



E-ISSN: 2320-7078  
P-ISSN: 2349-6800  
JEZS 2018; 6(4): 369-378  
© 2018 JEZS  
Received: 13-05-2018  
Accepted: 14-06-2018

**Rani Dhanze**  
Professor and Head, Department  
of Fisheries Resource  
Management, Central  
Agriculture University (I),  
Lembucherra, Agartala, Tripura,  
India

**Prabir Debbarma**  
Center of Excellence on Fishery  
and Aquaculture Biotechnology  
for northeast India, COF, CAU,  
Lembucherra, Tripura, India

**Amarjit Debbarma**  
Center of Excellence on Fishery  
and Aquaculture Biotechnology  
for northeast India, COF, CAU,  
Lembucherra, Tripura, India

**JR Dhanze**  
Consultant and Former Dean,  
Center of Excellence on Fishery  
and Aquaculture Biotechnology  
for Northeast India, COF, CAU,  
Lembucherra, Tripura, India

**Correspondence**  
**Rani Dhanze**  
Professor and Head, Department  
of Fisheries Resource  
Management, Central  
Agriculture University (I),  
Lembucherra, Agartala, Tripura,  
India

## Biosystematics and distributional status of spiny eel fish species of the genus *Macrogathus* Lacepede, (Synbranchiformes: Mastacembelidae) from Northeastern region of India

Rani Dhanze, Prabir Debbarma, Amarjit Debbarma and JR Dhanze

### Abstract

Extensive surveys of entire northeastern India conducted during the last five years indicated the abundance and distributional status of four species of the genus *Macrogathus*. The evaluation of morphometric, meristic and osteological traits in 185 specimens of different size groups resolved the taxonomic status of three distinct species *Macrogathus aral*, *Macrogathus pancalus* and *Macrogathus aculeatus*. However, identification of fourth species *Macrogathus morehensis* is based on only one specimen collected from Manipur. The abundance and distributional analysis revealed that *M. aral* is the most common species commercially important and uniformly distributed in all states except Manipur and Mizoram. Whereas, the other two species seem to be confined to fewer states as per the material examined (*M. pancalus*: Sikkim, Assam and Tripura; *M. aculeatus*: Meghalaya, Assam and Tripura).

**Keywords:** *Macrogathus aculeatus*, *M. aral*, *M. pancalus* taxonomic traits, osteology

### 1. Introduction

The entire Northeastern region of India is blessed with enormous natural renewable water resources and biodiversity. The major drainage system of this region includes the Brahmaputra and Barak Rivers which drain into the Bay of Bengal, traversing plain of Bangladesh and a small area of Eastern Manipur, Nagaland and Mizoram, drain into Chindwin, a tributary of Irrawaddy, which flows into the Gulf of Martaban, a part of Andaman Sea [1]. In view of this uniqueness of zoogeographic region the attention of scientists in various fields is focused here to document different genetic resources with their higher degree of endemism for proper planning, management and conservation. In this pursuit we also undertook the inventorisation of the fish faunal resources of the region by conducting extensive surveys of all major drainage system of entire Northeastern States under the project "Centre of Excellence for fishery and Aquaculture Biotechnology for Northeast". As a result a huge collection of fish species have been made during the last five years (2013-2017), which is being systematically investigated by the experts in the college of Fisheries, CAU(I), Lembucherra. During this study fish species belonging to the family Mastacembelidae comprising of two genera *Mastacembelus* Scopoli and *Macrogathus* Lacepede, we observed some distinct features in respect of distributional pattern as well as taxonomic attributes, which are discussed in the present communication. The genus *Macrogathus* Lacepede, is uniformly distributed in Indian sub-continent and more pronounced in Southeast Asian region with higher degree of endemism. The spiny eel-like fishes of this genus are characterised by cylindrical and compressed body with a long tapering snout with tubular nostrils guarded by fimbriae. The non-protractile pre-maxilla and the distinct bones with the series of rostral tooth plates are present or absent in some species. Pre-opercular and pre-orbital spines are indistinct or absent. The gills are moderately developed, confluent across the breast, without any gill rakers and restricted to the lower half of the body. Pelvic fins absent, soft dorsal and anal fins displaced posterior but not confluent with the caudal fin. Many species of this genus invariably more than eight are known from adjacent Southeast Asian countries [2], however, from Northeastern Indian aquatic habitats only two

species, *Macrogathus aral* and *M. pancalus* have been invariably recorded as per the pertinent published literature [3-5]. Subsequent to the description of a new species *M. morehensis* [6], the number of species of this genus has increased to three from this region [7-9]. Equal or more than three species are recorded from Kerala, Western Ghat Biodiversity Hot spot [10]. However, based on our field study of different aquatic ecosystem in the region and the sizeable collection of specimens of this genus, we feel that there exists more than four species. Perhaps because of the overlapping nature of taxonomic traits, morphological characters and colour patterns of different species of this genus, it is difficult to pinpoint the range of specific variation, which resulted erroneous identification of the species from Indian waters. Sufi [11] made the first revisionary study of the fishes of family Mastacembelidae from oriental region and recognized only two species of the genus *Macrogathus* from this region. However, Roberts [2] published a comprehensive systematic review of the Mastacembelidae of Burma and Thailand, based on the evaluation of different taxonomic traits and established the threshold of inter-specific variation, which is considered as one of the standard work for identification of the genus *Macrogathus*. Hence, in view of these differences of opinion, the present study has been carried out to ascertain the specific identity of fishes of this genus with its distributional range in the

region for final cataloguing in Natural History Referral Museum, College of Fisheries, CAU, Lembucherra, Agartala.

## 2. Materials and methods

Extensive surveys were conducted for the last five years (March, 2013 to December, 2017) as a result more than 185 specimens of the genus *Macrogathus* have been collected from different River system and their tributaries of Northeastern Region (Fig. 4) with the aim to establish a Referral Museum of fish species in the region. For the validation of authentic specific identification, different morphometric measurements were mensurated with the help of digital Dial caliper (up to 0.01 mm) and meristic counts with the help of binocular microscope. Out of total 43 morphometric characters, 35 proportions as percentage of different measurements for each specimen were calculated and subjected to statistical analysis (to determine the range of variation, mean and SD) as tabulated in Tab. 1. The Microsoft Excel version 2007 (12.0.4518.1014) service pack was used to analyze the data statistically. Further, to confirm the specific identity, soft X-ray of some specimens of *M. aculeatus*, *M. aral* and *M. pancalus* (Fig. 2 a,b,c) were taken besides the standard technique of maceration of soft tissue in 1% KOH solution to study the osteological attributes. All the specimens examined are catalogued with a unique accession number as detailed below.

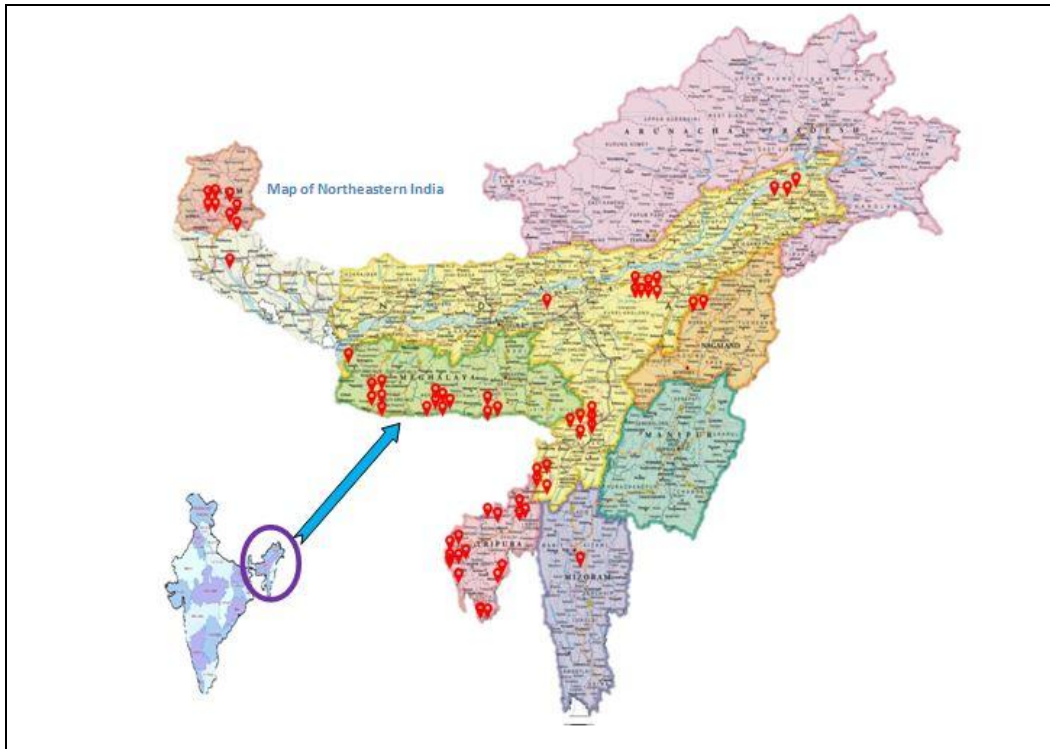


Fig 4: Map of Northeastern States depicting locations of the specimens collected.

### 2.1 *Macrogathus aculeatus* (Bloch, 1786)

COF-CAU-602, 2ex, 102.19–106.69 mm SL, Balut River, Bhagma, Meghalaya, N25°14.212" E091°22.205" 02.07.16, JY. Singh & Party.  
COF-CAU-603, 1ex, 109.40 mm SL, Feni River, Sabroom, Tripura, N23°00.094" E091°43.901" Alt: 17m, 28.03.17, Amarjit & Party.  
COF-CAU-604, 1ex, 74.78 mm SL, Longai River, Harara, Assam, N24°31.365" E092°16.018" Alt: 12m, 06.08.16, P.Biswas & Party.  
COF-CAU-605, 1ex, 53.44 mm SL, Rudrasagar, Tripura.  
COF-CAU-606, 1ex, 95.56 mm SL, Feni River, East sampara, Tripura, N22°59.002" E091°39.007" Alt: 17m, 28.03.17, Amit & Party.

COF-CAU-607, 1ex, 91.71 mm SL, Feni River, East Sampara, Tripura, N22°59.002" E091°39.007" Alt: 13m, 28.03.17, Amit & Party.  
COF-CAU-608, 2ex, 88.51–108.02 mm SL, Juri River, Jolabasha, Tripura, N24°15.529" E092°10.703" 12.01.17, Hijam & Party.  
COF-CAU-609, 1ex, 80.35 mm SL, Juri River, Chantila, Tripura, N24°17.033" E092°09.381" 12.01.17, Hijam & Party.  
COF-CAU-610, 1ex, 106.89mm SL, Khowai River, Ramchandraghat, Tripura, N24°00.744" E091°37.044" 28.12.13, Panchali & Party.  
COF-CAU-611, 1ex, 126.25 mm SL, Gomati River, Rajghat, Tripura, N23°29.696"

E091<sup>0</sup>19.160” 23.09.13, Panchali & Party.  
 COF-CAU-612, 1ex, 71.11mm SL, Gomati River, Moharani, Tripura, 22.03.14, Panchali & Party.  
 COF-CAU-613, 4ex, 62.22–74.22mm SL, Kachigong River, Chandanmura, Tripura, 22.03.15, Akhtar & Party.  
 COF-CAU-614, 1ex, 91.72mm SL, Brahmaputra River, Amolapathy, Assam, N27<sup>0</sup>44.215”  
 E095<sup>0</sup>04.512” Alt: 152m, 22.04.17, P. Biswas & Party.  
 COF-CAU-615, 1ex, 76.09mm SL, Brahmaputra River, Sollang, Assam, N26<sup>0</sup>34.217”  
 E092<sup>0</sup>52.218” Alt: 58m, 21.10.16, P. Biswas & Party.  
 COF-CAU-616, 1ex, 100.94mm SL, Katakhal River, Guramara, Assam, N24<sup>0</sup>48.615”  
 E092<sup>0</sup>27.172” Alt: 14m, 11.08.16, P. Biswas & Party.  
 COF-CAU-617, 2ex, 91.25–93.82mm SL, Longhai River, Shibbari, Assam, N24<sup>0</sup>28.372”  
 E092<sup>0</sup>72.312” Alt: 13m, 12.08.16, P. Biswas & Party.  
 COF-CAU-618, 2ex, 69.4–100.79mm SL, Rangapanibeel, Rangapan, Assam, N26<sup>0</sup>41.188”  
 E092<sup>0</sup>48.978” Alt: 39m, 22.10.16, P. Biswas & Party.  
 COF-CAU-619, 1ex, 104.81mm SL, Umkham River, Komphow, Meghalaya, N25<sup>0</sup>43.471”  
 E091<sup>0</sup>50.820” Alt: 705m, 26.06.16, Jackey & Party.  
 COF-CAU-620, 1ex, 85.55mm SL, Wahkaba River, Laitryngow, Meghalaya, N25<sup>0</sup>43.480”  
 E091<sup>0</sup>40.936” Alt: 612m, 28.06.16, Jackey & Party.  
 COF-CAU-621, 1ex, 109.80mm SL, Mansiri River, Rangajan, Assam, N26<sup>0</sup>47.084”  
 E092<sup>0</sup>50.058” Alt: 68m, 23.10.16, P. Biswas & Party.  
 COF-CAU-622, 1ex, 78.22mm SL, Sihhmui, Tlawng River, Mizoram, 21.11.13, Samar & Jama.

## 2.2 *Macrognaethus pancalus* Hamilton, 1822

COF-CAU-623, 3ex, 72.82–98.57mm SL, Teesta River, Gjalldoba, Sikkim, N26<sup>0</sup>46.930”  
 E088<sup>0</sup>46.230” Alt: 356m, 05.06.14, Tanmoy & Party.  
 COF-CAU-624, 1ex, 134.09mm SL, Teesta River, Sardar para, Sikkim, N26<sup>0</sup>40.427” E088<sup>0</sup>  
 41.197”, 12.08.14, Tanmoy.  
 COF-CAU-625, 2ex, 119.61–124.17mm SL, Teesta River, Jublipark, Sikkim, 12.04.14, Tanmoy  
 COF-CAU-626, 2ex, 122.11–130.14mm SL, Teesta River, Jublipark, Sikkim, 12.04.14, Tanmoy  
 COF-CAU-627, 1ex, 135.67mm SL, Teesta River, Mandirghat, Sikkim, 07.06.13, Tanmoy.  
 COF-CAU-628, 1ex, 64.01mm SL, Teesta River, Budineri, Sikkim, N26<sup>0</sup>20.777” E088<sup>0</sup>50.710”  
 Alt: 186m, 04.06.14, Tanmoy & Party.  
 COF-CAU-629, 1ex, 106.81mm SL, Teesta River, Gjalldoba, Sikkim, N26<sup>0</sup>28.448” E088<sup>0</sup>44.620”  
 Alt: 31m, 07.03.16, Tanmoy & Party.  
 COF-CAU-630, 2ex, 122.79–127.87mm SL, Teesta River, Manahaghat, Sikkim, N36<sup>0</sup>19.752”  
 E088<sup>0</sup>52.000” Alt: 63m, 15.09.15, Tanmoy & Party.  
 COF-CAU-631, 3ex, 93.48–117.8mm SL, Gomati River, Bhubaneswari, Tripura, N23<sup>0</sup>32.302”  
 E091<sup>0</sup>30.384” Alt: 23m, 22.03.14, Panchali & Party.  
 COF-CAU-632, 1ex, 110.03mm SL, Gomati River, Dumbur, Tripura, 20.03.14, Panchali & Party.  
 COF-CAU-633, 7ex, 65.65–137.69mm SL, Gomati River, Mandirghat, Tripura, N23<sup>0</sup>25.531” E091<sup>0</sup>49.635” 08.03.14, Panchali & Party.  
 COF-CAU-634, 1ex, 144.04mm SL, Gomati River, Dumbur, Tripura, N23<sup>0</sup>28.312” E091<sup>0</sup>51.068” 21.03.14, Panchali & Party.  
 COF-CAU-635, 2ex, 86.21–98.41mm SL, Gomati River, Indira nagar, Tripura, 23.03.15, Akhter

COF-CAU-636, 1ex, 80.09mm SL, Gomati River, Kakraban, Tripura, 21.03.15, Akhter & Party,  
 COF-CAU-637, 10ex, 85.19–118.16mm SL, Rudrasagare, Kemtali, Tripura, 22.03.15, Akhter.  
 COF-CAU-638, 1ex, 72.73mm SL, Feni River, Loccha para, Tripura, 19.05.13, Anjan & Party.  
 COF-CAU-639, 1ex, 106.02mm SL, Feni River, Sabroom, Tripura, N23<sup>0</sup>00.911” E091<sup>0</sup>43.901”  
 Alt: 17m, 28.03.17, Amarjit & Party.  
 COF-CAU-640, 1ex, 114.76mm SL, nwang River, Santi bazar, Tripura, N23<sup>0</sup>18.237”  
 E091<sup>0</sup>33.793” Alt: 12m, 30.03.17, Amit & Party.  
 COF-CAU-641, 2ex, 92.83–105.37mm SL, Manu River, Kakulia, Tripura, N23<sup>0</sup>14.112”  
 E091<sup>0</sup>36.701” Alt: 17m, 30.03.17, Amarjit & Party.  
 COF-CAU-642, 1ex, 120.95 mm SL, Gomati River, Rajghat, Tripura, N23<sup>0</sup>29.696” E091<sup>0</sup>19.160  
 23.09.13, Panchali & Party.  
 COF-CAU-643, 2ex, 103.47–112.17mm SL, Khowai River, Ramchandraghat, Tripura, N24<sup>0</sup>00.744” E091<sup>0</sup>37.044” 28.12.13, Panchali & Party.  
 COF-CAU-644, 6ex, 76.47–121.13mm SL, Gomati River, Moharani, Tripura, 22.03.14, Panchali  
 COF-CAU-645, 6ex, 74.02–99.21mm SL, Kachigong River, Chandanmura, Tripura, 22.03.15, Aktar & Party.  
 COF-CAU-646, 1ex, 84.71mm SL, Bailna River, Saterkandi, Assam, N24<sup>0</sup>52.997” E092<sup>0</sup>15.240”  
 Alt: 12m, 07.08.16, P. Biswas & Party.  
 COF-CAU-647, 2ex, 78.72–103.75mm SL, Anair River, Guramara, Assam, N24<sup>0</sup>46.371”  
 E092<sup>0</sup>51.379” Alt: 12m, 12.08.16, P. Biswas & Party.  
 COF-CAU-648, 2ex, 61.91–84.67mm SL, Gunti River, Jankirghat, Assam, N24<sup>0</sup>47.960”  
 E092<sup>0</sup>28.911” Alt: 13m, 11.08.16, P. Biswas & Party.  
 COF-CAU-649, 1ex, 75.75mm SL, Kakra River, Kaligang, Assam, N24<sup>0</sup>47.351” E092<sup>0</sup>24.797”  
 Alt: 12m, 10.08.16, P. Biswas & Party.  
 COF-CAU-650, 1ex, 75.71mm SL, Jiaborati River, Jiaborati bridged, Assam, N26<sup>0</sup>48.801”  
 E092<sup>0</sup>52.423” Alt: 61m, 23.10.16, P. Biswas & Party.  
 COF-CAU-651, 1ex, 93.48mm SL, Katakhal River, Damapur, Assam, N24<sup>0</sup>51.027” E092<sup>0</sup>35.322” Alt: 14m, 06.08.16, P. Biswas & Party.  
 COF-CAU-652, 1ex, 97.03mm SL, Dhaleswari River, Chandpur, Assam, N24<sup>0</sup>41.761”  
 E092<sup>0</sup>31.687” Alt: 10m, 11.08.16, P. Biswas & Party.  
 COF-CAU-653, 2ex, 69.35–75.78mm SL, Brahmaputra River, Bhojkhawachaper, Assam, N20<sup>0</sup>42.814” E092<sup>0</sup>49.121” Alt: 64m, 19.10.16, P. Biswas & Party.  
 COF-CAU-654, 1ex, 125.08mm SL, Sessa River, Golinpokori, Assam, N27<sup>0</sup>27.218”  
 E094<sup>0</sup>72.399” Alt: 147m, 25.04.17, P. Biswas & Party.  
 COF-CAU-655, 1ex, 110.15mm SL, Muslum, Assam, 19.05.14, P. Biswas & Party.  
 COF-CAU-656, 1ex, 108.74mm SL, Lupharu, Assam, 19.09.14, P. Biswas & Party.  
 COF-CAU-657, 1ex, 63.51mm SL, Brahmaputra River, Sollang, Assam, N26<sup>0</sup>34.217”  
 E092<sup>0</sup>52.218” Alt: 58m, 21.10.16, P. Biswas & Party.  
 COF-CAU-658, 1ex, 90.72mm SL, Katakhal River, Guramara, Assam, N24<sup>0</sup>48.615”  
 E092<sup>0</sup>27.172” Alt: 14m, 11.08.16, P. Biswas & Party.  
 COF-CAU-659, 2ex, 101.14–124.66mm SL, Umngot River, Dowki upper, Meghalaya, N25<sup>0</sup>11.425” E092<sup>0</sup>01.104” 24.08.16, jackey & Party.  
 COF-CAU-660, 1ex, 103.01mm SL, Umphelm River,

Pomisingma, Meghalaya, N23°44.477”  
 E091°48.556” Alt: 681m, 29.06.16, Jackey & Party.  
 COF-CAU-661, 1ex, 106.69mm SL, Rongkhat River,  
 Sangsangui, Meghalaya, 09.09.13, Jackey  
 COF-CAU-662, 1ex, 137.77mm SL, Ginjeram River, Rajabala,  
 Meghalaya, 17.09.13, Jackey  
 COF-CAU-663, 1ex, 101.6mm SL, Dhansari River, Uria,  
 Nagaland, 10.06.14, Tapan Datta  
 COF-CAU-664, 1ex, 127.01mm SL, Sihhmui, Tlawang River,  
 Mizoram, 21.11.13, Samar  
 COF-CAU-665, 1ex, 96.52mm SL, Wahkaba River, Laitryngow,  
 Meghalaya, N25°43.480”  
 E091°40.936” Alt: 612m, 28.06.16, Jackey & Party.  
 COF-CAU-666, 1ex, 125.37mm SL, Balut River, Bhagma,  
 Meghalaya, N25°14.212”  
 E091°22.205” 02.07.16, Jackey & Party.  
 COF-CAU-667, 4ex, 86.37–131.06mm SL, Umngot  
 River, Dawki, Meghalaya, N25°12.494”  
 E092°00.408” Alt: 24m, 27.08.17, Jackey & Party.

### 2.3 *Macrognathus aral* (Bloch & Schneider, 1801)

COF-CAU-668, 1ex, 133.78mm SL, Valukei, Nkwareu River,  
 Nagaland, 20.06.15. Lama & Moa  
 COF-CAU-669, 1ex, 110.35mm SL, Umngot River, Dawki  
 upper, Meghalaya, N25°11.425”  
 E092°01.104” 24.06.16, Jackey & Party.  
 COF-CAU-670, 1ex, 141.92 mm SL, Rangkhoh River, Sangangre,  
 Meghalaya,  
 13.09.13, Thongam Bidhya Devi.  
 COF-CAU-671, 1ex, 190.32mm SL, Umngot River, Dawki  
 upper, Meghalaya,  
 N25°11.425” E092°01.104” 24.06.16, Jackey & Party.  
 COF-CAU-672, 2ex, 143.18–156.9mm SL, Lailonggew River,  
 Wahkaba, Meghalaya,  
 N25°43.480” E091°40.930” 25.06.16, Jackey & Party.  
 COF-CAU-673, 5ex, 97.76–123.69mm SL, Umngot River,  
 Dawki, Meghalaya,  
 N25°12.494” E092°00.408” Alt- 24m, 27.08.17, Jackey & Party.  
 COF-CAU-674, 1ex, 132.33mm SL, Teesta River, Gjaldotsa,  
 Sikkim, N26°46.930” E088°46.230”  
 Alt: 356m, 05.06.14, Tanmoy & Party.  
 COF-CAU-675, 1ex, 168.72mm SL, Teesta River, Barman para,  
 Sikkim, N26°34.533”  
 E088°45.859” Alt: 77m, 16.09.15, Tanmoy & Party.  
 COF-CAU-676, 3ex, 130.61–169.08mm SL, Teesta River,  
 Barman para, Sikkim, N26°46.930”  
 E088°46.230” Alt: 356m, 05.06.14, Tanmoy & Party.  
 COF-CAU-677, 2ex, 108.92–122.37mm SL, Anair River,  
 Guramara, Assam, N24°46.391”  
 E092°51.379” Alt: 12m, 12.08.16, P. Biswas & Party.  
 COF-CAU-678, 1ex, 120.34mm SL, Longai River, Rahimpur,  
 Assam, N24°42.678” E092°36.609”  
 Alt: 12m, 12.08.16, P. Biswas & Party.  
 COF-CAU-679, 1ex, 122.79mm SL, Longai River, Longhaighat,  
 Assam, N24°51.358”  
 E091°20.701” Alt: 10m, 09.08.16, P. Biswas & Party.  
 COF-CAU-680, 1ex, 102.54mm SL, Baline River, Alampur,  
 Assam, N24°49.295” E092°18.365”  
 Alt: 10m, 07.08.14, P. Biswas & Party.  
 COF-CAU-681, 1ex, 116.94mm SL, Dhaleswari River,  
 Chandpur, Assam,  
 N24°49.295” E092°18.365” Alt: 10m, 11.08.16, P. Biswas &  
 Party.  
 COF-CAU-682, 1ex, 94.44mm SL, Katakhal River, Narayanpur,  
 Assam, N24°41.506”  
 E092°32.703” Alt: 8m, 10.08.16, P. Biswas & Party.  
 COF-CAU-683, 2ex, 118.23–125.28mm SL, Longhai River,  
 Shibbari, Assam,

N24°28.392” E092°072.312” Alt: 13m, 12.08.16, P. Biswas &  
 Party.  
 COF-CAU-684, 1ex, 154.31mm SL, Longhai River, Jaminpur,  
 Assam, N24°51.325”  
 E092°20.591” Alt: 13m, 07.08.16, P. Biswas & Party.  
 COF-CAU-685, 2ex, 118.14–126.41mm SL, Kashiara River,  
 Devpur, Assam, N24°52.732”  
 E092°21.205” Alt: 10m, 09.08.16, P. Biswas & Party.  
 COF-CAU-686, 1ex, 160.37mm SL, Lupharu, Assam, 19.09.14,  
 P. Biswas & Party.  
 COF-CAU-687, 1ex, 148.94mm SL, Longhai River, Jhanpur,  
 Assam, N24°51.515” E092°20.942”  
 Alt: 15m, 07.08.16, P. Biswas & Party.  
 COF-CAU-688, 1ex, 117.12mm SL, Gomati River, Dumbur,  
 Tripura, 21.03.14, Panchali.  
 COF-CAU-689, 1ex, 106.12mm SL, Gomati River, Gudraghat,  
 Tripura, 28.06.14, Panchali  
 COF-CAU-690, 1ex, 165.97mm SL, Gomati River, Indranagar,  
 Tripura, 13.05.14, Akhtar Hossain.  
 COF-CAU-691, 1ex, 164.12mm SL, Haara River, Pratapgarh,  
 Tripura, N23°49.237”  
 E091°17.264” 31.01.14, Panchali Debnath.  
 COF-CAU-692, 2ex, 127.19–138.02mm SL, Umngot River,  
 Dawki, Meghalaya, N25°12.494”  
 E092°00.408” Alt-24m, 27.08.17, Jackey & Party.

### 2.4 *Macrognathus morehensis* Arunkumar & Tombi Singh, 2000

COF-CAU-0699, 1ex, 193.85mm SL, Lokchao River, Satleai,  
 Manipur, N24°18.846” E094°22.077” Alt-?, 06.05.16, B.  
 Hijam.

### 3. Results

Out of the total 185 specimens of the genus *Macrognathus* examined, which probably include five species (*Macrognathus aral*, *M. pancalus*, *M. aculeatus*, *M. morehensis* and one more species not yet assigned any taxonomic status), we came across 28 specimens tentatively identified either as *Macrognathus aral* or *M. pancalus*, but apparently different from the rest of other 157 specimens in respect of morphological and colour patterns which is quite variable in most of the Mastacembeloids depending upon the size, age and habitat. On meticulous re-examination and analysis of the morphometric and meristic data mensurated from these 28 specimens of different age groups and compared with the data of *M. aral* and *M. pancalus* as tabulated in (Tab.1), it is inferred that these 28 specimens belong to *Macrognathus aculeatus*. This species can easily be distinguished from other species available in the region, based on the combination of 16 morphological, morphometric and meristic characters (Tab.1&2; Fig. 2 & 3). The most consistent characters that can distinguished these three species from each other include the shape and relative size of the rostrum with tooth plates or absent in *M. pancalus*, dorsal and anal fins are not united with caudal fin and the distinct colour pattern of course with slight intra-specific variations, which may either be habitat dependent or sexual dimorphic (Fig. 1. a–e). *M. aral* has invariably 4–6 distinct ocelli on the base of soft dorsal fin, dorsum greenish brown with longitudinal bands along the entire length from eye to caudal peduncle, first one pale yellow and second band is brownish (Fig. 1.e), in addition to the ocelli on dorsal fin we observed one specimen (COF-CAU-0671) with single ocellus on the anal fin. Whereas, *M. pancalus* vs. *M. aculeatus*, can easily be distinguished from each other based on colour pattern as the entire body is brown speckled with white spots may be in rows or irregular pattern (Fig. 1. c, d) in former vs. entire body light brown with distinct vertical bands broad above lateral line may be straight or oblique tapering and lighter below the lateral line (Fig. 1. a, b) in later species. Besides these morphological



differences, the evaluation of morphometric and meristic characters reveals that *M. aral* can be distinguished from the other two species in respect of combination of 21 taxonomic characters. The dorsal fin base length is one of the most distinguishing character (58.85 % of SL vs. 75.90% & 76.07% of SL) and also supported by the fin rays counts (XVII–XXI 45–53 vs. XXIV–XXVII 31–38 & XXII–XXVII 30–40) in *M. aral* vs. *M. aculeatus* and *M. pancalus* respectively. Pectoral and anal fin ray counts also seem to be species specific (15–20, 42–53; 15–18, 30–41; 15–17, 30–44) in *M. aral* vs. *M. aculeatus* and *M. pancalus* respectively. The other body proportions which can distinctly differentiate these three species includes, Pr-SDL as % of SL ( 24.50, 41.03, 23.98); Ps-OL (52.00, 45.36, 52.73), UJL (28.81, 36.54, 28.09), LJL (12.13, 9.93, 11.85), HD ( 34.15, 28.25, 32.45), all as % of HL; ED (28.96, 24.04, 26.32), IOW (28.88, 20.00, 26.87), UJL (73.74, 77.56, 71.90), LJL 31.09, 21.08, 30.33) all as % of Pr-OL; ED (21.83, 24.96, 19.51), Pr-OL (75.42, 104.10, 74.19) all as % of Ps-OL; Pr-SDL ( 40.02, 64.68, 39.25), Pr-SfDL (107.27, 101.61, 107.19) all as % of Pr-SfAL; these are the average values respectively for *M. aculeatus*, *M. aral*, *M. pancalus* (Tab. 1 & 2, Fig. 3). The findings were further supplemented by the osteological attributes particularly the number of vertebrae which is considered to be as a reliable traits for the diagnosis of fish species of this genus <sup>[12]</sup>. We found a total of 72, 65, and 60 vertebrae in *M. aculeatus*, *M. aral*, *M. pancalus*, respectively (Fig. 2). In addition to these classical taxonomic traits, we observed geographical and habitat preference of these species, which gives better insight to the

biological species concept to supplement the taxonomic data for delimitating the taxa. Based on the periodical survey during the last five years it is seen that *M. aral* is the largest (21 cm) amongst the three species, abundantly distributed in the plains and foothills of Brahmaputra and Meghana-Barak drainage system of Assam, Meghalaya, Sikkim and Tripura States with an exception of only one specimen (COF-CAU-668, 1ex, 133.78mm SL) collected from Nagaland, contributing for both food and ornamental value. It thrives well in the slow flowing or still waters having riparian or submerged vegetation with a tendency to camouflage as per the habitat. Despite of all strenuous efforts of different survey parties, no specimens of this species could be collected from the Chindwin-Irrawaddy basin of Manipur and Mizoram States. *M. pancalus* rank 2<sup>nd</sup> in relative size (15 cm) is uniformly distributed in the slow flowing or stagnant water of Assam, Meghalaya, Tripura and Sikkim with a lone exception of single stray specimen collected from Mizoram, while *M. aculeatus* is the smallest (14 cm) only confined to the running water of Assam, Meghalaya and Tripura, and also do not occur in the Chindwin-Irrawaddy drainage system as such could not be collected from Manipur and Mizoram States, however, occasionally seen frequenting upstream in shallow slow flowing water of the foot-hills of Arunachal Pradesh, these two species are of more ornamental value as such being exploited illegally by the aquarium traders in the region. Academicians are conducting biological research on these three species but sometimes with erroneous identification, as such the ambiguity in specific identification of the genus *Macrognathus* is discussed here under.



**Fig 1.a.** *Macrognathus aculeatus* (from Assam)



**Fig 1.b:** *Macrognathus aculeatus* (from Tripura)



**Fig 1.c:** *Macrognathus pancalus* (from Assam)



**Fig 1.d:** *Macrognathus pancalus* (from Sikkim)



Fig 1.e: *Macrognathus aral* (fom Meghaiaya)

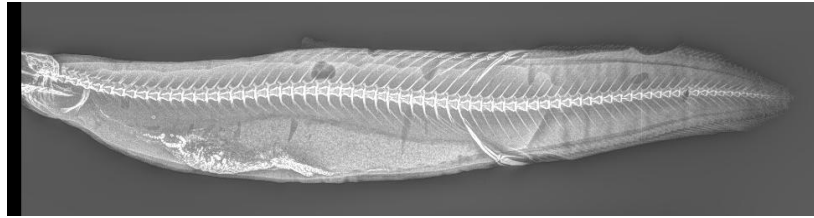


Fig 2.a: *Macrognathus aculeatus* (X-Ray Vertebral column: 34+38=72)

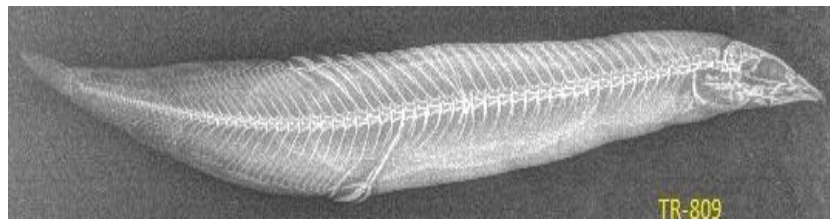


Fig 2.b: *Macrognathus pancalus* (X-Ray Vertebral column: 29+36=65)

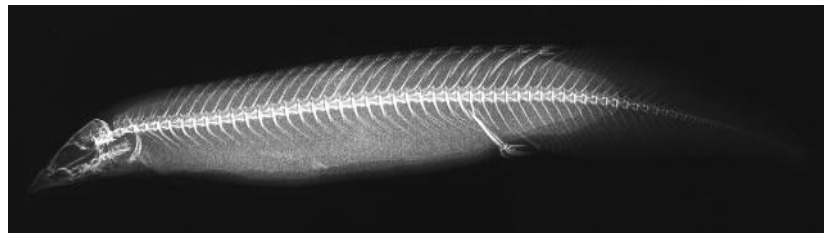
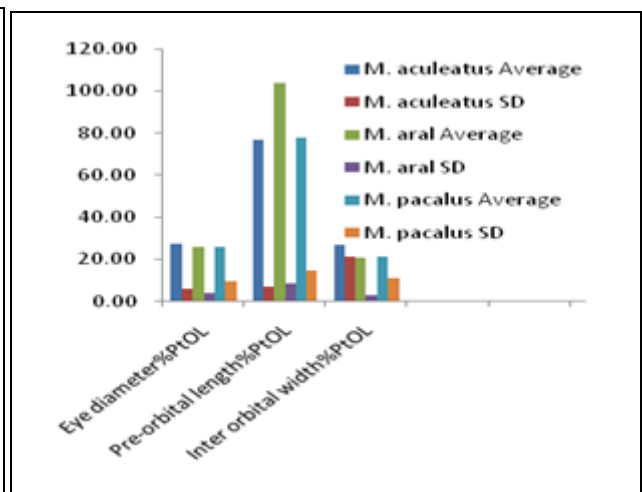
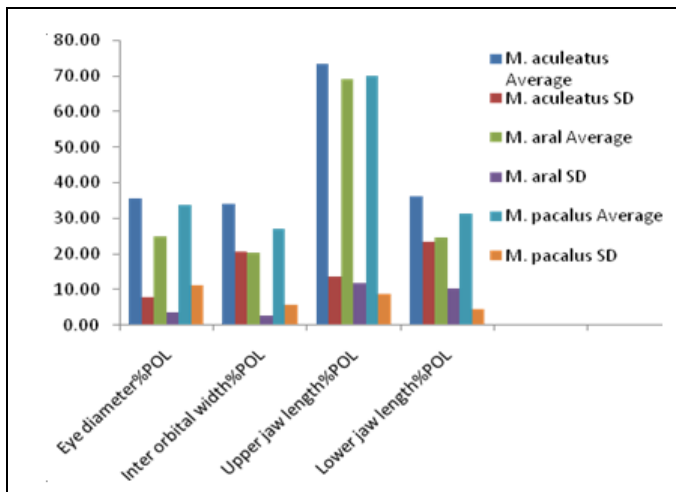


Fig 2.c: *Macrognathus aral* (X-Ray Vertebral column: 27+33=60)



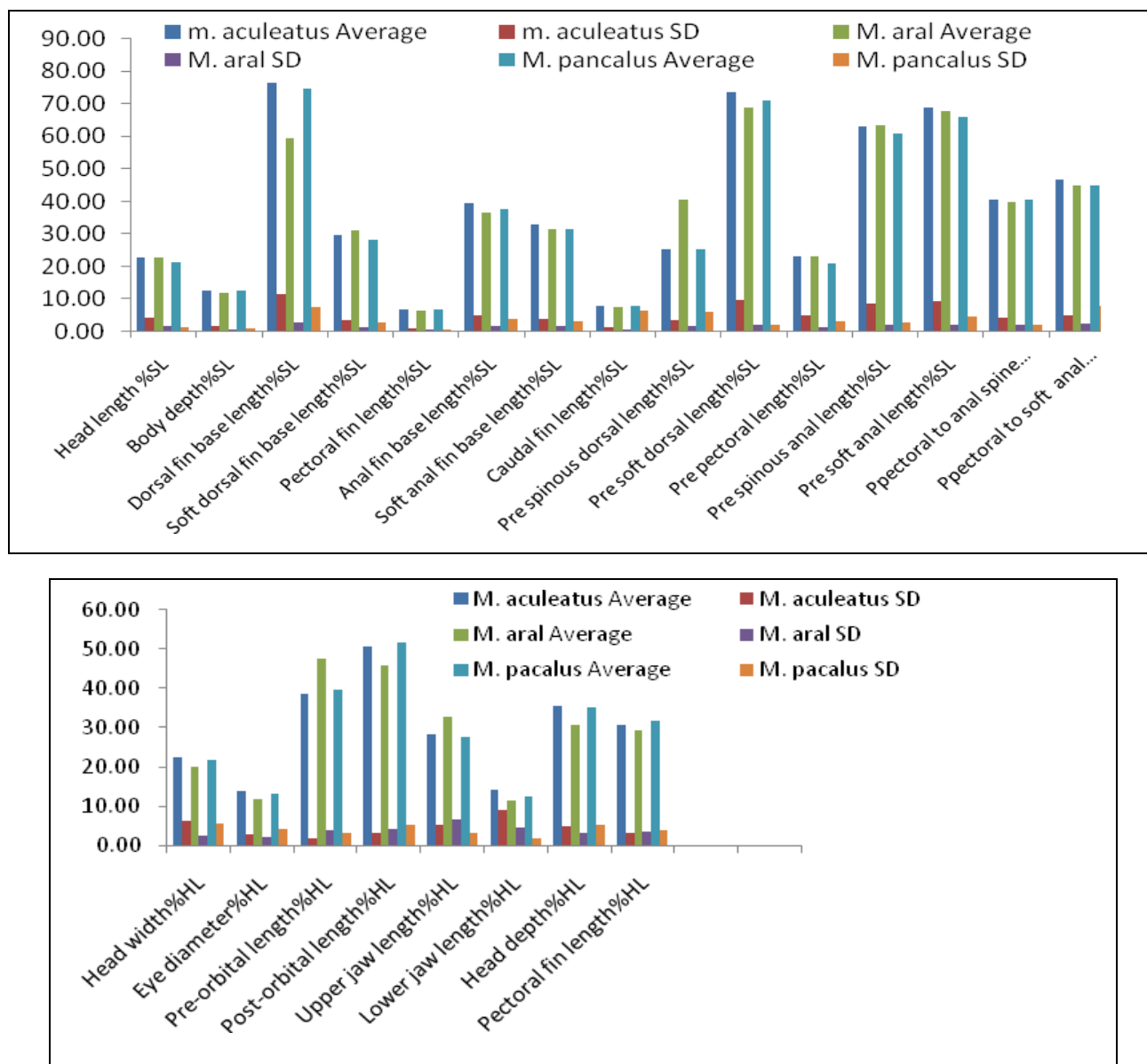


Fig 3: Comparative diagrammatic presentation of body proportions in three species of *Macrognathus*

#### 4. Discussion

The genus *Macrognathus* was described by Lacepede, (type-species: *Ophidium aculeatum* Bloch). Hamilton<sup>[13]</sup>, described two new species *M. aculeatus* and *M. pancalus* from Gangatic river system of Eastern India, based on the meristic counts and colour pattern, however, he confused the two distinct species (*M. aculeatus* and *M. aral*) by clubbing the characters together to describe a single species *M. aculeatus* and commented that “(This fish, if native names are rejected, should be called as *M. ocellatus*” p.29). Taking the advantage of this comment the subsequent researchers considered it as junior synonym of *M. aculeatus* of Bloch or a secondary junior homonym of *M. aral* (Schneider). Sufi<sup>[11]</sup>, made a comprehensive revision of the oriental fishes of the family Mastacembelidae, by examining the types of various species in different Museum and recognised only one species of the genus *Macrognathus* i.e. *M. aculeatus*, considering single diagnostic generic character (presence of series of rostral tooth plate) and rest other species of this genus without tooth plates, he placed under the genus *Mastacembelus*. However, Roberts<sup>[14]</sup>, while revising the fishes of the genus *Macrognathus* based on the material present in (BMNH), opined that the single diagnostic generic characters is not

easily discernable without alizarin preparation, moreover in poorly preserved specimens it is difficult to count the rostral tooth plates which is in conformity with the present study, as such this single generic character cannot be considered as diagnostic. Therefore, he differentiated the species of this genus from the sister taxa *Mastacembelus* based on the combination of various meristic and morphometric characters such as the disposition and counts of the dorsal and anal fin rays, which are not confluent with the caudal fin, vertebral counts, presence or absence of opercular and pre-orbital spines, besides the presence of fimbriae guarding the nasal apertures. Travers<sup>[15]</sup> based on the phylogenetic analysis differentiated African and Asian Mastacembeloids and relegated them to the order Synbranchiformes. Roberts<sup>[2]</sup> reviewed the systematic status of Mastacembelidae of Burma, Thailand and concluded that there are more than eight valid species of the genus *Macrognathus* in the Southeast Asian region; however, he could not examine any material from Indian waters. Yazdani<sup>[3]</sup>, contributed to the fish fauna of India Mastacembeliformes but simply followed Sufi (*op cit.*), by considering only one species *M. aculeatus* and all other species under the genus *Mastacembelus*, perhaps he was not aware of the systematic work of Roberts<sup>[14, 2]</sup>. Talwar and

Jhingran [4] compiled a list of five species of *Macrognathus* from Indian sub-continent but only two species *M. aral* and *M. pancalus* was reported from Northeastern region. Arunkumar and Tombi Singh [6] described a new species *M. morehensis* from Manipur, Chindwin drainage, Myanmar border. However, it is not being discussed here due to want of adequate material as except one specimen of *M. morehensis* collected from Manipur, no other species have been reported during the last five years. Vreven [12], exhaustively evaluated the osteological traits of Mastacembelidae and highlighted certain species and generic characters based on which, he concluded that there is no sufficient evidence for the division of the family in to two subfamily (Mawstacembelinae and Afromastacembelinae) and further synonymised the two genera (Caecomastembelus & Aethiomastacembelus) of Travers [15], with the genus *Mastacembelus*. Kottelat [16] agreed with Vreven (*op.cit.*) and catalogued 17 valid species of the genus *Macrognathus*, which we also followed to delineate the species in taxonomic categories.

In the recent past many new species of the genus *Macrognathus* have been described from peninsular India [10] (Plamoottil and Abraham, 2014) such as (*M. albus*, *M. fasciatus* and *M. malabaricus*) are also not being discussed as our study is based on the data retrieved from the material examined and moreover these species are from distinctly different geographic locations. Recently, Arunkumar described a new species *M. siangensis* from river Siang Arunachal Pradesh, which seems to be doubtful status in as much as we have examined the specimens from the same locality of Siang River but the meristic and morphometric data of this species falls within the range of either *M. pancalus* or *M. aculeatus* of our material examined (Tab. 1 & 2), however, we could not examine the type material of the proposed new species. Moreover, he has compared the data of proposed sp. nov. with the published data from other geographically isolated locations such as south India or Southeast Asian countries, rather than comparing it in depth with the data of existing specie (*M. aculeatus*, *M. aral*, *M.*

*pancalus* and *M. morehensis*) of the region. The species identification key provided is not dichotomous as such faulty and not able to distinguish the closely related species. Further, author mentioned “rostral barbel length” in the key, which perhaps is an erroneous statement in as much as no Mastacembeloid fishes have any barbells. Numbers of academicians are working on the biology of different species of the genus *Macrognathus* [17-19]. These studies are indicative of the fact that both the species *M. aculeatus* and *M. aral* are abundantly found in Brahmaputra and Barak-Meghna drainage system so the assertion of Roberts [2] that “*All or almost all reports of M. aculeatus from India and Sri Lanka are referable to M. aral*” is not tenable, moreover he did not examine any specimen of *Macrognathus* from India. Perhaps under the influence of Roberts (*op.cit.*), Talwar and Jhingran [4] could not consider *M. aculeatus* as valid species from India, despite of the presence of number of specimens catalogued in the National Zoological collection (see: Sufi [11], p102). Although general body colour pattern resemble with *M. zebrinus* (Blyth), however distinctly differ from it in morphometric and meristic traits (Roberts [2]). In view of these controversies regarding the systematic and distributional status of *Macrognathus* species occurring in Northeastern states of India, we endeavored to evaluate the specific diagnostic characters in a series of specimens of different age groups. As a result three species *M. aculeatus*, *M. aral* and *M. pancalus* could be identified, which are uniformly distributed in six states except Manipur from where only one species *M. morehensis* was reported that too represented by only one specimen. There are a few more specimens of the same size range, which differs from the above three species in respect of many morphometric and meristic characters but could not decide whether a new species or a habitat morpho-variant of the existing species owing to the lack of inadequate material as such not catalogued here. Efforts are on to collect more specimens from the type locality and to be published elsewhere later on.

**Table 1:** Comparative morphometric data of *Macrognathus aculeatus*, *M. aral* and *M. pancalus* specimens examined.

Morphometric traits	<i>M. aculeatus</i> (n=28)			<i>M. aral</i> (n=36)			<i>M. pancalus</i> (n=88)		
	mean	range	SD	mean	range	SD	mean	range	SD
Total length(TL)	95.41	57.61–137.93		139.15	97.76–205.39		108.36	69.06–152.94	
Standard length(SL)	88.67	53.44–126.25		129.40	90.31–190.32		100.96	61.91–144.04	
Percent of Total length									
Standard length	92.88	89.56–94.89	1.25	92.97	90.52–95.81	1.09	93.08	89.27–95.78	1.17
Head length	20.24	18.27–23.59	1.43	21.90	19.58–25.14	1.41	19.78	17.76–22.59	1.00
Body depth(BD)	11.52	9.46–13.08	0.82	10.98	9.26–12.58	0.75	11.85	9.41–13.50	0.86
Percent of Standard length									
Head length(HL)	21.81	19.64–25.43	1.73	23.56	20.94–27.29	1.60	21.25	18.67–24.57	1.15
Body depth	12.40	10.30–14.04	0.87	11.81	10.02–13.34	0.80	12.73	9.97–14.56	0.92
Dorsal fin base length(DFL)	75.90	72.64–79.94	2.00	58.85	54.15–64.66	2.92	76.07	70.00–80.06	1.83
Soft dorsal fin base length(SDFL)	28.78	26.43–31.81	1.52	31.11	27.86–34.26	1.58	28.41	24.41–31.09	1.53
Pectoral fin length(PFL)	6.75	5.56–8.04	0.66	6.62	5.59–8.17	0.61	6.81	5.65–8.15	0.56
Anal fin base length(AFL)	38.67	36.56–41.99	1.32	36.40	32.42–41.95	1.89	38.31	30.65–40.50	1.69
Soft anal fin base length(SAFL)	31.66	23.13–36.01	2.04	31.27	27.84–34.71	1.70	32.20	27.69–36.42	1.54
Caudal fin length(CFL)	7.53	6.37–9.26	0.64	7.73	6.19–8.98	0.70	7.57	5.47–11.26	0.92
Pre-spinous dorsal length(Pr-SDL)	24.50	22.06–27.47	1.40	41.03	37.36–45.33	1.82	23.98	21.74–27.38	1.17
Pre-soft dorsal length(Pr-SfDL)	71.79	68.69–76.26	1.76	68.88	65.48–75.05	2.01	71.51	67.58–76.48	1.72
Pre-pectoral length(Pr-PL)	22.04	19.45–27.77	1.77	23.72	20.69–27.68	1.66	21.30	19.02–24.07	1.08
Pre spinous anal length(Pr-SAL)	61.12	56.31–64.54	1.94	63.46	59.79–68.23	2.08	61.15	57.32–67.54	1.88
Pre soft anal length(Pr-SFAL)	66.94	62.92–69.70	1.59	67.85	63.07–72.91	2.23	66.76	59.25–71.97	2.15
Ppectoral to anal spine dist.	39.79	35.97–44.60	2.02	40.02	35.73–46.33	2.12	40.77	35.04–46.09	1.88
Ppectoral to soft anal dist.	45.96	42.48–50.08	2.10	44.68	40.02–53.37	2.52	46.38	40.19–51.07	1.99
Percent of Head length									



Head width(HW)	20.73	15.22–29.14	4.55	19.25	14.33–25.04	2.50	20.04	14.39–27.96	3.68
Eye diameter(ED)	11.31	8.05–14.29	1.49	11.32	7.82–14.33	1.56	10.27	7.79–13.29	1.10
Pre-orbital length(Pr-OL)	39.13	34.27–43.98	2.19	47.14	44.17–50.63	1.64	39.09	35.39–43.39	1.59
Post-orbital length(Ps-OL)	52.00	46.90–56.21	2.71	45.36	42.22–50.02	2.11	52.73	48.34–57.30	1.85
Upper jaw length(UJL)	28.81	24.34–33.02	2.56	36.54	32.42–38.87	1.75	28.09	23.92–32.41	1.89
Lower jaw length(LJL)	12.13	8.53–15.31	1.49	9.93	7.69–13.11	1.56	11.85	9.40–15.46	1.35
Head depth(HD)	34.15	28.45–43.62	4.55	28.25	24.91–37.32	2.54	32.45	27.45–39.89	3.21
Pectoral fin length(PFL)	31.06	25.09–37.58	3.12	28.22	22.70–36.19	3.22	32.11	26.22–38.35	2.77
Percent of (Pr-OL)									
Eye diameter(ED)	28.96	21.61–37.40	3.94	24.04	15.93–29.88	3.34	26.32	20.77–36.71	3.08
Inter orbital width(IOW)	28.88	20.52–36.77	3.90	20.00	14.79–24.84	2.80	26.87	17.29–35.66	3.80
Upper jaw length(UJL)	73.74	56.74–83.76	6.45	77.57	69.88–85.57	3.80	71.90	62.48–81.84	4.50
Lower jaw length(LJL)	31.09	21.03–42.63	4.32	21.08	15.93–29.41	3.36	30.33	24.22–39.70	3.34
Percent of (Ps-OL)									
Eye diameter(ED)	21.83	15.29–27.30	3.19	24.96	17.97–30.31	3.27	19.51	14.84–25.78	2.29
Pre-orbital length(Pr-OL)	75.42	62.05–85.94	5.39	104.1	97.01–113.83	5.42	74.19	67.48–79.87	3.13
Inter orbital width(IOW)	21.78	14.52–29.70	3.36	20.80	15.10–27.50	3.07	19.93	13.04–25.94	2.91
Percent of(Pr-SfAL)									
Pre spinous dorsal length(Pr-SDL)	40.12	24.22–46.22	2.60	64.68	57.32–69.91	2.68	39.25	35.48–46.85	2.12
Pre soft dorsal length(Pr-SfDL)	107.27	102.76–111.02	2.54	101.6	93.12–110.23	3.71	107.19	99.65–121.42	3.36

**Table 2:** Mean and range of variation in meristic data of specimens examined.

Characters	<i>M. aculeatus</i> (n=28)		<i>M. aral</i> (n=36)		<i>M. pancalus</i> (n=88)	
	mean	range	mean	range	mean	range
Dorsal -fin Spine	XXV	XXIV–XXVII	XIX	XVII–XXI	XXV	XXII–XXVII
Dorsal -fin rays	35	31–38	48	45–53	34	30–40
Pectoral- fin rays	i16	i15–i18	i17	i15–i20	i16	i15–i17
Anal -fin rays	iii35	iii30–iii41	iii47	iii42–iii53	iii37	iii30–iii44
Caudal -fin rays	12	10–12	13	12–15	12	10–12

## 5. Conclusion

The available taxonomic description of many species of the genus *Macrognothus* from Northeastern region is sketchy and needs to be revised, so the present study highlights the brief diagnostic characters of three species *M. aculeatus*, *M. aral* and *M. pancalus*, based on the evaluation of various taxonomic traits so as to resolve the confusion of misidentification and distribution status. However, this is not an ultimate conclusion as still some biosystematics ambiguity of the fishes belonging to family Mastacembelidae exists. Therefore, we are of the opinion that a comprehensive revisionary study of all the fishes belonging to the family Mastacembelidae from Indian subcontinent should be undertake, based on evaluation of morphometric, meristic and osteological traits supplemented by molecular tools, which perhaps would resolve the existing biosystematics ambiguity (Dhanze, *et al*)<sup>[20]</sup>. The inference so drawn would lead to redescription of some of the existing species described in the recent past or may even revalidate some of the earlier forgotten or synonymised species such as *Macrognothus* (= *Rhynchobdella*) *dhanashrii* and so no. While concluding, a brief diagnostic description of three species is given here under

## Diagnosis

### 5.1. *Macrognothus aculeatus* (Bloch, 1786)

*Ophidium aculeatum* Bloch, 1786:261, pl.159 fig.2; type locality: East Indies, Indonesia, Java.

*Macrognothus aculeatus* (Bloch, 1786); (original type locality : fresh waters of Eastern India; neotype: ZRC 49866, designated by Kottelat & Widjanarti, 2005: 168, fig. 15).

D XXIV–XXVII 31–38; P i15–18; A III30–41; C 10–12

A beautiful spiny eel with cylindrical body contour, tapering gently from occipital region to the pointed tip of snout anteriorly and from the origin of soft dorsal fin to caudal

peduncle posteriorly, rostrum with tubular nostril guarded by fimbriae. Opercular and pre-orbital spines absent; overall colour yellowish grey with light brown vertically strait or oblique bands on dorsum and lateral aspect of entire body from opercular region to caudal peduncle giving zebra like striations but should not be confused with (*M. zebrinus* a southeast Asian species); dorsal and anal fin hyaline with oblique black dotted streaks and on caudal fin vertical black dotted streaks (Fig. 1 a & b). Dorsal and anal fins are not confluent with the caudal fin; vertebral count (34+38=72). Various other diagnostic body proportions are given in (Tab. 1, Fig. 3).

### 5.2. *Macrognothus aral* (Schneider, 1801)

*Rhynchobdella aral* Schneider, 1801:479,pl.89 (type locality: India: Rivers of Tranquebar; lectotype: ZMB 1420, designated by Paepke, 1999: 98, pl. 22 fig. 1)

D XVII–XXI 45–43; P i15–20; A III42–53; C 12–15

A moderately large double band spiny eel with slightly compressed cylindrical body contour more or less like other species of the genus, fairly longer rostrum with distinct tooth plates in the concavity and tubular nostril guarded by fimbriae near the tip of snout, opercular and pre-orbital spines absent. Overall body colour brown above and light grey below, two longitudinal broad bands, 1<sup>st</sup> one yellowish grey above the lateral line and 2<sup>nd</sup> dark brown along the lateral line from eye to caudal peduncle. Soft dorsal fin brown with a longitudinal white streak in the middle throughout its length and 3-7 distinct ocelli at the base, anal fin uniformly brown generally without any white streak or ocelli, however we observed one ocellus at the base of this fin in one specimen only; caudal fin light brown with 4-5 white zigzag vertical bands (Fig. 1 e). Dorsal and anal fins are also not confluent with the caudal fin; vertebral count (27+33=60). Other diagnostic body proportions are given in (Tab. 1, Fig. 3).

### 5.3. *Macrognathus pancalus* Hamilton, 1822

*Macrognathus pancalus* Hamilton, 1822, Fishes of Ganges:30, 364, pl.22, fig. 7 (type-locality: tanks of Gangetic provinces).

D XXII–XXVII 30–40; P i15–17; A III30–44; C 10–12

A typical still water spiny eel with cylindrical body contour like that of *M. aculeatus*, however, with relatively shorter rostrum without tooth plates but tubular nostril guarded by fimbriae present, opercular and pre-orbital spines absent. Overall body colour brown spackled with spots arranged in three to four longitudinal rows or may be irregularly arranged on dorsum and lateral aspect of entire body from opercular region to caudal peduncle; dorsal and anal fin hyaline grey with spackled with black dots and caudal fin with vertical black dotted streaks (Fig. 1 c & d). Dorsal and anal fins are not confluent with the caudal fin; vertebral count (29+36=65). Other diagnostic body proportions are depicted in (Tab. 1, Fig. 3).

### 6. Acknowledgements

Authors acknowledge the financial support from the Department of Biotechnology, Ministry of Science and Technology, Govt. of India for sanctioning the Project “Centre of Excellence on Fisheries and Aquaculture Biotechnology in Northeastern Region” and the present work is a part of this project. We are thankful to the Dean, College of Fisheries, Lembucherra, Tripura, for providing the adequate infrastructural as well as administrative facilities to carry out this work. The strenuous efforts of all collectors, Drs. P.Bhattacharji, C. Radhakrishnan, AS. Barman, J. Parhi, P. Biswas, H. Saha, J. Singh, KS. Singh and other field staff for their sincere efforts to collect the specimens are also sincerely acknowledged.

### 7. References

1. Dhanze R, Debbarma A, Dhanze JR. Biosystematics of the species *Xenentodon cancila* (Hamilton 1822) (Beloniformes: Beloniidae) from Northeastern States of India, with special reference to sexual dimorphism. International journal of Fisheries and aquatic Studies. 2018; 6(2):610-615.
2. Roberts TR. Systematic review of the Mastacembelidae or spiny eels of Burma and Thailand, with description of two new species of *Macrognathus*. Japanese Journal of Ichthyology. 1986; 33(2):95-109.
3. Yazdani GM. Contribution to the fish fauna of India (Including adjacent countries) Order Mastacembeliformes. Record Zoological Survey of India, 1990; 124:36.
4. Talwar PK, Jhingran AG. Inland Fishes of India and Adjacent Countries. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, 1991, 1158.
5. Barman RP. Fish fauna of Tripura, North East-India. Journal of Bombay Natural History Society, 1994; 91(1):37-46.
6. Arunkumar L, Tombi Singh H. Spiny eels of the genus *Macrognathus* Lacepede from Manipur, with description of a new species. Journal of Bombay Natural History Society, 2000; 97(1):117-120.
7. Vishwanath W, Lakra WS, Sarkar UK. Fishes of North East India. NBFGR, ICAR, Lucknow, 2007, 263.
8. Kar D, Sen N. Systematic list and distribution of fishes in Mizoram, Tripura and Barak drainage of northeastern

- India. Zoo's Print Journal. 2007; 22(3):2599-2607.
9. Jayaram KC. The Freshwater Fishes of The Indian Region. Narendra Publication, New Delhi, (corrected 2<sup>nd</sup> ed.), 2013; 616:XXXIX pls.
10. Plamoottil M, Abraham NP. *Macrognathus albus* (Order: Synbranchiformes; Family: Mastacembelidae), a new fish species from Kerala, India. International Journal of Pure and Applied Zoology. 2014; 2(2):100-105.
11. Sufi SMK. Revision of the oriental fishes of the family Mastacembelidae. Bulletin Raffles Museum. 1956; 27:93-146.
12. Vreven EJ. Mastacembelidae (Teleostei; Synbranchiformes) subfamily division and African generic divisions: an evaluation. Journal of Natural History. 2005; 39(4):351-370.
13. Hamilton F. An Account of the Fishes Found in the River Ganges and its Branches. Edinburgh and London, Archibald Constable and Co. 1822; vii+405:39.
14. Roberts TR. A revision of the Assian Mastacembelid Fish Genus *Macrognathus*. Copeia, 1980; 3:385-391.
15. Travers RA. A review of the Mastacembeloidei, a sub order of Synbranchiform teleost fishes, Part II: Phylogenetic analysis. Bulletin British Museum (Natural History) Zoology. 1984; 46(2):83-150.
16. Kottelat M. The Fishes of the Inland Waters of Southeast Asia: A Catalogue and Core Bibliography of the Fishes Known to Occur in Freshwaters, Mangroves and Estuaries. The Raffles Bulletin of Zoology. 2013; 27:1-663.
17. Das SK, Kalita N. Captive Breeding of Peacock Eel, *Macrognathus aculeatus*. Assam Agricultural University, College of Fisheries, Raha, Nagaon, Assam, India. 2003; 8(3):17-21.
18. Pathak BC, Serajuddin M. A Comparative Study of Length-Weight Relationship and Condition Factor of Lesser Spiny Eel, *Macrognathus aculeatus* (Bloach) from the Different River Basins of India. World Journal of Fish and Marine Sciences. 2015; 7(2):82-86.
19. Faridi AA, Rizvi MMA, Serajuddin M. Food and feeding habits of peacock eel, *Macrognathus aculeatus* (Bloch, 1786) from Eastern Uttar Pradesh, India. International Journal of Fisheries and Aquatic Studies. 2016; 4(4):130-134.
20. Dhanze R, Debbarma P, Dhanze JR. New record of a little known species *Mastacembelus oatessii* Boulenger, 1893 (Synbranchiformes: Mastacembelidae) from Nagaland and Mizoram States of Northeast India, with redescription. International journal of Fisheries and aquatic Studies. 2018; 6(3):38-43.