

TWO NEW SPECIES OF CATFISHES OF THE GENUS *CLARIAS* FROM BORNEO (TELEOSTEI: CLARIIDAE)

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ABSTRACT. - Two new species of the catfish *Clarias* are described from Borneo. *Clarias planiceps*, new species, from the Kapit and Kapuas River drainages in western Borneo and the Kayan River drainage in eastern Borneo, can be differentiated from all other Southeast Asian clariids by a combination of an extremely flattened head, presence of relatively large and distinct serrations on anterior edge of pectoral spine and lighter body coloration with smaller and fainter spots. *Clarias anfractus*, new species, from the Kalabakan and Segama River drainages in northeastern Borneo, can be differentiated from all other Southeast Asian clariids by a combination of a pectoral spine with an irregular outline, a pear-shaped genital papilla in males with the genital opening exposed at the tip and relatively large white spots on the sides of the body. *Clarias leiacanthus* Bleeker, 1851 is found to be a subjective senior synonym of *C. teijsmanni* Bleeker, 1857.

KEY WORDS. - *Clarias*, Borneo, Clariidae, new species.

INTRODUCTION

Catfishes of the genus *Clarias* are characterized by their anguilliform body, long dorsal and anal fins, flattened bony head and a broad mouth with 4 pairs of barbels. They have an accessory air-breathing organ that allows them to survive out of water for some time. *Clarias* is distributed throughout Africa, Asia Minor, India, Southeast Asia, China and Japan. Seventeen nominal species of *Clarias* have been reported to occur in Southeast Asia, viz. **Clarias batrachus* (Linnaeus, 1758), **C. batu* Lim & Ng, 1999, *C. cataractus* (Fowler, 1939), **C. fuscus* (La Cepède, 1803), *C. gilli* Smith & Seale, 1906, *C. jagur* Hamilton, 1822, **C. leiacanthus* Bleeker, 1851a, **C. macrocephalus* Günther, 1864, *C. magur* (Hamilton, 1822), **C. meladerma* Bleeker, 1846 (also variously spelled as *C. melanoderma*, *C. melasoma* and *C. melanosoma*), **C. nieuhoftii* Valenciennes, in Cuvier & Valenciennes, 1840, **C. olivaceus* (Fowler, 1904), *C. pentapterus* Bleeker, 1851b, *C. pulcher* Popta, 1904, *C. punctatus* Valenciennes, in Cuvier & Valenciennes, 1840, *C. thienemanni* Ahl, 1934 and

**C. teijsmanni* Bleeker, 1857. Seven are currently recognized as valid (marked with an asterisk in the above list). *Clarias magur* and *C. punctatus* have been synonymised with *C. batrachus* (cf. Bleeker, 1858); *C. pulcher* is considered a junior synonym of *C. teijsmanni* (cf. Weber & de Beaufort, 1913) and *C. gilli* and *C. pentapterus* have been synonymised under *C. nieuhoftii* (cf. Bleeker, 1858; Weber & de Beaufort, 1913; Fowler, 1941). *Clarias fuscus* is a Chinese taxon; one record from the Philippines (Fowler, 1941) is probably a misidentification. *Clarias jagur* is a synonym of *C. batrachus* based on Indian material (Hora, 1936) and the report of its presence in Southeast Asia by von Martens (1876) seems to be based on a misidentification (Weber & de Beaufort, 1913). Clearly, there is much scope for taxonomic work in this genus and a critical revision is sorely lacking.

During the last few years, several specimens of *Clarias* have been collected from the upper reaches of the Kapit River drainage in Sarawak and from the upper reaches of the Segama River drainage in Sabah. Comparison of these specimens with all other nominal species of Southeast Asia *Clarias* reveal several unusual characteristics and both the populations are described as new species below. The identity of *C. leiakanthus* is also clarified.

MATERIALS AND METHODS

The following abbreviations are used: HL, head length; HW, head width; SL, standard length. The measurements used here are point to point and follow Teugels (1986) except for standard length, which is measured from the tip of snout to the posterior margin of the hypural complex, and head depth (for which a more explicit reference point is needed), which is measured at the tip of the occipital process. Barbel length is measured from the base to the tip. Measurements of bilateral characters, such as pectoral spine length and pelvic fin length, were made on the left side of the body.

Fin ray counts were obtained under a binocular dissecting microscope using transmitted light. Vertebral counts were taken from radiographs (which were obtained using a Hitex HAC-60 x-ray radiography system) following the method of Roberts (1994). Numbers in parentheses following a particular count are the numbers of examined specimens with that count. Drawings of the specimens were made with a Nikon SMZ-10 camera lucida. Institutional codes follow Eschmeyer (1998).

TAXONOMY

Clarias anfractus, new species

(Fig. 1a, 2a)

Clarias teysmanni - Inger & Chin, 1962: 131, fig. 65 (in part).

Clarias teijsmanni (non Bleeker, 1857) - Martin-Smith, 1998: 475; Martin-Smith & Tan, 1998: 591.

Holotype - ZRC 42598, 176.4 mm SL; Borneo: Sabah, Danum, forest stream 600 m into conservation area, tributary of Sungai Segama; H. H. Tan & Y. Y. Goh, 4 Oct.1996.

Paratypes - FMNH 68095, 2 ex., 166.3-172.1 mm SL; Borneo: Sabah, Tawau District, Kalabakan, Sungai Tibas camp, Sungai Tawan, 4°25'N 117°28'E; R. F. Inger, 6 Jun.1956. - FMNH 68096, 1 ex., 204.2 mm SL; Borneo: Sabah, Tawau District, Kalabakan, Sungai Tibas camp, Sungai Tawan, 4°25'N 117°28'E; R. F. Inger, 8 Jun.1956. ZRC 43392, 2 ex., 140.4-151.9 mm SL; data as for holotype.



Fig. 1. a. *Clarias anfractus*, ZRC 43392, paratype, 140.4 mm SL; Borneo: Segama River drainage; b. *C. planiceps*, paratype, ZRC 37800, 90.0 mm SL, Borneo: Rajang River drainage; c. *C. leiacanthus*, ZRC 37758, 112.8 mm SL, Borneo: Sarawak.

Diagnosis. - *Clarias anfractus* is distinguished from all other presently recognized Southeast Asian *Clarias* by a combination of its pectoral spine with (vs. without) an irregular outline (Fig. 2), a pear-shaped genital papilla in males with the genital opening exposed at the tip (Fig. 3) and having relatively large white spots on the sides of the body (Fig. 4).

Description. - Body relatively short, cylindrical; in %SL (measured in 4 specimens): body depth at anus 11.3-15.5, predorsal length 32.9-33.4, preanal length 45.6-50.0, prepelvic length 40.0-43.3, prepectoral length 18.4-21.0, dorsal-fin length 68.4-71.1, anal-fin length 52.9-54.9, pelvic-fin length 8.2-8.8, pectoral-fin length 12.2-14.2, length of pectoral spine 6.6-9.2, distance between occipital process and dorsal fin 7.9-10.7, depth of caudal peduncle 6.4-7.3, caudal-fin length 12.3-15.2, head length 23.3-25.2, head width 16.3-18.4, head depth 11.3-12.5; in %HL: snout length 29.6-35.5, interorbital distance 43.4-47.7, length of occipital process 9.7-11.9, width of occipital process 22.0-28.2. Skin smooth. Lateral line median, beginning just after operculum and ending at caudal peduncle. Openings to secondary sensory canals on body arranged regularly on upper parts of flanks, in vertical branches above lateral line, visible as white spots. Anterior fontanelle short and squat ("sole-shaped" of Teugels, 1986), length 9.8-16.3 %HL, width 3.7-4.9 %HL; anterior edge reaching imaginary line connecting anterior orbital borders. Occipital fontanelle oval, narrower than anterior fontanelle, length 6.8-8.0 %HL, width 2.4-4.1 %HL; posterior edge reaching imaginary line connecting base of pectoral spines. Eye small and subcutaneous, diameter 5.1-6.1 %HL. Four pairs of barbels present, with thick fleshy base, gradually tapering towards tips; length of nasal barbel 72.3-81.7 %HL, length of maxillary barbel 108.2-183.0 %HL, length of inner

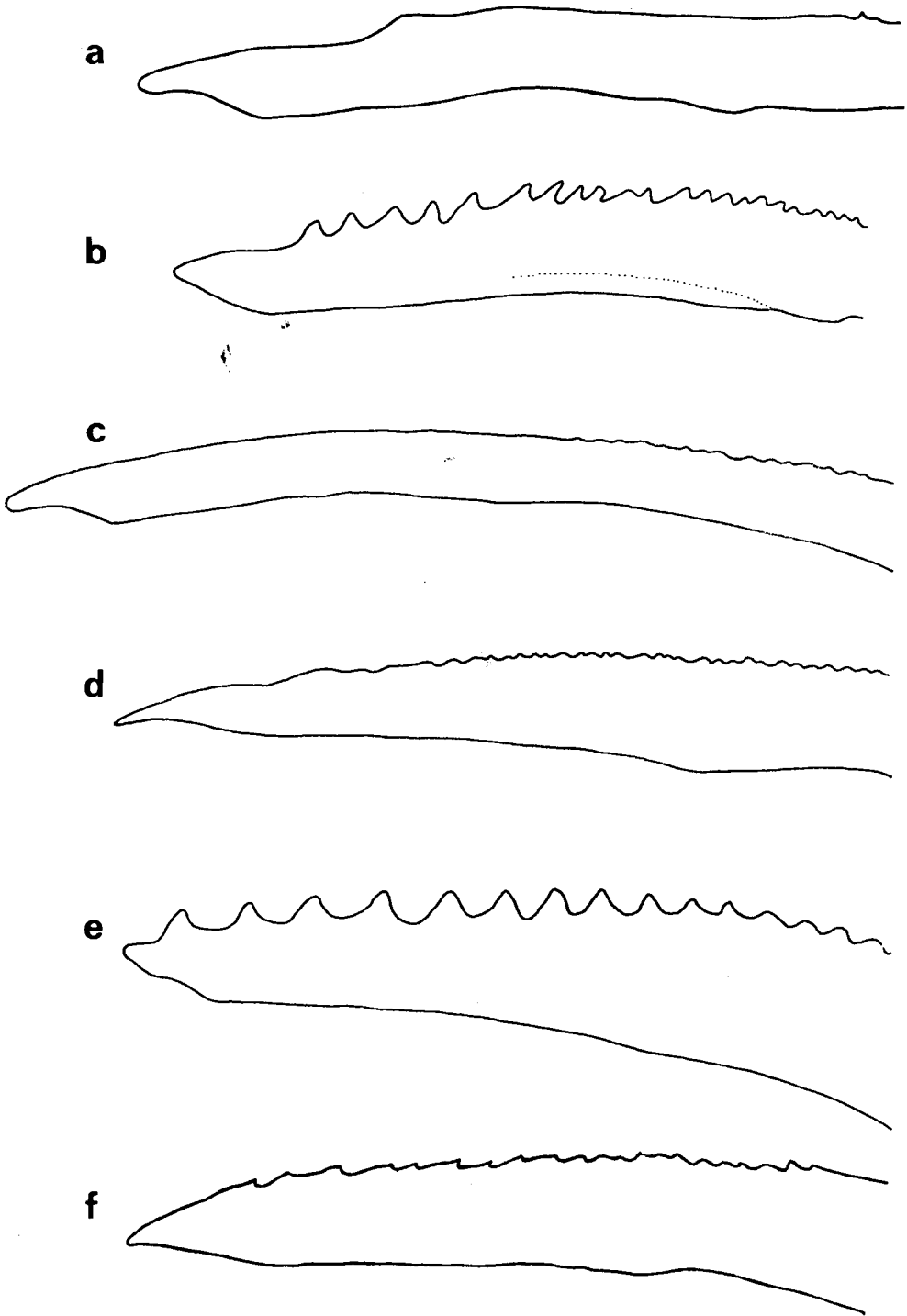


Fig. 2. Schematic illustration of the dorsal view of pectoral spines of: a. *Clarias anfractus*, ZRC 43392, paratype, 140.4 mm SL; b. *C. planiceps*, paratype, ZRC 45544, 145.0 mm SL; c. *C. leiacanthus*, ZRC 37758, 129.5 mm SL; d. *C. leiacanthus*, ZRC 39105, 150.0 mm SL; e. *C. meladerma*, ZRC 38979, 172.8 mm SL; f. *C. olivaceus*, paratype, ANSP 27281, 181.3 mm SL.

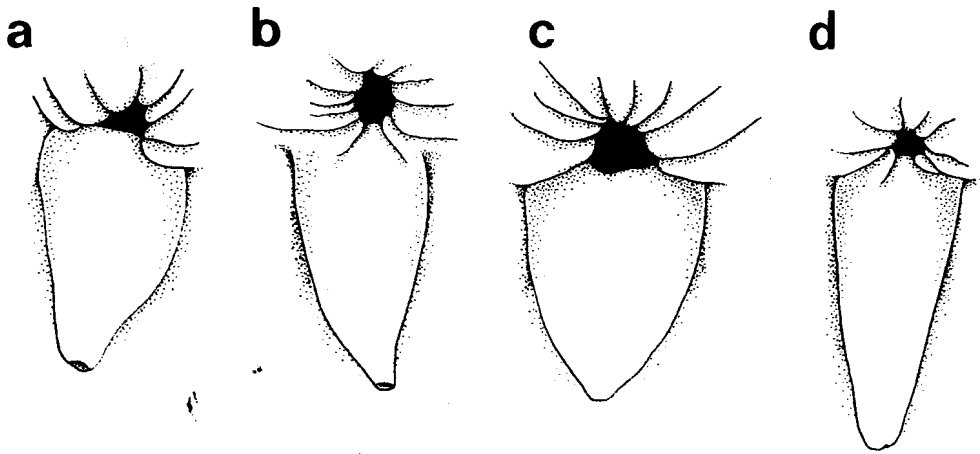


Fig. 3. Schematic illustration of the male genital papilla of: a. *Clarias anfractus*, ZRC 42598, holotype, 176.4 mm SL; b. *C. planiceps*, ZRC 42545, paratype, 246.7 mm SL; c. *C. leiacanthus*, FMNH 68102, 208.6 mm SL; d. *C. olivaceus*, ZRC 43236, 223.8 mm SL. Scale bar indicates 1 mm.

mandibular barbel 64.1-81.9 %HL, length of outer mandibular barbel 99.0-114.7 %HL. Nostril tube long, extending beyond snout margin when directed forwards. Vomerine toothplate slightly longer and narrower than premaxillary toothplate (length of vomerine toothplate 5.1 %HL vs. 4.3 in premaxillary teeth; width 20.5 %HL vs. 25.1; measured in FMNH 68095, 172.1 mm SL); vomerine teeth subgranular, premaxillary teeth villiform. Gill rakers 2+14=16 (1). Branchiostegal rays 8 (4). Vertebral formula 18+44=62 (1), 20+43=63 (1), 21+43=64 (1) or 21+44=65 (1).

Fin-ray counts: dorsal 71 (1), 72 (1), 73 (1) or 77 (1); pectoral I,8 (2) or I,9 (2); pelvic i,5 (4); anal 57 (2), 61 (1) or 62 (1); caudal 8/7 (4). Pectoral spine broad, covered by skin, anterior margin with small inward directed serrae (Fig. 2a); pelvic fin origin at vertical through base of dorsal ray 7; first dorsal-fin ray shortest, last few rays progressively shorter, posterior part rounded, not joined to caudal fin; origin of anal fin at vertical through base of dorsal ray 14-18, first anal-fin ray shortest, last few rays progressively shorter, posterior part rounded, not joined to caudal fin; caudal fin rounded.

Mature males with white, pear-shaped genital papilla with genital opening exposed at tip located anterior to anal fin (Fig. 3). Mature females with round genital protuberance similarly located anterior to anal fin.

Coloration. - Preserved specimens (in 10% formalin) are grey, paler on the undersides. A row of relatively large white spots runs along the body below the lateral line, with another 10-14 transverse rows extending dorsally on the body. Dorsal, caudal and anal fins the colour of the body, pelvic and pectoral fins opaque white to hyaline. Fin rays dusky.

Distribution. - Known from the Segama and Kalabakan drainages in northeastern Borneo.

Habitat and biology. - *Clarias anfractus* inhabits slow pools of forested fast-flowing streams with a substrate of mud and soil with substantial amounts of leaf debris. The fish were usually found living in holes in the substrate. In the Segama River drainage, it is found syntopically with *Anguilla malgumora*, *Nematabramis everetti*, *Puntius sealei*, *Rasbora sumatrana*, *Hemibagrus* sp. and *Betta ocellata*.

Etymology. - From the Latin "anfractus" (=twisted or crooked), in reference to the shape of the pectoral spine. Used as a noun in apposition.

***Clarias planiceps*, new species**

(Fig. 1a, 2a, 4a)

Clarias teysmanni (non Bleeker) - Rendahl, 1922: 199.

Holotype - SMK uncat., 1 ex., 106.5 mm SL; Borneo: Sarawak, Belakin area, Ulu Sungai Anap; R. Stuebing, 16 Jul.1994.

Paratypes - CMK 11999, 1 ex., 82.8 mm SL; CMK 12000, 1 ex., 130.0 mm SL; ZRC 42543, 1 ex., 117.0 mm SL; data as for holotype. - FMNH 68103, 22 ex., 70.8-210.8 mm SL; Borneo: Sarawak, Third Division, tributary of Baleh River between Sungai Entunau and Sungai Putai; R. F. Inger, 5 Aug.1960. - FMNH 68104, 4 ex., 108.6-147.7 mm SL; Borneo: Sarawak, Third Division, Baleh River, Sungai Putai camp; R. F. Inger, 12 Aug.1956. - FMNH 68105, 8 ex., 88.4-236.1 mm SL; 1 c&s 106.6 mm SL; Borneo: Sarawak, Baleh River, Sungai-Putai camp, Sungai Papu 1°48'N 113°45'E; R. F. Inger, 8 Aug.1956. - FMNH 68569, 1 ex., 135.7 mm SL; Borneo: Sarawak, First Division, Mt. Matang; R. F. Inger, 25 Jul.1956. - FMNH 68926, 18 ex., 46.9-166.4 mm SL; Borneo: Sarawak, Kapit district, Mengiong river; R. F. Inger et al., 22 Sep.1962. - FMNH 68932, 26 ex., 63.5-166.7 mm SL; 1 c&s 100.2 mm SL; Borneo: Sarawak, Kapit District, Mengiong River, Nanga Tekalit camp, Sungai Serbong; Greenberg, Inger & King, 27 Sep.1962. - MZB 6666, 1 ex., 230.0 mm SL; Borneo: Kalimantan Barat, Sungai Embaloh, small stream at mouth of Sungai Tekelan; I. Rachmatika & A. Mun'im, 26 Nov.1996. - USNM 323727, 1 ex., 297.3 mm SL; Borneo: Sarawak, Batang Balui, tributary stream, Batang Belahui; L. R. Parenti, K. Luhah & A. Among, 1 Aug.1991. - USNM 323728, 1 ex., 193.2 mm SL; Borneo: Sarawak, Batang Balui, tributary stream, Long Tow, where it enters Batang Balui, just downstream from logging camp; L. R. Parenti, A. Among, K. Luhah & A. Luhah, 6 Aug.1991. - USNM 323729, 2 ex., 119.3-178.4 mm SL; Borneo: Sarawak, Batang Balui, tributary stream, Batang Luan Paha; L. R. Parenti, K. Luhah & A. Among, 1 Aug.1991. - USNM 323733, 2 ex., 112.1-142.9 mm SL; Borneo: Sarawak, Batang Balui, tributary stream, Batang Luan; L. R. Parenti, K. Luhah & A. Among, 2 Aug.1991. - USNM 323734, 1 ex., 265.2 mm SL; Borneo: Sarawak, Batang Balui, tributary stream, Long Ulu; L. R. Parenti, A. Among, K. Luhah & S. Surat, 5 Aug.1991. - USNM 323736, 1 ex., 146.5 mm SL; Borneo: Sarawak, Batang Balui, tributary stream, Long Tanyit, where it enters Batang Balui; L. R. Parenti, A. Among & K. Luhah, 5 Aug.1991. - USNM 323738, 1 ex., 76.0 mm SL; Borneo: Sarawak, Baleh River, creek entering southern bank, approximately 20 km E of Sut River; L. R. Parenti, M. Zakaria-Ismail & K. Luhah, 24 Jul.1991. - ZRC 37800, 1 ex., 90.0 mm SL; Borneo: Sarawak, Second Division, Lanjak Entimau Wildlife Sanctuary, Sungai Jelian; R. Stuebing, 13 Oct.1993. - ZRC 37809, 1 ex., 193.6 mm SL; Borneo: Sarawak, Second Division, Lanjak Entimau Wildlife Sanctuary, Sungai Engkari; R. Stuebing, 14 Aug.1993. - ZRC 37820, 1 ex., 144.5 mm SL; Borneo: Sarawak, Second Division, Lanjak Entimau Wildlife Sanctuary, Sungai Brauh; R. Stuebing, 10 Oct 1993. - ZRC 45544, 1 ex., 145.0 mm SL; Borneo: Sarawak, Sungai Belakin; R. Stuebing, 16 Jul.1994. - ZRC 42545, 1 ex., 246.7 mm SL; Borneo: Sarawak, Kapit River; don. C. Leh, 1996.

Non-types - FMNH 68106, 1 ex., 166.1 mm SL; FMNH 68107, 6 ex., 18.8-133.1 mm SL; Borneo: Sarawak, Third Division, small boulder pool near Sungai Menuang Ili, c. 1700 ft. a.s.l.; N. S. Haile, Aug.1956. - FMNH 68108, 1 ex., 106.4 mm SL; Borneo: Sarawak, Third Division, Sungai Bunoh near Sungai Balang, 1000 ft. a.s.l.; N. S. Haile, Aug.1956. - FMNH 68109, 1 ex., 116.6 mm SL; Borneo: Sarawak, Third Division, headwaters of the Baleh River; N. S. Haile, Aug.1956. - FMNH 68110, 2 ex., 79.4-135.6 mm SL; Borneo: Sarawak, Third Division, tributary of Baleh river, c. 1000 ft. a.s.l.; N. S. Haile, Aug.1956. - FMNH 96005, 1 ex., 19.0 mm SL; Borneo: Sarawak, Third Division, Baleh river, Sungai Putai camp; R. F. Inger, Aug.1950. - NRM 10273, 1 ex., 178.4 mm SL; Borneo: Kalimantan Timur, Kayan River, Bulungan; C. Lumholtz, 1914.

Diagnosis. - *Clarias planiceps* is distinguished from all other presently recognized Southeast Asian *Clarias* by its flattened head (head depth 59.0-63.8 %HW vs. 64.5-80.2; Fig. 5), presence of relatively large and distinct serrations on the anterior edge of the pectoral spine (vs. without serrations or with anterior edge of pectoral spine rugose; Fig. 2); light purplish-

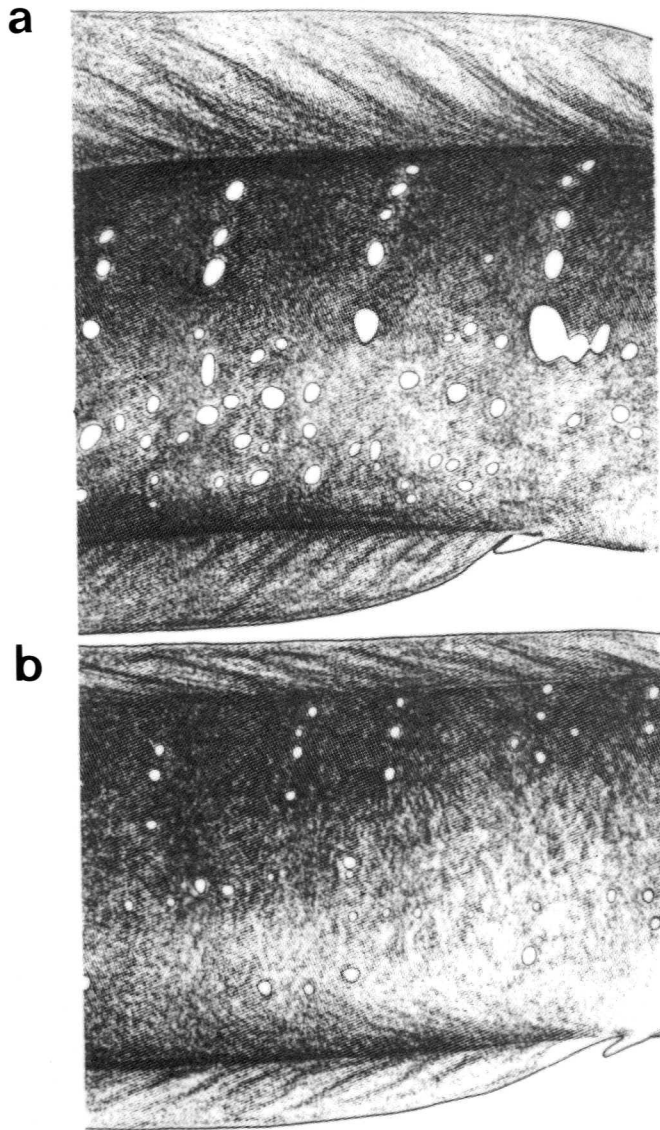


Fig. 4. Schematic illustration of the body colour pattern on the lateral surface of: a. *Clarias anfractus*, ZRC 42598, holotype, 176.4 mm SL; b. *C. leiacanthus*, FMNH 68102, 154.2 mm SL. Scale bar indicates 10 mm.

brown body with small and faint white spots (vs. darker greyish brown body with larger and more well-defined spots).

Description. - Body relatively short, cylindrical; in %SL (measured in 9 specimens): body depth at anus 9.7-13.9, predorsal length 32.1-34.0, preanal length 45.8-50.5, prepelvic length 39.5-43.9, prepectoral length 17.4-21.7, dorsal-fin length 64.2-71.4, anal-fin length 51.4-57.7, pelvic-fin length 6.8-8.4, pectoral-fin length 11.9-14.2, length of pectoral spine 6.8-9.5, distance between occipital process and dorsal fin 6.2-12.2, depth of caudal peduncle 5.9-7.6, caudal-fin length 13.8-17.8, head length 22.6-24.8, head width 15.7-17.6, head depth 9.5-11.5; in %HL: snout length 20.6-28.7, interorbital distance 46.4-49.9, length of occipital

process 8.9-14.0, width of occipital process 24.9-30.9. Skin smooth. Lateral line median, beginning just after operculum and ending at caudal peduncle. Openings to secondary sensory canals on body arranged regularly on upper parts of flanks, in vertical branches above lateral line, visible as white spots. Head extremely flattened (head depth 9.5-11.5 %SL; 59.0-63.8 %HW). Anterior fontanelle short and squat ("sole-shaped" of Teugels, 1986), length 10.5-17.6 %HL, width 3.4-8.0 %HL; anterior edge reaching imaginary line connecting anterior orbital borders. Occipital fontanelle oval, narrower than anterior fontanelle, length 5.4-11.0 %HL, width 2.7-5.9 %HL; posterior edge reaching imaginary line connecting base of pectoral spines. Eye small and subcutaneous, diameter 3.6-8.6 %HL. Four pairs of barbels present, with thick fleshy base, gradually tapering towards tips; length of nasal barbel 84.5-103.5 %HL, length of maxillary barbel 116.9-176.1 %HL, length of inner mandibular barbel 85.9-99.1 %HL, length of outer mandibular barbel 121.0-144.6 %HL. Nostril tube long, extending beyond snout margin when directed forwards. Vomerine toothplate slightly longer and narrower than premaxillary toothplate (length of vomerine toothplate 8 %HL vs. 6 in premaxillary teeth; width 26 %HL vs. 28; measured in ZRC 37800, 193.6 mm SL); vomerine teeth subgranular, premaxillary teeth villiform. Gill rakers 4+16=20 (1). Branchiostegal rays 8 (3). Vertebral formula 21+42=63 (1), 22+43=65 (1) or 23+42=65 (1).

Fin-ray counts: dorsal 68 (2), 70 (1), 72 (1), 73 (2) or 74 (1); pectoral I,8 (1) or I,9 (6); pelvic i,5 (7); anal 58 (1) or 59 (1); caudal 7/8 (1), 8/7 (1), 8/8 (4) or 9/8 (1). Pectoral spine broad, covered by skin, anterior margin with small inward directed serrae (Fig. 2b); pelvic fin origin at vertical through base of dorsal ray 7; first dorsal-fin ray shortest, last few rays progressively shorter, posterior part rounded, not joined to caudal fin; origin of anal fin at vertical through base of dorsal ray 14-18, first anal-fin ray shortest, last few rays progressively shorter, posterior part rounded, not joined to caudal fin; caudal fin rounded.

Mature males with white, pear-shaped genital papilla with genital opening exposed at tip located anterior to anal fin (Fig. 3). Mature females with round genital protuberance similarly located anterior to anal fin.

Coloration. - Preserved specimens (in 10% formalin) are a uniform purplish brown, paler on the undersides. A row of faint and small white spots runs along the body below the lateral line, with another 10-14 transverse rows extending dorsally on the body. The dorsal, caudal and anal fins the colour of the body; pelvic and pectoral fins are opaque white to hyaline. Fin rays are dusky.

Distribution. - Known from the upper reaches of the Rajang and Kapuas Rivers in western Borneo, and the Kayan River in eastern Borneo.

Habitat and biology. - *Clarias planiceps* inhabits slower parts of relatively fast-flowing forest streams having a substrate of sand or mud. About 15 other fish species were obtained together with the paratypes, most of them found only in fast-flowing waters (genera *Paracrossocheilus*, *Gastromyzon*, *Hypergastromyzon*, *Parhomaloptera* and *Glyptothorax*).

Etymology. - The name refers to the extremely flattened head: from the Latin "planus" (= flat) and "-ceps", the Latinized form of the Greek "kephalos" (= head). Used as a noun in apposition.

DISCUSSION

The identification of Southeast Asian *Clarias* species is difficult, compounded by the number of names available. Moreover, morphological characters useful for separating species of African *Clarias* cannot be extrapolated to Southeast Asian *Clarias* for accurate identification. For example, Benech et al. (1993) reported on the use of the shape of the cleithrum to differentiate *C. anguillaris* and *C. gariepinus*, but the shape of the cleithrum of Southeast Asian *Clarias* (see comparative material examined) does not differ significantly in the species examined.

Because the relatively large number of comparisons that need to be made among the new species described here and the nominal species of Southeast Asian *Clarias* would make this discussion unwieldy and difficult for the reader to follow, it becomes necessary to categorize the species into species-groups so that comparisons need only be made among a few species. It is therefore for this convenience that three artificial species-groups of Southeast Asian *Clarias* are recognized herein. The first group has a relatively short body with 60-76 dorsal-fin rays and an extremely short distance (2.1-4.7 %SL) between the tip of the occipital process and the base of the first dorsal-fin ray. This group includes the following nominal species: *C. batrachus*, *C. fuscus*, *C. jagur*, *C. macrocephalus*, *C. magur*, *C. meladerma* and *C. punctatus*. The second group also has a relatively short body, with 62-74 dorsal fin rays but a longer distance (7.1-12.5 %SL) between the tip of the occipital process and the base of the first dorsal-fin ray than the first group. This group includes the nominal species *C. batu*, *C. cataractus*, *C. leiakanthus*, *C. olivaceus*, *C. pulcher*, *C. teijsmanni* and *C. thienemanni*. The third group consists of *C. gilli*, *C. nieuhoftii* and *C. pentapterus* and differs in having a relatively long and slender body, with 87-106 dorsal fin rays and a similar distance (6.6-9.3 %SL) between the tip of the occipital process and the base of the first dorsal-fin ray as the second group. Lim & Ng (1999) characterised this third group as species with a relatively elongate, slender body (body depth at anus 8.7-12.5 %SL), but I find that this character overlaps considerably with those of the other two groups and prefer to define this group by the number of dorsal-fin rays which is unique. When this new character is used, *C. batu* is considered to belong to the second group instead of the third; however, *C. batu* is easily distinguished from all other species of the second group in having more vertebrae (67-71 vs. 60-65; Lim & Ng, 1999).

Both *C. anfractus* and *C. planiceps* belong to the second group in having a short body (with 70-77 dorsal fin rays) and the longer distance between the tip of the occipital process and the base of the first dorsal-fin ray (6.2-12.2 %SL). In this study, the only three species considered valid in this group besides the two described here are *C. batu*, *C. leiakanthus* and *C. olivaceus* (see below). Because of much confusion in the identity and taxonomic status of *C. leiakanthus*, and the difficulty in distinguishing *C. leiakanthus* from *C. teijsmanni* (see Roberts, 1989), a discussion of the taxonomy of *C. leiakanthus* and other nominal species of *Clarias* in the second species-group is necessary before we can make any meaningful comparisons.

Bleeker (1851) described *C. leiakanthus* from a single specimen of 160 mm TL from Sambas, western Borneo and later described *C. teijsmanni* based on a specimen, 110 mm in length, from "Tjikoppo, Provinciae Buitenzorg, 900 metr. supra mare" in Java (Bleeker, 1857: 344-345). Bleeker (1858: 349) later reported another specimen of 203 mm in length which may have been the specimen illustrated in Bleeker (1862), listing Pondokgedeh, Java as a second locality. The specimen of *C. teijsmanni* figured by Bleeker (1862: pl. 99 fig. 1) appears to

have an extremely flattened head, but this may be an artefact as some of his drawings are known to be somewhat schematic, e.g. the drawing of the lateral view of *Encheloclarias tapeinopterus* shows a much flatter head than does the actual specimen (Ng & Lim, 1992). *Clarias leiacanthus* as originally defined by Bleeker (1851: 430-431), was characterized by the presence of a pectoral spine with a rugose anterior edge but without serrations (“...pectoralibus spina ossea superne antice scabriscula non dentata...”) and an occipital process with a rounded tip (“...osse interparietali lato apice rotundato...”). The original description did not mention whether there are any white spots on the body, stating merely “...colore corpore, cirris pinnisque nigro, ventre tantum griseo.”; Bleeker’s later description of *C. leiacanthus* in his Prodrumus (Bleeker, 1858: 347) and Atlas (Bleeker, 1862: 104), however, mentions white spots on the sides of the body (“...lateribus interdum punctis flavicantibus in series transversas dispositis...”), although the accompanying figure (Bleeker, 1862: pl. 98 fig. 1) shows a fish lacking such spots. Examination of the Bleeker material in the BMNH and RMNH shows that faint traces of spots are present on the sides of the body. Comparison with the description of the colour of *C. teijsmanni* (“...dorso lateribusque guttulis luteis vel aurantiacis ex parte in series 11 ad 13 simplices transversas obliquas dispositis ex parte sparsis...”), shows that little significant exists between the colour of the two nominal species. Bleeker (1858, 1862) therefore differentiated *C. teijsmanni* and *C. leiacanthus* chiefly by the shape of their occipital processes (evident by the key he provided and the fact that the only common character mentioned in both species accounts is the shape of the occipital process): *C. leiacanthus* having an occipital process with a rounded tip and *C. teijsmanni* having an occipital process with a pointed tip, a character also used by subsequent authors (e.g. Weber & de Beaufort). However, Teugels (1986) has reported on the variability of the shape of the occipital process, particularly during ontogeny, for African *Clarias* and examination of material identified as *C. teijsmanni* of different sizes from Peninsular Malaysia (ZRC 15393-15396) has shown similar variability for this species of Asian clariid (Fig. 5). The fact that the holotype of *C. leiacanthus* is larger than that of *C. teijsmanni* (160 mm TL vs. 110 mm) may explain the difference in the shape of the occipital process between the species descriptions.

Comparison of the Bleeker specimens of *C. leiacanthus*, fresh material of *C. leiacanthus* obtained from Bako National Park in western Sarawak, which is near the type locality of *C. leiacanthus* (about 100 km from Sambas), the type of *C. teijsmanni*, and fresh topotypes of *C. teijsmanni* show that they do not differ significantly in overall morphology, morphometrics or meristics. I therefore see no valid reason to consider the two nominal species as distinct and consider *C. leiacanthus* to be the senior synonym of *C. teijsmanni*. *Clarias olivaceus*, described from Padang in western Sumatra by Fowler (1904), has been considered a species distinct from *C. leiacanthus* by Ng & Tan (1999). It can be differentiated from *C. leiacanthus* by the presence of relatively large and distinct serrations on the anterior edge of the pectoral spine (vs. without serrations or with anterior edge of pectoral spine rugose which in extreme cases is manifested as a series of low asperities; Fig. 2), uniformly dark body coloration without any pale spots on the body (vs. with pale spots present) and fewer dorsal-fin rays (62-66 vs. 68-74).

Both *C. cataractus* and *C. pulcher* (subjective synonym of *C. teijsmanni* according to Weber & de Beaufort, 1913) are described as having dorsal and anal fins confluent with the caudal fin. This could be an artefact arising from the damage and subsequent healing and regrowth of the caudal region (Deraniyagala, 1932; Lim & Ng, 1999); among African *Clarias* Teugels (1986) has synonymised several nominal species originally recognized on the basis of fused dorsal, caudal and anal fins with species having separate fins. This, together with other

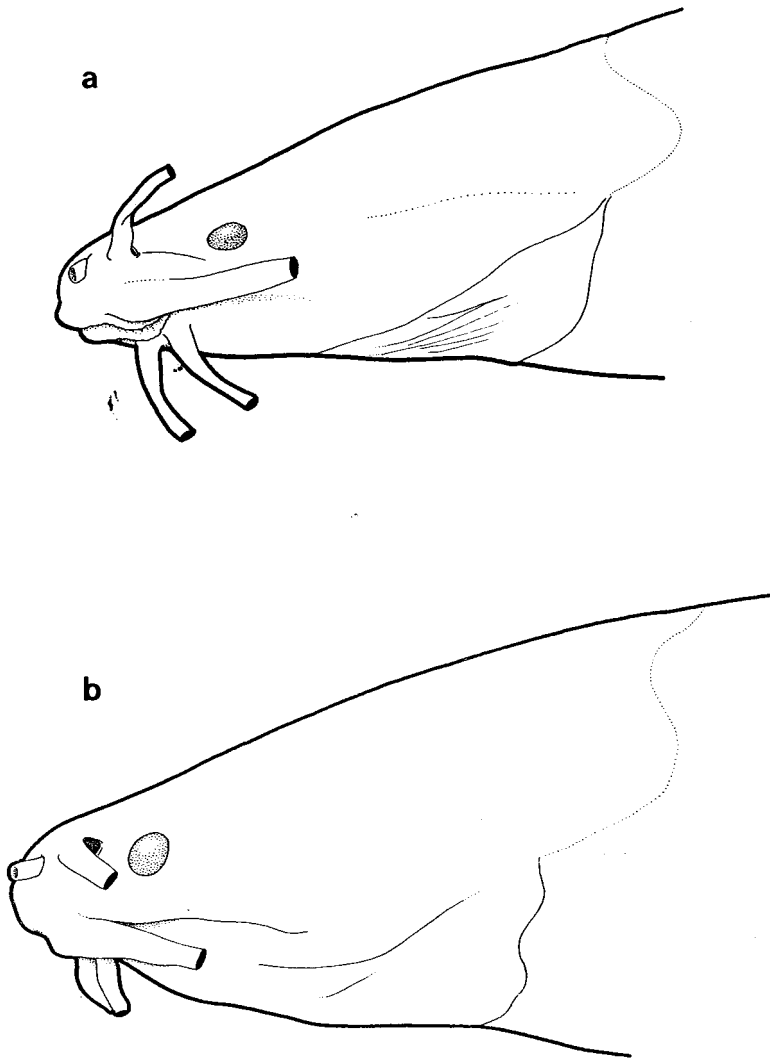


Fig. 5. Schematic illustration of the lateral views of heads of: a. *Clarias planiceps*, holotype, SMK, 106.5 mm SL; b. other Southeast Asian *Clarias* species (*C. leiacanthus*, ZRC 37851, 153.3 mm SL illustrated). Scale bar indicates 1 mm.

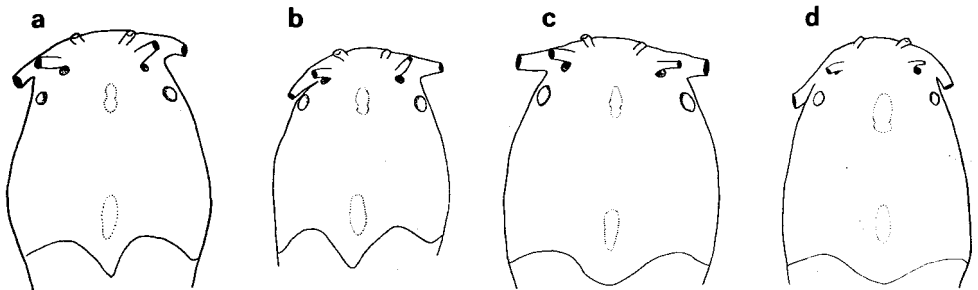


Fig. 6. Schematic illustration of the dorsal view of heads of *C. leiacanthus* showing ontogenetic change in shape of occipital process: a. ZRC 15393, 42.4 mm SL; b. ZRC 15394, 57.5 mm SL; c. ZRC 15395, 76.8 mm SL; d. ZRC 15396, 109.1 mm SL.

morphological characters of *C. pulcher* and *C. cataractus* suggest that Weber & de Beaufort's (1913) synonymy of *C. pulcher* and Lim & Ng's (1999) synonymy of *C. cataractus* with *C. leiakanthus* is justified.

Clarias thienemanni shows no distinct morphometric difference from *C. leiakanthus* and has been listed as a synonym of *C. teijsmanni* (Kottelat et al., 1993), itself a synonym of *C. leiakanthus* (above). The material illustrated as *C. leiakanthus* in Kottelat et al. (1993: Pl. 37; CMK 6868) is actually *C. nieuhoftii*.

As both the new species described here have dorsal-fin ray counts and the distance between the occipital process and the dorsal fin characteristic of the second species-group, comparisons need only be made here with the other members of this group. *Clarias anfractus* can be differentiated from its congeners within this group by its pectoral spine with (vs. without) an irregular outline and larger white spots on the sides of the body (particularly when compared with *C. leiakanthus* from the neighbouring Kinabatangan River drainage in Borneo; Fig. 4). The males of *C. anfractus* and *C. planiceps* have the genital papilla of a different shape from those of *C. leiakanthus* and *C. olivaceus*: those of *C. anfractus* and *C. planiceps* are pear-shaped, with the genital opening exposed at the tip of the papilla, whereas those of *C. leiakanthus* and *C. olivaceus* are triangular and have the genital opening covered by a flap of skin.

Clarias planiceps can be differentiated from its congeners within this group by its extremely flattened head (head depth 59.0-63.8 %HW vs. 65.2-74.6, Fig. 5) and overall lighter body coloration with smaller and fainter spots on the body. It can be further differentiated from *C. leiakanthus* and *C. anfractus* by the presence of relatively large and distinct serrations on the anterior edge of the pectoral spine (vs. without serrations or with anterior edge of pectoral spine rugose; Fig. 2). Both *C. planiceps* and *C. olivaceus* have relatively large and distinct serrations on the anterior edge of the pectoral spine, but the two species differ in the former having a flatter head (head depth 59.0-63.8 %HW vs. 71.7-74.6), more dorsal-fin rays (68-74 vs. 62-66) and overall lighter coloration.

The only other species of Southeast Asian *Clarias* with relatively large and distinct serrations on the anterior edge of the pectoral spine is *C. meladerma*, but the serrations on *C. meladerma* are larger (Fig. 2) and can be felt through the thick skin covering the pectoral spine, whereas those of *C. planiceps* are smaller and cannot be felt through the skin covering the pectoral spine. In addition, *C. meladerma* belongs to the first species-group defined here and further differs from *C. planiceps* in having a shorter distance between the tip of the occipital process and the base of the first dorsal-fin ray (2.1-4.7 %SL vs. 6.2-12.2), a deeper head (head depth 64.5-69.2 %HW vs. 59.0-63.8), and a darker-coloured body with round, black spots (vs. uniformly light-coloured body without any dark spots).

Both *C. anfractus* and *C. planiceps* have been found so far only in relatively slow-moving parts of fast-flowing hill streams while *C. leiakanthus* is found in a wide variety of habitats, primarily in slow-flowing forested streams and in acid water or peat swamp forests.

COMPARATIVE MATERIAL

Clarias batu: ZRC 40087, 1 ex., holotype, 245.0 mm SL; ZRC 40088, 8 ex., paratypes, 101.3-228.0 mm SL; CMK 13010, 1 ex., paratype, 167.0 mm SL; Malaysia: Pulau Tioman, Sungai Baharu, on

right side of Tekek-Juara trail (towards Juara); H. H. Ng et al., 28 Jun.1996. - ZRC 40089, 9 ex., paratypes, 179.0-305.0 mm SL; BMNH 1997.2.4: 7-8, 2 ex., paratypes, 191.0-263.0 mm SL; CAS 90501, 1 ex., paratype, 250.0 mm SL; RMNH 33019, 1 ex., paratype, 265.0 mm SL; Malaysia: Pulau Tioman, Sungai Nipah; H. H. Ng et al., 28 Jun.1996.

Clarias leiacanthus: ZRC 37758, 10 ex., 49.1- 129.5 mm SL; Borneo: Sarawak, Kuching, Bako National Park, Ulu Assam, stream 1; K. Lim et al., 30 Jun.1994. - BMNH 1863.12.4.55, 1 ex., 186.7 mm SL; Bleeker collection. - RMNH 6805, 4 ex., 190-320 mm TL; Bleeker collection. - RMNH 6803, 1 ex., 91.0 mm SL; Java: Tjikoppo, Bogor Province; J. E. Teijsmann, 1857 (holotype of *C. teijsmanni*). - CMK 11560, 1 ex., 91.9 mm SL, Java: Bogor, Sungai Ciawi in BIOTROP; M. Kottelat, 31 May.1995. - ZMA 121.779, 8 ex., 76.5-90.4 mm SL; Java: Buitenzorg [=Bogor]; M. Weber, 1888. - ZRC 40131, 1 ex., 97.7 mm SL; Java: Bogor, tributary of Cipinang Gading; H. H. Tan & S. H. Tan, 10 Jul.1996. - ANSP 64862, 1 ex., 180.8 mm SL; Thailand: waterfall at Trang; R. M. de Schauensee, 13 Oct 1936 (holotype of *C. cataractus*; photograph and radiograph examined). - ZRC 15393-15396, 4 ex., 42.4-109.1 mm SL; Malaysia: Selangor, North Selangor peat swamp forest, stream at 43 km marker on road to Sungai Besar; NUS 1991-92 Zoology Honours class, 18 Jun.1991. - ZRC 18594, 1 ex., 149.0 mm SL; Malaysia: Pahang, about 200 m southwest of 33 km Segamat-Kuantan road; P. K. L. Ng et al., 20 Oct.1991. - ZRC 13988, 1 ex., 97.3 mm SL; Malaysia: Johor, Kota Tinggi, foothills of Gunung Pantii; P. K. L. Ng & S. T. Quek, 20 Sep.1990. - ZRC 11678-11679, 2 ex., 109.8-202.9 mm SL; Singapore: Nee Soon swamp forest; K. Yong & P. K. L. Ng, 30 Apr.1990. - ZRC 22241, 1 ex., 105.8 mm SL; Riau archipelago: Pulau Batam, northwest of Sanggulung; P. K. L. Ng et al., 29 Jan.1992. - ZRC 31183, 1 ex., 135.4 mm SL; Banka: 96.5 km south of Pangkalpinang; M. Kottelat et al., 3 Mar.1993. - ZMB 20944, 1 ex., 115.7 mm SL; Sumatra: Porsea, Lake Toba; A. Thienemann, 1933 (syntype of *C. thienemanni*). - ZMB 20931, 2 ex., 82.8-106.5 mm SL; data as for ZMB 20944 (syntypes of *C. thienemanni*). - ZRC 39105, 4 ex., 37.0-150.0 mm SL; Sumatra: Riau province, stream with grassy banks near Pangkalankasai, 43 km from Rengat on Rengat to Jambi road; H. H. Ng, S. H. Tan et al., 15 Jun.1995. - CAS 49422, 2 ex., 119.9-134.3 mm SL; Borneo: Kalimantan Barat, Sungai Paklehung, a low-lying forested hillstream tributary to Sungai Mempawah, 48 km NNW of Pontiank, 9 km NE of Andjongan and 1-3 km upstream from Toho (0°24.5'N 109°13.5'E); T. R. Roberts & S. Wirjoatmodjo, 13 Jul.1976. - FMNH 51723, 3 ex., 113.1-140.4 mm SL; Borneo: Sabah, Kinabatangan district, tributary of Little Kretam River (Sungai Gaja), just above nipa belt; R. F. Inger, 12 May.1950. - FMNH 51724, 2 ex., 140.1-140.6 mm SL; Borneo: Sabah, Sandakan district, tributary of Sapagaya River; R. F. Inger, 20 Jul.1950. - FMNH 51725, 5 ex., 119.3-162.2 mm SL; Borneo: Sabah, Kinabatangan district, clear water tributary of Little Kretam River, below falls; R. F. Inger, 11 May.1950. - FMNH 68097, 4 ex., 112.1-207.9 mm SL; Borneo: Sabah, Kinabatangan district, Deramakot camp, Deramakot, hill stream below waterfall; R. F. Inger & P. K. Chin, 2 May.1956. - FMNH 68099, 1 ex., 92.1 mm SL; Borneo: Sabah, Kinabatangan district, Deramakot camp, small stream in swamp forest; R. F. Inger, 6 May.1956. - FMNH 68100, 1 ex., 135.2 mm SL; Borneo: Sabah, Kinabatangan district, Deramakot camp, unnamed stream crossing railroad trace (5°17'N 117°33'E); R. F. Inger & P. K. Chin, 28 Apr.1956. - FMNH 68101, 1 ex., 174.9 mm SL; Borneo: Sabah, Kinabatangan district, Deramakot camp, in hill stream (5°17'N 117°33'E); R. F. Inger, 2 May.1956. - FMNH 68102, 4 ex., 154.2-222.8 mm SL; Borneo: Sabah, Sandakan district, Sepilok Forest Reserve; R. F. Inger, 9 Apr.1956. - RMNH 7542, 1 ex., 83.5 mm SL; Borneo: Howong; A. W. Nieuwenhuis, 1898 (holotype of *C. pulcher*). - ZRC 37851, 1 ex., 153.3 mm SL; Borneo: Sarawak, waterfall in Taman Selangkoi, 25 km south of Sarikei; M. Kottelat et al., 7 May.1994. - ZRC 39744, 12 ex., 155.0-326.7 mm SL; Borneo: Sarawak, Serian market, from Batang Kerang; P. K. L. Ng et al., 14-17 Jan.1996. - ZRC 39880, 4 ex., 33.3-62.2 mm SL; Borneo: Sarawak, peat swamp at about 11 km towards Gedong after turnoff from Serian-Sri Aman road (1°12'8.0"N 110°39'52.2"E); H. H. Tan et al., 16 Jan.1996. - ZRC 40551, 3 ex., 191.7-206.0 mm SL; Borneo: Sarawak, Miri, from pasar malam next to bus station, purportedly from Sungai Bakung; H. H. Tan & Y. Y. Goh, 24 Sep.1996.

Clarias macrocephalus: ZRC 30465, 1 ex., 223.7 mm SL; Malaysia: Pahang, Sungai Jelai; J. Cramphorn, 14 Nov.1992.

Clarias meladerma: ZRC 38979, 6 ex., 172.8-185.5 mm SL; Sumatra: Jambi, Pasar Angso Duo (fish market); P. K. L. Ng et al., Jun.1995.

Clarias nieuwhofii: RMNH 6804, 1 ex., 314.6 mm SL; Bleeker collection (syntypes of *C. pentapterus*). - ZRC 38978, 1 ex., 206.0 mm SL; Indonesia: Jambi, Pasar Angso Duo (fish market) at Jambi, P. K. L. Ng et al., 13 Jun.1995. - ZRC 39093, 5 ex., 204.5-358 mm SL; Indonesia: Sumatra, Riau province,

fish market at Rengat; P. K. L. Ng et al., 15 Jun.1995. - CMK 6868, 1 ex., 186.6 mm SL; Borneo: Kalimantan Barat, Mintas Sembolong, a short cut between meanders S of the Kapuas River mainstream, upstream of Nanga Embaloh (approx. 0°50'N 112°39'E); M. Kottelat et al., 27 Apr.1990.

Clarias olivaceus: ANSP 27280, 1 ex., holotype, 241.8 mm SL; ANSP 27281, 3 ex., paratypes, 157.5-209.5 mm SL; Sumatra: Padang; A. C. Harrison Jr. and H. M. Miller, 1901. - USNM 193033, 9 ex., 113.0-149.8 mm SL; Sumatra: Lake Toba at Prapet; Smithsonian-National Geographic expedition, 1937. - ZRC 41697, 8 ex., 116.2-231.7 mm SL; Sumatra: Jambi province, Kerinci, Sungaipenuh market; H. H. Tan et al., 10 Jun.1996. - ZRC 42562, 2 ex., 150.5-177.6 mm SL; Sumatra: Jambi province, from aquarium fish collectors; H. H. Tan et al., 23 Nov-1 Dec.1996.

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