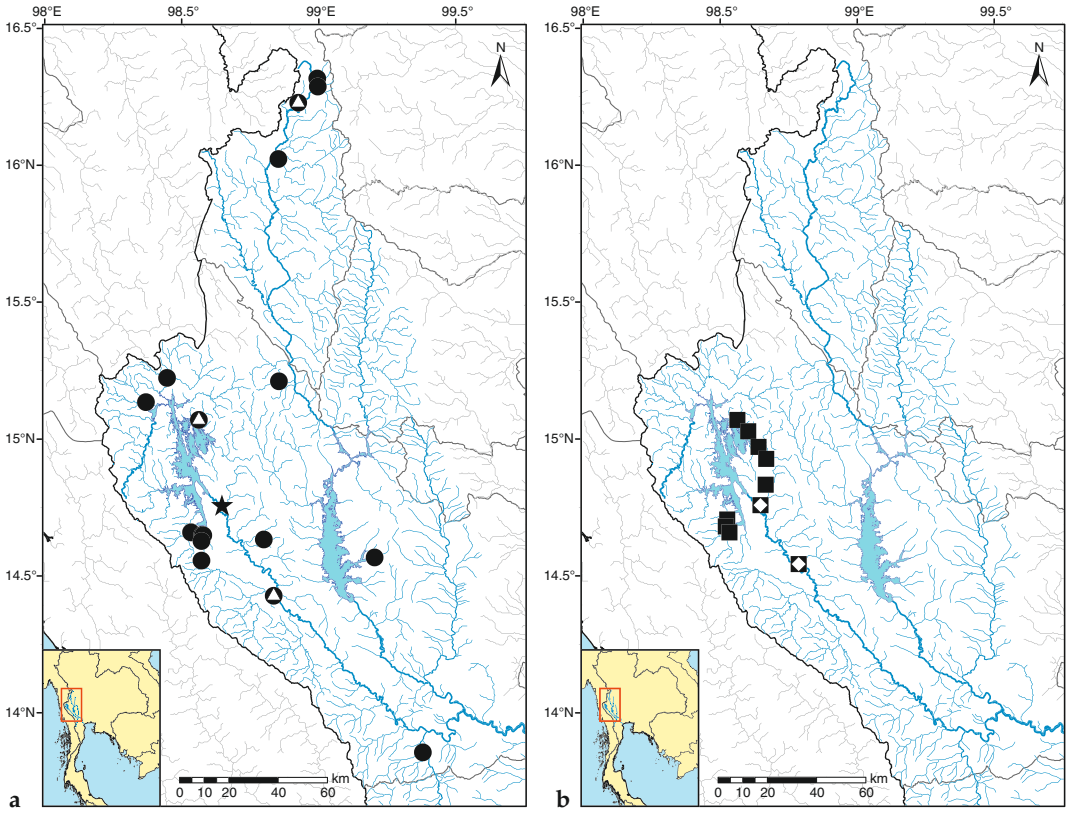


Fig. 6. Distributions of: **a,** *Garra surinbinnani* (●) and *G. fuliginosa* (△), and **b,** *G. fluviatilis* (■) and *G. cambodgiensis* (◇) in the Mae Khlong basin. ★, type locality of *G. surinbinnani*.

slightly closer to caudal-fin origin than to pelvic-fin origin. Caudal fin forked with 17 branched rays (9 upper, 8 lower); tips of lobes rounded to slightly pointed, lobes equally long. Pectoral fin with 11–17 rays, reaching past midway from origin to pelvic-fin origin. Pelvic fin with 7–10 rays, reaching past midway from origin to anal-fin origin, surpassing anus. Lateral line complete with 28–31 (modally 30) scales, 2–3 pored scales on caudal fin. Scales in transverse row between dorsal-fin origin and lateral line 3–4, between lateral line and anal-fin origin 2–3, predorsal scales 8–10, circumpeduncular scales 12–13, 2½–3½ scales between anus and anal-fin base. Two long axillary scales dorsally, 1 ventrally, at base of pelvic fin. Abdominal vertebrae 21, caudal vertebrae 11, total vertebrae 32 (n = 1).

Color in life. Head and body of adults dark brown overall; wide dusky black stripe usually along midside (Fig. 4a). Juveniles with 3–6 dusky black stripes on side of body, middle 2 darkest; stripes darker on posterior half of body (Fig. 5a). Fins dusky overall with melanophores concentrated along rays; membranes clear to dusky to black; dorsal and anal fins often with yellow tips. Some individuals with melanophores concentrated along anterior margins of fins and along upper and lower margins of caudal fin. Large adults of both sexes may have bright yellow scales scattered on posterior half of body, tuberculated areas on head, and base of maxillary barbel blue (Fig. 2a).

Etymology. The specific name *surinbinnani,* a noun in genitive case, is the concatenated form of the chosen appellation of our friend and colleague, Mr. Amphol Tapanapunnitikul. Surin Binnan was director of the Foundation of Western Forest Complex Conservation and a leading figure in efforts to protect natural areas in Thailand.

Distribution and habitat. *Garra surinbinnani* appears to be endemic to the Mae Khlong basin in western Thailand (Fig. 6). It occurs sympatrically with G. *fuliginosa* in fast rocky riffles in streams throughout the basin and with *G. cambodgiensis* and *G. fluviatilis* in the Khwae Noi, the large western tributary of the Mae Khlong basin.

Discussion

Species of *Garra* in Southeast Asia with a proboscis and a transverse lobe on the snout in addition to *G. surinbinnani* are *G. fuliginosa*, *G. salweenica* and *G. notata* in the Salween basin, and *G. cyrano* in the Mekong basin (Nebeshwar & Vishwanath, 2017). Although Nebeshwar & Vishwanath (2017) reported *G. notata* to have a smooth snout, in the original description (as *Platycara notata*) Blyth (1860) noted that the species has characteristics typical of the genus as exemplified by *Platycara nasuta* (now *Garra nasuta*), which McClelland (1838) described as having "snout abruptly depressed between the eyes with a large pit between the nostrils." The depression, pit and what appears to be a proboscis on *G. nasuta* are illustrated by McClelland (1838: pl. 55), as noted by Nebeshwar & Vishwanath (2013).

Garra surinbinnani is readily distinguished from all four of the species of *Garra* in Southeast Asia with a proboscis by having 12–13 (vs. 15–16) circumpeduncular scales. It is further distinguished from *G. fuliginosa* and *G. salweenica* by having a bilobed (vs. trilobed – more developed in *G. fuliginosa* than in *G. salweenica*) proboscis on the snout (Fig. 2), usually one wide dusky black stripe along midline (vs. 5–6 thin dark stripes along the side typically well developed), and no or a faint dark spot at the base of the caudal fin (vs. a large black spot at the base of the caudal fin – the spot is surrounded by light pigment on juveniles – Fig. 5). It is further distinguished from *G. salweenica* and *G. notata* by lacking conspicuous black spots at the base of the dorsal fin (vs. present in adults) and by having no black stripes or blotches on the caudal fin (vs. black spots at the base of the dorsal fin and a black stripe or blotch on one or both lobes of the caudal fin in individuals >40 mm SL). It is further distinguished from *G. cyrano* by having a relatively short, wide, bilobed proboscis (vs. long and slender unilobed proboscis, length greater than width) (Fig. 2; Kottelat, 2000: 41, fig. 6). *Garra fluviatilis* and *G. cambodgiensis* occur sympatrically with *G. surinbinnani* in the Mae Khlong basin (Fig. 6b), but they lack a proboscis and a transverse lobe, and differ greatly in body shape and color pattern (Fig. 7).

Species of *Garra* outside Southeast Asia with a bilobed proboscis and a modal count of 12 circumpeduncular scales are *G. arunachalensis*, *G. chindwinensis*, *G. motuoensis*, and *G. yajiangensis*. *Garra surinbinnani* is distinguished from all of these species by having 28–31 lateral-line scales vs. 35 in *G. arunachalensis*, 34 in *G. chindwinensis*, 36–37 in *G. motuoensis*, and 34–36 in *G. yajiangensis*.

The BI phylogeny (Fig. 8) was produced from the combined COI and RAG1 dataset for 16 *Garra* specimens and the three outgroup cypriniform taxa (Table 1), and from COI-only sequence data downloaded from GenBank (JX074214) for one *G. cyrano* representative for which RAG1 data were unavailable (Yang et al., 2012). The average sequence length for COI was 628 nt and for RAG1 was 902 nt. In both the ML and BI analyses, all codon positions for each gene were partitioned separately and employed the GTR+G model of nucleotide substitution. Successful convergence of BI runs was assumed from the low average standard deviation of split frequencies (1.016×10^{-3}), the average potential scale reduction factor (1.000), and the high effective sample size (min. 5279).

In both the BI and ML analyses, species with a proboscis formed a clade, with *Garra surinbinnani* being sister to all other proboscis-bearing species (Fig. 8). *Garra fluviatilis* was sister to the proboscis-bearing clade, and *G. cambodgiensis* and *G. fasciacauda* were sister to all other species of *Garra* sampled. *Garra fuliginosa* was shown to share more recent common ancestry with species in the Salween and Mekong Rivers than with *G. surinbinnani*, and the mean p-distance between the two species was 8.9 %. Average interspecific p-distances ranged from 5.0 % between *G. fuliginosa* and *G. cyrano* to 15.1 % between *G. salweenica* and *G. fasciacauda* (Table 4). While taxon sampling in the present study is limited, other phylogenetic studies (Yang et al., 2012; Sun et al., 2018) also suggest that the possession of a proboscis is an indication of a shared ancestry.

Discolabeo fisheri was described from the Tachin River basin in Samut Sakhon Province, Thailand (Fowler, 1937). The Tachin basin is adjacent to the Mae Khlong to the west, and the lower parts of the two basins are interconnected by a network of canals providing fishes in either basin access to the other. The holotype of *D. fisheri*

Fig. 7. Lateral views of: **a,** *Garra fluviatilis*, UF 191270, 66.1 mm SL; **b,** *G. cambodgiensis*, UF 192044, 102.0 mm SL.

was only 43 mm in total length (Fowler 1937: 211; figs. 177–178) when collected and now is in poor condition (Fig. 9). However, it has 16 circumpeduncular scales and a large dark spot at the base of the caudal fin indicating that the specimen is not a member of the species described herein as *G. surinbinnani*. *Discolabeo fisheri* was treated as a synonym of *G. fuliginosa* by Kottelat (2013). *Garra fuliginosa* was described from a specimen (Fig. 9) collected from the Mae Tang, a tributary of the

Table 4. Mean inter- and intraspecific p-distances among species of *Garra*, calculated from COI sequence data and given as percentages.

	Species	1	2	3	4	5	6	7	8
1	*Garra fuliginosa*	1.7							
2	*G. notata*	8.0	N/A						
3	*G. cyrano*	5.0	7.4	N/A					
4	*G. salweenica*	6.7	8.7	5.2	N/A				
5	*G. surinbinnani*	8.9	8.0	7.3	8.2	0.1			
6	*G. fluviatilis*	10.6	11.2	10.5	12.1	10.0	0.7		
7	*G. cambodgiensis*	12.3	11.8	12.4	13.4	13.3	13.7	1.3	
8	*G. fasciacauda*	14.0	12.9	13.7	15.1	13.8	14.6	9.2	N/A

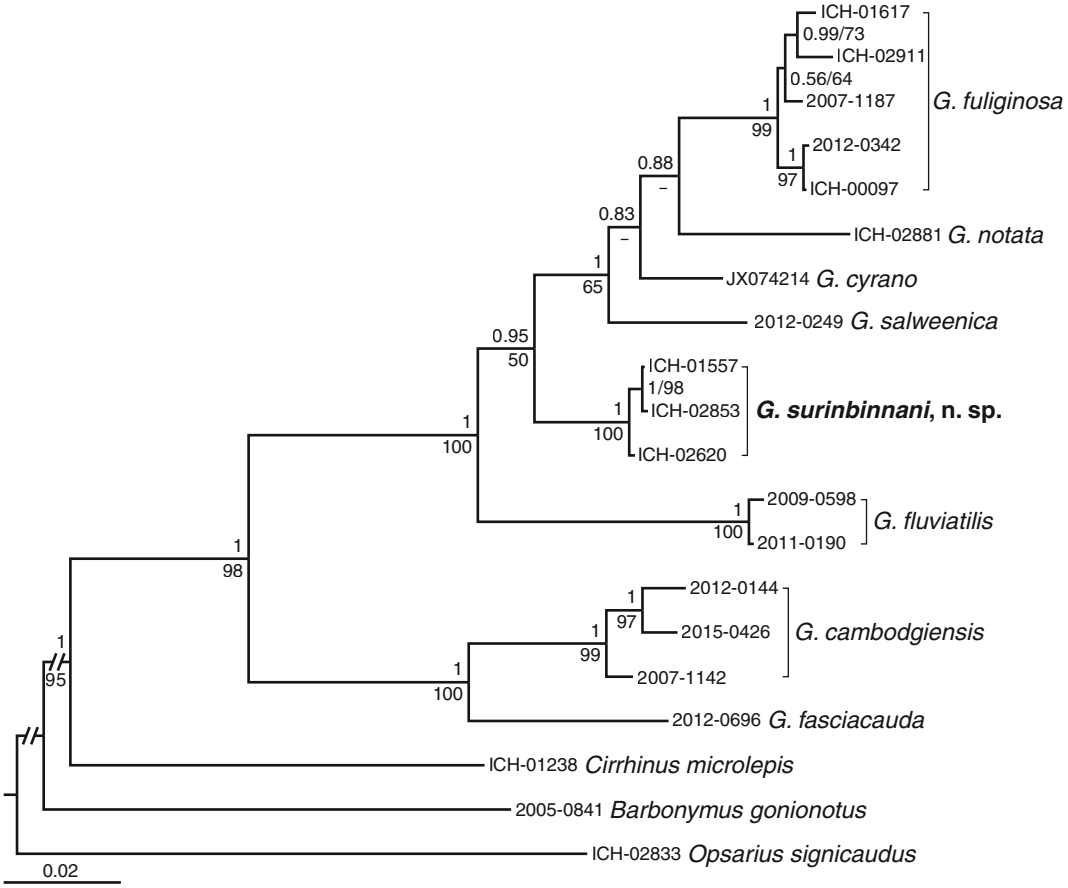


Fig. 8. Bayesian maximum clade credibility tree inferred from combined COI and RAG1 sequence data for species of *Garra* and three outgroup cyprinids. BI posterior probabilities are shown above branches, ML bootstrap values below. Dashes (–) represent bootstrap support of <50 %.

Ping River in the Chao Phraya basin, and occurs in the Mekong basin of Thailand, Laos, and Cambodia (Kottelat, 2001, Rainboth et al., 2012), and in the Tapi basin in South Thailand (UF 191849).

Comparative material. *Garra cambodgiensis*: Thailand: Mae Khlong basin: Kanchanaburi Province: UF 192044, 2, 102.0–112.7 mm SL; Ulong Creek at Vale Resort on Rt. 323, Thong Pha Phum District. – UF 237398, 4, 54.3–70.0 mm SL; same data as UF 192044. Mekong basin: Chantaburi Province: UF 170343, 3, 70.4–83.3 mm SL; Khrua Wai Creek, Pong Nam Ron District. Tapi basin: Nakhon Si Thammarat Province: UF 183816, 7, 54.4–78.0 mm SL; Tapi River, Chang Klang District.

G. cyrano: Laos: Mekong basin: Vientiane Province: ZRC 45303, holotype, 89.7 mm SL; Nam Leuk, ca. 500 m downstream of Thad Leuk Waterfall.

G. fluviatilis: Thailand: Mae Khlong basin: Kanchanaburi Province: UF 176452, 18, 26.2–53.6 mm SL; Lin Tin Creek off Rt. 323, Thong Pha Phum District. – UF 181134, 1, 85.6 mm SL; Li Chia River at Rt. 323, Thong Pha Phum District. – UF 191270, 35, 27.3–66.1 mm SL; Kroeng Krawia River at Rt. 323, Thong Pha Phum District.

G. fuliginosa: Thailand: Chao Phraya basin: Chiang Mai Province: ANSP 58006, holotype, 133.7 mm SL; Metang [Mae Tang] River, 35 miles north of Chieng Mai [Chiang Mai]. – UF 183401, 1, 52.6 mm SL; Ping River on Rt. 7 at km 62. Phrae Province: UF 188288, 1, 37.1 mm SL; Yom River SSW of Ban Nong Muang Khai [village], Nong Muang Khai District. Mae Khlong basin: Kanchanaburi Province: UF 191353, 9, 40.0–154.4 mm SL; Li Chia River at Rt. 323, Thong Pha Phum District. – UF 191764, 2, 44.4–48.5 mm SL; Mae Nam Noi Creek, Sai Yok District. – UF 237392, 6, 50.8–116.2 mm SL; trib. of Lake Vajiralongkorn, Sangkhla Buri District. Tak Province: UF 191926, 3, 36.6–36.7 mm SL; Khwae Yai

Fig. 9. Lateral and dorsal views of **a,** *Garra fuliginosa,* ANSP 58006, holotype, 133.7 mm SL; **b,** *Discolabeo fisheri,* ANSP 68219, holotype, 31.2 mm SL.

River at Ban Mae Khlong Kee [village] on Rt. 1090, Umphang District. Mekong Basin: Chanthaburi Province: UF 170307, 1, 120.8 mm SL; and UF 188869, 1, 104.7 mm SL; Khlong Khruo Wai [canal], Pong Nam Ron District. Tachin basin: Samut Sakhon Province**:** ANSP 68219, holotype of *Discolabeo fisheri*, 31.2 mm SL; and ANSP 68220, 1, paratype, 31.1 mm SL; Tachin. Tapi basin: Surat Thani Province: UF 191849, 4, 29.17–37.19 mm SL; Yan River at Ban Nam Hak [village] off Rt. 4262, Khiri Rat Nikhom District.

G. notata: Thailand: Salween basin: Tak Province: UF 192116, 5, 35.8–62.7 mm SL; Mae Charao Creek on

Rt. 4016 NE of Ban Pa Rai Neua [village], Mae Ramat District.

G. salweenica: Thailand: Salween basin: Mae Hong Son Province: UF 183853, 12, 33.2–101.7 mm SL; Salween River at mouth of Mae Nam Sakoep Creek, Mae Sariang District.

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Literature cited

Blyth, E. 1860. Report on some fishes received chiefly from the Sitang River and its tributary streams, Tenasserim Provinces. Journal of the Asiatic Society of Bengal, 29: 138–174.

Baldwin, C. C., J. H. Mounts, D. G. Smith & L. A. Weigt. 2009. Genetic identification and color descriptions of early life-history stages of Belizean *Phaeoptyx* and *Astrapogon* (Teleostei: Apogonidae) with comments on identification of adult *Phaeoptyx*. Zootaxa, 2008: 1–22.

Chakrabarty, P., M. Warren, L. M. Page & C. C. Baldwin. 2013. GenSeq: an updated nomenclature and ranking for genetic sequences from type and non-type sources. Zookeys, 346: 29–41.

Fowler, H. W. 1937. Zoological results of the Third De Schauensee Siamese Expedition. Part VIII: fishes obtained in 1936. Proceedings of the Academy of Natural Sciences of Philadelphia, 89: 125–264.

Fricke, R., W. N. Eschmeyer, & R. van der Laan (eds). 2019. Eschmeyer's catalog of fishes: genera, species, references. Available from http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp. Accessed on 30 March 2019.

Gong, Z., J. Freyhof, J. Wang, M. Liu, F. Liu, P.-C. Lin, Y.-L. Jiang & H.-Z. Liu. 2018. Two new species of *Garra* (Cypriniformes: Cyprinidae) from the lower Yarlung Tsangpo River drainage in southeastern Tibet, China. Zootaxa, 4532: 367–384.

Hubbs, C. L. & K. F. Lagler. 1958. Fishes of the Great Lakes region. Cranbrook Institute of Science Bulletin 26, Bloomfield Hills, 213 pp.

Kangrang, P., R. J. Thoni, R. L. Mayden & F. W. H. Beamish. 2016. *Garra fluviatilis*, a new hillstream fish species (Cypriniformes: Cyprinidae) from the Khwae Noi River system, Mae Khlong basin, Thailand. Zootaxa, 4175: 335–344.

Kottelat, M. 2000. Diagnoses of a new genus and 64 new species of fishes from Laos (Teleostei: Cyprinidae, Balitoridae, Bagridae, Syngnathidae, Chaudhuriidae and Tetraodontidae). Journal of South Asian Natural History, 5: 37–82.

— 2001. Fishes of Laos. Wildlife Heritage Trust, Colombo, 198 pp.

— 2013. The fishes of the inland waters of Southeast Asia: a catalogue and core bibliography of the fishes known to occur in freshwaters, mangroves and estuaries. The Raffles Bulletin of Zoology, Supplement 27: 1–663.

Kullander, S. O. & F. Fang. 2004. Seven new species of *Garra* (Cyprinidae: Cyprininae) from the Rakhine Yoma, southern Myanmar. Ichthyological Exploration of Freshwaters, 15: 257–278.

Kumar S., G. Stecher & K. Tamura. 2016. MEGA7: molecular evolutionary genetics analysis version 7.0 for bigger datasets. Molecular Biology and Evolution, 33: 1870–1874.

Lanfear, R., B. Calcott, S. Y. W. Ho & S. Guindon. 2012. PartitionFinder: combined selection of partitioning schemes and substitution models for phylogenetic analyses. Molecular Biology and Evolution, 29: 1695–1701.

Lanfear, R., P. B. Frandsen, A. M. Wright, T. Senfeld & B. Calcott. 2016. PartitionFinder 2: new methods for selecting partitioned models of evolution for molecular and morphological phylogenetic analyses. Molecular Biology and Evolution, 34: 772–773.

Larkin, M. A., G. Blackshields, N. P. Brown, R. Chenna, P. A. McGettigan, H. McWilliam, F. Valentin, I. M. Wallace, A. Wilm, R. Lopez, J. D. Thompson, T. J. Gibson & D. G. Higgins. 2007. Clustal W and Clustal X version 2.0. Bioinformatics, 23: 2947–2948.

Liu, S., R. L. Mayden, J. Zhang, D. Yu, Q. Tang, X. Deng & H. Liu. 2012. Phylogenetic relationships of the Cobitoidea (Teleostei: Cypriniformes) inferred from mitochondrial and nuclear genes with analyses of gene evolution. Gene, 508: 60–72.

Maddison, W. P. & D. R. Maddison. 2018. Mesquite: a modular system for evolutionary analysis. Version 3.51. Available from: http://www.mesquiteproject.org.

McClelland, J. 1838. Observations on six new species of Cyprinidae, with an outline of a new classification of the family. Journal of the Asiatic Society of Bengal, 7: 941–948, pls. 55–56.

Nebeshwar, K. & W. Vishwanath. 2013. Three new species of *Garra* (Pisces: Cyprinidae) from north-eastern India and redescription of *G. gotyla*. Ichthyological Exploration of Freshwaters, 24: 97–120.

Nebeshwar, K. & W. Vishwanath. 2017. On the snout and oromandibular morphology of genus *Garra*, description of two new species from the Koladyne River basin in Mizoram, India, and redescription of *G. manipurensis* (Teleostei: Cyprinidae). Ichthyological Exploration of Freshwaters, 28: 17–53.

Premananda, N., L. Kosygin & B. Saidullah. 2017. *Garra chindwinensis*, a new species of cyprinid fish (Teleostei: Cypriniformes) from Manipur, Northeastern India. Records of the Zoological Survey of India, 117: 191–197.

Quenouille, B., E. Bermingham & S. Planes. 2004. Molecular systematics of the damselfishes (Teleostei: Pomacentridae): Bayesian phylogenetic analyses of mitochondrial and nuclear DNA sequences. Molecular Phylogenetics and Evolution, 31: 66–88.

Rainboth, W. J., C. Vidthayanon & M. Dinh Yen. 2012. Fishes of the greater Mekong ecosystem with species list and photographic atlas. Miscellaneous Publications, Museum of Zoology, University of Michigan, 201: i–xvi, 1–173, pls. 1–121.

Ronquist, F., M. Teslenko, P. van der Mark, D. L. Ayres, A. Darling, S. Höhna, B. Larget, L. Liu, M. A. Suchard & J. P. Huelsenbeck. 2012. MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. Systematic Biology, 61: 539–542.

Šlechtová, V., J. Bohlen & H. H. Tan. 2007. Families of Cobitoidea (Teleostei; Cypriniformes) as revealed from nuclear genetic data and the position of the mysterious genera *Barbucca*, *Psilorhynchus*, *Serpenticobitis* and *Vaillantella*. Molecular Phylogenetics and Evolution, 44: 1358–1365.

Stamatakis, A. 2014. RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. Bioinformatics, 30: 1312–1313.

Sun, C., X. Li, W. Zhou & F. Li. 2018. A review of *Garra* (Teleostei: Cypriniformes) from two rivers in West Yunnan, China with description of a new species. Zootaxa, 4378: 49–70.

Tamang, L., B. Sinha, S. Abujam & R. Kumar. 2019. *Garra ranganensis*, a new cyprinid fish (Teleostei: Cypriniformes) from Arunachal Pradesh, northeastern India. Species, 20: 59–71.

Tongnunui, S., F. W. H. Beamish & C. Kongchaiya. 2016. Fish species, relative abundances and environmental associations in small rivers of the Mae Klong River basin in Thailand. Agriculture and Natural Resources, 50: 408–415.

Yang, L., M. Arunachalam, T. Sado, B. A. Levin, A. S. Golubtsov, J. Freyhof, J. P. Friel, W.-J. Chen, M. Vicent Hirt, R. Manickam, M. K. Agnew, A. M. Simons, K. Saitoh, M. Miya, R. L. Mayden & S. He. 2012. Molecular phylogeny of the cyprinid tribe Labeonini (Teleostei: Cypriniformes). Molecular Phylogenetics and Evolution, 65: 362–379.

Yu, Q., X. Wang, H. Xiong & S. He. 2016. *Garra longchuanensis*, a new cyprinid (Teleostei: Cypriniformes) from southern China. Zootaxa, 4126: 295–300.

Zhang, E & Y.-Y. Chen. 2002. *Garra tengchongensis*, a new cyprinid species from the upper Irrawaddy River basin in Yunnan, China (Pisces: Teleostei). The Raffles Bulletin of Zoology, 50: 459–464.

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