



## ***Phallostethus cuulong*, a new species of priapiumfish (Actinopterygii: Atheriniformes: Phallostethidae) from the Vietnamese Mekong**

KOICHI SHIBUKAWA<sup>1</sup>, DINH DAC TRAN<sup>2</sup> & LOI XUAN TRAN<sup>2</sup>

<sup>1</sup>Nagao Natural Environment Foundation, 3-10-10 Shitaya, Taito-ku, Tokyo 110-0004, Japan.

E-mail: kshibukawa@nagaofoundation.or.jp

<sup>2</sup>College of Aquaculture and Fisheries, Can Tho University, 3-2 Street, Can Tho, Vietnam.

E-mail: tddinh@ctu.edu.vn; txloi@ctu.edu.vn

### **Abstract**

A new species of priapiumfish, *Phallostethus cuulong*, is described based on nine specimens collected from the Vietnamese Mekong. This is the third species of the genus, following the type species *P. dunckeri* (from Malay peninsula) and *P. lehi* (from northwestern Borneo), and distinguished from them by having: seven serrae on the second ctenactinium in adult males (vs. five in *P. dunckeri* and eight in *P. lehi*); 25–26 caudal vertebrae (vs. 27 in *P. dunckeri* and 28 in *P. lehi*); approximately 5–19 teeth on parodontary (vs. 15–20 and 28 or more in *P. dunckeri* and *P. lehi*, respectively). All six examined males are dextral (vs. one and two known males are sinistral and dextral respectively in *P. dunckeri*, and all four known males are sinistral in *P. lehi*). Sexual dimorphism is also found in the number of precaudal vertebrae, i.e., 13–14 in males and 11–12 in females (vs. sexual dimorphism is not found in number of precaudal vertebrae of *P. dunckeri* and *P. lehi*).

**Key words:** Atheriniformes, Phallostethidae, *Phallostethus cuulong*, new species, Vietnamese Mekong

### **Introduction**

Members of the atheriniform family Phallostethidae (*sensu* Parenti & Louie, 1998) are small and slender, nearly transparent surface-swimming fishes, known from Southeast Asian waters. Male phallostethids have a unique complex copulatory organ, termed the priapium, under the throat (thus the fishes of this family are commonly called “priapiumfish”). The priapium is a bilaterally asymmetric organ for holding or clasping onto females and fertilizing their eggs internally; following internal fertilization, phallostethid females do not give birth to live young, but instead lay fertilized eggs (Parenti, 1989; Grier & Parenti, 1994; Parenti, 2005). The family comprises 21 species, in addition to the new species described here, classified in four genera [Parenti, 1989, 1996; Parenti & Louie, 1998; Nelson, 2006 (as Phallostethinae)]: *Gulaphallus* Herre, 1925 (5 species); *Neostethus* Regan, 1916 (11 species); *Phallostethus* Regan, 1913 (2 species); *Phenacostethus* Myers, 1928 (3 species).

The phallostethid fauna in the Mekong basin has not been well studied. In his checklist of inland fishes of the Indochina and adjacent areas (including Malay Peninsula), Kottelat (1989) confirmed the records of following six phallostethids from the region: *Ceratostethus bicornis* (Regan, 1916) (= *Neostethus bicornis*); *Neostethus lankesteri* Regan, 1916; *Neostethus siamensis* Myers, 1937 (a junior synonym of *Neostethus lankesteri*); *Phallostethus dunckeri* Regan, 1913; *Phenacostethus posthon* Roberts, 1971; *Phenacostethus smithi* Myers, 1928. Kottelat (1989) recognized all of these euryhaline species, but he did not record any species directly from the Mekong. Rainboth (1996: 171) recorded *Phenacostethus smithi* from the Cambodian Mekong, with a comment “1 or 2 species found in the Cambodian Mekong” for the genus. He also noted that the other species of the family had been taken from the Mekong delta, although he did not list the names.

During our recent field surveys of the fish-fauna in the Vietnamese Mekong, at least four species of phallostethid fishes were collected. Three of them are identified as *Phenacostethus smithi*, *Neostethus bicornis* and *N. lankesteri*. The first was locally abundant in the slow-flowing tidal canals (but easily overlooked because of its small size, up to 15.6 mm SL), whereas the other two species were common in the intertidal areas of mangrove

forests and adjacent brackish-water creeks. The fourth species was frequently collected with *P. smithi* and/or *N. lankesteri* but, compared with these two, it was relatively uncommon. The species lacks a first dorsal fin, and has long rod-like toxactinium and long-based anal fin with 24–27 rays (Figs. 1–4); these characters indicate that it is unambiguously a *Phallostethus* of the phallostethid subfamily Phallostethinae (sensu Parenti, 1989).

*Phallostethus* was hitherto known only from two allopatric species: *P. dunckeri* (type species of the genus, Johor, Malaysia) and *P. lehi* Parenti, 1996 (northwestern Borneo). The Mekong species, described here as new, differs from these two described congeners in number of caudal vertebrae, teeth on parodontary and serrae on second ctenactinium.

## Material and methods

The examined specimens are deposited in the fish collection of the Can Tho University, Can Tho (CTU), National Museum of Nature and Science, Tokyo (NSMT), Division of Fishes, National Museum of Natural History, Washington D.C. (USNM), and Zoological Reference Collection, Department of Life Science, Faculty of Science, National University of Singapore, Singapore (ZRC). Measurements were made point-to-point with calipers under dissecting microscopes to the nearest 0.01 mm (but rounded to a tenth of a millimeter in the descriptions here). The methods for measurements and counts follow Hubbs & Lagler (1958), with exceptions given below (the snout tip refers to the mid-anteriormost point of the upper lip): interorbital width was the least width of bony interorbital space; jaw length was measured between the snout tip and the posteriormost point of lip; body depth was measured in 2 ways, the first is the maximum depth (not including the membranous abdominal keel), and the second was taken at the anal-fin origin; preanal length was measured from snout tip to origin of anal fin; pectoral- and caudal-fin lengths were measured from the base to the tip of the longest ray in respective fins; transverse scales were counted from dorsal-fin origin downward and forward to anal-fin base; predorsal scales were divided into two parts in the new species by a small naked space behind the occipital region, and here represented as “scales along predorsal midline on occipital region” + “scales along predorsal midline behind naked space”; circumpeduncular scale count was the number of scales along a zigzag vertical line through the narrowest point of caudal peduncle. All fish lengths given are standard length (SL). Fin-ray counts include all rudiments, except as follows: uppermost pectoral-fin ray was a nubby ossicle (confirmed on cleared and stained specimens), and not counted; last two rays of dorsal and anal fins were supported by a single pterygiophore, and counted as one ray in each fin. Scales (except for predorsal and circumpeduncular scales) and paired fin rays were counted on both sides, but gill rakers were counted on the right-side only. Scales and details of the head were observed on a specimen stained with cyanine blue. Osteological features were observed from radiographs (for all specimens) and two cleared and stained specimens following the method of Potthoff (1984). Osteological descriptions and frequency of dominance (sinistral/dextral) follow Parenti (1984, 1989) and Parenti (1996), respectively.

### *Phallostethus cuulong*, new species

New Vietnamese name: Cá bụng đầu

(Figures 1–4)

**Holotype.** ZRC 53233, male, 24.2 mm SL, a branch of Hau River (a tributary of Mekong), Cu Lao Dung, Soc Trang Province, Vietnam (9°30.8' N, 106°13.7' E), 0–0.5 m depth, 31 July 2009, collected by K. Shibukawa.

**Paratypes.** Total eight specimens (five males and three females), 20.0–24.5 mm SL: CTU-P 2327, 1 specimen (female), 23.7 mm SL, Duyen Hai, Tra Vinh Province, Vietnam (9°40.9' N, 106°30.7' E), 0.3–0.8 m depths, 5 April 2009, collected by K. Shibukawa, V.V. Tran and L.X. Tran; CTU-P 2494, 1 specimen (male), 22.5 mm SL, My Thanh River (a tributary of Mekong), Vinh Chau, Soc Trang Province, Vietnam (9°22.7' N, 106°0.7' E), 0.5–1.2 m depths, 1 August 2009, collected by H.P. Ha, V.V. Tran and L.X. Tran; CTU-P 5020, 1 specimen (male, cleared and stained), 23.5 mm SL, Cho Lach, Ben Tre, Vietnam (10°10.5' N, 106°8.9' E), 0.5 m depth, 3 February 2010, collected by L.X. Tran; NSMT-P 106664, 1 specimen (male), 20.0 mm SL, collected with CTU-P 2494; NSMT-P 106665, 1 specimen (female), 22.0 mm SL, collected with CTU-P 2494; USNM 404477, 1 specimen (female), 23.8 mm SL, collected with CTU-P 2494; USNM 404478, 1 specimen (male), 20.3 mm SL, Cau Ke, Tra

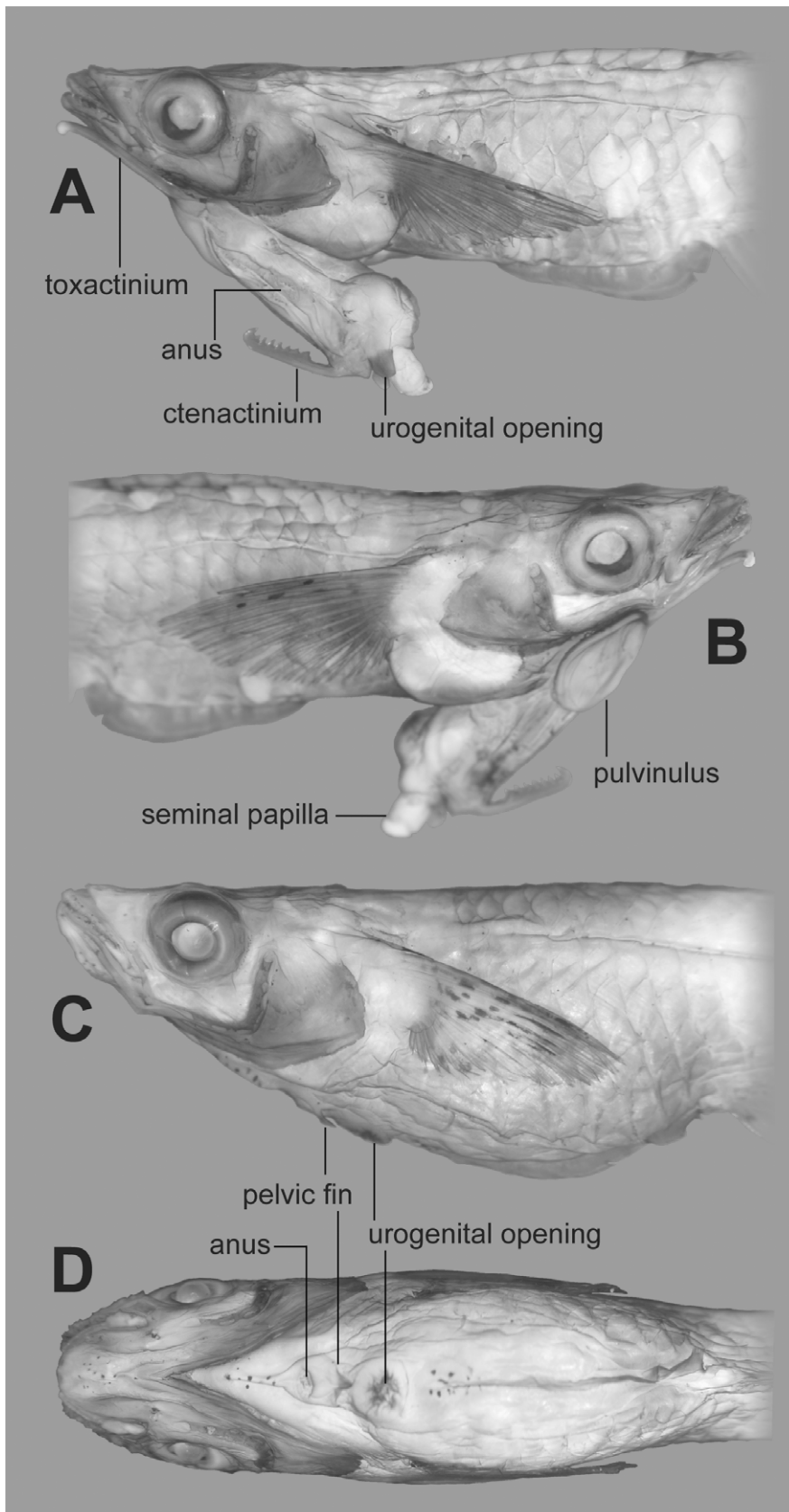
Vinh Province, Vietnam (9°57.1' N, 106°1.8' E), 0.5–3.5 m depths, 28 May 2010, collected by L.X. Tran; USNM 404479, 1 specimen (male, cleared and stained), 24.5 mm SL, collected with CTU-P 5020.



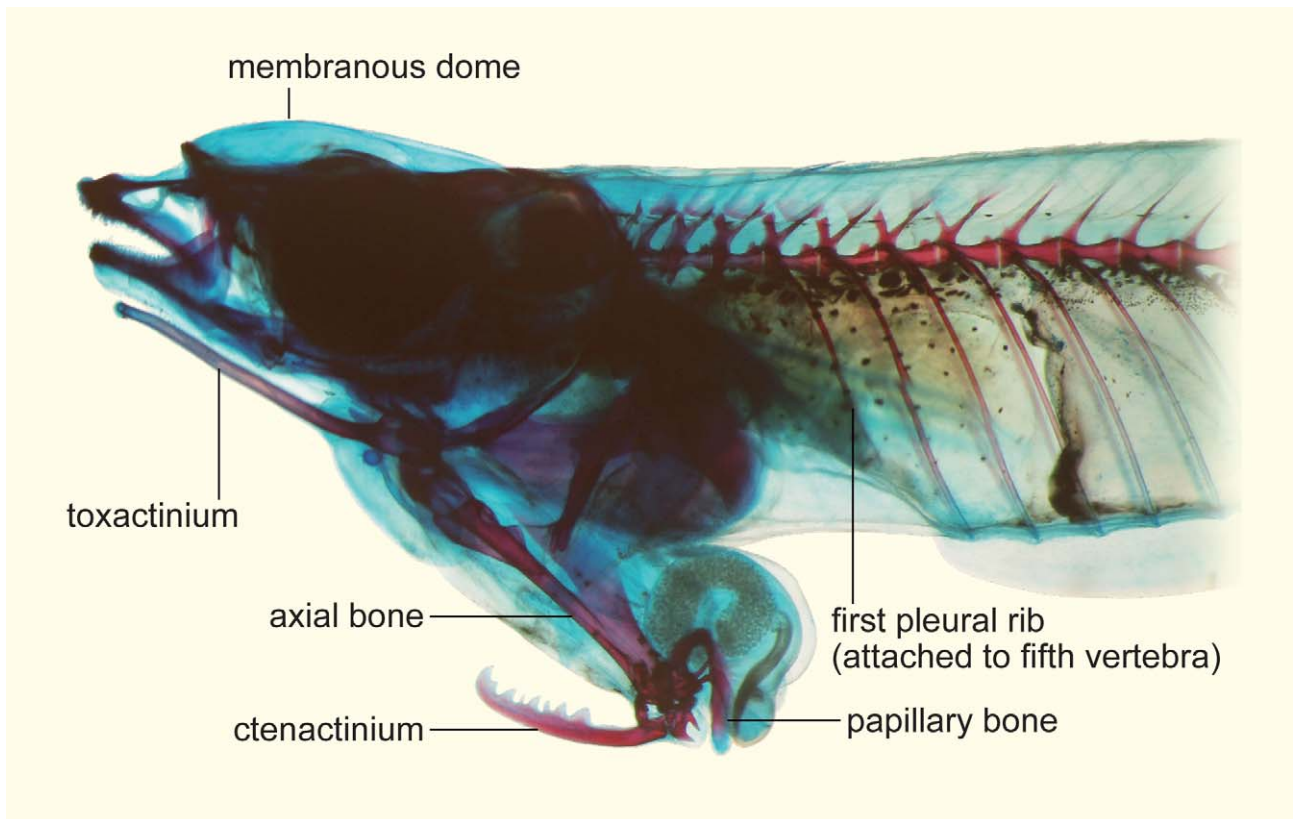
**FIGURE 1.** Freshly-collected specimens of *Phallostethus cuulong*. A) CTU-P 2494, male, 22.5 mm SL, Tra Vinh Province, Vietnam; B) CTU-P 2327, female, 23.7 mm SL, Sóc Trăng Province, Vietnam. Photographed and retouched by L.X. Tran and K. Shibukawa, respectively.



**FIGURE 2.** Preserved specimen of *Phallostethus cuulong*, showing dorsal (A), lateral (B) and ventral (C) views. ZRC 53233, holotype (male), 24.2 mm SL, Sóc Trăng Province, Vietnam. Photographed and retouched by L.X. Tran.



**FIGURE 3.** Head and anterior part of body of *Phallostethus cuulong*. A) lateral view of left side of head and body of male, ZRC 53233, holotype, 24.2 mm SL; B) lateral view of right side of head and body of male (same specimen with A); C) lateral view of head and body of female, USNM 404477; D) ventral view of head and body of female (same specimen with C). Specimens are temporally stained with cyanine blue. Photographed and retouched by L.X. Tran and K. Shibukawa, respectively.



**FIGURE 4.** Lateral view of head and anterior part of body of cleared and stained specimen of *Phallostethus cuulong*. CTU-P 5020, male, 23.5 mm SL. Photographed by L.X. Tran.

**Diagnosis.** *Phallostethus cuulong* is distinguished from congeners in having following characters: seven serrae on the second ctenactinium in adult males (vs. five and eight in *P. dunckeri* and *P. lehi*, respectively); 11–13 pectoral-fin rays (vs. 9–10 and 12 in *P. dunckeri* and *P. lehi*, respectively); 11–14+25–26=37–40 vertebrae (vs. 13+27=40 and 12+28=40 in *P. dunckeri* and *P. lehi*); approximately 5–19 teeth on parodontary (vs. 15–20 and 28 or more in *P. dunckeri* and *P. lehi*, respectively). All six examined males are dextral (vs. one and two known males of *P. dunckeri* are sinistral and dextral respectively, and all four known males of *P. lehi* are sinistral).

**Description.** Counts of the holotype are asterisked, and the frequency of each count is given in parentheses following the relevant count. Dorsal-fin rays 7 (2), 8\* (6) or 9 (1); anal-fin rays 24\* (4), 25 (1), 26 (3) or 27 (1); pectoral-fin rays 11 (2), 12\* (7) or 13\* (9); scales in lateral series 34 (5), 35\* (10) or 36 (3); predorsal scales 1+25 (1), 2+25 (1), 2+26 (4) or 2+27\* (3); transverse scales 6 (3), 7\* (12) or 8\* (3); circumpeduncular scales 12\* (8) or 13 (1); parodontary teeth approximately 5 (1), 6 (3), 7 (3), 8 (3), 10 (1), 13\* (1), 14 (2), 15\* (1), 18 (2) or 19 (1).

The following measurements are % of SL: head length 22.1–24.1; snout length 7.0–8.5; eye diameter 6.7–7.3; interorbital width 3.3–5.2; length of jaw 8.0–9.4; predorsal length 78.0–82.6; preanal length 46.4–48.7; maximum body depth 15.0–18.7; body depth at anal-fin origin 12.4–15.0; body width 9.4–14.0; caudal-peduncle length 18.6–20.7; caudal-peduncle depth 5.6–7.6; length of dorsal-fin base 9.1–10.5; length of anal-fin base 32.3–36.7; pectoral-fin length 14.6–19.1; caudal-fin length 20.1–22.4.

Head depressed anteriorly, with flat or barely concave interorbital space. Dorsal surface of head with membranous dome when alive or freshly collected (which can be seen in the cleared and stained specimens, e.g., Fig. 4), but shrunken and not apparent in alcohol specimen. Snout rather pointed. Eyes lateral on head, large, diameter slightly less than snout length. Mouth terminal or subterminal; jaws small, barely extend to a level of anterior margin of eye; upper jaws highly protractile. Body compressed, moderately deep. Anus and urogenital openings anterior, ventral to pectoral-fin base. A slightly frayed, fleshy membranous mid-ventral keel between urogenital opening and anal-fin origin. In males, a distinct mid-ventral groove, deepened and widened anteriorly, supports the priapium and mid-ventral keel. Pectoral fin falcate, the uppermost branched ray longest in most specimens; pectoral-fin rays branched, except for the uppermost 1 (uppermost nubby ossicle not included here; see “Materials and

Methods" above) and lowermost 1–2 rays unbranched. Pelvic fin absent in males, present but rudimentary in females (Fig. 3). First dorsal fin absent; origin of second dorsal fin at, or slightly before, a level of posterior end of anal-fin base; anterior 2–3 rays simple, whereas the other rays branched. Anal fin with a long base, commencing well before midlength; anterior 2–4 rays simple, whereas the other rays branched. Caudal fin emarginate, symmetrical dorsoventrally.

Male bilaterally asymmetric, dextral; namely, seminal papilla offset to right side of body (= aproctal side), and anus offset to left side of body (= proctal side); a long rod-like toxactinium curved from left to right; a large fleshy pad, the pulvinulus, covers articulation point of toxactinium and aproctal axial bone (Fig. 3).

Scales on body cycloid, moderately large and deciduous; scales on abdomen largest; body entirely scaled, except for pectoral-fin base, mid-ventral groove before anal-fin origin, and mid-predorsal narrow naked space slightly behind occipital region; head and fins naked, except for posterior part of occipital region and basal part of caudal fin with some scales.

Teeth on premaxilla and dentary unicuspid, slightly curved inward. Paradentary slender (as in *Phallostethus dunckeri* illustrated by Parenti, 1984: 4, fig. 1), with 5–19 minute teeth laterally; teeth on paradentary form a uniserial row or, in some larger specimens, biserial rows; teeth on inner row, if present, much smaller than those on outer row.

Cephalic sensory canals reduced, comprising: two short infraorbital canals (each with terminal pores only) anteriorly and anteroventrally to eye; preopercular canal (with 6–7 pores).

Main external bones in males including a long, curved toxactinium and a short stout ctenactinium with seven serrae dorsally (not including a hook-like distal tip); two smallest males examined (CTU-P 2493 and USNM 404478, 20.0–20.3 mm SL) bearing 5–6 serrae on ctenactinium, assumed to represent the immature condition (and not included in the diagnosis, above). First pleural rib attached to fifth vertebra in males, fourth in females; first pleural rib in female much shorter than in male. Branchiostegal rays 4.

**Color when alive or freshly collected.** Body subtranslucent in life, but whitish immediately after death (Fig. 1); a bright white blotch over brain when alive (assumed to fade just after death); iris silvery; minute melanophores scattered on snout, cheek and jaws; a melanophore at angle of lower jaw; a large reddish yellow blotch, slightly smaller than eye, at mid-lateral caudal fin base; male priapium with several large and small melanophores, particularly on the aproctal side (= right side in the new species) just anterior to the base of second ctenactinium; a series of minute black dots along mid-lateral septum of body musculature at least on caudal part of body; inner side of pectoral fin with many melanophores at least dorsally (the area with melanophores much more broader in females than in males); a series of mid-ventral black dots from anal-fin origin to caudal-fin base; other fins transparent.

**Color in alcohol.** Head and body pale straw-colored; a series of irregular-sized melanophores (several of them dash-like) along midlateral septum of body musculature (at least on caudal part); paired patches of melanophores on anterior part of snout dorsally; many melanophores scattered on head above neurocranium, those posterior distinctly larger than those anterior; a melanophore at angle of lower jaw; a patch of minute gular melanophores; two patches of melanophores at throat and just behind urogenital opening in females; male priapium with several large and small melanophores, particularly on the aproctal side (= right side in this species) just anterior to the base of second ctenactinium; a mid-ventral series of black dots from anal- to caudal-fin bases, each along anal-fin base on interspace between fin rays (continuous and forming a irregular blackish gray line in some specimens); inner side of pectoral fin with many melanophores dorsally (the area with melanophores much broader in females than in males); caudal fin covered by numerous minute melanophores; other fins transparent.

**Distribution, habitat and the other notes.** *Phallostethus cuulong* is known from nine specimens, six males and three females, collected from shallow waters (< 1.2m depth) around banks of slow-flowing turbid canals and rivers with soft muddy bottoms in Soc Trang and Tra Vinh Provinces, Vietnam.

The first author (KS) observed that a fish, latter designated as one of the paratypes of *Phallostethus cuulong* (NSMT-P 106665), swam slowly at the water surface around a bank of the slow-flowing tidal canal with dense semi-aquatic vegetation. A bright white blotch on dorsal surface of head was clearly confirmed in the field, but less vivid than that of the sympatric aplocheilid, *Aplocheilus panchax* (well-known for its reflective "pineal" spot on the top of the head). When the fish was disturbed, it quickly swam a short distance away from the original position; it was subsequently scooped up carefully using a hand net by KS. The species was usually solitary, and collected by hand nets or seine nets.

Like the other phallostethids in the Vietnamese Mekong, this species has never been seen in the fish markets. As far as we aware, all fishes of the family Phallostethidae have no vernacular names in the Vietnamese Mekong (except for the new species herein named), since they are usually overlooked.

**Etymology.** The specific name, *cuulong*, is the Vietnamese name of the Mekong delta (Cuu Long), where the type series of the new species was collected. The name, here applied as a noun in apposition, means “nine dragons,” in reference to nine distributaries of the Mekong basin in Vietnam.

**Remarks.** Following the key to genera of phallostethid fishes by Parenti (1989), the new species is clearly assigned to *Phallostethus* by having the combination of, e.g., shield-like pulvinulus, large seminal papilla, long toxactinium, membranous dome on dorsal surface of head, 24–27 anal-fin rays, 37–40 vertebrae, serrated ctenactinium, non-projecting lower jaw beyond upper jaw, no first dorsal fin, and 7–9 second dorsal-fin rays. In particular, no other phallostethid genera are known that bear 24 or more anal-fin rays (vs. 22 or less anal-fin rays in the other phallostethids). Within the genus, the new species resembles the Bornean species *Phallostethus lehi* in sharing 11–13 pectoral-fin rays, but differs in having seven serrae on second ctenactinium in adult (vs. eight in *P. lehi*), 25–26 caudal vertebrae (vs. 28), and 6–19 paradentary teeth (vs. 28 or more). All six examined males of the new species are dextral, immediately distinguishing them from sinistral males in *P. lehi*. The new species is also distinguished from *Phallostethus dunckeri*, known only from Johor, Malay Peninsula but presumed to be extinct (Parenti, 1996), by having seven serrae on second ctenactinium in adults (vs. five in *P. dunckeri*), 11–13 pectoral-fin rays (vs. 9–10), and 25–26 caudal vertebrae (vs. 27).

Sexual dimorphism in the pleural ribs was reported from *Phallostethus lehi* by Parenti (1996); according to her, the species has the first pair of pleural ribs on the fifth vertebrae in males, the fourth vertebrae in females. This dimorphism is also found in *Phallostethus cuulong*. Furthermore, *P. cuulong* appears to show sexual dimorphism in the number of precaudal vertebrae: all six males examined have 13–14 precaudal vertebrae, as against 11–12 in all three females examined. Although Parenti & Louie (1998) reported similar sexual dimorphism in vertebral counts from four species of *Neostethus*, hitherto it has never been known from the other species of *Phallostethus*.

## Acknowledgments

All type series of the new species were collected during the joint project on field surveys of fishes in the Vietnamese Mekong on 2007–2010, performed by the Nagao Natural Environment Foundation (NEF), Tokyo, and the College of Aquaculture and Fisheries, Can Tho University (CTU), Can Tho. We express our sincere thanks to the following persons for conducting the project: Phuong Thanh Nguyen, Hung Phuoc Ha, Viet Van Tran (CTU); Yasuhiko Taki, Makoto Komoda, Kenzo Utsugi and Tomoko Oizumi (NEF). We are also grateful to Lynne Parenti (USNM) for critical reading of the draft manuscript, and Gento Shinohara (NSMT), Jeffrey T. Williams and Shirleen Smith (USNM) and Kelvin Lim (ZRC) for their curatorial help.

## References

- Grier, H.J. & Parenti, L.R. (1994) Reproductive biology and systematic of phallostethid fishes as revealed by gonad structure. *Environmental Biology of Fishes*, 41(1–4), 287–299.
- Parenti, L.R. (1989) A phylogenetic revision of the phallostethid fishes (Atherinomorpha, Phallostethidae). *Proceedings of the California Academy of Sciences (Series 4)*, 46(11), 243–277.
- Parenti, L.R. (1996) Phylogenetic systematics and biogeography of phallostethid fishes (Atherinomorpha, Phallostethidae) of northwestern Borneo, with description of new species. *Copeia*, 1996(3), 703–712.
- Parenti, L.R. (2005) The phylogeny of atherinomorphs: evolution of a novel fish reproductive system. In: Uribe, M.C. & Grier, H.J. (Eds.) *Viviparous Fishes*. New Life Publications, Florida, pp. 13–30.
- Parenti, L.R. & Louie, K.D. (1998) *Neostethus djajaorum*, new species, from Sulawesi, Indonesia, the first phallostethid fish (Teleostei: Atherinomorpha) known from east of Wallace's Line. *The Raffles Bulletin of Zoology*, 46(1), 139–150.
- Regan, C.T. (1913) *Phallostethus dunckeri*, a remarkable new cyprinodont fish from Johore. *Annals and Magazine of Natural History (Series 8)*, 12(72), 548–555.
- Regan, C.T. (1916) The morphology of the cyprinodont fishes of the subfamily Phallostethinae, with descriptions of a new genus and two new species. *Proceedings of the General Meetings for Scientific Business of the Zoological Society of London*, 1916 (1), 1–26, 4 pls.