PROC. BIOL. SOC. WASH.
91(1), 1978, pp. 132–157

REVIEW OF THE INDO-PACIFIC PIPEFISH GENUS *HIPPICHTHYS* (SYNGNATHIDAE)

C. E. Dawson

Abstract.—The syngnathine pipefish genus *Hippichthys* Bleeker, 1849 [type-species: *H. heptagonus* Bleeker (= *Syngnathus djarong* Bleeker)] is resurrected from synonymy, diagnosed and shown to be a senior synonym of *Bombonia* Herre, 1927. Descriptions, illustrations, key, nomenclatural discussion and distribution data are given for the three species recognized: *H. heptagonus*, *H. spicifer* and *H. cyanospilus*.

The genus *Hippichthys* Bleeker has historically been confused with other pipefish genera and has been variously treated as valid or relegated to the synonymy of *Syngnathus* Linnaeus, *Corythoichthys* Kaup or *Ichthyocampus* Kaup. This problem has been mentioned briefly in recent reports (Dawson, 1977, 1977a) and I here review *Hippichthys*, including therein three species commonly referred to *Syngnathus* or *Bombonia* Herre. This constitutes one of a series of reviews of tropical pipefish genera which will hopefully provide a foundation for rational analyses of their relationships and distribution.

In *Hippichthys*, point of dorsal-fin origin ranges from center of penultimate trunk ring to center of the 3rd tail ring. Point of dorsal-fin origin, estimated to nearest ¼ of ring length, is recorded (Table 3) in ¼ ring intervals before (+) and after (–) anterior margin of 1st tail ring (O-point). Paired or equivalent pectoral-fin ray counts (Table 2) represent equal counts in right and left fins. Measurements of standard length (SL) or total length (TL) were made to the nearest 0.5 millimeter (mm); trunk depth is the greatest distance between outer margins of superior and median ventral trunk ridges; other counts and measurements follow Dawson (1976). Materials examined are listed by general localities from west to east and roughly north to south; the map delineates general distribution and may not show all collection sites in immediate vicinity of symbols.

Abbreviations for repositories of examined material: AMNH—American Museum of Natural History; AMS—Australian Museum, Sydney; ANSP—Academy of Natural Sciences of Philadelphia; BMNH—British Museum (Natural History); BOC—Bingham Oceanographic Collection, Peabody Museum; BPBM—Bernice P. Bishop Museum; CAS—California Academy of Sciences; CAS-SU—former Stanford University specimens now housed at CAS; FMNH—Field Museum of Natural History; GCRL—Gulf Coast Research Laboratory Museum; HUJ—Hebrew University, Jerusalem; MCZ—Museum of Comparative Zoology, Harvard University; MNHN—Muséum

National d'Histoire Naturelle, Paris; QM—Queensland Museum, Brisbane; RMNH—Rijksmuseum van Natuurlijke Historie, Leiden; RUSI—J. L. B. Smith Institute of Ichthyology, Rhodes University; SMF—Natur-Museum und Forschungs-Institut "Senckenberg," Frankfurt; UMMZ—Museum of Zoology, University of Michigan; USNM—National Museum of Natural History, Smithsonian Institution; UZMK—Universitetets Zoologiske Museum, Copenhagen; ZMA—Zoölogisch Museum, Universiteit van Amsterdam; ZSI—Zoological Survey of India, Calcutta.

Hippichthys Bleeker

Hippichthys Bleeker, 1849:15 (type-species by original designation: *Hippichthys heptagonus* Bleeker, 1849).

Parasyngnathus Duncker, 1915:79 (in part: as subgenus of *Syngnathus*; type-species by original designation: *Syngnathus argyrostictus* Kaup, 1856).

Bombonia Herre, 1927:274 (type-species by original designation: *Bombonia luzonica* Herre, 1927 equals *Hippichthys heptagonus* Bleeker).

Diagnosis.—Superior trunk and tail ridges discontinuous near rear of dorsal fin; lateral tail ridge ends near anal ring; lateral trunk ridge deflected ventrad near anal ring to terminate just above, or unite with, the continuous inferior trunk and tail ridges (Figs. 1 and 4); subadults and adults with deep trunk, venter distinctly V-shaped, usually with prominent median ventral ridge, scutella with or without longitudinal keel; median dorsal snout ridge low, entire; lateral snout ridge present or absent; opercle with complete median longitudinal ridge and low striae radiating above and below; pectoral-fin base not strongly protruding laterad, crossed by two low ridges; body ridges distinct but not deeply notched or indented between rings, margins entire to finely denticulate; devoid of spines, serrae, dermal flaps or papillae; dorsum of trunk and tail flat to somewhat depressed between superior ridges; dorsal-fin base not elevated; dorsal-fin membrane closely bound to fin rays. Head length (HL) 6.9–12.7 in SL; snout length 1.3–2.8 in HL; length of dorsal-fin base 0.8–1.8 in HL; trunk rings 12–16; rings total 45–57; subdorsal rings 4.25–6.25, mostly on tail; dorsal-fin rays 20–30; pectoral-fin rays 13–18; anal fin present; caudal-fin rays 10. Brood pouch under tail, with pouch protective plates; brood-pouch eggs in up to 10–11 transverse rows (typically in single layer), not in continuous gelatinous matrix, and covered by protective folds which meet or overlap on ventral midline; brood-pouch closure the everted type of Herald (1959). Without odontoid processes in jaws (Dawson and Fritzsche, 1975); nares 2-pored bilaterally. Maximum size at least 170 mm SL. Indo-Pacific.

Comparisons.—The *Hippichthys* configuration of principal body ridges is not shared with other genera of syngnathine (tail pouch) pipefishes.

Lateral trunk ridge is deflected to or near the continuous inferior trunk and tail ridges in the superficially similar monotypic genus *Ichthyocampus* Kaup (type-species: *Syngnathus carce* Hamilton Buchanan), but superior trunk and tail ridges are confluent and lateral tail ridge is absent (superior ridges discontinuous, lateral tail ridge present in *Hippichthys*). Lateral trunk ridge may end with deflection of 10–15° in *Bhanotia* Hora but ridge is never strongly deflected as in *Hippichthys*. Specimens of *Hippichthys* have occasionally been referred in error to *Micrognathus* Duncker which also has a lateral tail ridge and deflected lateral trunk ridge. In *Micrognathus*, however, inferior trunk and tail ridges are interrupted near anal ring (continuous in *Hippichthys*) and lateral trunk ridge is confluent with inferior tail ridge. The *Hippichthys* body ridge configuration occasionally occurs as a unilateral (infrequently bilateral) anomaly in the west African *Syngnathus pulchellus* Boulenger (Clausen, 1956; pers. obs.), but caudal-fin rays are typically 9 and lateral trunk ridge typically ends without deflection (caudal rays 10, lateral trunk ridge deflected in *Hippichthys*).

Remarks.—Degree of lateral trunk ridge deflection is variable but the ridge ends just above inferior ridge in most specimens (Figs. 4 and 6), and infrequently reaches and unites with the inferior ridge (Fig. 1).

Brood-pouch eggs of large males are oval, crowded in irregular rows across upper part of pouch folds and dorsum of pouch, with long axes directed toward center of pouch; advanced larvae are often present in pouch of preserved specimens. Among examined material, the smallest egg-bearing male is 75 mm SL, smallest male with developing pouch folds is 59 mm SL, and maximum number of brood-pouch rings is 22. Fielder (1967) described reproductive behavior of aquarium specimens of *H. heptagonus*.

Anal fin small, typically narrow and rays difficult to enumerate; counts range from 2–4 and appear to be modally 2 in *H. heptagonus* (12 counts) and modally 3 in *H. spicifer* and *H. cyanospilus* (17 and 39 counts, respectively).

Ground color of all species tan to dark brown in alcohol, markings brown to nearly black.

Weber and de Beaufort (1922), Duncker and Mohr (1925) and others have reported *H. heptagonus* (as *Syngnathus djarong*) and *Hippichthys spicifer* from estuarine and river habitats, but there are few records of *H. cyanospilus* from low salinity environments. Collections examined here suggest that *H. heptagonus* and *H. spicifer* are euryhaline, whereas *H. cyanospilus* appears restricted to coastal marine or brackish waters. Nineteen samples with reliable data show these species to be taken within the 0–2 m depth range; young of each species have been taken in inshore night-light samples. Although widely distributed (Fig. 3), I have seen neither young nor adults from oceanic collections.

Discussion.—Bleeker (1849) originally described *Hippichthys* as lacking

anal fin and included *H. heptagonus* Bleeker and *Syngnathus spicifer* Rüppell within the genus. Later (1853) he synonymized *Hippichthys* with *Syngnathus*, noted the presence of an anal fin in redescribing the holotype of *heptagonus* and described *Syngnathus djarong* from an unpublished figure by van Hasselt. Kaup (1856), without access to Bleeker's material, incorrectly synonymized *Hippichthys heptagonus* with *Ichthyocampus ponticerianus* Kaup (= *Syngnathus carce* Hamilton Buchanan). As a consequence of this error, *Hippichthys* has been employed as a senior synonym of *Ichthyocampus* by a number of later authors (for further discussion see Dawson, 1977a). Günther (1870) questioned Kaup's action, noting that Bleeker (1859) still considered *Syngnathus heptagonus* as distinct from *Ichthyocampus*, and suggested that *heptagonus* (as *pentagonus* sic) was "one of the varieties of *S. spicifer*." It should here be noted that Bleeker's unpublished manuscript revision of the 'Enumeratio' (see Whitehead et al., 1966:13) has an entry (No. 1994) for "*Ichthyocampus heptagonus*" changed in Bleeker's script to read "*Syngnathus heptagonus*." Thus there seems little doubt that Bleeker recognized *heptagonus* as being distinct from *Ichthyocampus carce*.

Duncker (1915) evidently failed to note Günther's (1870) remarks and retained *Hippichthys heptagonus* without comment in the synonymy of *Ichthyocampus carce*. At the same time he also established *Parasyngnathus* (as a subgenus of *Syngnathus*) and included therein two species groups with differing body ridge configurations. One (including *Syngnathus djarong*, *S. spicifer* and *S. cyanospilus*) was characterized as having lateral trunk ridge subcontinuous with inferior ridge, whereas the other (including the type-species, *S. argyrostictus* Kaup) had lateral trunk ridge subcontinuous with superior tail ridge. Subsequently Herre (1927) described *Bombonia* (*type-species*: *B. luzonica* [= *Syngnathus djarong*]) and Herald (1959) considered this genus (including *S. djarong*, *S. spicifer* and, questionably, *S. cyanospilus*) intermediate between *Syngnathus* and *Micrognathus*. Smith (1963) and most later authors have nevertheless continued to refer these species to *Syngnathus*.

My examination of the Auction Catalogue specimen of *Hippichthys heptagonus* (Hubrecht, 1879), Bleeker's topotypes of *Syngnathus djarong* and Bleeker's unpublished Atlas figure of *S. djarong* shows these forms to be conspecific. Thus *heptagonus* is the senior subjective synonym of *djarong* and *Hippichthys* Bleeker has priority over *Bombonia* Herre.

Pending further study, I consider *Hippichthys* most closely related to *Ichthyocampus*. Among other characters these genera share the complete opercular ridge, deflected lateral trunk ridge, confluent inferior ridges and everted brood-pouch closure. Dorsal-fin origin is typically on 1st–3rd tail ring in *I. carce*, *Hippichthys heptagonus* and *H. spicifer*. Furthermore, all included species commonly occur in coastal, estuarine or low salinity

waters rather than open reef environments. Although lateral ridge configuration is intermediate between *Syngnathus* and *Micrognathus*, I do not believe this character is sufficient to substantiate the phylogenetic relationships implied by Herald (1959).

Key to the genus *Hippichthys*

1. Trunk rings 14–16 (modally 15); total rings 51–57; dorsal-fin origin usually (99%) on tail 2
– Trunk ridges 12–14 (modally 13); total rings 45–48; dorsal-fin origin always on trunk *cyanospilus*
2. Scutella without longitudinal ridge; lateral snout ridge usually prominent (Fig. 1); dorsal-fin origin usually (94%) in advance of 2nd tail ring; HL averages 10 in SL *heptagonus*
– At least some scutella with distinct ridge (Fig. 4); lateral snout ridge vestigial or obsolete; dorsal-fin origin usually (98%) on or posteriad of 2nd tail ring; HL averages 8 in SL *spicifer*

Hippichthys heptagonus Bleeker
Fig. 1

Hippichthys heptagonus Bleeker, 1849:15 (original description; Madura Is., Indonesia).
Syngnathus heptagonus: Bleeker, 1853:5, 23 (new combination).
Syngnathus djarong Bleeker, 1853:22 (original description; Java).
Syngnathus helfrichii Bleeker, 1855:428 (original description; Bandjermasin, Borneo).
Syngnathus spicifer var. *rivalis* Peters, 1869:276 (diagnosis; Philippine Is.).
Syngnathus parviceps Ramsay and Ogilby, 1887:475 (original description; Clarence River, New South Wales, Australia).
Corythroichthys pullus Smith and Seale, 1906:75 (original description; Rio Grande, Mindanao, Philippine Is.).
Syngnathus spicifer var. *djarong* Duncker, 1910:32 (diagnosis).
Syngnathus (*Parasyngnathus*) *djarong*: Duncker, 1915:80 (new combination).
Corythroichthys matterni Fowler, 1918:12 (original description; Philippine Is.).
Syngnathus matterni: Fowler, 1922:442 (new combination).
Bombonia luzonica Herre, 1927:275 (original description; Lake Taal, Luzon, Philippine Is.).
Bombonia uxorius Herre, 1935:395 (original description; Waigiu Is., Indonesia).

Syngnathus djarong luzonica Aurich, 1935:98 (original description; Lake Taal, Luzon, Philippine Is.).
Bombonia djarong: Herald, 1953:232 (new combination).

Diagnosis.—Scutella not keeled; lateral snout ridge usually well developed in subadults and adults; rings total 51–57; pectoral-fin rays modally 15; dorsal-fin origin usually (99%) on tail.

Description.—Dorsal-fin rays 23–30 ($\bar{x}$ = 26.6); pectoral-fin rays 13–16 (14.8); rings 14–15 + 36–42 = 51–57 (54.4); total subdorsal rings 5.0–6.25 (5.6); dorsal-fin origin usually (93%) on 1st tail ring. Proportional data based on 45 specimens 71.5–139.0 ($\bar{x}$ = 96.7) mm SL follow: HL in SL 8.6–12.7 (10.17); snout length in HL 1.9–2.8 (2.40); snout depth in snout length 2.6–4.4 (3.37), 29 fish; length of dorsal-fin base in HL 0.8–1.4 (1.08); anal ring depth in HL 3.1–4.7 (3.92), 19 fish; trunk depth in HL 2.0–2.8 (2.36); pectoral-fin length in HL 5.8–7.1 (6.55), 13 fish. See Tables 1–4 for additional counts and measurements.

Lateral snout ridge distinct in most subadults and adults; scutella without longitudinal keel.

Color in alcohol variable (Fig. 2), often without distinctive markings. Ground color tan to dark brown; dorsum of head brownish; lower half of snout and venter of head often pale, with or without irregular row of brown spots or blotches on side of snout; some specimens with dark stripe on side of snout and diagonal dark bar crossing opercle from rear margin of orbit; sides and dorsum of body plain, mottled, or with indications of irregular pale bars; venter of trunk most commonly dusky brown, shading to near black on median ridge, infrequently with faint indications of brownish bars crossing venter; dorsal fin not distinctly spotted, usually hyaline but infrequently with rays streaked with brown; pectoral fin hyaline or streaked with brown; caudal fin brown with narrow pale margin.

Comparisons.—*Hippichthys heptagonus* is most readily separated from congeners by characters in key. At lengths above 70 mm SL, head length is relatively shorter than that of either *H. spicifer* or *H. cyanospilus* (Table 4). Dorsal-fin origin on 1st tail ring and modally 15 pectoral rays permit ready separation of most juvenile *H. heptagonus* from young *H. spicifer* wherein dorsal fin usually originates on 2nd tail ring and pectoral rays are modally 17.

Types.—Bleeker's (1849) description of the holotype of *Hippichthys heptagonus* (101 mm TL) notes the presence of 50–55 rings, 23 dorsal, 12 pectoral and 10 caudal-fin rays; anal fin is stated to be absent and lack of comment on brood pouch suggests that the specimen was a female. In redescribing this specimen, Bleeker (1853) recorded 14 trunk and 39 tail rings, noted the presence of 3–4 anal-fin rays and changed his count of pectoral-

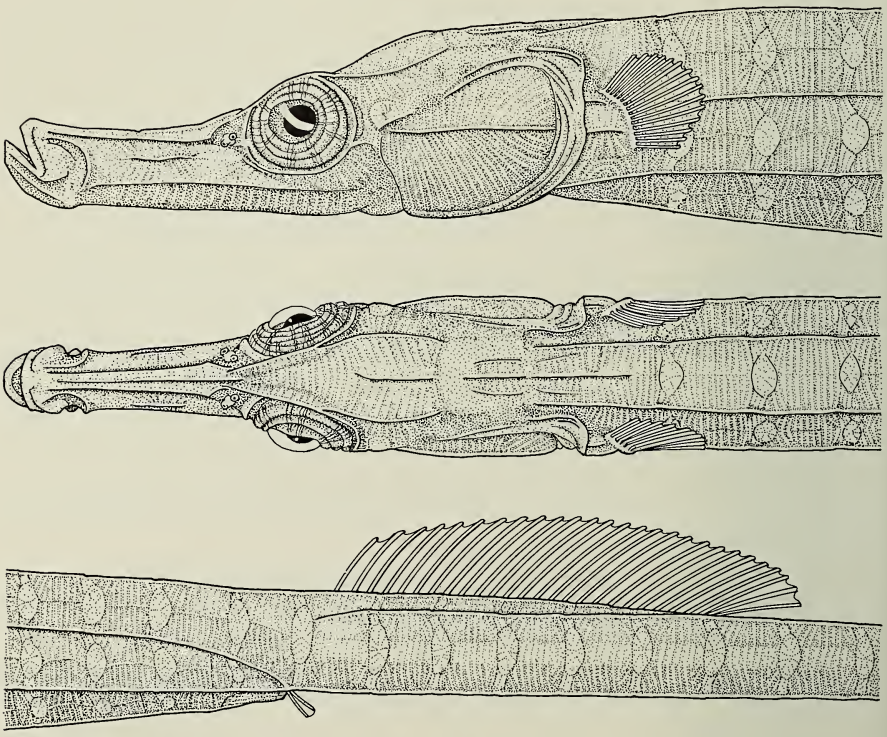

Fig. 1. *Hippichthys heptagonus.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. From 96 mm SL female, GCRL 15529.

fin rays to 15; dorsal fin was stated to originate on the 3rd tail ring and end on the 8th. Bleeker subsequently reported *H. heptagonus* (as *Syngnathus heptagonus*) from Java (1858) and Bali (1858–59) but failed to mention numbers or lengths of specimens and did not add to his earlier descriptions. Although Bleeker appears to have had at least three specimens of *Hippichthys heptagonus*, Günther (1870) stated that the holotype was not received at the British Museum. Hubrecht (1879) listed only one specimen (A series) in the Auction Catalogue and the fate of other specimens is unknown.

The Auction Catalogue specimen (RMNH 7234) lacks the distal third of caudal fin, and dorsal fin and dorsum of anterior subdorsal ring are damaged. I estimate total length at about 94–95 mm and dorsal rays about 23. Both pectoral fins are damaged, only rudiments of anal fin persist, there are 10 caudal-fin rays and 15 + 41 rings; dorsal fin evidently originated near anterior fourth of 1st tail ring and ended near posterior margin of 6th tail ring (subdorsal rings total ca. 5.75). This fish is about 5 mm shorter

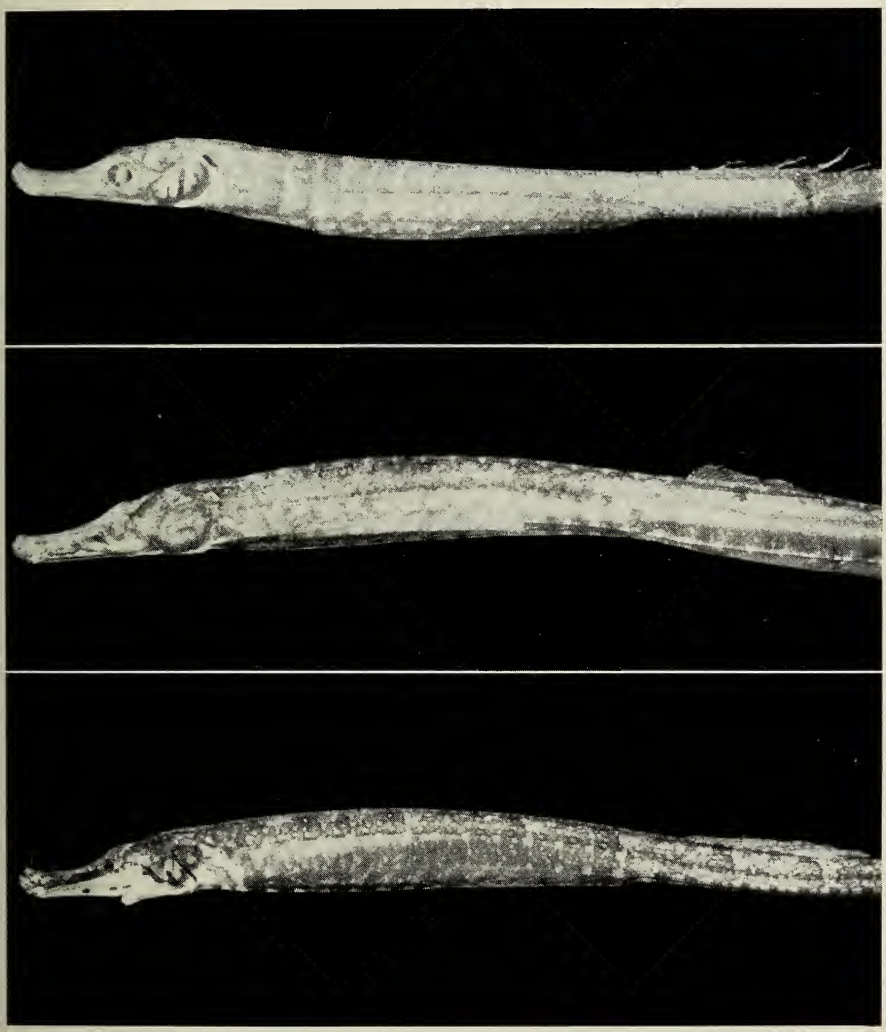

Fig. 2. *Hippichthys heptagonus* Bleeker. Top: RMNH 7234 (91.5 mm SL, female, neotype). Middle: Male, 103 mm SL. Bottom: Female, 96 mm SL (both GCRL 15529; New Guinea).

than the holotype of *heptagonus* and further differs from Bleeker's (1853) description in having more rings (56 versus 53) and in dorsal-fin origin on 1st tail ring rather than on 3rd. None of the extant Bleeker specimens, here referred to *Hippichthys*, have 14 trunk rings, this count is infrequent in other examined material (Table 1) and the holotype of *H. heptagonus* may well have had 15 rather than the described 14 trunk rings; adjustment

for this would place dorsal-fin origin on 2nd rather than 3rd tail ring. These differences indicate that the Auction Catalogue specimen is not the holotype and evidently originated from the Bali or Java collections. In the absence of syntypic material I designate this fish (RMNH 7324) as the neotype of *Hippichthys heptagonus* Bleeker, 1849. Measurements (mm) of this 91.5 mm SL female (Fig. 2) follow: head length 10.2, snout length 4.6, minimum snout depth 1.2, anal ring depth 2.2, trunk depth 3.6.

Bleeker (1853) described *Syngnathus djarong*, without mention of brood pouch, from an unpublished 94 mm figure by van Hasselt. Bleeker's (1854) redescription, including reference to pouch location, was based on two topotypes (75 and 95 mm TL) from Panimbang, Java. Known Bleeker specimens of *S. djarong* now include BMNH 1867.11.28.346, a badly damaged fish about 80 mm SL erroneously referenced as the holotype by Duncker (1915), and two Auction Catalogue specimens (RMNH 7233). One of these (estimated at about 70 mm SL) is in pieces and part of the tail is missing, the other is a 90 mm SL male. Since a male is included and lengths are in close agreement, I consider these to be Bleeker's Panimbang specimens. This male would also appear to be the model for the 97 mm illustration (plate 450, fig. 7) of *S. djarong* in the unpublished Bleeker Atlas; the van Hasselt figure is evidently lost.

Two fish (103 and 133 mm TL) were included in the original description of *Syngnathus helfrichii*. There is a Bleeker specimen (99 mm SL) labeled "type" in the British Museum (BMNH 1867.11.28.348) and there are two Auction Catalogue specimens (107 and 129 mm SL) in the Rijksmuseum (RMNH 7232). The smaller of these does not agree with Bleeker's original length range and I consider the 129 mm fish and the British Museum specimen to be syntypes of *S. helfrichii*; the smaller Auction Catalogue specimen may have come from Sumatra (Bleeker, 1859–60).

Duncker (1915) and Munro (1958) tentatively referred *Syngnathus parviceps* to the synonymy of *S. djarong*. Ramsay and Ogilby (1887) described 14 pectoral and 7 caudal-fin rays in the holotype of *S. parviceps* (AMS I.191) and stated that "egg-pouch is rather more than half the length of the tail" and "dorsal fin commences on the first, and extends over seven caudal rings." I have examined the single specimen now in AMS I.191 and find it to be a 101.5 mm SL female with 10 caudal rays, 15 rays in each pectoral fin and dorsal fin located on 0 + 6 rings. This fish is conspecific with *Hippichthys heptagonus*, it agrees with the original description in number of dorsal-fin rays, ring counts and total length, but absence of brood pouch suggests that it may not be the holotype of *Syngnathus parviceps*. Ramsay and Ogilby may have had more than one specimen, thus accounting for remarks on brood pouch but this is not stated in their description. Despite this apparent discrepancy, the description of *S. parviceps* indicates no differences from *Hippichthys heptagonus* and I consider these forms to be conspecific.

The type-material of *Bombonia luzonica* was destroyed during World War II (Herre, 1953) and types were apparently not designated for nominal varieties or subspecies; I have examined the types of all other species included in the synonymy.

Duncker (1915) and Weber and de Beaufort (1922) tentatively referred *Microphis tenuis* Blyth to the Synonymy of *Hippichthys spicifer*. Blyth (1859:272) based his description on two specimens, less than 4 inches long, from the Andaman Is. Ridge configurations were not described and there was no illustration. The reported combination of dorsal-fin location on 1st seven tail rings, counts of 16 + 36 rings, "24?" dorsal, "16?" pectoral and "9?" caudal-fin rays and somewhat banded color pattern is applicable to several Indian Ocean pipefishes. In the absence of type-material (evidently lost), diagnostic description or illustration I treat *Microphis tenuis* as a nomen dubium.

Remarks.—Sixteen egg-bearing males (78–129 mm SL) had brood pouches developed beneath 14–17 rings; thirty-two other males (73–140 mm SL) had pouches below 13–20 ($\bar{x}$ = 15.7) rings. A 103 mm fish contained eggs in single layer of up to 6 transverse rows and there were 61 eggs in outer right row of the 16 ring pouch.

Eighteen fish from Lake Taal (= Lake Bombon), Luzon Is. (FMNH 47470; UMMZ 100341–2) have tail ring counts of 36–38 ($\bar{x}$ = 36.9), whereas this count is 39–41 (39.8) in 29 specimens from other Philippine localities. In other features, the Lake Taal material agrees with other samples of *H. heptagonus* and I consider these populations conspecific. Study materials show no other significant geographic variations in meristics or coloration.

On the basis of examined material, *H. heptagonus* is presently known from the east coast of Africa to the Solomon Is. (Fig. 3). This species commonly occurs in rivers, streams, estuaries and harbors and it has been taken with *H. spicifer* in some Philippine collections.

Material examined.—136 specimens, 46–140 mm SL, including neotype.

Neotype.—RMNH 7234 (91.5 mm SL, female), Indonesia.

Other material.—INDIAN OCEAN—East Africa (St. Lucia, S. Afr. and Kenya): RUSI 5730. Ceylon: RMNH 20892. USNM 217537–38, 217546. Indonesia: ZMA 102.049, 113.267, 114.944, 114.950, 114.952. PACIFIC OCEAN—Singapore: FMNH 47194. Philippine Is. ANSP 47484 (holotype of *Corythroichthys matterni*). FMNH 47470. RMNH 27593. UMMZ 100341–42. USNM 55621 (holotype of *C. pullus*), 139066–68, 139073, 139078, 139081, 139083, 139085, 139087, 139091, 139093, 139098, 139100. Indonesia: BMNH 1867.11.28.346, 1867.11.28.348 (syntype of *Syngnathus helfrichii*). CAS-SU 25764 (paratype of *Bombonia uxorius*). FMNH 17493 (holotype of *B. uxorius*). MCZ 30477. RMNH 7232 (2, including 129 mm SL syntype of *Syngnathus helfrichii*), 7233. USNM 217547. ZMA 113.265, 114.946, 114.951. New Guinea: ANSP 81569. BPBM 15834. GCRL 15529. RMNH 27537, 37585.

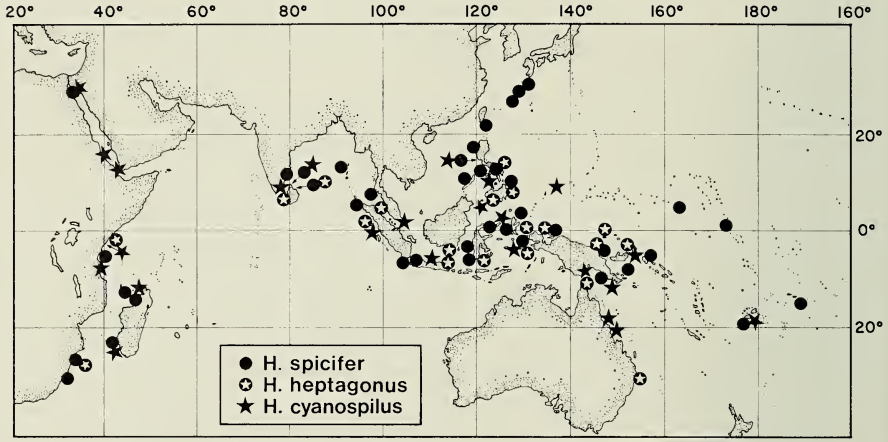

Fig. 3. Distributions of species of *Hippichthys* as determined from material examined.

USNM 217472–74, 217536. Admiralty Is.: USNM 143632. Bismarck Arch., New Britain: USNM 217480. Australia, Queensland: QM I.437. New South Wales: AMS I.191 (putative holotype of *S. parviceps*), I.19341-001. Solomon Is., Guadalcanal: USNM 217523.

Hippichthys spicifer (Rüppell)
Fig. 4

Syngnathus spicifer Rüppell, 1838:143 (original description; Tor, Red Sea).
Syngnathus gastrotaenia Bleeker, 1852:713 (original description; Wahai, Ceram).
Syngnathus tapeinosoma Bleeker, 1854a:375 (original description; Anjer, Java).
Syngnathus hunnii Bleeker, 1860:70 (original description; Tandjong, Sumatra).
Syngnathus gracilis Steindachner, 1903:458 (original description; Ternate).
Corythroichthys spicifer: Jordan and Seale, 1907:9 (new combination).
Syngnathus spicifer var. *gastrotaenia* Duncker, 1910:32 (diagnosis).
Syngnathus (*Parasyngnathus*) *spicifer*: Duncker, 1915:79 (new combination).
Hippichthys spicifer: Jordan, Evermann and Clark, 1930:243 (new combination).
Micrognathus suvensis Herre, 1935:396 (original description; Suva, Fiji Is.).
Doryichthys suvensis: Herald, 1953:232 (new combination).
Bombonia spicifer: Herre, 1953:204 (new combination).

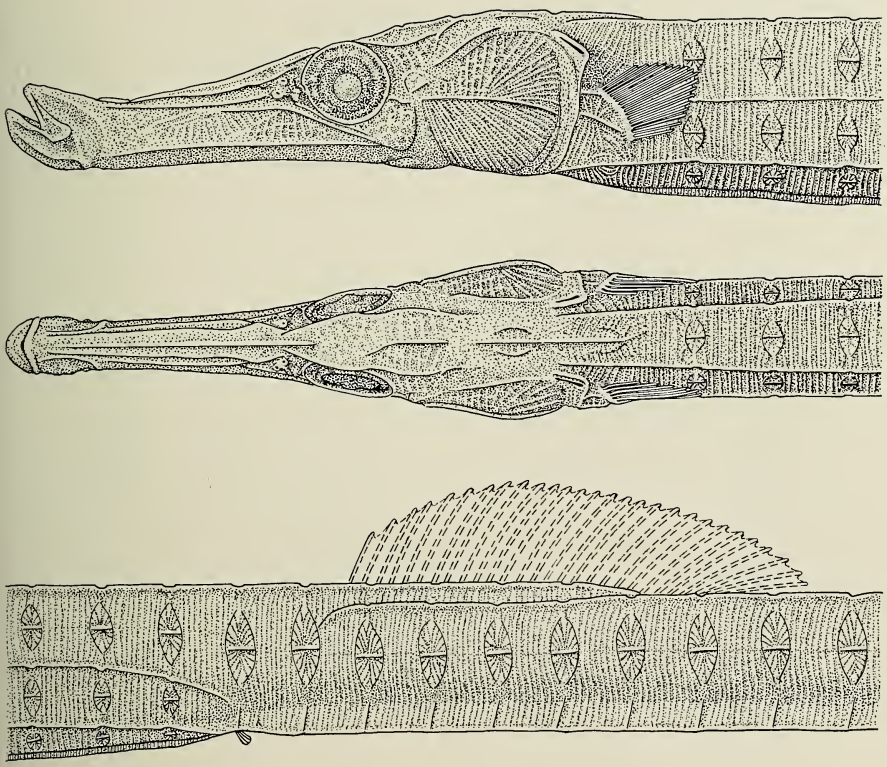

Fig. 4. *Hippichthys spicifer.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. Note longitudinal ridges on scutella. From 130 mm SL male, GCRL 15530.

Diagnosis.—Scutella keeled in subadults and adults; lateral snout ridge vestigial or obsolete; rings total 51–56; pectoral-fin rays modally 17; dorsal-fin origin always on tail.

Description.—Dorsal-fin rays 25–30 ($\bar{x}$ = 27.8); pectoral-fin rays 15–18 (17.1); rings 14–16 + 36–41 = 51–56 (53.5); total subdorsal rings 5.0–6.0 (5.6); dorsal-fin origin usually (93%) on 2nd tail ring. Proportional data based on 63 specimens 80.5–170.5 ($\bar{x}$ = 110.9) mm SL follow: HL in SL 6.9–10.3 (8.09); snout length in HL 1.8–2.1 (1.99); snout depth in snout length 3.6–5.7 (4.64), 47 fish; length of dorsal-fin base in HL 1.1–1.8 (1.41); anal ring depth in HL 3.1–6.0 (4.65), 40 fish; trunk depth in HL 2.3–4.1 (2.94), 39 fish; pectoral-fin length in HL 6.2–8.6 (7.44), 23 fish. See Tables 1–4 for additional counts and measurements.

Lateral snout ridge usually obsolete; scutella typically with a low but distinct longitudinal ridge (Fig. 4).

Table 1. Frequency distributions of trunk, tail and total rings in species of *Hippichthys*.

Character	Species		
	heptagonus	*spicifer*	*cyanospilus*
Trunk rings			
12			1
13			168*
14	3	5	5
15	123*	178	
16		1	
Tail rings			
32			11
33			90
34			63*
35			10
36	4	4	
37	11	17	
38	5	66	
39	36	69	
40	47	27	
41	21*	1	
42	2		
Total rings			
45			10
46			90
47			62*
48			12
49			
50			
51	4	4	
52	11	17	
53	6	69	
54	35	67	
55	48	26	
56	20*	1	
57	2		

* Primary type.

Color in alcohol tan to dark brown; dorsum of head, opercle and upper half of snout plain or mottled; lower half of snout usually pale, often flecked or rather distinctly spotted with brown. Body variably plain brownish, mottled or with prominent brown bars crossing lower half of side and venter of trunk (Fig. 5); trunk bars sometimes present in small specimens (ca. 80 mm SL), absent or obscured by generally dark ground color in some adults.

Table 2. Frequency distributions of dorsal and pectoral-fin rays and paired (equivalent) pectoral ray counts in species of *Hippichthys*.

Character	Species		
	heptagonus	*spicifer*	*cyanospilus*
Dorsal-fin rays			
20			2
21			3
22			52
23	2		95*
24	1		24
25	17	2	2
26	36	9	1
27	34	49	
28	18	76	1
29	5	31	
30	1	8	
Pectoral-fin rays			
13	2		15
14	42		115*
15	104	2	130
16	20	55	19
17		140	
18		80	
19			
Paired pectoral counts			
13			5
14	6		46
15	25	1	50
16		16	7
17		45	
18		22	

* Primary type.

Dorsal and pectoral fins hyaline or flecked with brown, not distinctly spotted; caudal fin brown, with narrow pale margin.

Comparisons.—Hippichthys spicifer is readily separated from subadult and adult congeners by characters in the key and diagnosis. The keeled scutella, present on at least some rings in specimens as small as 66 mm SL, are unusual among syngnathine (tail-pouch) pipefish and materially aid in identification of this species. Head length of subadults and adults is relatively longer than that of congeners (Table 4). Juveniles are superficially similar to young *H. heptagonus* but differences in counts of pectoral

Table 3. Frequency distributions for point of dorsal-fin origin and total subdorsal rings in species of *Hippichthys*. Plus (+) indicates dorsal-fin origin in advance of O-point (anterior margin of 1st tail ring); minus (–) indicates origin behind O-point.

Character	Species		
	heptagonus	*spicifer*	*cyanospilus*
Point of dorsal-fin origin			
+1.50			3
+1.25			13
+1.00			89
+0.75			67
+0.50			12*
+0.25	1		3
0.00	35		
–0.25	26		
–0.50	47		
–0.75	17	4	
–1.00	8	12	
–1.25		57	
–1.50		83	
–1.75		27	
–2.00		6	
–2.25		2	
–2.50		2	
Total subdorsal rings			
4.25			1
4.50			2
4.75			27*
5.00	3	8	82
5.25	14	27	49
5.50	46	86	22
5.75	45	55	3
6.00	24	17	1
6.25	2		

* Primary type.

rays and dorsal-fin position (see Comparisons under *heptagonus*) permit identification of most individuals.

Types.—I have seen only one Rüppell specimen of *Hippichthys spicifer* but the original description and figure (Rüppell, 1838, Pl. 33, fig. 4) adequately characterize the species. Figured configuration of body ridges is clearly that of *Hippichthys*, and the slender snout and described abdominal bars are characteristic of specimens here referred to *H. spicifer* rather than *H. heptagonus*. Rüppell's ring count of 56 and figured dorsal-fin origin on tail prevent referral of his specimen to *H. cyanospilus* wherein there are 45–

Table 4. Measurements (mm) and regression equations for head length against standard length and snout length against head length in species of *Hippichthys*. ($\bar{x}$ = mean; σ = standard deviation; r = coefficient of correlation).

Species	N	Standard length			Head length			r	Regression equation
		Range	$\bar{x}$	σ	Range	$\bar{x}$	σ		
heptagonus	45	71.5–139.0	96.7	15.4	7.5–15.3	9.6	1.8	0.8878	$y = -0.3589 + 0.1263x$
spicifer	63	80.5–170.5	110.8	19.5	8.4–21.9	13.9	3.2	0.9502	$y = -3.4406 + 0.1568x$
cyanospilus	56	47.5–156.0	107.1	23.1	5.7–16.4	12.2	2.5	0.9662	$y = 1.1476 + 0.1036x$
		Head length			Snout length				
		Range	$\bar{x}$	σ	Range	$\bar{x}$	σ		
heptagonus	45	7.5–15.3	9.6	1.8	2.8– 7.9	4.0	1.1	0.9862	$y = -1.7642 + 0.6079x$
spicifer	63	8.4–21.9	13.9	3.2	4.0–11.5	7.0	1.8	0.9950	$y = -0.9272 + 0.5726x$
cyanospilus	56	5.7–16.4	12.2	2.5	2.5– 7.6	5.6	1.2	0.9549	$y = -0.0540 + 0.4639x$

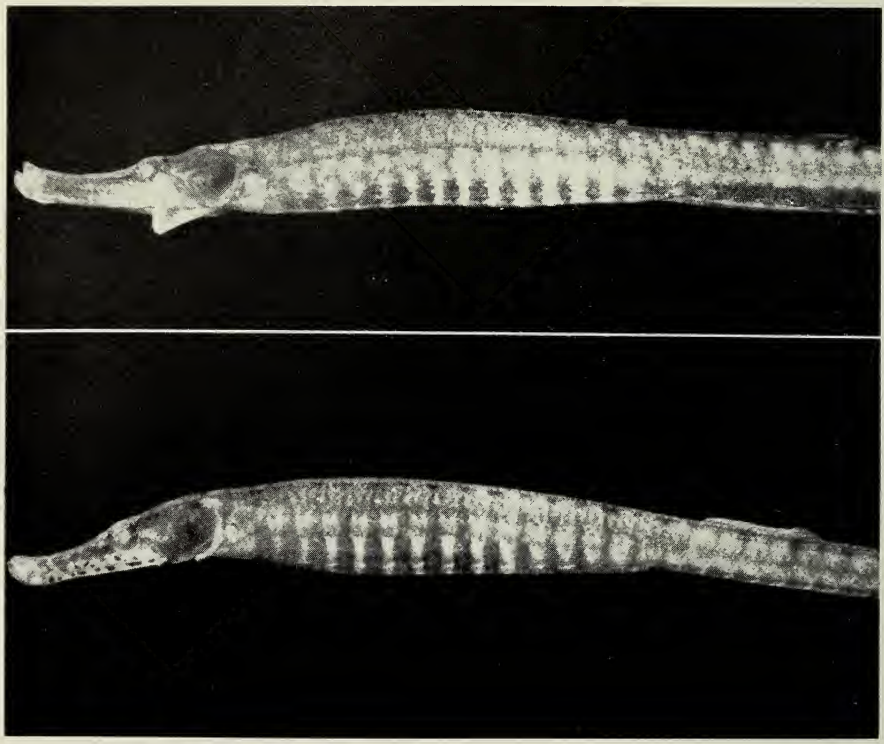

Fig. 5. *Hippichthys spicifer* (Rüppell); New Guinea. Top: USNM 217539, male, 170.5 mm SL. Bottom: USNM 217540, female, 110.5 mm SL.

48 rings and dorsal-fin origin is always on trunk. Rüppell's count of 16 trunk rings and statement that dorsal-fin origin is opposite anus are probably errors in observation. His figure shows dorsal fin originating at anterior margin of 1st tail ring (a position not found in other *spicifer*) and 16 trunk rings occur in only 3 percent of specimens examined here. The figured specimen is a male and careful examination is often required to correctly locate the anus and anal ring in relation to pouch plates, pouch folds and dorsal-fin origin. It seems likely that this fish actually had 15 trunk rings and this count would place dorsal-fin origin on 2nd tail ring, the usual location in *H. spicifer*. A pencil-marked 135 mm SL male syntype (SMF 4908) has 15 + 39 rings, 28 dorsal-fin rays and 6 subdorsal rings beginning at anterior margin of 2nd tail ring. I have not seen a second Rüppell specimen in the SMF collection.

Bleeker (1852) described *Syngnathus gastrotaenia* from five apparently female fish (102–125 mm TL) from Ceram and subsequently reported additional specimens from Borneo (1861), Halmahera (1867) and New Guinea

(1878). Known Bleeker specimens now include a 110 mm SL male (BMNH 1867.11.28.347) and five fish in RMNH 7230. The latter, possibly the combination of the 4 specimens in A series and the single B series specimen in the Auction Catalogue, included two egg-bearing males (100.5–133.5 mm SL) and three females (100–120 mm SL). The males are evidently not syntypes, the fate of Bleeker's smallest specimen (102 mm TL) is unknown, and the three Leiden females (100–120 mm SL) are presumably the only extant syntypes.

Syngnathus tapeinosoma was described from a single, presumably female, specimen (99 mm TL) and there is no evidence that additional specimens were obtained by Bleeker. The single Auction Catalogue specimen (RMNH 7229) is in poor condition, but it generally agrees with the description and is here considered the holotype. Similarly, *Syngnathus hunnii* was described from a single male (140 mm TL), and the 133 mm SL male Auction Catalogue specimen (RMNH 7231) is without doubt the holotype.

Type-material of *Micrognathus suvensis* includes the 89 mm SL holotype (FMNH 17229) and one 84 mm SL paratype (CAS-SU 24432). These juveniles are largely faded but keeled scutella are present and they are clearly conspecific with *Hippichthys spicifer*. I have not seen the holotype of *Syngnathus gracilis* but Steindachner's (1903) description and figure (Pl. 18, fig. 1) are clearly based on a young *Hippichthys spicifer*.

Remarks.—Thirteen egg-bearing males (99–170 mm SL) had brood pouches developed beneath 18–21 rings; twenty-six other males (91–147 mm SL) had pouches beneath 12–22 ($\bar{x}$ = 18.0) rings. A 130 mm fish contained eggs in single layer of up to 10 transverse rows, and there were 90 eggs in the outer right row along 18 rings of the 20-ring pouch. I find no significant geographic variation in meristics or coloration in studied specimens.

Although originally described from the Red Sea, I have seen but two specimens from that area and there are apparently only two other Red Sea records of *H. spicifer* (and *Syngnathus tapeinosoma*); Klunzinger (1871) from Kosseir, and Picagalia (1894) from Assab. Regan's (1908) record from Tehuantepec (Mexico) is without doubt erroneous; I have been unable to locate his specimens in the BMNH collections.

Whitehead and Talwar (1976) list two ZSI catalog numbers (2623, 7163) for possible type-specimens of *Microphis bleekeri* Day [= *Oostethus brachyurus* (Bleeker)]. Dr. Talwar advises (pers. comm.) that ZSI 7163, model for the illustration of *Microphis bleekeri* (Day, 1878, Pl. 174, fig. 3), is presently not traceable in the ZSI collection. My examination of ZSI 2623 shows it to be a badly damaged egg-bearing male *Hippichthys spicifer*. Day's (1865) description of *Microphis bleekeri* is clearly diagnostic and it would appear that a curatorial error occurred when this specimen was originally registered in October 1879.

Materials examined (Fig. 3) range from the Red Sea to Samoa. This species has not been found in studied Australian collections, but it should be expected to occur in Queensland and along the northern coast. Examined specimens are from coastal, estuarine and river habitats; *H. spicifer* has been taken with *H. heptagonus* and *H. cyanospilus* in separate Philippine collections.

Material examined.—261 specimens, 59–170 mm SL, including one syntype.

Syntype.—SMF 4908 (135.0 mm SL, male), Red Sea, Gulf of Suez, Sinai, Tor.

Other material.—RED SEA.—Egypt, Kosseir: SMF 964. INDIAN OCEAN.—South Africa, Natal: ANSP 64051, 64053. RUSI 5719. Mozambique: RUSI 5716, 74–78. ZMA 110.038. Zanzibar: MCZ 52495. MNHN 6137. Comoro Is.: USNM 217491. Madagascar: GCRL 14823. MNHN 0710, 91673, 1965-348. UMMZ 185427, 185467, 185843. USNM 217485–87. India, Pondichery: MNHN 6136. ZSI 2623 (registered as possible type of *Microphis bleekeri*). Ceylon: GCRL 15530. USNM 217542–43. Andaman Is.: RMNH 8819. Thailand, Phuket: USNM 217483–84. Indonesia: RMNH 7229 (holotype of *Syngnathus tapeinosoma*), 7231 (holotype of *S. hunnii*). ZMA 114.945. PACIFIC OCEAN.—Taiwan: USNM 217548. Philippine Is.: CAS-SU 27681. USNM 56280, 112912, 137281–84, 139065, 139069, 139071, 139074–75, 139077, 139080, 139082, 139084, 139086, 139088–90, 139092, 139095–97, 139101, 139104, 139106, 217513–15. Indonesia: BMNH 1867.11.28.347. BPBM 19440. FMNH 23474–79. RMNH 4426, 7230 (in part, syntypes of *S. gastrotaenia*), 21093. USNM 137285, 139107. ZMA 104.666, 108.360, 113.266. Japan, Ryukyu Is.: GCRL 15550–51. USNM 132789. Tanagashima: GCRL 15549. New Guinea: BPBM 15830. GCRL 15545. RMNH 25093, 27536, 27589. USNM 217468–71, 217539–41. Solomon Is., Bougainville: USNM 217488. Caroline Is., Kusaie: USNM 65806. Gilbert Is., Tarawa: BPBM 10437. Fiji Is.: ANSP 81601. BPBM 14548. CAS-SU 24432 (paratype of *Micrognathus suvensis*). FMNH 17229 (holotype of *M. suvensis*). GCRL 13196, 14245. USNM 217489–90. Samoa Is.: AMNH 18110.

Hippichthys cyanospilus (Bleeker)
Fig. 6

Syngnathus cyanospilos Bleeker, 1854b:114 (original description; Indonesia, Banda Neira).

Syngnathus mossambicus Peters, 1855:277 (original description; Mozambique).

Syngnathus kuhlii Kaup, 1856:34 (original description; based on Indonesian specimens collected by Kuhl and van Hasselt).

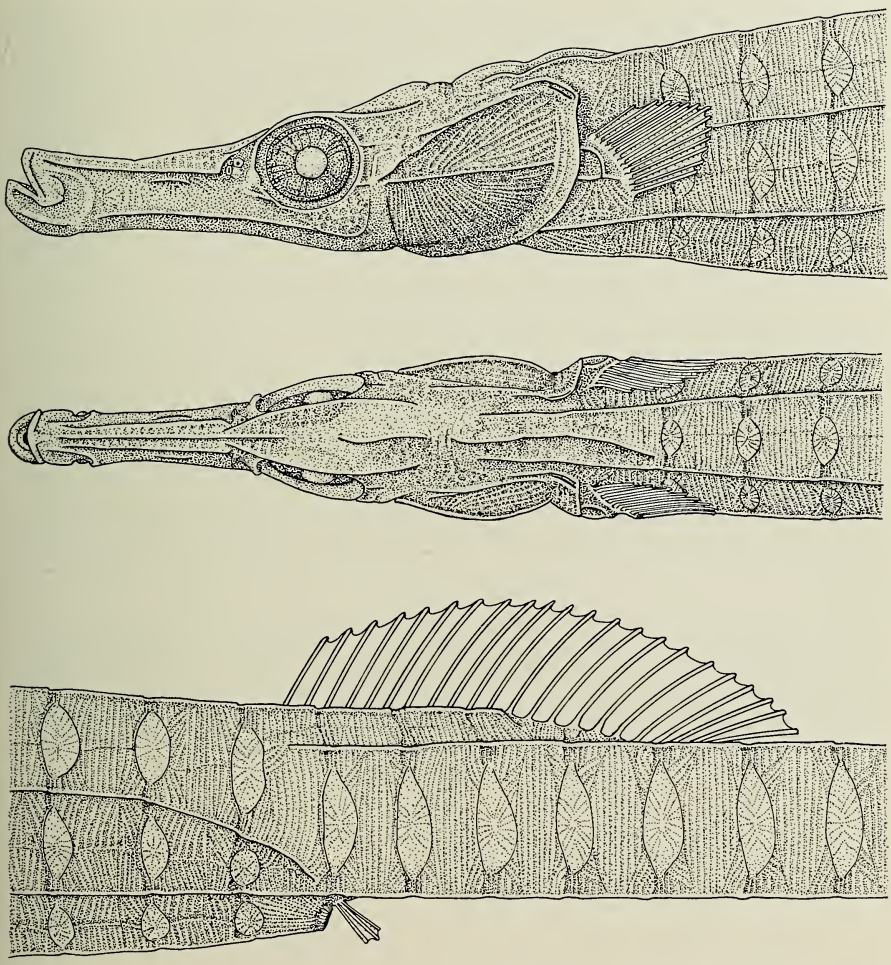

Fig. 6. *Hippichthys cyanospilus.* Top and middle: Lateral and dorsal aspects of head and anterior trunk rings. Bottom: Section of body illustrating ridges, dorsal and anal fins. From 123 mm SL female, GCRL 14822.

Doryichthys spaniaspis Jordan and Seale, 1907:10 (original description; Cavite, Philippine Is.).

Syngnathus (*Parasyngnathus*) *cyanospilus*: Duncker, 1915:81 (new combination).

Parasyngnathus wardi Whitley, 1948:77 (original description; Lindeman Is., Queensland, Australia).

Syngnathus wardi: Munro, 1958:83 (new combination).

Diagnosis.—Scutella not keeled; lateral snout ridge usually distinct; rings total 45–48; pectoral-fin rays modally 15; dorsal-fin origin always on trunk.

Description.—Dorsal-fin rays 20–28 ($\bar{x}$ = 22.8); pectoral-fin rays 13–16 (14.6); rings 12–14 + 32–35 = 45–48 (46.4); total subdorsal rings 4.25–6.0 (5.1); dorsal-fin origin on 0.25–1.5 (0.9) trunk rings. Proportional data based on 56 specimens 47.5–156.0 ($\bar{x}$ = 107.1) mm SL follow: HL in SL 7.5–9.8 (8.73); snout length in HL 1.3–2.6 (2.19); snout depth in snout length 3.0–5.4 (3.63); length of dorsal-fin base in HL 1.0–1.6 (1.27); anal ring depth in HL 2.3–5.2 (3.02), 47 fish; trunk depth in HL 1.8–2.8 (2.26), 46 fish; pectoral-fin length in HL 4.8–7.4 (5.90), 38 fish. See Tables 1–4 for additional counts and measurements.

Lateral snout ridge distinct in most subadults and adults; scutella not keeled.

Ground color in alcohol tan to dark brown. Lower portion of snout usually pale (Fig. 7); dorsum and sides of body and head plain, mottled or blotched; venter of trunk without transverse bars, often brownish, shading to near black along median ridge; pectoral fins hyaline or spotted; dorsal fin typically with 3–4 prominent brown spots on each ray; caudal fin brown with narrow pale margin.

Comparisons.—Relative head length of *H. cyanospilus* is roughly intermediate between that of *H. heptagonus* and *H. spicifer* (Table 4). The modal trunk ring count of 13 and total ring count of 45–48 clearly distinguish *H. cyanospilus* from congeners wherein these counts are 15 and 51–57, respectively. It shares a modal count of 15 pectoral rays with *H. heptagonus* (modally 17 in *spicifer*) but *H. cyanospilus* usually has fewer dorsal-fin rays (modally 23) than either congener (modally 26 or 27). Dorsal-fin origin on 1st or 2nd trunk ring further separates *H. cyanospilus* from all *H. spicifer* (origin always on tail) and most *H. heptagonus* (99% on tail). The strongly spotted dorsal-fin rays of *H. cyanospilus* are not found in either congener, and this species lacks the bars on venter and sides of trunk occurring in many *H. spicifer* and some *H. heptagonus*.

Types.—The holotype of *Syngnathus cyanospilus* (RMNH 7228) is a faded 115.5 mm SL male with pouch folds below 15 rings; pencil marks suggest that this fish was the model for the illustration (plate 450, fig. 6) of *S. cyanospilus* in the unpublished Bleeker Atlas. Measurements (mm) follow: HL 13.7, snout length 6.7, snout depth 1.6, length of dorsal-fin base 9.9, anal ring depth 5.0, trunk depth 5.6; see Tables 1–4 for counts.

Kaup's (1856) description of *Syngnathus kuhlii* was based on a male fish from Java in the Paris Museum and seven specimens in the Leiden collection; Kaup listed *S. variegatus* Kuhl and van Hasselt Ms. as a junior synonym. Search of the Rijksmuseum collection has failed to locate the Leiden specimens mentioned by Kaup. There are now only two Kuhl and van Hasselt

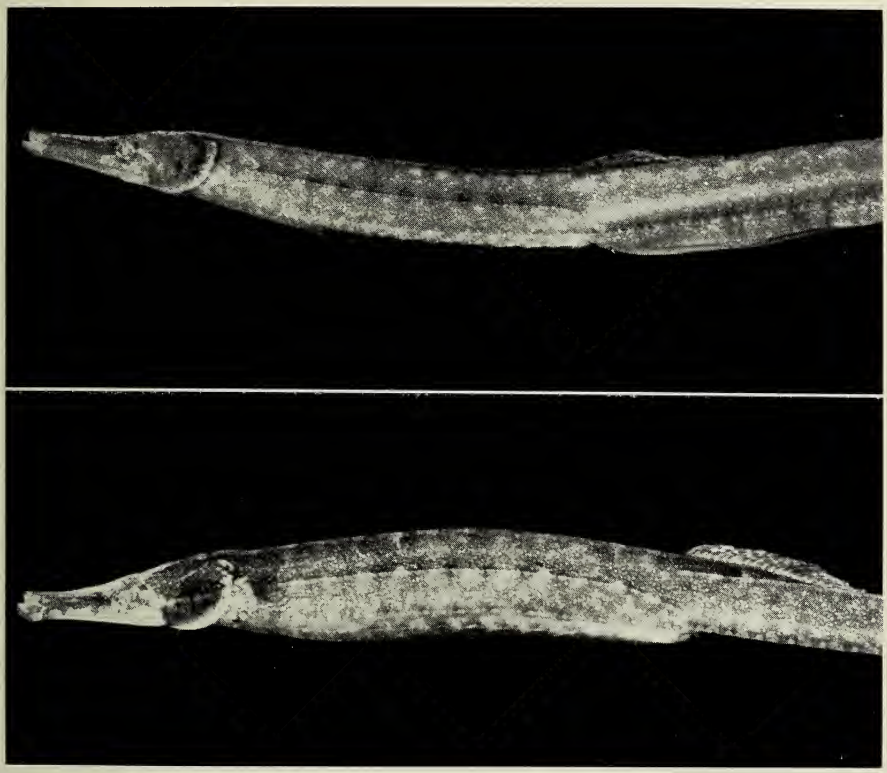

Fig. 7. *Hippichthys cyanospilus* (Bleeker). GCRL 14822, New Guinea. Top: Male, 109.5 mm SL. Bottom: Female, 123 mm SL.

specimens of "S. *variegatus*" (RMNH 3862) and these are conspecific with *S. acus* L. A 98 mm SL male in Paris (MNHN 6138) is apparently the only extant syntype of *S. kuhlii*.

I have examined the holotype (AMS IB.1911) and six paratypes of *Parasyngnathus wardi* and all are conspecific with *Hippichthys cyanospilus*. Whitley (1948) reported 9 caudal rays and 14 + 36 rings in the holotype but I count 10 caudal rays in all specimens and 13 + 35 rings in the holotype.

I have not seen the holotype of *Syngnathus mossambicus* but Peters (1855) description of 13 trunk rings, 47 total rings, 23 dorsal rays and dorsal-fin origin on last trunk ring is diagnostic of *Hippichthys cyanospilus*.

Remarks.—Sixteen egg-bearing males (75–156 mm SL) had brood pouches developed below 14–17 rings; thirteen other males (59–134 mm SL) had pouches beneath 11–17 ($\bar{x}$ = 14.5) rings. A 109 mm fish contained eggs in single layer of up to 10 transverse rows and there were 70 eggs in outer right row along 14 rings of the 16 ring pouch.

Two fish (89 and 106 mm SL) from unspecified Thailand localities (ANSP 62184, 62185) have high counts of dorsal-fin rays (26 and 28, against 20–25 in other specimens). With this possible exception, I find no evidence of significant geographic variation in study material.

Examined materials (Fig. 3) range from the Red Sea coast of Israel to Fiji. Most collections are from coastal habitats but one (USNM 217516) is from a brackish Philippine river. This species has occurred in the same collection with *H. spicifer* but I have not seen samples including both *H. cyanospilus* and *H. heptagonus*.

Material examined.—189 specimens, 36.5–156.0 mm SL, including holotype.

Holotype.—RMNH 7228 (115.5 mm SL), Indonesia, Banda Is., Banda Neira (Bandaneira).

Other material.—RED SEA.—Israel: HUJ F.4370. Ethiopia: HUJ E.62-642. Loc. uncertain: HUJ E.62-1303, E.62-3636. INDIAN OCEAN.—Parim: MNHN 95-146. Kenya: BOC 1722. Mozambique: RUSI 5734. Zanzibar: MCZ 52497. MNHN 2409, A.2004. Madagascar: MNHN 1965-347. UMMZ 185664, 185985. USNM 217482. India, Madras: FMNH 75865. GCRL 15261. Ceylon: USNM 217544. UZMK P.39476. PACIFIC OCEAN.—Singapore: CAS-SU 34958. Thailand: ANSP 62184–5. Philippine Is.: CAS-SU 9240 (holotype of *Doryichthys spaniaspis*). USNM 102583, 102555, 102802, 102803, 102859, 135689, 139072, 139076, 139094, 217516–19. Indonesia: MNHN 6138 (syntype of *Syngnathus kuhlii*), 1969–45. UZMK P.39475. ZMA 114.947–949. Caroline Is., Yap Is.: CAS 39089. New Guinea: GCRL 14822. USNM 217467, 217545. Bismarck Archipelago, New Britain: BPBM 15720. Australia, Queensland: AMS IB.1911 (holotype of *Parasyngnathus wardi*), IB.1912 (paratypes (5) of *P. wardi*). QM I.11257 (paratype of *P. wardi*), I.7660. Fiji Is.: USNM 217481.

Acknowledgments

I thank the curators of the various repositories for loans of materials in their care, for prompt response to numerous inquiries and for other courtesies. For loans of type-material or permission to examine types in their collections I thank M. L. Bauchot (MNHN), M. Boeseman (RMNH), J. E. Böhlke (ANSP), W. N. Eschmeyer and P. Sonoda (CAS), R. K. Johnson (FMNH), W. Klausewitz (SMF), E. A. Lachner and associates (USNM), J. R. Paxton and D. F. Hoese (AMS), R. J. McKay (QM) and A. C. Wheeler (BMNH). For gifts of specimens I thank B. Carlson and J. E. Randall (BPBM), K. V. Rama Rao (Zoological Survey of India) and H. I. H. The Crown Prince of Japan. Special acknowledgment is due Dr. Boeseman for sharing his broad knowledge of the Bleeker literature and collections and for commenting on portions of the draft manuscript. Dr. P. K. Talwar (ZSI)

kindly provided information on possible types of *Microphis bleekeri* and expedited loans of pertinent specimens. Thanks are also due Elizabeth Heal for technical secretarial assistance and F. N. Jackson for curatorial services. Drawings are by Mrs. Dianne Yandell.

This study was in part supported by National Science Foundation Grant BMS 75–19502.

Literature Cited

Aurich, H. 1935. Mitteilungen der Wallacea-Expedition Woltereck. Mitteilungen XIII. Fische I. Zool. Anzeiger 112(5/6):97–107.

Blyth, E. 1859. Report of curator, Zoological Department, for May, 1858. J. Asiatic Soc. Bengal 27(3):267–290.

Bleeker, P. 1849. Bijdrage tot de kennis der ichthyologische fauna van het eiland Madura, met beschrijving van eenige nieuwe soorten. Verh. Bat. Gen. 22(8): 1–16.

———. 1852. Nieuwe bijdrage tot de kennis der ichthyologische fauna van Ceram. Natuurk. Tijdschr. Ned. Ind. 3:689–714.

———. 1853. Bijdrage tot de kennis der Troskieuwige visschen van den Indischen Archipel. Ver. Bat. Gen. 26(6):1–30.

———. 1854. Ichthyologische waarnemingen gedaan op verschillende reizen in de residentie Banten. Natuurk. Tijdschr. Ned. Ind. 7:309–326.

———. 1854a. *Syngnathus tapeinosoma*, eene nieuwe zeenaald van Anjer. Ibid. 6: 375–376.

———. 1854b. Derde bijdrage tot de kennis der ichthyologische fauna van de Banda-eilanden (1). Ibid. 6:89–114.

———. 1855. Negende bijdrage tot de kennis der ichthyologische fauna van Borneo. Ibid. 9:415–430.

———. 1858. Enumeratio specierum piscium javanensium hucusque cognitarum. Ibid. 15:359–456.

———. 1858–59. Derde bijdrage tot de kennis der ichthyologische fauna van Bali. Ibid. 17:141–175.

———. 1859. Enumeratio specierum piscium hucusque in Archipelago indico observatarum, . . . Act. Soc. Sci. Indo-Neerl. 6:1–276.

———. 1859–60. Visschen uit de omstreken van Tandjong aan de Samangkabaai, verzameld door den heer Hunnius. Natuurk. Tijdschr. Ned. Ind. 20:218–220.

———. 1860. Achtste bijdrage tot de kennis der vischfauna van Sumatra. Act. Soc. Sci. Indo-Neerl. 8:1–88.

———. 1861. Derde bijdrage tot de kennis der ichthyologische fauna van Boero. Natuurk. Tijdschr. Ned. Ind. 22:109–114.

———. 1867. Quatrième notice sur la faune ichthyologique de l'ile de Halmahéra. Arch. Neerl. Sci. Nat. 2:397–399.

———. 1878. Quatrième mémoire sur la faune ichthyologique de la Nouvelle-Guinée. Ibid. 13:35–66.

Clausen, H. S. 1956. Biological and taxonomical notes on Nigerian fresh-water *Syngnathus* (Linné 1758) Kaup 1856, with remarks on the taxonomic value of crista media trunci and c. superior caudae. Vidensk. Medd. Dansk naturh. Foren. 118:225–234.

Dawson, C. E. 1976. Review of the Indo-Pacific pipefish genus *Choeroichthys*

(Pisces: Syngnathidae), with descriptions of two new species. Proc. Biol. Soc. Wash. 89(3):39–66.

———. 1977. Review of the genus *Corythoichthys* (Pisces: Syngnathidae) with description of three new species. Copeia 1977(2):295–338.

———. 1977a. Synopsis of syngnathine pipefishes usually referred to the genus *Ichthyocampus* Kaup, with description of new genera and species. Bull. Mar. Sci. 27(4):595–650.

Dawson, C. E., and R. A. Fritzsche. 1975. Odontoid processes in pipefish jaws. Nature 257:390.

Day, F. 1865. The fishes of Malabar. Quaritch, London. 293 pp.

———. 1878. The fishes of India, being a natural history of the fishes known to inhabit the seas and freshwaters of India, Burma and Ceylon. Part 4. William Dawson & Sons, London.

Duncker, G. 1910. On some syngnathids ("pipe fish") from Ceylon. Spolia Zeylanica 7(25):25–34.

———. 1915. Revision der Syngnathidae. Mitt. Naturh. Mus. Hamburg 39:9–120.

Duncker, G., and E. Mohr. 1925. Die Fische der Südsee-Expedition den Hamburgischen Wissenschaftlichen Stiftung 1908–1909. Mitt. Zool. Mus. Hamburg 41:93–112.

Fiedler, K. 1967. Das Fortpflanzungsverhalten von *Syngnathus djarong*, einer Süsswassernadel aus Ceylon (Syngnathidae, Teleostei). Natur und Museum 97(7):259–269.

Fowler, H. W. 1918. New and little-known fishes from the Philippine Islands. Proc. Acad. Nat. Sci. Phila. 70:2–71.

———. 1922. Notes on hemibranchiate and lophobranchiate fishes. Ibid. 73:437–448.

Günther, A. 1870. Catalogue of the fishes in the British Museum. Taylor and Francis, London. Vol. 8, 549 pp.

Herald, E. S. 1953. Family Syngnathidae: Pipefishes. *In* L. P. Schultz et al.— Fishes of the Marshall and Marianas Islands. Bull. U.S. Nat. Mus. 202:231–278.

———. 1959. From pipefish to seahorse—a study in phylogenetic relationships. Proc. Calif. Acad. Sci., 4th ser., 29(13):465–473.

Herre, A. W. 1927. Four new fishes from Lake Taal (Bombon). Philippine J. Sci. 34(3):273–279.

———. 1935. New fishes obtained by the Crane Pacific Expedition. Publ. Field Mus. Nat. Hist., Zool. Ser., 18(12):383–438.

———. 1953. Check list of Philippine fishes. Res. Rept. U.S. Fish. Wildlf. Serv. 20:1–977.

Hubrecht, A. A. W. 1879. Catalogue des collections formées et laissées par M. P. Bleeker. Leiden. Pp. i–iv + 1–71.

Jordan, D. S., B. W. Evermann, and W. H. Clark. 1930. Checklist of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. Rep. U.S. Comm. Fish for 1928, App. 10, 670 pp.

Jordan, D. S., and A. Seale. 1907. Fishes of the islands of Luzon and Panay. Bull. U.S. Bur. Fish. 26:3–48.

Kaup, J. J. 1856. Catalogue of lophobranchiate fish in the collection of the British Museum. Taylor and Francis, London. 76 pp.

Klunzinger, C. B. 1871. Synopsis der Fische des Rothen Meeres. II Theil. Verh. zool.-bot. Ges. Wien 21:441–688.

Munro, I. S. R. 1958. Family Syngnathidae. Handbook Austr. Fishes 20:82–84. *In* Austr. Fish. Newsletter 17(2):18–20.

Peters, W. 1855. Uebersicht der in Mossambique beobachten Fische. Arch. Naturgesch. 21(1):234–282.

———. 1869. Über die von Herrn Dr. F. Jagor in dem ostindischen Archipel gesammelten und dem Konigl. zoologischen Museum übergebenen Fische. Monatsber. Akad. Berlin (1868), pp. 254–281.

Picagalia, L. 1894. Pesci del Mar Rosso pescati nella campagna idrographica della Regia Nave Scilla nell 1891–92. Atti Soc. Nat. Moderna, ser. 3, 13:22–40.

Ramsay, E. P., and J. D. Ogilby. 1887. Descriptions of two new fishes. Proc. Linn. Soc., New South Wales, 2nd Ser., 1:474–475.

Regan, C. T. 1906–08. Pisces. *In* Biologia Centrali-Americana 8:1–203.

Rüppell, E. 1838. Neue Wirbeltheire zu der fauna von Abyssinien gehörig. Lfg. 12, pp. 81–148. Frankfurt am Main.

Smith, H. M., and A. Seale. 1906. Notes on a collection of fishes from the island of Mindanao, Philippine Archipelago, with descriptions of new genera and species. Proc. Biol. Soc. Wash. 19:73–82.

Smith, J. L. B. 1963. Fishes of the family Syngnathidae from the Red Sea and western Indian Ocean. Ichthyol. Bull. Rhodes Univ. 27:515–543.

Steindachner, F. 1903. Die Fische. *In* W. Kükenthal—Ergebnisse einer zoologischen Forschungsreise in den Molukken und Borneo. 2 Theil. Abhandl. Senckenb. naturf. Ges. 25:409–464.

Weber, M., and L. F. De Beaufort. 1922. The fishes of the Indo-Australian archipelago. E. J. Brill, Leiden. 4:i–xiii + 1–410.

Whitehead, P. J. P., M. Boeseman, and A. C. Wheeler. 1966. The types of Bleeker's Indo-Pacific elopoid and clupeoid fishes. Zool. Verhand. 84:1–159.

Whitehead, P. J. P., and P. K. Talwar. 1976. Francis Day (1829–1889) and his collections of Indian fishes. Bull. Brit. Mus. (Nat. Hist.), Historical Ser., 5(1): 1–189.

Whitley, G. P. 1948. Studies in ichthyology. No. 13. Rec. Austr. Mus. 22(1): 70–94.

Gulf Coast Research Laboratory Museum, Ocean Springs, Mississippi 39564.