



MORPHOLOGICAL DIAGNOSES OF *GARRA* (CYPRINIFORMES: CYPRINIDAE) FROM NORTH-EASTERN INDIA WITH FOUR NEW SPECIES DESCRIPTION FROM BRAHMAPUTRA RIVER

ARUNACHALAM M.¹, NANDAGOPAL S.¹ AND MAYDEN R.L.^{2*}

¹Sri Paramakalyani Centre for Environmental Sciences, Manonmaniam Sundaranar University, Alwarkurichi- 627 412, TN, India.

²Department of Biology, Saint Louis University, Saint Louis, Missouri- 63103, USA.

*Corresponding Author: Email- cypriniformes@gmail.com

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Abstract- *Garra minimus* is described from the Ranga River of upper Brahmaputra River Drainage, *Garra kimini* is described from the tributary of Ranga river, *Garra nigricauda* is described from Pasighat and *Garra alticaputus* is described from Dikrong river at Boorum village from the Indian State of Arunachal Pradesh. *Garra minimus* is unique in its size in comparisons with all other species of *Garra* reported/published from North East India and also with more number of branched pectoral-fin rays. *Garra alticaputus* is diagnosed in having a deeper head and lacking any coloration on fins and body relative to other species from these drainages and the region that have distinctive colour patterns either on the body or in their the fins. *Garra nigricauda* is diagnosed from other species of *Garra* from this region with its distinctive robust body size and by the forked caudal-fin tipped black and the upper lobe of caudal-fin being pointed and shorter than the lower lobe. *Garra kimini* is diagnosed in moderately large headed, height less than its length; width almost equal to height with more pectoral-fin rays like the other three species described herein.

Keywords- *Garra minimus*, *Garra alticaputus*, *Garra nigricauda*, *Garra kimini*

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Introduction

Since first described by Hamilton [1] in his book on the fishes of the Ganges River, the genus *Garra* (type species *Cyprinus lamta* (= *Garra lamta*) has been, and continues to be, one of the most enigmatic and taxonomically difficult cyprinid genera of the Asian region. As traditionally recognized the species occur from Borneo to West Africa through China, South and Southeast Asia, Middle East, Arabian Peninsula and East Africa. The genus, however, is an extremely difficult group for biodiversity studies and warrants extensive studies as to the morphology, taxonomy, and phylogenetics. Two of the most significant factors underlying difficulties with the group include a combination of its diversity and its taxonomic instability, both serving as major impediments for researchers. Similar complications exist even for the subfamily to which this genus is allocated, Labeonini, through the constant flux in its composition and internal taxonomy, two recalcitrant qualities, that are only to be compounded by current phylogenetic evidence that the genus is not monophyletic [2,3].

In addition to the underlying issues outlined above, multiple, even more basic hindrances contribute to difficulties and/or complications for anyone working with or hoping to work on "*Garra*" [3] or *Garra* as traditionally recognized. These include the fact the traditionally recognized *Garra* is very widespread, has a great diversity of species (over 100) and many undescribed species, confusing morphological

variation often seen in species without thorough evaluation across the genus, notably complex and frequently confusing literature on its diversity and taxonomy, and many issues surrounding types specimens for species and type species for genera in Cyprinidae. Some examples include the descriptions of or placement of species in different genera, including *Discognathus* Heckel [4], *Chondrostoma* and *Gobio* [5], *Gonorhynchus* and *Platyca* [6-8] and *Gonorhynchus* [9]. Day [10] subsequently allocated all of these species to *Garra*.

To date, 20 species of *Garra* have been reported to occur cross north and northeastern India. These include the type species for the genus, *G. lamta* [1] and the following 19 species: *G. gotyla* [12], *G. nasuta* [7], *G. rupecula* [8], *G. lissorhynchus* [9], *G. kemp* [13], *G. annandalei* [13], *G. naganensis* [13], *G. abhoyai* [13], *G. manipurensis* [14], *G. litanensis* [15], *G. compressus* [16], *G. elongata* [17], *G. nambulica* [18], *G. paralissorhynchus* [19], *G. arupi* [20], *G. kalpangi* [21], *G. namyaensis* [22], *G. dampensis* [23], *G. magnidiscus* [24].

Species so far reported from the Indian state of Arunachal Pradesh include *G. annandalei*, *G. gotyla gotyla*, *G. kemp*, *G. lissorhynchus*, *G. maclellandi*, *G. lamta* and *G. naganensis* [25]. Recently, an additional species, *Garra arupi* was described from upper Brahmaputra basin in Arunachal Pradesh [20] and also *Garra magnidiscus* was described from the same basin [24] and is also a member of the "*Garra* fauna" of this region. In recent inventory surveys of fishes

from this region we collected and purchased fishes from local villagers from Betapul colony near the Ranga River. Some of the *Garra* specimens obtained in these inventory efforts are morphologically distinctive and diagnosable, and are herein described as new to science.

Materials and Methods

Abbreviations used herein include SL = standard length, HL = head length, ZSI/SRS = Zoological Survey of India/Southern Regional Station, F = Fish, FF = Freshwater Fish, MSUMNH = Manon-

maniam Sundaranar University Museum of Natural History, (MSUMNH) in Alwarkurichi, India, MUMF = Manipur University Museum of Fishes and CMA = Collection of M. Arunachalam. Methods for measurements and counts follow those of Hubbs and Lagler [26]. Measurements were taken to the nearest 0.1 mm using digital calipers. Body measurements are expressed as percentage of Standard length (%SL); head measurements are expressed as percentage of head length (%HL). Distance between pectoral-fin origin and vent and distance between pelvic-fin origin and vent are also taken for the present study [Fig-1].

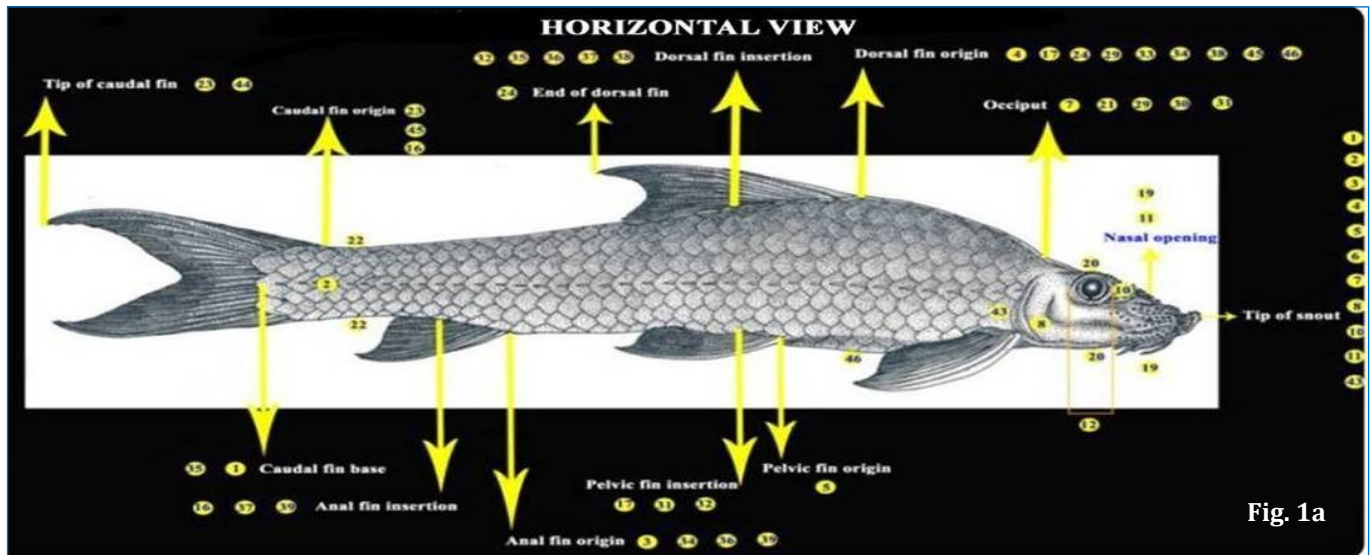


Fig. 1a

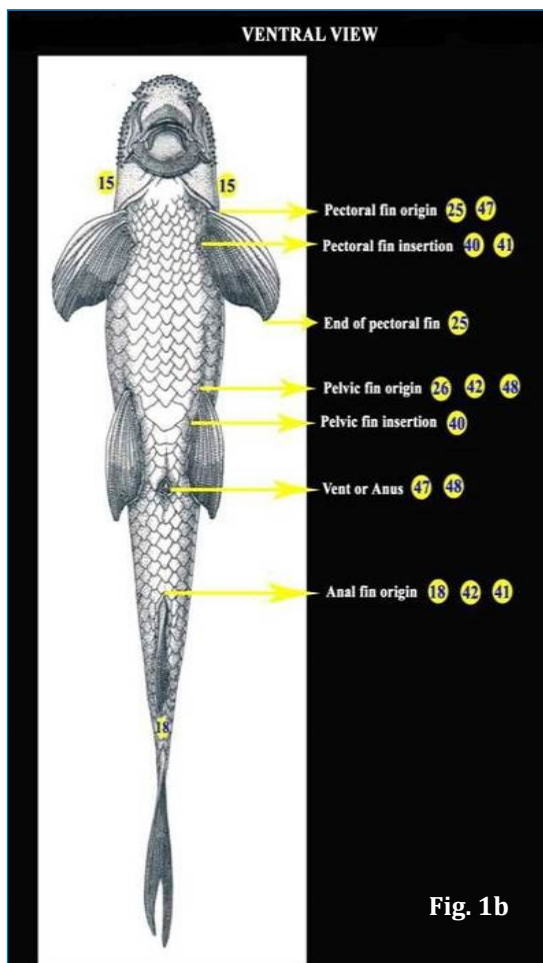


Fig. 1b

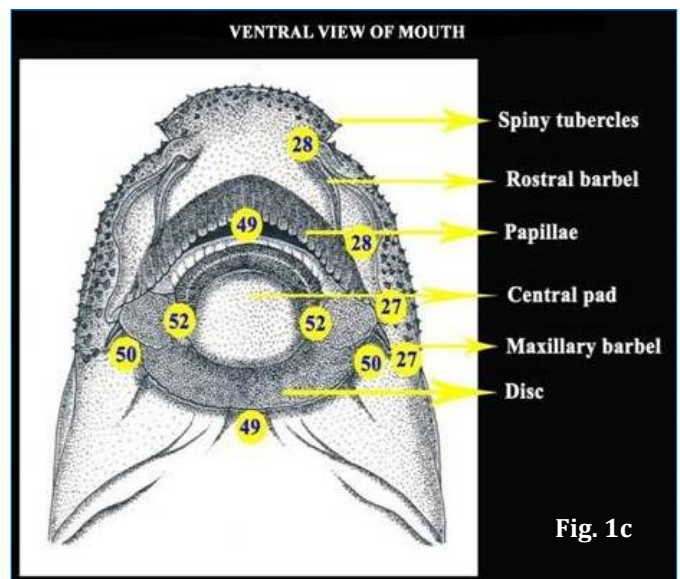


Fig. 1c

Fig. 1- Morphometric measurement of *Garra*

Methods for PCA was employed using the sheared data of the morphometric measurements of the four species and types of other species were not included in this analysis because of such limited materials (N = 1 or 2 specimens).

Counts and morphometric characters such as disc length, disc width, central-pad length, central-pad width, post-dorsal length and body depth follow methods of Kullander and Fang [27]. As noted by Kullander and Fang [27] lip structures serve as important characters for the diagnosis and identification of most species of *Garra* and are also important for resolving their phylogenetic relationships. It is unfortunate

that most descriptions of *Garra*, even recent, lack details of lip structure and are thus not useful for comparisons without having specimens, many of which are either difficult to obtain via loans due to institutional policies or the number of specimens are few.

Garra minimus, *Garra alticaputus*, *Garra nigricauda* and *Garra kimini* were compared with the related species *Garra elongata* (ZSI FF 4157- Paratype); *Garra gotyla gotyla* (ZSI F 198 / 2); *Garra naganensis*, (ZSI F 9970 / 1); *Garra lissorhynchus* (ZSI F 8098 / 1 - Holotype); *Garra nambulica* (ZSI 4139 - Paratype); *Garra annandalei* (ZSI F 6082 / 2 - Holotype); *Garra paralissorhynchus* (ZSI FF

4158 - Paratype); *Garra kempi* (ZSI FF 7716 / 1); *Garra abhoyai* (F 5307 / 1) from the Zoological Survey of India, Calcutta [Fig-2]. Specimens of *G. compressus* *G. litanensis* *G. namyensis* *G. manipurensis* were examined from Manipur University Museum of Fishes, Manipur, India (MUMF) [Fig-3]. Holotypes are deposited in the Zoological Survey of India/Southern Regional Station (ZSI/SRS) at Chennai; paratypes are deposited at the Manonmaniam Sundaranar University Museum of Natural History, (MSUMNH) in Alwarkurichi, India, and in first author's personal collections (Collection of M. Arunachalam, CMA).



Fig. 2- Type specimens of *Garra* from ZSI, Kolkatta

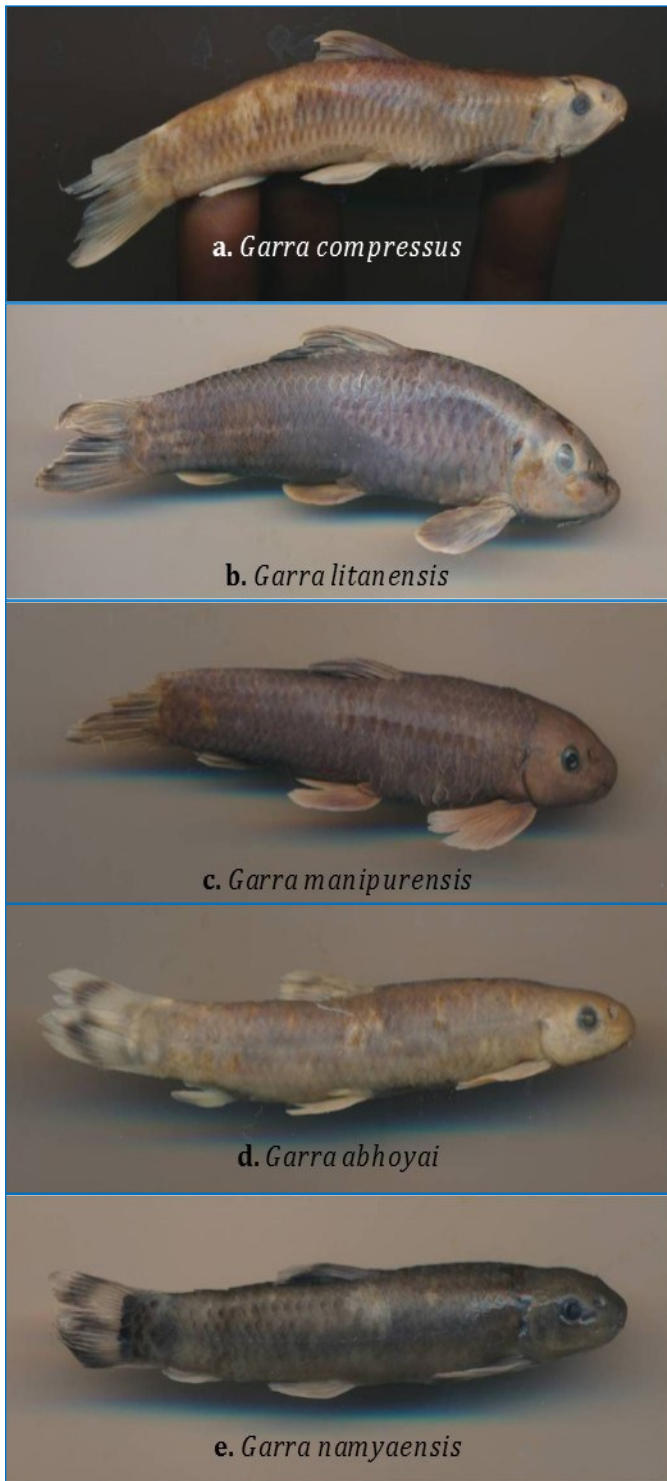


Fig. 3- Type specimens of *Garra* examined from MUMF, Manipur. (A to E)

New Species Descriptions

Garra minimus sp. nov. [Fig-4]

Holotype: ZSI/SRS F8577, 1 ex. Male. 52.9 mm SL, tributary of Ranga River, Lower Subanshri District, Arunachal Pradesh, India (N 27° 21' 359" E 93.° 42' 214"), Collectors: M. Arunachalam, M. Raja, C. Vijayakumar and S. Nandagopal. 17 Jun 2011.

Paratypes: MSUMNH 59, 5 ex. 39.8-52.9 mm SL CMA 17, 14 ex, 35.6-53.1 mm SL. All other details same as Holotype.

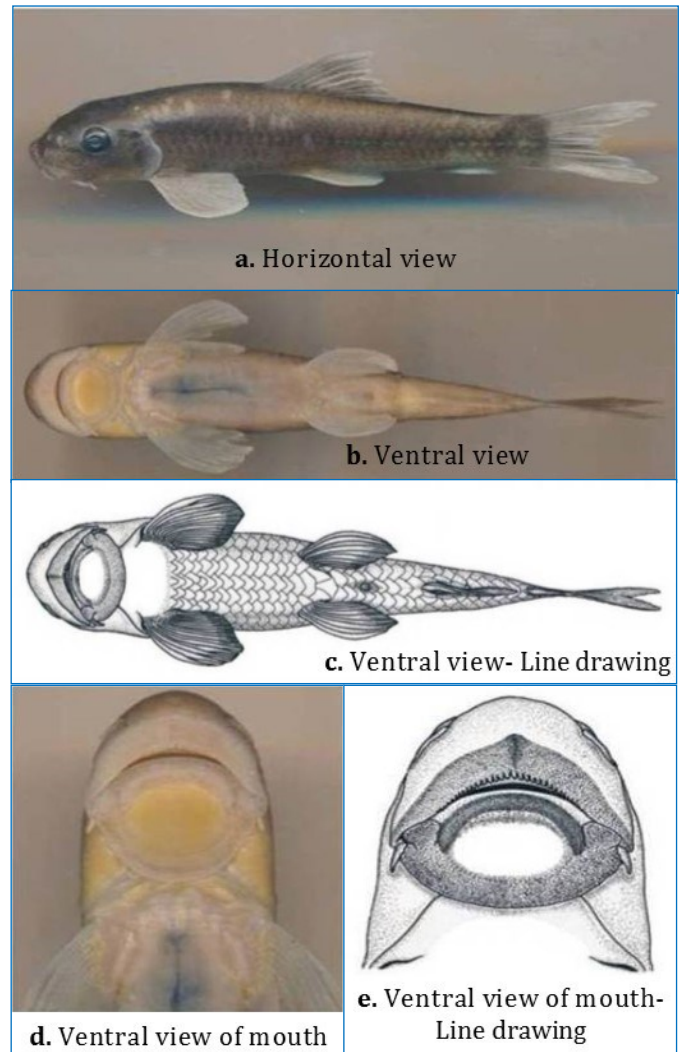


Fig. 4- *Garra minimus* sp. nov.

Diagnosis

Garra minimus sp. nov. can be differentiated from other species of *Garra* by multiple homologous morphometric characters, the latter being relative sizes of homologous structures and distances between homologous landmarks. [Table-1] provides comparative meristic characteristics of type species of *Garra* type specimens from ZSI and MUMF.

Garra minimus is a very small species of *Garra* with smoothly rounded snout tip, a very distinct rostral lobe and without a proboscis. Barbels in two pairs, pre dorsal and venter scales present, breast scales absent, lateral-line scale rows 35-37, circumpeduncular scale rows 12, circumferential scale rows 18-20.

G. minimus is distinguished from *G. lissorhynchus* by fewer pre dorsal-fin scale rows (10-11 vs. 13), fewer circumpeduncular scale rows (12 vs. 16), greater anal-fin scale rows (4-6 vs. 3.5) and absence of W-shaped band on caudal-fin (vs. presence). It is distinguished from *G. nambulica* by fewer pre dorsal-fin scale rows (10-11 vs. 24), fewer circumpeduncular scale rows (12 vs. 16) and absence of W-shaped band on caudal-fin (vs. presence). The species is distinguished from *G. annandalei* by more branched pectoral-fin rays (14-16 vs. 13), more pre dorsal-fin scale rows (10-11 vs. 9); more lateral-line scale rows (35-37 vs. 34) and fewer circumpeduncular scale rows (12 vs. 16). *Garra minimus* differs from *G. gotyla*

gotyla in having more lateral-line scale rows (35-37 vs. 33), fewer circumpeduncular scale rows (12 vs. 16), more anal scale rows (4-6 vs. 3), absence of scales on breast (vs. present) and snout without a proboscis (weakly developed vs. well developed median proboscis). It is distinguished from *G. elongata* in having more branched pectoral-fin rays (14-16 vs. 12) and fewer lateral-line scale rows (35-37 vs. 39) and from *G. naganensis* in having more branched pectoral-fin rays (14-16 vs. 13), fewer lateral-line scale rows (35-37 vs. 39) and fewer circumpeduncular scale rows (12 vs. 16). From *G. paralissorhynchus* it is distinguished by more pectoral-fin rays (14-

16 vs. 11) and lateral-line scale rows (35-37 vs. 31) and fewer pre dorsal-fin scale rows (10-11 vs. 12) and circumpeduncular scale rows (12 vs. 16). It is distinct from *G. kempi* in having more pectoral-fin rays (14-16 vs. 12), fewer lateral-line scale rows (35-37 vs. 40) and fewer pre dorsal-fin scale rows (10-11 vs. 12). From *G. arupi* it is distinguished by more branched pectoral-fin rays (14-16 vs. 10-11) and fewer circumpeduncular scale rows (12 vs. 16). It is distinguished from *G. gravelyi* by more lateral-line scale rows (35-37 vs. 32-34); from *Garra nasuta* (McClelland) by more lateral-line scale rows (35-37 vs. 34).

Table 1- Comparative meristic characteristics of species of *Garra* from ZSI and MUMF, with *Garra minimus*, *Garra alticaputus*, *Garra nigricauda* and *Garra kimini* sp. nov.(counts)

No	Meristic counts	Topotype <i>G. lissorhynchus</i> F 8098 / 1	Paratype <i>G. nambulica</i> 4139	Holotype <i>G. annandalei</i> F 6082 / 2 - 1	Registered specimen <i>G. gotyla gotyla</i> F 198 / 2	Paratype <i>G. elongata</i> FF 4157	Paratype <i>G. paralissorhynchus</i> FF 4158	Holotype <i>G. kempi</i> FF 7716/1
1.	Un branched dorsal fin rays	2	2	3	3	1	2	2
2.	Branched dorsal fin rays	6	6	8	7	7	6	8
3.	Un branched anal fin rays	2	2	2	2	1	2	2
4.	Branched anal fin rays	4	4	5	5	5	4	5
5.	Un branched pelvic fin rays	1	1	1	1	1	1	1
6.	Branched pelvic fin rays	8	6	8	8	8	7	8
7.	Un branched pectoral fin rays	1	1	1	1	1	1	1
8.	Branched pectoral fin rays	14	12	13	14	12	11	12
9.	Caudal fin upper lobe	D	10	D	D	10	9	D
10.	Caudal fin lower lobe	D	9	D	D	9	8	D
11.	Lateral line scales	34	34	34	33	39	31	40
12.	Pre dorsal scales	13	24	9	9	13	12	12
13.	Upper transverse rows	4.5	4.5	3.5	4.5	3.5	3.5	4.5
14.	Lateral line to pelvic scale rows	3.5	3.5	3.5	3.5	2.5	3.5	3.5
15.	Lower transverse rows (anus)	3.5	3.5	3.5	3.5	3	3.5	3.5
16.	Circumpeduncular scales	16	16	16	16	12	16	12
17.	Circumferential scales	21	D	22	23	19	20	22
18.	Anal scale rows	3.5	4.5	3.5	3	5.5	3.5	7
19.	Pre anal scales	8	8	18	D	13	8	19
20.	Proboscis & transverse groove on snout	No proboscis and transverse groove	No proboscis and transverse groove	No proboscis and transverse groove	Well developed median proboscis	Weakly developed proboscis & transverse groove on snout	No proboscis and transverse groove	No proboscis and transverse groove
21.	Scales on Chest and Belly	Chest and Belly naked	Chest and Belly naked	Chest and Belly scaled, but scales in chest greatly reduced.	Chest and Belly scaled	Scales absent on chest & Poorly developed scales on belly	Scales absent on chest and belly	Chest naked. Belly scaled but reduced along midline
22.	Spiny tubercles on the pectoral fin	Absent	Absent	Absent	Absent	Absent	Absent	Absent
No	Meristic counts	<i>G. naganensis</i> F 9970 / 1	<i>G. arupi</i> (Nebeshwar & Viswanath [20])	<i>G. magnidiscus</i> (Tamang [24])	<i>G. kalpangi</i> (Nebeshwar, et al [21])	<i>G. gravelyi</i> (Talwar and Jhingran [36])	<i>G. manipurensis</i> Type series examined from MUMF	<i>G. nasuta</i> (Talwar & Jhingran [36])
1	Un branched dorsal fin rays	2	3	3	02-03	2	2	2
2	Branched dorsal fin rays	7	7	7.5-9	8	7	7	08-09
3	Un branched anal fin rays	2	3	3	02-03	2	2	01-02
4	Branched anal fin rays	5	5	5.5	5	5	4	5
5	Un branched pelvic fin rays	1	1	1	1	1	1	1
6	Branched pelvic fin rays	8	07-08	06-08	07-08	8	8	7
7	Un branched pectoral fin rays	1	1	1	1	1	1	1
8	Branched pectoral fin rays	13	10-11	10-12	10-12	13	12	14
9	Caudal fin upper lobe	D	10	10	NK	9	10	NK
10	Caudal fin lower lobe	D	9	9	NK	8	9	NK
11	Lateral line scales	39	35-36	40-42	32-33	32-34	34	33-34
12	Pre dorsal scales	12	11-12	12-15	10-11	08-09	11	09-10
13	Upper transverse rows	4.5	3.5-4.5	4-4.5	3.5	3.5-4.5	4.5	4.5
14	Lateral line to pelvic scale rows	3.5	3.5	3-3.5	3.5-4.0	3.5	3.5	3.5
15	Lower transverse rows (anus)	4.5	NK	3-3.5	NK	3.5	4.5	NK
16	Circumpeduncular scales	16	16	12-14	16	D	16	NK
17	Circumferential scales	22	NK	NK	NK	D	24	NK
18	Anal scale rows	6	06-Aug	NK	3	D	4	NK
19	Pre anal scales	14	NK	NK	NK	D	12	NK

Table 1 - Continue...

No	Meristic counts	<i>G. naganensis</i> F 9970 / 1	<i>G. arupi</i> (Nebeshwar & Viswanath [20])	<i>G. magnidiscus</i> (Tamang [24])	<i>G. kalpangi</i> (Nebeshwar, et al [21])	<i>G. gravelyi</i> (Talwar and Jhingran [36])	<i>G. manipurensis</i> Type series exam- ined from MUMF	<i>G. nasuta</i> (Talwar & Jhingran [36])	
20	Proboscis & transverse groove on snout	Snout is broad and semicircular	Not well developed proboscis and shallow transverse groove	Snout broadly rounded and No proboscis	Snout blunt, without transverse groove on tip. a poorly developed proboscis	Snout pointed, a transverse groove at its tip and weakly developed proboscis	No proboscis and transverse groove	Snout with a prominent trilobed proboscis and tip of snout marked off into a transverse lobe	
21	Scales in Breast and Belly	Chest & Belly scaled. Scales on chest much reduced	Chest & Belly scaled	Chest and belly scaled invisible by naked eye in smaller individual.	Not Known	Breast and belly scaled	Chest naked & Belly scaled	Both chest and belly scaled	
22	Spiny tubercles on the pectoral fin	Absent	Absent	Present	Absent	Absent	Absent	Absent	
No	Meristic counts	<i>G. compressus</i> Type series exam- ined from MUMF	<i>G. litanensis</i> Type series examined from MUMF	<i>G. namyaensis</i> Type series exam- ined from MUMF	<i>G. abhoyai</i> Type series examined from MUMF	ZSI/SRS Holotype <i>G. alticaputus</i> F 8578	ZSI/SRS Holotype <i>G. minimus</i> F 8577	ZSI/SRS Holotype <i>Garra nigri- cauda</i> F 8580	ZSI/SRS Holotype <i>Garra kimini</i> F8581
1	Unbranched dorsal fin rays	2	2	2	1	2	2	2	2
2	Branched dorsal fin rays	7	8	7	6	8	8	8	8
3	Unbranched anal fin rays	2	1	2	1	2	2	2	2
4	Branched anal fin rays	5	5	4	5	5	5	5	5
5	Unbranched pelvic fin rays	1	1	1	1	1	1	1	1
6	Branched pelvic fin rays	8	8	7	7	8	8	8	8
7	Unbranched pectoral fin rays	1	1	1	1	1	1	1	1
8	Branched pectoral fin rays	12	13	12	11	15	15	14	15
9	Caudal fin upper lobe	9	10	10	9	9	9	9	9
10	Caudal fin lower lobe	8	9	9	8	8	8	8	8
11	Lateral line scales	39	32	31	33	33	37	36	34
12	Pre dorsal scales	12	10	13	17	10	11	10	9
13	Upper transverse rows	3.5	4.5	3.5	4.5	4.5	3.5	4.5	4.5
14	Lateral line to pelvic scale rows	2.5	3.5	3.5	3.5	3.5	2.5	3.5	3.5
15	Lower transverse rows (anus)	3	3.5	3.5	4.5	3.5	2.5	4	3.5
16	Circumpeduncular scales	12	12	16	16	16	12	12	16
17	Circumferential scales	20	21	22	22	22	19	22	23
18	Anal scale rows	5	3.5	3.5	3.5	3.5	6	4	3
19	Pre anal scales	22	22	18	7	21	18	23	19
20	Proboscis & transverse groove on snout	Snout slightly conical without transverse groove and proboscis Pentagonal suctorial disc	Snout slightly pointed. A transverse groove and squarish proboscis present on snout	Smoothly rounded snout tip. proboscis and transverse groove absent	Smoothly rounded snout tip. proboscis and transverse groove absent	Not well developed proboscis and shallow transverse groove	Not well developed proboscis and shallow transverse groove	Proboscis with slight protrusion and shallow transverse groove	Proboscis with slight protrusion and deep
21	Scales in Breast and Belly	Reduced breast scaled and belly scales are large	Chest naked & poorly developed on belly	Both chest and belly scaled.	Chest and abdominal region naked. In front of pelvic fin has scales covered by mucus	Belly scaled and subcutaneous scales in chest region	Belly scaled and chest naked	Well developed Scales on Chest and belly region	Scales on chest naked and Belly scaled
22	Spiny tubercles on the pectoral fin	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present

It is diagnosed from *G. nigricauda* sp. nov. by size, scales on breast (naked vs. well developed) and fewer circumferential scale rows (18-20 vs. 22-24). From *G. kimini* sp. nov. it is diagnosed in having more lateral-line scale rows (35-37 vs. 33-34) and fewer circumpeduncular scales (12 vs. 16). It is distinguished from *G. kalpangi* in having more branched pectoral-fin rays (14-16 vs. 10-12), more lateral-line scale rows (35-37 vs. 32-33), fewer circumpeduncular scale rows (12 vs. 16) and more anal-fin scale rows (4-6 vs. 3). It is diagnosed from *G. rupecula* in having more branched dorsal-fin rays (8 vs. 6-7), more lateral-line scale rows (35-37 vs. 32-34) and fewer upper transverse scale rows (3.5 vs. 4.5-6.5). It is diagnosable from *G. manipurensis* in having more pectoral-fin rays (14-16 vs. 12), lateral-line scale rows (35-37 vs. 34), and pre anal-fin scale rows (14-18 vs. 12), as well as fewer transverse scale rows (3.5/2.5

-3.0/2.5-3.0 vs. 4.5/3.5/4.5), circumpeduncular scale rows (12 vs. 16), and circumferential scales (18-20 vs. 24). From *G. compressus* it is distinguished in having more pectoral-fin rays (14-16 vs. 12) and fewer lateral-line scale rows (35-37 vs. 39); from *G. litanensis* in having more pectoral-fin rays (14-16 vs. 13) and lateral-line scale rows (35-37 vs. 32); from *G. namyaensis* in having more pectoral-fin rays (14-16 vs. 12), lateral-line scale rows (35-37 vs. 31) and fewer pre dorsal-fin scale rows (10-11 vs. 13) and circumpeduncular scale rows (12 vs. 16). It is differentiated from *G. abhoyai* in having more pectoral-fin rays (14-16 vs. 11), lateral-line scale rows (35-37 vs. 33) and fewer pre dorsal-fin scale rows (10-11 vs. 17) and circumpeduncular scale rows (12 vs. 16). It is diagnosable from *G. magnidiscus* in having more branched pectoral-fin rays (14-16 vs. 10-12), less pre dorsal-fin scale rows (10-11 vs. 12-15) and less

lateral-line scales (35-37 vs. 40-42), as well as fewer transverse scale rows (3.5/2.5-3/2.5-3 vs. 4-4.4/3-3.5/3-3.5).

Description

Body elongate, predorsum ascending very slightly with body depth and almost equal in dorsal and ventral profiles [Table-2].

Table 2- Morphometric characteristics of *Garra minimus* sp. nov. from Ranga river, Arunachal Pradesh

No.	Morphometric measurement	Min	Max	Mean
1	Standard length	53.1	35.6	43.28
2	Snout to urocentrum	97.97	92.56	94.74
3	Pre anal length	80.41	69.6	75.39
4	Pre dorsal length	51.2	44.9	48.29
5	Pre pelvic length	54.77	46.89	51.81
6	Pre pectoral length	26.26	18.53	23.46
7	Pre occipital length	99.37	78.86	90.66
8	Snout to opercle	99.09	79.28	92.9
9	Upper jaw length	51.03	28.21	42.58
10	Snout length	55.95	31.38	46.39
11	Pre nasal length	38.43	22.92	30.27
12	Orbit width	31.49	20.69	25.78
13	Inter orbital width	48.96	30.27	41.65
14	Inter nasal width	36.23	24.12	29.23
15	Head width	73.85	52.23	65.89
16	Peduncle length	18.26	8.49	11.88
17	Dorsal origin to pelvic insertion	23.16	17.5	20.43
18	Anal fin height	27.1	15.08	19.64
19	Head depth at nostril	44.19	24.78	34.38
20	Head depth at pupil	59.27	39.32	51.37
21	Head depth at occiput	67.53	46.22	60.97
22	Peduncle depth	12.2	7.46	10.35
23	Caudal fin length	33.1	23.57	29.78
24	Dorsal fin height	26.07	19.54	23.67
25	Pectoral fin length	23.51	15.75	20.55
26	Pelvic fin length	20.61	14.2	18.75
27	Maxillary barbel length	11.8	4.39	6.81
28	Rostral barbel length	16.96	10.27	13.51
29	Occiput to dorsal-fin origin	28.5	20.19	25.2
30	Occiput to pectoral insertion	20.92	13.64	17.01
31	Occiput to pelvic insertion	43.49	30.75	39.18
32	Dorsal insertion to pelvic insertion	19.17	13.57	15.71
33	Dorsal origin to pectoral insertion	29.35	21.32	24.83
34	Dorsal origin to anal origin	38.03	28.16	34.61
35	Dorsal insertion to caudal base	38.53	27.74	32.01
36	Dorsal insertion to anal origin	24.76	16.79	20.45
37	Dorsal insertion to anal insertion	30.27	22.06	25.69
38	Dorsal fin base length	20.4	13.04	16.87
39	Anal fin base length	11.09	6.1	8.14
40	Pectoral insert / pelvic insert	31.08	23.92	28.08
41	Pectoral insert \ anal origin	49.34	40.84	45.52
42	Pelvic insert to anal origin	26.2	13.64	17.81
43	Head length	29.69	24.67	26.87
44	Total length	66.04	44.7	53.98
45	Post-dorsal length	56.85	43	49.05
46	Body depth	20.55	14.72	17.9
47	Distance b/w pectoral fin to vent	47.89	37.92	44.49
48	Distance b/w pelvic fin to vent	18.59	7.37	14.68
49	Disc length	45.91	37.65	42.27
50	Disc width	61.55	51.13	56.25
51	Central pad length	31.38	21.89	26.62
52	Central pad width	40.33	30.42	35.63

Snout rounded with transverse grooves. Orbit is nearer to preopercle than to tip of snout. Rostral lobe with many small erect tubercles; smaller individuals with only 5 tubercles. Snout with minute, scattered and erect tubercles. Two pairs of barbels present; rostral barbels reaching middle of rostral cap and placed inside a groove not connected with rostral caps. Central pad wider than long. Upper lip with a median notch and papilliferous along upper jaw. Lower labial fold covering only 40% of central pad.

Dorsal-fin origin 2 scale rows anterior to pelvic-fin origin; first and second branched rays longest; posterior margin of fin concave. Pectoral-fin rounded; when depressed not reaching base of pelvic-fin. Pelvic-fin with pointed tip; when depressed not reaching to origin of anal-fin. Anal-fin short; when depressed almost reaching base of caudal-fin. Upper lobe of caudal-fin slightly longer than the lower lobe.

Dorsal-fin rays ii, 8 (last ray branched at base); pectoral-fin rays i, 14-16; pelvic-fin rays i, 8-9; anal-fin rays ii, 5; caudal-fin rays 10+9 (17 branched); lateral-line complete, scale rows 35-37; dorsal-fin origin and lateral-line separate by 3.5 scale rows; lateral transverse scales between lateral-line and pelvic-fin origin 2.5-3.0 scale rows; and between lateral-line and anal-fin origin by 2.5-3.0 scale rows; pre dorsal-fin scale rows 10-11; circumpeduncular scale rows 12; circumferential scales 18-20; pre anal-fin scale rows 14-18 [Table-3].

Table 3- Morphometric characteristics of *Garra alticaputus* sp. nov. from Dikrong river, Arunachal Pradesh

S. No	Meristic counts	Max	Min
1	Unbranched dorsal fin rays	2	2
2	Branched dorsal fin rays	8	8
3	Unbranched anal fin rays	2	2
4	Branched anal fin rays	5	5
5	Unbranched pelvic fin rays	1	1
6	Branched pelvic fin rays	9	8
7	Unbranched pectoral fin rays	1	1
8	Branched pectoral fin rays	16	14
9	Caudal fin upper lobe	9	9
10	Caudal fin lower lobe	8	8
11	Lateral line scales	37	35
12	Pre dorsal scales	11	10
13	Upper transverse rows	3.5	3.5
14	Lateral line to pelvic scale rows	3	2.5
15	Lower transverse rows (anus)	3	2.5
16	Circumpeduncular scales	12	12
17	Circumferential scales	20	18
18	Anal scale rows	6	4
19	Pre anal scales	18	14

Scales

Breast area with V-shaped naked pattern; venter with scales up to pectoral-fin insertion.

Color in Live

Dorsal, lateral, and ventro-lateral scale rows, to one scale row above venter, with base color of olive brown; scales above lateral-line with dark dorsal and ventral blotches that confluence to form distinct dark lateral stripes from occiput where distinctly separated to anterior caudal peduncle and then converging near posterior extend of pigmented caudal peduncle; center of dorsum with scale dark and with narrow dark margins. On caudal peduncle, area around hypural plate and slightly posterior on bases of caudal-fin

rays, dorsally and ventrally to anterior extent of procurrent rays cream-colored and without melanophores; base of caudal-fin with distinct black circular spot separate from body but continuous with black stripe present on median rays and membranes of caudal-fin.

Head dark olive brown dorsally and laterally. Powder blue spot present where opercle joins body dorsally; blue coloration encircling eye and on lower-anterior cheek, ventro-lateral edges of rostral barbels, and corner of mouth, notably contrasting with surrounding areas. No light region posterior to orbit or dark spots on cheek or upper opercle. Lower cheek and branchiostegal rays and membranes silver; above which tan. Snout light tan. Nares and barbels red. Ventrally, head pinkish to cream anteriorly; lips, barbels, and papillae similar in color.

Breast, belly, and posterior to anal-fin origin silver-white, immaculate. Ventrolaterally light green coloration extending at least two scale dorsally. Well-developed, distinct black spot present just behind operculum, on the first lateral-line scale.

Distally, all branched rays of dorsal-fin base dusky; short unbranched rays dark, creating darkened anterior to dorsal-fin; leading ray unpigmented; membranes of branched rays dusky to black medially and distally but reddish-yellow to orange all along base of fin; distal margin of fin clear anteriorly, becoming reddish-pink posteriorly. Dorsally, pectoral-fin pinkish-red and dusky, and with some darkened areas. Leading unbranched ray darkened medially and distally; clear basally. Membrane between leading ray and first branched ray dusky; membranes for rays 2-6 dusky. Branched rays 2-8 pinkish red, especially distally where most concentrated; basally, fin lighter in color but with similar coloration; interior membranes within a branched ray reddish. Narrow distal edge of fin powder blue. Pelvic-fin as in pectoral-fin except leading ray not dark and reddish coloration more intense. Caudal-fin with similar reddish coloration throughout, lightening posteriorly, except for extreme dorsal and ventral lobes; principal and branched rays lined with melanophores; median branched rays more darkly pigmented, creating a broad median stripe; posterior 1/3 of lower lobe of caudal-fin darkly pigmented; dark stripe on distal edge of upper and lower lobes. Ventrally, pectoral and pelvic-fins are as above black median rays and membranes, creating stripe from caudal spot, and narrow black lines along.

Color in Preservative

Dorsum and head dark. Dorsal-fin base with black spots; no spots or colouration in pelvic, pectoral or anal-fins.

Distribution and Habitat

Garra minimus inhabits an unregulated region of the Ranga River, 20 km downstream of a Hydro-electric project in the Lower Subanshri District of Arunachal Pradesh [Fig-5]. Sampling was conducted in the river at a local settlement area called Betapul Colony. At the sampling site, the right bank (looking upstream) was more stable and with rooted vegetation; the left bank was relatively unstable. The stream had high and fast flow during the sampling period due to heavy rain the previous day. Water was turbid and depth ranged from 0.5 m to 0.6 m with the deeper portions towards the right bank. Substrate types included bedrock, large boulders, small boulders, cobbles, gravel and silt. Water in this area was relatively undisturbed except for bathing and cloth washing by people of the colony. Two women from the colony used hook and line fishing and caught larger fish specimens and species, including species of *Tor* and *Neolissochilus*; four of the torine specimens were purchased

from them. The women also fished using a round steel dining plate. Wheat flower paste with turmeric was made into small bead-sized balls and were placed on the plate and covered by a white cloth with small holes for catching loaches. Other species found at this locality included *Devario aequipinnatus*, *Schistura* sp., *Barilius* sp., *Schizothorax* sp., *Neolissochilus hexagonolepis*, *Tor putitora*, and *Aborichthys* sp.



Fig. 5- Ranga River, the type locality of *Garra minimus* sp. nov.

Etymology

The name *minimus* is Latin, referring to the small body size of the species as compared to the other species reported from this region.

Garra alticaputus sp. nov. [Fig-6]

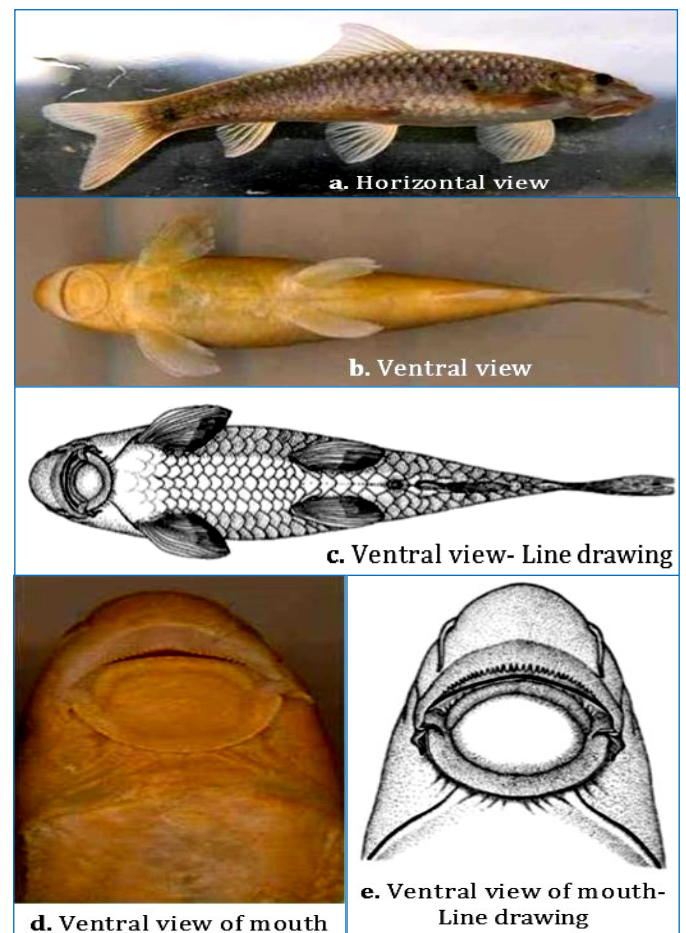


Fig. 6- *Garra alticaputus* sp. nov.

Holotype: ZSI/SRS F8578, 1 ex. Male. 71.6 mm SL, Dikrong River at Boorum Village (tributary of Ranga River), Lower Subanshri District, Arunachal Pradesh, India (N 27°09' 026" E 93° 42' 227"). Collectors: M. Arunachalam, M. Raja, C. Vijayakumar and S. Nandagopal. 16 Jun 2011.

Paratypes: MSUMNH 60, 3 ex. 57.6-61.6 mm SL; CMA 18, 4 ex, 57.6-71.6 mm SL. All other details same as Holotype.

Diagnosis

Garra alticaputus can be differentiated from other species of *Garra* by multiple homologous meristic characters, relative sizes of homologous structures and distances between homologous landmarks.

Garra alticaputus be diagnosed from *G. lissorhynchus* by the absence of a W-shaped dark band at the posterior end of caudal-fin, fewer lateral-line scale rows (33 vs. 34) and fewer pre dorsal-fin scale rows (10 vs. 13). From *G. nambulica* it is distinguished in having more branched pectoral-fin rays (13-15 vs. 12) and fewer pre dorsal-fin scale rows (10 vs. 24); from *G. annandalei* in having more pectoral-fin rays (13-15 vs. 13) and pre anal-fin scale rows (16-22 vs. 18); from *G. gotyla gotyla* in having subcutaneous scales on breast (vs. well developed) and proboscis on snout (not well developed vs. well developed median proboscis). The species is distinguished from *G. elongata* in lacking dark grey longitudinal stripe from gill-opening to caudal-fin base, transverse black bar near the free margin of dorsal-fin, black longitudinal mark on medium rays of caudal-fin and absence of colours in other fins, fewer lateral-line (33 vs. 39), pre dorsal-fin scale rows (10 vs. 13) and anal-fin scale rows (3-3.5 vs. 5.5). It is distinguished from *G. naganensis* in having fewer lateral-line (33 vs. 39), pre dorsal-fin scale rows (10 vs. 12) and anal-fin scale rows (3-3.5 vs. 6) and a greater number of pectoral-fin rays (13-15 vs. 13). From *G. paralissorhynchus* it differs in having more pectoral-fin rays (13-15 vs. 11) and lateral-line scale rows (33 vs. 31) and fewer pre dorsal-fin scale rows (10 vs. 12); from *G. kempfi* in having more pectoral-fin rays (13-15 vs. 12) and circumpeduncular scale rows (16 vs. 12) and fewer lateral-line (33 vs. 40) and pre dorsal-fin scale rows (10 vs. 12).

The new species differs from *G. kalpangi* in having more pectoral-fin branched rays (13-15 vs. 10-12); from *G. rupecula* in having more branched dorsal-fin branched rays (8 vs. 6-7) and fewer upper transverse rows (4.5 vs. 4.5 to 6.5). In ventral side of *G. rupecula*, breast, belly and post pelvic-fin regions naked while in *G. alticaputus* well developed scales on belly region and subcutaneous scales on breast region. The species is diagnosed from *G. manipurensis* in having more pectoral-fin rays (13-15 vs. 12) and anal-fin scale rows (16-22 vs. 12), fewer lateral-line scale rows (33 vs. 34) and subcutaneous scales on breast region (vs. naked). From *G. compressus* in differs in having more pectoral-fin rays (13-15 vs. 12) and transverse (4.5/3.5/3.5 vs. 3.5/2.5/3.0) and circumpeduncular scale rows (16 vs. 12), as well as fewer lateral-line (33 vs. 39), pre dorsal-fin scale rows (10 vs. 12) and anal-fin scale rows (3-3.5 vs. 5). From *G. litanensis* it differs in having more lateral-line (33 vs. 32) and circumpeduncular scale rows (16 vs. 12). It is distinguished from *G. namyaensis* in having more pectoral-fin rays (13-15 vs. 12) and lateral-line scale rows (33 vs. 31), and fewer pre dorsal-fin scale rows (10-11 vs. 13). It is diagnosable from *G. abhoyai* it differs in having more pectoral-fin rays (13-15 vs. 11) and pre anal-fin scale rows (16-22 vs. 7), and fewer pre dorsal-fin scale rows (10 vs. 17); from *Garra arupi* in having more branched pectoral-fin rays (13-15 vs. 10-11) and fewer lateral-line (33 vs. 35-36), pre dorsal-fin scale rows (10 vs. 11-12) and anal-fin scale rows (3-3.5 vs. 6-8). It differs

from *G. gravelyi* in having more pre dorsal-fin scale rows (10 vs. 8-9). It differs from *G. nasuta* (McClelland) in having fewer lateral-line scale rows (33 vs. 34) and poorly developed proboscis (vs. well developed trilobed proboscis). The species differs from *G. minimus* (described herein) in having fewer lateral-line (33 vs. 35-37) and anal-fin scale rows (3-3.5 vs. 4-6) and more circumpeduncular (16 vs. 12) and circumferential scale rows (22 vs. 18-20); from *G. nigricauda* sp. nov. in having fewer lateral-line scale rows (33 vs. 35-36); more circumpeduncular scale rows (16 vs. 12) and scales present on breast region (subcutaneous vs. well developed); from *G. kimini* in having subcutaneous breast scales (vs. naked), poorly developed proboscis (vs. present and well developed) and a shallow transverse groove on snout (vs. deep). It is diagnosable from *G. magnidiscus* in having more branched pectoral-fin rays (13-15 vs. 10-12), less pre dorsal-fin scale rows (10 vs. 12-15), less lateral-line scales (33 vs. 40-42), as well as more circumpeduncular scales (16 vs. 12-14).

Description

Body short and thin; dorsal profile not ascending. Snout rounded and with transverse groove. Orbit closer to preopercle than to snout [Table-4]. Rostral lobe distinct and with at least 16 pointed [erect, retrose, antrose] tubercles. Two pairs of barbels. Rostral barbel extending beyond rostral cap and placed inside a groove connected to rostral cap. Central pad wider than long. Upper lip without a median notch and upper jaw papilliferous. Lower fold covering 40% of central pad.

Table 4- Morphometric characteristics of *Garra nigricauda* sp. nov. from Siang river, Pasighat, Arunachal Pradesh

No.	Morphometric measurement	Min	Max	Mean
1	Standard length	57.6	71.6	62.9
2	Snout to urocentrum	93.3	97.8	95.7
3	Pre anal length	72.9	76.2	74.8
4	Pre dorsal length	45.0	48.7	46.5
5	Pre pelvic length	47.2	51.1	49.4
6	Pre pectoral length	20.3	22.0	21.0
7	Pre occipital length	85.4	97.2	90.4
8	Snout to opercle	91.8	96.2	93.7
9	Upper jaw length	24.1	29.9	27.6
10	Snout length	46.8	52.1	49.2
11	Pre nasal length	30.7	40.7	33.8
12	Orbit width	18.5	25.2	22.0
13	Inter orbital width	37.6	44.9	41.2
14	Inter nasal width	20.9	31.0	25.9
15	Head width	62.7	73.2	69.0
16	Peduncle length	8.8	13.7	12.0
17	Dorsal origin to pelvic insertion	21.3	32.0	24.7
18	Anal fin height	17.0	18.6	17.6
19	Head depth at nostril	28.6	38.5	33.3
20	Head depth at pupil	57.4	65.5	61.2
21	Head depth at occiput	69.8	84.4	73.3
22	Peduncle depth	11.5	12.4	12.0
23	Caudal fin length	25.1	29.2	27.0
24	Dorsal fin height	20.5	24.9	22.1
25	Pectoral fin length	17.3	21.5	19.8
26	Pelvic fin length	17.7	18.6	18.2
27	Maxillary barbel length	1.9	5.4	2.8
28	Rostral barbel length	2.7	3.7	3.3
29	Occiput to dorsal-fin origin	23.4	28.3	26.0
30	Occiput to pectoral insertion	18.3	20.7	19.3
31	Occiput to pelvic insertion	38.3	42.8	40.9
32	Dorsal insertion to pelvic insertion	18.9	24.9	22.0
33	Dorsal origin to pectoral insertion	25.8	30.5	28.0

Table 4- Continue..

No.	Morphometric measurement	Min	Max	Mean
34	Dorsal origin to anal origin	36.5	38.8	38.0
35	Dorsal insertion to caudal base	34.0	38.2	35.8
36	Dorsal insertion to anal origin	23.3	26.9	24.7
37	Dorsal insertion to anal insertion	27.5	33.2	29.1
38	Dorsal fin base length	16.0	21.1	18.1
39	Anal fin base length	6.4	8.9	8.1
40	Pectoral insert / pelvic insert	27.6	31.7	29.8
41	Pectoral insert \ anal origin	49.0	54.2	50.9
42	Pelvic insert to anal origin	18.6	23.3	21.4
43	Head length	13.8	16.6	15.0
44	Total length	71.3	86.2	77.2
45	Post-dorsal length	52.1	58.8	54.6
46	Body depth	20.8	25.6	23.4
47	Distance b/w pectoral fin to vent	48.3	51.9	50.3
48	Distance b/w pelvic fin to vent	18.9	22.0	20.0
49	Disc length	32.5	38.0	36.0
50	Disc width	44.6	51.9	47.9
51	Central pad length	21.6	26.7	24.4
52	Central pad width	28.2	33.3	30.9

Dorsal-fin origin 2 scale rows anterior to pelvic-fin origin; first and second branched dorsal-fin rays longest; posterior margin of fin almost straight. Pectoral-fin rounded; when depressed not reaching pelvic-fin origin. Pelvic-fin with pointed tip; when depressed not reaching anal-fin origin. Anal-fin is very short; when depressed not reaching caudal base. Upper and lower lobes of caudal-fin equal.

Dorsal-fin rays ii, 8 (last ray branched at base); pectoral-fin rays i, 13-15; pelvic-fin rays i, 8; anal-fin rays ii, 5; caudal-fin rays 10+9 (17 branched); lateral-line complete, scales 33; lateral transverse scales 4.5 between dorsal-fin origin and lateral-line, 3.5 between lateral-line and pelvic- fin origin and 3.5 between lateral-line and anal-fin origin; pre dorsal-fin scale rows 10; circumpeduncular scale rows 16; circumferential scale rows 22; pre anal-fin scales 16-22 [Table-5].

Table 5- Morphometric characteristics of *Garra kimini* sp. nov. from 7 km away from Hola camp, Arunachal Pradesh.

S. No	Meristic counts	Max	Min
1	Unbranched dorsal fin rays	2	2
2	Branched dorsal fin rays	8	8
3	Unbranched anal fin rays	2	2
4	Branched anal fin rays	5	5
5	Unbranched pelvic fin rays	1	1
6	Branched pelvic fin rays	8	8
7	Unbranched pectoral fin rays	1	1
8	Branched pectoral fin rays	15	13
9	Caudal fin upper lobe	9	9
10	Caudal fin lower lobe	8	8
11	Lateral line scales	33	33
12	Pre dorsal scales	10	10
13	Upper transverse rows	4.5	4.5
14	Lateral line to pelvic scale rows	3.5	3.5
15	Lower transverse rows (anus)	3.5	3.5
16	Circumpeduncular scales	16	16
17	Circumferential scales	22	22
18	Anal scale rows	3.5	3
19	Pre anal scales	22	16

Scales

Belly scaled and subcutaneous scales in chest region.

Color in Live

Dorsum and dorso-lateral areas of body with light green base color

to two scale rows below lateral-line; more ventrally base coloration silvery-white. Dorso-lateral scales with silvery center and dusky at margin and with large dark base. Lateral-line punctate; pores covered and encircled with melanophores, creating darker and more noticeable spots than as described for dorsal and dorso-lateral scales. Caudal peduncle posterior to posterior base of anal-fin greenish brown laterally, cream dorsally, and pinkish ventrally; laterally dorsal and ventral edges of scales with confluence of concentrated melanophores, creating 4 narrow stripes extending base of caudal-fin; base of caudal-fin with narrow dark band around edge; anterior to and separate from band central 3 scales at hypural plate with broad dark bark bar. Venter of head and body silver or yellow in life, cream-yellow following preservation.

Head pinkish-brown dorsally; opercle, subopercle, cleithral area, extending to base of pectoral-fin insertion where spot is dark and large, greenish. Cheek, area encircling orbit, lacrimal area, and snout light pinkish-tan; lower cheek and branchiostegals, extending to venter, silvery. Well-developed, distinct black spot present just behind operculum, on the first lateral-line scale. Barbels whitish.

Dorsal-fin largely dusky with yellowish hue; leading unbranched rays and first 4 branched rays more darkly pigmented; bases of branched rays 2-6 black, creating spotted pattern on rays alone. Dorsally, pectoral-fin creamish-yellow basally on all rays and membranes; unbranched and 1st, 2nd, 3rd rays of branched rays light reddish; anterior 4-6 rays darkly pigmented posteriorly with thin line; ventrally basal 2/3 of fin yellow, light reddish distally. Pelvic-fin similar to pectoral-fin except unbranched and 1st and 2nd branched rays light reddish, remaining rays light greenish-yellow excluding last branched ray that is clear. Outer region of anal-fin whitish; base of fin with creamish-pink base for all rays; unbranched, 1st ray of branched ray, and distal end of 2nd branched ray light reddish; rays 2-5 yellow basally and extending distally to near edge of fin. Pectoral, pelvic and anal-fins are without black markings. Caudal-fin yellowish-cream, especially at base and along distal areas of lobes; ventral lobe with longer yellow extension; edges of rays and membranes dusky, slightly more dense centrally but not dark enough for any dark stripe extending from base of fin; tip of lower lobe with more dense concentration of melanophores in membranes and along rays, creating dark spot. Ventrals lateral scales yellowish; dorsal region of caudal peduncle yellowish in colour; middle region of caudal peduncle some scales are greenish in colour; 4th row of lateral scale rows have bunch of melanopores forming a green band up to the insertion of dorsal-fin. Melanopores concentration is more in tip of the scales; less in dorsal-fin insertion to end of the caudal peduncle region. Characteristically well-developed, distinct black spot present just behind operculum, on the first lateral-line scale. venter whitish; Barbels whitish. 3rd to 6th branched rays of dorsal-fin base with black dots. Outer region of pectoral-fin has whitish in colour; unbranched and 1st, 2nd, 3rd rays of branched rays are light reddish in colour; lower portion of the remaining rays are light yellowish in colour; upper portion has whitish in colour. Outer region of pelvic-fin have whitish in colour; unbranched and 1st and 2nd rays of branched rays are light reddish in colour; remaining rays are light greenish in colour excluding last branched ray. Outer region of anal-fin have whitish in colour; unbranched and 1st ray of branched rays are light reddish in colour; lower portion of the 2nd branched ray have light green in colour; upper portion of the 2nd branched ray have light reddish in colour; remaining rays are light green in colour excluding last branched ray. Pectoral, pelvic and anal-fins are without any black markings in the basal regions. Cau-

dal peduncle with small black blotch. After preservation, there is no pigmentation in ventral surface.

Color in Preservative

Dorsum not dark; dorsum and venter light in colour. Dorsal-fin base with black dots. Pectoral, pelvic and anal-fins are without markings. Caudal peduncle with small black blotch.

Distribution and Habitat

This species has only been sampled from the Dikrong River at Boorum village [Fig-7]. This river is located near the Helipad of Itanagar in a village called Boorum. Along left bank (looking upstream) the river is shallow with a substrate of sand and cobble. The right river bank is highly confined and with more vegetation. Collections were made all along the shallow and deeper regions using cast nets, seines and hand nets. This area is densely populated with humans and the left bank is highly disturbed with dumping of litter. The extraction of cobbles from this area is major threat to fish habitats. Other species sampled from this site included *Crossocheilus latius*, *Barilius bendelisis*, *Aspidoparia morar*, *Tor putitora*, *Chagunius chaugunio*, *Schistura* sp., *Psilorhynchus* sp., *Botia* sp., *Gagata cenia* and *Mystus* sp.



Fig. 7- Dikrong River, the type locality of *Garra alticaputus* sp. nov.

Etymology

The name *alticaputus* is a Latin adjective referring to the deep head of the species.

***Garra nigricauda* sp. nov. [Fig-8]**

Holotype: ZSI/SRS F8580, 1 ex. Male. 142.8 mm SL, Siang river, near Pasighat, Arunachal Pradesh, India. (N 27° 55' 22" E 95° 05' 54"). Collectors: M. Arunachalam, M. Raja, C. Vijayakumar, M. Muralidharan. 13 Nov 2010.

Paratypes: MSUMNH 61, 5 ex. 102.2-142.8 mm SL, CMA 19, 9 ex, 92.6-114.7 mm SL. All other details same as Holotype.

Diagnosis

Garra nigricauda sp. nov. is distinguished from *G. lissorhynchus* in having more branched pectoral-fin rays (14-16 vs. 14); fewer pre dorsal-fin scale rows (9-10 vs. 13); fewer circumpeduncular scale rows (12 vs. 16); more circumferential scales (22-24 vs. 21); the lack of a W - shaped marking on caudal-fin (vs. Present); and a distinct black subterminal stripe in each caudal lobe. The species is distinguished from *G. nambulica* in having more branched pectoral-fin rays (14-16 vs. 12); fewer pre dorsal-fin scale rows (9-10 vs. 24); and fewer circumpeduncular scale rows (12 vs. 16); from *G. annandalei* by more pectoral-fin rays (14-16 vs. 13); fewer circumpedun-

cular scale rows (12 vs. 16); more pre anal-fin scale rows (22-24 vs. 18); and from *G. gotyla gotyla* by more lateral-line scale rows (34-36 vs. 33); fewer circumpeduncular scale rows (12 vs. 16).

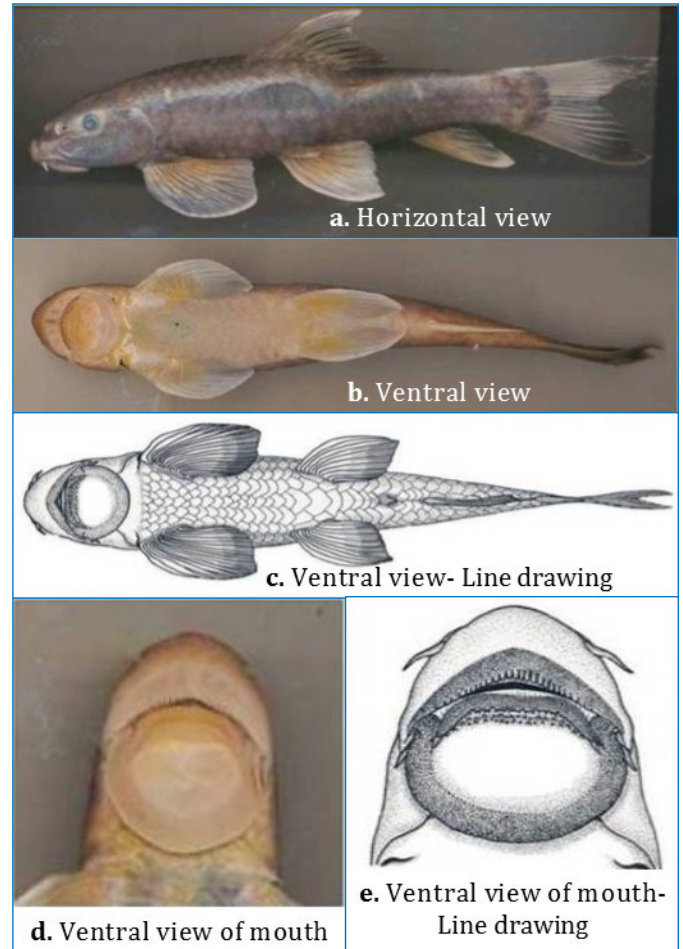


Fig. 8- *Garra nigricauda* sp. nov.

It is diagnosed from *G. elongata* in having more branched pectoral-fin rays (14-16 vs. 12); fewer lateral-line scale rows (34-36 vs. 39); fewer pre dorsal-fin scale rows (9-10 vs. 13); and the presence of breast scales (vs. absent); from *G. naganensis* by fewer circumpeduncular (12 vs. 16) and pre dorsal-fin scale rows (9-10 vs. 12); from *G. paralissorhynchus* by more branched pectoral-fin rays (14-16 vs. 11); more lateral-line (34-36 vs. 31) and circumferential scale rows (22-24 vs. 20); fewer pre dorsal-fin scale rows (9-10 vs. 12); fewer circumpeduncular scale rows (12 vs. 16); from *G. kempi* sp. nov. in having more branched pectoral-fin rays (14-16 vs. 12); fewer lateral-line scale rows (34-36 vs. 40); and fewer pre dorsal-fin scale rows (9-0 vs. 12); from *G. kalpangi* in having more branched pectoral-fin rays (14-16 vs. 10-12); more lateral-line scale rows (35-36 vs. 32-33); and fewer circumpeduncular scale rows (12 vs. 16); from *G. rupecula* by more branched dorsal-fin rays (8 vs. 6-7) and lateral-line scale rows (35-36 vs. 32-34); fewer upper transverse scale rows (4.5 vs. 4.5-6.5) and well developed scaled on breast, belly, and post pelvic areas of venter (vs. naked breast, belly and post pelvic areas) from *G. manipurensis* by more pectoral-fin rays (14-16 vs. 12); lateral-line scale rows (35-36 vs. 34) and pre anal-fin scale rows (22-24 vs. 12) and fewer circumpeduncular scale rows (12 vs. 16); from *G. compressus* by more pectoral-fin rays (14-16 vs. 12) and transverse scale rows (4.5/3.0-3.5/3.5-4.0 vs. 3.5/2.5/3.0) and fewer lateral-line (35-36 vs. 39) and anal-fin scale rows (3-4 vs. 5).

This species is distinguished from *G. litanensis* by more pectoral-fin rays (14-16 vs. 13) and lateral-line scale rows (35-36 vs. 32), and from *G. namyaensis* by more pectoral-fin rays (14-16 vs. 12); lateral-line scale rows (35-36 vs. 31) and fewer pre dorsal-fin scale rows (9-10 vs. 13) and circumpeduncular scale rows (12 vs. 16). It is differentiated from *G. abhoyai* in having more pectoral-fin rays (14-16 vs. 11) and lateral-line scale rows (34-36 vs. 33), and fewer pre dorsal-fin scale rows (10-11 vs. 17) and circumpeduncular scale rows (12 vs. 16). It is distinguishable from *G. kimini* sp. nov. by its overall size, more lateral-line (35-36 vs. 33-34) and pre anal-fin scale rows (22-24 vs. 17-21). It is diagnosable from *G. magnidiscus* in having more branched pectoral-fin rays (14-16 vs. 10-12), less pre dorsal-fin scale rows (9-10 vs. 12-15) and less lateral-line scales (35-36 vs. 40-42), as well as well developed scales on chest and belly (vs. Subcutaneous).

Description

Body elongate and robust, with rising dorsal profile. Ventral surface on head and breast flattened, abdomen slightly rounded [Table-6]. Snout rounded, shallow, and with long transverse groove with rostral lobes marginally adnate. Tubercles present laterally on snout to level of nostrils. Two pairs of barbels. Rostral barbel reaching margin of rostral cap. Central pad wider than long. Between exposed lower jaw and lower lip short straight papilliferous fold extending medially from corner of mouth.

Table 6- Meristic characteristics of *Garra minimus* sp. nov. from Ranga river, Arunachal Pradesh

No.	Morphometric measurement	Min	Max	Mean
1	Standard length	92.60	142.84	108.87
2	Snout to urocentrum	90.87	95.29	92.65
3	Pre anal length	69.82	76.14	73.51
4	Pre dorsal length	23.26	47.44	42.14
5	Pre pelvic length	47.14	52.23	49.31
6	Pre pectoral length	18.50	23.71	21.37
7	Pre occipital length	86.38	98.63	91.99
8	Snout to opercle	80.26	94.76	87.37
9	Upper jaw length	37.90	47.13	41.66
10	Snout length	49.78	60.12	53.92
11	Pre nasal length	31.40	41.24	35.43
12	Orbit width	15.01	23.88	18.32
13	Inter orbital width	37.12	45.18	41.90
14	Inter nasal width	24.24	39.18	31.07
15	Head width	65.70	77.37	71.27
16	Peduncle length	11.14	16.30	13.46
17	Dorsal origin to pelvic insertion	19.66	24.24	21.28
18	Anal fin height	17.39	21.74	19.40
19	Head depth at nostril	32.69	52.05	40.91
20	Head depth at pupil	49.35	61.27	54.78
21	Head depth at occiput	56.13	67.72	63.38
22	Peduncle depth	9.71	11.65	10.78
23	Caudal fin length	26.92	31.52	29.21
24	Dorsal fin height	22.04	24.80	23.33
25	Pectoral fin length	21.84	24.75	23.01
26	Pelvic fin length	19.50	23.52	21.09
27	Maxillary barbel length	5.27	13.22	9.56
28	Rostral barbel length	10.72	13.98	12.23
29	Occiput to dorsal-fin origin	21.31	26.16	23.89
30	Occiput to pectoral insertion	15.58	24.49	17.68
31	Occiput to pelvic insertion	35.29	41.79	38.03
32	Dorsal insertion to pelvic insertion	15.94	19.69	17.68

Table 6- Continue..

No.	Morphometric measurement	Min	Max	Mean
33	Dorsal origin to pectoral insertion	22.63	27.65	25.62
34	Dorsal origin to anal origin	33.63	37.20	35.58
35	Dorsal insertion to caudal base	29.57	38.04	32.81
36	Dorsal insertion to anal origin	18.99	22.70	20.83
37	Dorsal insertion to anal insertion	23.19	26.64	25.22
38	Dorsal fin base length	16.19	19.68	17.71
39	Anal fin base length	5.84	8.89	8.08
40	Pectoral insert / pelvic insert	23.91	30.32	27.52
41	Pectoral insert \ anal origin	37.46	50.99	46.97
42	Pelvic insert to anal origin	17.14	23.57	21.09
43	Head length	21.60	37.03	25.88
44	Total length	112.82	177.28	132.94
45	Post-dorsal length	46.85	54.52	50.03
46	Body depth	17.57	21.53	19.38
47	Distance b/w pectoral fin to vent	44.76	53.35	48.66
48	Distance b/w pelvic fin to vent	17.24	21.18	19.46
49	Disc length	39.53	55.37	48.78
50	Disc width	57.19	68.47	61.51
51	Central pad length	27.37	35.55	31.64
52	Central pad width	35.71	49.74	41.74

Dorsal-fin insertion 2.5 scale rows anterior to pelvic-fin origin. First and second branched rays of dorsal-fin longest; posterior margin of fin concave, longest ray of depressed fin vertical to pelvic-fin insertion; and vertically 5 scale rows. Pectoral-fin is rounded; branched rays 4-5 longest, when depressed extending to base of pelvic-fin. Pelvic-fin is rounded, first and second branched rays longest, when depressed almost reaching base of anal-fin. Anal-fin pointed, first branched ray longest, when depressed tip extending to base of caudal-fin base. Tips of caudal-fin lobes pointed, upper lobe shorter than lower lobe.

Table 7- Meristic characteristics of *Garra alticaputus* sp. nov. from Dikrong river, Arunachal Pradesh.

S. No	Meristic counts	Max	Min
1	Unbranched dorsal fin rays	2	2
2	Branched dorsal fin rays	8	8
3	Unbranched anal fin rays	2	2
4	Branched anal fin rays	5	5
5	Unbranched pelvic fin rays	1	1
6	Branched pelvic fin rays	8	8
7	Unbranched pectoral fin rays	1	1
8	Branched pectoral fin rays	16	14
9	Caudal fin upper lobe	9	9
10	Caudal fin lower lobe	8	8
11	Lateral line scales	36	35
12	Pre dorsal scales	10	9
13	Upper transverse rows	4.5	4.5
14	Lateral line to pelvic scale rows	3.5	3.0
15	Lower transverse rows (anus)	4	3.5
16	Circumpeduncular scales	12	12
17	Circumferential scales	24	22
18	Anal scale rows	4	3
19	Pre anal scales	24	22

Dorsal-fin rays ii, 8 (last ray branched at base); pectoral-fin rays i, 14-16; pelvic-fin rays i, 8; anal-fin rays ii, 5; caudal-fin rays 10+9 (17 branched); lateral-line complete, scales 35-36; lateral transverse scales 4.5 between dorsal-fin origin and lateral-line; 3.0-3.5 between lateral-line and pelvic-fin origin; 3.5-4.0 between lateral-line and anal-fin origin; pre dorsal-fin scale rows 9-10; circumpeduncular

scale rows 12; circumferential scale rows 22-24; pre anal-fin scale rows 22-24 [Table-7].

Scales

On venter, well developed scales in chest and belly region.

Color in Preservative

All the specimens were obtained from the market but were relatively fresh and had lost some of their wild colouration or it appeared somewhat muted; however, specimens were intact without any damage (damaged specimens were not included in the study). Dorsum and sides of head and body with base coloration grayish-brown; scales above lateral-line and on dorsum with light grayish-brown center and thin, darkly pigmented margins, creating a distinct scaled pattern. Below lateral-line base coloration lighter; some, but not all, scales with light center, as above lateral-line, but with broader marginal band on scales, creating a somewhat mottled color pattern. Mid-lateral stripe appearing lighter than coloration above or below lateral-line; stripe three scale rows deep anteriorly and narrowing to one scale row on caudal peduncle. Base of caudal-fin with dark round spot surrounded posteriorly, dorsally, and ventrally by creamish-colored area; posteriorly to cream area complete base of caudal-fin with broad dark bar extending from, but not including, dorsal and ventral procurent rays. Caudal peduncle coloration same as anterior part of body; no narrow dark stripes from pigmentation on dorsal and ventral edges of scales. Venter of head immaculate; breast, belly, and region between pelvic-fin insertion and anal-fin origin immaculate to light cream; post anal-fin area of caudal peduncle creamish but also with some melanophores and appearing darker approaching caudal-fin.

Head with large dark and oval-shaped spot posterior to eye and directly above opercle and dorsal preopercle. Orbit encircled by broad, creamish-colored ring. Lacrimal region and tip of snout connected and light gray. Dorsal-fin with dusky unbranched and branched rays; bases of branched rays, beginning with second branched ray with distinct dark and elongate spots with melanophore covering the rays in this region; distal to dark part of ray, rays yellowing-red; beginning with second branched fin ray all membranes black. Distal tip of tallest unbranched and first branched rays yellowing-red. Dorsum of pectoral-fins are with narrow white distal band on leading unbranched ray and six branched rays; basally and medially rays reddish-orange and membranes dusky; leading ray darkly pigmented complete length and set apart from all other rays of fin; subdistally fin with broad black band, widest anteriorly and narrowing to only margin after 8th ray. Basal area at pectoral-fin insertion darkly pigmented and set apart from coloration of body. Ventrally, pectoral-fins with distinct yellowish coloration, beyond which fin is immaculate. Pelvic-fin with yellowish-red color widely distributed and dark pigmentation restricted to membranes, darkest in first membrane; distally, fin with broad light to clearish band. Ventrally pelvic-fin colored as in pectoral-fin. Anal-fin coloration with more reddish-yellow pigmentation basally and extending to medial area of fin; leading rays not darkly pigmented, colored reddish-yellow; distal tip of anterior few rays clear to creamish; distal to reddish-yellow coloration fin with broad black band. Caudal-fin rays and membranes dusky; median branched rays and membranes black, creating appearance of stripe in center of fin; first and second branched caudal rays and membranes of lower lobe black distally and becoming more gray anteriorly, creating stripe; upper and lower lobes of caudal-fin and distal edge black; black area largest in lower lobe. Fins grayish with markings along the outer margins of pecto-

ral, pelvic and caudal-fins; caudal-fin also tipped with black with more concentrated on the lower lobe than upper lobe. Anal-fin with black streaks; edge of fin black.

Distribution and Habitat

This species has only been sampled from the Siang River, near Pasighat [Fig-9]. Siang River is a 5th order river with unstable banks on both sides. Substrate types is mostly cobbles and sand. The width of the river is 0.5-0.6 km. Except fishing activity there is no disturbance in this stretch where *G. nigricauda* is collected.

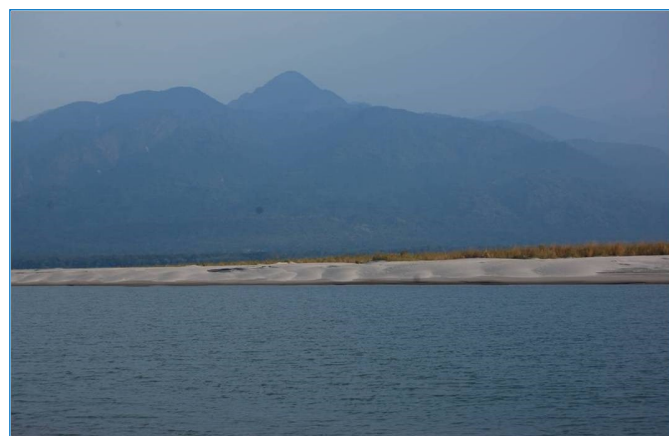


Fig. 9- Siang River, the type locality of *Garra nigricauda* sp. nov.

Etymology

The name is *nigricauda* is Latin referring to the black caudal-fin edges.

Garra kimini sp. nov. [Fig-10]

Holotype: ZSI/SRS F8581, 1 ex. Male. 83.4 mm SL, tributary of Ranga River, 7 km from Hola camp, Lower Subanshri District, Arunachal Pradesh, India (N 27° 20' 59" E 93° 56' 37"). Collectors: M. Arunachalam, M. Raja, C. Vijayakumar and S. Nandagopal. 18 Jun 2011.

Paratypes: MSUMNH 62, 10 ex. 62.3-85.0 mm SL, CMA 20, 6 ex, 64.9-78.4 mm SL. All other details same as Holotype.

Diagnosis

Garra kimini is distinguished from *G. lissorhynchus* by fewer pre dorsal-fin scale rows (9-10 vs. 13); more circumferential scales (22-24 vs. 21); and lack of W - shaped marking on caudal lobe (vs. W - shape marking present). From *G. nambulica* it is distinguished by more branched pectoral-fin rays (14-15 vs. 12); fewer pre dorsal-fin scale rows (9-10 vs. 24); naked breast (vs. well-developed scales). It is distinguished from *G. annandalei* in having more pectoral-fin rays (14-15 vs. 13); circumferential (22-24 vs. 22); and pre anal-fin scale rows (17-21 vs. 18); proboscis with slight protrusion (vs. no proboscis); and deep transverse groove (vs. transverse groove absence). The species is distinguished from *G. gotyla gotyla* in having more lateral-line scale rows (33-34 vs. 33); naked breast (vs. well-developed scales); and slight protrusion for proboscis (vs. well-developed median proboscis); from the *Garra elongata* by more branched pectoral-fin rays (14-15 vs. 12) and fewer lateral-line (33-34 vs. 39) and less pre dorsal-fin scale rows (9-10 vs. 13); and poorly developed scales in breast region (vs. naked); from *G. naganensis* in having fewer lateral-line (33-34 vs. 39) and fewer pre dorsal-fin scale rows (9-10 vs. 12); and naked breast area (vs. reduced breast squamation); from *G. paralissorhynchus* by more branched

pectoral-fin rays (14-15 vs. 11) and lateral-line (33-34 vs. 31) and circumferential scale rows (22-24 vs. 20) and fewer pre dorsal-fin scale rows (9-10 vs. 12).

40-42), as well as more circumpeduncular scales (16 vs. 12-14), presence of tubercles on pectoral-fin (vs. absence).

Description

Body elongate, slightly compressed laterally, becoming more extreme on caudal peduncle. Dorsal profile of body slightly convex from tip of occiput to dorsal-fin origin [Table-8].

Table 8- Meristic characteristics of *Garra nigricauda* sp. nov. from Siang river, Pasighat, Arunachal Pradesh

No.	Morphometric measurement	Min	Max	Mean
1	Standard length	62.29	85.03	74.57
2	Snout to urocentrum	90.19	96.42	93.95
3	Pre anal length	68.90	75.79	72.43
4	Pre dorsal length	42.41	47.41	44.59
5	Pre pelvic length	44.11	49.75	47.24
6	Pre pectoral length	17.09	22.84	20.53
7	Pre occipital length	82.43	99.49	90.22
8	Snout to opercle	89.82	96.93	93.19
9	Upper jaw length	32.52	44.58	38.97
10	Snout length	47.12	58.36	53.29
11	Pre nasal length	31.35	40.65	34.82
12	Orbit width	18.72	25.27	21.48
13	Inter orbital width	37.51	42.65	40.48
14	Inter nasal width	23.96	33.26	29.66
15	Head width	63.04	79.27	71.47
16	Peduncle length	9.79	16.39	12.90
17	Dorsal origin to pelvic insertion	10.43	28.80	22.07
18	Anal fin height	16.53	21.69	19.33
19	Head depth at nostril	35.31	50.64	41.68
20	Head depth at pupil	50.50	64.41	57.23
21	Head depth at occiput	64.25	77.35	70.24
22	Peduncle depth	10.90	12.86	11.87
23	Caudal fin length	25.07	33.84	28.87
24	Dorsal fin height	20.57	29.06	24.32
25	Pectoral fin length	17.78	25.33	21.07
26	Pelvic fin length	15.78	23.07	19.65
27	Maxillary barbel length	3.62	15.22	6.84
28	Rostral barbel length	10.82	18.15	14.37
29	Occiput to dorsal-fin origin	19.40	26.17	23.88
30	Occiput to pectoral insertion	16.93	19.03	17.54
31	Occiput to pelvic insertion	35.86	39.64	38.05
32	Dorsal insertion to pelvic insertion	16.83	22.96	19.09
33	Dorsal origin to pectoral insertion	22.61	28.01	24.73
34	Dorsal origin to anal origin	34.88	39.12	37.05
35	Dorsal insertion to caudal base	31.26	37.53	34.30
36	Dorsal insertion to anal origin	20.75	25.10	22.90
37	Dorsal insertion to anal insertion	24.53	30.40	27.66
38	Dorsal fin base length	13.41	20.99	17.76
39	Anal fin base length	5.36	10.07	7.16
40	Pectoral insert / pelvic insert	24.51	29.73	26.55
41	Pectoral insert \ anal origin	44.18	49.50	45.97
42	Pelvic insert to anal origin	16.91	20.28	18.51
43	Head length	15.68	19.64	17.51
44	Total length	82.29	103.90	91.86
45	Post-dorsal length	50.12	62.30	54.63
46	Body depth	19.76	24.76	21.89
47	Distance b/w pectoral fin to vent	44.46	50.52	47.41
48	Distance b/w pelvic fin to vent	16.56	22.37	18.89
49	Disc length	36.08	45.08	40.63
50	Disc width	46.37	58.55	53.00
51	Central pad length	23.02	29.27	25.92
52	Central pad width	30.58	40.78	35.49

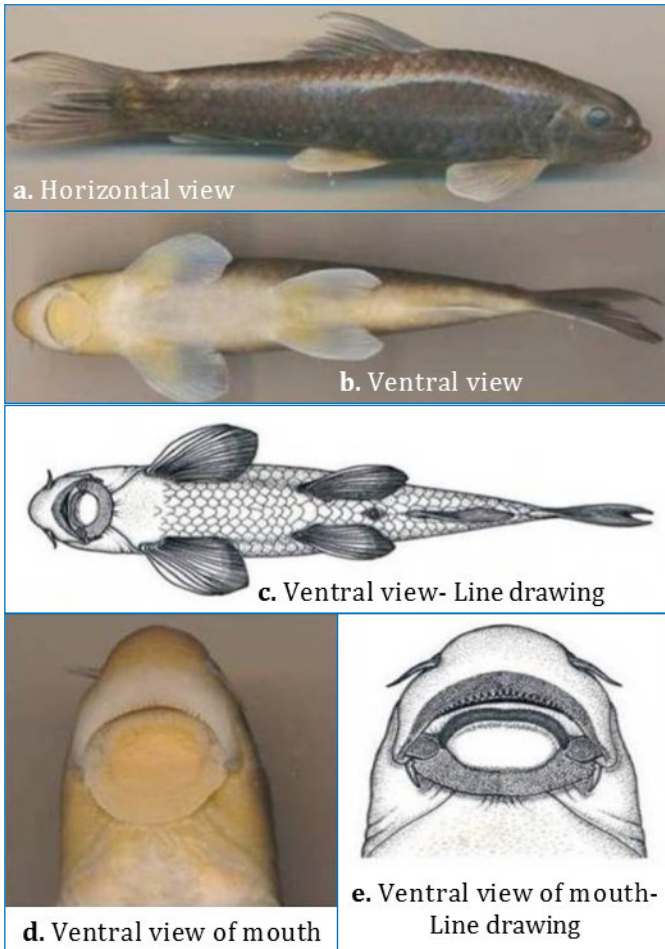


Fig. 10- *Garra kimini* sp. nov.

The species is diagnosed from *G. kempi* in having more branched pectoral-fin rays (14-15 vs. 12) and fewer lateral-line (33-34 vs. 40) and pre dorsal-fin scale rows (9-10 vs. 12); from *G. kalpangi* in having more branched pectoral-fin rays (14-15 vs. 10-12). The species is further distinguished from *G. rupecula* in having more branched dorsal-fin rays (8 vs. 6-7); fewer upper transverse scale rows (4.5 vs. 4.5-6.5); and well developed belly scales (vs. breast area naked); and well developed scales on belly (vs. belly naked); from *G. manipurensis* by more pectoral-fin rays (14-15 vs. 12); fewer anal-fin scale rows (2.5-3.0 vs. 4) and pre dorsal-fin scale rows (11 vs. 9-10); and more pre anal-fin scale rows (17-21 vs. 12); from *G. compressus* by more branched pectoral-fin rays (14-15 vs. 12); fewer lateral-line (33-34 vs. 39), pre dorsal-fin scale rows (9-10 vs. 12) and circumpeduncular scale rows (16 vs. 12); from *G. litanensis* by more branched pectoral-fin rays (14-15 vs. 13); lateral-line scale rows (33-34 vs. 32); and fewer anal-fin scale rows (3.5 vs. 2.5-3.0). The species is diagnosed from *G. namyaensis* by more branched pectoral-fin rays (14-15 vs. 12); more lateral-line scale rows (33-34 vs. 31); fewer pre dorsal-fin scale rows (9-10 vs. 13); and from *G. abhoyai* by more pectoral-fin rays (14-15 vs. 11); fewer pre dorsal-fin scale rows (9-10 vs. 17) and more pre anal-fin scale rows (17-21 vs. 7). It is diagnosable from *G. magnidiscus* in having more branched pectoral-fin rays (14-15 vs. 10-12), less pre dorsal-fin scale rows (9-10 vs. 12-15) and less lateral-line scales (33-34 vs.

Base of dorsal-fin sloped slightly. Dorsal profile straight from posterior end of base of dorsal-fin to base of caudal-fin. Ventral profile of body almost straight from pectoral to pelvic-fin insertions and from pelvic-fin insertion to anal-fin origin. Posteroventally, anal-fin base nearly straight. Profile between posterior end of base of anal-fin to base of caudal-fin straight. Head moderately large, depressed and with a convex interorbital space; head height less than length; head width almost equal to height. Snout broadly rounded and with a narrow, shallow groove across snout tip, forming a transverse lobe with 12-13 small to large erect tubercles. Two pairs of barbels; rostral barbels located antero-laterally and longer than diameter of eye; maxillary barbels at corner of mouth and shorter than rostral barbels. Rostral cap well developed, moderately granulated and with a narrow papillated margin. Disc elliptical, length shorter than wide. Caudal-fin emarginated; lobes equal in length and tips slightly pointed.

Dorsal-fin rays ii, 8 (last ray branched at base); pectoral-fin rays i, 14-15; pelvic-fin rays i, 8; anal-fin rays ii, 5; caudal-fin rays 10+9 (17 branched); lateral-line complete, scale rows 33-34; 4.5 lateral transverse scale rows between dorsal-fin origin and lateral-line; 3.5 between lateral-line and pelvic-fin origin; and 3.5 between lateral-line and anal-fin origin; pre dorsal-fin scale rows 9-10; circumpeduncular scale rows 16; circumferential scale rows 22-24; pre anal-fin scale rows 17-21 [Table-9].

Table 9- Meristic characteristics of *Garra kimini* sp. nov. from 7 km away from Hola camp, Arunachal Pradesh.

S. No	Meristic counts	Max	Min
1	Unbranched dorsal fin rays	2	2
2	Branched dorsal fin rays	8	8
3	Unbranched anal fin rays	2	2
4	Branched anal fin rays	5	5
5	Unbranched pelvic fin rays	1	1
6	Branched pelvic fin rays	8	8
7	Unbranched pectoral fin rays	1	1
8	Branched pectoral fin rays	15	14
9	Caudal fin upper lobe	9	9
10	Caudal fin lower lobe	8	8
11	Lateral line scales	34	33
12	Pre dorsal scales	10	9
13	Upper transverse rows	4.5	4.5
14	Lateral line to pelvic scale rows	3.5	3.5
15	Lower transverse rows (anus)	3.5	3.5
16	Circumpeduncular scales	16	16
17	Circumferential scales	24	22
18	Anal scale rows	3	2.5
19	Pre anal scales	21	17

Tubercles are absent on pelvic, anal and caudal-fins. Dorsal surface of pectoral-fin covered with spiny tubercles; each ray bearing numerous minute organs for its entire length. Leading unbranched ray with 3 rows of tubercles; first row with 27 tubercles, second row with 23, and third row with 38. First branched ray of pectoral-fin with 2 rows of tubercles; first row with 58 tubercles and second row with 30. The second branched ray also with 2 rows; first row with 52 tubercles and second row with 35. The third branched ray with 2 rows of tubercles; first row with 54 tubercles and second row with 37. Pectoral-fin with erect tubercles to 7th branched ray.

Scales

Scales on chest naked and Belly scaled.

Color in Preservative

In live specimens head, body, and dorsum grey with a blackish spot immediately posterior to dorsal gill-opening. Colours of dorsal, pectoral and pelvic-fins are not distinct.

Distribution and Habitat

Only one population is currently known for this species from a stream near Hola camp. This stream confluences with Ranga River in Lower Subanshri district [Fig-11]. With few human settlements in the area, the terrestrial habitats and stream appears to be relatively undisturbed. As a third-order stream it contains numerous rocks and large boulders. At the time of collection flow was not high and the stream. Morphology of stream valley "U"- shaped within this reach and not steep enough; slopes of both sides shallow. Because of the U-shaped valley, stream gradient was less than 5% and water velocity was low. Species of *Garra* was found in areas with a high velocity and the substrate types are mostly large boulders. Loaches were collected by local people in areas with cobbles and sand. Water was clear and appeared unpolluted, although there were visual signs of the stream being used by nearby villagers for bathing and washing clothes.



Fig. 11- 7 km away from Hola camp, the type locality of *Garra kimini* sp. nov.

Etymology

The name *kimini* is a noun in apposition and refers to the nearby village where the new species was collected.

Comparisons of Species Using Morphometric Characters

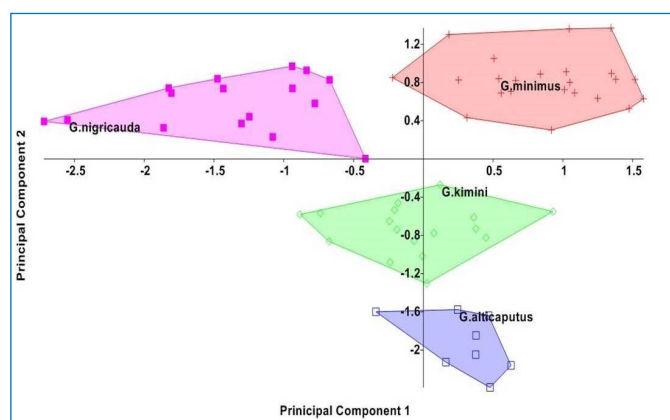


Fig. 12- Principal Component plot of axes 1 and 2 for pooled morphometric data derived from four new species of *G. minimus*, (Cross) *G. alticaputus*, (Square) *G. nigricauda* (filled square) and *G. kimini* (diamond) from Arunachal Pradesh, India.

Principal component analysis provides a summarization of the morphometric variation and comparisons of the four new species relative to one another [Fig-12]. This analysis demonstrates the distinctiveness of these species in morphometric characters serving to provide information regarding shape. Characters of high loading on PCI included head depth at occiput, head depth at pupil, peduncle depth, dorsal-fin insertion to pelvic-fin insertion; those on PCII included pelvic-fin length, disc length, disc width, central pad width. The summary of the shape variables in this analysis, as well as the data provided in diagnoses, descriptions, and comparisons, in combination with meristic characters, coloration, lip and disc morphology, demonstrate these four species as both diagnosable and distinct evolutionary lineages (sensu Evolutionary Species Concept). Using this summary of morphometric features *G. minimus*, *G. alticaputus*, *G. nigricauda* and *Garra kimini* are clearly distinct.

Discussion

All species of *Garra* have at least one branched pectoral-fin ray, a characteristic feature of Asian *Garra* [27,28]. Species of *Garra* thus far reported or recently described from the Indian state of Arunachal Pradesh include: *G. lissorhynchus*, *G. paralissorhynchus*, *G. annandalei*, *G. gotyla gotyla*, *G. kempfi*, *G. lamta*, *G. naganensis*, *G. arupi*, *G. nasuta* and *G. rupecula* [8]. *Garra minimus*, *Garra nigricauda*, *Garra elongata* and *Garra kempfi* have 12 circumpeduncular scale rows while all other species have 16 circumpeduncular scale rows, except for *Garra alticaputus* and *Garra kimini* that also has 16 circumpeduncular scale rows. *G. minimus* sp. nov. differs from *G. manipurensis* [14] by the presence of proboscis and transverse groove; showed variation in lateral-line scales and more pectoral-fin rays. Another described species, *G. compressus* [16] from Manipur also showed distinctive characters by the presence of proboscis and transverse groove and also by the scale less chest. Also described from the same locality, *G. litanensis* [14] is closely related to *G. minimus*, but with the differences is in more number of lateral-line scales. *G. alticaputus* sp. nov. is also distinguished from *G. manipurensis* by not well developed proboscis and shallow transverse groove; showed variation in pectoral-fin rays. Also *G. alticaputus* showed variation from *G. compressus* by more branched pectoral-fin rays; less lateral-line scales; less pre dorsal-fin scales and the presence of proboscis and transverse groove on snout with belly scaled and subcutaneous scales on chest region. *G. alticaputus* showed distinction with *G. litanensis* by the well developed scales on belly. *G. nigricauda* sp. nov. is closely related to *G. manipurensis* but the variations are in more number of pectoral-fin rays and the presence of proboscis and transverse groove and also presence of scales on chest and belly. It showed variation with *G. compressus* by also more pectoral-fin rays; less lateral-line scales; less pre dorsal-fin scales and the presence of transverse groove on snout and also the presence of scales on belly and chest. *G. nigricauda* is also distinguished from *G. litanensis* by more number of lateral-line scales. *G. kimini* sp. nov. is also distinct from *G. manipurensis* by more branched pectoral-fin rays; presence of proboscis and transverse groove on snout. *G. kimini* is also distinct from *G. compressus* by more branched pectoral-fin rays; less lateral-line scales; less pre dorsal-fin scales. However, *G. elongata* has 39 lateral-line scale rows while *G. kempfi* has 40 lateral-line scale rows and both species have 1 vs. 2 unbranched dorsal-fin rays and 7 vs. 8 branched dorsal-fin rays, respectively. *G. minimus* has 14-16 branched pectoral-fin rays which is higher than any *Garra* species reported or described so far from India.

Arrangement of breeding tubercles on the head and body to be of taxonomic importance. Bailey and Suttkus [29]; Robins and Raney [30] and earlier authors Gibbs [31]; Hubbs and Black, [32] considered them to be valuable indications of phylogeny. The distribution of tubercles in the genus *Garra* has been reported only from the regions of snout and cheek and however, the distribution of 'Pearl organs' to other parts of body and fins can be considered as taxonomically important. A similar condition of the distribution of nuptial tubercles in males and sometimes in females from head to trunk and all of the fins up to caudal has been reported in some catostomid fishes from Kansas.

It was noted by Kullander and Fang [27] that lip structures are important for the identification of most species of *Garra* and are also important for resolving their phylogenetic relationships. It was lamented that most of the new descriptions of *Garra* are lacking the details of lip structure and hence are not comparable. However, *Garra minimus* and *Garra alticaputus* have distinct upper-lip structures formed by papillae. *Garra rupecula* McClelland [8] was described from the Mismi Mountains, Assam (now in Arunachal Pradesh) of the Bramaputra River basin and as having a W-Shaped band on the caudal-fin and absence of scales in the pre dorsal-fin areas [13]; however, types of this species are not available for examination. McClelland described *Garra nasuta* under *Gonorhynchus* from a single specimen collected from the Kasya Mountains. However, the real identity of this species is not clear as the description was quite inadequate. Thus, Menon [33] described this species from specimens collected from Kasya mountains. However, the species described by Menon [33] turned out to be an another species, *Gonorhynchus caudatus* McClelland [34,35].

Garra is one of the most diverse and taxonomically confusing groups of the Cyprinidae (Cypriniformes) that has yet to be examined for evidence of monophyly or examined a breadth of morphological and molecular traits. Given the distribution of this genus, information as to the genealogical relationships of the species would provide critical historical inferences as to the biogeographic connections both within and between Africa and Asia. However, the taxonomy of *Garra* is not mature enough to support such a well-developed hypothesis and awaits further studies using morphological and molecular data focused on species-group level questions. Many old descriptions exist and many names are available but resolution of species diversity and nomenclature within this putative monophyletic genus is in need of great attention by many researchers. The above example is only one of several cases wherein there is considerable confusion of appropriate names, lack of type materials, and unknown geographic variation that may or may not be considered species diversity. Phylogenetic studies are critically important even now with confused nomenclature but not until many of the types, names, and nomenclatorial issues remaining in the genus are resolved, taxonomic revisions and a well-resolved phylogeny must await more detailed examine and report and illustrate the same characters for comparisons and diagnoses. This would initially be well served if a prioritized and collaborative effort were conducted for collections of topotypes of species of *Garra* and dorsal, lateral, and ventral color photos were made available of the whole body, head and fins, as well as consistency in the collection of comparative characters.

Comparative Materials Examined

Garra lissorhynchus Topotype: ZSI Calcutta, FF 8098 / 1; 73.05 mm SL; Collected by: L. Kosygin. *Garra nambulica* Paratype: ZSI Cal-

cutta, 4139; 50.41 mm SL; Irengloic Stream flowing to Nambal River, Shingala Village, Imphal West District, Manipur, India. 03rd Feb. 2004. MUMF 8002; Type series examined from Manipur University Museum of Fishes. *Garra annandalei* Holotype: ZSI Calcutta, F 6082 / 2-1; 60.17 mm SL; Kokha nallah, Koshi river, District: Barabakshetra. India. 30th Jan.1946. *Garra gotyla gotyla* ZSI Calcutta, F 198/2; 121.92 mm SL; Kumaon Hills survey, Kosi River Kosi village, Almorah, 07th June1948. *Garra elongata* ZSI Calcutta, FF 4157; 81.28 mm SL; Hill stream near Tollai, Ukhrul district, Manipur, India, 12th Nov. 1997. *Garra naganensis* ZSI Calcutta, F 9970 / 1; 89.93 mm SL; Senapathi Stream, Naga hills, Assam, India). Collector L. Kosygin; Type series examined from MUMF. *Garra paralissorhynchus* Paratype: ZSI Calcutta, 4158; 52.35 mm SL; Location: Khuga River, Churachandrapur district, Manipur, India. 25th July 2000. *Garra kempi* Holotype: ZSI Calcutta, F 7716 / 1; 88.51 mm SL; Sharjon River, below Damda, the Abor hills, India. 25th July 2000 [Fig-2]. *Garra abhoyai* Type series examined from MUMF. *Garra manipurensis* Type series examined from MUMF. *Garra compressus* Type series examined from MUMF. *Garra litanensis* Type series examined from MUMF. *Garra namyaensis* Type series examined from MUMF [Fig-3]. *Garra kalpangi* data from Nebeshwar, et al [20]. *Garra arupi* data from Nebeshwar, et al [21]. *Garra nasuta* data from Monograph [33] of the Cyprinid fishes of the genus *Garra* Hamilton-*Garra rupecula* data from Talwar and Jhingran [36]. *Garra dampansensis* data from Lalronunga, et al [23]. *Garra magnidiscus* data from Tamang [24].

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