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Two new records of worm or spaghetti eel genus *Moringua* (Anguilliformes: Moringuidae) from estuaries and lagoons in Vietnam

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ABSTRACT

During a survey of central Vietnam estuaries and lagoons, 82 specimens of two newly recorded worm eels species, *Moringua microchir* Bleeker, 1853 and *Moringua raitaborua* (Hamilton, 1822) for Vietnam were collected and their morphometric and meristic details were recorded. *Moringua microchir* is characterized by a body depth of 30–44.5 in total length (TL), head length (HL) 8.7–10.7 in TL, anus far behind mid-body, distances from the tip of snout to the anus 1.5–1.6 in TL, pectoral fin small and rudimentary, 10.6–30.5 in HL, and total vertebrae 105–108. *Moringua raitaborua* is distinguished by a body depth of 26.7–40.9 in TL, HL 7.4–8.7 in TL, rictus before the posterior margin of the eye, pectoral fin small, but not rudimentary, 3.3–5.8 in HL and total vertebrae 102–104. Morphological variations occur in the ontogenetic stage and they differ significantly in appearance at different growth stages. This discovery suggests that these two species have broader distributions in Vietnam.

Keywords: Taxonomy, ichthyology, new records.

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INTRODUCTION

The Moringuidae is a family of burrowing eels that inhabit tropical oceans worldwide, with the apparent exception of the Eastern Atlantic [1, 2]. The family consists of two valid genera and about 18 species worldwide; the genus *Moringua* includes 12 species. *Moringua* is characterized by the anus behind mid-length and the dorsal fin origin (DFO) distinctly behind the anus; the lower jaw is usually longer than the upper jaw [2, 3]. *Moringua* is known for its extreme ontogenetic variation in morphology; immatures, mature males, and mature females differ so significantly in appearance that distinct generic names have been applied to them in the past [2, 4, 5], causing ongoing taxonomic confusion and a proliferation of names within the genus *Moringua* [4]. The Indo-Pacific Ocean contains numerous moringuid eels referred to the genus *Moringua* Gray, namely *M. bicolor* Kaup, 1856, *M. javanica* (Kaup, 1856), *M. abbreviata* (Bleeker, 1863), *M. ferruginea* Bliss, 1883, *M. microchir*, *M. macrocephalus* (Bleeker, 1863), *M. macrochir* Bleeker, 1855, and *M. raitaborua* [6–8].

In Vietnam waters, five *Moringua* species have been reported, including *M. abbreviata*, *M. ferruginea*, *M. javanica*, *M. macrocephalus* and *M. macrochir* [9, 10]. However, there are no vouchers to verify these records, and the species composition of *Moringua* in Vietnam remains unresolved. On the central Vietnamese coast from 11°N to 17°N, *Moringua* were regularly recorded regularly during the rainy season (September to December). In some places, they were rather abundant and caught for food with high commercial value. In the present study, we report the two species collected in Thi Nai lagoon (Binh Dinh Province) and two estuaries, including Truong Giang (Quang Nam Province) and Nha Phu (Khanh Hoa Province). These are the first reports concluding that *Moringua* is diverse of species composition from Vietnam. It brings our knowledge of this genus to Vietnam and represents a significant advance and a new starting point for reviewing this genus in Vietnam.

MATERIALS AND METHODS

Eighty-two fresh specimens of *Moringua* were collected from three sites of estuaries and lagoons along the coastal line of central Vietnam (Fig. 1).

Methods for making measurements, counts, and terminology follow Böhlke (1989) [11], Vo et al., (2021) [12], and Smith et al., (2024) [2]. Total length (TL) from tip of snout to tip of tail, including caudal fin; head length (HL) from the tip of snout to upper edge of pectoral-fin base; preanal length (PAL) from the tip of snout to anus; predorsal length (PreDL) from the tip of snout to origin of dorsal fin; head depth (HD) and head width (HW) measured at gill, body depth (BD) and body width (DW) measured at anus; snout length (SNL) from the tip of snout to anterior margin of eye; eye diameter (ED) measured horizontally; snout to rictus (UJL) from tip of snout to angle of mouth; interorbital width (IO) dorsal distance between clear margins of eyes; pectoral-fin length (PL) from base of dorsal-most ray to tip of longest ray; pectoral-fin base (WP) width pectoral-fin base; gill opening (GO) measured between upper and lower ends; interbranchial distance (IB) measured between lower ends of gill openings. Vertebrae were counted from digital radiographs and are presented as predorsal (PDV), preanal (PAV), total (TV) and mean vertebral formula (MVF).

Radiographs were produced by a digital x-ray system at the National Museum of Marine Biology & Aquarium, Taiwan, with pins inserted at the origins of dorsal and anal fins. Specimens were deposited at the Pisces collection of National Museum of Marine Biology & Aquarium, Pingtung, Taiwan (NMMB-P), and the Institute of Oceanography, Nha Trang, Vietnam (OIM-E), Vietnam. Data used for comparison were taken from specimens examined by the authors and various publications as indicated.

A comparative morphological analysis was conducted using eighteen traditional morphometrics as proportions of total length and head length for each specimen to support finding differences between the two species. We used multivariate methods including the principal component analysis (PCA), effectively

showing the morphometric variation between these morphotypes. The data were transformed by square root before analysis to prevent biases from using ratios and proportions to measure fish body characteristics [13]. The scatter plot

uses dots to represent values for different morphological variables in one chart combining both species. All statistical analyses were performed in PAST v. 4.17 [14] and Excel v.2021.

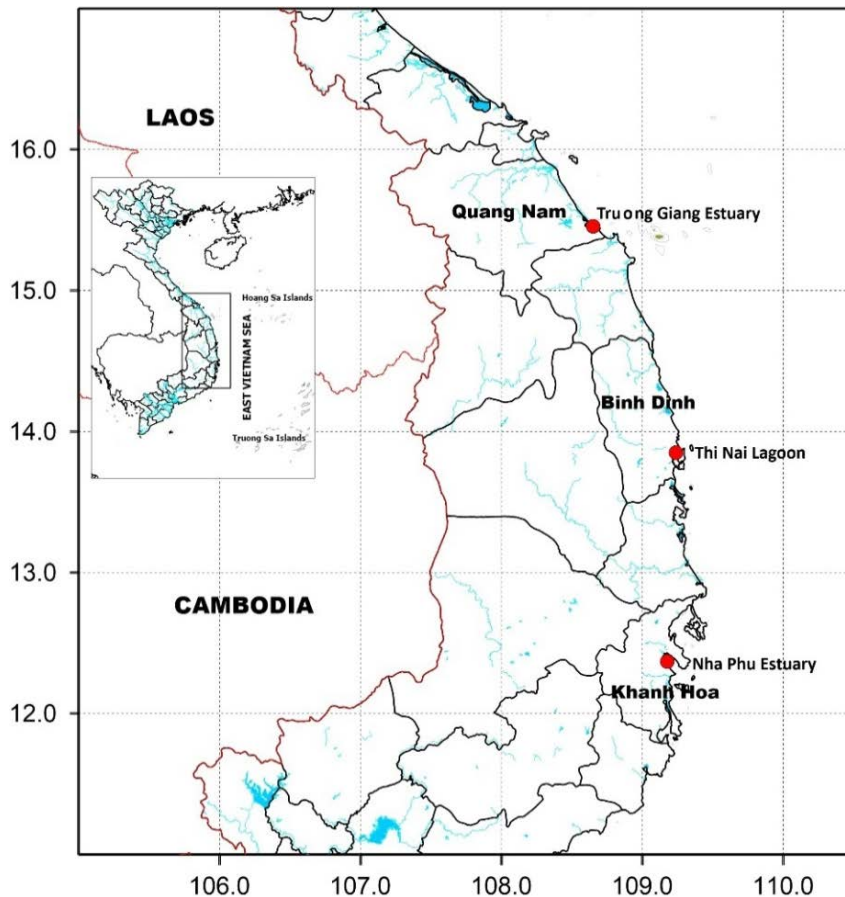


Figure 1. Map showing three sampling sites (●) from estuary and lagoon in the central Vietnam

Ethical statement: No specific permits were required to perform this work. The fresh specimens used were caught by local fishers.

RESULTS

Taxonomy

Oder: Anguilliformes

Family Moringuidae Gill, 1885

Genus *Moringua* Gray, 1831

Moringua microchir Bleeker, 1853 (Figs. 2–3, Table 1)

English name: Lesser thrush eel.

Vietnamese name: Cá lịch huyết.

Synonyms: *Moringua microchir* Bleeker, 1853. Bleeker (1853) [15]: 124 (type locality: Indonesia: Ambon/Sumatra: Cauer). - Weber et al., (1916) [7]: 338–339 (Indo-Australian archipelago, description). - Castle (1968) [4]: 16 (western Indian Ocean, revision). - Winterbottom et al., (1989) [16]: 5 (Chagos Archipelago, central Indian Ocean, annotated checklist). - Hutchins (2001) [17]: 16 (Western

Australian, checklist). - Dingerkus et al., (1992) [18]: 175–176 (New Caledonia, first record). - Hatooka (2002) [19]: 193 (Japan, short description). - Allen et al., (2003) [20]: 22 (Papua to Sumatra, checklist). - Manilo et al., (2003) [21]: S94 (eastern coast of Somali, Arabian Sea, checklist). - Myers et al., (2003) [22]: 606 (Mariana Islands, checklist). - Fricke et al., (2011) [23]: 349 (New Caledonia, annotated checklist). - Kottelat (2013) [8]: 40 (Southeast

Asia, checklist). - Fricke et al., (2014) [24]: 17 (Papua New Guinea, annotated checklist). - Hibino (2017) [25]: 28 (Philippines, short description). - Fricke et al., (2018) [26]: 32 (Madagascar, annotated checklist). - Keith et al., (2021) [27]: 22 (Solomon Islands, short description). - Eudeline (2022) [28]: 132 (Comoros Archipelago, Illustrated checklist). - Smith (2022) [29]: 83 (Western Indian Ocean, short description).



Figure 2. *Moringua microchir* Bleeker, 1853; OIM-E.55834, 420 mm TL, fresh specimen; (a) whole fish, and (b) close-up of head view from lateral side

Aphthaimichthys affinis Ogilby, 1907: 9 (type locality: Japan: Southern Ryukyu Islands: Yaeyama).

Material examined: OIM-E.55834 field code. Q.00970 (29 specimens), 269–420 mm TL, NMMB-uncat. (6 specimens), 225–395 mm TL, Thi Nai landed fishing, ca.13°50'12"N, 109°12'49"E, North Quy Nhon City, Binh Dinh Province, Vietnam, 3

January 2020; OIM-E.55835 (5 specimens), 142.5–182 mm TL, Ky Ha fishing port, ca.15°28'21"N, 108°40'56"E, Nui Thanh District, Quang Nam Province, Vietnam, 22 December 2022; OIM-E.55836 (2 specimens) 276–289 mm TL, Ngoc Diem landed fishing, ca. 12°23'40", 109°11'54"E, Ninh Hoa District, Khanh Hoa Province, Vietnam, 12 December 2023, coll. Q. V. Vo.

Description: Body moderately elongated, cylindrical anteriorly, strongly compressed near end of tail (Figs. 2a & b); body depth 30–44.5 in TL. Head length 8.7–10.7 in TL; anus far behind mid-length, pre-anal length 1.5–1.6 in TL. Dorsal and anal fins continuous with caudal, clearly behind the anus; clearly behind the anal fin; distances from snout to dorsal origin 1.4–1.5 in TL. Pectorals very short with broad rudiment pectoral fin, their length 10.6–30.5 in HL. Gill opening crescentic and transverse, on the lower half of body, upper corner touching middle to the upper edge of pectoral-fin base. Lateral line complete, ending near the level of the anus; pores tiny and difficult to discern; head pores present only on the mandibular with 6–7 pores. Head conical and smoothly tapering anteriorly, andible projects slightly beyond dentary or almost equal in size, rictus

behind the level of eye. Eye small, covered by transparent skin. Anterior nostrils placed laterally on snout, somewhat behind tip, without a tube in immature specimens; posterior nostrils larger, immediately before the eye, oval in shape, and elongate in an anteroventral to posterodorsal direction. Upper lip continuous with the skin of the cheek, lower lip separated from the skin of the jaw by a slight groove. Vertebrae: PDV 65–68, PAV 60–63, TV 105–108; MVF: 66.5/61.8/105.8 ($n = 8$).

Teeth conical, pointed, uniserial, about 16–18 in mandible, about 13–17 in maxillary, 8–11 on the vomer, 8–9 of stouter teeth somewhat larger on the intermaxillary plate in one row, not separated from maxillary, but a gap before vomerine teeth. Vomerine teeth uniserial, reaching almost to the posterior end of the maxillary row (Figs. 3a & b).

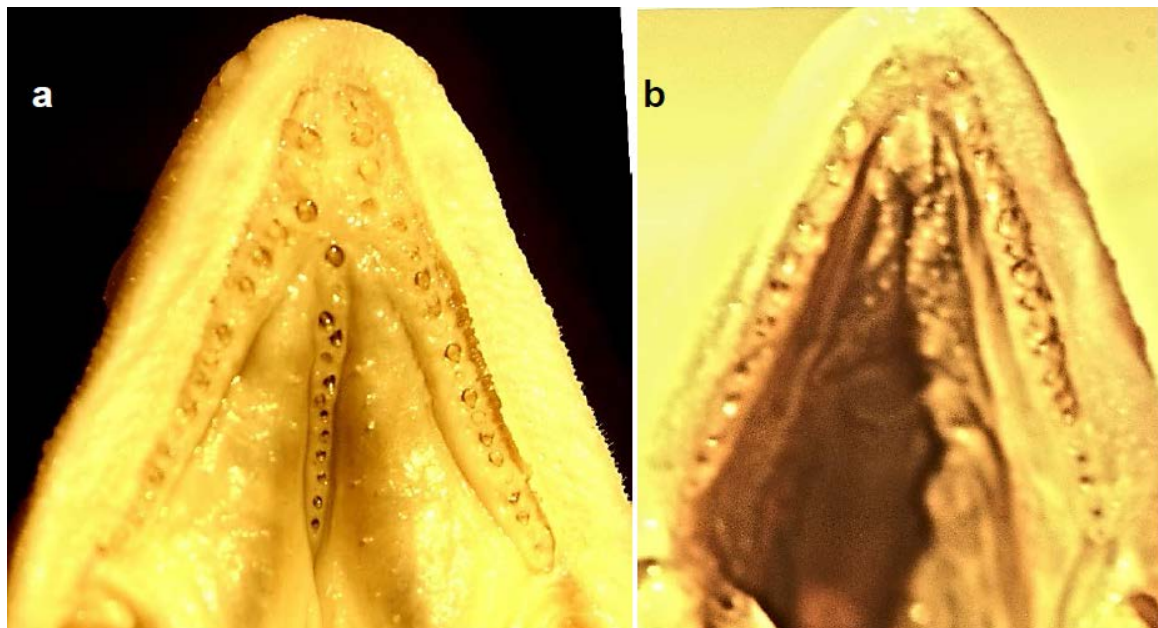


Figure 3. Teeth on jaws of *Moringua microchir* Bleeker, 1853; OIM-E.55834, 420 mm TL; (a) upper jaw and (b) lower jaw

Size: The largest known specimen is 420 mm TL, a immature female.

Coloration: When fresh: adults pink, brown on the back and lighter on the belly; juveniles with orange-yellow back and a bluish belly. In preservative: pale brown on the back, paler to white on the abdomen.

Distribution and habits: Widely distributed in the Indo-West Pacific from East Africa to Samoa, north to the Ryukyus, south to the Southern Great Barrier Reef. Its habitats are freshwater, brackish, marine.

In Vietnam, collected from waters in Thi Nai lagoon and the estuary of Truong Giang

and Nha Phu at depths of less than 10 m. They can be distributed in most coastal lagoons and estuaries in the central locations of Vietnam. All evidence suggests that juvenile and pre-spawning adult of *Moringua microchir* spend most of their time buried in the sediment and

come out only briefly to feed and spawn. The fishermen used scrapers with bent steel bars folded into narrow slots to dig 20–40 cm into the sediment to catch them. Occasionally, they are caught by bamboo stake traps.

Table 1. Morphometric and meristic data of *Moringua microchir* and *Moringua raitaborua*

	<i>Moringua microchir</i>			<i>Moringua raitaborua</i>		
	Vietnam		Philippines (Hibino (2017))	Vietnam		India (Behera et al., (2021))
Total length (mm)	145–420 (n = 42)		380	179–397 (n = 30)		314–328 mm
Proportions	Mean (Range)	SD		Mean (Range)	SD	
As % of TL						
Head length (HL)	10.4 (9.3–11.5)	0.5	7.1–9.1	12.5 (10.3–13.4)	0.6	10.9–11.2
Preanal length	64.7 (62.3–66.4)	1.1		65.5 (63.3–67.6)	1	
Trunk length	54.3 (51.5–55.7)	1.2		53.0 (50.2–55.4)	1.2	
Tail length	35.3 (33.6–37.7)	1.1		34.5 (32.4–36.7)	1.1	35.7–37.0
Predorsal length	69.6 (66.9–72.7)	1.3		69.6 (67.6–69.9)	1.2	66.7–76.9
Body depth at gill opening	2.8 (2.2–3.5)	0.3		3.3 (2.7–3.8)	0.3	
Body width at gill opening	2.7 (2.1–3.2)	0.2		3.2 (2.3–3.7)	0.3	
Body depth at mid-anus	2.9 (2.2–3.3)	0.3	2.0–2.8	3.4 (2.4–3.7)	0.3	2.7–2.9
Body width at mid-anus	2.9 (2.2–3.6)	0.3		3.3 (2.2–3.6)	0.3	
As % of HL						
Snout length	12.5 (10.3–15.7)	1.2		14.1 (12.4–15.2)	0.7	10.8–11.8
Eye diameter	4.8 (3.4–6.4)	0.7		10.9 (8.8–12.8)	1	11.2–11.8
Interorbital width	11.0 (7.8–13.8)	1.3		13.5 (9.3–15.7)	1.3	
Upper-jaw length	20.5 (17.9–24.6)	1.3		22.8 (19.4–25.5)	1.5	16.1–17.5
Low-jaw length	20.3 (17.6–24.3)	1.4		23.0 (14.9–26.3)	1.5	16.1–17.5
Gill-opening length	8.6 (3.8–12.2)	2.3		11.5 (9.6–14.6)	1.1	
Isthmus width	13.7 (10.5–19.0)	1.7		14.8 (11.0–18.7)	1.8	
Pectoral-fin length	6.4 (3.3–9.4)	1.8		24.1 (18.5–27.5)	2.3	17.5–18.9
Pectoral-fin base width	5.6 (2.7–7.8)	1.3		9.4 (7.8–10.8)	0.7	
Counts	n=8			n=3		
Lateral-line pores before anus	62.5 (61–64)	1	61–65			
Predorsal vertebrae	66.5 (65–68)	1.1		64.3 (62–67)	2.5	66
Preanal vertebrae	61.8 (60–63)	1.2		59.3 (58–61)	1.5	61
Total vertebrae	105.8 (105–108)	1	105–113	102.7 (101–104)	1.5	101

Moringua raitaborua (Hamilton, 1822) (Figs. 4–5, Table 1)

English name: Purple spaghetti-eel.

Vietnamese name: Cá lịch huyết tía.

Synonyms: *Muraena raitaborua* Hamilton, 1822. Hamilton (1822) [30]: 25, 364 (type locality: India: Ganges). - Talwar et al., (1991) [31]: 77 (India, short description). - Bucol et al., (2010) [32]: 99 (Philippines, checklist). -

Kottelat (2013) [8]: 40 (Southeast Asia, checklist). - Miesen et al., (2016) [33]: 81 (Sulawesi, Indonesia, checklist). - Behera et al., (2021) [1]: 1–3 (India, description).

Moringua linearis Gray, 1831. - Gray (1831) [34]: vol. 1, pl. 95 fig. 3 (type locality: India: Ganges).

Rataboura hardwickii Gray, 1831. - Gray (1831) [34]: vol. 1, pl. 95 fig. 4 (type locality: India: Ganges).

Rataboura hamiltonii Gray, 1831. - Gray (1831) [35]: 9 (replacement name for *Muraena raitaborua* Hamilton, 1822).

Anguilla maculatus Swainson, 1839. - Swainson (1839) [36]: 334 (replacement name for *Muraena raitaborua* Hamilton, 1822).

Ptyobranchus erythreus McClelland, 1844. - Mclelland (1944) [37]: 201, 223, pl. 9 fig. 3 (type locality: India: Bengal).

Ptyobranchus multidentatus McClelland, 1844. - Mclelland (1944) [37]: 201, 203, 223, pl. 9 fig. 4 (type locality: India: Bengal).

Ptyobranchus parvidentatus McClelland, 1844. - Mclelland (1944) [37]: 202, 203, 223, pl. 9 fig. 5 (type locality: India: Bengal).

Ptyobranchus gracilis McClelland, 1844. - Mclelland (1944) [37]: 202, 204, 223, pl. 9 fig. 6 (type locality: India: Bengal).

Ptyobranchus brevis McClelland, 1844. - Mclelland (1944) [37]: 223 (type locality: not stated).

Moringua lumbricoidea Richardson, 1845. - Richardson (1845) [38]: 113, pl. 56 figs. 7–11 (type locality: not stated).

Moringua lumbriciformis Kaup, 1856. - Kaup (1857) [39]: 70 (type locality: India).

Moringua floresiana Weber & de Beaufort, 1916. - Weber et al., (1916) [7]: 340, fig. 167 (type locality: Indonesia: South coast of Flores).



Figure 4. *Moringua raitaborua* (Hamilton, 1822); OIM-E.55837, 397 mm TL, fresh specimen; (a) lateral view and (b) lateral head; OIM-E.55837, 209 mm TL, fresh specimen; (c) dorsal view; (d) close-up of dorsal head and anterior body

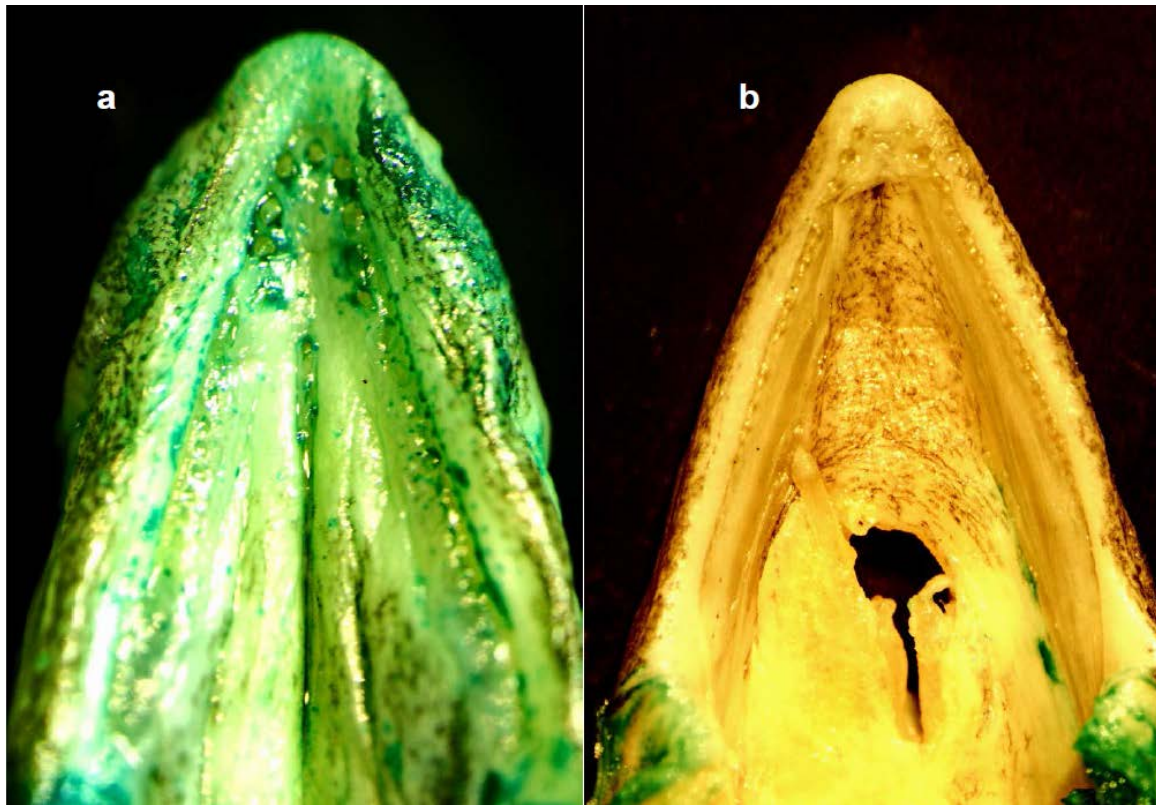


Figure 5. Teeth on both jaws of *Moringua raitaborua* (Hamilton, 1822); OIM-E.55837, 209mm TL; (a) upper jaw and (b) lower jaw

Moringua robusta Herre, 1923. - Herre (1923) [40]: 185, pl. 7 (type locality: Philippines: Negros: Oriental Negros: Dumaguete).

Rataboura oculata Fowler, 1934. - Fowler (1934) [41]: 278, fig. 39 (type locality: Indonesia: Buru: Tifu Bay).

Rataboura amphotomelaena Fowler, 1938. - Fowler (1938) [42]: 190, fig. 25 (type locality: Christmas Island).

Aphthalmichthys wui Fang, 1942. - Fang (1942) [43]: 80 (type locality: China: Fukien [Fujian]: Fou-Tchéou [Fuzhou]).

Moringua latebrosa Schultz, 1953. - Schultz et al., (1953) [44]: 95, fig. 20a (type locality: Indonesia: Sulawesi: Kwandang).

Moringua semperviridis McCann, 1967. - McCann (1967) [45]: 211, fig. 1 (type locality: Northern Cook Islands: Manihiki Atoll, south end of Tauhunu Island).

Specimen examined: OIM-E.55837, field code Q.01121 (30 specimens) 179–397 mm TL, Ngọc Diêm landed fishing, ca. 12°23'40",

109°11'54"E, Ninh Hoa District, Khanh Hoa Province, Vietnam, 16 December 2023. NMMB-uncat. (10 specimens), unmeasurable, collect with OIM-E.55837, coll. Q. V. Vo.

Description: Body elongated, slippery, rounded, and become compressed near the end of the tail (Figs. 4a–d); body depth at anus 26.7–40.9 in TL. Head length 7.4–8.7 in TL; anus far behind midlength, pre-anus length 1.5–1.6 in TL. Dorsal and anal fins continuous around the tail, clearly behind the anus; fin origin far behind to level of the anus; distance from snout to dorsal fin origin 1.4–1.5 in TL. Head conical and smoothly tapering anteriorly; mouth small, upper jaws and lower jaws almost equal in size, 3.8–5.1 in HL; rictus before the posterior margin of eye. Eye small 7.8–11.4 in HL. Pectorals small; length 3.3–5.8 in HL. Gill opening round, positioned on lower half of body. Lateral line complete, pores tiny and difficult to discern; head pores present only on Mandibular 6–7 pores. Anterior nostrils on the side of the snout,

somewhat behind the tip, without a tube in females and immatures, become tubular in mature males. The posterior nostril is larger, immediately before the eye, and elongated in an anteroventral to posterodorsal direction, with a raised rim higher on the anterior side, lower at the posterodorsal corner. The upper lip is continuous with the skin of the cheek; the lower lip is separated from the skin of the jaw by a slight groove. Vertebrae: PDV 62–67, PAV 58–61, TV 102–104, MVF 64.3/59.3/102.7 ($n = 3$).

Teeth small, pointed, uniserial on each jaw, about 18–22 in mandible, about 15–18 in maxillary, 7–10 uniserial vomerine teeth, intermaxillary uniserial row of 4–5 stouter teeth larger on the side, not separated from maxillary, with a gap before vomerine teeth (Figs. 5a & b).

Size: Largest known specimen 397 mm TL, an immature female.

Coloration: In fresh form, purplish dorsally becomes light silvery ventrally. In preservation, pale brown on the back and pale to white on the belly.

Distribution and habits: This species is distributed in India, Nepal, Bangladesh, Indonesia, China, and the Philippines [8]. It

occurs in brackish and marine waters and can be found in freshwater.

In Vietnam they are collected from waters in the Nha Phu estuary at depths of less than 5 m. They can be distributed in most coastal lagoons and estuaries in the central region. The fishermen used bamboo stake traps to catch them.

DISCUSSION

The two species, *Moringua microchir* Bleeker, 1853 and *M. raitaborua* (Hamilton, 1822), can be distinguished by the following characteristics: eye diameter, pectoral fin, vertebrae and body color. The former has small eyes (15.6–29.2 vs. 7.8–11.4 in HL), pectoral fin is very small and rudimentary (10.6–30.5 in HL) compared to small and not rudimentary (3.3–5.5 in HL), higher total vertebrae (105–108 vs. 102–104). The dorsal color is pinkish brown in adults and orange-yellow in juveniles compared to dark purple to purple-brown. The principal component analysis (PCA) of traditional morphometrics also showed differences between the two species by this morphotype (Fig. 6).

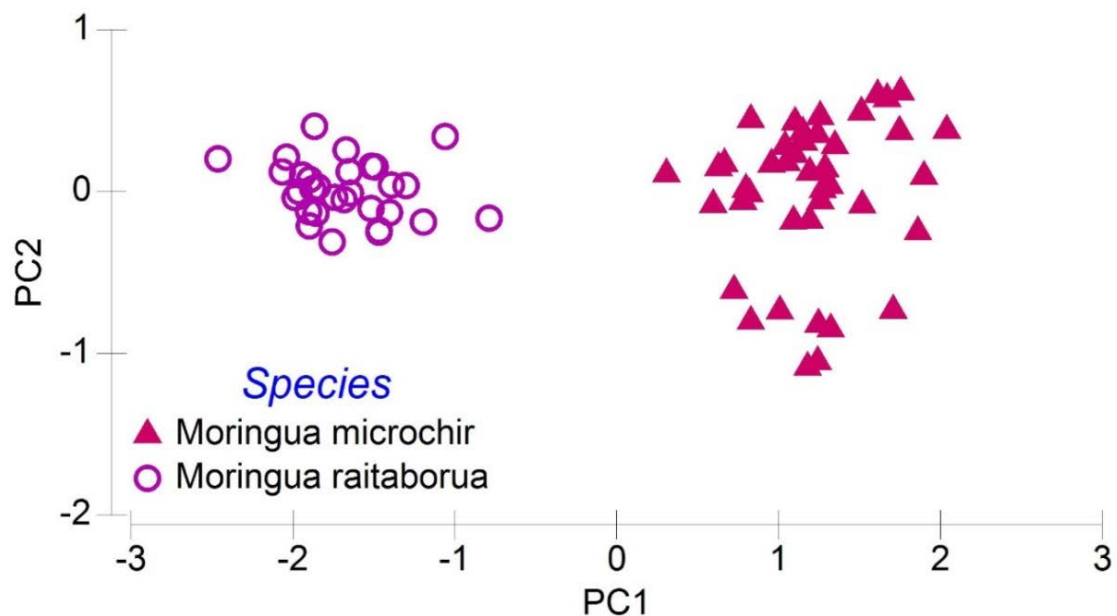


Figure 6. Principal component analysis (PCA) results of the two of *Moringua* species samples plotted on 18 morphometric traits

Table 2. Selected morphological and meristic characteristics of species belong genus *Moringua*

Species	Head length	Body depth	Pectoral-fin length	Preanal vertebrae	Vertebrae	Data sources
<i>Moringua abbreviata</i>	8.3	2.2–2.5				Bleeker (1864)
	7.4–9.5	1.7–2.5				Weber & de Beaufort (1916)
				66–69	106–111	Castle (1968)
	8.5	2.1				Zhang et al., (2010)
	12–16	1.7–2.5	equal snout length		102–111	Hibino (2019)
<i>M. bicolor</i>	7.1	1.6				Bleeker (1864)
	6.3–8.0	1.1–1.6	15.4–16.7			Weber & de Beaufort (1916)
	6.2–7.6			95	147	Castle (1968)
<i>M. edwardsi</i>	7.0–12.0	1.0–3.0	1–22	74–84	109–123	Smith (1989)
<i>M. ferruginea</i>	6.7–8.3	1.6–2.0			127	Hibino (2019)
	7.4–12.5			70–80	115–125	Castle (1968)
<i>M. guthriana</i>	8.3–10.0	2.0–2.1			115–130	Talwar & Jhingran (1991)
<i>M. hawaiiensis</i>	5.9–8.0	1.4–2.5			118–130	Randall (2007)
<i>M. javanicus</i>	4.5–6.7	1.0–1.3				Bleeker (1864)
	4.5–8.3	1.1–1.5				Weber & de Beaufort (1916)
				103	159	Castle (1968)
<i>M. macrocephalus</i>	11.1	2.2–2.5				Bleeker (1864)
	10.1–11.5	2.5–2.9				Weber & de Beaufort (1916)
<i>M. microchir</i>	9.3–11.5	2.2–3.3	3.3–9.4	60–63	105–108	This study
	7.1–9.1	2.0–2.8			105–113	Hibino (2019)
	9.4–9.7	3.2	4.2–5.2		105–109	Dingerkus & Séret (1992)
	8.3	2.1				Bleeker (1864)
	8.0–9.3	2.1				Weber & de Beaufort (1916)
				66	106	Castle (1968)
<i>M. macrochir</i>	10.3	2.7				Bleeker (1864)
	9.1–10.3	2.3–2.7	14.3–20.0			Weber & de Beaufort (1916)
					110	Castle (1968)
<i>M. penni</i>	9.7–11.3	2.7–2.8	2.7–4.1	65	113*	Schultz (1953), Castle (1968)*
<i>M. raitaborua</i>	10.3–13.4	2.4–3.7	18.5–27.5	58–61	101–104	This study
	9.5–11.0				104	Castle (1968)
	10.9–11.2	2.7–2.9	17.5–18.9	61	101	Behera et al., (2021)

Moringua microchir is similar to the *Moringua abbreviata* by having overlapping total vertebrae counts; 105–113 in the former [18, 46] and 102–111 in *Moringua abbreviata* [25]. Castle (1968) [4] showed that *M. abbreviata* is almost certainly a synonym of *M. microchir*, but can distinguished by the pectoral-fin length almost equal to snout length in the former [25]

and is small and rudimentary in the latter. A single characteristic that can be used to distinguish the species of genus *Moringua* is that the lower jaw projects beyond or is equal with the upper jaw versus in front or slightly longer lower jaw in *M. microchir* and *M. raitaborua*. Based on available data, they are distinguished from *M. abbreviata*.

M. microchir and *M. raitaborua* are distinguished from congeners *M. bicolor*, *M. edwardsi*, *M. ferruginea*, *M. guthriana*, *M. javanicus*, *M. hawaiiensis*, *M. macrochir*, *M. macrocephalus*, *M. penni*. Thus, morphologically, *M. bicolor*, *M. edwardsi*, *M. ferruginea*, *M. guthriana*, *M. javanicus* also have a higher vertebral number of about 115–159 and more slender bodies, compared with *M. microchir* and *M. raitaborua* relatively short body and low vertebral number (Table 2).

CONCLUSION

Two species in genus *Moringua*, including *M. microchir* Bleeker, 1853 and *M. raitaborua* (Hamilton, 1822) were recorded and described from lagoons and estuaries in Central Vietnam. These results have clarified the species of “Cá lịch huyết - worm eel” caught by fishermen during the rainy season in these water bodies, and contributed to the understanding of their distribution.

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REFERENCES

- [1] R. K. Behera, S. R. Mohanty, S. Patro, and A. Mohapatra, “New distributional record of *Moringua raitaborua* (Hamilton, 1822)—First record of the genus in the Chilika Lagoon, India,” *Thalassas: An International Journal of Marine Sciences*, vol. 37, no. 2, pp. 439–443, 2021. DOI: 10.1007/s41208-021-00310-7.
- [2] D. G. Smith, A. P. Marceniuk, M. M. Rotundo, C. O. Carvalho, and R. A. Caires, “A review of the genus *Neoconger* (Anguilliformes: Moringuidae), with the description of a new species,” *Zootaxa*, vol. 5492, no. 1, pp. 109–128, 2024. DOI: 10.11646/zootaxa.5492.1.6.
- [3] D. G. Smith, “Anguilliformes: Moringuidae,” in *FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific*, vol. 3, K. E. Carpenter and V. H. Niem, Eds. Rome, Italy: FAO, 1999, pp. 1637–1638.
- [4] P. H. J. Castle, *A contribution to a revision of the moringuid eels*, Dept. Ichthyol., Rhodes Univ., Spec. Publ. no. 3, pp. 1–29, 1968.
- [5] P. H. J. Castle and J. E. Böhlke, “Sexual dimorphism in size and vertebral number in the western Atlantic eel *Moringua edwardsi* (Anguilliformes, Moringuidae),” *Bulletin of Marine Science*, vol. 26, no. 4, pp. 615–619, 1976.
- [6] J. L. B. Smith, “Sand-dwelling eels of the Western Indian Ocean and the Red Sea,” *Ichthyological Bulletin*, no. 24, pp. 447–466, 1962.
- [7] M. Weber and L. F. de Beaufort, *The Fishes of the Indo-Australian Archipelago*, vol. 3. Leiden, The Netherlands: E. J. Brill Limited, 1916.
- [8] M. Kottelat, *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 no. 27, pp. 1–663, 2013.
- [9] T. T. T. Le, V. Q. Vo, P. U. V. Nguyen, T. H. H. Tran, and C. T. Tran, “A checklist of the eels and morays (order: Anguilliformes) in the Vietnamese marine waters,” in *Proceedings of the 5th National Conference on Ecology and Biological Resources*, Hanoi, Vietnam, 2013, vol. 21, pp. 282–294.
- [10] H. P. Nguyen, N. T. Nguyen, P. D. Nguyen, and T. N. N. Do, *Checklist of Marine Fishes in Vietnam. Osteichthyes, from Elopiformes to Mugiliformes*, vol. 2. Hanoi, Vietnam:

- Science and Technics Publishing House, 1994.
- [11] E. B. Böhlke, "Methods and terminology," in *Fishes of the Western North Atlantic*, Memoir of the Sears Foundation for Marine Research, vol. 1, no. 9, pp. 1–7, 1989. DOI: 10.12987/9781933789323-003.
 - [12] V. Q. Vo, H. C. Ho, H. V. Dao, and H. H. T. Tran, "A new arrowtooth eel of genus *Meadia* (Synphobranchidae: Ilyophinae) from Vietnam, South China Sea," *Zootaxa*, vol. 4952, no. 1, pp. 181–191, 2021. DOI: 10.11646/zootaxa.4952.1.11.
 - [13] E. Damadi, F. Y. Moghaddam, and M. Ghanbarifardi, "Taxonomic characterization of five species of emperor fishes (Actinopterygii: Eupercaria: Lethrinidae) based on external morphology, morphometry, and geographic distribution in the northwestern Indian Ocean," *Acta Ichthyologica et Piscatoria*, vol. 54, pp. 115–124, 2024. DOI: 10.3897/aiep.54.118586.
 - [14] Ø. Hammer and D. A. Harper, "PAST: Paleontological statistics software package for education and data analysis," *Palaeontologia Electronica*, vol. 4, no. 1, 9 pp., 2001.
 - [15] P. Bleeker, "Derde bijdrage tot de kennis der ichthyologische fauna van Amboina," *Natuurkundig Tijdschrift voor Nederlandsch Indië*, vol. 4, no. 1, pp. 91–130, 1853.
 - [16] R. Winterbottom, A. Emery, and E. Holm, *An annotated checklist of the fishes of the Chagos Archipelago, Central Indian Ocean*, Royal Ontario Museum, Life Sciences Contributions, no. 145, pp. 1–226, 1989.
 - [17] J. B. Hutchins, "Checklist of the fishes of Western Australia," *Records of the Western Australian Museum*, Supplement no. 63, pp. 9–50, 2001.
 - [18] G. Dingerkus and B. Seret, "First record of *Moringua microchir* for New Caledonia and from freshwater (Teleostei: Anguilliformes: Moringuidae)," *Cybiurn*, vol. 16, no. 2, pp. 175–176, 1992.
 - [19] K. Hatooka, "Moringuidae (spaghetti eels)," in *Fishes of Japan with Pictorial Keys to the Species*, T. Nakabo, Ed., English ed. Tokyo, Japan: Tokai University Press, vol. 1, p. 193, 2002.
 - [20] G. R. Allen and M. Adrim, "Coral reef fishes of Indonesia," *Zoological Studies*, vol. 42, no. 1, pp. 1–72, 2003.
 - [21] L. G. Manilo and S. V. Bogorodsky, "Taxonomic composition, diversity and distribution of coastal fishes of the Arabian Sea," *Journal of Ichthyology*, vol. 43, no. 1, pp. S75–S149, 2003.
 - [22] R. F. Myers and T. J. Donaldson, "The fishes of the Mariana Islands," *Micronesica*, vol. 35–36, pp. 594–648, 2003.
 - [23] R. Fricke, M. Kulbicki, and L. Wantiez, "Checklist of the fishes of New Caledonia, and their distribution in the Southwest Pacific Ocean (Pisces)," *Stuttgarter Beiträge zur Naturkunde A, Neue Serie*, no. 4, pp. 341–463, 2011.
 - [24] R. Fricke, G. R. Allen, S. Andréfouët, W.-J. Chen, M. A. Hamel, P. Laboute, R. Mana, T. H. Hui, and D. Uyeno, "Checklist of the marine and estuarine fishes of Madang District, Papua New Guinea, western Pacific Ocean, with 820 new records," *Zootaxa*, vol. 3832, no. 1, pp. 1–247, 2014. DOI: 10.11646/zootaxa.3832.1.1.
 - [25] Y. Hibino, "Moringidae," in *Commercial and Bycatch Market Fishes of Panay Island, Republic of the Philippines*, H. Motomura, U. B. Alama, N. Muto, R. P. Babaran, and S. Ishikawa, Eds. Kagoshima, Japan: The Kagoshima University Museum; Iloilo, Philippines: University of the Philippines Visayas; Kyoto, Japan: Research Institute for Humanity and Nature, 2017, pp. 27–28.
 - [26] R. Fricke, J. Mahafina, F. Behivoke, H. Jaonalison, M. Léopold, and D. Ponton, "Annotated checklist of the fishes of Madagascar, southwestern Indian Ocean, with 158 new records," *FishTaxa*, vol. 3, no. 1, pp. 1–432, 2018.
 - [27] P. Keith, D. Boseto, and C. Lord, *Freshwater Fish of the Solomon Islands*. Paris, France: Société Française d'Ichtyologie, 2021, pp. 1–173.
 - [28] R. Eudeline, "Illustrated checklist of Anguilliformes (Pisces, Teleostei) of the lagoon of Mayotte (West Indian Ocean)

- with 14 new records,” *Marine & Fishery Sciences (MAFIS)*, vol. 35, no. 1, pp. 123–161, 2022. DOI: 10.47193/mafis.3512022010103.
- [29] D. G. Smith, “Family Moringuidae, Spaghetti eels,” in *Coastal Fishes of the Western Indian Ocean*, P. C. Heemstra, E. Heemstra, D. A. Ebert, W. Holleman, and J. E. Randall, Eds. Makhanda, South Africa: South African Institute for Aquatic Biodiversity, vol. 2, p. 83, pl. 12, 2022.
- [30] F. Hamilton, *An Account of the Fishes Found in the River Ganges and Its Branches*, vol. 1. Edinburgh, U.K.: Archibald Constable, 1822.
- [31] P. K. Talwar and A. G. Jhingran, *Inland Fishes of India and Adjacent Countries*, vol. 2. Boca Raton, FL, USA: CRC Press, 1991.
- [32] A. A. Bucol and E. E. Carumbana, “Checklist of fishes found in the fresh and brackish waters of Negros and Siquijor, Philippines,” *Asian Journal of Biodiversity*, vol. 1, no. 1, pp. 91–126, 2010.
- [33] F. W. Miesen, F. Droppelmann, S. Hüllen, R. K. Hadiaty, and F. Herder, “An annotated checklist of the inland fishes of Sulawesi,” *Bonn Zoological Bulletin*, vol. 64, no. 2, pp. 77–106, 2016.
- [34] J. E. Gray, *Illustrations of Indian Zoology: Chiefly Selected from the Collection of Major-General Hardwicke*, vol. 1. London, U.K.: Treuttel, Wurtz, Jun. and Richter, 1832.
- [35] J. E. Gray, “Description of twelve new genera of fish discovered by Gen. Hardwicke, in India, the greater part in the British Museum,” *Zoological Miscellany*, pp. 7–10, 1831.
- [36] W. Swainson, *The Natural History of Fishes, Amphibians and Reptiles, Or Monocardian Animals*, vol. 2. London, U.K.: Longman, 1839.
- [37] J. M’Clelland, “Apodal fishes of Bengal,” *Calcutta Journal of Natural History, and Miscellany of the Arts and Sciences in India*, vol. 5, pp. 151–226, 1844, pls. 5–14.
- [38] J. Richardson, “Ichthyology—Part 1,” in *The Zoology of the Voyage of H.M.S. Sulphur, under the Command of Captain Sir Edward Belcher, R.N., C.B., F.R.G.S., etc., during the Years 1836–42*, R. B. Hinds, Ed., no. 10. London, U.K., 1845, pp. 99–150, pls. 55–64.
- [39] J. J. Kaup, *Catalogue of Apodal Fish: In the Collection of the British Museum*. London, U.K.: Order of the Trustees, 1856.
- [40] A. W. C. T. Herre, “A review on the eels of the Philippine archipelago,” *The Philippine Journal of Science*, vol. 23, no. 2, pp. 123–236, 1923.
- [41] H. W. Fowler, “Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas,” *Proceedings of the Academy of Natural Sciences of Philadelphia*, vol. 85, pp. 233–367, 1933.
- [42] H. W. Fowler, *The Fishes of the George Vanderbilt South Pacific Expedition, 1937*. Monograph of the Academy of Natural Sciences of Philadelphia, no. 2. Philadelphia, PA, USA, 1938, pp. 1–349.
- [43] P. W. Fang, “Poissons de Chine de M. Ho: Description de cinq espèces et deux sous-espèces nouvelles,” *Bulletin de la Société Zoologique de France*, vol. 67, pp. 79–85, 1942.
- [44] L. P. Schultz, *Fishes of the Marshall and Marianas Islands: Families from Asymmetriontidae through Siganidae*, vol. 202. Washington, DC, USA: U.S. Government Printing Office, 1953.
- [45] C. McCann, “A new species of eel of genus *Moringua* (Pisces) from Manihiki Atoll, Northern Cook Islands,” *Transactions of the Royal Society of New Zealand: Zoology*, vol. 8, no. 20, pp. 211–213, 1967.
- [46] P. Keith, G. Marquet, P. Valade, P. Bosc, and E. Vigneux, *Atlas des poissons et des crustacés d'eau douce des Comores, Mascareignes et Seychelles*, vol. 65. Paris, France: Muséum national d'Histoire naturelle, 2006.