

***Barbodes pyrpholeos*, new species, the first cave-dwelling cyprinid fish in the Philippines, with redescription of *B. montanoi* (Teleostei: Cyprinidae)**

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Abstract. *Barbodes pyrpholeos*, new species, is the first cave-dwelling cyprinid fish reported from the Philippines. It is described from karst systems in Mindanao. It is distinguished from other congeners by having a poorly pigmented body with reddish fins in combination with a smooth dorsal-fin spine without serrations, and several additional morphological characters. It differs from the Indonesian troglobitic congener *Barbodes microps* by the presence of eyes, and a narrower body amongst other characters. *Barbodes montanoi*, a putative close relative of the new species, is redescribed based on recently collected material.

Key words. troglobite, Cyprinidae, biodiversity, new species, Southeast Asia

INTRODUCTION

The freshwater fishes of Mindanao are not well documented, except for the endemic species flock of cyprinids in Lake Lanao (Herre, 1933). This flock comprises five genera and 18 species (Herre, 1924; Myers, 1960), for which there is no recent update, and most are apparently in danger of extinction or have become extinct (Ismail et al., 2014). Herre (1953) provided a checklist of fishes from the Philippines and listed more than 2,000 species, but this list included both marine and freshwater taxa. At present, around 290 species of fishes are recorded from the inland waters of the Philippines by some sources (e.g., see Fishbase, 2019), but such lists are outdated and in need of revision.

Recently, cyprinids normally placed collectively under *Systomus* have been split up and revalidated with older available names, and some also given new generic names (see Kottelat, 2013: 481–483), including *Barbodes*, *Desmopuntius*, *Oliotius*, *Pethia*, *Puntigrus*, *Striuntius*, and *Systomus*. Many of the species previously identified as *Puntius binotatus* or its species complex are now reassigned to the genus *Barbodes* (Kottelat, 2013: 482).

Amongst the Sundaic populations of *Barbodes*, there is one cave-dwelling (troglobitic) species known from Java—*B. microps*. This poorly known species was described by Günther (1868) from the Gunung Sewu cave system, Central Java (according to Weber & de Beaufort, 1916: 186). *Barbodes microps* apparently exhibits a complete lack of pigmentation (see Kottelat et al., 1993: pl. 16) and variation in eye size and eye presence (eyes absent in some individuals). Haryono (2006) reported on the morphometry and meristics of 10 specimens of *B. microps*, and demonstrated morphometric differences between *B. microps* and *B. binotatus* (based on individuals from Sumatra, Kalimantan, and Java).

Exploration of aquatic habitats in cave systems of the Philippines by the second author has resulted in the discovery of two cave-dwelling fish species to date. This includes the gobiid fish *Caecogobius personatus* (described by Larson & Husana, 2018) and an undescribed cyprinid of the genus *Barbodes*.

The present paper serves to describe this new species of *Barbodes*, which represents the first record of a cave-dwelling cyprinid fish from the Philippines. We also take this opportunity to redescribe the poorly known *B. montanoi*, a putative close relative of the new species described by Sauvage in 1881.

MATERIAL AND METHODS

Specimens were visually targeted and caught with a hand net (around 15 × 15 cm opening, mesh size 5 mm) while snorkelling in the cave waters. Specimens were fixed in formalin and subsequently stored in 75 % ethanol. Specimens were measured from the left side using dial calipers (accuracy to 0.5 mm). Meristics and measurements were taken according

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to Kottelat (2001) and Kottelat & Freyhof (2007). The last two branched dorsal and anal rays supported by a single pterygiophore (appearing as a single ray branched at the base) are noted as '1½'. Vertebral and fin-ray counts were obtained from digital radiographs using a Faxitron LX-60 digital x-ray machine.

Specimens examined are deposited at the Muséum national d'Histoire naturelle (MNHN), Paris, France; National Museum of the Philippines (PNM), Manila, Philippines; and the Zoological Reference Collection (ZRC), Lee Kong Chian Natural History Museum, Singapore. Abbreviations used: SL – standard length, length measured from tip of upper jaw to base of caudal fin; BL – trunk length, length measured from posterior edge of operculum to base of caudal fin; HL – head length, length measured from tip of upper jaw to posterior edge of opercle.

TAXONOMY

Barbodes pyrpholeos, new species

(Figs. 1–8)

Unidentified cyprinid fish – Husana, 2020: 216.

Material examined. Holotype — PNM 15649, 104.1 mm SL; Philippines: Mindanao, Agusan drainage; Ugnop Cave system; coll. D. E. Husana, 14 May 2014.

Paratypes — PNM 15650, 2 ex., ZRC 61230, 3 ex., 69.6–93.1 mm SL; same locality data as holotype. — PNM 15651, 3 ex., ZRC 61231, 3 ex., 68.2–103.4 mm SL; Philippines: Mindanao, Agusan drainage; Ugnop Cave system; coll. Prosperidad Mountaineering Club, 1 May 2012. — ZRC 61232, 2 ex., 59.7–76.1 mm SL; Philippines: Mindanao, Agusan drainage; Ugnop Cave system; coll. D. E. Husana and local residents, 14 May 2014.

Diagnosis. *Barbodes pyrpholeos* can be differentiated from all congeners by the following unique combination of characters: body with little brown pigment, appearing white or pinkish in life; unpaired fins with posterior half bright orangey-red in life, anterior half of unpaired fins and paired fins hyaline; eyes present and pigmented, possibly still functional. All other congeners (except the cave-dwelling *B. microps*) having body with black blotches, bars, stripes, dots, and triangular markings; body and fins appear pigmentless in *B. microps* (information on colours in life not available). *Barbodes pyrpholeos* can be further differentiated from *B. microps* (some data obtained from Haryono, 2006) in having the following characters: eye present, though variable in size (based on available material only) vs. eye absent or represented by a small, possibly non-functional eye in some individuals of *B. microps*; more dorsal-fin rays (8–9½, vs. 8); greater mean head length (32.3% SL, vs. 30.8%); lower mean predorsal length (55.1% SL, vs. 57.5%); lower mean body depth at anus (20.6% SL, vs. 36.5%); lower mean caudal peduncle depth (12.4% SL, vs. 14.7%); larger eye



Fig. 1. *Barbodes pyrpholeos*, in situ photograph of an immature fish near lower part of second author's leg, about 60 mm SL, Ugnop Cave system. (Photograph by Daniel Edison M. Husana)



Fig. 2. *Barbodes pyrpholeos*, freshly caught individual of about 100 mm SL, Ugnop Cave system. (Photograph by Daniel Edison M. Husana)

diameter (14.9–22.3, mean 17.3% HL, vs. 10.2–17.9, mean 14.9, when present).

From the geographically close congener *Barbodes montanoi*, the new species can be further distinguished by having a smaller eye (eye diameter 14.9–22.3% HL, vs. 21.9–29.4%), longer head (head length 30.7–34.1% SL, vs. 27.4–29.5%), slimmer body (body depth 19.1–22.2% SL, vs. 23.6–25.5%), slimmer caudal peduncle (caudal peduncle depth 11.6–12.9% SL, vs. 13.8–15.3%); last unbranched dorsal-fin ray spinous, but without serrations (see Fig. 8; vs. serrations present on last unbranched dorsal-fin ray); lateral series scales 23–25 (mode 23) (vs. 24–27, mode 24); predorsal scales 8–9 (mode 9) (vs. 8).

Description. See Figs. 1–7 for general impression, and Table 1 for meristic and morphometric data.

Body slim, deepest at dorsal-fin origin (27.9–31.7% SL), tapering to its narrowest at caudal peduncle (11.6–12.9% SL). Head blunt (head depth 56.3–68.5% HL, head width 54.1–63.9% HL), relatively long about ⅓ of standard length (head length 30.7–34.1% SL). Mouth sub-terminal, two pairs of maxillary barbels, barbels longer than eye diameter (up to three times), posterior pair longer than anterior, reaching past eye posterior margin. Eye relatively small (eye diameter

Table 1. Meristics and morphometric data for *Barbodes pyrpholeos*, new species (holotype and four paratypes), and *Barbodes montanoi* (five specimens); some data are based on more specimens and their number is provided in square brackets.

	<i>Barbodes pyrpholeos</i>			<i>Barbodes montanoi</i>	
	Holotype	Paratypes	Mode	Mode	
SL (mm)	104.1	85.3–102.5		58.9–87.0	
Vertebral count	18 + 14 = 32	17–18 + 14–15 = 32	32 [n = 8]	17–19 + 13–14 = 31–32	32 (6) [n = 10]
Dorsal-fin rays	iii,I,8	iii,I,7–8½	iii,I,8½ (7) [n = 8]	iii,I,8½	iii,I,8½ [n = 9]
Anal-fin rays	i,7	i,7½	i,7½ [n = 8]	i,7½	i,7½ [n = 9]
Caudal-fin rays (principle rays only)	10 + 9	10 + 9	10 + 9 [n = 8]	10 + 9	10 + 9 [n = 9]
Lateral scales	23	23–25	23 (9) [n = 10]	24–27	24 (3)
Predorsal scales	9	8–9	9 (7) [n = 10]	8	8
Caudal peduncular scales	2½.1.2	2½.1.2	2½.1.2 [n = 10]	2½.1.2½	2½.1.2½
Circumpeduncular scales	11	11–12	11 (8) [n = 10]	12	12
Dorsal-fin origin (lateral series)	6½	6½–8	8 (7) [n = 10]	7–9	8 (3)
Anal-fin origin (lateral series)	13	13–15	15 (6) [n = 10]	15–17	16 or 17
Pelvic-fin origin (lateral series)	7	7–9	8 (5) [n = 10]	8–9	9 (3)
Scale rows between lateral series and pelvic fin	4½	4½	4½ [n = 10]	4½	4½
% Standard length		Range	Mean (± std dev)	Range	Mean (± std dev)
Total length	127.7	116.5–133.2	89.0 (5.5)	132.6 (n = 1)	-
Body length	72.0	65.6–73.7	70.3 (2.5)	71.9–76.0	73.8 (1.8)
Predorsal length	54.9	51.2–56.7	55.1 (2.0)	53.1–56.1	54.4 (1.2)
Preanal length	76.6	72.3–79.2	76.1 (1.5)	74.7–76.9	75.9 (0.8)
Prepelvic length	59.1	53.5–61.9	57.4 (1.8)	51.8–54.5	53.4 (1.4)
Head length	33.4	30.7–34.1	32.3 (0.8)	27.4–29.5	28.5 (0.8)
Body depth at dorsal-fin origin	31.7	27.9–31.7	26.6 (11.3)	31.8–35.7	33.1 (1.6)
Body depth at anus	20.4	19.1–22.2	20.6 (1.0)	23.6–25.5	24.4 (0.7)
Caudal peduncle depth	12.8	11.6–12.9	12.4 (0.4)	13.8–15.3	14.4 (0.7)
Caudal peduncle length	18.6	16.4–18.7	17.7 (0.7)	16.2–19.6	18.4 (1.6)
Dorsal fin base length	13.3	13.2–17.4	14.1 (1.5)	12.3–17.0	14.7 (2.0)
Anal fin base length	9.4	7.6–9.4	8.7 (0.6)	7.5–10.0	9.1 (1.1)
Pelvic fin length	16.9	14.7–17.1	14.7 (1.2)	14.4–17.7	16.2 (1.2)
Pectoral fin length	22.6	18.6–22.6	20.9 (1.9)	17.4–19.9	18.7 (1.0)
Upper caudal lobe length	32.9	25.5–33.3	21.1 (2.9)	30.7–33.2 (n = 3)	31.9 (1.3)
Median caudal length	14.9	12.3–16.8	13.6 (1.3)	13.7–25.4	16.3 (5.1)
Lower caudal lobe length	33.0	25.5–33.0	27.3 (2.5)	29.1–30.4	29.8 (0.9)
Head width	18.6	16.6–21.5	19.4 (1.6)	14.8–18.2	16.4 (1.2)
Head depth	22.4	19.2–23.0	20.6 (1.2)	17.6–21.3	19.2 (1.5)
Gape height	11.9	9.0–15.1	11.7 (2.2)	7.4–9.6	8.2 (0.9)
Mouth width	12.0	9.2–15.1	11.6 (1.7)	7.1–8.4	7.7 (0.5)
% Head length					
Head width	55.2	54.1–63.9	58.3 (3.3)	52.3–58.3	55.3 (2.3)
Head depth	66.6	56.3–68.5	61.9 (3.8)	60.6–69.8	64.8 (3.9)
Gape height	35.4	26.6–43.3	35.0 (5.9)	24.6–33.5	28.8 (3.6)
Mouth width	35.6	29.8–46.9	34.9 (4.8)	23.4–28.2	25.9 (0.9)
Head depth	72.7	61.8–76.8	68.6 (3.9)	68.9–73.9	71.3 (2.6)
Head width	68.4	51.4–68.4	60.5 (5.5)	54.5–60.7	56.7 (2.6)
Snout length	35.6	30.9–39.7	34.9 (2.8)	28.3–35.1	31.8 (2.7)
Eye diameter	14.9	14.9–22.3	17.3 (2.7)	21.9–29.4	25.5 (3.2)
Interorbital width	42.5	37.8–48.3	42.0 (2.1)	42.2–43.3	42.8 (0.4)



Fig. 3. *Barbodes pyrpholeos*, freshly captured individual (likely to be the holotype), about 100 mm SL, Ugnop Cave system. (Photograph by Daniel Edison M. Husana)



Fig. 4. *Barbodes pyrpholeos*, PNM 15649, holotype, 104.1 mm SL; radiograph below. (Photograph and radiograph by Tan Heok Hui)

14.9–22.3% HL). Mouth large, gape height 9.0–15.1% SL, 26.6–43.3% HL; mouth width 9.2–15.1% SL, 29.8–46.9% HL. Dorsal-fin origin and pelvic-fin origin at roughly mid-body (predorsal-fin length 51.2–56.7% SL; pre-pelvic fin length 53.4–61.9% SL), anal-fin origin at $\frac{3}{4}$ length of body (preanal-fin length 72.3–79.2% SL). Dorsal and anal fins triangular in shape, with a smooth and straight anterior margin, straight posterior margin. Caudal fin symmetrically

forked (upper caudal-fin lobe length 25.5–33.3% SL; lower caudal-fin lobe length 25.5–33.0% SL). Pelvic fins triangular-shaped with straight margins, pectoral fin rounded. Lateral series with 23–25 scales (mode 23), 8–9 predorsal scales (mode 9), $4\frac{1}{2}$.1.2 $\frac{1}{2}$ –3 $\frac{1}{2}$ transverse scales, 11–12 circumpeduncular scales (mode 11), $4\frac{1}{2}$ scales between lateral series and pelvic-fin origin. Vertebral count 17–18 + 14–15 = 32 (mode = 32; n = 8).



Fig. 5. *Barbodes pyrpholeos*, ZRC 61230, 92.0 mm SL, Ugnop Cave system, dorsal and lateral views; right side reversed (note large gaped mouth and broad head; left pectoral fin excised). (Photographs by Tan Heok Hui)



Fig. 6. *Barbodes pyrpholeos*, PNM 15650, 86.6 mm SL, Ugnop Cave system, dorsal and lateral views (note bulging eyes and broad head). (Photographs by Tan Heok Hui)

Live colouration. See Figs. 1–3. Head and rest of body white or pinkish, with some body scales silvery. Eyes pigmented. Posterior half of unpaired fins orange-red, anterior half hyaline. Paired fins hyaline; posterior margin of pelvic fin with slight orange tint (observations based on photographs of 1–2 freshly caught specimens).

Preserved colouration. See Figs. 4–7. Head and rest of body cream, with yellowish overtone. Dorsum of head and anterior part of body with extremely faint light brown pigment, most obvious around posterior margin of dorsal scales and forming weak reticulate pattern. An extremely faint light brown rounded blotch on caudal peduncle anterior to caudal-fin base. All fins hyaline.



Fig. 7. *Barbodes pyrpholeos*, Ugnop Cave system. Top: ZRC 61230, 68.8 mm SL; bottom: ZRC 61232, 59.0 mm SL. (Photographs by Tan Heek Hui)

Distribution. Known only from karstic cave systems in Mindanao Island, the Philippines.

Field notes. See Larson & Husana (2018: 98, fig. 1) and Husana (2020) for view of the habitat and syntopic species. *Barbodes pyrpholeos* was originally discovered by Arnel Pasilan (Prosperidad Mountaineering Club) during their earlier exploration, and brought to the attention of the second author.

Etymology. The species name is a combination of the Greek words *pyr*, meaning fire, and *pholeos*, meaning cave, in reference to the fiery red fins of this cave-dwelling species. Used as a noun in apposition.

Remarks. To date only three species of cave fish are recorded in the Philippines, viz. *Caecogobius cryptophthalmus* Berti & Ercolini, 1991, *Caecogobius personatus* Larson & Husana, 2018, and this present new species, *Barbodes pyrpholeos*. The majority of Philippine aquatic cave species recorded so far are invertebrates. Husana (2020) reviewed various species of cavernicolous crabs in the Philippine archipelago, belonging to the families Gecarcinucidae, Gecarcinidae, Hymenosomatidae, Sesarmidae, and Varunidae. Shrimps of the families Alpheidae, Atyidae, and Palaemonidae were also recorded from various caves in different parts of the archipelago (Cai & Anker, 2004; Cai & Husana, 2009). There are also other smaller invertebrates present in the same cave systems, including amphipods (Melitidae), copepods

(Boholiniidae), isopods (Cirolanidae), and gastropods (Neritiliidae) (Fosshagen & Iliffe, 1989; Bruce & Iliffe, 1992; Kano & Kase, 2004; Sawicki, Holsinger & Iliffe, 2005). Still, many undescribed species from various caves in different parts of the Philippines were observed and collected by the second author during speleological expeditions, and this material awaits further study.

Until now, no cave-dwelling *Barbodes* has been documented from the Philippines. *Barbodes pyrpholeos* is not only the first known cave-dwelling cyprinid described from the Philippines, but is also only the second species of cave-dwelling cyprinid reported from the Sundaic islands. *Barbodes microps*, the first species of cave-dwelling cyprinid reported from the Sundaic islands, was described by Günther in 1868 from material collected in Central Java. Little information is available for *B. microps*, but it appears to be pigmentless (see Kottelat et al., 1993: pl. 16).

Along with the collection of *Barbodes pyrpholeos*, pigmented and eyed *Barbodes* were obtained from surface waters in close proximity to the Ugnop Cave system. Based on morphological characters and geographic location, these individuals were identified as *Barbodes montanoi*. Based on geographic proximity, *B. montanoi* may be a close relative of *B. pyrpholeos*, but this subject requires further investigation with morphological and molecular characters and is beyond the scope of this study. As *B. montanoi* is poorly known, we take this opportunity to redescribe this species.

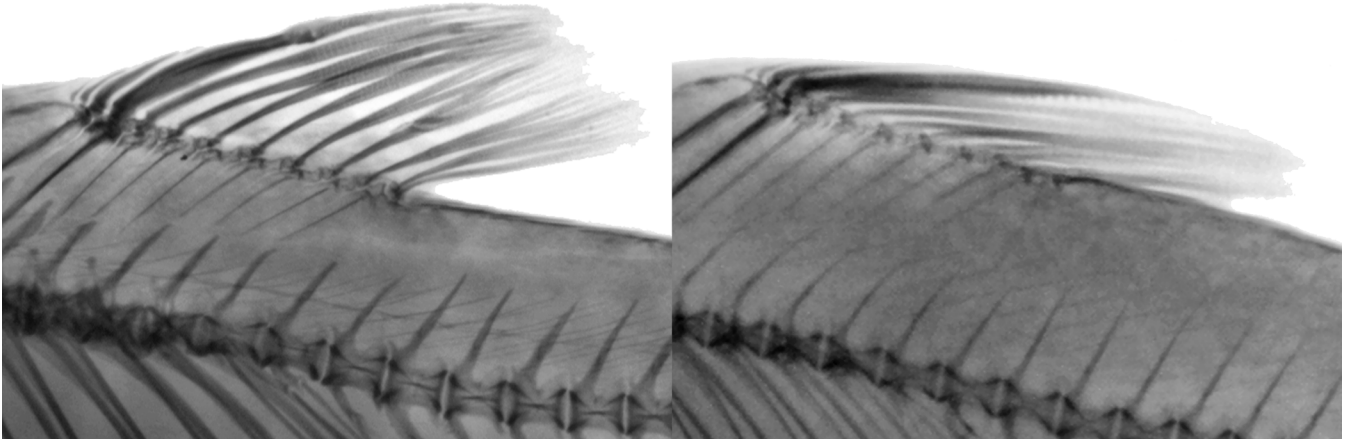


Fig. 8. *Barbodes pyrpholeos* (left), 104.1 mm SL, showing smooth last unbranched dorsal-fin ray (damaged, broken mid-way but healed); *Barbodes montanoi* (right), 62.8 mm SL, showing last unbranched dorsal-fin ray with weak serrations. (Images by Tan Heok Hui)



Fig. 9. Live colouration of *Barbodes montanoi*, about 90 mm SL, from Enchanted Falls. (Photograph by Daniel Edison M. Husana)

***Barbodes montanoi* (Sauvage, 1881)**
(Figs. 8–11)

Puntius montanoi Sauvage, 1881: 103; Bertin & Estève, 1948: 29.
Barbodes montanoi (Sauvage) – Herre, 1924: 292; 1953: 125;
Kottelat, 2013: 79.

Material examined. Syntypes — MNHN 3398, 1 ex., ca. 90 mm TL; Philippines: Mindanao, Simulao River; Montano, 1880 [low resolution image only; <https://science.mnhn.fr/institution/mnhn/collection/ic/item/list?scientificName=puntius+montanoi>]. — MNHN 3399, 4 ex. (of 12); Philippines: Mindanao [low resolution images and digital radiographs only; <https://science.mnhn.fr/institution/mnhn/collection/ic/item/a-3399?listIndex=2&listCount=2>].

Non-type material — PNM 15652, 6 ex., ZRC 61233, 6 ex., 17.5–87.2 mm SL; Philippines: Mindanao, Agusan drainage; Enchanted Falls; coll. D. E. Husana, 14 May 2014. — ZRC 61234, 2 ex., 50.0–67.2 mm SL; Philippines: Mindanao, Agusan drainage; pools at Ugnop; coll. Prosperidad Mountaineering Club, 1 May 2012.

Diagnosis. Entire body yellowish-brown dorsally and cream ventrally, with faint brown reticulate pattern corresponding to anterior margin of exposed part of body scales; body pattern consisting of four to six black dots or dashes (dependent on ontogenetic stage), two positioned at base of dorsal fin and anal fin (anal-fin spot missing or faint in adults), one at dorsal part of opercular opening (missing or faint in adults), one at mid-body below dorsal-fin origin, one at mid-body above anal-fin origin, one at middle of caudal peduncle anterior to caudal fin; unpaired fins anterior half golden-yellow, posterior half reddish-orange; paired fins yellowish or hyaline; eyes present and pigmented; last unbranched dorsal-fin ray spinous, with 8–12 weak serrations on specimens smaller than 62 mm SL (see Fig. 8); lateral scale series 24–27 (mode 24); predorsal scales 8.

Barbodes montanoi is chiefly distinguished from other selected Philippine and Sundaic congeners as follows: from *B. amarus*, *B. lateristriga*, and *B. kuchingensis* by having a pattern of black spots on the body (vs. body without black markings in *B. amarus*; pattern of two black bars on anterior half of body with central black stripe on posterior half of body



Fig. 10. *Barbodes montanoi*, ZRC 61233, 87.0 mm SL, adult, Enchanted Falls. Top: dorsal view; middle: lateral view; bottom: radiograph. (Photographs and radiograph by Tan Heok Hui)

in *B. lateristriga* and *B. kuchingensis*); from *B. manguaoensis* and *B. palavanensis* by having larger black spots, covering 2–3 scales (vs. smaller spots, restricted to single scale); from *B. banksi*, *B. bunau*, and *B. rhombeus* by having a small round black spot below dorsal-fin base (vs. black triangular marking in *B. banksi* and *B. bunau*; short black bar in *B. rhombeus*); from *B. binotatus* by having fewer black spots on body when young (ca. 4 vs. ca. 9); from *B. dunckeri* by the absence (vs. presence) of orange pigment on the paired fins in life; from *B. everetti* by having distinct black spots on body in sub-adults and adults (vs. black spots on body connected by black lateral stripe in sub-adults and adults); and from *B. sealei* by having only 8–12 weak serrations on last unbranched dorsal-fin ray in specimens smaller than 62 mm SL (vs. last unbranched dorsal-fin ray with 13–21 well-developed serrations in specimens larger than 60 mm SL).

Description. See Figs. 9–11 for general impression, and Table 1 for meristic and morphometric data.

Body slim, deepest at dorsal-fin origin (31.8–35.7% SL), tapering to its narrowest at caudal peduncle (13.8–15.3% SL). Head pointed (head depth 68.9–73.9% HL, head width 54.5–60.7% HL), relatively short, less than $\frac{1}{3}$ of standard length (head length 27.4–29.5% SL). Mouth sub-terminal, two pairs of maxillary barbels, barbel not longer than eye diameter, posterior pair longer than anterior, reaching past middle of eye. Eye relatively large (eye diameter 21.9–29.4% HL). Dorsal-fin origin and pelvic-fin origin at mid-body (predorsal-fin length 53.1–56.1% SL; pre-pelvic fin length 51.8–54.5% SL), anal-fin origin at $\frac{3}{4}$ length of body (preanal-fin length 74.7–76.9% SL). Dorsal and anal fins triangular in shape, with a smooth and straight anterior margin, straight posterior margin. Caudal fin forked with upper lobe slightly longer (upper caudal-fin lobe length 30.7–33.2% SL; lower caudal-fin lobe length 29.1–30.4% SL). Pelvic fin triangular with straight margin, pectoral fin rounded. Lateral series with 24–27 scales (mode 24), 8 predorsal scales, $4\frac{1}{2}$ –1.3 transverse scales, 12 circumpeduncular scales, $4\frac{1}{2}$ scales between lateral series and pelvic-fin origin. Vertebral count $17-19 + 13-14 = 31-32$ (mode = 32; n = 9).



Fig. 11. *Barbodes montanoi*, ZRC 61233. Top: 55.0 mm SL sub-adult; middle: 52.9 mm SL sub-adult; bottom: 32.2 mm SL juvenile; illustrating ontogenetic variation of black spot pattern (not to scale). (Photographs by Tan Heok Hui)

Live colouration. See Fig. 9 for fresh colouration. Head and body dorsum brownish, sides golden, venter silverish to cream. Body scales with anterior portion with narrow, dark brown edge, giving a reticulation pattern. Body with distinct black to dark brown dots or dashes (number of dots variable dependent on maturation stage), one dot just above dorsal part of opercle opening, one dot at dorsal-fin base, one dot along mid-body below dorsal-fin origin, one dot along mid-flank above anal-fin origin, one dot at anal-fin base, dot spot along middle of caudal peduncle before caudal-fin base. Unpaired fins with anterior portions yellowish and middle to posterior portions orange to red. Paired fins yellowish-brown.

Preserved colouration. See Figs. 10, 11 for preserved colouration. Head and body brownish, darker on dorsum and cream on ventrum. Four to six distinct dark brown/black dots or dashes along flank, all larger or equal to eye diameter. Faint brown blotch on body just posterior to edge of opercle. First distinct dark brown spot at anterior base

of dorsal fin, second dark brown spot on mid-flank below dorsal-fin origin, third dark brown tiny blotch along mid-flank above anal-fin origin, fourth dark brown spot on middle of caudal peduncle before caudal-fin base. A faint brown spot can sometimes be visible above the anal-fin base. Some individuals (50–60 mm SL) with interrupted dark brown lateral stripe, running from opercle edge to caudal-fin base. All fins hyaline.

In a juvenile (Fig. 11; 32.2 mm SL), six distinct black to dark brown spots can be observed. The locations of the spots as above, except the spot on body just posterior to opercle edge and above the anal-fin origin are very distinct. All spots equivalent to or slightly larger than eye diameter.

The ontogenic change in body pattern is exhibited where the number of body spots decreases with age, as noted by Kottelat (2013: 482).



Fig. 12. *Barbodes sealei*, ZRC 40411, Sabah: Danum. Top and middle: 68.3 mm SL sub-adult (note strong serrations on dorsal-fin spine); bottom: 46.6 mm SL juvenile (both images right-side reversed). (Photographs and radiograph by Tan Heok Hui)

Distribution. Reported from Mindanao only. This species may be restricted to the Agusan River basin in Mindanao, Philippines. Further surveys are necessary to clarify the true distribution of this species.

Field notes. Syntopic fish species from Enchanted Falls locality include: *Nomorhamphus* cf. *bakeri* (Zenarchopteridae), *Gulaphallus* cf. *panayensis* (Phallostethidae), and multiple species of goby (Gobiidae).

Remarks. The type locality for *B. montanoi* is Simulao River, in central Mindanao (Sauvage, 1881; Kottelat, 2013); and not Simulac River as stated by Fricke et al. (2021). The specimens of *B. montanoi* examined herein are from the water pools at Ugnop and Enchanted Falls, and likely represent true *B. montanoi*.

This species was named after the celebrated French traveller and collector Joseph Montano (1844–1914), who passed through Mindanao in 1880 (Herre, 1924: 293). The original description of *Puntius montanoi* (Sauvage, 1881: 103, 104) is based on 13 individuals (Kottelat, 2013). The MNHN currently contains specimens labelled as both holotype (MNHN 3398) and paratypes (MNHN 3399, 12 individuals) of *Puntius montanoi*, likely following Bertin & Estève (1948). Following ICZN article 72.1, these 13 specimens must be referred to collectively as syntypes for the following reasons: 1) Sauvage (1881) did not explicitly designate a holotype for *Puntius montanoi*; and 2) no lectotype designation has taken place in the years subsequent to the original description.

Sauvage (1881) stated that the third bony dorsal ray is smooth (presumably without serrations) and nearly the



Fig. 13. *Barbodes banksi*, Sarawak: Lanjak. Top: 79.0 mm SL; bottom: 19.4 mm SL (to scale). (Photographs by Tan Heok Hui)



Fig. 14. *Barbodes binotatus*, Java: Bogor. Top: 40.8 mm SL; bottom: 16.8 mm SL (to scale). (Photographs by Tan Heok Hui)

length of the head. Based on our examination of the recently collected specimens from Enchanted Falls and radiographs of nine additional specimens (ZRC 61233 and PNM 15652), specimens smaller than 62 mm SL have 8–12 weak serrations on the spinous last unbranched dorsal-fin ray, and specimens larger than 65 mm SL have no visible serrations. This could possibly be attributed to ontogenetic changes with size. The radiograph of four specimens listed as MNHN 3399 shows no signs of serrations on the spinous last unbranched dorsal-fin ray, either indicating that they are mature individuals or the digital radiograph is of a resolution grade insufficient to show such fine details. Herre (1924: 293) noted that the absence of dorsal-fin ray serrations would make this species unique among lowland cyprinids found in Mindanao Island.

General notes on *Barbodes*. There are at least 27 other *Barbodes* species recorded from the Philippines, most of them poorly known and either not depicted with figures when originally described or badly illustrated. Within Mindanao Island in the Philippines, six other *Barbodes* have been recorded from riverine habitats (fide Kottelat, 2013—*B. cataractae*, *B. joaquinae*, *B. montanoi*, *B. quinque maculatus*, *B. resimus*, and *B. umalii*). There are 17 endemic species of *Barbodes* that occur only from within Lake Lanao and the single outflow river—*B. amarus*, *B. baoulan*, *B. clemensi*, *B. disa*, *B. flavifuscus*, *B. herrei*, *B. katolo*, *B. lanaoensis*, *B. lindog*, *B. manalak*, *B. pachycheilus*, *B. palaemophagus*, *B. palata*, *B. sirang*, *B. tras*, *B. truncatulus*, and *B. tumba* (fide Herre, 1924; Myers, 1960; Kottelat, 2013). From Mindoro,



Fig. 15. *Barbodes rhombeus*, Singapore (non-native introduction). Top: 70.2 mm SL; bottom: 19.1 mm SL (to scale). (Photographs by Tan Heok Hui)

B. hemictenus is recorded; from Balabac, *B. ivis* is known; from Palawan, *B. manguaoensis* and *B. palavanensis* are listed (see Kottelat, 2013).

From Borneo, *B. bunau* is described from Sesayap basin in North Kalimantan; *B. banksi*, *B. everetti*, *B. kuchingensis*, and *B. lateristriga* are recorded from the southern half of Borneo; *B. xouthos* is known only from Lake Merimbun in Tutong District, Brunei Darussalam, northwestern Borneo; and *B. sealei* has been collected from throughout Borneo.

From Peninsular Malaysia, *B. banksi*, *B. dunckeri*, *B. lateristriga*, and *B. rhombeus* are found. From Java, *B. binotatus* sensu stricto is now assumed to be restricted to western Java; *B. microps* is known only from the Gunung Sewu cave system, Central Java (according to Weber & de Beaufort, 1916: 186).

Amongst all these species of *Barbodes*, *B. montanoi* looks superficially most similar to *B. sealei* (only known from Borneo; see Fig. 12), but differs in the following characters: body spots tend to be stretched longitudinally thus appearing ovoid (vs. taller and rounder spots for *B. sealei*); both species with faint dark brown reticulate pattern on body, but with different extent of pigmentation—*B. montanoi* with only anterior portion of non-embedded body scales with brown pigments, vs. *B. sealei* with crescentic anterior margin of non-embedded body scales with brown pigments; dorsal and anal fins hyaline (vs. presence of narrow dusky black posterior margins for *B. sealei*); slimmer upper and lower caudal-fin lobes (vs. broad caudal-fin lobes for *B. sealei*); fewer vertebral count than *B. sealei* (31–32 [mode = 32, $n = 9$], vs. 33 [$n = 4$]); fewer and weak serrations on last

unbranched dorsal-fin ray (8–12, vs. 13–21 stronger serrations for *B. sealei*).

There are five *Barbodes* species from the main Sundaic landmass which may look similar to *B. montanoi* in terms of having a spotted body pattern. They include *B. banksi* (Fig. 13), *B. binotatus* (Fig. 14), *B. rhombeus* (Fig. 15), *B. dunckeri* (Fig. 16), and *B. everetti* (Fig. 17). The common feature of these five taxa is that at the juvenile stage, the body pattern consists of numerous black spots and blotches (see Kottelat, 2013: 482). For *B. banksi*, *B. binotatus*, and *B. rhombeus*, the small spots are lost upon maturity, the adult only retaining the black spot or blotch below the dorsal-fin base, supra-anal region, and caudal peduncle (see Figs. 13–15). For *B. dunckeri* and *B. everetti*, these spots and blotches enlarge with age (see Figs. 16, 17). Another common feature for all five taxa is the presence of serrations on the spinous last unbranched dorsal-fin ray at both juvenile and mature stages. *Barbodes montanoi* also exhibits a slenderer body when compared to *B. banksi*, *B. rhombeus*, *B. dunckeri*, and *B. everetti*.

Herre (1924, 1935) and Myers (1960) suggested that the ancestral stock of the *Barbodes* species flock in Lake Lanao is *Barbodes binotatus*. They also indicated that *B. binotatus* is found throughout the island of Mindanao except within Lake Lanao. At that juncture, the species of origin for the Lake Lanao species flock was not doubted. In today's context, *B. binotatus* sensu stricto is believed to be restricted to the island of Java (M. Kottelat, pers. comm.). All other populations of *B. binotatus* sensu lato are believed to be other named taxa (currently in the synonymy of *B. binotatus*) or undescribed taxa (M. Kottelat, ongoing research).



Fig. 16. *Barbodes dunckeri*, Malaysia: Kahang. Top: 81.1 mm SL; bottom: aquarium trade, ca. 30 mm SL (to scale). (Photographs by Tan Heok Hui)



Fig. 17. *Barbodes everetti*, Sarawak: Poeh, ZRC 54289. Top: 72.0 mm SL; bottom: 17.8 mm SL (to scale). (Photographs by Tan Heok Hui)

Comparative material examined

Philippines.

Barbodes amarus — ZRC 51648, 2 ex., 79.5–125.6 mm SL; Mindanao: Lake Lanao; April 2007.

Barbodes manguaoensis — ZRC 60530, 10 ex., 25.2–54.8 mm SL; Palawan: Taytay, Lake Manguao; 13 October 1988.

Barbodes palavanensis — ZRC 60529, 10 ex., 41.2–57.6 mm SL; Palawan, Irawan; 18 November 1988.

Sundaic area.

Barbodes banksi — ZRC 43643, 10 ex., 23.1–49.7 mm SL; Sarawak: Lundu, Sungai Sebiris, 8.7 km to Sematan on Lundu-Sematan road; 2 October 1998. — ZRC 39387, 5 ex., 58.5–72.5 mm SL; Sarawak: Kampung Matang, 1.3 km to Sungai Cina Matang; 4 September 1995. — ZRC 60155, 9 ex., 35.5–91.6 mm SL; Sarawak: Song District: Rejang River basin: Katibas River: Ulu Katibas, Sungei Merating, draining into Sungei Bloh, 01°38.045'N, 112°17.350'E, 121

m asl; 19 May 2018. — ZRC 60076, 18 ex., 14.8–96.0 mm SL; Sarawak: Song District: Rejang River basin: Katibas River: Ulu Katibas, Sungei Satap, ca. 25 min upriver of Nanga Bloh Field Station, 01°39.240'N, 112°15.108'E, 117 m asl; 24 May 2018.

Barbodes binotatus — ZRC 40127, 13 ex., 21.2–72.2 mm SL; Java: Bogor, tributary of Cipinang Gading; 10 July 1996. — ZRC 40141, 8 ex., 33.6–61.0 mm SL; Java: Desa Cinangueng, Kecamatan Ciampea; 10 July 1996.

Barbodes dunckeri — ZRC 60671, 1 ex., 79.6 mm SL; Malaysia: Johoe, Kahang, Gunung Belumut Recreational Forest; 11 June 2018. — ZRC 37602, 1 ex., 58.4 mm SL; Malaysia: Johoe, near Kota Tinggi falls; 1993.

Barbodes everetti — ZRC 54289, 13 ex., 12.6–71.6 mm SL; Sarawak: Sematan outskirts, Kampung Poeh, hill stream at base of Gunung Poeh; 5 November 2013.

Barbodes rhombeus — ZRC 55401, 7 ex., 36.6–60.7 mm SL; Singapore: Mandai Track 15 stream; 18 June 2015. — ZRC 54686, 20 ex., 25.6–87.2 mm SL; Singapore: Mandai Track 15 stream; 28 July 2015.

Barbodes sealei — ZRC 40411, 3 ex., 46.6–70.1 mm SL; Malaysia: Sabah: Danum Valley, Sungei Bilong; 3 October 1996. — ZRC 61238, 5 ex., 37.6–94.0 mm SL; Malaysia: Sabah: Kalabakan basin, un-named stream en route to SAFE camp; 21 April 2017. — ZRC 56188, 1 ex., 65.4 mm SL; Sabah: Sandakan, Kabili-Sepilok; 27 April 2017. — ZRC 60536, 5 ex., 59.6–90.5 mm SL; Sabah: Kalabakan Forest Reserve, Brantian basin, 5 m buffer stream; 4 May 2015. — ZRC 60359, 18 ex., 29.0–80.0 mm SL; Sarawak: Sarawak Kiri basin, Annah Rais, Sungai Timouh; 28 September 2018.

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LITERATURE CITED

- Berti R & Ercolini A (1991) *Caecogobius cryptophthalmus* n. gen. n. sp. (Gobiidae Gobiinae), the first stygobitic fish from Philippines. *Tropical Zoology*, 4(1): 129–138.
- Bertin L & Estève R (1948) Catalogue des types de poissons du Muséum national d'Histoire naturelle. 4e partie. Ostariophysaires (Cypriniformes). Muséum National d'Histoire Naturelle, Paris, 117 pp.
- Bruce NL & Iliffe TM (1992) *Anopsilana conditoria*, a new species of anchialine troglobitic cirrolanid isopod (Crustacea) from the Philippines. *Stygologia*, 7(4): 225–230.
- Cai Y & Anker A (2004) On a collection of freshwater shrimps (Crustacea Decapoda Caridea) from the Philippines, with descriptions of five new species. *Tropical Zoology*, 17: 233–266.
- Cai Y & Husana DEM (2009) Cave shrimps of the genus *Edoneus* Holthuisi, 1978, from Luzon, the Philippines, with descriptions of three new species (Crustacea: Decapoda: Atyidae). *Raffles Bulletin of Zoology*, 57(1): 51–63.
- Fishbase (2019) List of Freshwater Fishes Reported from Philippines. Version 12/2019. https://www.fishbase.se/country/CountryChecklist.php?showAll=yes&what=list&trp=50&c_code=608&cpresence=Reported&sortby=alpha2&ext_CL=on&ext_pic=on&vhabitat=fresh (Accessed 20 June 2020). [List includes non-native species]
- Fosshagen A & Iliffe TM (1989) *Boholina*, a new genus (Copepoda: Calanoida) with two new species from an anchialine cave in the Philippines. *Sarsia*, 74: 201–208.
- Fricke R, Eschmeyer WN & Van der Laan R (eds.) (2021) Eschmeyer's Catalog of Fishes: Genera, Species. <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp> (Accessed 8 June 2021).
- Günther A (1868) Catalogue of the Fishes in the British Museum. Volume 7. British Museum, London, xx + 512 pp.
- Haryono (2006) Studi morfometri Ikan Wader Goa (*Puntius microps* Gunther, 1868) yang unik dan dilingungi undang-undang. *Berkala Penelitian Hayati*, 12: 51–55. [In Bahasa Indonesia]
- Herre AWCT (1924) Distribution of the true fresh-water fishes in the Philippines. I. The Philippine Cyprinidae. *The Philippines Journal of Science*, 24(3): 249–307.
- Herre AWCT (1935) The fishes of Lake Lanao: A problem in evolution. *The American Society of Naturalists*, 67(709): 154–162.
- Herre AWCT (1953) A Checklist of Philippine Fishes. Research Report Vol. 20. Fish and Wildlife Service, United States Department of Interior, Government Publishing Office, Washington, D.C., 977 pp.
- Husana DEM (2020) *Sundathelphusa prosperidad*, sp. n. (Decapoda: Brachyura: Gecarcinucidae), a new cave-obligate freshwater crab from Mindanao Island, the Philippines, with notes on the conservation status of Philippine cave species. *Journal of Cave and Karst Studies*, 82(3): 210–218.
- ICZN (1999) International Code of Zoological Nomenclature, 4th Edition. The International Trust for Zoological Nomenclature, London, xxix + 306 pp.
- Ismail GB, Sampson DB & Noakes DLG (2014) The status of Lake Lanao endemic cyprinids (*Puntius* species) and their conservation. *Environmental Biology of Fishes* (2014), 97: 425–434.
- Kano Y & Kase T (2004) Genetic exchange between anchialine cave populations by means of larval dispersal: The case of a new gastropod species *Neritilia cavernicola*. *Zoologica Scripta*, 33: 423–437.
- Kottelat M (2001) Fishes of Laos. Wildlife Heritage Trust, Colombo, 198 pp.

- Kottelat M (2013) The fishes of the inland waters of Southeast Asia: A catalogue and core bibliography of the fishes known to occur in freshwaters, mangroves and estuaries. *Raffles Bulletin of Zoology*, Supplement 27: 1–663.
- Kottelat M & Freyhof J (2007) Handbook of European Freshwater Fishes. Kottelat, Cornol & Freyhof, Berlin, xiv + 646 pp.
- Kottelat M, Whitten AJ, Kartikasari SN & Wirjoatmodjo S (1993) Freshwater Fishes of Western Indonesia and Sulawesi. Periplus Editions, Hong Kong, 221 pp., 84 pls.
- Larson HK & Husana DEM (2018) A new species of the blind goby *Caecogobius* (Gobioidei, Gobiidae, Gobionellinae) from a cave system on Mindanao Island, Philippines. *Ichthyological Research*, 66: 97–103.
- Myers GS (1960) The endemic fish fauna of Lake Lanao, and the evolution of higher taxonomic categories. *Evolution*, 14(3): 323–333.
- Sauvage H-E (1881) Description de quelques poissons de la collection du Muséum d'histoire naturelle. *Bulletin de la Société Philomathique de Paris, Série 7*, 5: 101–104.
- Sawicki TR, Holsinger JR & Iliffe TM (2005) New species of amphipod crustaceans in the genera *Tegano* and *Melita* (Hadzioidea: Melitidae) from subterranean groundwaters in Guam, Palau, and the Philippines. *Journal of Crustacean Biology*, 25(1): 49–74.
- Weber M & de Beaufort LF (1916) The Fishes of the Indo-Australian Archipelago. III. Ostariophysi: II. Cyprinoidea, Apodes, Sunbranchii. Brill, Leiden, 455 pp.