



Betta nuluhon, a new species of fighting fish from western Sabah, Malaysia (Teleostei: Osphronemidae)

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Abstract

Betta nuluhon, new species, is described from a hill stream habitat in western Sabah. This species is allied to both *B. chini* and *B. balunga*, and differs from rest of its congeners in the *B. akarensis* group in having the following combination of characters: yellow iris when live; mature males with greenish-blue iridescence on opercle when live; mature fish with distinct transverse bars on caudal fin; slender body (body depth 22.1–25.2 % SL); belly area with faint reticulate pattern (scales posteriorly rimmed with black); absence of tiny black spots on anal fin; lateral scales 29–31 (mode 30); predorsal scales 20–21 (mode 20). Notes on a fresh series of *B. chini* are also provided.

Key words: Taxonomy, biodiversity, Southeast Asia, Anabantiformes, riparian habitat

Introduction

The genus *Betta*, popularly known as fighting fishes, consists of small-fish (not larger than 110 mm SL) adapted to swampy, stagnant-water pool and hill stream habitats. They possess the ability to breathe atmospheric air, display specialized egg and brood care (either oral brooding or bubble-nest building) and exhibit strong territorial instincts (Britz, 2001; Rüber *et al.*, 2004; Tan & Ng, 2005). The genus *Betta* currently contains some 70 species (Tan & Ng, 2005; Schindler & Schmidt, 2008; Tan, 2009; Tan & Ahmad, 2018; pers. obs.). The most recent revision, by Tan & Ng (2005), covered all 23 Malaysian species considered valid at that time: Peninsular Malaysia with 13 species—*B. bellica* Sauvage, *B. coccina* Vierke, *B. hipposideros* Ng & Kottelat, *B. imbellis* Ladiges, *B. livida* Ng & Kottelat, *B. Persephone* Schaller, *B. pi* Tan, *B. pulchra* Tan & Tan, *B. pugnax* (Cantor), *B. stigmosa* Tan & N, *B. tomi* Ng & Kottelat, *B. tussyae* Schaller, *B. waseri* Krummenacher; Sarawak with six species—*B. akarensis* Regan, *B. brownorum* Witte & Schmidt, *B. ibanorum* Tan & Ng, *B. lehi* Tan & Ng, *B. macrostoma* Regan, *B. taeniata* Regan; and Sabah with four species—*B. balunga* Herre, *B. chini* Ng, *B. gladiator* Tan & Ng, *B. ocellata* de Beaufort. Since then, another three species have been described and documented: *B. kuehnei* Schindler & Schmidt 2008 and *B. omega* Tan & Ahmad 2018 from Peninsular Malaysia, and *B. midas* Tan 2009 from Sarawak.

Ng *et al.* 2017 provided an overview of all freshwater fishes documented in Sabah based on Inger & Chin's (1962) pioneering work. Recently, a species of fighting fish was encountered in hills streams in a hitherto unexplored locality. From interviewing elders in the neighboring villages, intentional or accidental introduction was ruled out: the hillside indigenous communities have known the species for generations. The locals have a vernacular name for the species in the Kadazandusun dialect—"dindilik".

Three other *Betta* species have been documented from the eastern part of Sabah draining into the Sulu Sea, viz., *B. ocellata* de Beaufort 1933 (originally described from Sandakan), *B. balunga* Herre 1940 (originally described from Tawau), and *B. gladiator* Tan & Ng 2005 (originally described from Maliau basin). From the western part of

Sabah draining into South China Sea, only one species of *Betta* had been documented thus far—*B. chini* Ng 1993. This species was described from a lowland coastal peat (and heath forest habitats) near Beaufort, in the Klias Peninsula (adjacent to the Crocker Range). However, hill-stream and peat-swamp habitat types are extreme opposites. Heath and peat swamps are associated with slow-flowing, low pH, tannin-rich, nutrient-poor waters with low dissolved oxygen content over clayey, sandy or peaty bottoms. Hill stream waters, by contrast, are fast-flowing with neutral pH and high dissolved oxygen content, usually over sand and rock substrata.

Initially, we considered the hill-stream taxon to be an outlier population of *B. chini*. Here we show that the hill-stream taxon is an undescribed species, which we name *Betta nuluhon*, new species. The new species is a member of the *Betta akarensis* group, which is distinguished by the following character suite (see Tan & Kottelat, 1998): presence of preorbital and postorbital stripes (postorbital stripe may be interrupted or faint), and a chin-bar; caudal fin lanceolate, median rays distinctly elongated in mature males, with branching of caudal-fin rays starting from ca. 40 mm SL, usually with caudal-fin transverse bars (always distinct in mature males); greenish to bluish iridescent body scales in some species; opercle without iridescent scales (vide Witte & Schmidt, 1992; Ng, 1993). Adult specimens may possess a greenish-gold to greenish-blue opercular scales, which tend to disappear in captivity. Juveniles may possess gold opercular scales, but these disappear with age. The faintly coloured greenish opercular scales of the adults could be due to stress from handling. All members of the group are male oral brooders. As presently understood, the *B. akarensis* group presently comprises: *B. akarensis*, *B. balunga*, *B. chini*, *B. pinguis* Tan & Kottelat, *B. ibanorum*, *B. aurigans* Tan & Lim, *B. obscura* Tan & Ng, *B. antoni* Tan & Ng, and *B. nuluhon*, new species.

Material and methods

Fish specimens were obtained using hand nets in shallow water, or angled using baited hook-and-line. The fish were initially fixed in 10 % formalin solution and then stored long term in 75 % ethanol. Counts and measurements were taken from the left side of the body, the latter with a pair of dial calipers, to the nearest 0.1 mm. Methodology follows that of Tan & Ng (2005). Vertebral counts were obtained from radiographs using a Faxitron LS-60 digital x-ray machine. Water abiotic parameters were recorded with HACH DR900 portable colorimeter, and HANNA HI98130. Specimens were deposited in the Forest Research Centre (FRC), Sandakan, Sabah; and the Zoological Reference Collection (ZRC) at the Lee Kong Chian Natural History Museum, National University of Singapore, Singapore. Abbreviations used: SL—standard length; HL—head length. GPS coordinates have not been declared herein, to discourage illegal collections.

Taxonomy

Betta nuluhon, new species

Figs. 1–4

Material examined. Holotype—ZRC 61247, 62.6 mm SL, male; Sabah: Crocker Range Forest Reserve; Kamal N. S. S. *et al.*, Nov 2019.

Paratypes. FRC 0162, 5 ex., ZRC 61154, 5 ex., 39.8–54.0 mm SL; same locality data as holotype. FRC 0161, 3 ex., ZRC 57026, 3 ex., 46.0–57.4 mm SL; Sabah: Crocker Range Forest Reserve; Kamal N. S. S. *et al.*, April 2018.

Diagnosis. *Betta nuluhon* is distinct from its congeners in the *B. akarensis* group in having the following unique combination of characters: yellow iris when live; mature males with greenish-blue iridescence on opercle when live; mature fish with distinct transverse bars on caudal fin; slender body (body depth 22.1–25.2 % SL); belly area with faint reticulate pattern (posterior margin of scales rimmed with black); anal-fin plain; lateral scales 29–31; predorsal scales 20–21.

Description. See Figs. 1–4 for general appearance. See Table 1 for meristic and morphometric data of *B. nuluhon*.

Head broad, blunt, short (head length 31.7–35.2 % SL); body cylindrical in cross-section anteriorly, becoming compressed at dorsal-fin origin to caudal region; body deepest at dorsal-fin origin (22.1–25.2 % SL), shallowest in caudal peduncle (16.4–20.0 % SL); dorsal-fin rays I, 7 (total 8), pointed, situated at about $\frac{2}{3}$ head-and-body

length (predorsal length 65.8–71.3 % SL), dorsal-fin base short (10.6–13.5 % SL); caudal-fin lanceolate, with 5+6 principal rays, middle rays elongated slightly beyond interradial membrane margin; anal-fin with I–II, 25–27 (total 26–28) rays, pointed, situated around ½ body (preanal length 45.4–49.7 % SL), anal-fin base long (49.5–54.6 % SL); pelvic-fin with i, 5 rays, rounded, with filamentous second ray, adpressed filamentous ray reaching 13th anal-fin ray (pelvic-fin length 31.5–45.1 % SL); pectoral-fin rays 13–14, rounded; lateral scales 29–31, predorsal scales 20–21, subdorsal scales 5½–6½, postdorsal scales 10–11, transverse scales 9½. Vertebral count 11–12 + 19–20, total vertebrae = 31 (n = 6).

TABLE 1. Meristic and morphometric data of *Betta nuluhon*, new species

Meristics	Holotype	Paratypes (+ holotype data, n = 17, SL = 39.8–54.0 mm)			
	ZRC 61247	ZRC 57026+FRC, 61154+FRC			
anal fin rays	I,25	I–II,25–27 (total 26–28, mode 27)			
dorsal fin rays	I,7	I,7			
caudal fin rays	iii,5+6,ii	iii,5+6,ii			
pelvic fin rays	I,5	I,5			
pectoral fin rays	14	13–14 (mode 13)			
subdorsal scales	6	5½–6½ (mode 6)			
dorsal depth scales	9½	9½			
lateral scales	31	29–31 (mode 30)			
Lateral scale count at dorsal-fin origin	16	14–16 (mode 15)			
Lateral scale count at anal-fin origin	6	6–7 (mode 6)			
predorsal scales	21	20–21 (mode 20)			
postdorsal scales	11	10–11 (mode 11)			
Morphometrics					
% standard length		min	max	mean	SD
total length	145.4	139.6	148.4	143.1	2.75
body length	70.6	65.8	70.6	68.4	1.51
predorsal length	68.4	65.8	71.3	68.3	1.45
postdorsal length	22.0	18.1	24.2	20.9	1.66
caudal peduncle depth	20.0	16.4	20.0	17.7	0.79
preanal length	46.6	45.4	49.7	47.7	1.31
head length	33.5	31.7	35.2	33.6	0.95
dorsal depth	25.2	22.1	25.2	23.6	0.98
pelvic fin length	36.4	31.5	45.1	35.6	3.36
anal fin base length	51.1	49.5	54.6	51.9	1.40
dorsal fin base length	12.8	10.6	13.5	12.3	0.82
% head length					
orbit diameter	23.3	23.3	29.7	26.2	1.75
postorbital length	50.5	46.4	51.6	48.9	1.37
interorbital width	35.7	30.4	35.7	33.0	1.35
snout length	21.9	20.0	25.8	23.1	1.64

Fresh colouration. See Figs. 1, 2, 4. Head brown, dorsum dark brown; dark brown to black preorbital stripe running from upper jaw through eye to postorbital to opercle edge; black chin bar present, dark brown suborbital stripe present; eye with dorsal region of iris yellow, lateral regions black, bottom region reddish; mature male with whole throat area dark brown, sometimes with greenish-blue iridescence; female and juvenile with brown throat; body brown, dorsum dark brown, posterior edge of body scales along flank rimmed with bright blue; all fins brownish, dorsal fin with 4 to 6 black transverse bars, caudal fin with 12 to 16 black transverse bars, anal fin with broad reddish-brown margin, pelvic fin with whitish filamentous ray.



FIGURE 1. *Betta nuluhon*, new species, ca. 50 mm SL, freshly caught male specimen, not preserved.



FIGURE 2. *Betta nuluhon*, new species, male (top), female (bottom); freshly caught, not preserved.

Preserved colouration. See Fig. 3. Head brown, dorsum dark brown, black preorbital stripe running from upper jaw through eye to postorbital to opercular edge, black chin bar present, dark brown suborbital stripe present with pigments along opercle edge (pattern similar to *Betta chini*, see Tan & Ng, 2005: 49, Fig. 7c); mature male with whole throat area diffused with brown; female and juvenile with throat area light brown; body brown, dorsum dark brown; belly area cream with light brown reticulate pattern from posterior edge of scales bearing darker pigments; all fins brownish except hyaline pectoral fin, dorsal fin with 4 to 6 black transverse bars, caudal fin with 12 to 16 black transverse bars, anal fin reddish-brown, pelvic fin with white filamentous ray.

Field notes. Specimens were collected from the velocity refugia of a shallow (knee level) clear-water stream with overhanging bank vegetation in Crocker Range Forest Reserve's closed-canopy forest fringe area. The substrate was composed mainly of pebbles, sand and silt. Some water parameters were recorded: dissolved oxygen 6.25 mg/L, pH 6.57, suspended solids 0.4 mg/L, turbidity 28.0 FAU, temperature 24.0° C. Syntopic species include: *Anguilla marmorata* Quoy & Gaimard (Anguillidae), *Barbodes sealei* Herre, *Nematabramis borneensis* Inger & Chin, *Tor tambra* Valenciennes, in Cuvier & Valenciennes (Cyprinidae), and *Gastromyzon introrsus* Tan (Gastromyzontidae).

Etymology. This new species is named for the Kadazandusun vernacular *nuluhon*, meaning hill. This pertains to its hill stream habitat. Used as a noun in apposition.

Remarks. *Betta nuluhon* can be distinguished from similar species from the geographic vicinity (*B. akarensis*, *B. balunga* and *B. chini*) in the following characters: gently sloping anterior body dorsum profile (vs. convex profile of *B. balunga* and *B. chini*); absence of tiny black spots on anal fin (vs. presence of many tiny black spots in *B. chini*); shallower body depth than *B. akarensis* and *B. balunga* (22.1–25.2 % SL, vs. 23.5–27.9 and 28.0–31.5, respectively); shorter preanal length than *B. balunga* (45.4–49.7 % SL, vs. 49.2–52.2); shorter dorsal-fin base length than *B. balunga* (10.6–13.5 % SL, vs. 13.7–14.1); smaller orbit diameter than *B. balunga* (23.3–29.7 % SL, vs. 29.5–33.3).

Betta nuluhon can be differentiated from the other members of the *B. akarensis* group in the following characters:

From *B. antoni*—deeper body (22.1–25.2 % SL, vs. 20.6–22.9); fewer lateral scales (29–31, vs. 31–33); fewer predorsal scales (20–21, vs. 23–24). From *B. aurigans*—shallower body (22.1–25.2 % SL, vs. 25.2–27.4); fewer lateral scales (29–31, vs. 33–33½); fewer predorsal scales (20–21, vs. 24–26); fewer anal-fin rays (26–28, vs. 29–30). From *B. ibanorum*—more patterned opercle (vs. less patterned); lower range of lateral scales (29–31, vs. 30–32); fewer predorsal scales (20–21, vs. 21–23). From *B. obscura*—shallower body (22.1–25.2 % SL, vs. 28.7–32.7). From *B. pinguis*—less pigmented opercle (vs. heavily pigmented); shallower body (22.1–25.2 % SL, vs. 30.6–31.6); fewer lateral scales (29–31, vs. 31½–32½); fewer predorsal scales (20–21, vs. 23–24) (data obtained from Tan & Kottelat, 1998; Tan & Lim, 2004; Tan & Ng, 2004; 2005; 2006).



FIGURE 3. *Betta nuluhon*, new species, ZRC 61247, holotype, 62.6 mm SL (above with white background, bottom with black background).

The recent collection of *Betta chini* (ZRC 61155; see Figs. 4–5) from Klias Forest Reserve indicates that there is still a viable population. The heath and peat swamp forest habitat had been badly burnt previously, during the El-Niño fires of 1998 (Phua *et al.*, 2007), and there was suspicion the species may have become extinct. *Betta chini* is now assessed as Endangered by the International Union for Conservation of Nature (Low, 2019).

When *B. chini* was described, the largest specimen recorded was 56.0 mm SL (ZRC 35088; see Ng, 1993: 290). The recent series contains five specimens (out of ten) ranging from 57.5 to 62.5 mm SL, which indicate that the present series maybe occupying a preferred micro-habitat; as the type series had been obtained from peripheral streams of the reserve. All specimens of the recently-collected series have stocky bodies, with a convex body dorsum profile (see Fig. 5), similar to the range of values of body depth and caudal peduncle depth of *B. nuluhon* (see Table 2). From these values, the body shapes of both *B. chini* and *B. nuluhon* may be expected to be more similar, but they are distinctly different (see Figs. 3–5).



FIGURE 4. Top—*Betta chini*, ZRC 61155, 58.6 mm SL male; bottom—*Betta nuluhon*, holotype, ZRC 61247, 62.6 mm SL male; both freshly preserved.

TABLE 2. Comparison of percentages (% SL) of body depth and caudal peduncle depth of type series of *B. nuluhon*, and comparative material of *B. akarensis*, *B. balunga* and *B. chini* (BD [blue]: body depth at dorsal-fin origin; CPD [grey]: caudal peduncle depth; red represents mean value) (values have been rounded up or down to integer values for depiction).

Range (%SL)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
<i>Betta nuluhon</i> (n=17)			CPD				BD		BD								
<i>Betta akarensis</i> (n=8)			CPD								BD						
<i>Betta balunga</i> (n=2)																	BD
<i>Betta chini</i> (n=10)			CPD							BD							

Comparative material

Betta chini—FRC 0160, 5 ex., ZRC 61155, 5 ex., 49.1–62.5 mm SL; Sabah: Beaufort, Klias Forest Reserve; local fishers, 25 Nov 2019.

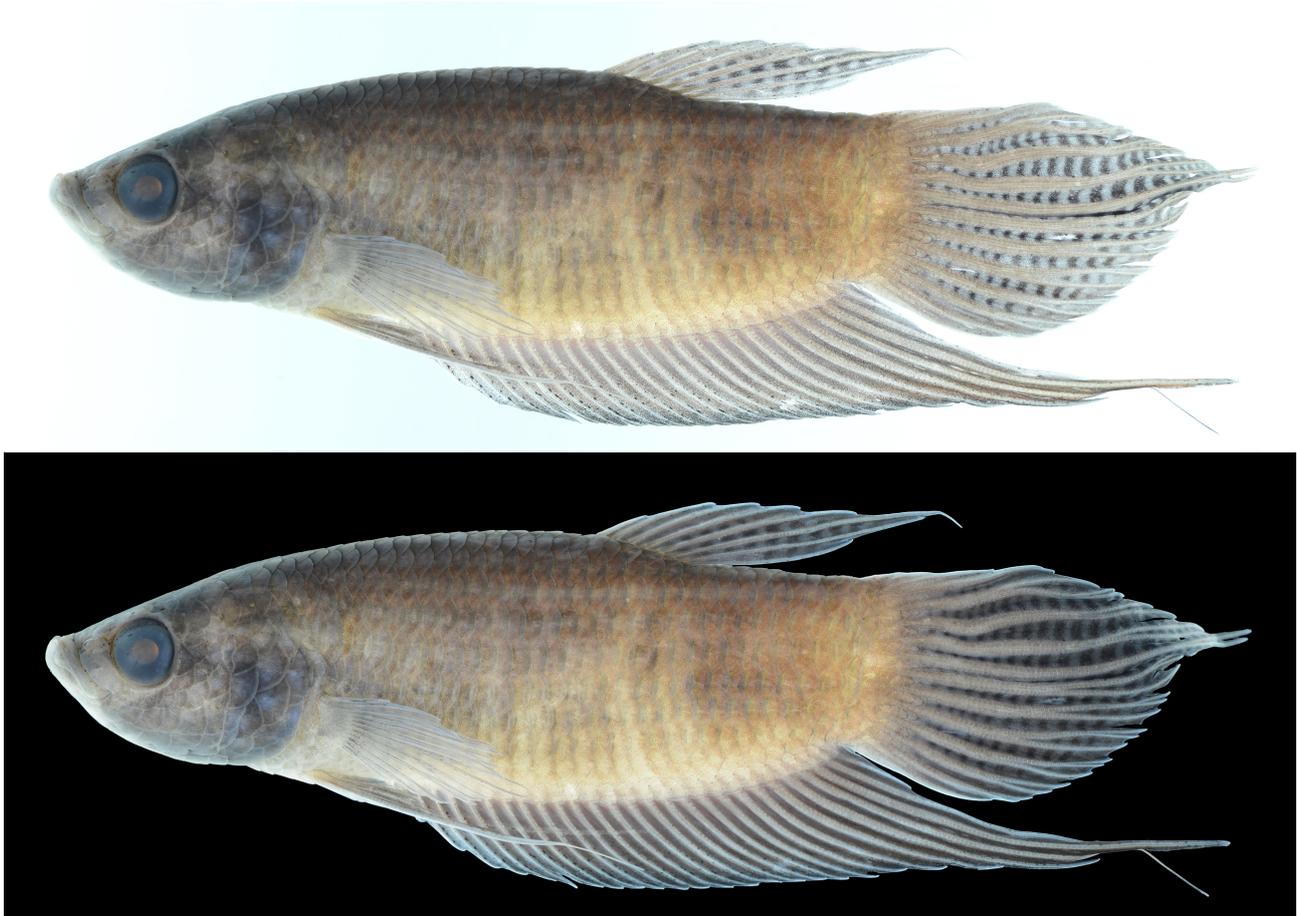


FIGURE 5. *Betta chini*, ZRC 61155, 58.6 mm SL; Sabah: Klias Forest Reserve (right side, laterally inverted) (above with white background, bottom with black background).

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