

A new loach species of the genus *Vanmanenia* (Actinopterygii: Cypriniformes: Gastromyzontidae) from hill streams of Vietnam

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Abstract

Recent ichthyofauna surveys in Phia Oac-Phia Den National Park, Vietnam, yielded 16 specimens of loach representing the genus *Vanmanenia*. These specimens were uniform in morphology and distinct from known species, leading to the designation of a new species, *Vanmanenia duci* **sp. nov.** This species is distinguished from congeners by the following combination of characters: pectoral fin: I, 15; pelvic fin: I, 8; lateral line scales 77–83; the distance from the anus to the posterior insertion of the pelvic fin being greater than from the anus to the anal fin origin; a lateral black stripe from the gill opening to the caudal fin base; a black spot at the caudal fin origin equal to the eye diameter; and a lower lip with three large papillae, with the middle one being larger. The new species differs from *Vanmanenia caldwelli* (Nichols, 1925) by its mouth soft-tissue structures and lower morphometric values and from *Vanmanenia ventrosquamata* (Mai, 1978) and *Vanmanenia caobangensis* Nguyen, 2005 by having more lateral line scales and lower body depth. Additionally, *Vanmanenia duci* **sp. nov.** has a larger eye and wider interorbital space compared to other species in Vietnam. This species is found in the Red River basin in Vietnam and the Bang Giang River flowing into China, indicating high potential for freshwater fish diversity in these river systems.

Keywords

Bang Giang River, Gam River, new species, northern Vietnam, taxonomy, *Vanmanenia*

Introduction

The genus *Vanmanenia* Hora, 1932, commonly known as hillstream loaches represents the family Gastromyzontidae, currently accommodates 24 species (Fricke et al. 2023). Some of its species were formerly assigned to *Homalosoma* Boulenger, 1901 (see Silas 1953). A total of 22 species can be found in southern China and Vietnam, i.e., *Vanmanenia caldwelli* (Nichols, 1925); *Vanmanenia*

caobangensis Nguyen, 2005; *Vanmanenia gymnetrus* Chen, 1980; *Vanmanenia hainanensis* Chen et Zheng, 1980; *Vanmanenia homalocephala* Zhang et Zhao, 2000; *Vanmanenia lineata* (Fang, 1935); *Vanmanenia maculata* Yi, Zhang & Shen, 2014; *Vanmanenia microcephala* Li, Zhou et Che, 2019; *Vanmanenia microlepis* Nguyen, 2005; *Vanmanenia monofasciodorsala* Nguyen, 2005; *Vanmanenia multiloba* (Mai, 1978); *Vanmanenia nahangensis* Nguyen, 2005; *Vanmanenia pingchowensis*

(Fang, 1935); *Vanmanenia polylepis* Pan, Liu et Zhang, 1983; *Vanmanenia pseudostrata* Zhu, Zhao, Liu et Niu, 2019; *Vanmanenia serrilineata* Kottelat, 2000; *Vanmanenia stenosoma* (Boulenger, 1901); *Vanmanenia striata* Chen, 1980; *Vanmanenia tetraloba* (Mai, 1978); *Vanmanenia trifasciodorsala* Nguyen, 2005; *Vanmanenia ventrosquamata* (Mai, 1978); and *Vanmanenia xinyiensis* Zheng et Chen, 1980 (see Li et al. 2019; Deng and Zhang 2020, 2021; Cai et al. 2021), and eight species in Vietnam (Nguyen 2005). Species in this genus prefer living in the fast-flowing waters of mountain brooks of China, Laos, and Vietnam (Yue et al. 2000; Yi et al. 2014). Thus, they could be diverse in the upper reaches of large rivers in northern Vietnam, such as the Red River and the Bang Giang River. In fact, of eight species recorded in northern Vietnam, seven are distributed in the Red River, i.e., *V. microlepis*, *V. monofasciodorsala*; *V. multiloba*, *V. nahangensis*, *V. tetraloba*, *V. trifasciodorsala*, and *V. ventrosquamata* (see Nguyen et al. 2019) and two species from the Bang Giang River in Cao Bang Province, i.e., *V. ventrosquamata* and *V. caobangensis* (see Nguyen 2005; Deng and Zhang 2020) (Fig. 1).

During the first surveys of the ichthyofauna in in Phia Oac-Phia Den National Park, Cao Bang Province, northern Vietnam (Fig. 2) in 2020 and 2021, 16 specimens of *Vanmanenia* were collected. Details of their external morphology indicated that all of them were one species, and they did not conform to any of the hitherto known species of the genus *Vanmanenia*. Therefore, we decided to describe these specimens as a new species, *Vanmanenia duci* sp. nov. and provide

a differential diagnosis to distinguish it from all its congeners.

Materials and methods

Two fieldwork surveys were carried out in May 2020 and May 2021 in Phia Oac-Phia Den National Park, Nguyen Binh District, Cao Bang Province, northern Vietnam. In this area, there are two different river basin systems, including the Gam River, one of the largest tributaries of the Red River, and the Bang Giang River, known as the Zuo River in China, an upper tributary of the Yu River in southern China (Pearl River basin) (Figs. 1, 2). Fish samples were collected by a hand net and by electro-fishing within 30 min per sampling site under the permission of local authorities. From these surveys, a total of 16 specimens of loach representing the genus *Vanmanenia* was collected at stations DO.02 in the Gam River, DO.05, and DO.07 in the Bang Giang River (Fig. 2). Fish were fixed in 10% formalin solution, and subsequently preserved in 70% ethanol in the Museum of Biology, Hanoi National University of Education. Measurements and counts followed by Yi et al. (2014) and were taken from the left side of each specimen. Measurements were made point-to-point, to the nearest 0.1 mm using calipers, and expressed as a percentage.

Comparative material. *Vanmanenia caldwelli*: SOU 201807801, 5 specimens, 30.15–62.13 mm SL; China: Fujian Province: Fuqing City; Min River; 7 July 2018.

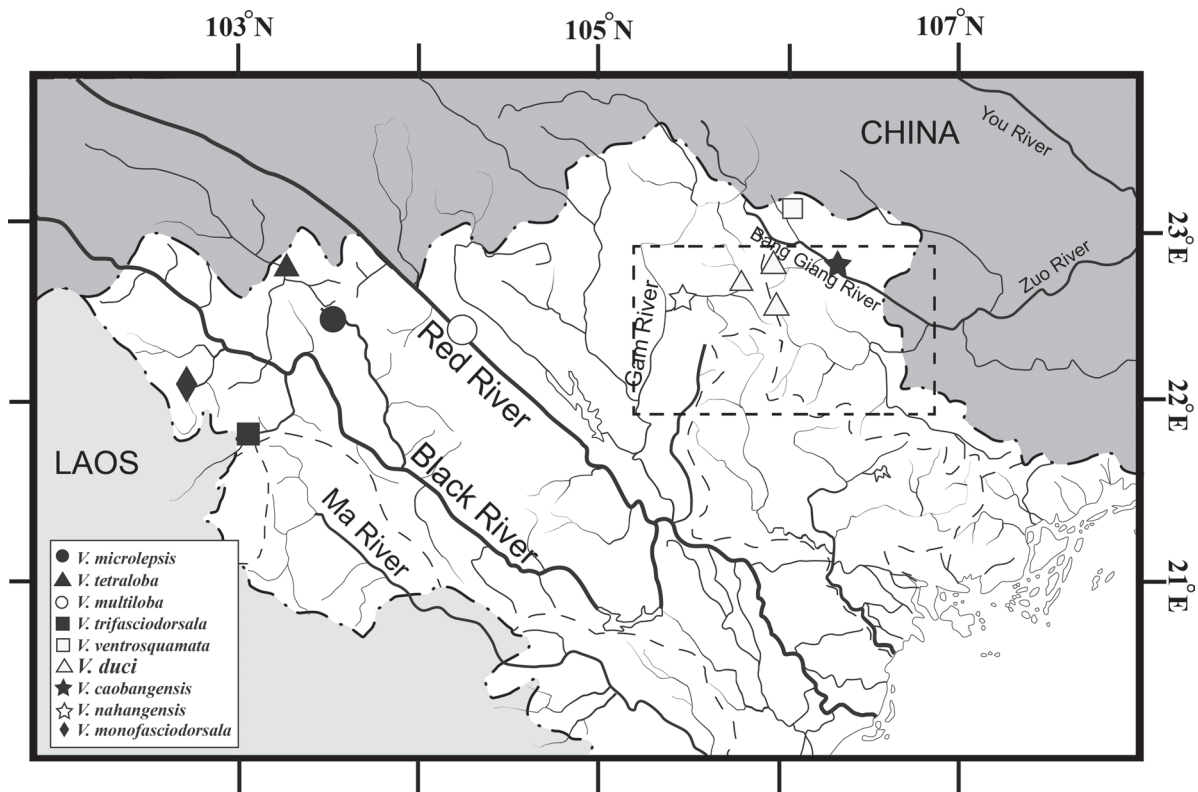


Figure 1. Distribution of species of the genus *Vanmanenia* in northern Vietnam.

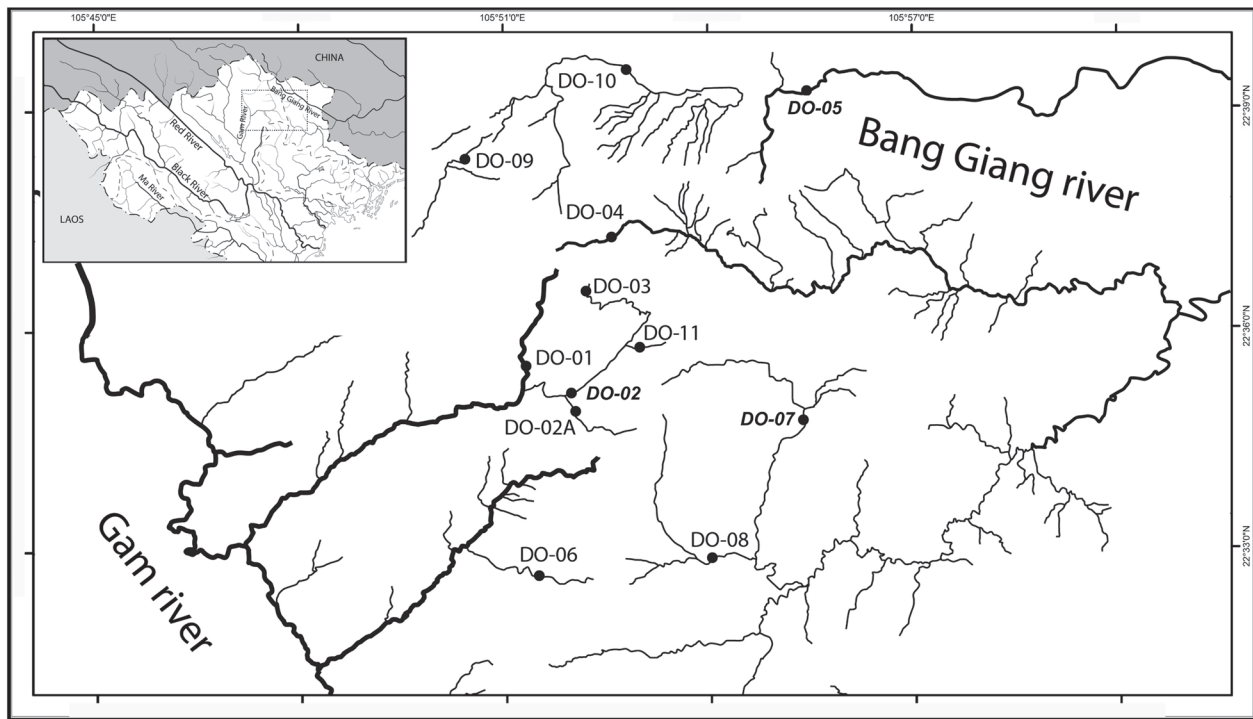


Figure 2. Sampling sites of *Vanmanenia duci* sp. nov. in Phia Oac-Phia Den National Park, Cao Bang Province, northern Vietnam.

Results

Taxonomy

Family Gastromyzontidae

Genus *Vanmanenia* Hora, 1932

Vanmanenia duci sp. nov.

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Figs. 3, 4, Table 1

Type locality. Vietnam, Cao Bang Province, Nguyen Binh District, Bang Giang River basin, 20°34'731"N, 105°55'407"E.

Holotype. HNUE-F00293, 47.6 mm SL, Vietnam, Cao Bang Province, Nguyen Binh District, Bang Giang River basin, 20°34'731"N, 105°55'407"E, ca. 760 m above sea level, 24 May 2020, coll. H.D. Tran, V.S. Ngo, and H.V. Pham; electro-fishing, medium speed current stream with stone and gravel bottom, both the sides fringed by plants.

Paratypes ($n = 15$). HNUE-F00294-296, 3 ex., 33.0–50.1 mm SL, data same as for holotype. HNUE-F00297-298, 2 ex., 35.8–39.4 mm SL, same locality as for holotype, 8 May 2021, coll. H.D. Tran, V.S. Ngo, H.Q. Nguyen, N.T. Nguyen, and A.N.T. Do. HNUE-F00299-303, 5 ex., 32.4–52.1 mm SL, Vietnam, Cao Bang Province, Nguyen Binh District, Gam River, 22°35'197"N, 105°51'903"E, 1005 m above sea, 21 May 2020, coll. H.D. Tran, V.S. Ngo, and H.V. Pham; electro-fishing and hand net, fast speed current stream with large stone and sandy bottom, both the sides fringed by plants. HNUE-F00304-305, 2 ex., 48.3–54.0 mm SL, same locality as for HNUE-F00299, 7 May 2021,

coll. H.D. Tran, V.S. Ngo, H.Q. Nguyen, N.T. Nguyen, and A.N.T. Do. HNUE-F00306, 1 ex., 41.3 mm SL, 8 May 2021, other data same as for HNUE-F00303. HNUE-F00307-308, 2 ex., 39.1–40.3 mm SL, Vietnam: Cao Bang Province, Nguyen Binh District, Bang Giang River basin, 22°39'289"N, 105°55'339"E, 500 m above sea, 22 May 2020, coll. H.D. Tran, V.S. Ngo, and H.V. Pham; electro-fishing and hand net, fast speed current stream with gravel bottom.

Diagnosis. *Vanmanenia duci* sp. nov. can be distinguished from congeners by following combination of characters: pectoral fin rays: I, 15; pelvic fin rays: I, 8; lateral line scales: 77–83; anus farther posterior insertion of pelvic fin than to anal fin origin, caudal peduncle depth approximately as caudal peduncle length (8.2%–8.5%), distance from pelvic fin to pectoral fin (39.1%) larger than distance from pelvic fin to anal fin (29.8%). It has a broad midlateral black stripe running from behind head to caudal-peduncle base. Black dotted stripe stretching from base of pectoral fin to posterior end of anal fin. Lower lip with three large papillae; median wider than two lateral ones. Rostral fold divided into three triangular lobules of same size. Distinct black dot at base of pelvic and pectoral fins, and fleshy black protrusion in pelvic fin base.

Description. Meristic and morphometric data for type specimens are presented in Table 1. View of body and its mouth structures are shown in Figs. 3, 4, 5A. Body elongate, anteriorly depressed before dorsal-fin origin and posteriorly compressed laterally. Body width almost as wide as body depth. Dorsal profile of head and predorsal body slightly curved, and flat ventral profile. Moderate gill opening extending to ventral surface for short distance in front of pectoral fin base (Fig. 3).



Figure 3. *Vanmanenia duci* sp. nov., HNUE-F00293, SL = 47.6 mm in Phia Oac-Phia Den National Park, Cao Bang Province, northern Vietnam.

Head depressed, slightly longer than wide, and wider than deep. Snout broadly rounded in dorsal view and bluntly pointed in lateral view. Small eyes situated dorso-laterally in posterior half of head, with interorbital space bigger than eye diameter. Nostrils large, closer to eyes than to snout. Small fleshy papillae above top of head and edges of the eyes. Mouth inferior, medium-sized and curved, with muzzle grooves and muzzle folds in front. Snout groove wide and shallow, extending to corner of mouth (Fig. 3). Lips fleshy; upper lip covered with conspicuous papillae, and shallow groove present with rostral fold and, disconnected from lower lip at corners of mouth; lower lip with three large papillae, slightly tips curved, one median bigger than lateral two ones. Rostral

fold divided into three triangular lobules same size, and two pairs of lobulated papillae between the folds, with inner side mastoid. Two pairs of rostral barbels, outer pair larger than inner pair, and about 1/2 of eye diameter (Fig. 5A). Body covered by small scales, present except on anterior pectoral fin to pelvic fin base, and on ventral surface in front of and between bases of pectoral fins. Lateral line complete and straight. No spine on dorsal fin, with 3 simple and 7 branched rays. Its origin anterior to pelvic fin origin, closer to caudal fin base than to tip of snout, and distal margin slightly straight. Two simple and 5 branched rays on anal fin, and its origin nearer to anus than to caudal fin base. One simple and 15 branched rays on pectoral fin, much longer than head length. Its base



Figure 4. Aquarium photograph of *Vanmanenia duci* sp. nov. (HNUE-F00293, 47.6 mm SL) from northern Vietnam.

Table 1. Morphometric and meristic data for examined materials of *Vanmanenia duci* sp. nov. from Phia Oac-Phia Den National Park, Vietnam.

Character	<i>Vanmanenia duci</i> sp. nov.			
	Holotype	Paratypes (<i>n</i> = 15)		
		Mean	SD	Range
Absolute morphometric values [mm]				
Standard length (SL)	47.6	42.5	7.03	32.4–54.0
Relative morphometric values [% in SL]				
Body depth	16.4	15.6	0.02	12.2–18.7
Predorsal length	53.0	51.2	0.01	48.6–53.7
Prepelvic length	55.5	54.4	0.01	51.7–56.8
Preanal length	84.7	84.4	0.01	82.9–86.1
Pectoral-to pelvic-fin insertion	40.1	39.1	0.02	34.3–41.9
Pelvic-fin insertion to anal-fin origin (PFAF)	29.6	29.8	0.01	27.6–31.1
Pectoral-fin base length	10.1	9.5	0.01	7.1–10.7
Pelvic-fin base length	4.4	4.2	0.01	3.6–5.0
Dorsal-fin base length	13.5	11.6	0.01	9.9–13.6
Anal-fin base length	5.3	4.6	0.01	3.7–6.0
Anus to anal-fin origin	8.8	9.5	0.02	7.1–14.7
Caudal-peduncle length (CPL)	7.9	8.2	0.01	7.5–9.8
Caudal-peduncle depth	8.4	8.5	0.01	7.9–9.1
Pectoral-fin length	29.4	29.2	0.01	27.8–30.0
Pelvic-fin length	20.2	19.7	0.01	18.8–20.9
Anal-fin length	16.4	16.1	0.01	14.2–19.3
Dorsal-fin length	23.5	22.5	0.01	20.5–24.1
Head length (HL)	16.2	16.0	0.01	15.4–16.7
Relative morphometric values [% in CPL]				
Caudal-peduncle depth	106.7	102.8	0.04	92.5–111.1
Relative morphometric values [% in PFAF]				
Anus to anal-fin origin	12.7	13.8	0.03	10.4–21.0
Relative morphometric values [% in HL]				
Head depth	66.2	64.6	0.06	52.8–79.5
Snout length	58.4	65.6	0.04	59.2–72.5
Head width	83.8	82.6	0.04	75.5–88.5
Eye diameter	24.0	25.7	0.03	21.0–30.4
Interorbital width	54.6	56.0	0.02	52.8–61.5
Mouth width	20.1	21.9	0.02	18.9–26.5
Meristic data				
Dorsal-fin rays	III, 7	III, 7		
Pectoral-fin rays	I, 15	I, 15		
Pelvic-fin rays	I, 8	I, 8		
Anal-fin rays	II, 5	II, 5		
Lateral-line scales	83	77–83		

Values of Mean, SD, and Range do not include the holotype.

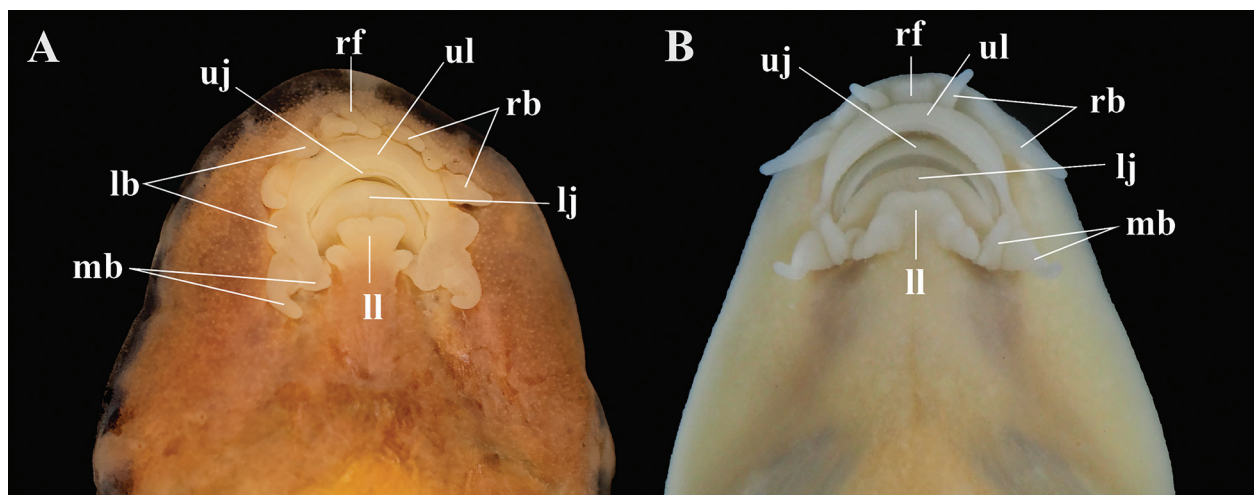


Figure 5. Mouth soft-tissue structures of two very similar species of *Vanmanenia* in Vietnam and China: (A) *Vanmanenia duci* sp. nov., HNUE-F00293, 47.6 mm SL, (B) *Vanmanenia caldwelli*, 62.1 mm SL (photo by Fan Li). Abbreviations: lj = lower jaw, mb = maxillary barbel, rb = rostral barbel, rf = rostral fold, uj = upper jaw, ul = upper lip, ll = lower lip, lb = lobulated papillae.

slightly behind lower extremity of eye, tip of adpressed fin not reaching pelvic-fin insertion. One simple and 8 branched rays on pelvic fin. Its origin closer to caudal fin base than to snout tip and tip of adpressed fin touching or exceeding anus, but far from anal fin origin. Anus positioned closer to anal fin origin than to base of pelvic fin. Caudal fin slightly concave, with lower lobe slightly longer than upper lobe.

Coloration (freshly collected). Body yellowish-brown; belly a pale ivory color (Figs. 3, 4). Head with small, irregular, black bars and blotches on cheeks and snout. Dorsum with eight or nine black blotches and irregular small blotches. Round black protrusions on pectoral and pelvic fin bases. One brown-black band across rays on dorsal fin, and two in caudal fin. Pectoral and pelvic fins pale yellow. Midlateral black stripe from behind head to caudal fin base. A brown-black dotted stripe along from pectoral-fin base to posterior insertion of the anal fin; caudal fin base with a black spot of eye size (Fig. 4).

Coloration (preserved). Specimens fixed in formalin solution with yellowish body and head; belly yellow. Black bars present on behind of head to caudal fin base. Black dotted stripes from posterior end of pectoral fin to anal fin. These fins pale whitish, with black bands across rays of dorsal and caudal fins (Fig. 3).

Distribution. *Vanmanenia duci* sp. nov. is known only from three localities in the Phia Oac-Phia Den National Park, Cao Bang Province, northern Vietnam (Fig. 2). Other species of *Vanmanenia* are distributed in different localities of the Red River and Bang Giang River.

Habitat and ecology. Figure 6 shows the three known localities of *Vanmanenia duci* sp. nov. The holotype was found in a narrow forests stream with medium speed current and gravel bottom (Fig. 6A). Co-occurring fish species included *Parazacco* sp. (Duong et al. 2022); *Lini-parhomaloptera* cf. *qiongzhongensis* Zheng et Chen, 1980;

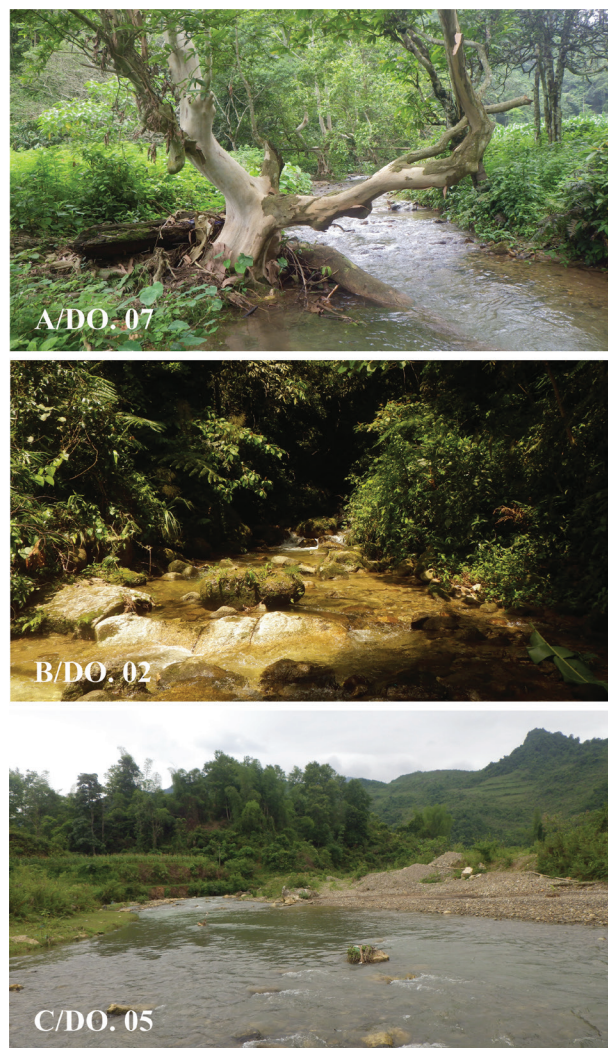


Figure 6. Habitat of *Vanmanenia duci* sp. nov., in the Gam River (DO.02) and Bang Giang River (DO.05, DO.07) in Phia Oac-Phia Den National Park, northern Vietnam.

Schistura sp.; *Carassius auratus* (Linnaeus, 1758); *Discogobio* sp., *Rhinogobius duospilus* (Herre, 1935) (see Nguyen et al. 2024). Several paratypes were found in a fast speed current forest stream with large stones and sand as bottom (Fig. 6B). This sampling site is next to the road, where a new bridge is under construction. There were several other fish species, including *Schistura* sp. (see Nguyen et al. 2024) and *Chimarrichthys nami* (Tran, Nguyen, Dang, Nguyen et Nguyen, 2023). At the third sampling site (Fig. 6C), accompanying fish species included *Beaufortia pingi* (Fang, 1930); *Schistura* spp.; *Barbodes semifasciolatus* (Günther, 1868); *Discogobio microstoma* (Mai, 1978); *Onychostoma gerlachi* (Peters, 1881); *Discogobio* spp.; *Hemibarbus cf. umbrifer* (Lin, 1931); and *Gambusia affinis* (Baird et Girard, 1853) (see Nguyen et al. 2024).

Etymology. The specific name is in honor of Vietnamese ichthyologist, Prof. Nguyen Huu Duc, who had spent his whole life studying freshwater fishes in Vietnam.

Discussion

Species group with black mid-lateral stripe. *Vanmanenia duci* sp. nov. differs from all other species of *Vanmanenia* except *V. caldwelli*, *V. lineata*, and *V. homalocephala* by having a broad black midlateral stripe on the body (vs. having bars or irregular blotches) (Figs. 3, 4, 7 in the presently reported study; fig. 278 in Yue et al. 2000; fig. 1 in Zhang and Zhao 2000). *Vanmanenia homalocephala*

and *V. lineata* are distributed in Xi-Jiang of the Pearl River basin (Yue et al. 2000; Zhang and Zhao 2000; Deng and Zhang 2020). The new species could be distinguished from *V. lineata* by maxillary barbel and lower lip in the mouth (fig. 1 in Li et al. 2019; Fig. 5A in the presently reported study). *Vanmanenia homalocephala* and *Vanmanenia duci* sp. nov. could be distinguished by scales in lateral line (95–100 vs. 77–83) and color pattern on the back (5–6 vs. 19 dark saddle-backed stripes) (fig. 1 in Zhang and Zhao 2000; Fig. 3 in the presently reported study).

The last species having a black midlateral stripe on the body is *V. caldwelli*, which is distributed in Min-Jiang River (Deng and Zhang 2021), far from the study site. Both *V. caldwelli* and *Vanmanenia duci* sp. nov. share the same gross morphology (Table 2). However, values of the majority of the measurements of *Vanmanenia duci* sp. nov. are lower than the range of measurements of *V. caldwelli*, such as body depth (12.2%–18.7%), caudal-peduncle depth (7.9%–9.1%), or head length (15.4%–16.7%), although snout length and eye diameter of *Vanmanenia duci* sp. nov. are larger than those of *V. caldwelli* (59.2%–72.5%, 21.0%–30.4%; respectively) (Table 2). In addition, the distance from the anus to posterior end of pelvic fin is farther than the distance from the anus to anterior insertion of the anal fin (vs. closer). Both species have a longitudinal black stripe on the body (Figs. 3, 7), but the starting position of this stripe in the two species is different. It starts from the tip of the snout in *V. caldwelli* and just behind the head in *Vanmanenia duci* sp. nov. The mouth structure is

Table 2. Morphometric and meristic data for examined materials of *Vanmanenia duci* sp. nov. in Vietnam and its very similar species, *Vanmanenia caldwelli* in China.

Character	Species, locality, reference, and number of specimens						
	<i>Vanmanenia duci</i> sp. nov.	<i>Vanmanenia caldwelli</i>					
	Gam and Bang Giang Rivers, Vietnam	Min River, Fuqing City, China	Yenping, Chungan, Fukein, China	Min-Jiang basin, China	Yenping, Fukien, China	Min-Jiang basin at Chong'an, south China	Min-Jiang basin, China
	This study <i>n</i> = 16	This study <i>n</i> = 5	Silas 1953 <i>n</i> = 4	Deng and Zhang 2020 <i>n</i> = 10	Nichols 1925 <i>n</i> = 1	Yi et al. 2014 <i>n</i> = 8	Yue et al. 2000 <i>n</i> = 16
	Absolute morphometric values [mm]						
Standard length (SL)	32.4–54.0	30.2–62.1	—	40.7–56.4	48	49.3–70.5	41–72
	Relative morphometric values [% in SL]						
Body depth	12.2–18.7	18.1–20.4	14.3–14.8	17.1–20.1	20	14.3–17.7	21.7–28.6
Predorsal length	48.6–53.7	51.9–55.3	—	50.9–53.3	—	50.1–52.2	50.0–52.6
Prepelvic length	51.7–56.8	55.2–59.5	—	55.0–60.7	—	52.2–57.1	52.6–55.6
Preanal length	82.9–86.1	80.6–84.2	—	80.9–87.8	—	80.8–85.5	—
Pectoral-to pelvic-fin insertion	34.3–41.9	33.9–39.2	—	37.1–42.8	—	36.6–41.2	—
Pelvic-fin insertion to anal-fin origin	27.6–31.1	24.4–27.6	—	24.6–28.4	—	24.8–27.9	—
Caudal-peduncle depth	7.9–9.1	10.3–13.4	—	9.1–11.2	—	9.2–10.2	10.0–11.0
Pectoral-fin length	27.8–30.0	19.8–22.9	—	22.4–26.7	—	22.9–26.2	—
Pelvic-fin length	18.8–20.9	15.2–20.0	—	19.1–23.4	—	18.9–20.9	—
Anal-fin length	14.2–19.3	16.0–18.1	—	16.6–19.7	—	15.9–19.4	—
Dorsal-fin length	20.5–24.1	21.2–22.8	—	19.8–24.9	—	22.4–25.0	—
Head length (HL)	15.4–16.7	18.6–20.7	20.0–21.1	20.5–22.6	21.7	18.4–20.6	16.7–18.9
	Relative morphometric values [% in HL]						
Snout length	59.2–72.5	43.2–48.1	33.3–44.4	40.0–49.2	50.0	45.5–56.1	41.7–55.6
Eye diameter	21.0–30.4	20.5–27.8	19.1–23.5	24.9–30.7	20.0	19.3–24.7	16.7–22.2
	Meristic data						
Dorsal-fin rays	III, 7	III, 8	III, 8	III, 7	10	III, 7	III, 7
Pectoral-fin rays	I, 15	I, 13	I, 13–14	I, 13	—	I, 13–15	I, 13–15
Pelvic-fin rays	I, 8	I, 8	I, 6–7	I, 8	—	I, 8	I, 8
Anal-fin rays	II, 5	II, 5; II, 6	III, 5	II, 5	7	II, 5	II, 5
Lateral-line scales	77–83	—	150	70–81	150	76–92	76–92

somewhat similar between the two species since they have a lower lip with three triangular lobes, the middle lobe larger than two lateral lobes, two pairs of maxillary barbel at the corner of the mouth, and the outer pair is larger than the lateral lobes (Fig. 5A, 5B). Nevertheless, the upper lip of *Vanmanenia duci* sp. nov. is thin, with four conspicuous lobulated papillae, rostral barbels alternate with lobulated papillae and rostral folds clear (vs. a thick upper lip, lobulated papillae are absent and rostral folds are unclear in *V. caldwelli*). The lower jaw of *V. duci* sp. nov. is larger and deeper (vs. small and shallow) (Figs. 5A, 5B). Besides, both species have a slightly black spot in the middle caudal fin base, but *Vanmanenia duci* sp. nov. has a black spot equal to the eye diameter (vs. smaller than the eye diameter). Moreover, the number of black bands across rays of dorsal and caudal fins of species *Vanmanenia duci*

sp. nov. are fewer than those in *V. caldwelli* (1, 2 vs. 2, 3, respectively). The caudal fin shape is also clearly different between the two species (slightly truncate in *Vanmanenia duci* sp. nov. vs. forked in *V. caldwelli*) (Figs. 3, 7). There is a larger black dot at the base of the pelvic and pectoral fins and a fleshy larger black protrusion of pelvic fin base in the new species than those in *V. caldwelli*. The new species has a black dotted stripe along from the posterior end of the pectoral fin to the posterior insertion of the anal fin (vs. absent in *V. caldwelli*) (Figs. 3, 7).

Species group without black mid-lateral stripe. The new species was collected in the Red River and the Bang Giang River (a tributary of the Pearl River in China) (Fig. 1). Thus, the presently reported study attempted to compare the morphology of the new species with known

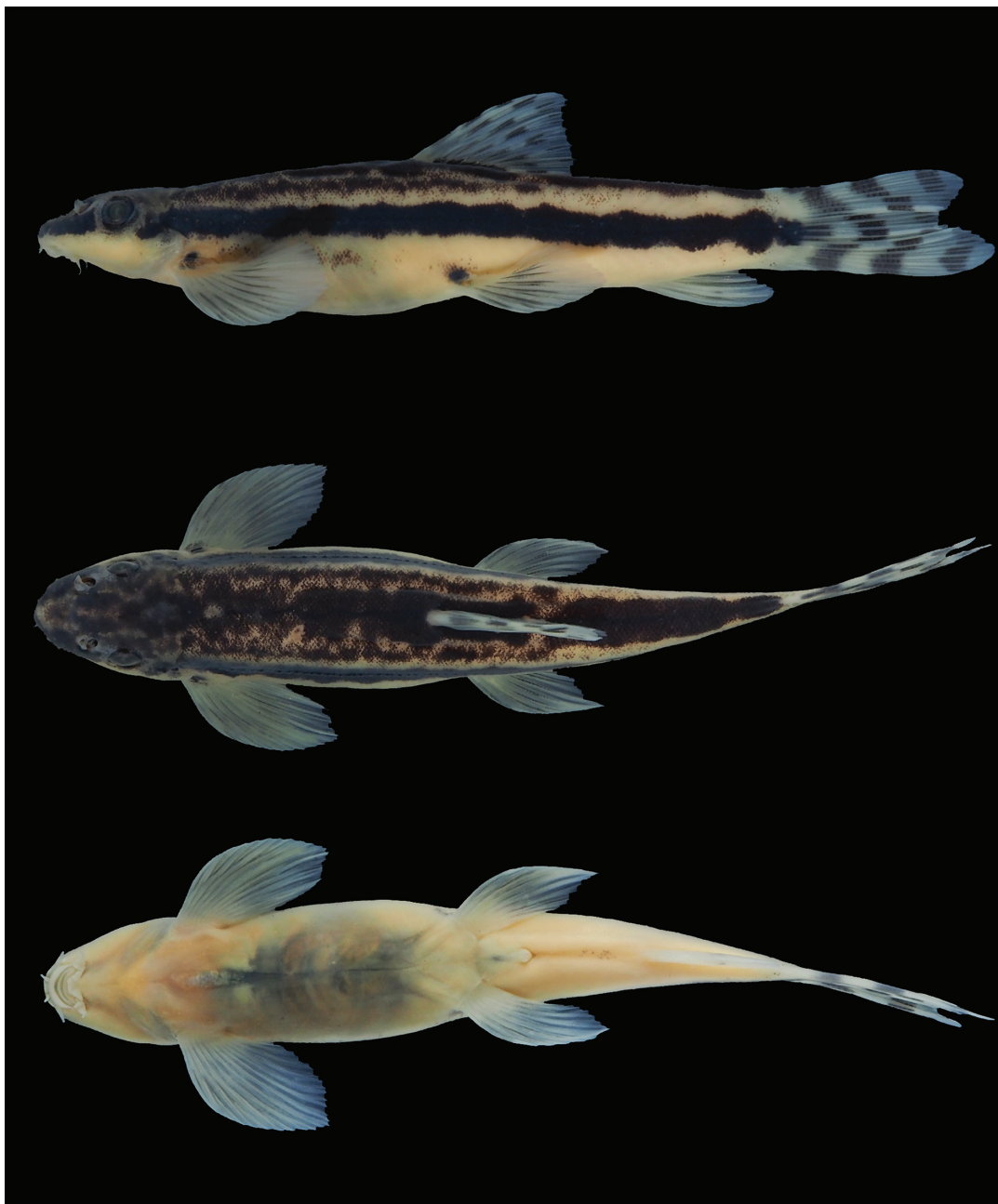


Figure 7. *Vanmanenia caldwelli* (62.1 mm SL) collected from the Min River, in Fuqing City, Fujian Province, China (Photos by Fan Li).

species of *Vanmanenia* in this group from the Red River and the Pearl River basins.

In the Red River, two species *V. tetraloba*, *V. striata* are present in this group from China (Li et al. 2019). These two species are different from the new species by body color patterns (flank with 11–21 vermiculations presence vs. absence) and mouth soft-tissue structures (figs. 7, 8 in Li et al. 2019; fig. 3 in Yi et al. 2014; Figs. 3, 5A, 5B, 8A, 8B, 8C in the presently reported study). As we can see from Fig. 1, this genus is diverse in the Red River basin located in Vietnam. Differences between *Vanmanenia duci* sp. nov. and the six species of *Vanmanenia* occurring in the Red River basin from Vietnam are listed in Tables 3, 4. The new species could be distinguished from its congeners in the Red River basin by the number of scales in the lateral line (Table 3). For example, the new species has fewer lateral-line scales (77–83) than *V. tetraloba* (104–112), *V. trifasciodorsala* (169), *V. monofasciodorsala* (164), and *V. microlepis* (124–135). Furthermore, *Vanmanenia duci* sp. nov. has a shorter head than *V. nahangensis* (15.4%–16.7% vs. 20.70%) (Table 3), which is distributed

in the Gam River, a different tributary of the Red River opposite to the Black River, where other four species of *Vanmanenia* present (Fig. 1). The records of this new species and others, such as *Pareuchiloglanis* sp. (Tran et al. 2021), *Parazacco* sp. (Duong et al. 2022), and *Chimarichthys nami* (see Tran et al. 2023) further indicate that the Red River basin is a home of many freshwater fish species (Nguyen et al. 2019). In the Pearl River, in addition to *V. lineata* and *V. homalocephala* as mentioned above, there are four species of this genus, i.e., *V. gymnetrus*, *V. intermedia*, *V. pingchowensis*, and *V. polylepis* in China. The new species differs from *V. gymnetrus*, *V. intermedia*, and *V. pingchowensis* in body color patterns (a broad black midlateral stripe on the body vs. absence) and mouth soft-tissue structures (fig. 1 in Li et al. 2019; figs. 2, 3, 7 in Deng and Zhang 2020; Figs. 3, 5A, 5B in the presently reported study). *Vanmanenia duci* sp. nov. can be distinguished from *V. polylepis* by the patch type on the caudal-fin base (complete vs. dissociated) (Li et al. 2019; Fig. 3 in the presently reported study). This character is also available to indicate the new species differing from

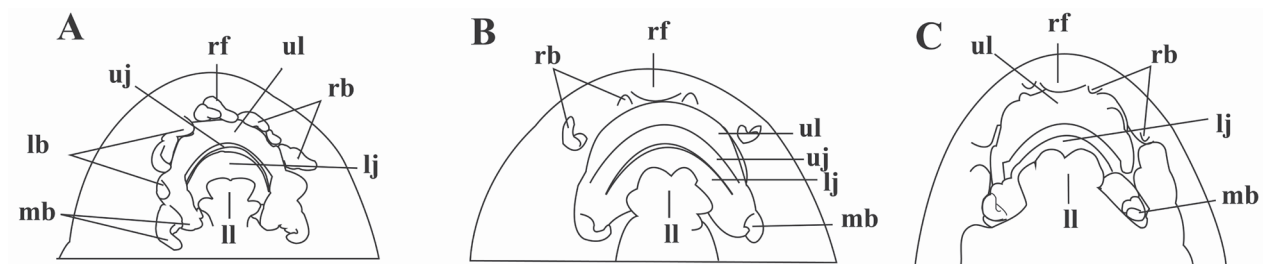


Figure 8. Mouth soft-tissue structures of three species of *Vanmanenia* distributed in the same river basin, the Red River in Vietnam and China: (A) *Vanmanenia duci* sp. nov., HNUE-F00304, 47.60 mm SL; (B) *Vanmanenia striata*, IHB 646482, 53.20 mm SL (Yi et al. 2014); (C) *Vanmanenia tetraloba*, SWFC 0512252, 75.30 mm SL (Li et al. 2019). Abbreviations: lj = lower jaw, mb = maxillary barbel, rb = rostral barbel, rf = rostral fold, uj = upper jaw, ul = upper lip, ll = lower lip, lb = lobulated papillae.

Table 3. Comparison meristic and morphometric data of *Vanmanenia duci* sp. nov. with other species of *Vanmanenia* occurring in northern Vietnam.

Character	Species, locality, reference, and number of specimens								
	<i>Vanmanenia duci</i> sp. nov.	<i>Vanmanenia ventrosquamata</i>	<i>Vanmanenia tetraloba</i>	<i>Vanmanenia trifasciodorsala</i>	<i>Vanmanenia caobangensis</i>	<i>Vanmanenia nahangensis</i>	<i>Vanmanenia monofasciodorsala</i>	<i>Vanmanenia microlepis</i>	<i>Vanmanenia multiloba</i>
	Red River, Pearl River	Pearl River	Red River	Red River	Pearl River	Red River	Red River	Red River	Red River
	<i>n</i> = 16	<i>n</i> = 1	<i>n</i> = 7	<i>n</i> = 9	<i>n</i> = 5	<i>n</i> = 1	<i>n</i> = 5	<i>n</i> = 3	—
	Absolute morphometric values [mm]								
Standard length (SL)	32.4–54.0	73.2	52.0–80.0	64.5–77.3	45.0–61.0	59.0	72.0–92.5	63.0–84.0	48.0–71.0
	Relative morphometric values [% in SL]								
Body depth	12.2–18.7	16.4	15.4–19.6	16.0–19.7	18.0–22.3	18.7	19.6–20.8	21.1–22.8	17.0
Caudal-peduncle length (CPL)	7.5–9.8	12.6	10.2–13.7	10.1–14.1	10.8–12.4	9.2	11.3–12.6	11.2–12.8	—
Caudal-peduncle depth	7.9–9.1	8.4	7.8–9.0	7.8–8.8	9.1–9.6	10.2	8.9–10.7	9.3–9.5	—
Head length (HL)	15.4–16.7	16.4	18.9–21.1	20.3–22.5	20.0–21.2	20.7	22.7–23.9	20.5–24.5	19.7
	Relative morphometric values [% in CPL]								
Caudal-peduncle depth	92.5–111.1	87.0	65.8–82.7	56.2–87.7	77.5–86.2	109.9	70.4–87.7	75.2–84.8	—
	Relative morphometric values [% in HL]								
Eye diameter	21.0–30.4	18.2	14.5–18.6	16.4–17.3	17.1–20.7	18.9	13.0–16.4	12.1–16.9	19.1
Interorbital width	52.4–61.5	46.3	35.0–5	32.4–39.5	39.1–47.0	43.5	36.0–40.7	43.7–46.1	—
	Meristic data								
Dorsal-fin rays	III, 7	III, 7	III, 7	II, 7	III, 7	III, 7	II, 7	II, 7	I, 7
Pectoral-fin rays	I, 15	I, 15	I, 14–15	I, 15	I, 15–16	I, 17	I, 14–16	I, 15	—
Pelvic-fin rays	I, 8	I, 8	I, 8	I, 8	I, 8	I, 7	I, 8	I, 9	—
Anal-fin rays	II, 5	I, 5	II, 5	II, 5	II, 5	I, 5	II, 5	II, 5	I, 5
Lateral-line scales	77–83	69–70	104–112	169	64–67	60	164	124–135	90–100

Table 4. Morphological comparison among nine species of *Vanmanenia* in northern Vietnam.

Parameter	Species and reference								
	<i>Vanmanenia duci</i> sp. nov.	<i>Vanmanenia ventrosquamata</i>	<i>Vanmanenia tetraloba</i>	<i>Vanmanenia trifascioidorsala</i>	<i>Vanmanenia caobangensis</i>	<i>Vanmanenia nahangensis</i>	<i>Vanmanenia monofascioidorsala</i>	<i>Vanmanenia microlepis</i>	<i>Vanmanenia multiloba</i>
	This study	Nguyen 2005	Nguyen 2005	Nguyen 2005	Nguyen 2005	Nguyen 2005	Nguyen 2005	Nguyen 2005	Mai 1978
Lobes on lower lip structures	3 lobules; median one wider than two lateral ones	3 lobules; median one wider than two lateral ones	3 lobules nearly equal in width	3 lobules nearly equal in width	3 lobules; median one wider than two lateral ones	3 lobules; median one wider than two lateral ones	3 lobules; median one wider than two lateral ones	3 lobules nearly equal in width	—
Barbels at mouth corner	2 pairs	2 pairs	1 pair	1 pair	1 pair	2 pairs	1 pair	1 pair	1 pair
Position of dorsal fin base	Farther to snout tip than to caudal-fin origin	Between snout tip and caudal-fin origin	Between snout tip and caudal-fin origin	Between snout tip and caudal-fin origin	Farther to snout tip than to caudal-fin origin	Between snout tip and caudal-fin origin	Between snout tip than to caudal-fin origin	Farther to snout tip than to caudal-fin origin	Between snout tip and caudal-fin origin
Position of anal fin base	Closer to anus than to caudal-fin origin	Between anus and caudal-fin origin	Closer to anus than to caudal-fin origin	—	Closer to anus than to caudal-fin origin	Between anus and caudal-fin origin	Between anus and caudal-fin origin	Closer to anus than to caudal-fin origin	—
Anus position	Farther to pelvic-fin posterior insertion than to anal-fin origin	Closer to pelvic-fin posterior insertion than to anal-fin	Between pelvic-fin posterior insertion and anal-fin origin	Between pelvic-fin posterior insertion and anal-fin origin	Between pelvic-fin posterior insertion and anal-fin origin	Between pelvic-fin posterior insertion and anal-fin origin	Closer to pelvic-fin posterior insertion than to anal-fin origin	Between pelvic-fin posterior insertion and anal-fin origin	Closer to pelvic-fin posterior insertion than to anal-fin origin
Shape of caudal fin	Slightly concave	Slightly concave	Slightly concave	Deeply concave	Obliquely concave	Slightly concave	Slightly concave	Slightly concave	Truncate
Scales distribution	Absent from prepectoral-fin to pelvic-fin origin; small scales present on postpelvic fin	Absent on prepectoral-fin; small scales present from postpectoral fin to caudal fin	Absent on chest and abdomen; small scales present on origin of prepelvic fin	Absent on chest and abdomen to pelvic-fin insertion	Absent on prepectoral fin; small scales present on postpectoral fin	Absent on prepectoral fin; small scales present on postpectoral fin to anal fin	Absent from chest to pelvic-fin origin; few areas with scales present on anterior part of both sides of pelvic-fin origin	Absent on chest and abdomen anterior to pelvic fins	Absent on chest
Coloration	Longitudinal black stripe from back of head to caudal fin origin base along lateral line on side of body; 8–9 brown-black saddles across back of head to caudal fin base; black spot slightly smaller than eye diameter at caudal fin origin	Many large and small irregular black blotches on dorsal profile, darker on lateral line; black large patch at caudal fin base	8–10 brown-black saddles across dorsal midline to caudal fin base; horizontal black bars thick and thin in front, and short and dark at back of body; longitudinal dark black stripe along lateral line	5 black saddles on dorsal profile: two spots in front of dorsal fin, and 3 dark spots behind dorsal fin; 28–30 irregular, evenly spaced black saddles	7 large round black blotches on dorsal profile; many black saddles on lateral line; black blotch bar on near belly border; many dark black spots in middle of caudal fin rays	6–8 round black spots across dorsal midline to caudal-fin base; irregular black notches on lateral line	4 wide, evenly spaced black saddles on dorsal profile and body: 1 on predorsal fin, 1 near end of dorsal-fin origin, and 2 on caudal fin base; 19–21 irregular-black horizontal bars on both sides of body; being shorter in anterior and longer in posterior parts and longer in the mone; no bar on belly and lower part of caudal fin	20–22 horizontal black bars, being thicker and narrower in anterior part, and larger, heavier, and sparser in posterior one, mostly connected between both sides of body; no longitudinal black stripe along lateral line; black dot on upper caudal fin	Many irregularly arranged black blotches on body; large black dot on caudal fin base

V. lineata, *V. homalocephala*, *V. caldwelli*, *V. striata*, and *V. pingchowensis* (see Li et al. 2019). There are two species of *Vanmanenia* in the Pearl River from Vietnam, i.e., *V. caobangensis* and *V. ventrosquamata* (Fig. 1). *Vanmanenia duci* sp. nov. has a slightly similar number of fin rays as *V. ventrosquamata* and *V. caobangensis* (Table 3), but the new species has a shorter head than *V. caobangensis* (7.54%–9.81% vs. 20.04%–21.23%) and shorter caudal-peduncle than *V. ventrosquamata* (7.54%–9.81% vs. 12.56%). In addition, *Vanmanenia duci* sp. nov. is further distinct from the species from the Red River and Pearl River basins in Vietnam in having a bigger eye, and a wider interorbital (Table 3).

Remarkably, *Vanmanenia duci* sp. nov. differs from other species of the genus in the Red River and Pearl River systems in Vietnam by presenting a longitudinal black

stripe from the back of the head to the caudal fin origin along the lateral line on the side of the body and mouth soft-tissue structures (Figs. 3, 5A; Table 4).

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