

## THE BAGRID CATFISH GENUS *HEMIBAGRUS* (TELEOSTEI: SILURIFORMES) IN CENTRAL INDOCHINA WITH A NEW SPECIES FROM THE MEKONG RIVER

Ng Heok Hee

Department of Biological Sciences, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260.

Walter J. Rainboth

Department of Biology and Microbiology, University of Wisconsin Oshkosh, 800 Algoma Boulevard, Oshkosh, Wisconsin 54901-8640, USA.

**ABSTRACT.** - The species of the genus *Hemibagrus* from central Indochina (consisting of the Mae Klong, Chao Phraya, Bang Pakong and Mekong River drainages) have been reviewed. Out of the seven nominal species reported from this region, five are considered valid with one previously undescribed species described here as *H. spilopterus*, new species.

**KEY WORDS.** - *Hemibagrus*, Indochina,

---

### INTRODUCTION

Species of the catfish genus *Hemibagrus* are large riverine catfishes found ubiquitously in river drainages east from the Ganges-Brahmaputra basin and south from the Yangtze basin. Throughout central Indochina (here defined as Indochina consisting of the Mae Klong, Chao Phraya, Bang Pakong and Mekong River drainages), as in other parts of Southeast Asia, they are an important source of animal protein for people.

Since the rehabilitation of *Hemibagrus* from synonymy with *Mystus* by Mo (1991), the exact number of valid species has been uncertain. A total of seven nominal species of *Hemibagrus* have been recorded from central Indochina, viz. *H. aubentoni* (Desoutter, 1975), *H. filamentus* (Chaux & Fang, 1949), *H. hoevenii* (Bleeker, 1846), *H. nemurus* (Valenciennes in Cuvier & Valenciennes, 1840), *H. planiceps* (Valenciennes in Cuvier & Valenciennes, 1840), *H. wyckii* (Bleeker, 1858) and *H. wyckiioides* (Chaux & Fang, 1949), but the diagnostic characters and limits of variation of these species remain poorly defined. The present paper is part of

a systematic revision of the genus *Hemibagrus*, and reviews the species found within central Indochina.

## MATERIAL AND METHODS

Measurements were made point to point with dial calipers and data recorded to tenths of a millimetre. Counts and measurements were made on the left side of specimens whenever possible. Subunits of the head are presented as proportions of head length (HL). Head length itself and measurements of body parts are given as proportions of standard length (SL). Measurements and counts were made following Ng & Ng (1995) with the following exceptions: head length is measured from the tip of the snout to the posteriormost extremity of fleshy opercular flap. Length of the adipose-fin base is measured from the anteriormost point of origin to the posteriormost point of the adipose-fin base. Post-adipose distance is measured from the posteriormost point of the adipose-fin base to the posterior margin of the hypural complex at the midline of the body.

The following additional measurements were made: predorsal, preanal, prepelvic and prepectoral lengths are those measured from the tip of the snout to the anterior base of each respective fin. Lengths of the dorsal- and anal-fin bases are from the origin to the posteriormost point of the base. Pelvic- and pectoral-fin lengths are measured from the origin to the tip of the longest ray. Dorsal and pectoral spine lengths are measured from the base to the tip. Dorsal to adipose distance is measured from the base of the last dorsal-fin ray to the origin of the adipose fin. Maximum adipose height is the maximum height from the body of the adipose fin at any point along its outer edge. Caudal-fin length is the length of the longest ray of the lower lobe measured from the posterior margin of the hypural complex. The length of the caudal peduncle is measured from base of the last anal-fin ray to the posterior margin of the hypural complex. Nasal-, maxillary- and mandibular-barbel lengths are measured from the base to the tip.

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. A list of the material examined for this study is presented in Appendix 1 and a list of comparative material in Appendix 2. Institutional codes for the repositories of specimens follow those of Eschmeyer (1998).

## ARTIFICIAL KEY TO THE SPECIES OF *HEMIBAGRUS* FROM CENTRAL INDOCHINA

1. Vertebrae 43-46; adipose fin short (11.3-18.6 %SL), with a steep anterior margin ..... 2
- Vertebrae 47-54; adipose fin long (18.7-25.7 %SL), with a gently-sloping anterior margin ... 3
2. Head long (head length 31.0-34.3 %SL); dorsal to adipose distance small (7.3-10.9 %SL) .....  
.....*H. filamentus*
- Head short (head length 28.1-32.6 %SL); dorsal to adipose distance large (11.1-16.7 %SL) ... 4

3. Dorsal spine thin, poorly-ossified and short (6.1-11.4 %SL) without serrations on posterior edge; maxillary barbels long, reaching to at least middle of adipose-fin base (230.1-297.0 %HL); red colour frequently partially or wholly present in caudal fin; grey coracoidal region .....  
..... *H. wyckioides*
- Dorsal spine thick, well-ossified and long (11.9-14.8 %SL) with 10-12 serrations on posterior edge; maxillary barbels short, reaching to middle of dorsal-fin base (143.7-195.4 %HL); red colour never present in caudal fin; cream coracoidal region ..... *H. wyckii*
4. Adipose fin-base short (11.3-12.7 %SL); distinct black spot on adipose fin; dorsal-fin rays in adults without filamentous extensions ..... *H. spilopterus* new species  
Adipose fin-base long (13.2-18.6 %SL); no black spot on adipose fin; first three dorsal-fin rays in adults with filamentous extensions ..... *H. cf. nemurus*

*Hemibagrus filamentus* (Chaux & Fang, 1949)  
(Fig. 1)

*Macrones filamentus* Chaux & Fang, 1949: 200, fig. 4 (type locality: Cambodia).  
*Mystus filamentus* - Rainboth 1996: 144, pl. 19 fig. 147.

*Material examined.* - See Appendix 1

**Diagnosis.** - *Hemibagrus filamentus* can be differentiated from its congeners by a unique combination of the following characters: head length 31.0-34.3 %SL; dorsal to adipose distance 7.3-10.9 %SL; length of dorsal-fin 27.3-30.8 %SL; post-adipose distance 14.7-16.2 %SL; interorbital distance 28.1-31.3 %HL; 44-46 vertebrae; and presence of filamentous extensions on the first three dorsal-fin rays in adults.

**Description.** - Head depressed and broad, body moderately compressed. Dorsal profile rising evenly but not steeply from tip of snout to origin of dorsal fin, then gently sloping ventrally to end of caudal peduncle. Ventral profile horizontal to origin of anal, then sloping dorsally to end of caudal peduncle. In %SL: head length 31.0-34.3, head width 18.8-20.9, head depth 14.3-16.4, predorsal distance 43.1-46.3, preanal length 70.3-76.2, prepelvic length 55.8-59.8, prepectoral length 27.0-31.0, body depth at anus 14.4-16.2, length of caudal peduncle 15.7-17.7, depth of caudal peduncle 7.6-9.0, pectoral-spine length 16.0-19.0, pectoral-fin length 18.8-21.8, dorsal-spine length 13.1-17.4, length of dorsal-fin 27.3-30.8, length of dorsal-fin base 15.1-17.9, pelvic-fin length 13.9-16.9, length of anal-fin base 11.0-

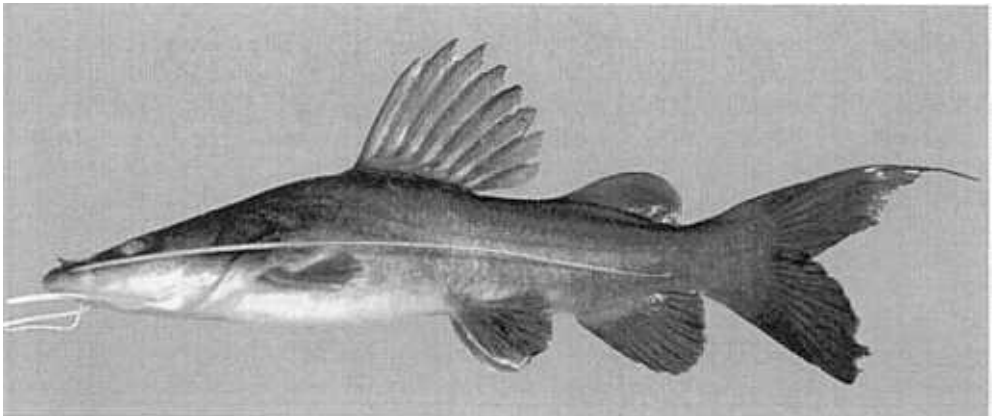


Fig. *Hemibagrus filamentus*, UMMZ 232462, 150.6 mm SL; Cambodia: Siem Reap.

12.9, caudal-fin length 20.8-25.5, length of adipose-fin base 14.0-17.7, maximum adipose height 5.2-7.2, post-adipose distance 14.7-16.2, dorsal to adipose distance 7.3-10.9; in %HL: snout length 35.1-40.6, interorbital distance 28.1-31.3, eye diameter 9.5-15.6, nasal barbel length 27.3-37.4, maxillary barbel length 209.3-265.4, inner mandibular barbel length 39.7-48.6, outer mandibular barbel length 68.3-95.9. Branchiostegal rays 10 (2), 11 (5) or 12 (3). Gill rakers 3+8=11 (1), 3+9=12 (1) or 4+9=13 (1). Vertebrae 23+21=44 (1), 22+23=45 (1), 23+22=45 (1) or 24+22=46 (1).

Fin ray counts: dorsal I,7 (10); pectoral I,7 (1), I,8 (6) or I,8,i (3); pelvic i,5 (10); anal iii,9 (1), iv,9 (2), v,8 (6) or v,9 (1); caudal 8/9 (10). Dorsal origin nearer tip of snout than caudal flexure. Dorsal spine stout, with 6 (1), 7 (2), 8 (1), 9 (2) or 10 (1) irregular serrae along posterior edge. Pectoral spine stout, with 13 (1), 14 (1), 15 (1), 16 (2) or 18 (2) large serrae along posterior edge. Caudal fin forked; upper and lower lobes rounded.

**Colour.** - Dorsal surface of head and body uniform brownish-grey; ventral surfaces of head and body dirty white; adipose fin brownish-grey, without black spot; fin-rays and inter-radial membranes of all fins grey; dorsal surfaces of barbels brownish-grey, ventral surfaces dirty white.

**Distribution.** - Known from the middle and lower Mekong in Laos, Thailand and Cambodia (Fig. 2).

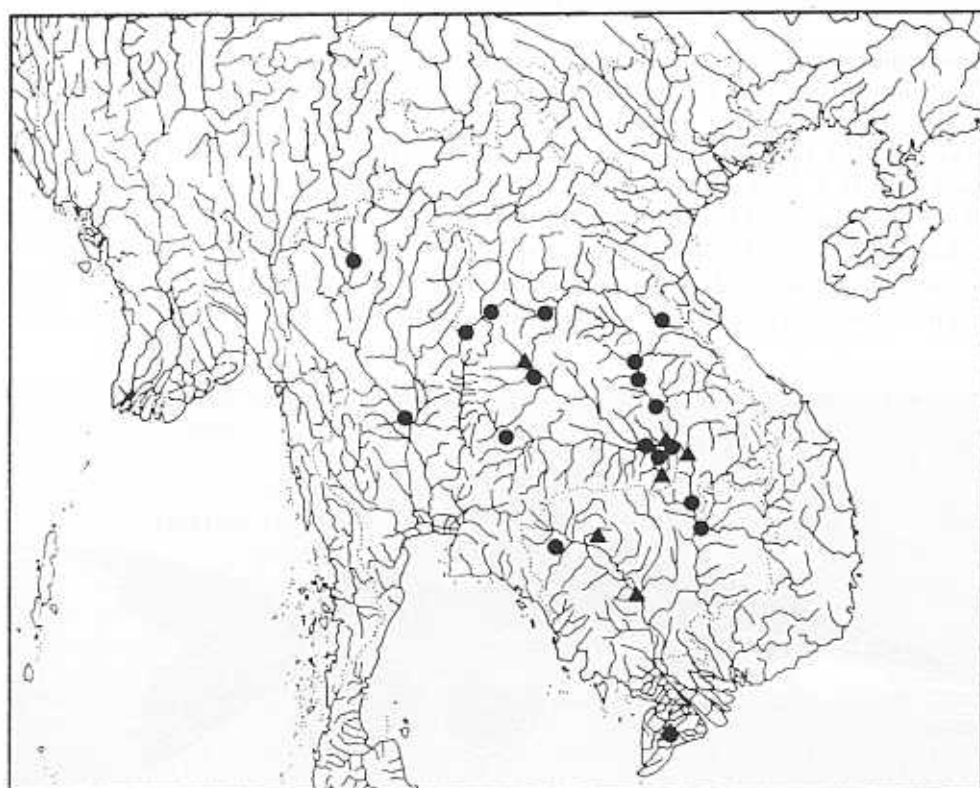


Fig. 2. Map of central Indochina showing distributions of *H. filamentus* (▲) and *H. wyckioides* (●).

**Remarks.** - Ng & Ng (1995) separated what is currently recognised as *H. nemurus* into two species-groups based on morphology. The *H. nemurus* species-group was defined as having 43-45 vertebrae; the longest dorsal fin ray just reaching the beginning of the adipose fin when adpressed against the body; and the body with a dark midaxial streak. The second unnamed group was defined as having 43-46 vertebrae, the body with or without a dark midaxial streak and the longest dorsal fin ray, when adpressed against the body, reaching or covering at least one third of the adipose fin. After examining a large series of specimens from throughout Southeast Asia, we find that the characters used may not always differentiate the two groups reliably. As this is not the place to treat this problem in depth, we tentatively recognise the validity of the species-groups, but call attention to the problem here.

Preliminary observations indicate that *H. nemurus* from Java (the type locality) may not be conspecific with specimens identified as such (and other nominal species) from the rest of Southeast Asia. Furthermore, the results of this study show that what is currently recognised as *H. nemurus* from Indochina actually belongs to three distinct species, viz. *H. filamentus*, *H. spilopterus* new species and *H. cf. nemurus*. For the purposes of this study, the former two species will be compared separately with *H. nemurus* s. str. from Java and *H. cf. nemurus* from Southeast Asia excluding Java.

Since its original description, the status of *H. filamentus* was not discussed until Rainboth (1996) treated it as a valid species. *Hemibagrus filamentus* was distinguished from all other species in the original description by long filamentous extensions to the distal portions of the first three dorsal-fin rays. We note that as a rule, adults of most species of the *H. nemurus* and the unnamed species-groups (see above) have filamentous extensions to the dorsal-fin rays, so this character cannot be used as diagnostic for this species. In any case, *H. filamentus* can be differentiated from both *H. nemurus* s. str. and *H. cf. nemurus* in having a smaller dorsal to adipose distance (7.3-10.9 %SL vs. 11.1-16.7), longer head (31.0-34.3 %SL vs. 27.3-31.1), longer dorsal-fin rays (length of dorsal fin 27.3-30.8 %SL vs. 22.6-27.4), smaller post-adipose distance (14.7-16.2 %SL vs. 15.4-23.4) and smaller interorbital distance (28.1-31.3 %HL vs. 30.1-36.9).

Rainboth (1996) suggested that *Mystus johorensis* Herre, 1940 may be a senior synonym of *H. filamentus*, but our examination of the holotype of *M. johorensis* (CAS 133026, 213.1 mm SL) reveals that it is not conspecific with *H. filamentus* as it has the larger dorsal to adipose distance (12.7 %SL) and shorter dorsal-fin rays (length of dorsal fin 25.9%SL) associated with *H. cf. nemurus*.

Some notes on the ecology of *H. filamentus* in the Cambodian Mekong are provided by Rainboth (1996): the species is found mainly in slowly flowing or standing waters of the lower Mekong and is particularly common in the Great Lake in Cambodia. It feeds on fish and crustaceans and moves into flooded forests during periods of high water levels.

### *Hemibagrus hoevenii* (Bleeker, 1846)

*Bagrus hoevenii* Bleeker, 1846: 154 (type locality: Java).

*Hemibagrus hoevenii* - Bleeker, 1865c: 175.

**Remarks.** - *Hemibagrus hoevenii*, previously considered a junior synonym of *H. nemurus*, has been shown to be a valid species by Kottelat & Lim (1995). The inclusion of this species

in this study is solely based on the record from the Chao Phraya delta by Bleeker (1865c). Because *H. hoevenii* is frequently found near the mouths of rivers and appears to be an estuarine species (pers. obs.), the presence of this species in central Indochina is not unexpected. Until fresh specimens can be obtained to verify the identity, we tentatively consider this species to be present in our area of study.

***Hemibagrus cf. nemurus* (Valenciennes in Cuvier & Valenciennes, 1840)**

(Fig. 3)

*Bagrus nemurus* Valenciennes in Cuvier & Valenciennes, 1840: 423 (type locality: Java).

*Hemibagrus nemurus* - Bleeker, 1864: 353; Bleeker, 1865a: 34; Bleeker, 1865b: 96; Bleeker, 1865c: 175; Sauvage, 1883: 154; Mo, 1991: 132; Kottelat, 1998: 100, fig. 147.

?*Macrones luridus* Tirant in Pétillot, 1911: 164 (nomen nudum); Chevey, 1929: 172

*Macrones nemurus* - Hora, 1923: 171; Hora, 1924: 468; Tirant in Pétillot, 1911: 164; Chevey, 1929: 172; Chevey, 1932: 17; Chevey, 1934: 201; Chevey & Le Poulain, 1940: 38.

*Mystus nemurus* - Fowler, 1934: 95; 1937: 148 (in part); Suvatti, 1936: 73; Kuronuma, 1961: 6; Mizuno & Mori, 1970: 109, fig. 12C; Orsi, 1974: 161; Beeckman & de Bont, 1985: 2646; Desoutter, 1975: 448; Roberts, 1993: 33.

*Macrones planiceps* (non Valenciennes in Cuvier & Valenciennes) - Chevey, 1932: 17.

*Mystus planiceps* (non Valenciennes in Cuvier & Valenciennes) - Suvatti, 1936: 75; Fowler, 1937: 148; Fowler, 1939: 40, 58; Kuronuma, 1961: 6; Desoutter, 1975: 451; Kottelat, 1985: 270.

*Mystus wyckii* (non Bleeker) - Anonymous, 1993: 213, fig. 92.

*Material examined.* - See Appendix

**Diagnosis.** - *Hemibagrus cf. nemurus* can be differentiated from its congeners by a unique combination of the following characters: length of adipose-fin base 13.2-18.6 %SL; dorsal to adipose distance 11.1-16.7 %SL; post-adipose distance 15.4-19.7 %SL; head width 18.0-21.1 %SL; 44-46 vertebrae; and presence of filamentous extensions on the first three dorsal-fin rays in adults.

**Description.** - Head depressed and broad, body moderately compressed. Dorsal profile rising evenly but not steeply from tip of snout to origin of dorsal fin, then gently sloping ventrally to end of caudal peduncle. Ventral profile horizontal to origin of anal, then sloping dorsally to end of caudal peduncle. In %SL: head length 28.1-31.1, head width 18.0-21.1 (63.2-71.2 %HL), head depth 13.7-16.5, predorsal distance 38.9-44.0, preanal length 69.7-72.9, prepelvic length 50.3-56.3, prepectoral length 23.1-28.0, body depth at anus 14.2-18.1, length of caudal peduncle 16.1-18.7, depth of caudal peduncle 7.3-9.7, pectoral-spine length 15.6-18.3, pectoral-fin length 17.6-21.5, dorsal-spine length 13.6-16.8, length of dorsal-fin 22.6-27.4, length of dorsal-fin base 13.7-18.0, pelvic-fin length 14.2-16.5, length of anal-

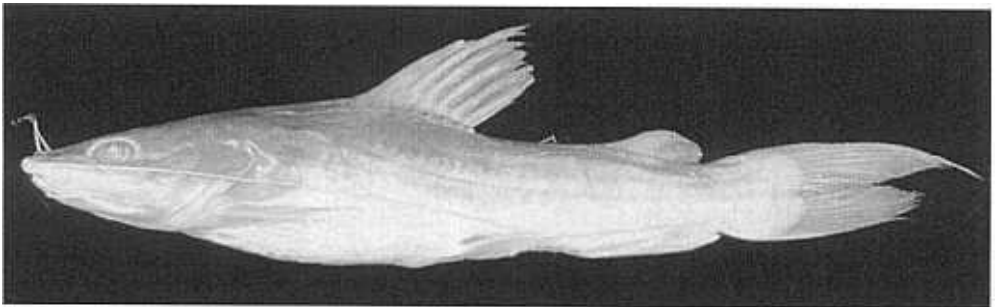


Fig. 3. *Hemibagrus cf. nemurus*, ZRC 29659, 132.3 mm SL; Thailand: Bangkok.

fin base 10.2-13.7, caudal-fin length 21.1-25.0, length of adipose-fin base 13.2-18.6, maximum adipose height 4.7-6.5, post-adipose distance 15.4-19.7, dorsal to adipose distance 11.1-16.7; in %HL: snout length 34.1-40.5, interorbital distance 30.5-36.0, eye diameter 13.4-17.6, nasal barbel length 28.3-45.0, maxillary barbel length 214.2-278.3, inner mandibular barbel length 43.4-63.4, outer mandibular barbel length 76.5-106.3. Branchiostegal rays 9 (4), 10 (12) or 11 (2). Gill rakers 4+13=17 (1), 5+12=17 (1), 4+14=18 (1), 5+13=18 (3), 6+12=18 (2) or 5+14=19 (2). Vertebrae 22+22=44 (3), 23+21=44 (9), 24+20=44 (2), 23+22=45 (5), 24+21=45 (1) or 25+21=46 (1).

Fin ray counts: dorsal I,7 (18); pectoral I,7,i (5), I,8 (8), I,8,i (3), I,9 (1) or I,10 (1); pelvic i,5 (18); anal iii,9 (1), iv,7 (1), iv,8 (5), iv,9 (9) or iv,10 (2); caudal 8/9 (18). Dorsal origin nearer tip of snout than caudal flexure. Dorsal spine stout, with 8 (2), 9 (2) or 10 (1) irregular serrae along posterior edge. Pectoral spine stout, with 16(3), 17 (1) or 24 (1) large serrae along posterior edge. Caudal fin forked; upper and lower lobes rounded.

**Colour.** - Dorsal surface of head and body uniform brownish-grey (live or freshly-dead specimens have a slight yellow hue which fades on preservation); ventral surfaces of head and body dirty white; adipose fin brownish-grey, without black spot; fin-rays and inter-radial membranes of all fins grey; dorsal surfaces of barbels brownish-grey, ventral surfaces dirty white.

**Distribution.** - Known from the Mekong, Ban Pakong, Mae Klong, and Chao Phraya drainages (Fig. 4). Specimens possibly conspecific with the Indochinese species have been reported from drainages throughout Sumatra, Borneo and the Malay Peninsula.

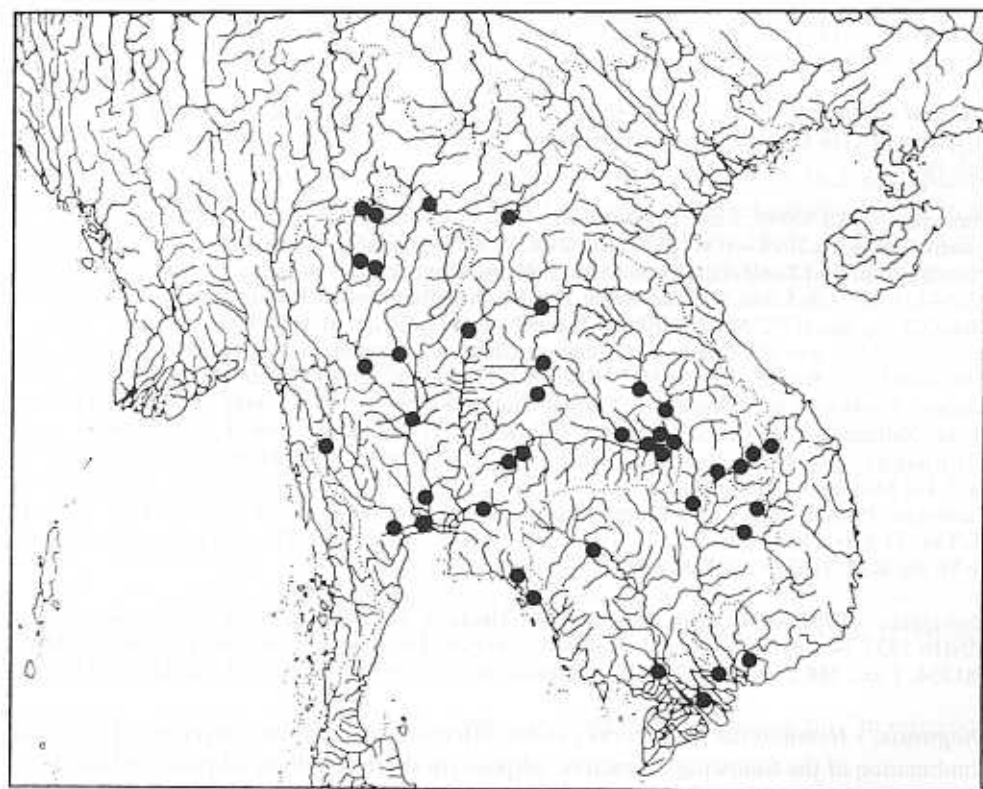


Fig. 4. Map of central Indochina showing distribution of *H. cf. nemurus*.

**Remarks.** - The problems with the identities of the material identified as *H. nemurus* from Indochina have been discussed above, but we will reiterate the main points again here: the Indochinese population of *H. nemurus* seems to belong to a species distinct from *H. nemurus* s. str. from Java. We tentatively identify this species as *H. cf. nemurus* and tentatively consider it conspecific with material identified as *H. nemurus* (and other nominal species presently considered as its synonyms) from Sumatra, Borneo and the Malay Peninsula, pending a critical re-examination of all this material (to be carried out in a separate study). The name *Macrones luridus* Tirant in Pétillet, 1911 may refer to this species, but the name is a nomen nudum and published only once in a list of fishes (republished in Chevey, 1929) sent by Tirant to the Musée Guimet d'Histoire Naturelle, Lyon (M. Kottelat, pers. comm.). Material identified as *H. planiceps* by previous authors (e.g. Fowler, 1937) has turned out to be *H. cf. nemurus* and as far as is known, *H. planiceps* is a species restricted to Java. Whether or not any species belonging to the *H. planiceps* species-group (defined by Ng & Ng (1995) as species having an elongate body with 47-50 vertebrae, a body with no midaxial streak and the longest dorsal-fin ray not or just reaching the beginning of the adipose fin) occurs at all in central Indochina has yet to be established. We have not seen any specimens which indicate that any do, but specimens of an elongate *Hemibagrus* which may belong to this species group have been reported from the middle Mekong River drainage (at That Phanom in Thailand; C. Vidthayanon, pers. comm.). Unfortunately, we were unable to examine the specimens to ascertain their status.

### *Hemibagrus spilopterus*, new species

(Figs. 5, 7a, 8a)

*Mystus nemurus* (non Valenciennes, in Cuvier & Valenciennes) - Fowler, 1937: 148, figs. 44-47 (in part); Kottelat, 1985: 270; Rainboth, 1996: 143, pl. 19 fig. 145.

**Material examined.** - Holotype. - UMMZ 232611, 147.5 mm SL; Cambodia: Kandal, Bassac River at village of Prek Chey on Vietnamese border (10°57'N 105°6'E); W. J. Rainboth & C. Rotha, 20 Feb.1995.

Paratypes. - CAS 93949, 1 ex., 203.2 mm SL; Cambodia: Stung Siem Reap near Angkor Wat; T. R. Roberts, 24-26 Jun.1994. - UMMZ 181163, 2 ex., 98.8-109.0 mm SL; Cambodia: Kandal, Prek Andhor, tributary from E of Tonlé Sap River, 15 km NW of Phnom Penh; J. Bardach, 19 Jan.1959. - UMMZ 232644, 1 ex., 126.5 mm SL; Cambodia: Kandal, Prek Bak Nam at fishing lot 9, just upstream of Phum Chong Sao (11°2'N 105°8'E); W. J. Rainboth & C. Rotha, 21 Feb.1995. - UMMZ 232699, 3 ex., 206.4-230.0 mm SL; Cambodia: Kompong Chhnang, morning market (12°15'N 104°40'E); W. J. Rainboth & C. Rotha, 28 Feb.1995. - UMMZ 232731, 2 ex., 93.0-127.0 mm SL; Cambodia: Tonlé Sap at exit to Great Lake, 4 km NW of Chhnok Trou, at Kompong Thom fishing lot 2; W. J. Rainboth, N. van Zalinge & C. Rotha, 28 Feb.1995. - CMK 15121, 1 ex., 168.2 mm SL; CAS 209760, 1 ex., 171.0 mm SL; ZRC 43324, 10 ex., 171.7-241.4 mm SL; Cambodia: Phnom Penh, Chompuvon market, ca. 5 km SW of city; H. H. Ng & H. H. Tan, 21-22 May.1999. - ZRC 43322, 1 ex., 209.9 mm SL; Cambodia: Phnom Penh, Chipa Ampe market, across Tonle Sap River NE of city; H. H. Ng & H. H. Tan, 23 May.1999. - ZRC 43323, 1 ex., 309.1 mm SL; Cambodia: Phnom Penh, central market; H. H. Ng & H. H. Tan, 23 May.1999.

Non-types. - ANSP 88047, 1 ex., 96.2 mm SL; Thailand: Me Poon; R. M. de Schauensee, 1936. - MNHN 1937-34, 1 ex., 138.7 mm SL; Cambodia: Angkor; Delacour & Lowe, date unknown. - UMMZ 181204, 1 ex., 188.2 mm SL; Cambodia: Mekong River N of Phnom Penh; J. Bardach, 8 Jul.1959.

**Diagnosis.** - *Hemibagrus spilopterus* can be differentiated from its congeners by a unique combination of the following characters: adipose fin short (length of adipose-fin base 11.3-12.7 %SL; 1.72-2.20 times maximum adipose height) with a steep anterior margin (length



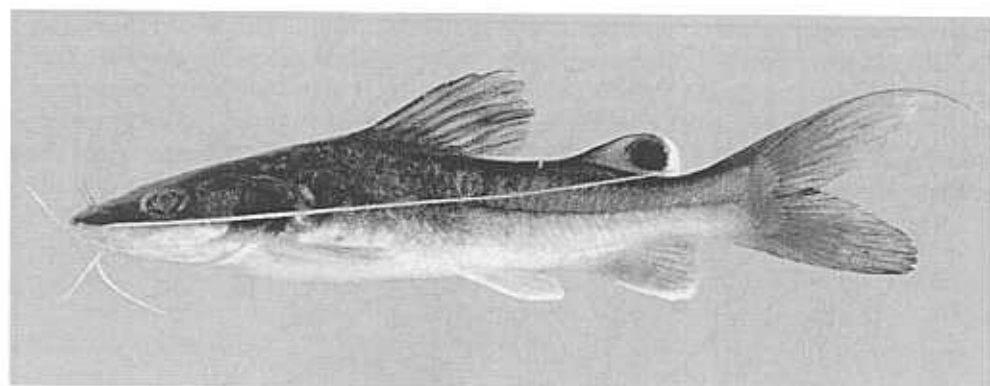


Fig. 5. *Hemibagrus spilopterus*, UMMZ 232611, holotype, 147.5 mm SL; Cambodia; Kandal.

of adipose-fin base and a distinct black spot on the posterior half; head width 20.6-23.4 %SL; dorsal to adipose distance 12.7-16.2 %SL; 43-44 vertebrae; and absence of filamentous extensions on the first three dorsal-fin rays in adults.

**Description.** - Head depressed and broad, body moderately compressed. Dorsal profile rising evenly but not steeply from tip of snout to origin of dorsal fin, then gently sloping ventrally to end of caudal peduncle. Ventral profile horizontal to origin of anal, then sloping dorsally to end of caudal peduncle. In %SL: head length 30.2-32.6, head width 20.6-23.4, head depth 15.5-17.0, predorsal distance 42.3-44.6, preanal length 71.3-74.6, prepelvic length 53.1-57.5, prepectoral length 25.1-30.4, body depth at anus 14.9-18.7, length of caudal peduncle 15.5-18.7, depth of caudal peduncle 7.5-9.3, pectoral-spine length 18.0-18.8, pectoral-fin length 16.6-21.2, dorsal-spine length 14.2-17.3, length of dorsal-fin 22.7-26.3, length of dorsal-fin base 15.3-16.9, pelvic-fin length 15.3-16.8, length of anal-fin base 12.1-13.2, caudal-fin length 21.3-23.1, length of adipose-fin base 11.3-12.7, maximum adipose height 5.5-6.7, post-adipose distance 16.7-17.8, dorsal to adipose distance 12.7-16.2; in %HL: snout length 36.1-38.3, interorbital distance 31.7-35.7, eye diameter 12.2-16.2, nasal barbel length 25.4-30.8, maxillary barbel length 222.4-234.0, inner mandibular barbel length 36.8-52.8, outer mandibular barbel length 62.4-91.3. Branchiostegal rays 10 (1), 11 (3) or 12 (2). Gill rakers 3+11=14 (1) or 4+10=14 (1). Vertebrae 23+20=43 (1), 23+21=44 (2) or 24+20=44 (2).

Fin ray counts: dorsal I,7 (6); pectoral I,8 (1) or I,9 (5); pelvic i,5 (6); anal iii,9 (1), iv,9 (3), v,8 (1) or v,9 (1); caudal 8/9 (6). Dorsal origin nearer tip of snout than caudal flexure. Dorsal spine stout, with 7 (2), 9 (1), 10 (1) or 11 (1) irregular serrae along posterior edge. Pectoral spine stout, with 15 (2), 17 (1), 19 (1) or 26 (1) large serrae along posterior edge. Caudal fin forked; upper and lower lobes rounded.

**Colour.** - Dorsal surface of head and body uniform brownish-grey; ventral surfaces of head and body dirty white; adipose fin brownish-grey, posterior half with a distinct black spot; fin-rays and inter-radial membranes of all fins grey; dorsal surfaces of barbels brownish-grey, ventral surfaces dirty white.

**Etymology.** - From the Greek *spilos*, meaning spot and *pteryx*, meaning fin. In reference to the black spot on the adipose fin.

**Distribution.** - Known only from the lower Mekong River drainage in Cambodia (Fig. 6).

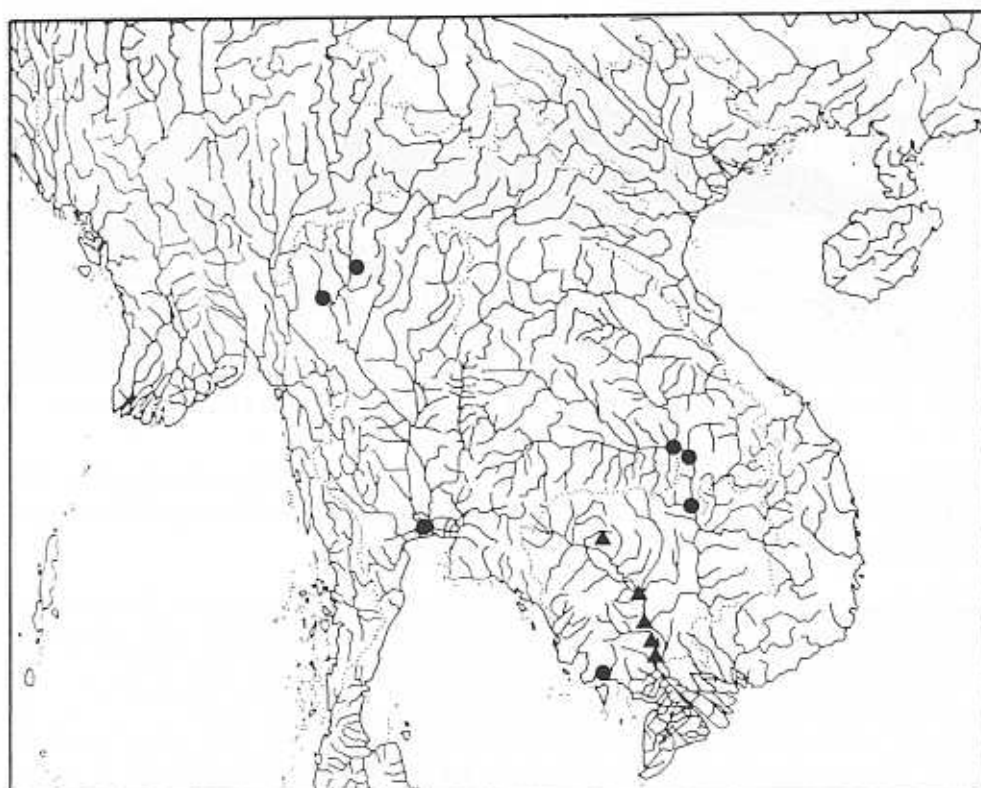


Fig. 6. Map of central Indochina showing distributions of *H. spiloferus* (▲) and *H. wyckii* (●).

**Remarks.** - *Hemibagrus spiloferus* can be differentiated from *H. filamentus*, *H. nemurus* s. str. from Java and *H. cf. nemurus* from the rest of Southeast Asia excluding Java by (vs. absence of) a distinct black spot on the adipose fin. It must be noted, however, that a black spot on the adipose fin is also present in specimens of *H. cf. nemurus* from Sumatra, but that it is more elongate than that of *H. spiloferus* (Fig. 7).

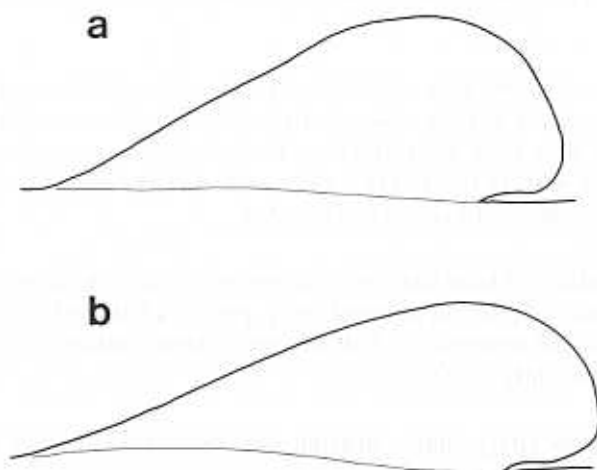


Fig. 7. Outline of adipose fins of: a. *H. spiloferus*, UMMZ 232644, paratype, 126.5 mm SL; b. *H. cf. nemurus*, ZRC 42261, 123.2 mm SL.

*Hemibagrus spilopterus* further differs from *H. nemurus* s. str. in having a shorter and taller adipose fin with a steep (vs. less steep) anterior margin (length of adipose-fin base 1.72-2.20 times maximum adipose height vs. 2.15-2.76) (Fig. 8), from *H. filamentus* in having a shorter adipose-fin base (11.3-12.7 %SL vs. 14.0-17.7), wider head (20.6-23.4 %SL vs. 18.8-20.9) and a longer dorsal to adipose distance (12.7-16.2 %SL vs. 7.3-10.9) and from *H. cf. nemurus* in having a shorter adipose-fin base (11.3-12.7 %SL vs. 13.0-21.4 %SL) and the absence of filamentous extensions on the first three dorsal-fin rays in adults.

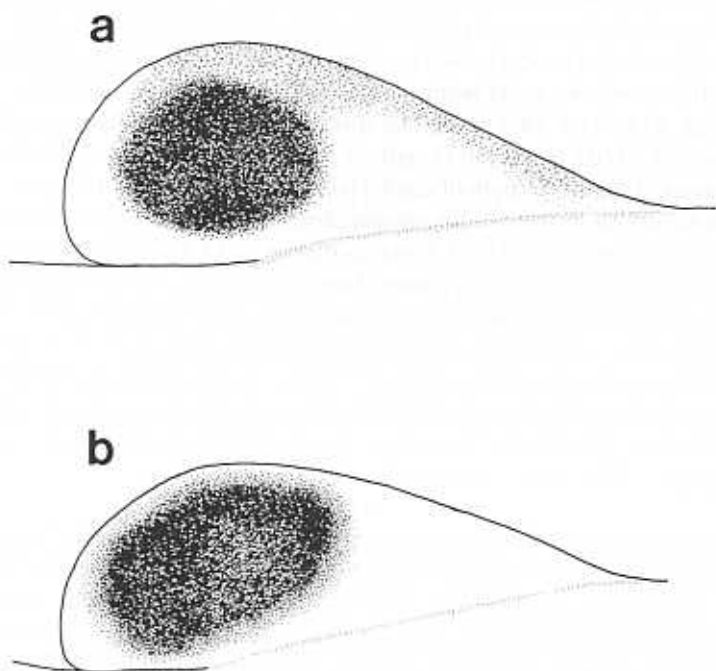


Fig. 8. Adipose fins of: a. *H. spilopterus*, UMMZ 232644, paratype, 126.5 mm SL b. *H. nemurus*, ZRC 41504, 255.0 mm SL.

*Hemibagrus spilopterus* feeds on exogenous insects, aquatic insect larvae, shrimps and other crustaceans, as well as fishes (Rainboth, 1996). In the Cambodian Mekong, it moves into flooded forests to spawn and the young are first seen in August, with the adults returning to rivers in November and December (Rainboth, 1996).

### *Hemibagrus wyckii* (Bleeker, 1858)

(Fig. 9)

*Bagrus wyckii* Bleeker, 1858: 156 (type locality: Java in flumine Tjitarum, provinciae Preanger, prope vicum Parongkalong).

*Hemibagrus wyckii* - Mo, 1991: 132.

*Macrones Wycki* - Durand, 1940: 29.

*Mystus wickii* - Kottelat, 1985: 270.

*Mystus wyckii* - Smith, 1929: 12; Orsi, 1974: 161; Rainboth, 1996: 144.

*Mystus wyckii* - Fowler, 1935: 104, fig. 31; Smith, 1945: 388; Kuronuma, 1961: 6; Desoutter, 1975: 452, fig. 4; Kottelat, 1989: 14; Roberts, 1989: 126; Kottelat et al., 1993: 67, pl. 32; Roberts, 1993: 33; Roberts & Warren, 1994: 102.

*Material examined.* - See Appendix 1.

**Diagnosis.** - *Hemibagrus wyckii* can be differentiated from its congeners by the unique combination of the following characters: head extremely depressed and broad, 50-51 vertebrae; dorsal spine well-ossified, long (11.9-14.8 %SL), and with 10-12 serrations on the posterior edge; cream-coloured coracoidal region; caudal fin dark grey, with cream procurrent and first principal caudal rays; and maxillary barbels reaching to middle of dorsal-fin base (143.7-195.4 %HL).

**Description.** - Head extremely depressed and broad, body moderately compressed. Dorsal profile rising evenly but not steeply from tip of snout to origin of dorsal fin, then gently sloping ventrally to end of caudal peduncle. Ventral profile horizontal to origin of anal, then sloping dorsally to end of caudal peduncle. In %SL: head length 29.7-32.1, head width 19.3-23.8, head depth 11.7-14.9, predorsal distance 41.9-45.6, preanal length 72.6-77.2, prepelvic length 55.1-60.0, prepectoral length 25.5-31.8, body depth at anus 13.6-15.8, length of caudal peduncle 14.0-17.4, depth of caudal peduncle 8.1-8.9, pectoral-spine length 11.7-15.9, pectoral-fin length 15.8-17.1, dorsal-spine length 11.9-14.8, length of dorsal-fin 20.0-25.3, length of dorsal-fin base 10.9-15.3, pelvic-fin length 14.0-16.2, length of anal-fin base 10.4-15.7, caudal-fin length 17.6-24.8, length of adipose-fin base 19.4-24.5, maximum adipose height 4.5-5.8, post-adipose distance 9.3-13.3, dorsal to adipose distance 7.1-11.1; in %HL: snout length 32.6-36.1, interorbital distance 28.7-31.6, eye diameter 7.7-10.2, nasal barbel length 15.8-21.1, maxillary barbel length 143.7-195.4, inner mandibular barbel length 26.2-31.7, outer mandibular barbel length 47.4-59.5. Branchiostegal rays 10 (6) or 11 (1). Gill rakers 3+8=11 (1) or 3+9=12 (1). Vertebrae 26+24=50 (1), 27+24=51 (2), 28+23=51 (1) or 24+27=51 (1).

Fin ray counts: dorsal I,7 (7); pectoral I,9;i (1), I,10 (1), I,10,i (3) or I,11 (2); pelvic i,5 (7); anal ii,8 (1), ii,8,i (1), iii,8,i (1), iv,9 (3) or v,7 (1); caudal 8/9 (6) or 9/9 (1). Dorsal origin nearer tip of snout than caudal flexure. Dorsal spine stout, with 10 (1), 12 (2) or 13 (1) irregular serrae along posterior edge. Pectoral spine stout, with 18 (1), 19 (2) or 21 (1) large serrae along posterior edge. Caudal fin forked; upper and lower lobes rounded.

**Colour.** - Dorsal and lateral surfaces of head and body uniform dark grey, ventral surfaces of head and body cream grading to light grey towards the lateral surfaces of body, coracoidal region cream; adipose fin grey with cream dorsal margin; anteriormost anal-fin rays, first pelvic-fin rays, and procurrent and first principal caudal rays cream, fin-rays and inter-radial membranes of all other fins dark grey; barbels cream.

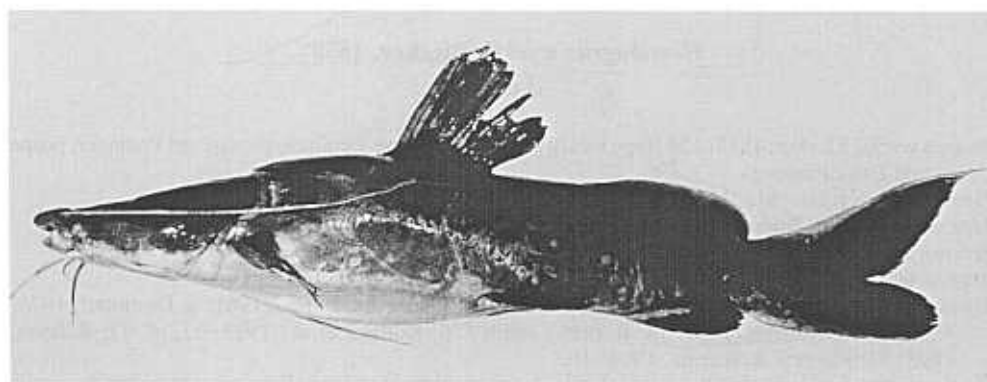


Fig. 9. *Hemibagrus wyckii*, UMMZ 232311, 252.0 mm SL; Cambodia: Stung Treng.

**Distribution.** - Known from the Mekong and Chao Phraya drainages in central Indochina (Fig. 6). Also known from the Batang Hari and Musi River drainages in Sumatra, the Pahang River drainage in Peninsular Malaysia, the Citarum drainage in Java, and the Baram, Rejang, Kapuas and Barito River drainages in Borneo.

**Remarks.** - Desoutter (1975) mentioned several morphological differences between *H. wyckii* from Indochina and the types, namely the presence of fewer pectoral fin-rays (10-11 vs. 11-12) and more vertebrae (45 vs. 41-44) in the Indochinese specimens. Our examination of the specimens in question (MNHN 1974-36, MNHN 1974-37 and MNHN 1974-43), other specimens of *H. wyckii* from Indochina and other parts of Southeast Asia, and subsequent comparison with the syntypes have shown that the differences in question are merely due to intraspecific variation. We therefore consider both populations to be conspecific.

With its relatively broad and flattened head, *H. wyckioides* resembles *H. wyckii* as mentioned earlier, but *H. wyckioides* has a poorly-ossified and short (vs. well-ossified and long) dorsal spine without serrations (vs. with 10-12 serrations) on the posterior edge. *Hemibagrus wyckii* also has a cream-coloured coracoidal region which is absent in *H. wyckioides*, a shorter dorsal-fin base (10.9-15.3 %SL vs. 16.3-18.3) and maxillary barbels (reaching to middle of dorsal-fin base; 143.7-195.4 %HL vs. reaching to at least middle of the adipose fin base; 230.1-297.0 %HL).

### *Hemibagrus wyckioides* (Chaux & Fang, 1949)

(Figs. 10, 11b)

*Macrones wyckioides* Chaux & Fang, 1949: 199, fig. 3 (type locality: Cambodia).

*Hemibagrus wyckioides* - Kottelat, 1998: 100, fig. 148.

*Hemibagrus wyckioides* - Mo, 1991: 132.

*Mystus aubentoni* Desoutter, 1975: 449, figs. 2-3 (type locality: Cambodia, Stung Treng); Kottelat, 1985: 270; Mo, 1991: 130.

*Mystus microphthalmus* (non Day) - Roberts, 1993: 42, fig. 7; Roberts & Warren, 1994: 101.

*Mystus nemurus* (non Cuvier & Valenciennes) - Cheng & Zheng, 1987: 216, fig. 1086

*Macrones rubicauda* Bardach, 1959: 32a (nomen nudum).

*Mystus wickii* (non Bleeker) - Taki, 1968: 20.

*Mystus wycki* (non Bleeker) - Taki, 1978: 39.

*Mystus wyckii* (non Bleeker) - Taki, 1974: 57; Mai et al., 1992: 193.

*Mystus wyckioides* - Chu & Chen, 1990: 163, fig. 166; Rainboth, 1996: 144, pl. 19, fig. 147.

*Mystus wyckioides* - Kottelat, 1989: 14.

**Material examined.** - See Appendix 1.

**Diagnosis.** - *Hemibagrus wyckioides* can be differentiated from its congeners by a unique combination of the following characters: red colour partially or wholly present in caudal fin, 52-53 vertebrae; adipose fin long (length of adipose-fin base 18.7-25.7 %SL), with a gently-sloping anterior margin; dorsal spine poorly-ossified and short (7.5-11.4 %SL) without serrations on posterior edge; length of dorsal-fin base 16.3-18.3 %SL; and maxillary barbels reaching to at least middle of adipose fin base (230.1-297.0 %HL).

**Description.** - Head depressed and broad, body moderately compressed. Dorsal profile rising evenly but not steeply from tip of snout to origin of dorsal fin, then gently sloping ventrally to end of caudal peduncle. Ventral profile horizontal to origin of anal, then sloping dorsally to the end of caudal peduncle. Adipose fin with a gently-sloping anterior margin. In %SL: head length 28.1-31.7, head width 19.5-23.9, head depth 12.1-15.1, predorsal distance 39.1-

44.5, preanal length 67.5-78.1, prepelvic length 53.7-61.1, prepectoral length 24.3-32.7, body depth at anus 11.5-15.7, length of caudal peduncle 15.4-18.9, depth of caudal peduncle 6.7-8.1, pectoral-spine length 11.1-15.3, pectoral-fin length 14.9-18.8, dorsal-spine length 7.5-11.4, length of dorsal-fin 21.9-30.9, length of dorsal-fin base 16.3-18.3, pelvic-fin length 13.2-15.6, length of anal-fin base 12.0-14.6, caudal-fin length 21.8-25.7, length of adipose-fin base 18.7-25.7, maximum adipose height 3.9-6.9, post-adipose distance 12.7-15.1, dorsal to adipose distance 9.6-13.6; in %HL: snout length 34.8-38.1, interorbital distance 31.6-36.9, eye diameter 8.4-11.6, nasal barbel length 21.5-31.9, maxillary barbel length 230.1-297.0, inner mandibular barbel length 40.8-49.0, outer mandibular barbel length 76.6-97.1. Branchiostegal rays 9 (2), 10 (7) or 11 (2). Gill rakers 2+8=10 (1), 3+8=11 (1), 3+9=12 (1) or 4+8=12 (1). Vertebrae 26+26=52 (1), 27+25=52 (1) or 27+26=53 (1).

Fin ray counts: dorsal I,7 (9) or I,8 (2); pectoral I,8 (1), I,9 (8), I,10 (1) or I,11 (1); pelvic i,5 (11); anal iii,9 (1), iii,9,i (1), iii,11 (1), iv,9 (6) or v,8 (2); caudal 8/9 (11). Dorsal origin nearer tip of snout than caudal flexure. Dorsal spine weakly-ossified, without serrae on

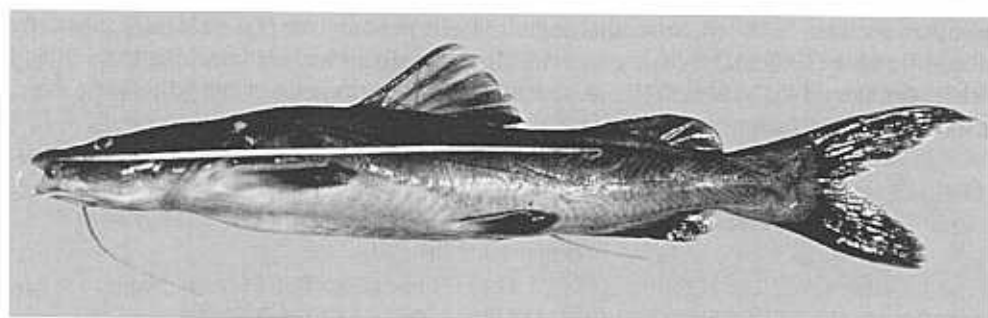


Fig. 10. *Hemibagrus wyckioides*, UMMZ 232312, 203.5 mm SL; Cambodia: Stung Treng.

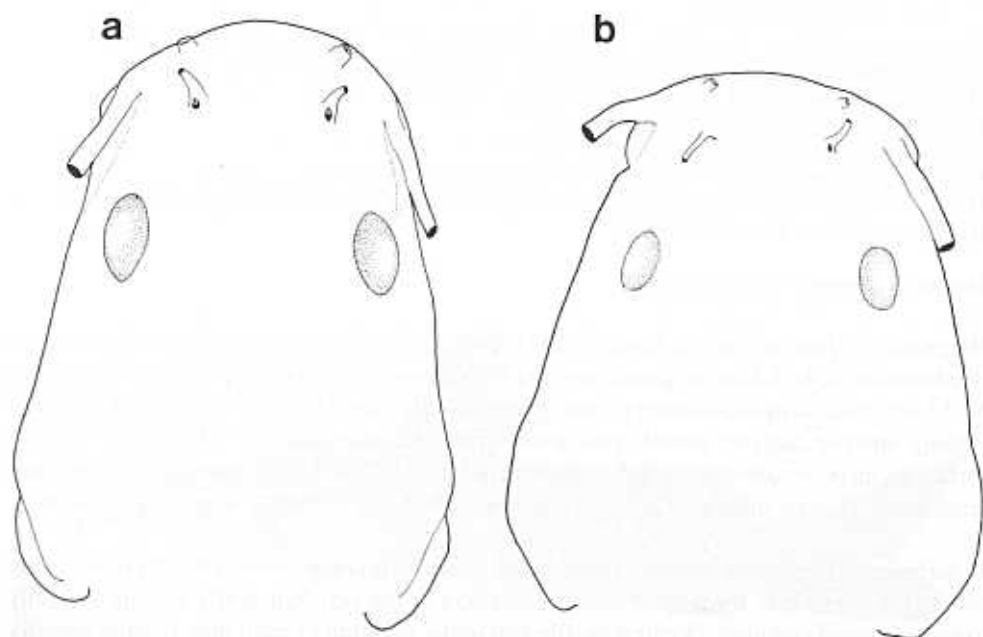


Fig. 11. Dorsal views of heads of: a. *H. microphthalmus*, USNM 344670, 201.6 mm SL; b. *H. wyckioides*, UMMZ 232312, 203.5 mm SL. Scale bar represents 10 mm.

posterior edge. Pectoral spine stout, with 11 (2), 12 (2) or 15 (1) large serrae along posterior edge. Caudal fin forked, upper and lower lobes rounded posteriorly; first principal ray of the upper lobe elongated to form a filament.

**Colour.** - Adult specimens with dorsal surface of head and body uniform grey (live or freshly-dead specimens generally have a darker shade which tends to fade on preservation); ventral surfaces of head and body dirty white; adipose fin grey, distal edge orange in life but fading to light grey on preservation; caudal fin red or grey with red distal margins in life, fading to grey with very light grey procurvent and first principal caudal-rays on preservation; all other fins grey with distal portions of fin rays and inter-radial membranes occasionally orange or red in life, fading to light grey on preservation. Red coloration on fins absent in some specimens. Live coloration of juvenile specimens similar, but with white procurvent and first principal caudal-rays.

**Distribution.** - Known from the Mekong and Chao Phraya drainages (Fig. 2).

**Remarks.** - In his rehabilitation of *Hemibagrus*, Mo (1991) listed both *H. aubentoni* (Desoutter, 1975) and *H. microphthalmus* (Day, 1877) as belonging to the genus *Mystus* without examining any specimens. Our examination of the types of both species has shown that they should be assigned to *Hemibagrus* instead and that *H. aubentoni* is a junior subjective synonym of *H. wyckioides* (see below). *Hemibagrus microphthalmus* and *H. wyckioides* (with *H. aubentoni* as a junior synonym) can be differentiated from all other species of *Hemibagrus* in having a combination of a distinct reddish or orange-colour frequently (vs. never) present in caudal fins and the dorsal spine poorly-ossified and relatively short (6.1-11.4 %SL) without serrations on the posterior edge (vs. well-ossified and long (11.8-16.6 %SL) with serrations on the posterior edge).

Desoutter (1975) differentiated *H. aubentoni* from *H. wyckioides* by the relatively larger fontanelle (reaching occipital process vs. not reaching), smaller eye and longer dorsal to adipose distance in the former species. However, an examination of the types of both species reveal the differences reported to be unsubstantial or non-existent. We consider *H. aubentoni* to be a junior synonym of *H. wyckioides*.

*Hemibagrus wyckioides* has been considered a junior synonym of *H. microphthalmus* by Roberts (1993) and Roberts & Warren (1994), evidently on the basis of similar external anatomies and that both species have orange or red colour present in the caudal fin. However, the two species differ in the shape of their snouts: *H. wyckioides* has a truncate snout while *H. microphthalmus* has a rounded snout (Fig. 11). *Hemibagrus wyckioides* also has a wider head (19.5-23.9 %SL vs. 18.0-19.7), longer dorsal-fin base (16.3-18.3 %SL vs. 13.7-16.7) and more wide-set eyes (interorbital distance 31.6-36.9 %HL vs. 28.4-31.8) compared to *H. microphthalmus*. Finally, the two species are geographically separate: *H. wyckioides* is only known from the Mekong and Chao Phraya drainages, and possibly the Mae Klong drainage (reported by Roberts, 1993 as *H. microphthalmus*, but we have not examined any specimen from the Mae Klong to ascertain the exact identity of Roberts' record) in central Indochina while *H. microphthalmus* is found only in the Thanlwin (Salween), Ayeryawaddy (Irrawaddy) and Sittoung (Sittang) drainages in western Indochina (Myanmar).

*Hemibagrus wyckioides* is the largest species of bagrid catfish in central Indochina, reaching sizes of up to 950 mm SL (per obs.) and weights of up to 70 or 80 kg (Roberts, 1993). It occurs most commonly in areas with rocky bottoms and irregular depths (Rainboth, 1996).

According to Roberts (1993), *H. wyckioides* apparently does not migrate but reproduces locally and enters the flooded forest during high water (July-October). It reportedly feeds on fish, shrimps and crabs.

#### ACKNOWLEDGMENTS

The authors thank the following for permission to examine specimens under their care and the loan of material: Mark McGruther (AMS), William Saul (ANSP), Darrell Siebert (BMNH), David Catania (CAS), Maurice Kottelat (CMK), Mary Ann Rogers (FMNH), Karsten Hartel (MCZ), Guy Duhamel (MNH), Kurt Grossenbacher (NMBE), Sven Kullander (NRM), Martin van Oijen (RMNH), William Fink (UMMZ), Douglas Nelson (UMMZ), Lynne Parenti (USNM), Isaïc Isbrücker (ZMA). We also thank Tyson Roberts for commenting on the manuscript. This study was supported by a short-term visitor grant to the first author from the Smithsonian Institution and research grant RP 960314 to Peter Ng from the National University of Singapore.

#### LITERATURE CITED

- Anonymous, 1993. *Dinh loai ca nguoc ngot vung dong bang song Cuu Long*. Khoa Thuy San, Truong dai Hoc Can Tho, Vietnam. 361 pp.
- Bardach, J., 1959. *Report on fisheries in Cambodia*. USOM/Cambodia, Phnom Penh, 80 pp.
- Beeckman, W. & A. F. de Bont, 1985. Characteristics of the Nam Ngum reservoir eco-system as deduced from the food of the most important fish-species. *Verh. Int. Verein. Limnol.*, **22**: 2643-2649.
- Bleeker, P., 1846. Overzicht der Siluroïden welke te Batavia voorkomen. *Nat. Geneesk. Arch. Ned. Ind.*, **3**: 135-184.
- Bleeker, P., 1858. *Ichthyologiae archipelagi indici prodromus. Vol. 1 Siluri*. Lange & Co., Batavia. 370 pp.
- Bleeker, P., 1862. *Atlas Ichthyologique des Indes Orientales Néerlandaises. Tome 2. Siluroïdes, Chacoïdes et Hétérobrancoïdes*. Frederic Muller, Amsterdam. 112 pp., pls. 49-101.
- Bleeker, P., 1864. Notice sur la faune ichthyologique de Siam. *Versl. Akad. Amsterdam*, **16**: 352-358.
- Bleeker, P., 1865a. Nouvelle notice sur la faune ichthyologique de Siam. *Ned. Tijds. Dierk.*, **2**: 33-37.
- Bleeker, P., 1865b. Notice sur la faune ichthyologique de Siam. *Ned. Tijds. Dierk.*, **2**: 96-99.
- Bleeker, P., 1865c. Sixième notice sur la faune ichthyologique de Siam. *Ned. Tijds. Dierk.*, **2**: 171-176.
- Chaux, J. & P. W. Fang, 1949. Catalogue des Siluroïdes d'Indochine de la collection du laboratoire des pêches coloniales au muséum, avec la description de six espèces nouvelles. *Bull. Mus. Natn. Hist. Nat.*, **2e Sér.**, **21**: 194-201.
- Chevey, P., 1929. Liste des poissons de l'Indochine envoyés, par le Docteur Gilbert Tirant, au Muséum de Sciences naturelles de Lyon. *Notes Inst. Océan. Indochine*, **6**: 164-175.
- Chevey, P., 1932. Inventaire de la faune ichthyologique de l'Indochine. Deuxième liste. *Notes Inst. Océan. Indochine*, **19**: 1-31.
- Chevey, P., 1934. Révision synonymique de l'Œuvre ichthyologique de G. Tirant. *Notes Inst. Océan. Indochine*, **7**: 1-291.
- Chevey, P. & F. Le Poulain, 1940. La pêche dans les eaux douces du Cambodge. *Trav. Inst. Océan. Indochine*, **5**: 1-193.



- Chu, X. L. & Chen, Y. R. (eds.), 1990. *The Fishes of Yunnan, China, Part II*. Science Press, Beijing. 313 pp. [in Chinese].
- Desoutter, M., 1975. Étude de quelques Bagridae (Siluriformes, Pisces) du Cambodge. Description d'une espèce nouvelle: *Mystus aubentonii*. *Bull. Mus. Natn. Hist. Nat.*, 3e Sér., **206**: 441-462.
- Durand, J., 1940. Notes sur quelques poissons d'espèces nouvelles ou peu connues des eaux douces cambodgiennes. *Notes Inst. Océan. Indochine*, **36**: 1-41.
- Eschmeyer, W., 1998. *Catalog of Fishes*. California Academy of Sciences, San Francisco. 2905 pp.
- Fowler, H. W., 1934. Zoological results of the third de Schauensee Siamese Expedition. Part I—Fishes. *Proc. Acad. Nat. Sci. Philadelphia*, **86**: 67-163.
- Fowler, H. W., 1935. Zoological results of the third de Schauensee Siamese Expedition. Part VI—Fishes obtained in 1934. *Proc. Acad. Nat. Sci. Philadelphia*, **87**: 89-163.
- Fowler, H. W., 1937. Zoological results of the third de Schauensee Siamese Expedition. Part VIII—Fishes obtained in 1936. *Proc. Acad. Nat. Sci. Philadelphia*, **89**: 125-264.
- Fowler, H. W., 1939. Zoological results of the third de Schauensee Siamese Expedition. Part IX—Additional fishes obtained in 1936. *Proc. Acad. Nat. Sci. Philadelphia*, **91**: 39-76.
- Hora, S. L., 1923. On a collection of fish from Siam. *J. Nat. Hist. Soc. Siam*, **6**: 143-184, pls. 10-12.
- Hora, S. L., 1924. Zoological results of a tour in the far east. Fish of the Talé Sap, Peninsular Siam. (Part 1). *Mem. Asiatic Soc. Bengal*, **6**: 463-476.
- Kottelat, M., 1985. Fresh-water fishes of Kampuchea — A provisory annotated check-list. *Hydrobiologia*, **121**: 249-279.
- Kottelat, M., 1989. Zoogeography of the fishes from Indochinese inland waters with an annotated check-list. *Bull. Zool. Mus.*, **12**: 1-55.
- Kottelat, M., 1998. Fishes of the Nam Theun and Xe Bangfai basins, Laos, with diagnoses of twenty-two new species (Teleostei: Cyprinidae, Balitoridae, Cobitidae, Coidae and Odontobutidae). *Ichthyol. Explor. Freshwaters*, **9**: 1-128.
- Kottelat, M. & K. K. P. Lim, 1995. *Hemibagrus hoevenii*, a valid species of Sundaic catfish (Teleostei: Bagridae). *Malayan Nat. J.*, **49**: 41-47.
- Kottelat, M., A. J. Whitten, S. N. Kartikasari & S. Wirjoatmodjo, 1993. *Freshwater Fishes of Western Indonesia and Sulawesi*. Periplus Editions, Hong Kong. 221 pp., 84 pls.
- Kuronuma, K., 1961. *A check list of fishes of Vietnam*. Division of Agriculture and Natural Resources, United States Operations Mission to Vietnam., 66 pp.
- Mai, D. Y., V. Trong Nguyen, V. Thien Nguyen, H. Y. Le & B. L. Hua, 1992. *Din loai cac loai ca nuoc ngot nam bo*. [Identification of the Fresh-water Fishes of South Vietnam]. Nha Xuat Ban Khoa Hoc Va Ky Thuat, Hanoi. 351 pp.
- Mizuno, T. & S. Mori, 1970. Preliminary hydrobiological survey of some Southeast Asian inland waters. *Biol. J. Linn. Soc.*, **2**: 77-117.
- Ng, P. K. L. & H. H. Ng, 1995. *Hemibagrus gracilis*, a new species of large riverine catfish (Teleostei: Bagridae) from Peninsular Malaysia. *Raffles Bull. Zool.*, **43**: 133-142.
- Orsi, J. J., 1974. A check list of the marine and freshwater fishes of Vietnam. *Pub. Seto Mar. Biol. Lab.*, **21**: 153-177.
- Pétillet, L., 1911. *Une Richesse du Cambodge. La Pêche et les Poissons*. Augustin Challamel, Paris. 167 pp.
- Rainboth, W. J., 1996. *Fishes of the Cambodian Mekong*. FAO Species Identification Field Guide for Fishery Purposes. FAO, Rome. xi+265, 27 pls.
- Roberts, T. R., 1989. The freshwater fishes of Western Borneo (Kalimantan Barat, Indonesia). *Mem. California Acad. Sci.*, **14**: 1-210.
- Roberts, T. R., 1993. Artisanal fisheries and fish ecology below the great waterfalls of the Mekong river in southern Laos. *Nat. Hist. Bull. Siam Soc.*, **41**: 31-62.
- Roberts, T. R., 1994. Systematic revision of Asian bagrid catfishes of the genus *Mystus* sensu stricto, with a new species from Thailand and Cambodia. *Ichthyol. Explor. Freshwaters*, **5**: 241-256.

- Roberts, T. R. & T. J. Warren, 1994. Observations on fishes and fisheries in southern Laos and northeastern Cambodia, Oct 1993-Feb.1994. *Nat. Hist. Bull. Siam Soc.*, **42**: 87-115.
- Sauvage, H. E. 1883. Sur une collection de poissons recueillis dans le Mé-Nam (Siam) par M. Harmand. *Bull. Soc. Philom. Paris*, **7**: 150-155.
- Smith, H. M., 1929. Notes on some Siamese fishes. *J. Siam Soc. Nat. Hist. Suppl.*, **8**: 11-14.
- Smith, H. M., 1945. The freshwater fishes of Siam or Thailand. *Bull. U.S. Natn. Mus.*, **188**: 1-622.
- Suvatti, N. C., 1936. *Index to Fishes of Siam*. Bureau of Fisheries, Bangkok. 226 pp.
- Taki, Y., 1968. *Notes on a collection of fishes from lowland Laos*. United States Agency for International Development Mission to Laos Agriculture Division. 47 pp.
- Taki, Y., 1974. *Fishes of the Lao Mekong basin*. United States Agency for International Development Mission to Laos Agriculture Division. 232 pp.
- Taki, Y., 1978. An analytical study of the fish fauna of the Mekong basin as a biological production system in nature. *Res. Inst. Evol. Biol. Spec. Pub. No. 1*, 77 pp.

## APPENDIX 1

### Material examined

- H. filamentus*: MNHN 1966-728, 1 ex., holotype, 419.8 mm SL; Cambodia, - NRM 15013, 1 ex., 236.8 mm SL; Laos: Sedone River, Pakse (14°9'N 105°50'E). - NRM 15019, 1 ex., 198.5 mm SL; NRM 15020, 1 ex., 191.9 mm SL; NRM 15022, 1 ex., 251.6 mm SL; Laos. - UMMZ 214370, 1 ex., 98.5 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, N shore of Mun River at Ban Dan, 2 km upstream from Mekong confluence. - UMMZ 214371, 1 ex., 185.0 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, Mun River at Ban Dan, 1.5 km upstream from Mekong confluence. - UMMZ 214373, 2 ex., 144.1-152.2 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, Mun River at Ban Dan, 3 km upstream from confluence with Mekong River. - UMMZ 214379, 1 ex., 106.2 mm SL; Thailand: Ubon Ratchathani province, stream from Bung Klang Huen to Mun River, 10 km from Mun River, 3 km E of Ubon Ratchathani. - UMMZ 214384, 2 ex., 51.6-203.3 mm SL; Thailand: Khon Kaen province, Nam Pong Reservoir, 3 km N of fish landing on E side of reservoir. - UMMZ 214394, 1 ex., 114.0 mm SL; Thailand: Ubon Ratchathani province, Huay Kwang, at confluence with Mun River, 3 km from Mekong River. - UMMZ 214395, 15 ex., 50.0-134.8 mm SL; Thailand: Ubon Ratchathani province, Huay Mark Tai, 1 km from Mekong River. - UMMZ 214396, 1 ex., 183.4 mm SL; Thailand: Ubon Ratchathani province, Lam Dom Noi reservoir, ca. 2.5 km S of Ban Khan Kom on W shore. - UMMZ 214397, 19.9-131.7 mm SL; Thailand: Khon Kaen province, Nam Pong Reservoir, 2.1 km N of damsite on E shore. - UMMZ 214398, Thailand: Khon Kaen province, Nam Pong Reservoir, 4.8 km N of damsite on E shore. - UMMZ 214412, 1 ex., 191.3 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, Mun River at Ban Dan, 3 km upstream from Mekong confluence. - UMMZ 214487, 47 ex., 40.7-138.1 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, Huay Kwang, 0.3 km from Mun River. - UMMZ 214938, 4 ex., 55.2-98.9 mm SL; Thailand: Khon Kaen province, Nam Pong Reservoir, 4.8 km N of damsite on E shore. - UMMZ 232423, 3 ex., 68.7-102.1 mm SL; Cambodia: Siem Reap, floating village at mouth of Siem Reap River, Mekong drainage, 13°16'N 103°48'E. - UMMZ 232462, 1 ex., 150.6 mm SL; Cambodia: Siem Reap, fish trap W of floating village at mouth of Siem Reap River, Mekong drainage, 13°16'N 103°46'E. - UMMZ 232698, 5 ex., 151.8-175.1 mm SL; Cambodia: Kompong Chhnang, Kompong Chhnang morning market, Mekong drainage.
- H. cf. nemurus*: ANSP 59375, 2 ex., 71.2-77.2 mm SL; ANSP 59377, 2 ex., 67.3-74.6 mm SL; ANSP 59379, 1 ex., 55.7 mm SL; ANSP 59380, 3 ex., 125.0-7157.7 mm SL; ANSP 59383, 1 ex., 118.5 mm SL; ANSP 59384, 3 ex., 75.9-86.1 mm SL; ANSP 59387, 2 ex., 110.7-113.5 mm SL; Thailand: Chiang Mai on Mae Nam Ping, - ANSP 59389, 2 ex., 100.4-127.1 mm SL; Thailand: Bangkok, 30 miles up the Mae Nam Chao Phraya. - ANSP 59391, 2 ex., 72.7-110.5 mm SL; Thailand: Mekong River at Chiang Sen, 5 miles S of Shan States border opposite French Laos. - ANSP 59467, 1 ex., 34.9 mm SL; Thailand: Silom Canal, Bangkok. - ANSP 89408, 13 ex., 71.2-124.2 mm SL; Thailand: Kemrat. - ANSP 89483, 1 ex., 87.5 mm SL; Thailand: Phitsanulok; R. M. de Schauensee, 1836. - ANSP 89533, 13 ex., 90.0-140.3 mm SL; Thailand: Bangkok. - ANSP 141235, 8 ex., 47.6-70.1 mm SL; Thailand: Tachin; R. M. de Schauensee, 1935. - BMNH 1898.11.8.110, 1 ex., 224.0 mm SL; Thailand: Ayuttaya.

- BMNH 1976.7.1.35-36, 2 ex., 157.5-171.4 mm SL; Laos: fish market at Vientiane. - CAS 61915, 2 ex., 147.8-152.9 mm SL; Thailand: fish market at Ubon Ratchathani. - CAS 61920, 2 ex., 112.0-112.2 mm SL; Thailand: fish market at Ubon Ratchathani. - CAS 79049, 3 ex., 102.8-131.1 mm SL; Thailand: Mae Klong basin, Huay Sangkalia, 7 km N of Sangklaburi on road to Chedi Sam Ong. - CAS 79051, 4 ex., 72.8-126.0 mm SL; Thailand: Mekong river near Ban Ha Bia, 30-40 km NW of Chiang Khan on Highway 2186. - CAS 92472, 4 ex., 23.8-39.4 mm SL; Laos: Attapeu province, Houay Samong, about 1 km upstream from its mouth into Xe Pian near Ban Hin Lat, Sekong watershed. - CAS 92504, 15 ex., 20.8-150.6 mm SL; Laos: Sekong watershed, small mountain stream entering right side of Se Kaman just upstream from Se Kaman 1 hydropower. - CAS 93268, 5 ex., 36.1-43.5 mm SL; Cambodia: Ratanakiri province, O Chalerm, ca. 5-10 km E of Lomphat. - CAS 92860, 1 ex., 64.0 mm SL; Thailand: Mae Nam Ping, about 41 km N of Chiang Mai. - CAS 92870, 1 ex., 63.7 mm SL; Thailand: Bangpakong basin, open channel in large swamp ca. 9 km SSW of Prachinburi town. - CAS 94757, 1 ex., 27.0 mm SL; Laos: Mekong basin, Sekong watershed, Bolaven plateau, Xe Nam Noy mainstream 26 km by road from Ban Nam Tong about 1 km downstream, elevation 270 m. - CAS 94772, 3 ex., 20.0-33.1 mm SL; Laos: Attapeu province, Sekong watershed, Xe Pian 1 km downstream from Se Pa waterfall and 5-6 km upstream from Ban Hin Lat. - CAS 94779, 47 ex., 10.5-104.6 mm SL; Cambodia: Ratanakiri province, O Champha, 4-8 km upstream from its mouth into Tonlé San near Te Veng. - CAS 96568, 4 ex., 145.4-204.8 mm SL; Thailand: Mukdahan market. - CAS 96573, 5 ex., 83.9-185.3 mm SL; Thailand: Mekong mainstream between Pak Ing and Jom Paing (about 4-5 km downstream). - CAS 96582, 1 ex., 157.3 mm SL; Thailand: Pak Menam Mun (mouth of Mun River). - CAS 96642, 5 ex., 43.3-129.4 mm SL; Cambodia: Ratanakiri province, O Kamang Chong, 20-25 km E of Lomphat. - CAS 96793, 1 ex., 91.0 mm SL; Laos: Se Khone. - CAS 96966, 3 ex., 66.5-68.9 mm SL; Thailand: Huay Nam Ngam & Mekong mainstream near That Phanom. - CAS 97076, 1 ex., 68.7 mm SL; Thailand: Menam Chi at Maha Chana Chai. - CMK 4834, 1 ex., 102.3 mm SL; Thailand: Lampong province, Mae Nam Yom basin, Huai Mae Phlung from Ban Pong (18°42'N 99°58'E) to 17 km upstream. - CMK 4874, 3 ex., 115.0-159.6 mm SL; Thailand: Ayuttaya province, market at Ayuttaya. - CMK 5018, 3 ex., 96.8-116.1 mm SL; Thailand: market at Sukhothai. - CMK 5043, 4 ex., 99.1-152.8 mm SL; Thailand: market at Nong Khai. - CMK 5087, 2 ex., 124.4-139.0 mm SL; Thailand: market at That Phanom. - CMK 5281, 1 ex., 157.2 mm SL; Thailand: market at Nakhon Sawan. - FMNH 50847, 89.1 mm SL; Thailand: Pak Nam Po. - FMNH 50848, 3 ex., 169.2-174.6 mm SL; Thailand: Kam Peng Pet province, Wong Pratart farm. - MCZ 35534, 2 ex., 122.1-140.6 mm SL; Thailand: Meping River at Chiang Mai (18°48'N 98°59'E). - MNHN 1554, 4 ex., 95.0-136.4 mm SL; Thailand: Me Nam River. - MNHN 1567, 4 ex., 87.0-127.3 mm SL; Thailand: Bangkok. - MNHN A1071, 3 ex., 197.8-273.4 mm SL; Cambodia. - MNHN A2393, 1 ex., 268.6 mm SL; MNHN A2394, 4 ex., 137.4-247.9 mm SL; MNHN B283, 3 ex., 198.1-232.4 mm SL; MNHN B285, 3 ex., 165.0-263.5 mm L; Cochinchina. - MNHN B281, 2 ex., 86.1-106.8 mm SL; Vietnam: Saigon. - MNHN 1974-27, 24 ex., 29.1-144.2 mm SL; Cambodia: Tonlé Sap km 9. - NRM 15001, 1 ex., 267.8 mm SL; Laos: Nam Ou River at Luang Prabang. - NRM 15015, 1 ex., 260.3 mm SL; NRM 15016, 1 ex., 235.1 mm SL; NRM 15017, 1 ex., 253.3 mm SL; NRM 15018, 1 ex., 222.4 mm SL; Laos: Mekong River at Luang Prabang (19°53'N 105°50'E). - NRM 31079, 1 ex., 256.1 mm SL; Vietnam: Song Langna (probably near Saigon-Da Lat road). - UMMZ 186685, 10 ex., 45.3-56.5 mm SL; Thailand: Nakhon Ratchasima province, ditches and flow, and borrow pits along drainage downstream from damsite at Pakthongchai, Korat. - UMMZ 186696, 1 ex., 138.9 mm SL; Thailand: Nakhon Sawan province, Chao Phraya River, floodwaters ca 20 km W of Nakhon Sawan. - UMMZ 186715, 5 ex., 108.2-121.5 mm SL; Thailand: Rajburi province, Mae Klong River, purchased in market at Rajburi. - UMMZ 186733, 81 ex., 62.8-173.0 mm SL; Thailand: Maharaj province, Chao Phraya River, floodwaters, 17.5 km N of Ayutthaya; Koke Tong Canal drainage. - UMMZ 186740, 7 ex., 64.3-105.7 mm SL; Thailand: Maharaj province, Koke Tong Canal, 17.5 km N of Ayutthaya. - UMMZ 186752, 3 ex., 75.0-100.9 mm SL; Thailand: Khon Kaen fish market. - UMMZ 186756, 1 ex., 84.1 mm SL; Thailand: Pangneeb province, Nam Phong River, about 90 km S of Udorn (25 km W of Nam Phong village). - UMMZ 186769, 3 ex., 113.6-159.5 mm SL; Thailand: market at Nakhon Phanom. - UMMZ 186779, 5 ex., 61.0-141.9 mm SL; Thailand: Nam Kham River at base of dam holding Nong Lahan. - UMMZ 186784, 2 ex., 168.0-221.9 mm SL; Thailand: Ubon Ratchathani province, market at Mukdahan. - UMMZ 186791, 1 ex., 210.4 mm SL; Thailand: irrigation reservoir at Ubon Ratchathani fisheries Station. - UMMZ 186800, 7 ex., 74.2-103.6 mm SL; Thailand: Ubon Ratchathani province, market at Ubon Ratchathani. - UMMZ 186814, 1 ex., 63.6 mm SL; Thailand: Ubon Ratchathani province, Mun River about 20 km downstream from Ubon Ratchathani. - UMMZ 186818, 1 ex., 75.0 mm SL; Thailand: Ubon Ratchathani province, Mun River about 5 km downstream from Ubon Ratchathani. - UMMZ 186820, 14 ex., 52.4-156.6 mm SL; Thailand: Reservoir at Maha Sarakhan.

– UMMZ 186827, 2 ex., 138.8-150.5 mm SL; Thailand: market at Korat. – UMMZ 186846, 1 ex., 104.9 mm SL; Thailand: Mae Nam Mae Klong at Ban Pong, 2 km downstream. – UMMZ 186852, 3 ex., 104.3-116.0 mm SL; Thailand: Mool River of the Mekong drainage. – UMMZ 195382, 1 ex., 74.9 mm SL; Thailand: Maharaj province, Chao Phraya River, floodwaters, 17.5 km N of Ayutthaya; Koke Tong Canal drainage. – UMMZ 213975, 13 ex., 67.3-182.1 mm SL; Thailand: Nong Khai province, Tha Bo district, Huay Kum Kang Mo at Mekong River. – UMMZ 214368, 3 ex., 98.1-119.0 mm SL; Thailand: Ubon Ratchathani province, Mekong River at Khemerat in front of River Patrol Station S of town. – UMMZ 214372, 3 ex., 118.0-141.3 mm SL; Thailand: Ubon Ratchathani province, Mun River, 3 km downstream from bridge at Ubon Ratchathani, at mouth of small creek on N bank of the Mun. – UMMZ 214374, 2 ex., 36.0-41.8 mm SL; UMMZ 214375, 1 ex., 42.9 mm SL; UMMZ 214376, 3 ex., 34.7-48.7 mm SL; UMMZ 214377, 1 ex., 31.9 mm SL; UMMZ 214378, 4 ex., 33.9-42.9 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, Mun River at Ban Dan, 3 km upstream from confluence with Mekong River. – UMMZ 214380, 5 ex., 43.8-51.6 mm SL; Thailand: Ubon Ratchathani province, Lam Dom Noi Reservoir near Ban Kham Kom. – UMMZ 214381, 1 ex., 56.8 mm SL; Thailand: Nakhon Phanom province, Mekong River at Ban Tha Kai, 20 km downstream from Mukdahan. – UMMZ 214382, 2 ex., 137.4-156.5 mm SL; Thailand: Ubon Ratchathani province, Mun River 15 km downstream from bridge at Ubon Ratchathani. – UMMZ 214383, 12 ex., 15.1-125.7 mm SL; Thailand: Ubon Ratchathani province, Huay Kwang, 1.5 km upstream from Mun River. – UMMZ 214385, 8 ex., 13.0-24.8 mm SL; Thailand: Ubon Ratchathani province, 6 km W of Ubon on highway 23, inundated scrub vegetation near flooded creek. – UMMZ 214386, 10 ex., 100.8-150.7 mm SL; Thailand: Kung Kang Moo, creek mouth into Mekong River. – UMMZ 214387, 25 ex., 40.5-116.2 mm SL; Thailand: Ubon Ratchathani province, Huay Thom-loc at Ban Bung Khee-lek, 7 km E of Khemerat, 2.5 km from Mekong River. – UMMZ 214388, 26 ex., 39.0-104.8 mm SL; Thailand: Ubon Ratchathani province, Huay Thom-loc at Ban Bung Rhee-lek, 7 km E of Khemerat, 1 km from Mekong River. – UMMZ 214389, 20 ex., 38.6-134.5 mm SL; Thailand: Nakhon Phanom province, Mekong River at Ban Tha Kai, 21 km downstream from Mukdahan. – UMMZ 214390, 1 ex., 83.0 mm SL; Thailand: Ubon Ratchathani province, Huay Kwang, S of Khong Chiam, 3 km up Mun River from Mekong-Mun River confluence. – UMMZ 214391, 2 ex., 34.2-66.2 mm SL; Thailand: Ubon Ratchathani province, Huay Phai, 7 km N of Khong Chiam, at confluence with Mekong River. – UMMZ 214392, 13 ex., 21.3-69.5 mm SL; Thailand: Nakhon Phanom province, Huay Nong Sao, 8 km SW of Nakhon Phanom, 1.5 km down footpath off main road. – UMMZ 214393, 6 ex., 90.5-215.6 mm SL; Thailand: Huay Mark, 8 km N of Khong Chiam, at confluence with Mekong River. – UMMZ 214399, 8 ex., 38.2-105.1 mm SL; UMMZ 214400, 8 ex., 33.7-92.5 mm SL; UMMZ 214401, 12 ex., 61.0-129.8 mm SL; Thailand: Nong Khai province, Tha Bo district, Mekong River at Ban Tha Sa-det. – UMMZ 214402, 3 ex., 50.0-72.6 mm SL; Thailand: Nakhon Phanom province, roadside ditch near Ban Thong, 6 km S of That Phanom. – UMMZ 214403, 3 ex., 66.6-77.9 mm SL; Thailand: Ubon Ratchathani province, Mun River, 1 km upstream of Ubon Ratchathani. – UMMZ 214404, 3 ex., 56.0-93.7 mm SL; Thailand: Ubon Ratchathani province, Mun River, 3 km downstream from Ubon Ratchathani. – UMMZ 214405, 3 ex., 83.8-112.0 mm SL; Thailand: creek running under Highway 1, 23 km S of Chiang Nai, Mae Nam Ping drainage. – UMMZ 214406, 11 ex., 37.6-55.3 mm SL; Thailand: Fang River, 23 km S of Fang on Vuang Mai Road-Highway 107, Chiang Mai. – UMMZ 214407, 1 ex., 33.5 mm SL; Thailand: Ubon Ratchathani province, Huay Hin Taek, just across Mun River from Ban Dan, 1.5 km up Huay Hin Taek from Mun River. – UMMZ 214408, 5 ex., 16.8-23.4 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, Huay Hin Taek, just across Mun River from Ban Dan, 0.75 km up Huay Hin Taek from Mun River. – UMMZ 214409, 1 ex., 137.8 mm SL; Thailand: Ubon Ratchathani province, Mun River, just below Ubon Ratchathani. – UMMZ 214410, 1 ex., 187.1 mm SL; Thailand: Vietnam: fish market at Vinh Long. – UMMZ 214411, 1 ex., 98.7 mm SL; Laos: Mekong River and tributary from km 1393 to 1596. – UMMZ 224551, 4 ex., 53.2-125.8 mm SL; Thailand: Ubon Ratchathani province, Lam Dam Noi Reservoir at Ban Kham Kom. – UMMZ 224622, 1 ex., 38.5 mm SL; Vietnam: Chau Doc, Mekong-Bassac River, 3 km downstream from Chau Doc. – UMMZ 224645, 1 ex., 104.5 mm SL; Vietnam: Chau Doc fish market. – UMMZ 224830, 2 ex., 47.1-76.4 mm SL; Vietnam: Chau Doc, S end of Vinh Tuong Island, Bassac River. – UMMZ 226867, 5 ex., 72.6-113.1 mm SL; Thailand: Nong Khai province, Tha Bo district, Mekong River backwater at Ban Tha Sadet. – UMMZ 226868, 20 ex., 81.5-121.5 mm SL; Thailand: Nong Khai province, Tha Bo district, Mekong River backwater at Ban Tha Sadet, 17°52'36"N 102°35'30"E. – USNM 103197, 1 ex., 222.1 mm SL; Thailand: Mae Nam Chao Phraya, Ayutthaya. – USNM 109566, 14 ex., 33.9-106.2 mm SL; Thailand: Mae Nam Ping at Chieng Mai. – USNM 109567, 1 ex., 207.8 mm SL; Thailand: Huey O, branch of Man Nam Nan. – USNM 109568, 1 ex., 121.1 mm SL; Thailand: Mae Nam Chem, tributary of Man Nam Ping. – USNM 109580, 1 ex., 76.8 mm SL; Thailand: Mekong at Chieng Sen Kao. – USNM 109582, 7 ex., 45.2-71.7 mm SL; N

Thailand. - USNM 118449, 1 ex., 134.7 mm SL; Thailand: Chiang Mai. - USNM 305707, 2 ex., 101.4-133.1 mm SL; Thailand: Ubon Ratchathani province, Warin Chamrap market. - USNM 317576, 1 ex., 135.7 mm SL; Thailand (15°14'N 104°52'E). - USNM 317587, 21 ex., 77.4-111.9 mm SL; Thailand: Ubon Ratchathani province, morning market at Ubon. - USNM 317588, 1 ex., 162.4 mm SL; Thailand: Ubon Ratchathani province, Victory Rapids (Kaeng Ja wa) on Mun river about 5 km W of Mekong River. - USNM 317589, 8 ex., 109.9-136.4 mm SL; Thailand: Ubon Ratchathani province, market in Ubon, at edge of Mun River. - USNM 317590, 17 ex., 96.5-118.0 mm SL; Thailand: Khon Kaen province, Huai Phra Ku, about 7 km e of Khon Khaen on highway 209. - USNM 317591, 2 ex., 124.9-186.8 mm SL; Thailand: Roi Et province, Lam Chi, 1.5 km below highway 23 bridge 4 km W of Selaphum. - USNM 317592, 13 ex., 101.4-142.0 mm SL; Thailand: Ubon Ratchathani province, Mun River at Bung Wai about 7 km W of Ubon. - USNM 317593, 6 ex., 142.8-182.4 mm SL; Thailand (15°45'N 102°37'E). - USNM 317595, 3 ex., 163.8-200.1 mm SL; Thailand: Nong Khai province, Mekong River near Ban Kong Nang. - USNM 317594, 32 ex., 84.0-127.5 mm SL; Thailand: Nakhon Phanom province, market at Nakhon Phanom. - USNM 317607, 1 ex., 90.3 mm SL; Thailand: Ubon Ratchathani province, morning market at Ubon. - USNM 317608, 1 ex., 115.5 mm SL; Thailand: Nakhon Ratchasima province, flood plain pool of Lam Nam Mun at Amphoe Phimai. - USNM 317609, 1 ex., 145.8 mm SL; Thailand: Ubon Ratchathani province, purchased from fisherman on Mae Nam Mun, just E of Phibun Mangsahan. - ZRC 29583-29596, 14 ex., 177.6-214.2 mm SL; Thailand: Bangkok. - ZRC 29659-29665, 7 ex., 132.3-158.0 mm SL; Thailand: Bangkok. - ZRC 39345, 4 ex., 95.2-135.3 mm SL; Thailand: Yasothon province, Amphoe Muang Yasothon. - ZRC 40896, 3 ex., 59.2-101.2 mm SL; Thailand: Nakhon Ratchasima province, drained irrigation ponds or padi fields along Highway 24, fed by Klong Kabau (14°44'34.8"N 102°12'31.7"E). *H. wyckii*: RMNH 6897, 1 ex., syntype, 330.0 mm SL; BMNH 1863.12.4.88, 1 ex., syntype, 242.5 mm SL; Java: Citarum River. - ANSP 60733, 1 ex., 143.8 mm SL; Thailand: Bangkok. - CAS 67222, 1 ex., 176.7 mm SL; Thailand: Khong Chiam market. - MNHN 1974-36, 1 ex., 201.0 mm SL; MNHN 1974-37, 1 ex., 290.0 mm SL; Cambodia: Mekong River at Beng Cha. - MNHN 1974-43, 1 ex., 126.3 mm SL; Cambodia: Kampot. - NRM 15006, 1 ex., 226.5 mm SL; Laos: Mekong river, Pakse. - NRM 15012, 1 ex., 232.2 mm SL; NRM 15014, 1 ex., 201.9 mm SL; Laos: Sedone River, Pakse. - NRM 15021, 1 ex., 269.4 mm SL; Laos. - UMMZ 232311, 1 ex., 252.0 mm SL; Cambodia: Stung Treng morning market, 13°30' N 105°58' E. - USNM 109578, 1 ex., 99.8 mm SL; Thailand: Mae Nam Chem, 50 miles above mouth, tributary of Mae Nam Ping. - USNM 109579, 1 ex., 119.1 mm SL; Thailand: Mae Nam Ping at Chiang Mai.

*H. wyckioides*: MNHN 1966-727, 1 ex., holotype, 402.2 mm SL; Cambodia. - ANSP 59398, 2 ex., 76.1-82.7 mm SL; Thailand: Chiang Mai on Mae Nam Ping. - ANSP 59400, 2 ex., 65.2-73.6 mm SL; Thailand: Chiang Mai on Mae Nam Ping. - ANSP 87236, 1 ex., 95.9 mm SL; Thailand: Kemrat (16°2'N 105°12'E). - CAS 61917, 7 ex., 37.9-235.2 mm SL; Thailand: fish market at Ubon Ratchathani. - CAS 67223, 2 ex., 140.3-193.1 mm SL; Thailand: Khong Chiam market. - CAS 93280, 1 ex., 129.3 mm SL; Thailand: Menam Mun, Gaeng Sa-Pu (rapids) at Phibun, 43 km E of Ubon Ratchathani. - CAS 93472, 1 ex., 82.9 mm SL; Cambodia: rapids in Se San or Tonlé San, 7km upstream from Stung Treng. - CAS 94611, 2 ex., 122.0-132.6 mm SL; Thailand: mouth of Huay Ngao where it flows into Mekong, 1 km S of Ban Chaem Pong (ca. 30 km SE of Chiang Khong). - CAS 94877, 2 ex., 57.7-149.0 mm SL; Laos: Mekong at Ban Hang Khone, just below Khone falls. - CAS 95029, 1 ex., 145.0 mm SL; Thailand: Nam Kok near Tha Ton. - CAS 96788, 2 ex., 63.7-103.8 mm SL; Thailand: Ubon Ratchathani market. - CMK 5044, 1 ex., 115.8 mm SL; Thailand: market at Nong Khai. - CMK 5086, 2 ex., 142.6-155.6 mm SL; Thailand: market at That Phanom. - CMK 12511, 2 ex., 202.4-220.6 mm SL; Laos: Khammouan province, Nam Theun at NT2 dam site (17°59'50"N 104°57'10"E). - CMK 14480, 1 ex., 159.1 mm SL; Thailand: Mae Nam Chao Phraya near Uthai Thani. - MNHN 1974-39, 1 ex., 294.0 mm SL; Cambodia: Stung Treng (holotype of *H. aubentoni*). - MNHN 1974-38, 1 ex., 181.3 mm SL; Cambodia: Battambang (paratype of *H. aubentoni*). - MNHN 1974-40, 1 ex., 359 mm SL; MNHN 1974-41, 1 ex., 454 mm SL; MNHN 1974-42, 1 ex., 446 mm SL; Cambodia: Stung Treng (paratypes of *H. aubentoni*). - UMMZ 213968, 1 ex., 79.4 mm SL; Thailand: Nakhon Phanom province, Mekong River, off Ban Tha Kai, 20 km downstream from Mukdahan, 1 km from Thai side, 5 km from Laos side. - UMMZ 213971, 1 ex., 60.6 mm SL; Thailand: Ubon Ratchathani province, Huay Kwang, S of Khong Chiam, 3 km up Mun River from Mekong-Mun confluence. - UMMZ 213973, 1 ex., 159.2 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, Huay Kwang, 1.5 km upstream from Mun River. - UMMZ 213974, 2 ex., 177.9-200.9 mm SL; Thailand: Ubon fish market. - UMMZ 214369, 1 ex., 237.6 mm SL; Thailand: Ubon Ratchathani province, Khong Chiam district, creek at Ban Tha Mui, mouth into Mekong River. - UMMZ 224950, 1 ex., 38.0 mm SL; Vietnam: Phung Ding province, S side of Can Tho Island, 3 km SE of Can Tho. - UMMZ 232312, 3 ex., 203.5-

286.6 mm SL; Cambodia: Stung Treng morning market (13°30'N 105°58'E). - USNM 317577, 1 ex., 158.3 mm SL; Thailand (15°14'N 104°52'E). - USNM 348912, 1 ex., 221.5 mm SL; Thailand: Ubon Ratchathani province, Mun River at Bung Wai about 7 km W of Ubon. - USNM 317621, 1 ex., Laos: Sithandone Province, morning market at Muang Khong. - ZMA 120.851, 1 ex., 105.7 mm SL; Thailand: Mekong basin, Ubon Ratchathani market.

## APPENDIX 2

### Comparative material

*H. microphthalmus*: ZSI 2592, holotype, 138.9 mm SL; Burma. - AMS B.7918, 1 ex., 164.0 mm SL; Burma. - CAS 93192, 3 ex., 132.0-151.5 mm SL; Myanmar: Ayeryawaddy River drainage, Mandalay markets. - CMK 14706, 1 ex., 204.6 mm SL; Thailand: Tak province, Mae Nam Moei at Mae Sarid (17°26'25"N 98°3'41"E). - NRM 13892, 1 ex., 116.1 mm SL; Myanmar: Mandalay Division, Ayeryawaddy River drainage, Mandalay area. - NRM 24979, 2 ex., 144.6-165.1 mm SL; Myanmar: Sagaing Division, Ayeryawaddy River drainage, Shweli River. - NRM 31072, 1 ex., 147.1 mm SL; Myanmar: Yangon Division, Yangon River at Yangon. - USNM 44754, 1 ex., 158.7 mm SL; Myanmar: Ayeryawaddy River drainage, Mandalay. - USNM 344670, 2 ex., 201.6-239.8 mm SL; Myanmar: Ayeryawaddy River drainage, Mandalay fish markets.

*H. nemurus*: ZRC 41504, 1 ex., 255.0 mm SL; Java: Sungai Sokan at Cibalagung, a probable outlet of the Cirata Reservoir at Citarum. - ZRC 40554, 6 ex., 339.0-390.0 mm SL; West Java.

*H. cf. nemurus*: RMNH 7551, 4 ex., 54.4-272 mm SL; Borneo: Bo (syntypes of *H. fortis*). - RMNH 7552, 1 ex., 197 mm SL; Borneo: Bo (holotype of *H. fortis* var. *capitulum*). - RMNH 7549, 1 ex., 134.5 mm SL; Borneo: Bo (holotype of *H. bo*). - RMNH 7547, 1 ex., 106.4 mm SL; Borneo: Howong (holotype of *H. howong*). - RMNH 7550, 1 ex., 122.7 mm SL; Borneo: Kajan (holotype of *H. kajan*). - ZRC 38753, 4 ex., 131.2-196.5 mm SL; Borneo: Sarawak, Balai Ringin, stalls by roadside next to bridge over Sungai Kerang. - NMBE 1020756, 1 ex., 129.1 mm SL; Sumatra: Palembang (holotype of *H. bleekeri* (non Day)). - ZRC 39032, 7 ex., 122.6-227 mm SL; Sumatra: Riau, Sg. Bengkwan, tributary of Indragiri (Batang Kuantan), 4 hrs downstream from Rengat. - ZRC 39181, 1 ex., 132.4 mm SL; Sumatra: Jambi, Sg. Alai at 19.5 km Muara Bungo-Muara Tebo road. - ZRC 39151, 1 ex., 115.2 mm SL; Sumatra: Jambi, Berbak Nature Reserve, Sungai Air Hitam Dalam. - ZRC 42261, 10 ex., 71.7-123.2 mm SL; Sumatra: Jambi, ca. 15 mins. After Kampung Rantau Panjang along Batang Hari confluence. - CAS 133026, 1 ex., 213.1 mm SL; Malaysia: Johor, Sg. Kayu, 16 miles north of Kota Tinggi (holotype of *H. johorensis*). - CAS 133025, 1 ex., 192.2 mm SL; Malaysia: Pahang, Sg. Garam near Karak (holotype of *H. pahangensis*).