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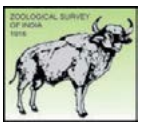

A Preliminary study of the fish diversity of east Siang and Loihit River of Pasighat and Tezu with the description of a new *Garra* species (Teleostei: Cyprinidae)

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Abstract

The present work is a result of a Preliminary survey on the fish diversity of two major rivers of Arunachal Pradesh *i.e* Siang river and Lohit river at Pasighat and Tezu. A total of 24 species belonging to 5 families of Cyprinidae, Siluridae, Sisoridae, Belonidae and Bagridae were collected. Among them, *Barilius, Garra, Tariqilabeo, Glyptothorax* were commonly found in both the rivers. While in Lohit River of Tezu a greater number of species of the genera *Raiamas, Xenentodon, Pterocryptis, Pseudocheneis, Schizothorax, Batasio, Puntius, Wallago* were collected. A new species of *garra* is also reported belonging to "Smooth snout group", having prominent, regular scales on abdomen, moderately large gular disc, broader than long (length 37.4% HL,55.3 width % HL), anus posteriorly positioned, a black spot at upper angle of gill opening.

Keywords: Fish Diversity, East Siang, Lohit River, Arunachal Pradesh, Brahmaputra, *Garra*.

Introduction

Arunachal Pradesh is located between 26.28°N and 29.30° N latitude and 91.20°E and 97.30°E longitude. The state is a part of Indo-Burma biodiversity hotspot region. It has a highest forest area to geographic area ratio (0.81) with a forest cover of 68.045 km² in the country (Sinha 2019). The state shares its international boundaries with Bhutan in the west, China in the north and Myanmar in the east. The five major rivers namely the Kameng, the Subansiri, the Siang, the Lohit and the Tirap draining the state. Siang River is the largest river among all the rivers of Arunachal Pradesh. It is called the Tsangpo in Tibet, where it has its origin of Brahmaputra River system, originates in Southern Tibet. The Tsangpo which originated in Tibet is called the Siang after it enters India through Upper Siang district in the North eastern state. The Siang joins two other rivers- The Lohit and The Dibang downstream to form the Brahmaputra. Many pioneer researchers had studied the fish diversity of Arunachal Pradesh. Earlier studies reported systematic account of fish resources of Arunachal Pradesh and recorded 131 fish belonging to 10 orders and 27 families (Nath and Dey 2000). The studies on Siang River reveals the presence of different 90 species of fish belonging to 8 order, 24 families and 52 genera (Bilap Kumar Das et. al 2014).

The diversity of topographic and climatic condition has made the state rich with various flora and fauna. Fish is one of the important bio resources which can be used as food, Aquarium fish and in sport industry (Gurumayum et. al 2016). In the present study, we provide a checklist of fish fauna of East Siang and Lohit River. A rigorous collection of fishes from the two rivers will obtain a good number of species diversity as the area lies in a hotspot. During the present study, individual of a hitherto undescribed species of *Garra* were collected from the Lohit river, which is described herein as *Garra tezuensis*, new species.

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Material and methodology

Study site: The survey was carried out at Pasighat and Tezu with co-ordinates 28°09'69.29" N and 95°3013'.65" E and 27°91'58.66" latitude and 96°17'38.98" longitude of East Siang and Lohit River, Arunachal Pradesh. The study period was during the winter season. Specimens were collected with the help of cast net along with local people. All the essential data such as place of collection, number of fish, body color and body marking were recorded. The collected specimens were preserved in 10 % formalin for further analysis. The descriptions are based on formalin preserved specimens. Measurements were taken point to point with digital calipers to 0.1mm. For identification and classification Nath & Day (2000), Darshan et. al (2018) and Vishwanath (2021) were followed. General count and measurement follows Hubbs and Lagler (1946). Fin rays and numbers of scales were counted under a stereoscopic zoom microscope. Terminology used for the description of the gular disc follows Kottelat (2001). Counts measurements, terminology of oromandibular structures and snout morphology of *Garra* follow Nebeshwar & Vishwanath (2013). Pre anal scales are the ventral mid line row of scales between the anal fin and the anus. Scales count follows Nebeshwar and Vishwanath (2013). The holotype is deposited in the Freshwater fish section, Zoological Survey of India, Kolkata and the paratype specimens are deposited in the Dhanamanjuri University Museum of Fishes, Manipur.

The conservation status of the fish species is based on the IUCN (www.iucnredlist.org.in).

Comparative data for species which could not be examined are derived from the published literature: *G. annandalei* from Bhakta, Meitei et. al (2021); *G. arupi* from Nebeshwar, Vishwanath & Das (2009); *G. chaudhuri, G. jenkinsonianum, G. naganensis* from Hora (1921); *G. compressa* from Kosygin & Vishwanath 1998*; G. jenkinsonianum, G. kempi* from Nebeshwar & Vishwanath (2015); *G. magnidicus*, *G. rupicola* from Nebeshwar & Vishwanath (2013); *G. mini* from (Rahman et. al 2016).

Table 1 shows the list of fish recorded from East Siang and Lohit River along with their economic value and the IUCN 2021 status. In the present study there was also a report of new species of *Garra*, *G. tezuensi*, its characters, morphology and the meristic study were taken

Results

Garra tezuensis, sp.nov

Holotype: ZSI Calcutta, F 9799, 65.2mm SL, India, Arunachal Pradesh, Lohit District, Lohit River at Tezu (Brahmaputra Basin) 27°91'58.66"N 96°17'38.98" E. K Thoidingjam, 18-02- 2023.

Paratype: DMUMF-KT02-10, 58.6-65.2 mm SL; same data as holotype.

Diagnosis: *Garra* can be divided into five species groups based on the snout morphology as suggested by Nebeshwar and Vishwanath (2017): 1) smooth snout species group, 2) transverse lobe species group, 3) rostral flap species group, 4) rostral lobe species group, and 5) proboscis group. *Garra tezuensis* belongs to "smooth snout with poorly developed transverse depression". It is distinguished from the other member of this group in possessing the following characters:

Black spot at upper angle of gill opening present vs absent except *G. jenkinsonianum*; from *G. jenkinsonianum, G. chakpiensis, G. arupi, G. annandalei* in having more posteriorly positioned anus vs anteriorly placed, lesser circumpeduncular scales vs few; from *G. chaudhurii* in having longer snout length vs shorter; from *G. rupecula* and *G. lissorhynchus* in having W shaped black band on caudal fin absent vs. present; from *G. ukhrulensis, G. chakpiensis* and *G. kempi* in having longer disc length vs shorter, wider pulvinus vs narrower and further from *G. magnidiscus, G. rupecula* and *G. mini* in having chest scaled vs naked. A detailed distinguishing characters are discussed.

Description: Morphometric data of the holotype and paratypes are given in Table 2. Body elongated, compressed, more compressed on caudal penduncle region. Dorsal head profile slightly convex rising gently above the snout, dorsal body profile to dorsal fin origin almost straight. Dorsal fin base slightly convex. Profile from the posterior end of the dorsal fin base to caudal fin base straight. Ventral profile from pectoral to pelvic fin origin convex and straight from pelvic fin to anal fin origin. Anal fin base nearly straight, posterodorsally inclined. Profile from posterior end of the anal fin base to caudal fin base straight. Head small (21.55 % SL) interorbital area convex, length greater than width. Snout moderately rounded with incomplete transverse depression interrupted in dorsolaterally in the middle of the head. Sublachrymal groove posteroventrally sloped continuous to the lateral groove of rostral cap.

Two pairs of barbels, rostral anterolaterally located, shorter than eye diameter, maxillary barbels at the corner of the mouth, shorter than rostral barbel. Rostral cap well developed, fimbriated, papillated, rostral cap covering upper jaw. Labrum papillated. Upper lip entirely covered by rostral cap. Lower lip modified into a mental adhesive disc. Disc elliptical, shorter than width and narrower than head width, gular disc large and medially positioned, groove between torus and pulvinus shallow devoid of any transverse lobe.

Dorsal fin rays with iii simple 8½ branched rays, last simple ray longer than head length, distal margin slightly concave, origin at middle of standard length, inserted anterior to vertical through pelvic- fin origin, second branched ray longest, last branched ray not extending to vertical of anal fin origin. Posterior margin emarginated; Pectoral fin with i simple and 12 branched rays reaching beyond mid - way to pelvic fin origin, fifth branched ray longest, shorter than head length. Margin convex when adpressed; Pelvic fin with i simple and 8 branched rays surpassing the anus, second branched ray longest, posterior base closer to anal fin origin than the pectoral fin origin, margin pointed; Anal fin short with ii simple ray and $4^{1}/_{2}$ branched ray. Posterior margin straight; Caudal fin forked, tip of lobes pointed with 10+9 rays. Lateral line complete with 32-33 scales; Transverse scales rows between dorsal fin origin to lateral line 3- 3½ and transverse scales rows between lateral line and pelvic fin origin 3; Circumpenduncular scales 12; Predorsal scales 9-10 Scales regularly arranged, Chest and belly scaled; Preanal scales 3, dorsal fin base scales 6; Anal fin base scales 4.

Colour in preservation: In formalin, head and dorsum grey and lateral side light grey. Mouth and abdomen whitish, chest yellowish, black spot at the upper angle of the gill opening. Tubercles on snout creamish white. In live, body dark grey or blackish, ventral whitish and dorsal, pectoral, pelvic, anal and caudal fin slightly orange.

Distribution: *Garra tezuensis* sp. nov. is presently known only from the type locality Lohit River at Tezu, Lohit District (Brahmaputra basin) Arunachal Pradesh.

Etymology: Name after its type locality, Tezu, Lohit District, Arunachal Pradesh, India

Discussion: - Morphology of the snout and the shape and distribution patterns of tubercles on the snout is of taxonomic significance in distinguishing species of *Garra* (Nebeshwar and Vishwanath 2017). The genus had been divided from five species group in which *Garra tezuensis* belongs to smooth snout group. Twenty-eight species of *Garra* currently recognized from the Brahmaputra River drainage in which 3 belongs to smooth snout, 3 from transverse lobe, 2 from rostral flap and the remaining 20 belongs to proboscis group species. In the adjacent river drainage (i,e the Barak - Meghana river, the Kaladan river, the Chindwin – Irrawaddy river drainage and some small coastal rivers between), there are 31 *Garra* species recognized (Zheng Gong *et al* 2018). Arunachalam *et al* (2013) described four species of *Garra* from the upper Brahmaputra River drainage of Arunachal Pradesh. Nebeshwar and Vishwanath (2017) indicated the likely synonymy of these four nominal species: G. *nigricauda* to *G. arunachalensis, G. minima to G. quadratirotris and G. kimini* and *G. alticaputus to G. birostris*.

Garra tezuensis belongs to smooth snout group. It differs from its congeners of the group as follows: from *G. annandalei* in having rostral lobe (absent vs present); tubercles on snout (present vs absent); fewer lateral line scale (32-33 vs. 34-38); longer snout length (44.7-52.7 % HL vs. 19.2-25); more posteriorly situated anus (distance from anus to anal fin origin 16.7-22.9 % of distance between pelvic to anal fin origin vs. 30-33.8); lesser circumpenduncular scales (12 vs.16); from *G. arupi* in having transverse lobe absent (vs present); lesser lateral line scale (32-33 vs. 35-36); lesser circumpeduncular scales (12 vs.16); more posteriorly situated anus (distance from anus to anal fin origin 16.7-22.9 % of distance between pelvic to anal fin origin vs. 52.6-60); fewer predorsal scale (9 vs.11-12); longer preanus length (70.2-73.3% SL vs. 62.4-65.6); from *G. chakpiensis* in having larger adhesive disc width (44.0-55.0% HL vs. 36.0-42.0); larger disc length (35.0-38.7% HL vs. 20.0-30.0); longer pulvinus length (21.0-29.0 % HL vs.15.0-18.0); more posteriorly situated anus (distance from anus to anal fin origin 16.7-22.9 % of distance between pelvic to anal fin origin vs 34-40%); lesser lateral line scale (32-33 vs. 38-40); lesser circumpenduncular scales (12 vs 16.); regular predorsal scales (9-10 vs. irregular 11-14, counted along immediately adjacent to the irregular scale row); less pre anal scales (3 vs 6); from *G. chaudhuri* in having black spot on the upper angle of gill opening present (vs absent), transverse scales between dorsal fin origin and pelvic fin origin (6-6½ vs. 8), large eye diameter (22.8-24.3 % HL vs.17.4-21.5), longer snout length (44.7-52.7 % HL vs. 36.8-43), dorsal fin origin at middle of standard length (vs dorsal fin origin slightly nearer to the tip of the snout); from *G. compressa* in having lesser lateral line scales (32-33 vs. 39-40), lesser pre dorsal scales (9 vs. 12-13), wider body at dorsal fin origin (18.5-19.4 vs. 13.7-14.9 %SL); from *G.*

jenkinsonianum in having transverse groove absent (present); head length greater than body depth at dorsal fin origin (vs. equal to body depth); lesser circumpenduncular scales (12 vs. 16); fewer predorsal scales (9 vs. 10-11), shorter pre pectoral fin (20.1-22 %SL vs 25.2); longer prepelvic distance (54.8-58.3% SL vs. 50.9); more posteriorly situated anus (distance from anus to anal fin origin 16.7-22.9 % distance between pelvic to anal fin origin vs. 32 %); from *G. kempi* in having lesser predorsal scale (9 vs.14); fewer lateral line scale (32-33 vs. 38-39); longer disc length (35.0-38.7 % HL vs. 20-30); wider pulvinus width (32.7- 36.9 % HL vs. 22-30); longer pulvinus length (21.0-29.0% HL vs.12-18); more posteriorly situated anus (distance from anus to anal fin origin 16.69-22.9 % of distance between pelvic to anal fin origin vs 34-46); from *G. magnidicus* in absence of transverse lobe (vs present); in having lesser lateral line scales (32-33vs 40-42); fewer predorsal scales (9 vs. 12-15); larger interorbital space (54.0-61.0 % HL vs. 41-45); more posteriorly situated anus (distance from anus to anal fin origin 16.7-22.9 % of distance between pelvic to anal fin origin vs 38-52); from *G. mini* in presence of scales on chest (vs absent); fewer predorsal scales (9 vs 14-16); fewer circumpenduncular scales (12 vs. 16); larger interorbital distance (12.7-14.5 % SL vs. 9-10.3); from *G. naganensis* in having longer pre pelvic distance (54.8-58.4 % SL vs. 51.8-53.7), more posteriorly situated anus (distance from anus to anal fin origin 16.7-22.9 % of distance between pelvic to anal fin origin (vs. 44.0-45.0), lesser lateral line scales (32-33 vs. 48), predorsal scales (9-10 vs. 13-14), fewer circumpenduncular scales (12 vs. 19). from *G. rupicola* in absence of W shaped caudal fin (vs present), fewer lateral line scales (32-33 vs. 35-36), scales on the pre dorsal, chest and abdomen present (vs absent), snout length (44.7-52.6 % HL vs. 36.8-43); from *G. ukhrulensis* in having greater disc length (35.0-38.7 % HL vs 24-27.); pulvinus width (32.9-36.7 % HL vs. 26.0-30.0); longer pre anus distance (70.2-73.3 % SL vs. 66.8-69.5); more posteriorly situated anus (distance from anus to anal fin origin 16.7-22.9 % vs 39-46); longer caudal peduncle length (17.6-22.2% SL vs. 13.2-16.8); predorsal scales regularly arranged (irregularly arranged); lesser circumpenduncular scales (12 vs. 16) and lesser pre anal scales (3 vs 6); from *G. lissorhynchus* in absence of W shaped caudal fin (vs. present); in absence of rostral flap (vs. present); lesser lateral line scales (32-33 vs 34-35); presence of scales on chest and abdomen (vs. absent); presence of fimbria on the rostral cap (vs. absent).

The study reveals the presence of twenty-four (24) species belonging to 3 orders, 5 family and 17 genera. Cypriniformes dominated by 16 species followed by 7 siluriformes and 1 beloniformes. The genus *Garra* retains the highest diversity followed by *Barilius* and *Puntius*. Cypriniformes (*B. barila*, *O. bendelesis*, *G. kalpangi* and *G. kempi)* were recorded abundantly from the Lohit River.

Comparative Materials: *Garra annandalei* (Hora) Holotype: ZSI Calcutta, F 6082/2-1; 60.17 mm SL; Kokha nallah, Koshi river, District: Barabakshetra. India. Date of collection: 30.01.1946.

Garra chaudhurii: ZSI F 8146-8148, 3 (holotype and 2 paratypes), 49.5-53.0 mm SL; India: West Bengal: Darjeeling district.

Garra jenkinsonianum: ZSI F 5736/1, holotype, 55.5 mm SL; India: West Bengal: Sita Nullah, Paresnath hills. Collectors-Jenkins and Annandalei.

Garra kempi (Hora) Holotype: ZSI Calcutta, F 7716/1; 87.0 mm SL; Location: Siyom River, below Damda, the Abor hills, Arunachal Pradesh, India. Date of collection: 25.07.2000. collector - Dr. S. W. Kemp.

Garra lissorhynchus (McClelland) Holotype: ZSI Calcutta, FF 8098/1; 73.05 mm SL; (Location: Museum Collection, Assam, India). Collected by: L. Kosygin.

Garra magnidiscus: ZSI/V/APFS/P-622, 83.8 mm SL; India: Arunachal Pradesh: Upper Siang district: a fast-flowing tributary to Siang River, about 3 km from Bomdo village on main road to Tuting, 28°44.04' N 94°51.97' E, 429 m asl; L. Tamang, 26 Oct 2011.

Garra naganensis: (Hora) ZSI Calcutta, F 9970/1; 89.93 mm SL; (Location: Senapathi Stream, Naga Hills, Assam, India). Collected by: L. Kosygin.

Garra chakpiensis: Holotype. MUMF 4308, 83.0mm SL; India: Manipur: Chandel district: Chakpi River at Tangpol (Chindwin River basin), 24 11 50 N 93 54 49 E; B. D Sangningam, 30-31, December 2010.

Garra Ukhrulensis: Holotype. MUMF 4311, 119.0mm SL; India: Manipur: Ukhrul district: Challou River at Khamson (Chindwin River basin), 25 12 18 N 94 30 56 E; L. Kosygin, 17 march 1998.

Garra lissorhynchus: Holotype. MUMF 4163-4166, 4, 67.1-86.2 mm SL; India: Manipur: Tamenglong district: Iyei River at Noney.

Garra jenkinsonianum: ZSI F 5736/1, Holotype, 55.5mm SL; India: West Bengal: Sitanullah, Pareshnath Hills.

Table 1 showing the IUCN data

DD- Data Deficient, LC-Least concern, NE- Not evaluated, VU- Vulnerable, F-Food, O-Ornamental, S-Sport

Sl No	Order	Family	Species	Economic value	Status (iucnredlist.org)
1	Cypriniformes	Cyprinidae	*Barilius barila*	F; O	LC
2	Cypriniformes	Cyprinidae	*Barilius vagra*	F; O	LC
3	Cypriniformes	Cyprinidae	*Opsarius barna*	F; O	LC
4	Cypriniformes	Cyprinidae	*Opsarius bendelesis*	F; O	LC
5	Cypriniformes	Cyprinidae	*Garra kalpangi*	F	NE
6	Cypriniformes	Cyprinidae	*Garra kempi*	F	LC
7	Cypriniformes	Cyprinidae	*Garra arunachalensis*	F	LC
8	Cypriniformes	Cyprinidae	*Garra sp.nov*	F	NE
9	Cypriniformes	Cyprinidae	*Raiamas bola*	F; O	LC
10	Cypriniformes	Cyprinidae	*Pethia ticto*	F; O	LC
11	Cypriniformes	Cyprinidae	*Puntius chola*	F; O	LC
12	Cypriniformes	Cyprinidae	*Neolissochilus dukai*	F; S	DD
13	Cypriniformes	Cyprinidae	*Tor tor*	S	LC
14	Cypriniformes	Cyprinidae	*Tariqilabeo latius*	F	LC
15	Cypriniformes	Cyprinidae	*Schizothorax progastus*	F; S	LC
16	Cypriniformes	Cyprinidae	*Chagunius chagunio*	F	LC
17	Siluriformes	Bagridae	*Batasio fasciolatus*	O	LC
18	Siluriformes	Siluridae	*Pterocyptis gangelica*	F; O	DD
19	Siluriformes	Siluridae	*Wallago attu*	F	VU
20	Siluriformes	Sisoridae	*Pseudecheneis sirenica*	O	VU
21	Siluriformes	Sisoridae	*Glyptothorax dikrongensis*	O	LC
22	Siluriformes	Sisoridae	*Glyptothorax indicus*	O	LC
23	Siluriformes	Bagridae	*Mystus prabini*	O	NEv
24	Beloniformes	Belonidae	*Xenetodon cancila*	F; O	LC

Table 2. Morphometric data of *Garra tezuensis* (n=10); range, mean and SD including holotype

	Holotype	Range			SD
		Min	Max	Mean	
STANDARD LENGTH mm	65.2	58.6	61.8		
In % STANDARD LENGTH					
Body depth at dorsal fin origin	19.6	19.6	21.7	20.7	1.1
Head length	21.6	21.5	25.2	23.4	1.9
Head depth at eye	10.3	8.8	14.9	11.9	3.1
Head width	16.8	16.8	18.7	17.8	0.9
Snout length	11.4	10.5	13.2	11.9	1.4
Eye diameter	5.2	5.2	5.8	5.5	0.3
Body width at anal fin origin	11.0	10.8	11.9	11.4	0.6
Body width at dorsal fin origin	18.6	18.6	19.4	19.0	0.4
Caudal penduncle length	22.2	17.7	22.2	20.0	2.3
Caudal penduncle depth	13.0	13.0	13.9	13.5	0.5
Dorsal fin base length	13.2	13.2	15.7	14.5	1.3
Dorsal fin length	22.3	21.6	25.8	23.7	2.1
Pectoral fin length	20.8	20.1	22.8	21.5	1.4
Pelvic fin length	18.1	17.1	19.6	18.4	1.3
Anal fin base length	7.2	7.2	7.8	7.5	0.3
Anal fin length	18.5	16.6	19.4	18.0	1.4
Pre dorsal length	44.8	44.8	50.4	47.6	2.8
Pre pectoral length	23.6	20.0	23.6	21.8	1.8
Pre pelvic length	56.1	54.8	58.4	56.6	1.8
Pre anal length	77.7	75.2	77.9	76.6	1.4
Pre anus length	72.8	70.2	73.3	71.8	1.6
Pelvic anal distance	17.5	16.3	23.1	19.7	3.4
Gular disc width	11.9	10.7	11.9	11.3	0.6
Gular disc length	8.2	8.0	8.8	8.4	0.4
Pulvinus width	7.9	7.5	8.3	7.9	0.4
Pulvinus length	6.8	5.3	6.3	5.8	0.5
Anus Anal fin distance	3.8	3.6	3.8	3.7	0.1

	Holotype	Range			SD
		Min	Max	Mean	
Inter orbital width (IOW)	13.2	12.7	14.5	13.6	0.9
In % of pelvic anal distance					
Distance from anus to anal fin	22.1	16.7	22.9	19.8	3.1
In % Head length					
Head depth at nape	47.6	37.5	47.6	42.6	5.1
Head depth at eye	64.4	53.3	66.0	59.7	6.4
Head width	77.4	73.7	79.3	76.5	2.8
Snout length	52.7	44.7	52.7	48.7	4.0
Eye diameter	23.8	22.8	24.3	23.6	0.8
Gular disc width	55.0	44.0	55.0	49.5	5.5
Gular disc length	37.0	35.0	38.7	36.9	1.9
Pulvinus width	36.9	32.8	36.9	34.9	2.1
Pulvinus length	29.0	21.0	29.0	25.0	4.0
Inter orbital distance	61.1	54.0	61.1	57.6	3.6

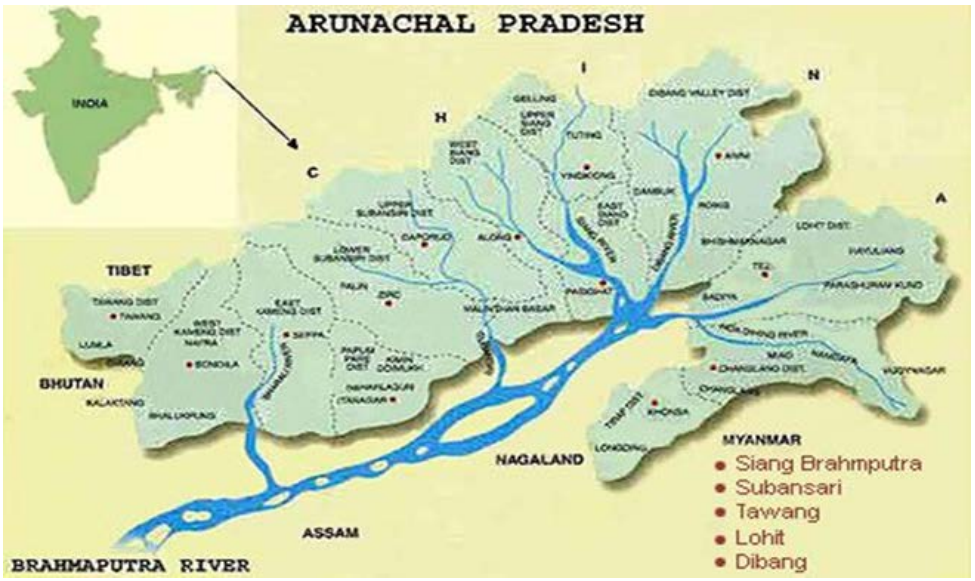

Figure 1- River system of Arunachal Pradesh showing the main five rivers; Siang Brahmaputra, Subansari, Tawang, Lohit and Dibang.

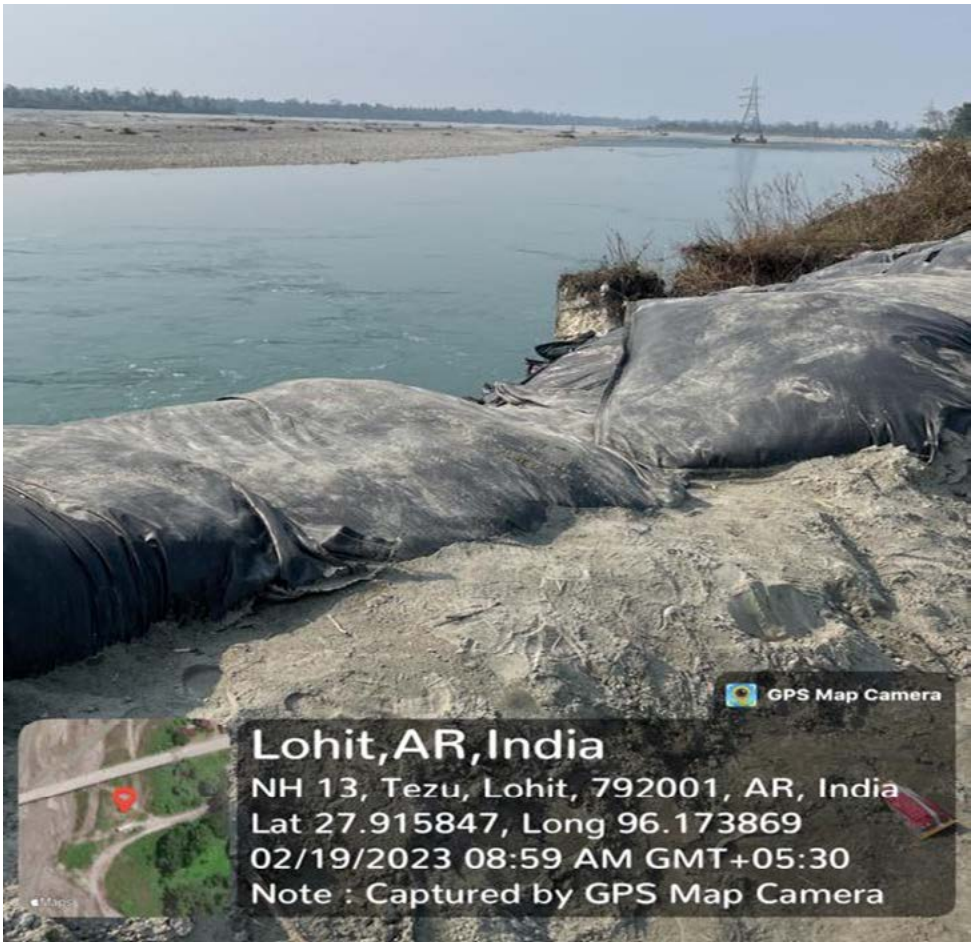

Figure 2- Lohit River, Tezu, Arunachal Pradesh, habitat of, *Garra* sp.nov

Figure 3- *Garra tezuenesis;* a-f ZSI Calcutta, F 9799, holotype, 65.21mm SL; India: Arunachal Pradesh: Lohit District: Tezu: Lohit River; (a), dorsal view (b), lateral view (c), ventral view (d) dorsal view of head (e), ventral view of oromandibular structure (f), side view of the snout showing the black spot on the gill.

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