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First record of *Macrognathus aral* (Bloch & Schneider, 1801) from the Himalayan Kingdom of Bhutan

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Abstract

This study reports a new record of freshwater fish *Macrognathus aral* (Bloch & Schneider) from Aiechu-Kalikhola tributary of the Maukhola river in Sarpang, Bhutan. The species was found in shoal of the tributary and was identified using its morphometric characters. It can be identified and distinguished from its congeners reported in Bhutan by dorsal fin rays XIX, 47, anal fin rays III, 52, rostral plates 28, pectoral fin rays 19, caudal fin rays 15, soft rayed part of dorsal and anal fin separated by a notch from rounded caudal fin, and presence of four ocelli at the base of dorsal fins. Further studies are needed to better understand its distribution, ecology, and population dynamics in the country. A key to species belonging to Mastacembelidae of Bhutan including the new record is provided.

Keywords: Aiechu-Kalikhola, Bhutan, Congeners, *Macrognathus aral*, New record

Introduction

Bhutan is located in the southern slopes of eastern Himalayas (Caspari et al., 2006) and is a part of 36 global biodiversity hotspots (Myers et al., 2000). The wide spectrum of ecological conditions ranging from subtropics to alpine meadows has endued the country with rich biological diversity including fishes (Gurung & Thoni, 2015). The country is home to 125 fish species (NBC, 2019) under eight orders (Anguilliformes, Beloniformes, Cypriniformes, Perciformes, Salmoniformes, Siluriformes, Synbranchiformes, and Tertadontiformes) and 24 families (Gurung & Thoni, 2015). Majority of the species belong to orders Cypriniformes and Siluriformes holding high significance in economic landscape, aquaculture, and source of animal protein (Gurung & Thoni, 2015; Nikam et al., 2014; Thai et al., 2007). However, species under other orders and families including Matsacembelidae contribute equally to the economic as well as social livelihood in the country.

Family Mastacembelidae under order Synbranchiformes contains spiny eels with elongated body, having 7–40 depressible well-separated dorsal spines, one to three anal spines, body covered with small scales, lack of pelvic fins and girdles, gill

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openings on later sides of head, short caudal fin with laterally compressed body towards the caudal region (Arunkumar, 2020; Plamoottil & Abraham, 2014). Globally, Mastacembelelidae consist of three genera (*Mastacembelus* Scolopi 1777, *Macrognathus* Lacepède, 1800, *Sinobdella* Kottelat & Lim, 1994) distributed in Africa, the Middle East, Southeast Asia, China, Vietnam, and Laos (Nelson et al., 2016; Yuan et al., 2020). Gurung et al. (2013) recognized two genera of spiny eels (*Macrognathus* and *Mastacemblus*) from Bhutan.

Based on current records only three species of spiny eels, namely *Macrognathus morehensis* Arunkumar & Singh, 2000, *Macrognathus pancalus* Hamilton, 1822, and *Mastacembelus armatus* Lacepède, 1800 are found in inland aquatic habitats of Bhutan (Gurung & Thoni, 2015; NRDCR & LF, 2020). Arunkumar (2016, 2020) recognized the presence of other species of *Macrognathus* including *Macrognathus aral* Schneider and Bloach 1801 from transboundary river drainages of Bhutan. However, *M. aral* has not been reported from Bhutan, but the authors have recorded a single specimen from Aiechu-kalikhola tributary of Maukhola river at Gelephu town under Sarpang district. Apart from the description of the new record, the authors have also developed a comprehensive key to identify species under Mastacembelidae of Bhutan by examining specimens present in the Ichthyology Laboratory, College of Natural Resources (CNR), Royal University of Bhutan (RUB) and comparing pertinent literature (Jayaram, 2010).

Materials and Methods

Specimen collection and preservation

A single specimen of *M. aral* was collected using Electro shocker (Honda GCV 160cc, Honda, Tokyo, Japan) from 26°53.314' N, 90°31.187' E on 16 October, 2022. General water parameters were recorded on site using HACH kit (HQ40d, Hach, Loveland, CO, USA) and riparian vegetation was noted. Additionally, other species associated with *M. aral* in the tributary was also examined. Following Arunkumar (2020) the color of the specimen was noted while it was fresh and euthanized using 0.2 mL of clove oil per 500 mL of water and treated with 10% formalin (Fernandes et al., 2017). The fixed specimen was preserved in 70% ethyl alcohol and catalogued at the Ichthyology Laboratory, CNR, RUB (RUB/CNR/Fish sample/Aiechu-kalikhola/16.10.2022/223).

Species identification and measurement

Identification of the species by comparing it with existing species from Bhutan and adjacent areas was carried out following ; Arunkumar (2020); Biswas et al. (2007); Gurung & Thoni (2015); Jayaram (2010) ; NRDCR & LF (2020); Shrestha (2008); Vishwanath et al. (2007). Methods followed are those of Jayaram (2010). All the measurements were made with digital caliper to nearest 0.1 mm and expressed as percentage of standard length (SL) (Arunkumar, 2020; Duong et al., 2020). Additionally, for diagnostic, spines and fin rays were counted using microscope (Nikon SMZ445, Nikon, Tokyo, Japan). Standard practices of Jayaram (2010); Ng & Tan (2020); Roberts (1980, 1986) were referred.

Results

Scientific history

The initial documentation of a spiny eel, identified as *Rhynchobdella aral*, originated from Tranquebar, Tamil Nadu, India (Talwar & Jhingran 1991). The species under genera *Macroganthus* found in the Indian subcontinent has been consistently referred to as *M. aculeatus* by nearly all authors (Roberts, 1980). However, there are no type specimens for *M. aral* (Roberts, 1980). *Rhynchobdella ocellata* was described from Pondicherry, India which was later considered as secondary junior homonym of *M. ocellatus* (Kottelat, 2013). Subsequently, a new species of spiny eel (*R. ocillata*) was described from Tenasseri, Myanmar but was considered incorrect subsequent spelling of *M. ocellatus* (Kottelat, 2013). Hora (1921) reported a new species of Mastacemblid *(R. dhanashorii*) from Manipur, India, with the only known holotype which was later declared as an ambiguous synonym of *M. aral*. Malhotra & Dutta (1975) reported a new species of spiny eel (*M. jammuensis*) from Jammu, India but was declared as a synonym of *M. aral* (Talwar & Jhingran, 1991). The current status of the species is valid as *M. aral* (Arunkumar, 2020).

Diagnostic character

Body elongated eel like, presence of paired tooth plates along the concave ventral surface of rostrum, snout trilobed, rim of anterior nostril with six finger like fimbriae, gape of mouth narrow, jaws with small pointed teeth, pre-orbital and pre-opercular spines absent or smooth, a distinct band on either side of the body above lateral line which becomes obscure in the post-anal region, presence of depressible dorsal spines, anal fin with three spines, caudal fin rounded, the dorsal fin originate much posterior to the pictorial fin, soft dorsal and soft anal fin partially separated by a

notch from rounded caudal fin, presence of four ocelli at dorsal fin base, ocellus at base of caudal fin absent. Body count and measurements are shown in Tables 1 and 2 respectively.
Fin formula: D. XIX, 47; P. 19; A. III, 52; C. 15 (23.71 cm TL, 22.13 cm SL)

Coloring pattern

Body brownish or greenish, yellowish along the abdomen which becomes lighter below, black shades of caudal, soft dorsal and soft anal fins (Fig. 1).

Distribution in Bhutan

Currently known to occur only in Aiechu-Kalikhola tributary of Maukhola river under Sarpang district.

Water parameters and habitat type of Aiechu-Kalikhola tributary

Seven water parameters (Table 3) were recorded from the point where the specimen was found. Water temperature (℃), dissolved oxygen (DO) (mg/L), conductivity (S/m), total dissolved solids (mg/L), pH, and salinity (g/kg) were recorded onsite while ammonia (μmol/L) was tested at the Soil Water and Air Testing (SWAT) laboratory, CNR, RUB. The habitat was predominantly subtropical with following floras; *Senegalia catechu, Ficus semicordata, Toona ciliate, Bombax ceiba, Ficus racemose, Murraya paniculate, Lantana camara, Urena lobata, Solanum viarum, Chromolaena odorata, Sida acuta, Oxalis corniculate, Borreria latifolia, Piper* sp., *Synedrella nodiflora,* and *Cyanotis vaga*.

Associated species

A total of 21 species under 10 families (Table 4) were recorded in the Aiechu-Kalikhola tributary where *M. aral* was found. The most abundant species was Copper mahseer (*Neolissochilus hexagonolepis* McClelland, 1839) (N = 12), followed by Hamilton's barila (*Opsarius bendelisis* Hamilton, 1807) (N = 8) and Giant Daino (*Devario aequipinnatus* McClelland, 1839) (N = 7) while *Glyptothorax botius* (Hamilton, 1822) and Golden mahseer (*Tor putitora*, Hamilton 1822) were the least abundant species (N = 1 each).

Table 2. Morphometric measurements of *Macrognathus aral* recorded in the present study and compared with reference data

	Present study (cm)	% of SL	Das et al. (2023) (cm)
Total length	23.7		15.7–32.5
Standard length	22.1		14.7–27.2
Head length	3.6	16.5	2.5–4.5
Pre-pectoral length	4.1	18.5	2.7–5.0
Pre-dorsal length	7.5	34.0	5.9–11.0
Pre-anal length	12.9	58.6	9.7–17.9
Base of pectoral length	0.5	2.5	0.3–0.6
Base of dorsal length	8.0	36.2	8.4–15.6
Base of anal length	7.9	36.0	4.8–8.9
Pectoral fin length	1.3	6.2	0.9–1.6
Dorsal fin length	0.9	4.2	0.5–1.0
Anal fin length	0.6	2.8	0.4–0.7
Caudal fin length	1.6	5.2	1.0–1.8
Body depth	2.6	11.7	1.7–3.5
Pre-orbital length	1.9	5.3	1.1–2.0
Post-orbital length	2.1	9.6	1.2–2.2
Eye diameter	0.3	1.3	0.2–0.3

SL, standard length.

Discussion

Distribution

The native range of *M. aral* includes lowland habitats of Indian subcontinent including, Bangladesh, Pakistan, Sri Lanka,

Table 1. Meristic characters of the new record (*Macrognathus aral*) compared with reference data and spiny eels reported from Bhutan

	M. aral		*Macrognathus pancalus*	*Macrognathus morehensis*	*Mastacembelus armatus*
	Present study	Jayaram (2010)	Gurung & Thoni (2015)	NRDCR & LF (2020)	Gurung & Thoni (2015)
Dorsal fin rays	XIX, 47	XVI–XXIII, 47–48	XXIV–XXVI, 30–42	XI–XVI, 39–51	XXXIII–XXXX, 67–82
Anal fin rays	III, 52	II–III, 44–52	III, 31–46	III, 40–54	III, 67–83
Pectoral fin rays	19	19	17–19	15–20	23
Caudal fin rays	15	15	11–13	11–14	14–17
Rostral plates	28	14–28	Absent	8–11	Devoid

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Fig. 1. *Macrognathus aral* (Bloch & Schneider, 1801), 22.13 cm SL, caught by electro shocker, 16 October 2022, Aiechu-Kalikhola, Sarpang, Bhutan.

Table 3. Water parameters from the point where new record of *Macrognathus aral* was found

	n	Highest	Lowest	Mean	SD
Ammonia (μmol/L)	4	0.0	0.0	0.0	0.0
Conductivity (S/m)	4	226	170	187.5	12.9
DO (mg/L)	4	8.5	7.3	8.1	0.5
pH	4	8.1	7.4	7.7	0.1
Salinity (g/kg)	4	0.1	0.08	0.09	0.007
TDS (mg/L)	4	105.5	78.1	86.8	6.3
Temperature (℃)	4	28.5	25.7	26.7	1.2

n, number of samples; DO, dissolved oxygen; TDS, total dissolved solids.

Table 4. Associated species with *Macrognathus aral* in Aiechu-Kalikhola tributary

Species	Family	N	IUCN status
Badis badis	Nandidae	3	Least concern
Balitora brucei	Balitoridae	2	Near threatened
Batasio batasio	Bagridae	2	Least concern
Cyprinion semiplotum	Cyprinidae	4	Vulnerable
Danio dangila	Danionidae	4	Least concern
Danio rerio	Danionidae	2	Least concern
Devario aequipinnatus	Danionidae	7	Least concern
Esomus danrica	Danionidae	4	Least concern
Garra arupi	Cyprinidae	4	Data deficient
Garra birostris	Cyprinidae	3	Data deficient
Glyptothorax botius	Sisoridae	1	Least concern
Lepidocephalichthys guntea	Cobitidae	2	Least concern
Neolissochilus hexagonolepis	Cyprinidae	12	Near threatened
Opsarius barna	Cyprinidae	5	Least concern
Opsarius bendelisis	Cyprinidae	8	Least concern
Paracanthocobitis botia	Nemacheilidae	3	Least concern
Pethia conchonius	Cyprinidae	6	Least concern
Psilorhynchus homaloptera	Psilorhynchidae	2	Least concern
Schistura savona	Nemacheilidae	2	Least concern
Tor putitora	Cyprinidae	1	Endangered
Xenentodon cancila	Belonidae	2	Least concern

IUCN, international union for conservation of nature.

Nepal, and Myanmar (Talwar & Jhingran, 1991). In the Indian subcontinent *M. aral* is uniformly distributed where it holds high significance as food and ornamental fish and is widely used in aquarium trade due to its slender body, attractive color pattern, and playful nature (Abujam et al., 2013; Gupta, 2016). Studies have recognized the presence of *M. aral* from Northeast India including Assam (Arunkumar, 2016; Dhanze et al., 2018; Gupta, 2016) which shares a close boarder with the current study area making the presence of *M. aral* highly probable. The preliminary checklist of fishes of Bhutan (Gurung & Thoni, 2015) and fishes of Eastern Bhutan (NRDCR & LF, 2020) have reported *M. pancalus* and *M. morehensis* respectively, from the same tributary (Aiechu-Kalikhola). However, there was no confirmation of *M. aral* from Aiechu-Kalilhola. This study confirms the presence and distribution of *M. aral* in Aiechu-Kalikhola tributary of Maukhola river in Sarpang district. Additionally, pertinent published literatures have reported the co-occurrence of *M. aral* and *M. pancalus* in single river system and basins (Arunkumar, 2020; Talwar & Jhingran, 1991).

Macrognathus aral differs from *M. pancalus* in a number of features. The most distinguishable taxonomic feature includes the presence of rostral tooth plates in *M. aral* (Fig. 2) which are absent in *M. pancalus* (Arunkumar & Singh, 2000), lesser dorsal spines (16–23 vs. 24–26), more soft dorsal fin rays (47–48 vs. 30–42) (Jayaram, 2010), preopercular and pre-orbital spines (absent vs. present) (Talwar & Jhingran, 1991). Similarly, *M. aral* differs from *M. morehensis* in many significant taxonomic characters. Data

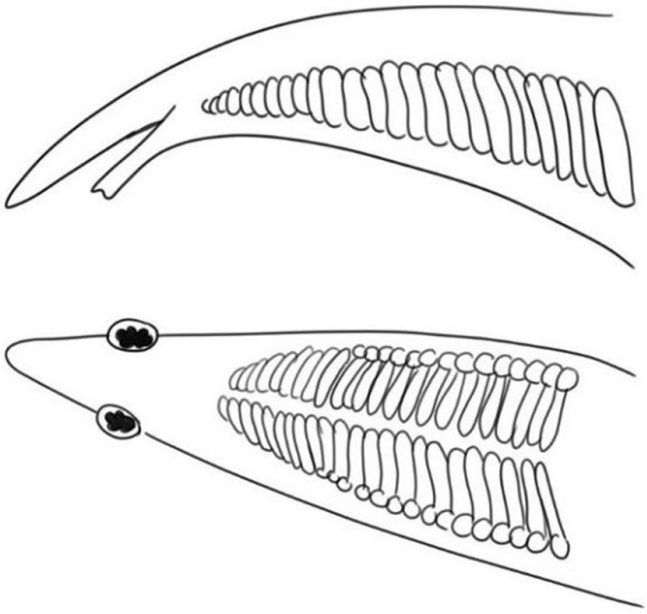

Fig. 2. Dorsal and ventral visualizations of rostrum in *Macrognathus aral*. *Adapted from Jayaram (2010) with permission of Narendra Publishing House.*

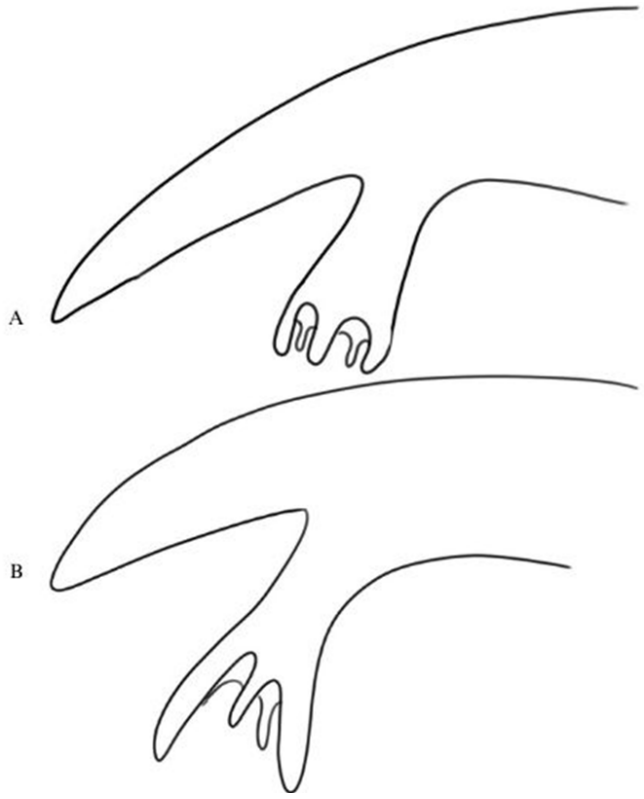

Fig. 3. Distinctive nasal structure in *Macrognathus* and *Matacembelus*. (A) Rim of anterior nostril with six finger-like projection in *Macrognathus*; (B) two broad-based flaps in *Mastacembelus*. Adapted from Jayaram (2010) with permission of Narendra Publishing House.

of Arunkumar & Singh (2000) for *M. morehensis* were used for comparison. It can be easily distinguished from *M. morehensis* by presence of more rostral plates (14–28 vs. 8–11), more dorsal spines (16–23 vs. 11–16), more caudal fin rays (15 vs. 11–14), pattern of band (longitudinal stripes along entire length vs. 20–25 transverse dark band), and ocellus at the base of caudal fin (absent vs. present).

Identification key to Mastacembelidae of Bhutan

Key to genera

Dorsal fin spines less than 33 (11–26), snout trilobed, ventral surface of rostrum with tooth plates. Rim of anterior tubular nostril with six finger-like projection (Fig. 3A)……***Macrognathus***

Dorsal fin spines 33 or more, no tooth plats in rostrum. Rim of anterior tubular nostrils with two broad-based flaps (Fig. 3B)…..……***Mastacembelus***

Key to species of Genus Macrognathus

1. Concave ventral surface of rostrum with paired tooth plates……..……2
   Rostrum globous, without tooth plates……3
2. Rostral tooth plates 8–11, Dorsal fin spines 11–16……
   ……..……*M. morehensis*
   Rostral tooth plates 14–28, Dorsal fin spines 19–23……
   ……..……*M. aral*
3. Caudal fin with 11–13 rays...……4
4. Dorsal fin spines 24–26 and 30–42 soft rays……*M. pancalus*

Key to species of Genus Mastacembelus

1. Caudal fin homocercal, confluent with the dorsal and anal fins. Caudal fin rays 14–16……..……*M. armatus*

Competing interests

No potential conflict of interest relevant to this article was reported.

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Availability of data and materials

Upon reasonable request, the datasets of this study can be available from the corresponding author.

Ethics approval and consent to participate

This study conformed to the guidance of animal ethical treatment for the care and use of experimental animals.

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