

## Systematic Review of the Mastacembelidae or Spiny Eels of Burma and Thailand, with Description of Two New Species of *Macrognathus*

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**Abstract** Burma and Thailand are inhabited by 14 species of Mastacembelidae, eight *Macrognathus* and six *Mastacembelus*. Two new species of *Macrognathus* are described from Thailand, one with rostral toothplates and one without. *Mastacembelus dayi*, known only from Burma, is a valid species related to *M. alboguttatus*; *Mastacembelus favus*, from Thailand and Western Malaysia, is distinct from its close relative *M. armatus*.

Mastacembeloids or spiny eels are a distinct group of percomorph fishes restricted to fresh waters of Africa and Asia. The suborder has recently been divided into two families, Chaudhuriidae and Mastacembelidae, and the Mastacembelidae into two subfamilies, Afromastacembelinae (restricted to Africa) and Mastacembelinae (restricted to Asia) (Travers, 1984a, b). Thus understood, Mastacembelinae comprise the genera *Macrognathus* and *Mastacembelus*. The 14 species of these two genera found in Burma and Thailand are reviewed in this paper.

This study began when Sven Kullander of the Naturhistoriska Riksmuseet in Stockholm sent 17 lots of mastacembelids collected in Burma prior to WW II to me for identification. The material included specimens of two rare and poorly known species, *Mastacembelus dayi* and *M. oatesii*. Subsequently, I spent several months of 1985 in Thailand, collecting fresh material and examining specimens in museum collections, including extensive collections from the poorly known Salween River and its tributaries collected by Sompote Ukkatewewat of the National Inland Fisheries Institute and others in recent years. Thus I am able to report on the rare species *Mastacembelus alboguttatus* collected in the Salween as well as on two new species of *Macrognathus*. One new *Macrognathus* is known only from a single collection, taken in the Meklong River basin of Western Thailand, but the other new species occurs in the Meklong, Chao Phrya and Mekong basins and is perhaps the commonest species of the mastacembelids in Central and Eastern Thailand. Having examined extensive material from Thailand, I conclude that *Macrognathus maculatus*

and *Mastacembelus unicolor* do not occur there. On the other hand, it appears that *Mastacembelus favus*, known only from Thailand and Western Malaysia, is distinct from the more widely distributed *Mastacembelus armatus*, with which it is sometimes sympatric.

### Methods and materials

Descriptions given for some species, including those *Macrognathus* treated in my revision (Roberts, 1980) are quite brief; more detailed accounts are given of the two new species and of poorly known species such as *Mastacembelus dayi* and *M. oatesii*. The only species known from Burma and Thailand for which material is not reported on are the relatively well known *Mastacembelus erythrotaenia* and *Macrognathus caudiocellatus*, known only from the type specimens. I examined several lots of *M. erythrotaenia* in Thailand but did not take data on the specimens and thus they are not included in this report.

This study is based on specimens deposited in the Naturhistoriska Riksmuseet (Stockholm), NRM; Institut Royal des Sciences Naturelles de Belgique, IRSNB; California Academy of Sciences, CAS, including material formerly at Stanford University, CAS-SU; British Museum of Natural History, BMNH; Philadelphia Academy of Natural Sciences, ANSP; Kasetsart University Museum of Fisheries, Bangkok, KUMF; National Inland Fisheries Institute of Thailand, Bangkok, NIFI; Thailand National Research Council, Bangkok, TNRC; University of Michigan Museum of Zoology, UMMZ; and Museum National d'Histoire Naturelle, Paris, MNHN.

Fully detailed locality data, including collector

and date of collection, if known, are given only for new species. In general, I have refrained from modifying the spelling or wording of localities obtained from labels accompanying specimens. The description of some localities may include ambiguities, but it seems better to admit them rather than to risk introducing erroneous locality citation.

In studying mastacembelids radiography is indispensable because meristic characters (including dorsal and anal fin ray counts) are important and cannot readily be obtained in other ways. Published counts of dorsal and anal fin rays obtained directly from whole specimens which have not been cleared and stained are often unreliable. There is also the problem that specimens may be anomalous (teratologically or due to mechanical injury), producing abnormal counts of fin rays and vertebrae. Such specimens may appear normal to casual or even detailed examination of external features, but the anomaly is readily apparent in radiography. In gathering meristic data on mastacembelids I routinely scan the radiograph of each specimen for anomalies in the axial skeleton (mainly vertebral fusions). If anomalies are present, data are not taken. To include data from such specimens would not serve any useful purpose, and would greatly lessen the utility of meristics in defining taxa. While there is an element of subjectivity in determining whether a specimen is normal, most of the specimens thus discounted are grossly abnormal. Thus in the series of 3 specimens of *Mastacembelus armatus* from the Tapi River basin, one specimen has only 68 dorsal fin rays, 69 anal fin rays, and  $40+44=84$  vertebrae. The specimen, including caudal fin, appears normal externally, but the radiograph reveals that the posteriormost vertebra and caudal fin skeleton are anomalous. The other two specimens from this locality have 91 vertebrae, 74 dorsal fin rays, and 76 anal fin rays. The lowest vertebral count known in *M. armatus* is 88 (Roberts, in press).

The number of specimens for which data has been disallowed is relatively few.

Most counts used for mastacembelids are comparable to those generally taken by fish systematists. It should be noted that the spinous dorsal fin invariably ends in an enlarged penultimate spine, and that the last spine is greatly reduced and often difficult to detect. In my ex-

perience (including examination of radiographs of several hundred specimens of Asian and African mastacembelids), this spine is invariably present. It is included in the counts given here. Counts of anal fin spines are not recorded for each species because *Macrogathus* and *Mastacembelus* invariably have 3 anal fin spines.

Definitions of vertebral counts are as follows: total vertebrae=all vertebrae with complete and separate centra, including urophore as one; predorsal vertebrae=vertebrae with neural spines lying anterior to first pterygiophore of spiny dorsal fin (whether or not first pterygiophore bears a dorsal fin spine); abdominal vertebrae=all vertebrae lying anterior to anteriormost anal fin pterygiophore; caudal vertebrae=vertebrae posterior to anteriormost anal fin pterygiophore (including urophore as 1). In instances where anteriormost anal fin pterygiophore lies exactly on the hemal spine of a vertebra, that vertebra is arbitrarily counted as an abdominal vertebra.

**Key to Mastacembelidae of Burma and Thailand**

- 1a. Dorsal fin spines 32 or less; total vertebrae usually 84 or less; rostrum relatively large, in some species concave ventral surface lined with toothplates; rim of tubular anterior nostril with six fingerlike projections except in one species; adductor arcus palatini muscle attached to first infraorbital bone (*Macrogathus*) . . . . .2
- 1b. Dorsal fin spines 33 or more; total vertebrae 79 or more; rostrum relatively small, never concave ventrally or with rostral toothplates; rim of anterior tubular nostril with two fingerlike projections and two broad-based flaps; adductor arcus palatini muscle not attached to first infraorbital bone (*Mastacembelus*) . . . . .9
- 2a. Rostrum with concave ventral surface lined with paired toothplates; preorbital and preopercular spines absent; dorsal fin spines 13-23; predorsal vertebrae 11-21; dorsal and anal fins separate from caudal fin . . . .3
- 2b. Rostrum rounded in cross section, without toothplates; preorbital spine always and preopercular spines usually present; dorsal fin spines 27-32; predorsal vertebrae 4-8; dorsal and anal fins separate from or joined to caudal fin . . . . .6

- 3a. Rostrum relatively small, rostral tooth-plates 7–14.....4
- 3b. Rostrum relatively large, rostral tooth-plates 14 or more.....5
- 4a. Dorsal fin base with series of large, perfectly formed ocelli; an ocellus often at base of caudal fin; dorsal and caudal fins without fine dark striations or dots.....  
.....*Macrognathus siamensis*
- 4b. Dorsal fin base and caudal peduncle without ocelli (small dark round spots may be present); dorsal and caudal fins with fine dark striations or dots.....  
.....*Macrognathus meklongensis* sp. nov.
- 5a. Rostral toothplates 14–28; body typically with two or more broad, pale longitudinal stripes extending its entire length, one dorsal to and one ventral to lateral line.....  
.....*Macrognathus aral*
- 5b. Rostral toothplates 29–55; body with 14–17 oblique dark bars.....  
.....*Macrognathus aculeatus*
- 6a. Rim of anterior nostril with six fingerlike projections.....7
- 6b. Rim of anterior nostril with two fingerlike projections and two broad-based flaps; dorsal, anal and caudal fins entirely confluent, caudal fin more or less pointed.....  
.....*Macrognathus semiocellatus* sp. nov.
- 7a. Dorsal and anal fins separate from caudal fin; body without vertical bars continued onto abdomen; ripe females without elongate genital papilla.....8
- 7b. Dorsal, anal, and caudal fins broadly joined; body with 15–19 dark vertical bars continued onto or across abdomen; ripe females with elongate genital papilla.....  
.....*Macrognathus circumcinctus*
- 8a. Dorsal fin spines 28–31; dorsal fin rays 49–55, anal fin rays 51–59; vertebrae 72–74; side of body with series of thin, dark vertical bars with pale outlines; caudal fin vertically striated with small black spots...  
.....*Macrognathus zebrinus*
- 8b. Dorsal fin spines 31–34; dorsal fin rays 62–68; anal fin rays 60–68; vertebrae 81; side of body with finely reticulate pattern; caudal fin with large pale round spots outlined by dark pigment ..*Macrognathus caudiocellatus*
- 9a. Dorsal and anal fins broadly joined to caudal fin, caudal fin outline merged with that of dorsal and anal fins; caudal fin rays 12–20.....10
- 9b. Dorsal and anal fins separate from caudal fin, or joined to caudal fin only near its base, caudal fin outline entirely or almost entirely separate from that of dorsal and anal fins; caudal fin rays 21–27.....12
- 10a. Soft-rayed portions of median fins and pectoral fins usually with relatively faint or indistinct markings; body usually with zig-zag longitudinal marks (sometimes broken up into isolated spots) or with a well-formed network of broad dark marks....11
- 10b. Soft-rayed portions of median fins and pectoral fin with a sharply defined white distal margin, basal portion of dorsal, anal and caudal fins dark, that of pectoral fin dark or with broad vertical bars; head and anterior part of body with longitudinal red and black bands, rest of body with red spots or elongate marks on a black background.....*Mastacembelus erythrotaenia*
- 11a. Dorsal fin spines 33–37; body with broadly connected network pattern almost always extending onto abdomen, which is often bright yellow in life; body relatively deep (see text).....*Mastacembelus favius*
- 11b. Dorsal fin spines 34–40; body usually with zig-zag lines, sometimes connecting to form a network, but almost never extending onto abdomen, which is never brightly colored in life; body relatively slender (see text)...  
.....*Mastacembelus armatus*
- 12a. Snout very narrow and elongate; jaws extending posteriorly half or less than half of distance to below anterior margin of eye; preorbital spine falling far short of anterior margin of eye; preopercle with 3–5 spines; dorsal and anal fins with 73 or more rays; body and fins with numerous pale round spots.....13
- 12b. Snout very broad and short; jaws extending posteriorly fully two-thirds of distance to below anterior margin of eye; preorbital spine extending posteriorly to below margin of eye or somewhat beyond; preopercle without spines; dorsal and anal fins with 61 or fewer rays; body with a few large dark spots which may extend onto base of dorsal fin, fins otherwise plain.....  
.....*Mastacembelus oatesii*

- 13a. Body and fins with very numerous, small round pale spots without dark edges; body with numerous rings composed of 9–10 small pale spots encircling a somewhat larger dark spot; caudal fin rays 21; vertebrae 82 . . . . . *Mastacembelus alboguttatus*
- 13b. Body and fins with moderately numerous, relatively large, pale spots with dark edges; spots on fins round, but those on body often vertically elongate; caudal fin rays 25–27; vertebrae 85–86. . . . .  
 . . . . . *Mastacembelus dayi*

*Macrogathus* Lacepède, 1800

*Macrogathus* Lacepède, 1800: 9 (type species: *Ophidium aculeatum* Bloch, 1786, by subsequent designation of Jordan, 1917: 56).

*Rhynchobdella* Bloch and Schneider, 1801: 478 (type species: *Ophidium aculeatum* Bloch, 1786, by subsequent designation of Jordan, 1917: 59).

**Diagnosis.** *Macrogathus* differs from all other mastacembelids in having 1) adductor arcus palatini muscle with distinct anterior portion inserting on first infraorbital bone; 2) coronomeckelian bone markedly slender and elongate; and 3) fleshy rostrum slightly to considerably larger. Except in one species it differs from all other mastacembelids in having 4) rim of anterior nostril with 6 slender fingerlike projections or fimbriae, rather than two fimbriae and two broad-based flaps or fimbriules. Additional characteristics or trends include 5) body deep, with elongate, slender neural and hemal spines; 6) dorsal fin spines relatively few, 13–32; 7) spiny dorsal fin usually originating posterior to 6th vertebra; 8) vertebrae 71–84; 9) adults relatively small, length always under 35 cm. Other characters (mostly osteological) are given by Travers (1984b: 135, 143–144).

*Macrogathus aculeatus* (Bloch, 1786)

*Ophidium aculeatum* Bloch, 1786 (type locality: “Süßen Wasser von Ostindien”).

**Material examined.** Thailand: NIFI 0219, 3, Surat Thani, Chiao Lam, Tapi River basin.

For additional synonymy, meristics, comparisons with other *Macrogathus*, and geographical distribution see Roberts (1980). The species occurs in Borneo, Sumatra, and the Malay Peninsula northwards to the Tapi River basin. It has not been found in Burma or in the Indian subcontinent. All or almost all reports

of *M. aculeatus* from India and Sri Lanka are referable to *M. aral*.

The three specimens from Chiao Lam have rostrum very large, with 31–33 rostral toothplates; dorsal fin spines 19 (2), 20 (1); body with series of obliquely oriented bars typically seen in *M. aculeatus* (see Roberts, 1980: fig. 2a).

*Macrogathus aral* (Bloch et Schneider, 1801)

*Rhynchobdella aral* Bloch and Schneider, 1801: 479 (type locality: “fluvius Tranquebarensis”=SE India).

**Material examined.** Burma: NRM HAG/1935139. 5264, 3: 111–146 mm, near Mandalay; NMR MAL/1935989. 5285, 3: 195–225 mm, Rangoon?

For additional synonymy, meristics, comparisons with other *Macrogathus*, and geographical distribution see Roberts (1980). This species occurs in lowland habitats and at moderate elevations in all of the larger river systems of the Indian subcontinent (including Sri Lanka) as well as in Burma. It has not been recorded from the Salween River basin or from Thailand.

The Burmese material examined has not been compared directly to specimens from India and other localities but so far as I can tell it does not differ from them. The Mandalay and Rangoon specimens have rostral toothplates 20–25; rostrum intermediate in size between the very large rostrum of *Macrogathus aculeatus* and the smaller rostra of *M. siamensis* and *M. meklongensis*; dorsal fin base with 8–11 small ocelli; midpeduncular ocellus absent; dorsal and caudal fins with numerous fine dark streaks (obliquely arranged on dorsal fin, vertically on caudal) as in *Macrogathus pancalus*, *M. zebrinus* and *M. meklongensis*.

*Macrogathus caudicellatus*

(Boulenger, 1893)

*Mastacembelus caudicellatus* Boulenger, 1893: 199 (type locality: “Fort Stedman, 3000 ft.”=Inle Lake).

*Macrogathus caudicellatus*: Travers 1984b: 144.

This species apparently is known only from the type specimens, which I have not examined. Thus it is known only from Inle Lake.

The following account is compiled from Boulenger (1893), Annandale (1918), Sufi (1956), and Travers (1984a, b). Standard length to 219 mm. Dorsal fin spines 31–34; dorsal fin rays 62–68; anal fin rays 60–68; pectoral fin rays 19–22; caudal fin rays 15–18. Preorbital spine present. No preopercular spines. Spiny dorsal fin originating above extremity of pectoral fin.

Dorsal and anal fins partially confluent with caudal fin (united to caudal fin only at its base) (Sufi, 1956). Vertebrae 37+44=81. Rim of anterior nostril with 6 fimbriae; part A1 of adductor arcus palatini muscle inserts on infra-orbital. For additional osteological characters see Travers (1984a, b).

The coloration is very distinctive (Annandale, 1918: pl. 1, fig. 3): body with a finely reticulate pattern not seen in other species; dorsal fin with fine longitudinal dark streaks similar to those seen in *Macrognathus pancalus*, *zebrinus*, and *meklongensis*. The round spots on the caudal fin to which the name *caudiocellatus* refers are not comparable to the ocelli of other species such as *Macrognathus siamensis*: the central portion is pale, rather than dark; and the dark circles surrounding each ocellus are continuous with each other, rather than lying in a field of contrasting color, as do the pale circles surrounding the ocelli in other species. Similar but less well defined round spots are present on the anal fin of the specimen figured by Annandale.

*Macrognathus circumcinctus* (Hora, 1924)

*Mastacembelus circumcinctus* Hora, 1924: 475 (type locality: "Patelung River, Tale Sap, Siam").

*Macrognathus circumcinctus*: Travers, 1984b: 144.

**Material examined.** Thailand: NIFI 00613, 4, Nakorn Nayok, Sarika waterfall near Kao Yai, Chao Phrya basin; NIFI 01590, 2, Chacherngsao Province, swamp near Kao Hinsorn, Chao Phrya basin; KUMF 1302, 2: 123–130 mm, Klong Song-Pee-Nong, Rayong; KUMF 1301, 2: 94.1–112 mm, Kao Sabap, Chantabun; NIFI 00622, 2, Oon River, Sakon Nakhon, Mekong basin; NIFI 01168, Wipavadi waterfall (Tapi River basin?); KUMF 1304, 71.2 mm, Klong Nakhon Noi, Nakorn Sritamarat; KUMF 1300, 155 mm, Tale Sap, Klong Ranant; KUMF 1303, 145 mm, Tale Noi.

This species differs from all other mastacembelids found in Burma and Thailand in having body with a series of very regular, oblique, dark bars, each with a narrow extension extending partially or entirely across abdomen, and having ripe females with a very elongate genital papilla (ovipositor?). The only other mastacembelids known to have a similar genital papilla are two apparent close relatives of this species, *Macrognathus guentheri* (Day, 1865) in southern India and *Macrognathus maculatus* (Valenciennes, 1831) in the southern Malay Peninsula, Borneo and Sumatra. The latter species apparently does not

occur in Thailand. It was reported from Bangkok by Bleeker (1865) on the basis of a painting obtained by Castelnau and this record has been cited by Smith (1945) and others although there is no additional evidence that the species occurs in Thailand.

The material examined exhibits the following frequencies of dorsal fin spine counts: 27(1), 28(9), 29(6), 30(3). No additional meristic data are presented for the species in this paper.

*Macrognathus meklongensis* sp. nov.

(Fig. 1a)

**Holotype.** NMR TRR/1984120.3002, 95.0 mm, Thailand: Meklong River basin, Kwaee Noi River, Kao Lam Dam area, Tong Pha Phum, Khanchanaburi. Jaranthada Karnasuta, 19–22 March 1984.

**Paratypes.** NIFI uncat. and NRM/1984120.3003, 4: 97.0–178 mm, collected with the holotype.

**Diagnosis.** A *Macrognathus* with a concave rostrum bearing 9–11 pairs of toothplates; coloration very distinctive; 10–12 faint small ocelli along base of dorsal fin; dorsal and anal fins with fine dark striation (present in *M. aral* but absent in *M. siamensis*). Dorsal, anal, and caudal fins entirely separate. Rim of anterior nostril with 6 fingerlike projections. Penultimate (enlarged) dorsal fin spine articulating with same vertebra (33–35) as enlarged anal fin spine. For additional meristic characters see Table 1.

In addition to the differences in color pattern indicated in the Key, the five type specimens of *M. meklongensis* differ from material examined of *M. siamensis* in having a more elongate snout; larger eye; more slender body tapering less strongly posteriorly; much lower soft dorsal and anal fins; and smaller caudal fin but with more numerous caudal fin rays (16–19 vs 15). In its more tapering body, lower dorsal and anal fins, and smaller caudal fins *M. meklongensis* resembles *M. aral*, but it differs from that species in having fewer rostral toothplates (10–11 vs 14–28); different coloration (see Key); fewer dorsal fin spines (14–15 or 16 vs 16–23) and correspondingly more predorsal vertebrae (19–21 vs only 6–11) (for meristic data on *M. aral* see Roberts, 1980).

*Macrognathus semiocellatus* sp. nov.

(Fig. 1b–d)

**Holotype.** NMR TRR/1985260.3004, 157 mm, Thailand: Ubon Ratchatani market (presumably

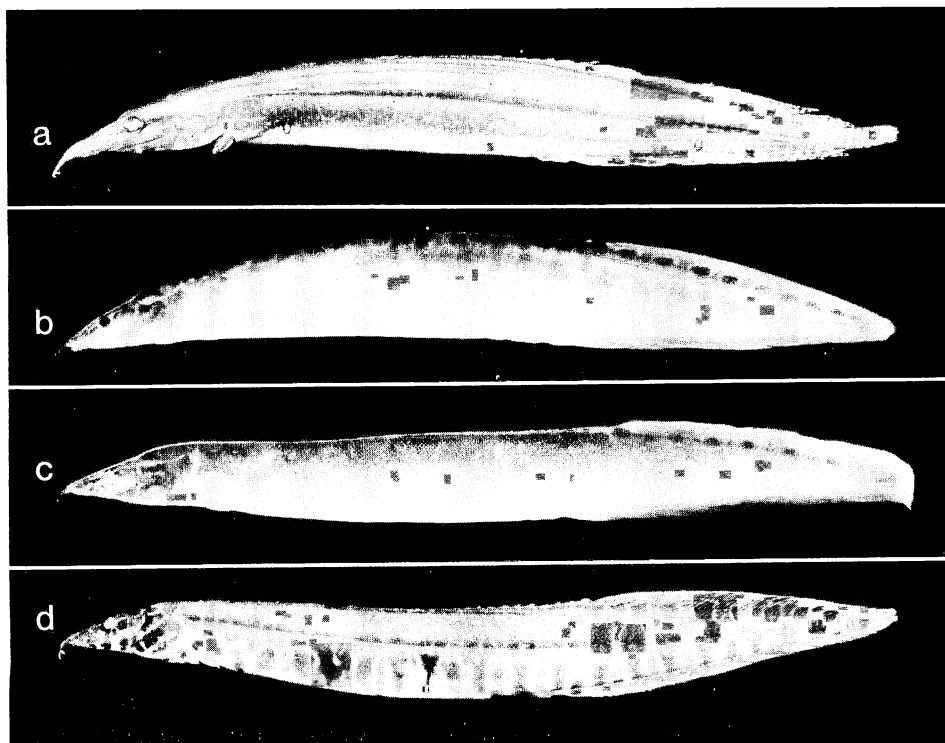


Fig. 1. *Macrognathus* of Burma and Thailand. a, *M. mekongensis*, 95.0 mm (holotype), Meklong basin; b, *M. semiocellatus*, 157 mm (holotype), Ubon Rathchatani; c, *M. semiocellatus*, 192 mm (paratype), Ubon Ratchatani; d, *M. semiocellatus*, 112 mm (paratype), Bung Borapet.

caught in Mun River near Ubon Ratchatani=Mekong basin). T. Roberts, 28 June–2 July 1985.

Paratypes. Meklong basin: NIFI 01676, 2: 100–113 mm, Srinakarin Reservoir, Srisawat, Kanchanaburi Prov., Sonkphan, 12 August 1983. Chao Phrya basin: CAS 57350, 11: 83.7–135 mm, 15 miles SW of Bangkok airport, Thanyaburi Prov.; NIFI 01674, 6: 118–170 mm, Nakon Sawan market, August 1978; NIFI 00618, 160 mm, Bung Borapet, Sompote, 26 August 1981; NIFI 01677, 4: 155–165 mm, Chao Phrya at Chainat, Sonkphan, May 1982; KUMF 2937, 18: 111–142 mm, Lopburi market (from Bang Li?); KUMF 2936, 166 mm, Ayuthia; NRM TRR/1985298.3006, 6: 107–125 mm, Bung Borapet, Sonkphan, July 1985. Mekong basin: NRM/TRR 1985260.3005, CAS 53751, BMNH 1985. 8. 21: 3–13, IRSNB 739, MNHN 1985-800, 113: 65.0–192 mm, Ubon Ratchatani market (presumably caught in Mun River), T. Roberts, 28 June–2 July 1985; KUMF 2939, 155 mm, Nam Pong Dam, Nong Wai 32 km from Khon Khaen to Udon, 22 March 1981, S. Monkolprasit; NIFI 00612, 5: 130–178 mm, Nakorn Phanom, Menam Sonkarm, 1 May 1966, Preecha Tienchalun; NIFI 01675, 2: 110–114 mm, Khon Khaen, Ubon Rathana Reservoir, Sonkphan, 13 Feb.

1985; NIFI 01678, 84.2 mm, Oon River near Sakon Nakon, Sopa Areerat Dec. 1968; TNRC 2623–2630, 8: 60.4–142 mm, Mun River at Ubon Ratchatani, T.P., 22 December 1972; KUMF 2938, 2: 82.0–138 mm, Pak Mun; NRM BJO/1935111.5380, 131 mm, Bao Cat; UMMZ 213430–31, 2: 128–165 mm, Vietnam, Chau Doc market, Chau Doc Province, Rainboth and Smith, 11–15 Oct. 1974; UMMZ 213434–35, 6: 27.9–169 mm, Thailand, Lam Doc Noc Reservoir, Rainboth *et al.*, 17–18 July 1975; UMMZ 213436, 4: 50.0–60.0 mm, Thailand, Huay Hin Taek opposite Ban Dan across Mun River, Rainboth *et al.*, 6 Aug. 1975; UMMZ 213437 and 213440, 32: 53.0–148 mm, Thailand, Khon Chiam District, Huay Kwang 0.3–1.5 km upstream from Mun River; UMMZ 213438, 14: 26.5–91.7 mm, Thailand, Lam Pao Reservoir opposite Ban Na Kok, approx. 10 km N of damsite, Rainboth *et al.*, 5 Nov. 1975; UMMZ 213439, 9: 45.8–161 mm, Thailand, Nam Pong Reservoir 4.8 km N of damsite of E shore. Rainboth *et al.*, 12 Dec. 1975; UMMZ 213432, 2: 98.1–122 mm, Laos, Mekong River and tributaries from km 1393 to 1596, Tucker *et al.*, 17 March–17 April 1975; UMMZ 213433, 20: 86.4–132 mm, Laos and Thailand, Mekong River and tributaries on Thai side from Ban Dan to Nakon

Table 1. Meristic characters of some mastacembelid species found in Burma and Thailand. See definition of vertebral counts and other remarks under Methods and materials.

|                         | Dorsal fin spines    | Dorsal fin rays | Anal fin rays | Pectoral fin rays | Caudal fin rays | Predorsal vertebrae | Abdominal vertebrae | Caudal vertebrae | Total vertebrae                    |
|-------------------------|----------------------|-----------------|---------------|-------------------|-----------------|---------------------|---------------------|------------------|------------------------------------|
| <i>Macragnathus</i>     |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| <i>M. meklongensis</i>  |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Kwae Noi                | 14(2), 15(2), 16(1)  | 50–54           | 48–52         | 22–23             | 16–19           | 19–21               | 32–34               | 42–45            | 76(1), 77(2), 78(2)                |
| <i>M. semiocellatus</i> |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Bung Borapet            | 31–32                | 49–57           | 53–62         | 23–24?            | 10–11           | 4–5                 | 30                  | 43–44            | 73(3), 74(3)                       |
| Thanyaburi              | 30–31                | 51–56           | 56–59         | 24                | 12–13           | 4–5                 | 29–31               | 43–44            | 73(2), 74(2), 75(1)                |
| Ubon Ratchatani         | 28–31                | 46–58           | 54–65         | 22–24             | 11–13           | 4–6                 | 29–30               | 41–45            | 71(8), 72(15), 73(6), 74(2), 75(1) |
| Bao Cat                 | 29                   | 55              | 59            | 23?               | 11              | 5                   | 30                  | 42               | 72                                 |
| <i>M. siamensis</i>     |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Ubon Ratchatani         | 16                   | 53              | 49            | 21–23             | 15              | 18                  | 33                  | 42               | 75                                 |
| <i>M. zebrinus</i>      |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Hlegu                   | 29                   | 52              | 48            | 18                | 19              | 4                   | 30                  | 42               | 72                                 |
| Rangoon                 | 29–30                | 51–54           | 53–59         |                   | 18–19           | 5                   | 31–32               | 41–43            | 73(2), 74(3)                       |
| <i>Mastacembelus</i>    |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| <i>M. alboguttatus</i>  |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Salween                 | 35(4)                | 73              | 74            | 25?               | 21              | 5                   | 36                  | 46               | 82(1)                              |
| <i>M. armatus</i>       |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Indus                   | 36(1), 38(5)         | 77–82           | 74–83         | 24                | 18–21           | 5                   | 42–44               | 51–53            | 93(1), 95(5)                       |
| Chitawan                | 37(2), 40(1)         | 73–78           | 76–79         | 26                | 17–18           | 4                   | 40–43               | 52–56            | 95(1), 96(2), 98(1)                |
| Bengal, Ganges          | 37(1), 38(1), 39(1)  | 77–80           | 77–81         | 24–26             | 18–20           | 4                   | 42–44               | 52–54            | 94(1), 95(1), 98(1)                |
| Sri Lanka               | 36(3), 37(1)         | 67–77           | 67–75         |                   | 15–19           | 4                   | 39                  | 49–52            | 88(1), 90(1), 91(2)                |
| Bung Kla                | 34                   | 80              | 77            | 25                | 15 or 16        | 4                   | 37                  | 50               | 87                                 |
| Tapi                    | 37(1), 38(4)         | 74              | 76            | 24–25             | 16              | 4                   | 40–41               | 50–51            | 91(2)                              |
| <i>M. dayi</i>          |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Rangoon                 | 35(3)                | 77–82           | 76–79         | 24(2)             | 25–27           | 5                   | 37–38               | 47–49            | 85(1), 86(2)                       |
| <i>M. favus</i>         |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Ubon Ratchatani         | 36                   | 73              | 71            | 24–26             | 15              | 4                   | 39                  | 47               | 86                                 |
| Rayong                  | 33(1), 35(1)         | 74              | 71            | 28–29             | 14              | 4                   | 38                  | 49               | 87(1)                              |
| Goh Kut                 | 35(11), 36(4), 37(1) | 77–84           | 77–82         | 28–29             | 12–15           | 4–5                 | 38–40               | 50–53            | 89(4), 90(5), 91(7)                |
| Pahang                  | 36                   | 85              | 87            | 25                | 14              | 5                   | 39                  | 53               | 92                                 |
| Tapi                    | 34(1), 36(1)         | 82              | 80            | 25                | 17?(1)          | 4                   | 40                  | 51               | 91(1)                              |
| <i>M. oatesii</i>       |                      |                 |               |                   |                 |                     |                     |                  |                                    |
| Inle                    | 34(2)                | 56–60           | 60–61         | 25–27             | 22              | 4                   | 36–37               | 43               | 79(1), 80(1)                       |

Phanom, Mekong River Survey team, March–April 1975. No collection locality: NIFI 01673, 7: 76.7–97.1 mm.

**Diagnosis.** A *Macrogathus* with 28–32 dorsal fin spines; predorsal vertebrae usually only 4–5 (6 in a single specimen); rostral toothplates absent; rim of anterior tubular nostril with 4 nearly equal digitiform processes (or 2 fimbriae and 2 fimbrules); dorsal, anal, and caudal fins confluent; caudal fin pointed posteriorly (not truncate or round, typically with 5/5 or 6/6 rays (total caudal fin rays 10–13). For additional meristic characters see Table 1.

Dorsal fin origin over middle of appressed pectoral fin; origin of soft-rayed anal fin distinctly more anterior than origin of soft-rayed dorsal fin; pterygiophore of enlarged anal fin spine usually articulating with hemal spine of vertebra 30 (sometimes with that of vertebra 29 or 31), pterygiophore of enlarged (penultimate) dorsal fin spine with neural spine of vertebra 34 or 35; jaws extending posteriorly to below posterior nostril, i.e. falling far short of anterior margin of eye; preorbital spine also failing to reach to below anterior margin of eye; preopercle with two large spines; occipital region of head scaleless but otherwise head including gill covers, cheeks and snout almost entirely covered with scales; about 20 scales between lateral line and spinous dorsal fin; portion of lateral line on body with 31–36 pores, more or less widely spaced, their positions indicated by longitudinal dashes of depigmented skin. One of the specimens from Nakhon Sawan Phanom is a gravid female of 148 mm. The largest eggs are about 1.5 mm diameter. The specimen has a pale or colorless distally rounded genital papilla 1.6 mm long.

Coloration varies greatly in intensity, apparently depending on the clarity of the water inhabited. The majority of specimens are relatively pallid, including all from the large series collected at Ubon Ratchatani. These were presumably caught in the Mun River, which is very muddy. A few lots, on the other hand, are very intensely colored, such as those from Bung Borapet and Srinakarin Reservoir. All of the specimens, no matter how pallid, show traces of a series of roundish, black spots along dorsal fin base. In most specimens these spots have pale outlines, especially dorsally; ventrally, their pale outlines are less distinct and tend to join with the pale

outlines of vertical bars on the body rather than closing around the dark spots. Many specimens, including all with intense coloration, have 16–22 complete or nearly complete narrow vertical bars on body, 8–10 roundish marks along base of soft dorsal fin, some or all continuous with vertical bars on posterior part of body; dorsal surface anterior to spiny dorsal fin sometimes with about 15 transversely oval or figure of eight-shaped marks, or with an irregular pattern of numerous ringed marks. Sometimes pale edges on vertical bars or the bars themselves are barely discernible. In nearly all specimens the abdomen from pectoral fin base to vent is entirely colorless. The only exceptions are the intensely colored specimens from Bung Borapet, three of which have more or less well developed patterns of black and white marks on the abdomen. In one specimen the marks are particularly well developed and form a continuous reticulated network. In *M. circumcinctus* the straight vertical bars on the side of the body invariably extend onto or across the abdomen, never forming a network or reticular pattern.

Color of live specimens at Ubon Ratchatani: overall usually drab greenish or drab yellowish; head and sometimes body with shiny yellowish, greenish, bluish, or bluish-green reflections; abdomen pale, off-white or slightly cream-colored (not yellowish); spots along dorsal fin (forming imperfect ocelli) variable in intensity from relatively faint to very dark (almost black). Base of dorsal fin sometimes orangish. Caudal and anal fins dusky, without markings, sometimes anal fin with a thin black marginal stripe. Pectoral fin from clear to orange-tinted. Color strongly resembles that of *Macrogathus siamensis* which often occurred in the same catch. *M. siamensis* had body usually somewhat darker, less drab, slightly shiny bluish-green; abdomen similarly pale; spots along dorsal fin base more evident, forming perfect ocelli, with central portion always very dark and pale ring more distinct; no vertical bars on side of body.

Prachaya Musikasinthorn, a student at Chulalongkorn University, accompanied me to Ubon Ratchatani and brought two live specimens of *M. semiocellatus* to the aquarium in his home in Bangkok. After several weeks in captivity the two fish spent most of their time completely buried in the moderately coarse sand in the



aquarium, coming out usually only for brief periods late at night.

*Macrognathus semiocellatus* and *M. siamensis* are known to the fishermen and market women of Ubon Ratchatani, who do not distinguish the two species, as “pla lot”. The resemblance due to the similar hues and partially or fully ocellated spots along the dorsal fin base is noteworthy.

Some records of *M. circumcinctus* from Thailand (and all or most from the Mekong basin) are probably based on this species, which is common in museum collections in Thailand. It was decidedly the most abundant mastacembelid species in the fish markets at Ubon Ratchatani during my two visits of several days each in June and July 1985.

***Macrognathus siamensis* Günther, 1861**

*Rhynchobdella aculeata* var. *siamensis* Günther, 1861 (type locality: “Pachebore, Siam”, presumably Petchaburi).

*Macrognathus siamensis*: Roberts, 1980: 389.

**Material examined.** Thailand: NRM TRR/1985260.3001, 5; 90.5–129 mm, market at Ubon Ratchatani (presumably from Mun River); KUMF 1284, 3, Lopburi. Kampuchea: NRM BJO/1935168. 5233, 194 mm Soai Rieng (=Svay Rieng).

For additional meristics and comparisons with other species see Roberts (1980). The species occurs mainly in the Mekong and Chao Phrya basins. It has not been found in the Meklong basin, in Burma, or in peninsular Thailand. The ocelli along the base of the dorsal fin are much larger than those in *M. aral* and the dorsal and caudal fins lack the fine striations seen in *M. aral* and *M. meklongensis* sp. nov. For color of live specimens see comparison with *M. semiocellatus*.

***Macrognathus zebrinus* (Blyth, 1859)**

*Mastacembelus zebrinus* Blyth, 1859: 281 (type locality: Moulmein).

*Macrognathus zebrinus*: Travers, 1984b: 144.

**Material examined.** Burma: NRM MAL/1934484. 5362, 6: 92.1–145 mm, Rangoon; NRM NNN/1936989.5377, 3: 103–107 mm, Rangoon; NRM MAL/1934457.5361, 2: 145–154 mm, Moulmein; NRM MAL/1934427.5387–88, 3: 135–167 mm, Pegu River; NRM MAL/1934809.5385, 161mm, Myitkyina?; NRM NNN/1935139.5382, 2: 117–142 mm, near Mandalay; NIFI 01672, 123 mm, Pegu Division, Kha Yein Chaung 4 mi NE of Hlegu; CAS-SU 35686, Rangoon.

For additional synonymy and other information see Sufi (1956). Meristic data are given in Table 1.

***Mastacembelus* Scopoli, 1777**

*Mastacembelus* Gronovius, 1763: 133 (non-binomial, not available for zoological nomenclature).

*Mastocembelus* Scopoli, 1777: 453 (misspelling of *Mastacembelus* Gronovius; type species: *Ophidium mastacembelus* Solander in Russell, 1794, by absolute tautonymy).

For additional synonymy and discussion of the correct spelling, see Sufi (1956: 105–106).

**Diagnosis.** *Mastacembelus* differs from *Macrognathus* in its larger size and usually more numerous dorsal fin spines, dorsal and anal fin rays, and vertebrae. Several species attain 60–80 cm in length, and all reach at least 40 cm (vs a maximum length of 35 cm or less in *Macrognathus*, some species of which apparently do not exceed 25 cm). Dorsal fin spines 32–40, dorsal fin rays 67–90, anal fin rays 67–86. Predorsal vertebrae 4–6. Total vertebrae, 79–98. Preorbital spine invariably present. Preopercular spines variable, sometimes absent. Anal fin spines invariably 3. Rostrum simple. Rim of anterior nostril with 2 fingerlike processes and 2 flaps. Adductor arcus palatini muscle not inserted on first infraorbital bone.

***Mastacembelus alboguttatus* Boulenger, 1893**

(Fig. 2a)

*Mastacembelus alboguttatus* Boulenger, 1893: 200 (type locality: Sittang River, Burma).

**Material examined.** Thailand, Salween River basin: NIFI 00972 and 01678, 3: 288–351 mm, Menam Pai, Mae Hong Sorn; KUMF 1292, 287 mm, Salween River at Mae Saem Leap?; NRM TRR/1982121.3007, 183 mm, Salween River at Mae Sariang.

This is a very distinctive but poorly known species, with unusual morphology and coloration. The only previously published illustration (Sufi, 1956: fig. 24) is of a specimen with a damaged tail with confluent dorsal, anal, and caudal fins, and gives a very erroneous impression. The five specimens examined by me are in excellent condition. Head exceptionally elongate and slender, jaws extending only about half-way to anterior margin of eye. Dorsal and anal fins entirely separate from caudal fin. Caudal fin large and rounded. Rim of anterior tubular nostril with 2 fimbriae and 2 flaps. Infraorbital spine well developed. Preopercular spines 3–5. Dorsal fin spines 35. Meristic data for the 183-mm specimen are given in Table 1. The 345-mm specimen (NIFI 01678) and 351-mm specimen (NIFI 00972)

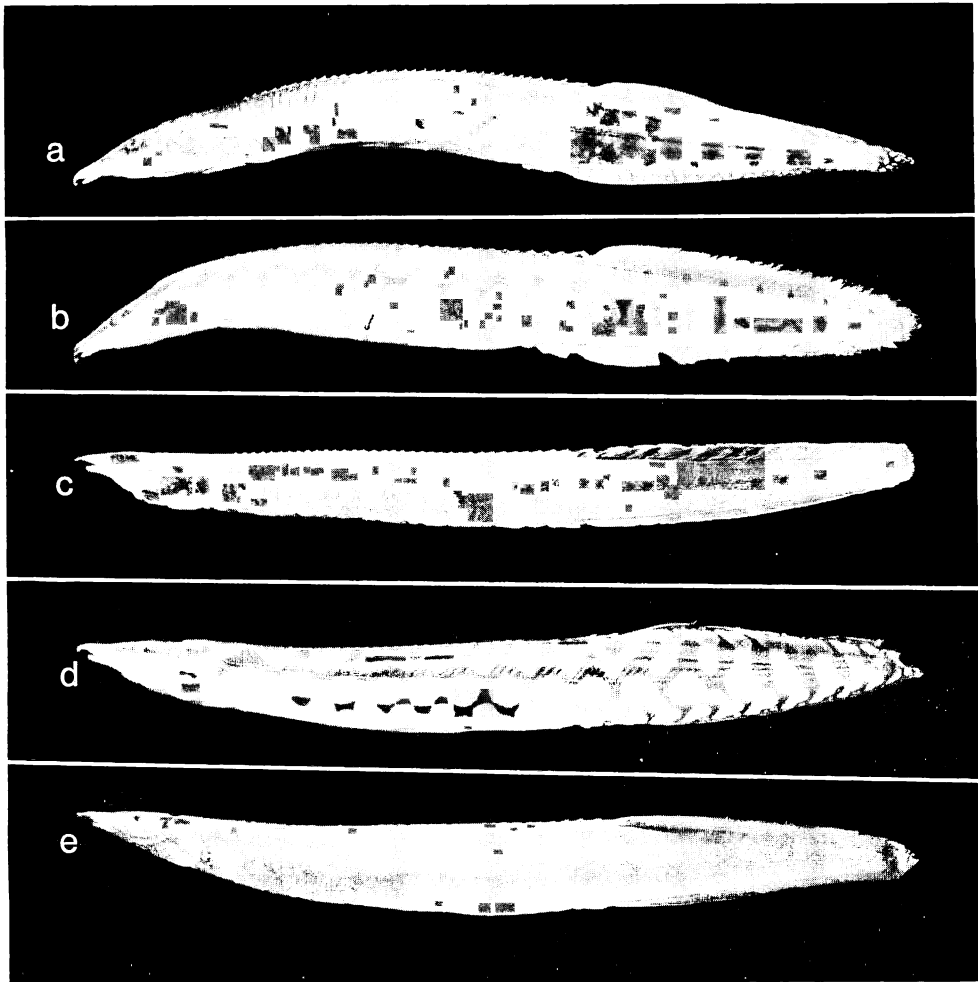


Fig. 2. *Mastacembelus* of Burma and Thailand. a, *M. alboguttatus*, 183 mm, Salween River at Mae Sariang; b, *M. armatus*, 142 mm, Mekong River at Bung Karn; c, *M. armatus*, 342 mm, Tapi basin, Khlong Sok; d, *M. favus*, 165 mm, Ubon Ratchatani; e, *M. favus*, 386 mm, Tapi basin, Khlong Sok.

are gravid females with eggs up to 2.2 and 2.9 mm in diameter respectively.

Coloration in life unknown. Preserved specimens with numerous small round pale spots (white in life?) covering head, body (except abdomen), median fins, and, sometimes, pectoral fins. On body pale spots form rings around larger dusky spots (usually 9 pale spots around each dusky spot). This pattern is remarkably constant and is present on all specimens examined by me. In some specimens pectoral fin with transverse dark bars instead of pale spots.

This species previously was known only from the Sittang River in Burma, so the specimens reported here extend its known range to the

Salween River basin and Thailand. *Mastacembelus alboguttatus* seems to be most similar to *M. dayi*; see comparison under the account of the latter species.

*Mastacembelus armatus* (Lacepède, 1800)  
(Fig. 2b, c)

*Macrogathus armatus* Lacepède, 1800: 286 (type locality unknown).

*Mastacembelus armatus*: Valenciennes in Cuvier and Valenciennes, 1832: 456).

**Material examined.** Pakistan: CAS 24256, 6, Indus River. Nepal: CAS 50217, 3, Chitawan. India: MNHN 5695, 5698, 0699, 3, Ganges, Bengal; NRM MAL/1934073.5389, 4: 245–299 mm. Sri Lanka: CAS-SU 30192, 2. Burma: NRM MAL/1934427.

5387, 158 mm, Pegu River; NRM NNN/1934168.5384, 2: 64.8–100 mm, Putao; NRM NNN/1935989.5381, 2: 143–166 mm, Schwel Kyaung, 24° N, 96° E; NRM NNN/1936989.5378, 13: 70.5–197 mm, Rangoon; NRM NNN/1935139.5383, 5: 93.0–188 mm, Mandalay. Thailand: Salween basin: NIFI 00645–51, 00653–61, 00664–66, 100: 78.3–402 mm. Mekong basin: NIFI 00610, 3: 174–257 mm, Mekong River at Nongkai; NRM TRR/1985277.3008, 142 mm, Mekong River at Bung Kla. Tapi basin: NIFI uncat., NRM TRR/1985145.3009, 5: 342–383 mm, Khlong Sok near Phanom, 90 km W of Surat Thani.

*Mastacembelus armatus* has an extensive synonymy, mostly due to numerous descriptions based on specimens from India (see Sufi, 1956: 134–136, for citations and some discussion). The range includes virtually the entire Indian subcontinent, Burma, Thailand including Chao Phrya and Mekong basins, Laos, Vietnam and Kampuchea (Mekong basin). It occurs in the Thai portion of the Malay Peninsula south to the Tapi River basin. Records from southernmost parts of the Malay Peninsula (West Malaysia) by Sufi (1956) and others are based on other species (Roberts, in press).

For further characterization and discussion of this species see account under *M. favus*.

#### *Mastacembelus dayi* Boulenger, 1912

*Mastacembelus unicolor* Day, 1876: 399 (not of Valenciennes, 1831) (Irrawaddy).

*Mastacembelus dayi* Boulenger, 1912: 200 (type locality: Irrawaddy).

*Mastacembelus unicolor*: Sufi, 1956: 127–130 (in part).

**Material examined:** NRM NNN/1936989.5379, 2: 159–204 mm, Rangoon; NRM NNN/1938999.5376, 306 mm, Rangoon.

This species has not been recognized since its original description by Boulenger (1912) based on the description and figure of a specimen from the Irrawaddy River identified as *M. unicolor* Valenciennes in Cuvier and Valenciennes, 1831 by Day (1876). The three specimens examined are the only specimens known to me.

*Mastacembelus dayi* is close to *M. unicolor* in most meristic characters (Roberts, in press), but differs markedly from it in coloration and in having more numerous caudal fin rays; *M. unicolor* is known only from the southern Malay Peninsula, Sumatra, Borneo, Java, and Banka (Roberts, in press). Reports of *M. unicolor* from Thailand (including the Thai portion of the Malay Peninsula) are based on *M. armatus* or

some other species; the name is occasionally applied to specimens of *M. armatus* in museum collections in Thailand. Meristic characters of the three specimens examined by me are given in Table 1.

*Mastacembelus dayi* is apparently closely related to *M. alboguttatus*. They agree with each other and differ from all other *Mastacembelus* in having 1) an elongate head and very narrow snout; 2) very short jaws, extending posteriorly only about half-way to anterior margin of eye; 3) body and fins with numerous round pale spots. Although the color pattern on the body differs in the two species (see Key), that of the fins is remarkably similar. The two species have similar dorsal fin spine and dorsal and anal fin ray counts, and only small differences in caudal fin ray and vertebral counts (Table 1).

#### *Mastacembelus erythrotaenia* Bleeker, 1850

*Mastacembelus erythrotaenia* Bleeker, 1850: 6 (type locality: Banjermassing, Borneo).

*Mastacembelus argus* Günther, 1861: 542 (type locality: freshwaters of Siam). See Sufi, 1956: 130–131.

This species, adults of which are brilliant red and black (hence the aquarium trade-name “fire-eel”) and attain up to 80 cm in length, is distributed in Thailand, West Malaysia, Sumatra, and Borneo. It has not been reported from Burma.

#### *Mastacembelus favus* Hora, 1923

(Fig. 2d, e)

*Mastacembelus armatus* var. *favus* Hora, 1923: 180 (type locality: Nontaburi=Chao Phrya near Bangkok).

*Mastacembelus favus*: Fowler, 1937: 222.

*Mastacembelus armatus favus*: Smith, 1945: 64.

*Mastacembelus armatus*: Sufi, 1956: 134–138 (in part).

**Material examined.** Thailand: Mekong basin: NIFI 01044, 6, Kwaee Noi. Chao Phrya basin: NIFI 00609, 3; KUMF 1297, 2: 110–124 mm, Lopburi market; KUMF 2674, 2: 175–252 mm, Sukotai; KUMF 2730, 160 mm, Phitsanulok; KUMF 1294, 1295, 1298, 8: 86.0–224 mm, Nong Bong Ngu, Rajburi; KUMF 1296, 2: 143, 151 mm, Chiangmai. Chantaburi River: NIFI 00608, 1. Mekong basin: NIFI 01529, Khon Kaen, 1; NRM TRR/1985260.3010, 3: 142–165 mm, Ubon Ratchatani market (presumably caught in Mun River near Ubon Ratchatani). Rayong: CAS 52670, 2. Goh Kut: CAS 52675, 16. Tapi basin: NRM TRR/1985145.3011, 386 mm, Khlong Sok near Phanom, 90 km west of Surat Thani; NIFI 00178, 2,

Surat Thani. Pattani basin: NIFI 01482, 3. Western Malaysia: CAS-SU 39407, 1. Pahang; CAS-SU 39508, 1, Perak River. Vietnam or Kampuchea: NRM BJO/1938989.3007, 71 cm.

*Mastacembelus favus* has had a brief but checkered nomenclatural history. It has not been recognized since Sufi placed it as a synonym of *M. armatus* and is not mentioned by Travers (1984a, b). Having examined extensive material in museum collections, and even more material in the field, I believe *M. armatus* and *M. favus* are closely related but distinct species differing in meristics, coloration, and body depth (or girth). Radiographs have been taken of too few specimens to permit a thorough analysis of meristic characters; data from these radiographs is presented for both species in Table 1. Counts of dorsal fin spines, however, are available for many specimens. These reveal that *M. armatus* generally has a higher number of dorsal fin spines. The frequency of dorsal fin spines for 67 specimens of *M. armatus* (from throughout its range) is as follows: 34(1), 35(2), 36(14), 37(17), 38(26), 39(6), 40(1). The frequency of dorsal fin spines in 67 *M. favus* is 33(1), 34(8), 35(26), 36(28), 37(4). To summarize, in *M. armatus* dorsal fin spines range from 34–40 (average 37.3) and in *M. favus* from 33–37 (average 35.2).

Much more striking are differences of coloration and size related to depth or girth of body. *Mastacembelus armatus* is highly variable in coloration. A few specimens have almost no color pattern at all, and are almost uniformly dark. Most specimens have a longitudinally oriented zig-zag pattern extending the length of the body. The number of zig-zagging longitudinal lines varies from one to several. When one is present, it may be complete (i.e. continuous) or broken up in various ways. When several lines are present they may join to form a network. Such lines tend to be restricted to the dorsal two-thirds of the body; usually there are no marks or extensions of the network on the abdomen.

*Mastacembelus favus* invariably has a well developed network, similar but even more pronounced to that seen in maximum development of the network in *M. armatus*, and it usually (almost always) extends over the entire abdomen as well as the entire length of the body. In live fish the pale areas within the network are often bright yellow, especially on the abdomen; such

coloration is not seen in *M. armatus*. Finally, both species attain standard lengths of at least 70 cm, but *M. armatus* is a relatively slender fish while *M. favus* is deeper, and more heavy-bodied, with a much greater girth. The difference in body size is evident in specimens of only about 100 mm, and is more pronounced in large fish. It is very noticeable in specimens of 30–40 cm.

I saw numerous *M. armatus* of 70 to 80 cm standard length caught in the Tungabhadra Reservoir (Krisha River basin) in January 1985, but these were far less in body depth, width and girth than the 71-cm specimen of *M. favus* in the material examined which is the largest and heaviest (although not the longest) of any mastacembelid I have seen. Its greatest depth is 63 mm, width 41 mm, and girth 205 mm (measured about midway between pectoral fin and anal fin origin). The specimen is beautifully preserved, not bloated or abnormal.

The geographical distribution of *M. favus* is quite different from that of *M. armatus*. It is unknown from the Indian subcontinent and Burma (including the Salween basin), but extends southward into Western Malaysia. In Thailand *M. favus* seems to be more abundant than *M. armatus*. In at least some localities the two species are sympatric. Thus in Khlong Sok, a small tributary of the Tapi basin in peninsular Thailand, L. Sonkphan, M. Kottelat, and I obtained two large *M. favus* and five large *M. armatus*.

#### *Mastacembelus oatesii* Boulenger, 1893

*Mastacembelus oatesii* Boulenger, 1893: 199 (type locality: Fort Stedman, Inle Lake).

**Material examined.** NRM MAL/1934378.5220–21, 2: 255–299 mm, Inle Lake, Taungdo.

This large species (attaining 370 mm according to Annandale, 1918), is distinguished from all other *Mastacembelus* (*sensu* Travers) by substantially lower counts of dorsal and anal fin rays and vertebrae. Dorsal rays only 48–56 and anal rays only 46–60 (other *Mastacembelus* with dorsal and anal rays usually 70 or more). Vertebrae 79–80 (other *Mastacembelus* usually with 85 or more vertebrae). The caudal fin ray count 21–22, is high (*Mastacembelus alboguttatus*, *M. dayi*, and *M. unicolor* are the only other species with as many [or more] caudal fin rays). Meristic characters of the two specimens examined by me are

given in Table 1.

Rim of anterior nostril with 2 stubby fingerlike projections and 2 low-lying flaps; dorsal and anal fins narrowly joined to caudal fin near its base; caudal fin large, rounded; preorbital spine present, extending posteriorly to below anterior margin of eye; preopercular spines absent; head relatively broad and short-snouted; upper lip uniform in width, not greatly expanded.

The species is known only from Inle Lake.

### Discussion

Our concept of the mastacembeline genus *Macrogathus* has changed substantially in recent years. It was generally considered to comprise a single species, *M. aculeatus*, defined by the presence of a greatly enlarged fleshy rostrum with a concave ventral surface lined with a long series of tooth-bearing paired bony plates (rostral toothplates). In 1980 I presented evidence that *M. aculeatus* auctorum comprised at least three and possibly as many as five species (Roberts, 1980). In this paper it was pointed out that these species and several of the smaller Asian species of *Mastacembelus* differed from other mastacembelids in having the rim of the tubular anterior nostril with 6 fimbriae rather than 2 fimbriae and 2 fimbrules. Travers (1984a, b) expanded the generic concept of *Macrogathus* to include all of the species with 6 fimbriae, and gave additional characters to support this new concept, notably the apparently uniquely derived insertion of a large anterior portion of the adductor arcus palatini muscle on the infraorbital 1. As understood by Travers, *Macrogathus* thus embraced some 11 species, most of which lack rostral toothplates.

Travers' basic concept of *Macrogathus* is accepted here, but the generic definition must be expanded again to include a new species, *Macrogathus semiocellatus*. This species differs from all previously known *Macrogathus* in having 1) rim of anterior nostril with 2 fimbriae and 2 flaps (or 4 almost equal digitiform processes); and 2) predorsal vertebrae usually 4 or 5 (rarely 5) (vs 6 or more). These characters presumably represent the more primitive condition than that found in the other species of *Macrogathus* because they are shared with most other mastacembelids.

Two lesser portions of the phylogeny of Asian

mastacembelids proposed by Travers (1984b, cladogram in fig. 19 and accompanying discussion) may be commented upon. These are his species group D of *Mastacembelus* and species group E of *Macrogathus*. Travers considered species group D an unresolved polychotomy with six species, *Mastacembelus armatus*, *M. erythrotaenia*, *M. mastacembelus*, *M. oatesii*, *M. unicolor* and (tentatively) *M. alboguttatus*. I believe that no fewer than 10 species should be recognized, and that they can be divided into at least two species groups. At the species level, the most difficult problem involves the *M. armatus* species complex or "super-species", including three species which have not been generally recognized. One of these, *M. favus*, is treated in this paper, the other two in my monograph on fishes of Western Borneo (Roberts, in press). *Mastacembelus erythrotaenia* is apparently closely related to this species group. A second quite distinct species group includes *Mastacembelus alboguttatus* and *M. dayi*; perhaps *M. oatesii* and *M. unicolor* also belong here. It is unclear whether the Mesopotamian *M. mastacembelus* belongs with one of these species groups.

In species group E of *Macrogathus*, also regarded as an unresolved polychotomy, Travers placed six species, *Macrogathus guentheri*, *M. keithi*, *M. perakensis*, *M. circumcinctus*, *M. caudiocellatus*, and *M. maculatus*. I have examined specimens and radiographs of all of these. Some of these observations and conclusions based on them will be reported elsewhere (Roberts, in press), including the placement of *M. perakensis* as a junior synonym of *M. maculatus*. The latter species, together with *M. guentheri* and *M. circumcinctus*, forms a species group, the *M. maculatus* species group or superspecies, defined by the uniquely derived character of an elongate genital papilla (ovipositor?) in ripe females. This genital papilla is usually darkly pigmented and up to 8 mm long. I have observed it in ripe females of all three species. The three species also exhibit similarities in coloration, similarly high counts of dorsal fin spines, dorsal and anal fin rays, and vertebrae, and confluent dorsal, anal, and caudal fins. *Mastacembelus keithi* and *M. caudiocellatus* lack these characteristics and do not seem particularly closely related to each other or to other species.

### Conclusion

The genus *Macrogathus* seems to be a monophyletic unit defined by specializations of the snout, notably the apparently uniquely derived character of the adductor arcus palatini muscle inserting on the first infraorbital bone (=spinous preorbital bone) (Travers, 1984a, b). This genus includes species with a relatively simple rostrum and also species with an extraordinarily specialized rostrum, ventrally excavated and lined with a long series of paired tooth-bearing, bony plates. The latter group appears to constitute a well defined monophyletic unit of at least four and possibly six species defined by marked posterior displacement of the spinous dorsal fin (accompanied by reduction of dorsal fin spines to 13–23 and increase in predorsal vertebrae to 11–21) and absence of preorbital spines, as well as by the rostral toothplates. This group includes *Macrogathus aculeatus*, type species of *Macrogathus*, but due to the expansion of the genus to include species without rostral toothplates it lacks a formal name. It may be referred to as the “group of *Macrogathus* with rostral toothplates”. The *Macrogathus* which lack rostral toothplates comprise eight species. Of these, *M. maculatus*, *M. guentheri*, and *M. circumcinctus* form a species group defined by presence of an enlarged genital papilla on gravid females. *Macrogathus zebrinus* and *M. pancalus* appear to form a second species group. Travers (1984a, b) has evidence that this group is most closely related to the group of *Macrogathus* with rostral toothplates. Finally, the relationships of *M. caudiovittatus*, *M. keithi*, and *M. semiocellatus* are unclear, but they do not seem each other’s closest relatives. *Macrogathus semiocellatus* differs from all other *Macrogathus* in having the rim of the anterior nostril with 2 fimbriae and 2 flaps, and in its slightly more numerous dorsal fin spines; it also differs from all other *Macrogathus* except the *M. maculatus* species group in having confluent dorsal, anal, and caudal fins. These characters suggest that *M. semiocellatus* may be closest to the ancestral stock of *Mastacembelus* from which the more specialized genus *Macrogathus* presumably evolved.

The biological significance of the remarkable specializations found in *Macrogathus* are unknown and can only be surmised, but there are

indications that *Macrogathus* have a very different life style from that of *Mastacembelus*. *Macrogathus* are relatively small species, and at least some of them (including *M. semiocellatus*) are burrowers. Burrowing is evidently involved in hiding or escaping predation, but the extent to which these fishes move around and whether they feed “underground” are unknown. Burrowing has not been reported for any of the species now referred to *Mastacembelus*.

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### Literature cited

- Annandale, N. 1918. Fish and fisheries in the Inle Lake. Rec. Ind. Mus., 14: 33–64.
- Bleeker, P. 1850. Bijdrage tot de Kennis der Notacanthini van den Soenda-Molukschen Archipel. Ver. Batav. Genootsch., 23: 1–6.
- Bleeker, P. 1865. Sixième notice sur la faune ichthyologique de Siam. Ned. Tijdschr. Dierk., 2: 171–176.
- Bloch, M. E. 1786. Naturgeschichte der ausländischen Fische, 2. Berlin, 160 pp., 36 pls.
- Bloch M. E. and J. G. Schneider. 1801. Systema ichthyologiae iconibus CX illustratum. Bibliopolio Sandriano Commisum, Berlin, lx+584 pp., 110 pls.
- Blyth, E. 1859. Report of Curator, Zoological Department, for May, 1858. J. Asiat. Soc. Bengal, 1858: 281–290.
- Boulenger, G. A. 1883. List of the fishes collected by Mr. E. W. Oates in the Southern Shan States, and presented by him to the British Museum. Ann.

- Mag. Nat. Hist., Ser. 12, 6: 198–203.
- Boulenger, G. A. 1912. A synopsis of the fishes of the genus *Mastacembelus*. J. Acad. Nat. Sci. Philad., Ser. 15, 2: 197–203.
- Cuvier, G. A. and A. Valenciennes. 1832. Histoire naturelle des poissons. Vol. 8. F. G. Levralt, Paris, 509 pp.
- Day, F. 1876. The fishes of India; being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma, and Ceylon. Vol. 1. London, xx+788 pp.
- Fowler, H. W. 1937. Zoological results of the third de Schauensee Siamese Expedition. Part 7. Fishes obtained in 1935. Proc. Acad. Nat. Sci. Philad., 87: 509–513.
- Gronovius, L. T. 1763. Zoophylacium Gronovianum. 1. Leiden.
- Günther, A. 1861. Catalogue of the acanthopterygian fishes in the Collection of the British Museum. 3. Trustees, British Museum, London, 586 pp.
- Hora, S. L. 1923. On a collection of fish from Siam. J. Siam Soc., Nat. Hist., Suppl. 6: 143–184.
- Hora, S. L. 1924. Zoological results of a tour in the Far East. Fishes of the Talé Sap, Peninsular Siam. Part 1. Mem. Asiat. Soc. Bengal, 6: 463–476.
- Jordan, D. S. 1917. The genera of fishes, from Linnaeus to Cuvier, 1758–1833; seventy-five years, with the accepted type of each. A contribution to the stability of scientific nomenclature. Leland Stanford University Publications, University Series, 161 pp.
- Lacepède, B. 1800. Histoire naturelle des poissons. 2. Paris, lxiv+632 pp., 20 pls.
- Roberts, T. R. 1980. A revision of the Asian mastacembelid fish genus *Macrognathus*. Copeia, 1980(3): 385–391.
- Roberts, T. (In press.) The freshwater fishes of Western Borneo (Kalimantan Barat, Indonesia). Mem. Calif. Acad. Sci.
- Scopoli, J. A. 1777. Introductio ad historiam naturalem, . . . leges naturae. Prague, x+506 pp.
- Smith, H. M. 1945. The fresh-water fishes of Siam, or Thailand. U. S. Natn. Mus., Bull. 188: i-xi+1–622.
- Sufi, S. F. K. 1956. Revision of the oriental fishes of the family Mastacembelidae. Bull. Raffles Mus., 27: 93–146.
- Travers, R. A. 1984a. A review of the Mastacembeloidei, a suborder of synbranchiform teleost fishes. Part I: Anatomical descriptions. Bull. Brit. Mus. (Nat. Hist.), Zool., 46(1): 1–133.
- Travers, R. A. 1984b. A review of the Mastacembeloidei, a suborder of synbranchiform teleost fishes. Part II: Phylogenetic analysis. Bull. Brit. Mus. (Nat. Hist.), Zool., 46(2): 83–150.
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ビルマとタイのトゲウナギ科魚類の分類学的再検討

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ビルマとタイには 14 種のトゲウナギ科魚類が生息している。8 種は *Macrognathus* 属に、6 種は *Mastacembelus* 属に分類される。前者のうち 2 種はタイから発見された新種である。*Mastacembelus dayi* はビルマのみから知られており、*M. alboguttatus* に近縁である。タイとマレーシア西部に分布する *Mastacembelus favus* は近縁の *M. armatus* から明瞭に識別できる。