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Species of the Eel Family Colocongridae (Order Anguilliformes), with Description of a New Species

Hsuan-Ching Ho[1,2,3], David G. Smith[4], and John J. Pogonoski[5]

This work is dedicated to the memory of David Smith who passed away prior to the publication of this work.

The short-tail eel family Colocongridae is a group of small to moderately large eels found in the mid- to upper-continental slope of all oceans except the eastern and central Pacific. The taxonomy of this group is still poorly known, and many diagnostic characteristics have never been tested and verified. Museum specimens were examined, and data were taken by following methods provided in previous studies, as well as some newly introduced. A total of seven species are recorded for the only genus, *Coloconger*, including a new species described herein from the Solomon Islands and Vanuatu. The diagnostic characters distinguishing species of *Coloconger* are discussed, comments are made on previous records, and a key to all known species is provided. Morphology of the post-metamorphic stage and transforming leptocephalus is also provided.

THE short-tail eel family Colocongridae was established by Smith (1989) to contain the single genus *Coloconger*, which had long been placed in the Congridae. Recent work (da Silva et al., 2019) indicates that *Coloconger* belongs to a group containing *Congriscus*, *Derichthys*, and *Nessorhamphus*. The species of *Coloconger* are benthic fishes that live on the mid- to upper-continental slope of the Atlantic and Indian Oceans, and the western Pacific as far as the Solomon Islands and Vanuatu. They do not extend farther eastward into the central Pacific and are absent from the eastern Pacific. They are largely limited to tropical waters. Virtually nothing is known of their biology (Smith, 1989).

Species of *Coloconger* can be distinguished by their short and stubby body; anus well behind mid-length; snout short and broad; eye large; pectoral fin well developed; gill opening a vertical slit, the upper corner opposite middle to upper end of pectoral-fin base; lateral line complete; sensory pores on head and lateral line open through low tubes; and no scales (Smith, 1989; Ho et al., 2021). Currently, there are seven nominal species recognized in the genus: *C. cadenati*, *C. japonicus*, *C. maculatus*, *C. meadi, C. raniceps, C. saldanhai*, and *C. scholesi* (Smith, 1989; Ho et al., 2021).

The taxonomy of *Coloconger* has not been treated comprehensively, and the diagnostic characters used for distinguishing species are ambiguous. For example, the data of congeners provided by previous authors (e.g., Castle, 1986) showed a broad range and may contain more than one species (Ho et al., 2021; this study). In order to verify the species, this study was mainly based on examining specimens deposited at several major collections around the world.

In this study, we recognize seven nominal species, including a new species commonly found in the Solomon Islands and one from Vanuatu. In addition, the diagnostic characters used to distinguish species are discussed and revised, and brief diagnoses and descriptions are provided for each species based on the material examined. A key to species of *Coloconger* is provided.

MATERIALS AND METHODS

Methods for taking measurements generally follow Böhlke (1989), but with three additional values taken: body width at gill opening, body width at anus, and trunk length (preanal length minus head length). Lengths provided as times in or percentages of head length (HL) and total length (TL). All specimen measurements are in TL and a '+' after a measurement denotes that the specimen is damaged and an accurate determination of length was not possible. Abbreviations: sta. = station, F/V = Fishing Vessel, F/R/V = Fisheries Research Vessel, R/V = Research Vessel, RIMS = Royal Indian Marine Survey.

Methods for taking meristic counts are defined below. Head sensory pores (mostly open through fleshy tubes). Supraorbital pores (SO), the total number of pores along upper surface of snout and head. There are usually three pores (including ethmoid pore) at front of snout, one or two pores above posterior nostrils, and 3–6 pores on interorbital space and nape. Infraorbital pores (IO), the total number of pores behind anterior nostril (including adnasal pore), along upper jaw, on cheek (behind rictus), and behind eye. Preoperculomandibular pores (POM), the total number of pores along lower jaw and preopercular canal. Supratemporal pores (ST), the total number of pores along supratemporal canal on nape, usually arranged in three clusters of pores, a central and two lateral clusters; for example, 1 (right) + 2 (middle) + 1 (left). Sometimes there are four pores in a series or a few additional ones in front of the middle one, but not in regular pairs, along the supratemporal canal. The total head pores are the sum of all pores on one side plus all ST (i.e., SO + IO + POM + ST). Pore numbers on

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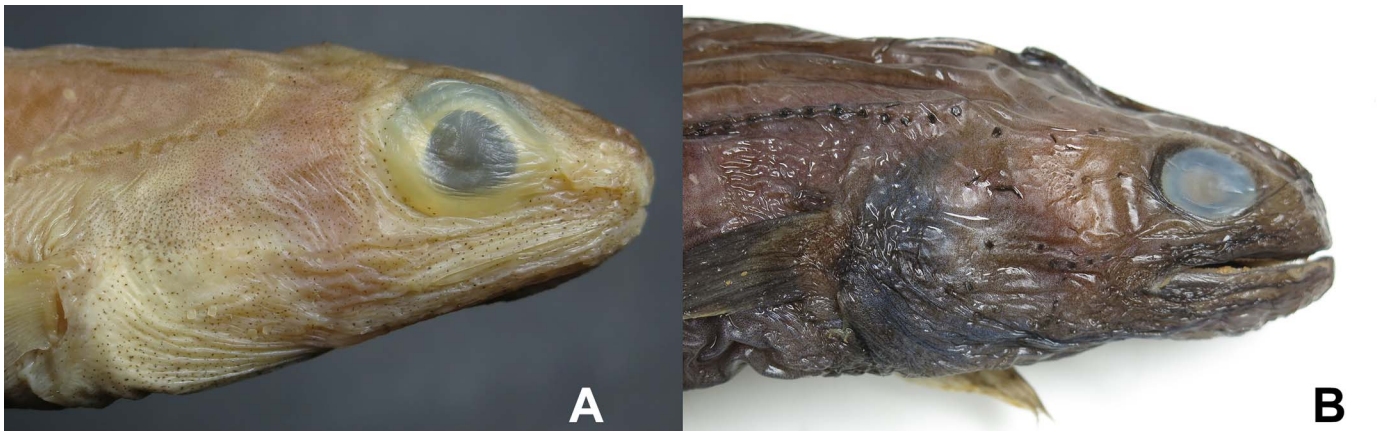

Fig. 1. Lateral view of head region showing the color of lateral-line pores (tubes) and the position of rictus. (A) *Coloconger saldanhai*, MNHN 1998-0597, 292 mm TL. (B) *C. scholesi*, MNHN 2016-0142, 356 mm TL.

head are counted on both sides, when available, in order to demonstrate the individual variation.

Lateral-line pores open through fleshy tubes along the entire length of the canal. There are sometimes additional pores accompanying the regular series (usually above the lateral-line series). Because the numbers of regular lateral-line pores are associated with the myomeres and thus vertebrae, these additional pores are not included in the counts in order to provide better comparisons. Cephalic (pre-pectoral; PPLL) pores, predorsal lateral-line pores (PDLL), and preanal lateral-line pores (PALL) are the total pores of the regular lateral-line series before pectoral-fin base, dorsal-fin base, and anal-fin base, respectively. Total lateral-line pores (TLL) are counted precisely (when complete) or estimated based on the regular lateral-line series, as the tubes are easily damaged by trawl operations.

Vertebrae and fin rays are counted from radiographic images taken by digital radiographic machines set up in each collection. The posterior ends of tails are often either less calcified (in smaller individuals) or twisted (caused by preservation), which sometimes makes it difficult to count precisely. Some individuals have their counts estimated or the closest values are given, when possible, whereas others have these numbers excluded. Abbreviations: CV, caudal vertebrae; PAV, preanal vertebrae; PCV, precaudal vertebrae; PDV, predorsal vertebrae; PHV, prehaemal vertebrae; TV, total vertebrae.

Dorsal-fin origin (DFO) is used throughout. Distance between pectoral-fin base and dorsal-fin origin (PO–DO) is calculated from predorsal length minus head length; trunk length is preanal length minus head length; tail length is total length minus preanal length. Preanal length is measured from the tip of snout to anal-fin origin.

Other abbreviations: AFO, anal-fin origin; ED, eye diameter; GO, gill opening; PN, posterior nostril; and SN, snout length.

Specimens examined are deposited at the following museums (abbreviations follow Sabaj, 2020): Australian Museum, Sydney (AMS), Biodiversity Research Center, Academia Sinica, Taipei (ASIZ P), Australian National Fish Collection, Commonwealth Scientific and Industrial Research Organisation, Hobart (CSIRO), Muséum national d'Histoire naturelle, Paris (MNHN), National Museum of Marine Biology and Aquarium, Pingtung (NMMB-P), Fish collection of National Museum of Nature and Science, Tsukuba (NSMT-P), and National Museum of Natural History, Smithsonian Institution, Maryland (USNM).

Family Colocongridae

Genus *Coloconger* Alcock, 1889

Coloconger Alcock, 1889: 456. Type species: *Coloconger raniceps* Alcock, 1889 by monotypy. Masculine.

KEY TO SPECIES OF *COLOCONGER*

1a. Sensory pores (tubes) on head and lateral line same as background color, not darkened (Fig. 1A); gill chamber entirely pale or with small dots; 4 tooth rows on posterior half of maxilla ..... ***C. saldanhai*** (New Caledonia, Australia)

1b. Sensory pores (tubes) on head and lateral line mostly darkened entirely or distally (Fig. 1B); gill chamber dark brown (except in juveniles); 1 or 2 tooth rows along entire maxilla 2

2a. Abdomen region paler than rest of body; a large blotch of pigment on rear end of tail ..... ***C. maculatus*** (eastern Taiwan)

2b. Body uniformly light brown to black, no distinct blotch on rear end of tail 3

3a. Anterior portion of mouth roof pale (Fig. 2A); eye diameter generally greater than snout length; ST usually 4–8 (usually 6 or more) ..... ***C. raniceps*** (Indo-west Pacific)

3b. Mouth roof entirely dark blue (Fig. 2B); eye smaller to larger than snout length; ST usually 3, rarely 4 or 5 4

4a. Anterior intermaxillary teeth present, a few teeth on each side or in 1 or 2 rows (Fig. 3A) 5

4b. Anterior intermaxillary teeth absent (Fig. 3B) 6

5a. Maxillary teeth entirely biserial; anal-fin rays 117–142 ..... ***C. cadenati*** (eastern Atlantic)

5b. Maxillary teeth uniserial anteriorly and irregularly biserial posteriorly; anal-fin rays 102–124 ..... ***C. meadi*** (western Atlantic)

6a. Snout usually longer than eye diameter (SN/ED = 0.9–1.7, mean 1.3); eye relatively small, 15–22% HL (mean 19% HL); total head pores 38–57 ..... ***C. scholesi*** [and ***C. japonicus***] (Indo-west Pacific [Japan])

6b. Snout subequal to or slightly longer than eye diameter (SN/ED = 0.9–1.4, mean 1.1); eye relatively large, 20–25% HL (mean 22% HL); total head pores 30–34 ..... ***C. paucitubus*, new species** (Solomon Islands and Vanuatu)

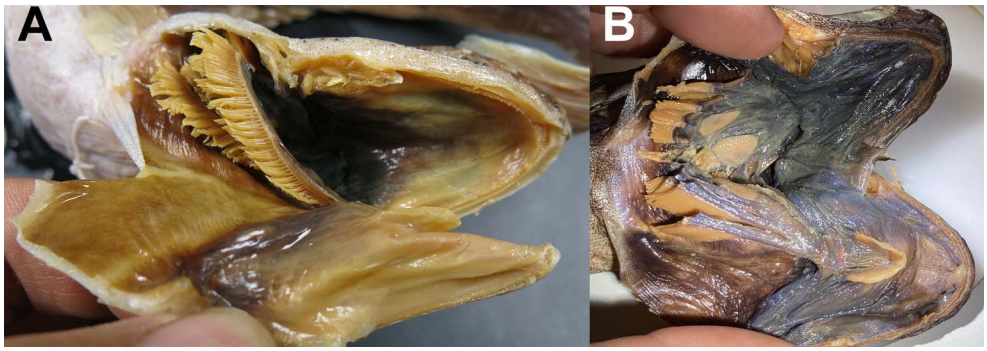

Fig. 2. Mouth cavity of species of *Coloconger* showing the coloration. (A) *C. raniceps*, MNHN 1979-0049, 350 mm TL. (B) *C. meadi*, MNHN 2000-5365, 337 mm TL.

***Coloconger paucitubus*, new species**
urn:lsid:zoobank.org:act:3E5E05FC-1DCD-41B3-BE60-8B4E7976E9B6
English name: Solomon Short-tailed Conger
Figures 4–6, Tables 1–3

Holotype.—MNHN 2006-0384, 345 mm TL, SALOMON 2, R/V *Alis*, sta. cp2219, 07°58′08.4″S, 157°37′15.6″E, Solomon Islands, western Pacific Ocean, 650–836 m, 27 October 2004.

Paratypes.—Thirteen specimens, 229–ca. 445 mm TL. Solomon Islands: MNHN 2005-2520, 2, 229–302, SALOMON 2, R/V *Alis*, sta. cp2215, 07°38′24″S, 157°46′8.4″E, 718–880 m, 26 October 2004; MNHN 2005-2521, 2, 332–335, SALOMON 2, R/V *Alis*, sta. cp2180, 08°45′32.4″S, 159°45′03.6″E, 708–828 m, 22 October 2004; MNHN 2006-0394, 1, ca. 445, SALOMON 2, R/V *Alis*, sta. cp2230, 06°35′16.8″S, 156°22′01.2″E, 837–945 m, 29 October 2004; MNHN 2006-0563, 1, 237, SALOMON 2, R/V *Alis*, sta. cp2248, 07°44′31.2″S, 156°26′13.2″E, 650–673 m, 1 November 2004; MNHN 2006-0707, 1, 414, SALOMON 2, R/V *Alis*, sta. cp2189, 08°17′31.2″S, 160°01′04.8″E, 660–854 m, 23 October 2014; MNHN 2014-1427, 3, 282–330, SALOMON 2, R/V *Alis*, sta. cp2835, 10°40′59.988″S, 162°19′59.988″E, 735–862 m, 21 September 2007; MNHN 2022-0186, 1, 345, from MNHN 2006-0384, collected with holotype. Vanuatu: MNHN 2005-3357, 1, 311, MNHN 2005-3427, 1, 277, BOA 0, R/V *Alis*, sta. cp2310, 14°45′10.8″S, 167°06′00″E, north of Espiritu Santo, 864–927 m, 15 November 2004.

Non-type material.—All from Solomon Islands: MNHN 2006-0051, 1, SALOMON 2, R/V *Alis*, sta. cp2269, 07°48′S, 156°57′07.2″E, 768–890 m, 4 November 2004; MNHN 2006-0075, 4, 163–212, SALOMON 2, R/V *Alis*, sta. cp2247, 07°42′21.6″S, 156°26′13.2″E, 686–690 m, 1 November 2004; MNHN 2006-0383, 1, 233, SALOMON 2, R/V *Alis*, sta. cp2230, 06°35′16.8″S, 156°22′01.2″E, 837–945 m, 29 October 2004; MNHN 2006-0408, 1, SALOMON 2, R/V *Alis*, sta. cp2228, 06°37′33.6″S, 156°14′09.6″E, 609–625 m, 28 October 2004; MNHN 2006-0653, 5, 184–245, SALOMON 2, R/V *Alis*, sta. cp2188, 08°17′16.8″S, 160°04′33.6″E, 495–677 m, 23 October 2004; MNHN 2006-0705, 2, SALOMON 2, R/V *Alis*, sta. cp2214, 07°37′26.4″S, 157°45′03.6″E, 550–682 m, 26 October 2004; MNHN 2006-0740, 3, 200–269, SALOMON 2, R/V *Alis*, sta. cp2215, 7°38′24″S, 157°46′08.4″E, 718–880 m, 26 October 2004; MNHN 2014-0927, 1, 196, BOA 3, R/V *Alis*, sta. DW2836, 10°24′00″S, 161°21′00″E, 360–378 m, 22 September 2007; MNHN 2014-0933, 2, BOA 3, R/V *Alis*, sta. cp2858, 9°40′00″S, 160°45′00″E, 650–725 m, 25 September 2007; MNHN 2014-0987, 3, BOA 3, R/V *Alis*, sta. cp2850, 9°37′00″S, 160°47′00″E, 502–621 m, 24 September 2007.

Diagnosis.—A species of *Coloconger* that differs from its congeners by having relatively few head sensory pores, total head pores usually 30–34, with 1 or 2 SO over posterior nostrils, IO usually 9 or 10, POM usually 11 or 12, and ST consistently 3; PDV 13–18, PAV 76–86, and TV 141–150; mouth cavity dark blue and gill chamber uniformly dark brown; rictus reaching vertical through posterior margin of pupil to posterior margin of eye; no anterior intermaxillary teeth; and body uniformly light brown to black, with lateral-line tubes darkened.

Description.—The following data are provided for type series only; morphometric and meristic data of types and non-types are provided in Tables 1–2.

Head length 5.3–6.3 (mean 5.6) times in TL; greatest body depth 6.3–8.8 (7.7); predorsal length 4.4–4.6 (4.5); preanal length 1.5–1.6 (1.6); trunk length 2.1–2.4 (2.2); tail length 2.6–3.0 (2.7); body depth at pectoral-fin base 7.3–9.5 (8.7); body width at pectoral-fin base 11.0–15.6 (12.9); body depth at anus 8.6–11.2 (9.6); body width at anus 21.6–30.8 (25.9). Snout length 3.7–4.9 (4.2) times in HL; eye diameter

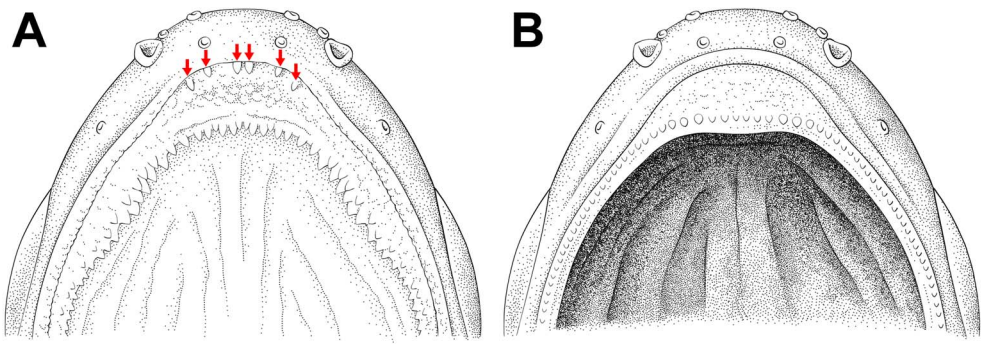

Fig. 3. Drawings show the intermaxillary teeth. (A) Anterior intermaxillary teeth present (arrowed), including *C. cadenati*, *C. maculatus*, *C. meadi*, *C. raniceps*, and *C. saldanhai*. (B) Anterior intermaxillary teeth absent, including *C. paucitubus*, new species, and *C. scholesi*. Drawn by Y.-K. Kiang.

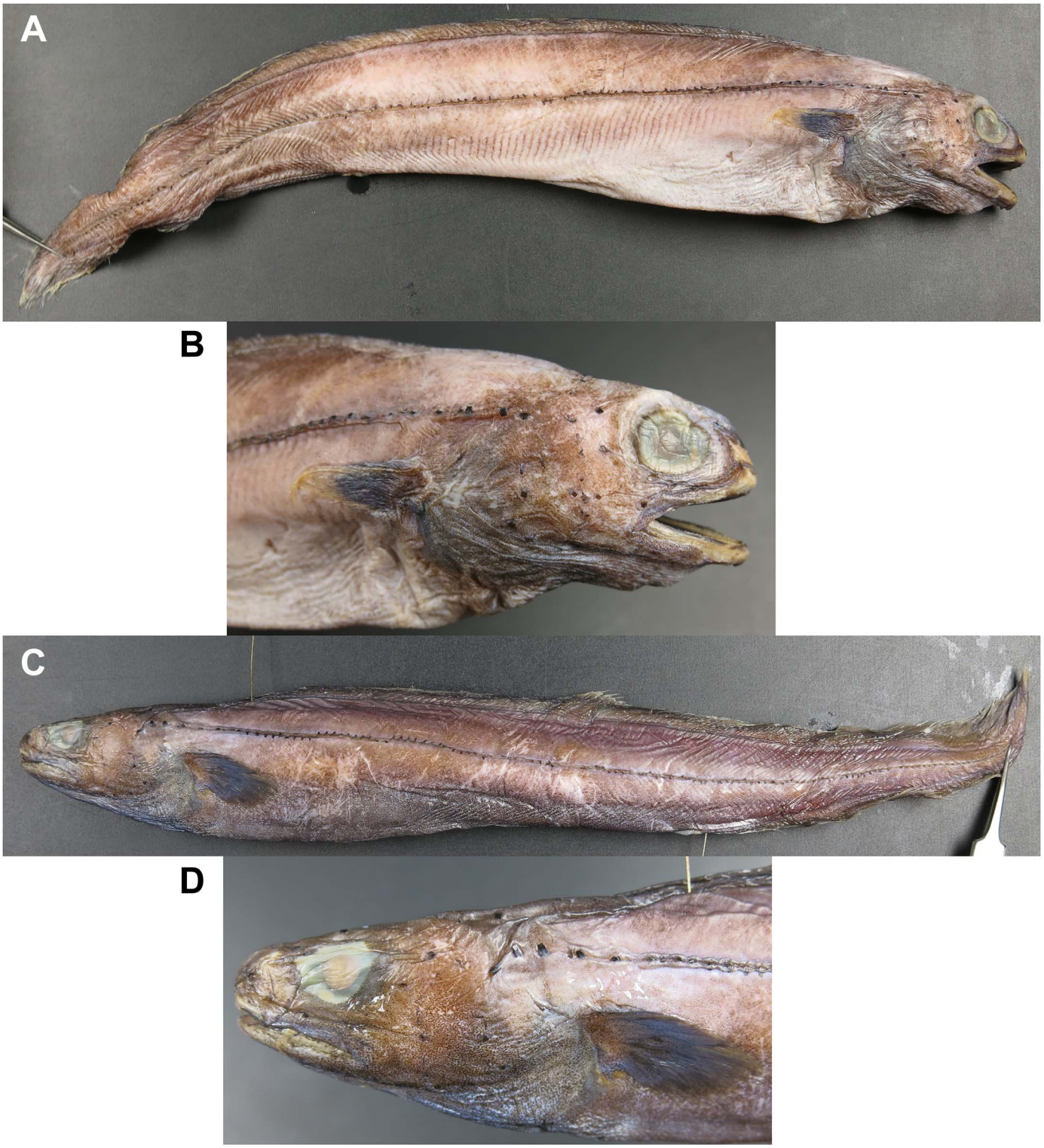

Fig. 4. *Coloconger paucitubus*, new species, preserved. (A–B) Holotype, MNHN 2006-0384, 345 mm TL, mature female, Solomon Islands. (C–D) Paratype, MNHN 2005-2520, 302 mm TL, Solomon Islands; pins are inserted at dorsal- and anal-fin origins.

4.1–5.1 (4.5); interorbital width 3.5–4.5 (3.9); snout–rictus length 2.1–2.5 (2.3); lower-jaw length 2.3–2.6 (2.4); postorbital length 1.6–2.1 (1.8); gill-opening height 5.3–8.8 (6.9); interbranchial width 2.8–5.0 (3.4); pectoral-fin length 1.8–2.2 (1.9); pectoral-fin base 4.2–7.3 (5.5); PO–DO 1.8–4.9 (3.6).

Dorsal-fin rays 194–211, anal-fin rays 82–103, number of dorsal-fin rays before anal-fin origin 72–95. Vertebrae: PDV 13–18, PAV 76–86, PHV 66–74, CV 62–70, TV 141–150. Lateral-line pores (tubes): PPLL 3–5, PDLL 6–13, PALL 66–75, TLL 132–145 (see below for variation).

Body short and stubby; skin rather loose; deepest area at anterior half of trunk; depth of head slightly larger than that of tail; head and trunk cylindrical to compressed, tail rather compressed; trunk long, 2.3–2.8 (mean 2.6) times HL;

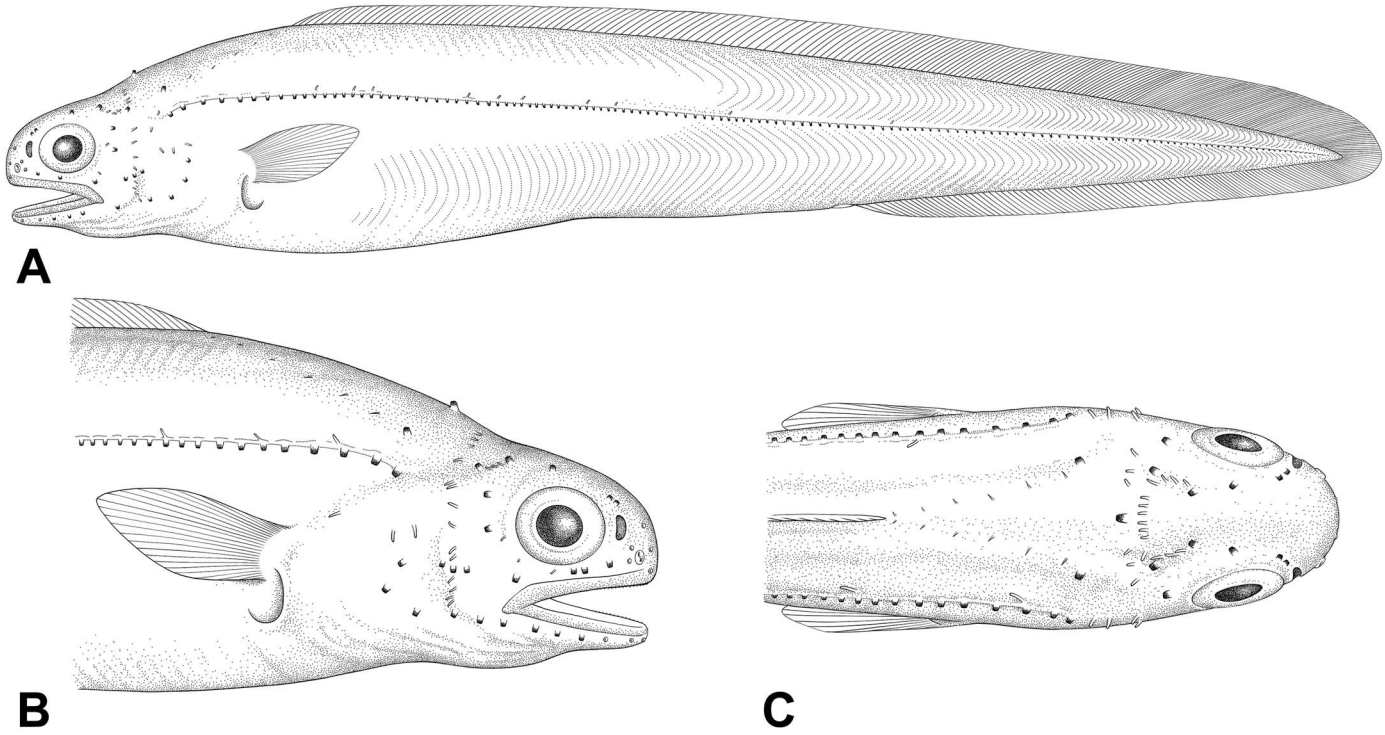

Fig. 5. *Coloconger paucitubus*, new species, from the holotype, MNHN 2006-0384. (A) Lateral view. (B) Lateral view of head. (C) Dorsal view of head. Drawn by Y.-K. Kiang.

tail short, shorter than trunk, posterior end broadly rounded, its length 1.1–1.4 (1.2) in trunk length.

Dorsal and anal fins well developed, confluent with caudal fin. Origin of dorsal fin above about middle of pectoral fin, predorsal length 1.2–1.3 (1.2) in HL; PO–DO 40.6–60.1% (48.3%) pectoral-fin length; origin of anal fin well posterior to mid-length, preanal length 3.3–3.8 (3.6) times HL. Pectoral fin broad and slightly pointed posteriorly, its upper margin straight and lower and posterior margins broadly rounded. Gill opening large vertical slit, in front of pectoral fin with its upper end extending dorsally to middle of pectoral-fin base.

Head not especially broad and deep; snout short and bluntly rounded, length 0.9–1.4 (1.1) times eye diameter, slightly projects beyond lower jaw; fleshy tip of snout extends anteriorly beyond intermaxillary teeth. Anterior nostril a broad tube, situated at front of snout, with anterior and posterior portion of rims well raised; posterior nostril large, posterodorsal to anterior nostril, its lower margin at a horizontal through middle of eye, bearing a tall rim on anterior margin. Eye large, over posterior half of upper jaw, its posterior margin extending to or slightly beyond vertical through rictus; interorbital space broad and flat, width 1.0–1.4 (1.2) times eye diameter.

Fig. 6. Post-metamorphic juvenile of *C. paucitubus*, new species, MNHN 2006-0075, 163 mm TL, Solomon Islands, preserved. (A) Lateral view. (B) Ventral view of abdominal region. Arrow points to the black dots along abdominal margin.

Table 1. Morphometric data of *Coloconger paucitubus*, new species, *C. cadenati*, and *C. meadi*. HT = holotype, PT = paratypes, NT = non-types.

	C. paucitubus, new species			*C. cadenati*			*C. meadi*	
		PT			HT+PT+NT		NT	
	HT	Mean (range)	SD	HT	Mean (range)	SD	Mean (range)	SD
TL (mm)	345	229–414 (n = 12)		561	250–561 (n = 16)		252–377 (n = 5)	
% TL								
HL	16.5	17.8 (16.5–18.8)	0.7	19.7	18.5 (17.3–19.7)	0.8	17.6 (16.7–18.6)	0.7
Predorsal length (PreD)	21.6	22.2 (21.6–22.6)	0.3	20.8	20.1 (19.0–21.6)	0.8	20.3 (18.6–21.3)	1.1
Preanal length	61.7	63.0 (61.0–66.2)	1.5	61.5	60.4 (58.1–63.4)	1.8	62.8 (59.3–68.5)	4.3
Trunk length	45.3	45.3 (42.3–48.4)	1.8	41.8	41.9 (39.1–46.1)	1.9	45.2 (41.7–49.9)	3.9
Tail length	38.3	37.0 (33.8–39.0)	1.5	38.5	37.3 (16.7–41.7)	1.8	37.2 (31.5–40.7)	4.3
PO–DO	5.1	5.0 (3.8–10.3)	1.8	1.1	1.7 (0.4–2.6)	0.6	2.7 (1.0–3.8)	1.1
Depth at GO	13.5	11.5 (10.5–13.8)	1.2	14.0	13.8 (10.2–16.3)	1.9	10.9 (9.5–12.6)	1.3
Width at GO	8.5	7.8 (6.4–9.1)	1.1	8.6	7.9 (6.9–9.0)	0.7	8.8 (7.4–9.5)	1.0
Depth at anus	11.7	10.4 (8.9–11.7)	0.9	10.2	10.5 (9.6–11.6)	0.6	9.5 (8.5–10.9)	1.0
Width at anus	4.6	3.9 (3.2–4.6)	0.4	3.7	4.2 (3.7–5.0)	0.5	3.5 (3.2–3.7)	0.2
Deepest body	15.7	13.0 (11.4–15.8)	1.6	14.7	15.4 (13.4–18.1)	1.8	13.6 (11.8–16.5)	2.5
Pectoral-fin length (PF)	8.7	9.1 (8.4–10.1)	0.5	10.8	9.7 (8.3–11.2)	0.8	8.8 (7.3–10.1)	1.0
Pectoral-fin base	3.7	3.2 (2.3–4.1)	0.5	3.5	3.3 (2.9–3.7)	0.3	2.7 (2.1–3.0)	0.3
Snout length (SN)	3.5	4.2 (3.5–4.7)	0.5	4.2	4.2 (3.6–4.8)	0.3	3.9 (3.6–4.2)	0.2
Eye diameter (ED)	3.5	3.9 (3.4–4.3)	0.3	4.4	4.2 (3.8–4.6)	0.3	4.2 (4.1–4.4)	0.1
Interorbital width (IO)	4.4	4.5 (4.1–5.0)	0.3	4.7	4.7 (3.7–5.4)	0.5	4.5 (3.6–5.2)	0.6
Upper jaw	7.1	7.6 (7.1–8.2)	0.4	9.7	8.3 (7.1–9.7)	0.7	7.5 (6.7–7.9)	0.5
Lower jaw	7.0	7.3 (6.9–7.7)	0.3	9.1	8.0 (6.5–9.1)	0.7	6.9 (6.2–7.3)	0.5
Post-orbital length	10.4	10 (8.7–11.3)	0.7	11.6	11.3 (10.7–11.7)	0.4	9.8 (8.8–10.7)	0.8
Gill opening height	3.0	2.6 (2.1–3.4)	0.5	3.7	3.6 (3.0–4.3)	0.5	2.8 (2.4–3.2)	0.4
Interbranchial width	4.6	5.1 (3.6–6.0)	0.9	8.0	6.9 (5.4–8.6)	1.2	5.4 (4.5–6.7)	0.8
% HL								
PO–DO	31.2	27.9 (20.5–55.3)	9.8	5.8	9.1 (2.1–13.7)	3.6	15.7 (5.9–21.4)	6.6
Pectoral-fin length	53.0	51.4 (44.9–55.8)	3.4	55.1	52.6 (46.6–58.8)	3.5	49.9 (43.7–57.6)	5.1
Pectoral-fin base	22.2	18.3 (13.7–23.8)	2.9	17.6	18.0 (15.3–20.5)	1.6	15.1 (12.8–16.5)	1.5
Snout length	21.5	23.6 (20.4–27.1)	2.2	21.2	23.1 (20.7–25.0)	1.4	22.2 (19.6–23.8)	1.6
Eye diameter	21.5	22.1 (19.8–24.7)	1.3	22.2	23.0 (21.5–24.5)	1.0	24.1 (22.5–26.1)	1.4
Interorbital width	26.6	25.6 (22.1–28.5)	2.1	23.9	25.4 (21.2–29.6)	2.7	25.3 (20.5–28.1)	3.1
Upper jaw	43.1	43.0 (40.0–46.9)	1.9	49.1	44.8 (40.4–49.1)	2.7	42.9 (39.9–44.9)	1.9
Lower jaw	42.3	40.9 (38.8–43.9)	1.9	46.2	42.9 (37.2–46.2)	3.1	39.0 (36.8–41.7)	2.4
Post-orbital length	63.4	56.5 (46.6–63.4)	4.3	58.8	60.9 (58.8–64.7)	2.1	55.7 (52.5–57.8)	2.7
Gill opening height	18.3	14.5 (11.4–18.7)	3.1	18.8	19.7 (16.9–23.8)	2.3	15.6 (13.9–18.0)	7.2
Interbranchial width	28.2	29.1 (20.1–35.4)	5.4	40.6	37.0 (29.5–45.7)	5.8	30.7 (25.7–37.9)	4.7
Other proportions								
PO–DO/PF	58.8%	48.3 (40.6–60.1)%		10.5%	17.8 (3.6–33.8)%		31.3 (12.4–44.6)%	
Trunk/Tail	1.2	1.2 (1.1–1.4)		1.1	1.0 (0.9–1.2)		1.2 (1.0–1.6)	
Trunk/HL	2.8	2.6 (2.3–2.8)		2.1	2.2 (2.1–2.4)		2.6 (2.4–2.8)	
PreD/HL	1.3	1.2 (1.2–1.3)		1.1	1.1 (1.0–1.2)		1.2 (1.1–1.2)	
SN/ED	1.0	1.1 (0.9–1.4)		1.0	1.0 (0.8–1.1)		0.9 (0.9–1.0)	
IO/ED	1.2	1.2 (1.0–1.4)		1.1	1.1 (0.9–1.4)		1.1 (0.8–1.2)	

Table 2. Meristic data of three species of *Coloconger*. HT = holotype, PT = paratypes, NT = non-types. Data in parentheses are exceptional values, and data in square brackets are adopted from Smith (1989).

	C. paucitubus, new species			*C. cadenati*		*C. meadi*
	HT	HT+PT (n = 13)	NT (n = 21)	HT	HT+PT+NT (n = 16)	NT (n = 15) [n = 36]
Vertebrae						
PDV	16	15–17	13–18	11	11–12	12–14 [11–17]
PAV	80	76–86	76–81	74	73–76	78–81 [75–86]
PHV	74	70–74	66–74	67	67–72	69–72
CV	67	(61, 62) 65–69	65–70	79	76–82	73
TV	147	(141) 143–148	143–150	153	151–155 [147–153]	151 [147–163]
Fin rays						
Dorsal-fin rays	194	194–211	195–211	254	220–254 [235–263]	[209–232]
Anal-fin rays	101	90–103	82–95	134	117–136 [133–142]	[102–124]
Dorsal-fin rays before AFO	76	(72) 79–95	80–88	107	82–110	92–96
Lateral-line pores						
PPLL	4	3–4	3–4 (5)	4	(2, 3) 4–6	3–5
PDLL	8	7–9 (11)	6–9 (10, 13)	6	(4) 6–7	6–9
PALL	72	67–75	66–74	65	64–72	66–76 [64–74]
TLL	140	132–145	ca. 136	—	152–153	132–ca. 145
Head pores						
SO	8;8	6–8	7–9 (11)	8	6–8	7–11 [6–8]
IO	11;10	8–12	8–12	15;14	11–19	9–17
POM	12;11	10–13 (18)	10–13 (15)	18;16	12–19	13–20 [14–22]
ST	3	3	3	3	3 (5)	3
Pores over PAN	2;2	1–2	1–2 (5)	2;2	1–2	1–2
Total	34;32	30–34 (41)	(27) 29–34 (38)	44;41	32–47	34–47

Mouth large, its opening slightly oblique, rictus extending to a vertical between posterior margin of pupil and posterior margin of eye; upper jaw slightly protrudes anterior to lower jaw; upper labial flange weakly developed; lower jaw with a thin fold from tip to rictus.

Sensory pores on head (Fig. 5) open through fleshy tubes with fairly consistent arrangement, unlike other species, the pores mostly separated from each other, rarely arranged in pairs, except for pores above posterior nostril (when 2 pores present). SO 6–9 (typically 7 or 8) on each side, first 3 pores with low rims, others tube-like, first 3 pores at front of snout, 1 or 2 (4th or 4th–5th) pores over posterior nostril, 3 pores on interorbital space and nape; IO 8–12 (typically 9–10), all tube-like, first two behind anterior nostril, 3rd pore below space between eye and posterior nostril, followed by 2 or 3 pores below eye, 2 or 3 pores on cheek, and 2 pores widely spaced and along posterior margin of eye; ST 3; and POM 10–15 (mainly 11–12, see variation below) on each side, anterior 3 with low rims and the others tube-like, 5 or 6 (mostly 6) along lower jaw, and 5–7 (mostly 6) behind rictus, not arranged in pairs mostly. Total pores usually 29–34 (see variation below). Additional series of small dermal papillae (or tendrils) behind eye, across supratemporal region, parallel to preopercular canal, nape, and at scattered locations elsewhere on head.

Teeth small, each with a flattened tip. No anterior intermaxillary teeth; single row of posterior intermaxillary teeth, continuous with the entirely uniserial maxillary teeth; no vomerine teeth; two complete rows of teeth on lower jaw, those on inner row clearly smaller than outer row and mostly embedded within fleshy tissue.

Coloration.—In preservation, smaller individuals are yellowish brown to deep brown with sensory pores (tubes) darkened; abdominal region and caudal fin lightly pigmented. Color gradually becoming dark purple or black in moderately large to large individuals. The largest specimen (ca. 445 mm TL, MNHN 2006-0394) is uniformly black with narrow white fin margins. In all specimens examined, mouth cavities are nearly completely dark blue, except for floor below tongue region which is paler; tooth band and their bases pale, without pigments. Peritoneal membranes pale with dense black dots; stomach and intestine black; gonads yellowish white; swim bladder silvery white. Sensory pores (less tube-like) on anterior portions of head pale in large specimens. Fresh coloration unknown, presumably similar to that in preservation.

Size.—The largest specimen examined is a paratype (ca. 445 mm TL), a ripe female with large ovaries and loose eggs which might be fully developed. The holotype (345 mm TL) is a female with large ovaries and undeveloped eggs.

Distribution.—Known from the type series and non-types collected from the Solomon Islands and one individual collected from Vanuatu. Bathymetric range 502–945 m, with one exception collected from 360–378 m by a drag net.

Etymology.—The specific name is a combination of Latin *pauci* (few) and *tubus* (tube), referring to the diagnostic low sensory tube (pore) count on the head in comparison to other species of the genus. A noun in apposition.

Comparisons.—*Coloconger paucitubus* has fewer head pores (mainly 29–34), with a rather consistent arrangement

Table 3. Frequencies of head pores of six species of *Coloconger* examined in the present study. PN = posterior nostril.

	Supraorbital (SO)								Infraorbital (IO)																				
	n	6	7	8	9	10	11	12	*n*	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
C. paucitubus	71	1	23	42	4	—	1		73	11	23	30	4	3															
C. cadenati	26	1	10	15					24				1	3	6	5	4	1	1	2	1								
C. meadi	28		5	16	5	1	1		28		1	4	7	4	5	2	3	1	1										
C. raniceps	49		1	12	10	18	7	1	44					4	8	7	8	5	3	2	4	2	1						
C. saldanhai	12		1	9	1	1			12				3	5	2	—	—	—	2										
C. scholesi	30	1	9	55	13	3	2		80					1	—	3	9	12	11	9	10	6	8	7	1	2	—	1	

	Preoperculomandibular (POM)													Supratemporal (ST)										SO over PN			
	n	10	11	12	13	14	15	16	17	18	19	20	21	*n*	2	3	4	5	6	7	8	9	10	*n*	1	2		5
C. paucitubus	71	8	40	17	4	—	1	—	—	1				35		35								72	27	44		1
C. cadenati	24			3	—	2	5	7	3	3	1			14		12	1	1						28	13	15		
C. meadi	28				2	6	8	8	2	1	—	1		14		10	3	1						28	18	10		
C. raniceps	44				3	11	16	9	4	—	1			25		2	4	2	9	3	4	—	1	48	1	47		
C. saldanhai	12				1	3	7	1						6		3	2	—	—	—	—	—	1	12	1	11		
C. scholesi	79		1	1	7	5	13	14	18	7	8	4	1	54	1	45	4	4						91	15	76		

	Total (SO+IO+POM+ST)																															
	n	27	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
C. paucitubus	71	1	1	13	23	18	7	5	—	—	—	1	—	—	1																	
C. cadenati	17					1	—	—	—	1	2	2	—	1	1	2	4	—	—	1	2											
C. meadi	28							1	2	2	1	5	3	2	—	2	5	3	—	—	2											
C. raniceps	49										1	1	1	2	4	2	5	5	8	5	1	1	3	2	3	—	2	1	1	—	—	1
C. saldanhai	12								1	—	1	3	4	—	1	—	—	—	—	—	—	1	—	1								
C. scholesi	69											1	3	3	7	4	2	5	9	3	4	5	5	2	4	4	2	4	1	—	1	

compared to those of all congeners. *Coloconger paucitubus* is most similar to *C. scholesi* (and the unresolved *C. japonicus*) in having the snout subequal or slightly longer than eye diameter (SN/ED = 0.9–1.4, mean 1.1; vs. 0.9–1.7, mean 1.3), reflected by the relatively large eye (20–25% HL, mean 22%; vs. 15–22% HL, mean 19%). These species are evidently not sympatric based on the large number of specimens examined by us.

Moreover, the uniformly dark blue mouth roof separates *C. paucitubus* from *C. raniceps* and *C. saldanhai*; the lack of anterior intermaxillary teeth separates it from *C. cadenati*, *C. meadi*, *C. raniceps*, and *C. saldanhai*. The blackened sensory pores (tubes) and dark blue gill chamber separate it from *C. saldanhai*. The uniform dark brown to black color without a black patch on rear end of tail separates it from *C. saldanhai* and *C. maculatus*.

Morphological variations.—The following descriptions are based on all specimens examined, including non-types. Although the head pores (tubes) are quite consistent in terms of numbers and arrangement, some variation is observed among the individuals. One paratype (MNHN 2006-0707) has 18 POM which results in a total of 41 head pores on the left side, whereas the right side of same individual has 11 POM and 33 total pores, which is within the range of the majority of values. A non-type (MNHN 2006-0653, 1 of 5) has 15 POM and 38 total pores on the left side, and 11 POM and 31 total pores on the right side. Another non-type (MNHN 2006-0383) has 7 SO and 10 POM, resulting in 27 total head pores on the left side, slightly fewer than the normal range, whereas there are 30 total pores on the right side. One paratype (MNHN 2014-1427) has 6 SO and a non-type (MNHN 2006-0075) has 11 SO, whereas all others have 7–9.

There are mainly 3 or 4 lateral-line pores before the pectoral-fin base (excluding those not on the regular row), but one non-type has 5. There are mainly 7–9 lateral-line pores before the dorsal-fin origin, except for a few individuals with 6 or 10–13. There are usually 68–72 PALL, with some exceptions having 66–67 or 73–75. There are mainly 15–18 PDV, except a few non-type individuals have 13–14. There are mainly 78–81 PAV, whereas a few individuals have 76–77 or 86. There are mainly 70–74 PHV, except for a few with 66. There are mainly 65–70 CV, except for a few with 61 or 62. There are 143–150 TV in complete individuals, whereas two individuals have 141 total vertebrae. Other specimens may have a slightly damaged and healed tail tip and have slightly fewer caudal and total vertebrae (not included in Tables 1–2).

The number of dorsal-fin rays before the anal-fin origin, and the total dorsal- and anal-fin counts also vary. There are mainly 79–95 dorsal-fin rays before the anal-fin origin, except the holotype has 76 and one paratype has 72; 194–211 dorsal-fin rays (generally more than 200) and 90–103 anal-fin rays (generally less than 100), except for a non-type with 82 anal-fin rays.

Similar to congeners studied, this species also shows intraspecific variation of meristic values, but these variations are relatively small compared to its congeners.

Remarks.—The MNHN 2006-0653 (2 of 5, 184–203 mm TL) have a light brown and rather compressed body; these are likely early post-metamorphic stage juveniles. Their black dots along the midline of the abdominal cavity are rather indistinct, which may indicate that this species has metamorphosis at a smaller size.

Coloconger cadenati Kanazawa, 1961

Figure 7, Tables 1–3

Coloconger cadenati Kanazawa, 1961: 111, pls. 1–2 (type locality: Senegal, South Kayar pit; holotype MNHN 1961-0302). Smith, 1989: 417 (description). Smith, 1994: 4 (type catalog). Smith, 2016: 1667 (listed). Ho et al., 2021: 280 (comparison).

Material Examined

Holotype.—MNHN 1961-0302, 561, 14°52′58.8″N, 17°10′01.2″W, south of Kayar pit, Senegal, 450–500 m, February 1959.

Paratypes.—MNHN 1975-0878, 1, 418, MNHN 1975-0879, 1, 452, 14°52′58.8″N, 17°10′01.2″W, south of Kayar pit, Senegal, 450–500 m, 6 February 1959; MNHN 1975-0880, 1, 479, MNHN 1975-0881, 1, 522, MNHN 1975-0882, 1, 479, 14°52′58.8″N, 17°10′01.2″W, south of Kayar pit, Senegal, 450–500 m, 12 February 1959; USNM 177890, 1, 490, French West Africa, Senegal, Sub Fasse Kayar, 450–500 m, 6–12 February 1959.

Non-type material.—CAS 222763, 1, 205, 8°29′S, 12°48′E, off Angola, 535–539 m, T. Iwamoto, 12 April 2005; CAS 223385, 3, 280–306, 12°27′S, 13°15′E, off Benguela, Angola, 646–650 m, T. Iwamoto, 1 April 2005; MNHN 1975-1151, 1, 445 R/V *Geronimo*, sta. 223/xvi, 03°04′58.8″S, 09°15′00″E, Gabon, 6 September 1963; MNHN 1975-1152, 1, 415, F/V *Gerard Treca*, ca.15°N, 18°W, off Senegal, 270–500 m, 12 February 1954; MNHN 1975-1153, 1, 396, 05°30′S, 11°31′58.8″E, off Cabinda, 500–505 m, 5 July 1967; MNHN 1975-1154, 1, 5°03′S, 11°22′01.2″E, off Congo, 400 m, 9 September 1967; MNHN 1975-1155, 1, 440, F/V *Gerard Treca*, 14°54′N, 17°37′01.2″W, off Senegal, 450–600 m, 18 January 1959; MNHN 1987-1511, 1, F/V *Laurent Amaro*, 15°42′N, 17°45′W, off Senegal, 300 m, April 1983; MNHN 1987-1517, 1, 476, F/V *Laurent Amaro*, sta. 7, 15°42′01.2″N, 17°45′W, off Senegal, 500 m, April 1983; MNHN 1987-1540, 1, 470, no. F/V *Laurent Amaro*, sta. 2, 12°58′58.8″N, 17°40′01.2″W, off Senegal, 500 m, February 1983; MNHN 1987-1556, 1, 250, F/V *Andre Nizery*, sta. 34, 03°18′S, 09°39′E, off Gabon, 470 m, February 1980; MNHN 1987-1570, 1, F/V *Laurent Amaro*, sta. 7, 12°42′N, 17°45′W, off Senegal, 300 m, April 1983; MNHN 1987-1571, 1, 430, F/V *Laurent Amaro*, sta. 6, 12°42′N, 17°03′W, off Senegal, 500 m, April 1983; MNHN 1988-0393, 2, 352–443, F/V *Walter Barth*, sta. 2, 16°07′01.2″N, 16°58′58.8″W, off Senegal, 600 m, March 1982.

Diagnosis.—Anterior intermaxillary teeth present, in 2 or 3 rows; posterior intermaxillary, maxillary, and dentary teeth uniformly biserial; rictus extends from posterior margin of pupil to the posterior margin of eye; mouth roof uniformly dark blue; dorsal-fin origin slightly behind pectoral-fin origin, above anterior half of pectoral fin; dorsal-fin rays 220–263; anal-fin rays 117–142; vertebrae 147–155.

Description.—Tables 1–2 provide complete morphometric and meristic data. Body relatively short, greatest body depth 6.5–7.4 in TL. Dorsal-fin origin above or slightly behind a vertical through upper end of pectoral-fin base, predorsal length 1.0–1.2 times HL, over middle of pectoral

Fig. 7. *Coloconger cadenati*, MNHN 1987-1517, 476 mm TL, Senegal, preserved. (A) Lateral view of right side of body. (B) Lateral view of right side of head.

fin, PO–DO 3.6–33.8% (mean 17.8%) pectoral-fin length. Rictus reaches posterior margin of pupil to posterior margin of eye. Trunk subequal to slightly longer than tail length, trunk length 0.9–1.2 times tail length. Snout length shorter to slightly longer than eye diameter, SN/ED 0.8–1.1.

Dorsal-fin rays 254 (holotype; 235–263 in type series; 220–254 in non-types), anal-fin rays 134 (133–142; 117–136), dorsal-fin rays before anal-fin origin 107 (82–110 in non-types). Vertebrae: PDV 11 (11–12 in all other specimens), PAV 74 (73–76), PCV 67 (67–72), CV 79 (76–82), TV 153 (147–155). Lateral-line pores: PPLL 4 (4–6, rarely 2 or 3), PDLL 6 (6–7, rarely 4), PALL 65 (64–72), TLL N/A (ca. 152–153 in non-types).

Head pores (based on holotype): SO 8, 1st–3rd pores at tip of snout, 4th and 5th arranged in pair, over posterior nostril, 6th–7th on interorbital space, and 8th on nape. IO 15 on right side, 2 pores behind anterior nostril, 3rd–4th, 5th–6th, and 7th–9th arranged in pairs or groups, respectively; 4 loosely arranged pores on cheek and 2 pores behind eye; 14 pores in similar arrangement on left side. POM 18 on right side, 9 pores along lower jaw, 5th–6th and 7th–9th pores arranged in groups, respectively; 9 pores behind rictus, 11th–12th, 13th–14th, and 15th–17th arranged in pairs or groups, respectively; 16 pores in similar arrangement on left side. ST 3, 1 on each side and middle. The paratypes and non-types have 6–8 SO, 1 or 2 pores above posterior nostril; IO 11–19 and POM 12–19, in similar arrangement to holotype. ST 3, except one specimen (MNHN 1975-0880) has 2 additional pores in front of the middle pore.

Tooth pattern: holotype has 3 irregular rows of anterior intermaxillary teeth (2 rows at middle), 2 irregular rows of posterior intermaxillary teeth connecting the maxillary teeth, which are also biserial, those on inner maxillary row slightly larger than those of outer row. Two rows of teeth on most of lower jaw, three irregular rows anteriorly, teeth in outer row slightly larger than those in inner row. Four small extra patches of 2–4 teeth on anterior portion of vomer. In paratypes, there are two irregular rows of anterior intermaxillary teeth at front and two irregular rows of posterior intermaxillary teeth connecting the biserial maxillary teeth; lower jaw with three rows of teeth at front and two rows along most of tooth band; and no additional teeth or tooth patches on vomer.

Coloration.—Body coloration is presumably uniformly black in holotype (pigments lost by trawl operation or long-term preservation); paratypes are either uniformly black or pale brown depending on the condition. Other non-types mostly uniformly black. Mouth roof completely dark blue, floor dark blue except for ventral surface of tongue, which is paler, and the bases of tooth bands are creamy white. Peritoneum pale with small, sparsely distributed melanophores. Stomach and intestine uniformly black. Gonads yellowish white.

Size.—Appears to be a moderately large species, attaining around 561 mm TL (holotype).

Distribution.—Tropical eastern Atlantic from Mauritania to Angola. Bathymetric range 270–650 m on the upper continental slope.

Remarks.—*Coloconger cadenati* is most similar to *C. meadi* from the western Atlantic Ocean. According to Kanazawa (1961), the two species can be separated by the numbers of fin rays and vertebrae. Based on our examination, these values slightly overlap between these two species, although *C. cadenati* tends to have slightly more fin rays than those of *C. meadi*. However, the uniformly biserial intermaxillary and jaw teeth in *C. cadenati* can also readily separate it from *C. meadi*.

A small individual (CAS 222763, 205 mm TL) has the adult appearance, except for a slightly pale body color, paler anterior mouth roof, single row of few anterior intermaxillary teeth. However, unlike other congeners, there are no distinct black spots along the abdominal region (beneath skin). Also, three other specimens (CAS 223385, 280–306 mm TL) show a uniform dark body and dark blue mouth roof. We may assume that this species transforms at a small size.

Fig. 8. *Coloconger meadi*, MNHN 2000-5364, 351 mm TL, French Guiana, preserved. (A) Lateral view of left side of body. (B) Lateral view of left side of head.

Coloconger maculatus Ho and Tang, 2021

Coloconger maculatus Ho and Tang, in Ho, Tang, and Chu, 2021: 272 (Type locality off Fu-gang, Taitung, eastern Taiwan, ca. 300 m; holotype NMMB-P 35247).

Material Examined

Holotype.—NMMB-P 35247, 520 mm TL, off Fu-gang, eastern Taiwan, ca. 300 m, hook and line, purchased from local auction.

Diagnosis.—Head small, HL 15.7% TL; ST 4, middle two in pair; two pores over posterior nostril; total pores 37 or 39; dorsal-fin rays 226 and anal-fin rays 122; PAV 77 and TV 145; rictus through a vertical at posterior margin of pupil; snout shorter than eye diameter, SN/ED = 0.87; PO–DO 69.4% pectoral-fin length; body brownish-gray dorsally, light gray ventrally, and dorsal fin dark gray; a large black blotch on posterior portion of tail with a white caudal fin.

Distribution.—Known only from eastern Taiwan off Taitung.

Remarks.—See Ho et al. (2021) for detailed description.

Coloconger meadi Kanazawa, 1957
Figures 2B, 8; Tables 1–3

Coloconger meadi Kanazawa, 1957: 234, fig. 1 (type locality: Gulf of Mexico, southwest of Dry Tortugas, Florida, U.S.A., depth 375 fathoms [686 m]; holotype USNM 157926). Kanazawa, 1961: 110 (in key). Smith, 1989: 417 (description). Smith, 2003: 734 (listed). Ho et al., 2021: 280 (comparison).

Material Examined

Holotype.—USNM 157926, 282, 24°16′N, 83°22′W, 375 fm, 686 m, southwest of Dry Tortugas, Florida, R/V *Oregon*, sta. 1019, 16 April 1964.

Non-type material.—MNHN 2000-5364, 2, 351–368, R/V *Thalassa*, sta. x285, French Guiana, July 1971; MNHN 2000-5365, 1, 337, R/V *Thalassa*, sta. x279, French Guiana, July 1971; MNHN 2000-5366, 1, 377, R/V *Thalassa*, sta. x280, French Guiana, July 1971; MNHN 2000-5367, 1, 252, R/V *Thalassa*, sta. x290/237, 6°57′N, 52°33′W, French Guiana, 7 August 1971; NSMT-P 40067, 1, 344, no data; NSMT-P 101785 (JAMARC 11285), 1, R/V *Nisshin-maru*, sta. T59, 7°52′N, 54°06′W, 830 m, 30 June 1980; NSMT-P 147414, 1, 243, R/V *Nisshin-maru*, sta. T95, 7°44′N, 54°15′W, off Suriname, 530 m, 29 August 1979; NSMT-P 147415, 1, 418, R/V *Nisshin-maru*, sta. T47, 7°52′N, 54°08′–54°12′W, off Suriname, 850 m, 23 April 1980; NSMT-P 147416, 1, 224, R/V *Nisshin-maru*, sta. T21, 7°32′N, 54°38′W, off Suriname, 450 m, 12 April 1980; NSMT-P 147417, 1, 373, R/V *Nisshin-maru*, sta. T67, 7°57′N, 54°26′–54°30′W, off Suriname, 925 m, 22 July 1979; NSMT-P 147418, 1, 253, R/V *Nisshin-maru*, sta. T31, 7°39′N, 53°48′W–7°34′N, 53°43′W, off Suriname, 496–501 m, 18 June 1979; NSMT-P 147419, 1, 445, R/V *Nisshin-maru*, sta. T41, 7°51′N, 54°21′W–7°52′N, 54°21′W, off Suriname, 810 m, 21 June 1980; NSMT-P 147420, 1, 303, NSMT-P 147421, 1, 362, NSMT-P 147422, 1, 317, R/V *Nisshin-maru*, sta. T60, 7°39′N, 54°01′–54°07′W, off Suriname, 420–423 m, 16 January 1980; NSMT-P 147424, 1, 318, NSMT-P 147425, 1, 282, R/V *Nisshin-maru*, unknown trawl number, 7°46′N, 54°14′W, off Suriname, 550 m, 17 January 1980; NSMT-P 147426, 1, 188, NSMT-P 147427, 1, 212, R/V *Nisshin-maru*, sta. T52, 7°32′N, 54°27′W–7°31′N, 54°33′W, off Suriname, 448–450 m, 5 October 1979.

Other specimens listed in Smith (1989).

Diagnosis.—Single row of anterior intermaxillary teeth; posterior intermaxillary and anterior half of maxillary teeth uniserial; posterior half of maxilla and entire dentary teeth biserial; rictus reaches posterior margin of pupil to posterior margin of eye; mouth roof uniformly dark blue; dorsal-fin origin slightly behind pectoral-fin base, above anterior half of pectoral fin; dorsal-fin rays 209–232; anal-fin rays 102–124; total vertebrae 147–163.

Description.—Tables 1–2 provide complete morphometric and meristic data. Body relatively short, greatest body depth 6.1–8.5 in TL. Dorsal-fin origin slightly behind a vertical through upper end of pectoral-fin base, predorsal length 1.1–1.2 times HL, over anterior half of pectoral fin, PO–DO 12.4–44.6% (mean 31.3%) pectoral-fin length. Rictus reaches posterior margin of pupil to posterior margin of eye.

Trunk equal to or longer than tail length, trunk length 1.0–1.4 (1 with 1.6) tail length. Snout length shorter than or equal to eye diameter, SN/ED 0.9–1.0.

Dorsal-fin rays 209–232, anal-fin rays 102–124, dorsal-fin rays before anal-fin origin 92–96. Vertebrae: PDV 11–17, PAV 75–86, CV 73 ($n = 1$, this study), TV 147–163. Lateral-line pores: PPLL 3–5, PDLL 6–9, PALL 64–76, TLL 132–ca. 145 (meristic data also adopted from Smith, 1989).

Head pores: SO 6–11 (mainly 7–8), 1 or 2 pores over posterior nostril; IO 9–17 (mostly 10–14); no frontal pore; POM 14–22; ST 3–5 (mostly 3); total pores 36–47 (one with 34/35).

Pore arrangement (based on MNHN 2000-5364): SO 8 (right)/8 (left), anterior 3 at tip of snout, 4th–5th above posterior nostril, 6th–7th on interorbital space, 8th on nape. IO 15/17, first 2 pores behind anterior nostril, 3rd (right) or 3rd–4th (left, paired) below space between eye and posterior nostril; 5 pores below eye, anterior 2 and posterior 3 close to each other, respectively; 5 (right)/6 (left) on cheek, 2 behind eye. POM 17/16, 7 along lower jaw, 5th–6th arranged in pair, 10/9 behind rictus, 9th–10th, 11th–12th, 13th–14th, 15th–16th arranged in pairs on right side, similar arrangement on left side. ST consistently 3, 1 pore on each side and middle.

Tooth pattern (based on MNHN 2000-5364): anterior intermaxillary with single row of 4 teeth (4–8 in other specimens), well separated from posterior row. Posterior intermaxillary teeth with single row of 5 teeth (5–8), connecting the maxillary teeth. Upper jaw with single regular teeth on anterior 3/4 portion, becoming 2 irregular rows on posterior 1/4 portion, those on outer row rather small. Lower jaw with 2 regular rows of teeth, those on inner row distinctly smaller and mostly embedded within tissues. Similar arrangements in other specimens.

Coloration.—Uniformly dark brown to blackish; mouth cavity and pharyngeal region dark blue, roof uniformly dark blue; mouth floor mostly dark blue, except for area below tongue; tongue with black base and broad pale margin. Gill chamber uniformly black or dark brown; gill arches black, filaments pale; teeth and their bases pale. Peritoneum pale with dense black dots. Stomach and intestine black; other internal organs yellowish white.

Size.—Appears to be a large species, attaining 505 mm TL (Smith, 1989).

Distribution.—Western Atlantic from the Gulf of Mexico to French Guiana. Bathymetric range 366–925 m.

Remarks.—One specimen (368 mm TL) has a long preanal length (68.5% TL) and trunk (49.9% TL), which might be abnormal, whereas the other specimens have these two proportions similar to these of congeners (preanal length 59.3–60.2% TL, trunk 41.7–42.6% TL). Although Smith (1989) reported that there is consistently 1 pore above the posterior nostrils, we found that number variable, either with 1 or 2. The arrangement of head pores (tubes) is also highly variable, usually single or 2 pores (tubes) close to each other, some with 3 in a cluster, but never more than that. The anterior lateral-line tubes almost always single, only a few individuals with additional tubes above the regular row.

Two small individuals (NSMT-P 147426 and 147427, 188–212 mm TL) were examined, both in post-metamorphic stage but rather similar to the adult form. This species may metamorphose at a relatively smaller size. The smallest specimen (188) has only three small dots on ventral midline (inner skin), which suggests that the juveniles have fewer dots than in other species.

Coloconger raniceps Alcock, 1889

Figures 2A, 9–10; Tables 3–5

Coloconger raniceps Alcock, 1889: 456 (Type locality: Andaman Sea off Ross Island, depth 265–271 fathoms [485–496 m]; four syntypes). Alcock, 1892: pl VII, fig. 4 (original drawing). Alcock, 1899: 196 (description). Lloyd, 1909: 152 (description). Kuronuma, 1940: 405 (description; Japan). Kanazawa, 1957: 235 (in key). Kanazawa, 1961: 110 (in key). Chan, 1967: 99 (comparison). Castle, 1968: 714 (description). Castle, 1969: 7 (description of metamorphic leptocephalus). Karrer, 1983: 41 (description). Masuda et al., 1984: 27 (description). Smith, 1989: 417 (mentioned). Smith, 1999: 1670 (listed). Quéro, 2001: 62 (in key). Ho et al., 2021: 280 (comparison).

Material Examined

Syntype.—MNHN 1890-0363, 1, 270, RIMS *Investigator* sta. 13, 12°10′01.2″N, 98°04′58.8″E, Mergui, Andaman Sea.

Non-type material.—Eastern Indian Ocean: USNM 44430, 1, USNM 437546, 1, R/V *Fridtjof Nansen*, 12°43′12″N, 96°36′36″E, Myanmar, 521 m, 23 May 2015; USNM 438242, 1, R/V *Fridtjof Nansen*, 17.15°N, 94.10°E, Myanmar, 772 m, 5 May 2015; USNM 438287, 1, R/V *Fridtjof Nansen*, 16.22°N, 93.75°E, Myanmar, 457 m, 20 May 2015; USNM 438288, 1, R/V *Fridtjof Nansen*, 14.06°N, 95.32°E, Myanmar, 457 m, 10 May 2015. Western Indian Ocean: AMS I.28116-003, 2, 324–330, R/V *Vityaz* II, 12°31′30″S, 48°05′30″E, northwest of Madagascar, shrimp trawl, 700–711 m, 12 November 1988; MNHN 1979-0047, 2, 321–360, F/V *Vauban*, sta. ch022, 12°27′00″S, 48°10′01.2″E, Madagascar, 680–700 m, 19 January 1972; MNHN 1979-0048, 2, 180–217, F/V *Vauban*, sta. ch048, 15°18′00″S, 46°12′00″E, Madagascar, 480–510 m, 8 November 1972; MNHN 1979-0049, 1, 350, F/V *Vauban*, sta. ch049, 15°18′03.6″S, 48°10′04.8″E, Madagascar, 500–550 m, 8 November 1972; MNHN 1979-0050, 1, 267, F/V *Vauban*, sta. ch090, 21°24′03.6″S, 43°13′04.8″E, Madagascar, 640–720 m, 26 November 1973; MNHN 1987-1230, 1, 379, F/V *Vauban*, sta. 60tu, 23°36′03.6″S, 43°28′08.4″E, Madagascar, 710 m, 27 February 1973; MNHN 1987-1231, 1, 305, F/V *Vauban*, sta. 65tu, 23°34′58.8″S, 43°28′04.8″E, Madagascar, 740–760 m, 28 February 1973; MNHN 1987-1232, 1, 305, FAO60, sta. 73/066, 15°21′00″S, 46°09′00″E, Madagascar, 180–200 m, 23 June 1973; MNHN 1987-1240, 1, 177, 20°52′58.8″S, 55°21′00″E, Réunion, September 1975; MNHN 1993-0276, 1, 277, MNHN 1993-0277, 1, 324, MNHN 1993-0278, 1, 319, MNHN 1993-0279, 1, 315, R/V *Marion-Dufresne*, sta. ca070, 21°22′58.8″S, 55°28′58.8″E, Réunion, 700–750 m, 23 August 1982; MNHN 1993-0280, 1, 368, R/V *Marion-Dufresne*, sta. ca141, 20°52′01.2″S, 55°39′00″E, Réunion, 720–760 m, 2 September 1982; MNHN 1998-0600, 1, 308, F/V *Vauban*, sta. 60tu, 23°36′03.6″S, 43°28′08.4″E, Madagascar, 710 m, 27 February 1973; MNHN 2014-1165, 1, 423, R/V *Miriky*, sta. cp3252, 15°23′55.8″S, 45°56′45″E, Madagascar, 650–850 m, 8 July 2009; MNHN 2014-1536, 3, 347+–360, MNHN 2014-2138, 1, 321, R/V *Miriky*, sta. cp3187, 12°31′45.6″S, 48°08′25.2″E, Madagascar, 691–695 m, 26 June 2009; MNHN 2016-0141, 1, 357, F/V *Atalante*, sta. moz1_cp3, Mozambique, 971 m, 10 August 2014;

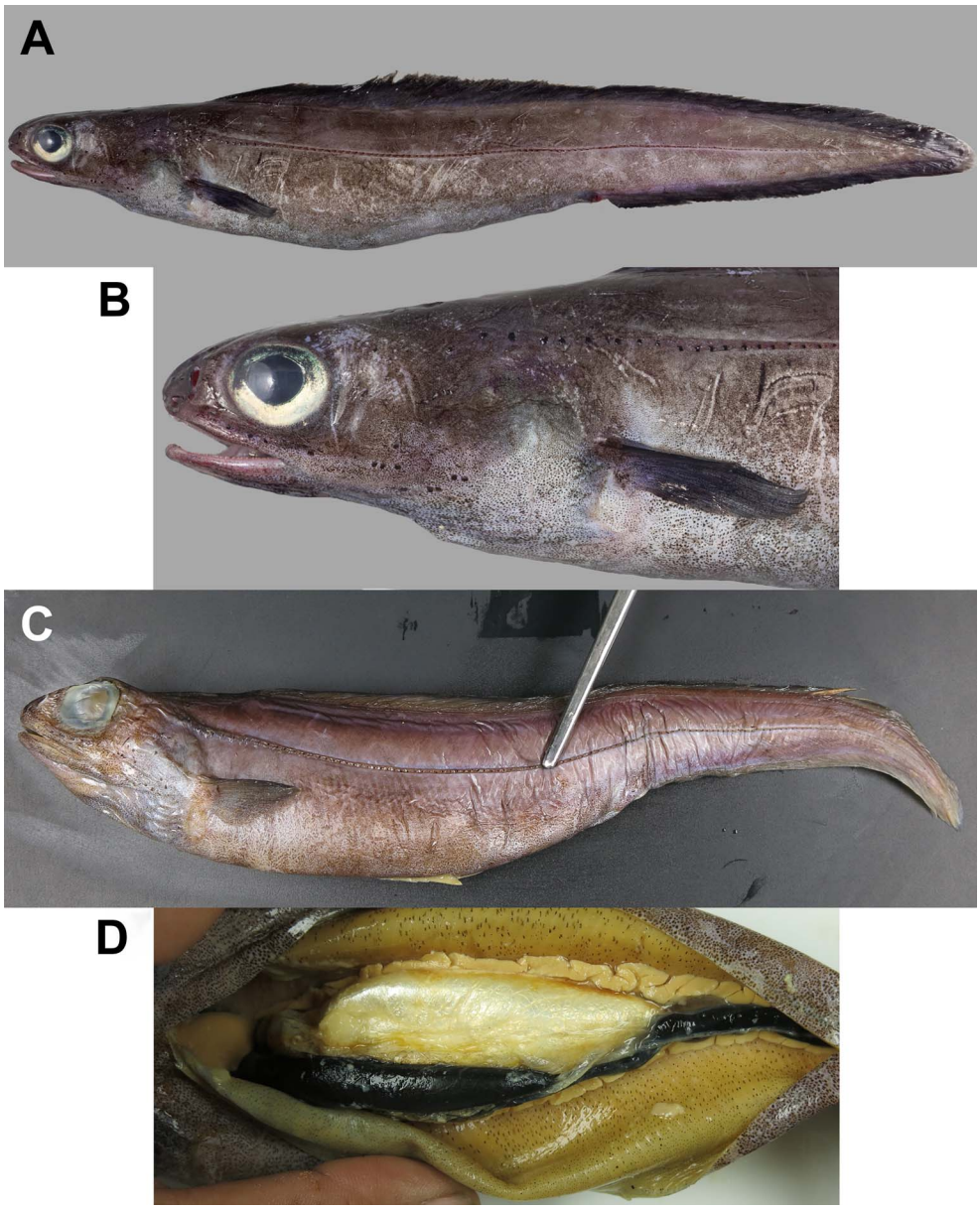

Fig. 9. *Coloconger raniceps*. (A–B) Fresh caught specimen from Tanzania, 270 mm TL. (A) Lateral view. (B) Lateral view of head. (C–D) MNHN 2016-0186, 336 mm TL, Mozambique, preserved. (C) Lateral view. (D) Abdominal cavity.

MNHN 2016-0186, 1, 336, F/V *Atalante*, sta. moz1_cp2, Mozambique, 869 m, 8 October 2014. Pacific Ocean: AMS I.44901-001, 1, 320, 31°04′40″S, 153°18′43″E, 31 Canyon, New South Wales, longline, 420–585 m, 7 September 2009; MNHN 2005-3344, 1, 192, R/V *Alis*, sta. cp2307, 16°38′02.4″S, 167°58′01.2″E, Vanuatu, 586–646 m, 14 November 2004; MNHN 2006-0189, 1, 187, R/V *Alis*, sta. cp2273, 8°56′06″S, 157°48′14.4″E, Solomon Islands, 732–839 m, 5 November 2004; MNHN 2014-0963, 1, 202, BOA 1, R/V *Alis*, 15°03′48.7″S, 166°53′49.1″E, Vanuatu, 441–568 m, 6 September 2005. South China Sea: MNHN 1998-0638, 1, 255, MUSORSTOM 2, R/V *Coriolis*, 13°39′00″N, 120°42′00″E, Luzon, Philippines, 550–520 m, 23 November 1980; MNHN 1998-0656, 1, 337, MUSORSTOM 2, R/V *Coriolis*, sta. 46cp4, 13°25′58.8″N, 122°16′58.5″E, Luzon, Philippines, 445–520 m, 26 November 1980; MNHN 1998-0669, 1, 158, MUSORSTOM 2, R/V *Coriolis*, sta. 78cp4, 13°49′01.2″N, 120°28′01.2″E, Lubang, Philippines, 441–550 m, 1 December 1980; MNHN 1998-0670, 1, 158, R/V *Coriolis*, sta. 79cp4, 13°45′00″N, 120°31′58.8″E, Luzon, Philippines, 682–770 m, 1 December 1908.

Provisional identification.—CAS 235482, 1, 384, 13°41′50.4″N, 120°40′30.0″E–13°41′20.4″N, 120°43′00.6″E, between Luzon and Mindoro Islands, otter trawl, 387.7–457.2 m, 29 May 2011.

Diagnosis.—Eye very large, 23.4–30.8% (mean 27.6%) HL; rictus reaches posterior margin of pupil; snout usually shorter than eye diameter; ST usually more than 5; dorsal-fin origin over anterior half of pectoral fin; single row of anterior intermaxillary teeth; maxillary teeth uniserial anteriorly, biserial posteriorly; lower jaw with 2 rows of teeth, those on inner row distinctly smaller than those in outer row; anterior portion of mouth cavity pale, with scattered black pigment present or absent; body uniformly brown to blackish; sensory tubes darkened.

Description.—Tables 3–5 provide complete morphometric and meristic data. Body rather short, greatest body depth 6.2–8.7 in TL. Dorsal-fin origin slightly behind a vertical through upper end of pectoral-fin base, over anterior half of pectoral fin, predorsal length 1.0–1.2 times HL, PO–DO 2.4–

Fig. 10. Post-metamorphic juvenile of *C. raniceps*, MNHN 2014-0963, 202 mm TL, Vanuatu. (A) Lateral view. (B) Lateral view of head.

32.6% (mean 18.5%) pectoral-fin length. Rictus reaches posterior margin of pupil; posterior margin of eye clearly behind the mouth gape. Trunk subequal to or longer than tail length, trunk length 0.9–1.3 times tail length. Snout length shorter than or about equal to eye diameter, SN/ED 0.6–1.0.

Dorsal-fin rays 206–221 (210 in syntype), anal-fin rays 105–126 (107), dorsal-fin rays before anal-fin origin 77–98 (89). Vertebrae: PDV 10–12 (11), PAV 73–79 (73), PHV 65–68 (65), CV 68–75 (68), TV 141–151 (141). Lateral-line pores: PPLL 3–7 (6), PDLL 5–9 (7), PALL 62–75 (67), TLL ca. 124–140 (ca. 134).

Head pores in syntype (MNHN 1890-0363): SO 11 (right)/10 (left), 1st–3rd at snout tip, 4th–5th above posterior nostril, 6th at interorbital space, 7th–11th (right)/7th–10th (left) on nape, 7th–8th and 10th–11th (right)/9th–10th (left) arranged in pairs. IO 15 (right)/13 (left), 1st (adnasal) and 2nd behind anterior nostril, 3rd–4th below posterior nostril, arranged in pair, 5th–8th below eye, 8th behind rictus, 5 (right)/3 (left) on cheek, and 2 behind eye. POM 14/14, 5 along lower jaw, the rest behind rictus, 8th–9th, 10th–11th, 12th–13th arranged in pairs. ST 6, arranged in 3 pairs (2 + 2+2).

In the non-types, there are 7–12 SO, pores on interorbital space and nape usually arranged in pairs; mostly 2 SO above posterior nostril, except for 1 specimen with 1 (right)/2 (left) and another specimen with 3/2 pores. IO 12–21, variable in numbers and arrangements among individuals, numbers on each side can be similar or up to 5 differences on both sides. POM 13–19, variable in number and arrangements among individuals, but usually similar on both sides of same individual. ST 3–10, usually 5 or more, with different compositions of pores: 4 + 2+4, 3 + 2+3, 3 + 2+2, 3 + 1+2, 2 + 3+3, 2 + 2+2, 2 + 1+2, 2 + 1+1, 1 + 1+2, and 1 + 1+1. However, there are usually 2 or 3 pores on each side and usually 2 in the middle.

Tooth pattern: premaxillary teeth present, 1 tooth on each outer corner in syntype, usually arranged in single row or 1–3 teeth on outer corner with small gap at middle; single row of 5–9 (5 in syntype) posterior intermaxillary teeth connecting the maxillary teeth. Upper jaw with single row of slightly larger teeth on anterior half, 2 irregular, closely spaced rows of small teeth on posterior half or only small portion at posterior end, those on outer row clearly smaller than those on inner row. Lower jaw with 2 regular, separated rows of teeth, gape at jaw symphysis, those in outer row clearly larger than those in inner row, which are mostly embedded within tissue; some individuals occasionally have 3 rows of teeth on posterior 1/4 of the lower jaw.

Coloration.—Body uniformly dark brown. The syntype is light brown due to long-term preservation. Sensory tubes on head and lateral line darkened. Anterior portion of mouth cavity pale; pharyngeal region dark blue; gill chamber blackish (faded in syntype with trace of pigments). Peritoneum pale with fine black dots. Stomach and intestine black. Swim bladder silvery white without any pigment. Gonads creamy white. Smaller individuals (including the syntype) have row of large black dots beneath skin on ventral midline of abdominal cavity (clearly seen from ventral view), which are faded in larger specimens.

Size.—Appears to be a moderately small species, attaining around 423 mm TL.

Distribution.—Known from Indian Ocean off South Africa, Madagascar, Réunion, India, Andaman Sea, and western Pacific Ocean off the Philippines, southeastern Australia, Vanuatu, Solomon Islands to southern Japan, the latter based on Kuronuma (1940). It appears to be more common in the Indian Ocean, whereas only scattered records are found in the western Pacific Ocean. Bathymetric range 180–971 m, based on specimens examined in present study.

Remarks.—*Coloconger raniceps* is one of two species with a pale mouth cavity (usually anterior portion), the other species being *C. saldanhai* which has most parts of the mouth cavity pale. Although this coloration is quite consistent, smaller individuals usually have larger pale areas, whereas the large adults retain the pale coloration mostly in the anterior area. Our observations agree with the description of Lloyd (1909). The relatively large eye is also a key character for this species; it extends well beyond the posterior end of rictus in all individuals.

Although previous authors diagnosed *C. raniceps* as having 3 pairs of pores on the supratemporal canal, we counted different combinations of pores (see above). Similar results

Table 4. Morphometric data of *Coloconger raniceps*, *C. saldanhai*, and *C. scholesi*. HT = holotype, ST = syntype, PT = paratype(s), NT = non-types.

	C. raniceps			*C. saldanhai*			*C. scholesi*	
		NT			HT+PT+NT		NT	
	ST	Mean (range)	SD	HT	Mean (range)	SD	Mean (range)	SD
TL (mm)	270	270–423 (n = 18)		275	204–294 (n = 6)		212–600 (n = 33)	
% TL								
HL	20.3	19.2 (17.7–20.4)	0.9	16.9	16.8 (16.0–18.0)	0.8	17.6 (16.3–19.3)	0.8
Predorsal length (PreD)	20.5	21.1 (19.4–23.5)	1.2	20.5	21.3 (19.4–24.8)	1.9	21.2 (18.8–23.0)	1.0
Preanal length	59.3	61.2 (57.4–64.6)	1.9	61.1	59.3 (58.2–61.1)	1.2	62.0 (57.0–65.2)	2.1
Trunk length	39.0	42.0 (38.5–45.4)	1.7	44.1	42.5 (40.1–44.3)	1.6	44.3 (38.6–47.6)	2.2
Tail length	40.7	38.8 (35.4–42.6)	1.9	38.9	40.7 (38.9–41.8)	1.2	38.0 (34.8–43.0)	2.1
PO–DO	0.2	1.8 (0.2–3.3)	0.9	3.5	4.4 (3.3–6.8)	1.2	3.6 (1.5–5.8)	0.9
Depth at GO	13.1	12.0 (9.6–14.6)	1.6	9.6	9.7 (9.1–10.9)	0.7	10.8 (7.6–13.9)	1.5
Width at GO	9.3	9.3 (7.3–12.1)	1.3	7.7	7.1 (5.9–8.5)	1.1	6.1 (3.0–10.4)	2.3
Depth at anus	10.4	9.9 (7.7–10.9)	1.0	8.1	8.7 (7.2–10.2)	1	9.7 (8.3–11.8)	1.0
Width at anus	4.1	4.3 (3.6–6.5)	0.8	3.6	3.5 (3–4.1)	0.4	3.8 (3.0–4.2)	0.3
deepest body	12.5	14.2 (11.5–16.2)	1.7	10.3	10.2 (9.7–10.9)	0.4	12.9 (9.4–16.6)	1.9
Pectoral-fin length (PF)	9.4	9.8 (7.6–11.3)	1.0	7.9	7.5 (6.1–8.4)	0.8	9.3 (7.8–10.7)	0.9
Pectoral-fin base	3.4	3.2 (2.8–3.6)	0.2	2.8	2.6 (2.4–3.1)	0.3	2.8 (1.8–3.5)	0.4
Snout length (SN)	3.9	4.7 (3.9–5.2)	0.4	4.4	4.2 (3.6–4.8)	0.4	4.3 (3.5–5.0)	0.4
Eye diameter (ED)	4.7	5.3 (4.7–6.0)	0.4	4.4	4.5 (4.3–5.2)	0.3	3.3 (2.7–4.0)	0.3
Interorbital width (IO)	5.3	5.2 (4.4–5.6)	0.5	4.2	4.4 (3.8–5.4)	0.7	4.6 (3.7–5.3)	0.5
Upper jaw	8.6	8.7 (7.8–9.3)	0.5	8.1	7.8 (6.8–8.6)	0.7	7.8 (6.5–9.1)	0.8
Lower jaw	7.9	8.1 (7.4–8.8)	0.4	7.2	7.5 (7.0–8.1)	0.4	7.7 (6.4–9.0)	0.8
Post-orbital length	11.8	10.2 (8.9–11.4)	0.8	7.9	8.7 (7.9–9.2)	3.6	10.7 (8.8–12.6)	0.8
Gill opening height	3.8	3.1 (2.2–3.8)	0.6	3.0	2.6 (1.9–3.2)	0.6	2.9 (2.0–3.6)	0.4
Interbranchial width	6.5	6.2 (4.8–8.2)	1.1	5.3	4.2 (3.4–5.3)	0.8	4.6 (3.7–6.5)	0.6
% HL								
PO–DO	1.1	9.6 (1.1–17.6)	4.4	20.8	26.1 (20.8–37.7)	6.2	20.7 (8.0–35.3)	5.8
Pectoral-fin length	46.6	51.1 (39.8–61.9)	5.6	46.4	44.5 (38.1–51.9)	4.8	52.9 (41.8–62.6)	5.4
Pectoral-fin base	16.6	16.6 (15.2–17.9)	0.8	16.3	15.5 (13.6–17.0)	1.1	15.8 (9.7–19.6)	2.2
Snout length	19.0	24.4 (19.0–27.4)	2.1	26.0	25.1 (21–26.6)	2.2	24.2 (19.7–27.9)	2.2
Eye diameter	23.4	27.6 (23.4–30.8)	2.0	26.2	26.9 (24.5–30.0)	1.8	18.9 (15.4–22.3)	1.9
Interorbital width	26.3	26.6 (23.4–28.9)	2.0	24.7	25.8 (22.4–30.2)	3.2	25.9 (20.3–31.3)	2.6
Upper jaw	42.4	44.8 (42.1–48.8)	2.0	47.6	46.3 (42.6–49.6)	2.6	44.2 (39.5–51.7)	3.2
Lower jaw	39.1	42.1 (39.1–46.1)	1.9	42.5	44.3 (42.0–47.0)	2	43.8 (38.0–51.1)	3.2
Post-orbital length	58.1	52.5 (46.1–58.5)	3.4	46.4	50.8 (46.4–53.1)	2.6	61.1 (53.4–68.9)	3.6
Gill opening height	18.8	16.3 (11.8–19.6)	2.9	17.6	15.6 (10.4–19.4)	3.8	16.6 (11.6–20.5)	2.4
Interbranchial width	32.0	32.2 (26.1–42.3)	5.3	31.5	24.9 (18.9–31.5)	5.6	26.3 (19.9–39.5)	4.2
Other proportions								
PO–DO/PF	2.4%	18.5 (2.4–32.6)%		54.3%	59.3 (44.9–90.9)%		39.4 (19.1–74.2)%	
Trunk/Tail	1.0	1.1 (0.9–1.3)		1.0	1.0 (1.0–1.1)		1.2 (0.9–1.4)	
Trunk/HL	1.9	2.2 (1.9–2.4)		2.4	2.5 (2.2–2.8)		2.5 (2.1–2.9)	
PreD/HL	1.0	1.1 (1.0–1.2)		1.3	1.3 (1.2–1.4)		1.2 (1.1–1.4)	
SN/ED	0.8	0.9 (0.6–1.0)		0.7	0.9 (0.7–1.1)		1.3 (0.9–1.7)	
IO/ED	1.1	1.0 (0.9–1.1)		0.7	1.0 (0.7–1.2)		1.4 (1.1–1.7)	

are also mentioned by Karrer (1983). However, the total ST are usually 5–8, which can be a good character to separate this species from its congeners, which usually have 3 ST, if a combination of characters is used.

Some small individuals, MNHN 1998-0670 (158 mm TL), MNHN 1987-1240 (177 mm TL), and MNHN 1979-0048 (2, 180–217 mm TL), are probably recently post-metamorphic, with a laterally compressed but not deep body. They have gill chambers and most portions of mouth cavity (anterior half of roof, entire tongue and floor) pale; the pharyngeal region is dark blue. There is a row of large black dots beneath the skin on the ventral midline of the abdominal cavity; these dots are relatively few and loose in arrangement. The body is light brown with sensory tubes, and cirri on the head and lateral line darkened.

One individual (CAS 235482, 384 mm TL) is provisionally identified as this species, with a pale mouth roof and a large eye. However, this specimen has a single anterior intermaxillary tooth, a distinctly paler abdominal region, and most of the mouth cavity is pale. These differences may lead to a different species when more specimens are available.

Table 5. Meristic data of three species of *Coloconger*. HT = holotype, NT = non-types, PT = paratypes, ST = syntype. Data in parentheses are exceptional values.

	C. raniceps		*C. saldanhai*		*C. scholesi*
	ST	NT ($n = 18$)	HT	PT+NT ($n = 4$)	NT ($n = 51$)
Vertebrae					
PDV	11	10–12	13	13–14	13–19
PAV	73	73–79	72	72–74	80–88
PHV	65	65–68	68	69–71	72–89
CV	68	68–75	72	70–73	67–74
TV	141	141–151	144	143–147	151–157 (164–165)
Fin rays					
Dorsal-fin rays	210	206–221	206	210–224	203–241
Anal-fin rays	107	105–126	128	119–123	98–116
Dorsal-fin rays before AFO	89	77–98	86	88–99	78–108
Lateral-line pores					
PPLL	6	3–7	4	3–4	3–7
PDLL	7	5–9	8	8–9	6–11
PALL	67	62–75	72	65–72	70–80
TLL	ca. 134	124–140	ca. 145	142–145	141–150
Head pores					
SO	11;10	7–12	8;8	7–10	6–11
IO	15;13	12–21	13;12	11–12	12–26
POM	14;14	13–19	14;14	14–16	11–20
ST	2 + 2+2	4–8 (rarely 3 or 10)	1 + 2+1	3–4	2–5
Pores over PAN	2;2	2 (rarely 1 or 3)	2;2	1–2	1–2
Total	46;43	37–58	39;38	35–41	38–57

Comments on historical records.—The most commonly recorded species in the literature is *C. raniceps*. Kuronuma (1940) documented a specimen of *C. raniceps* with a large eye (5.3% TL and 27.7% HL) and the rictus reaching posterior margin of pupil (based on drawing). However, the author also mentioned that his specimen has no anterior intermaxillary teeth and is unlikely to be this species but another species. We were unable to examine it and could not verify the identification; the location of the voucher is unknown.

Castle (1968) provided a reconstructed drawing of *C. raniceps*. Although his drawing has the rictus reaching the posterior margin of pupil, it has a longer snout than the eye diameter, which does not accurately depict the condition in *C. raniceps*.

Karrer (1983) described *C. raniceps* in detail. We examined all her specimens and confirmed the identification to be consistent with the syntype examined. Karrer (1983) mentioned that "there are 61–68 abdominal vertebrae (specimen SMF 2118 has only 59); only three specimens are not mutilated and probably have 83–87 caudal vertebrae, or 149–155 vertebrae in total; the caudal vertebrae begin well anterior to the anus." The "abdominal vertebrae" are clearly the prehaemal vertebrae of this study, of which we counted 65–68 ($n = 8$). However, we counted 141–151 ($n = 8$) total vertebrae, which overlap but are slightly fewer than those counted by Karrer (1983).

Karrer (1983) mentioned, "the 350 mm specimen MNHN 1979-0049 is a female with already ripe eggs; the ovaries completely fill the general cavity in the large specimens of the Valdivia; the 360 mm specimen is a male showing narrow, barely wrinkled testes," which may suggest this is a species that matures at a relatively small size. The largest individual examined in the present study is 423 mm TL, smaller than that of most congeners.

Quéro (2001) stated in the key that *C. raniceps* has "No premaxillary fangs," presumably referring to the anterior intermaxillary teeth; however, all specimens we examined have at least a few teeth to one complete row of teeth in that region. It is also possible that Quéro (2001) simply meant that there are no large caniniform teeth in that region.

Coloconger saldanhai Quéro, 2001

Figures 1A, 11; Tables 3–5

Coloconger saldanhai Quéro, 2001: 57, figs. 2–4 (Type locality: Grande Terre, New Caledonia, 18°58.00′S, 163°10.50′E, 580 m; holotype MNHN 1995-0402). Ho et al., 2021: 280 (comparison).

Material Examined

Holotype.—MNHN 1995-0402, 283, MUSORSTOM 4, F/V *Vauban*, sta. cc202, 18°58′1.2″S, 163°10′58.8″E, New Caledonia, Coral Sea, 580 m, 20 September 1985.

Paratypes.—MNHN 1998-0597, 3, 270–292 mm TL, collected with holotype.

Non-type material.—AMS I.32433-005, 1, 294, 10°29′49″S, 144°01′23″E, Papua Plateau, east of tip of Cape York, Queensland, beam trawl, 596–603 m, 20 August 1992; MNHN 2014-1087, 1, 204, CONCALIS, R/V *Alis*, sta. CP3029, 20°17′15″S, 163°49′40.2″E, New Caledonia, Coral Sea, 652–900 m, 10 May 2008.

Diagnosis.—Band of 3 or 4 rows of teeth on posterior half of upper jaw; sensory tubes same color as body color, not darkened; gill chamber uniformly pale, with tiny melanophores

Fig. 11. *Coloconger saldanhai*, preserved. (A) MNHN 1998-0597, paratype, 292 mm TL, New Caledonia. (B–D) MNHN 2014-1087, post-metamorphic juvenile, 204 mm TL, New Caledonia. (B) Lateral view. (C) Lateral view of head. (D) Lateral view of posterior portion of tail showing the black patch.

present; anterior intermaxillary teeth present, uniserial; eye about equal to or slightly larger than snout length; rictus reaches vertical through posterior margin of pupil; body light in color, dorsal-fin base slightly darker; large black pigment patch on rear portion of tail, but not overlapping with caudal fin; pectoral fin small, 6.1–8.4% TL.

Description.—Tables 3–5 provide complete morphometric and meristic data. Body relatively long, greatest body depth 9.7–10.9 in TL. Dorsal-fin origin behind a vertical through upper end of pectoral-fin base, predorsal length 1.2–1.4 times HL, over middle of pectoral fin, PO–DO 44.9–90.9% (mean 59.3%) pectoral-fin length. Rictus reaches posterior margin of eye. Trunk equal to or slightly longer than tail length, trunk length 1.0–1.1 times tail length. Snout length shorter than or equal to eye diameter, SN/ED 0.7–1.1.

Dorsal-fin rays 206–224, anal-fin rays 119–128, dorsal-fin rays before anal-fin origin 88–99. Vertebrae: PDV 13–14, PAV 72–74, PHV 68–71, CV 70–73, TV 143–147. Lateral-line pores: PPLL 3–4, PDLL 8–9, PALL 65–72, TLL 142–145.

Head pores (based on holotype) 39 (right)/38 (left) in total. SO pores 8, 3 on snout tip, 4th–5th above posterior nostril, 6th above eye, 7th and 8th on nape; IO 13/12, 2 behind anterior nostril, 5 along upper jaw, 4th–5th and 6th–7th arranged in pairs, 7th slightly behind the rictus, 4 on cheek, 8th–10th or 8th–9th close to each other, and 2 behind the eye, one at middle and one at dorsoposterior corner of eye. POM 14/14, 6/7 along lower jaw, the rest behind rictus, 10th–11th and 12th–13th arranged in pairs, respectively. ST 4, 1 on each side and 2 arranged in pair at middle.

The other five specimens have 7–10 SO, of which 5 have 2 on both sides over posterior nostril and one has 1 on right side and 2 on left side; 3 specimens have 11–12 IO, 14–16 POM and $1+1+1$ or $1+1+2$ ST, in similar arrangement as holotype. It is notable that AMS I.32433-005 has 17 IO on both sides and $4+2+4$ ST, which is higher than the other individuals.

Tooth pattern: anterior intermaxillary teeth 5–7 (5 in holotype) arranged in single row; posterior intermaxillary teeth single row of 5–6 (5) teeth, connecting the maxillary teeth. Single row of slightly larger teeth on anterior half of upper jaw, gradually becoming 3–4 (4) rows of smaller teeth on posterior half. Lower jaw with 2 well-defined rows of teeth on the anterior half, those of outer row slightly larger than those on inner row in size, whereas on the posterior half, those on inner row equal to or slightly larger than those on outer row.

Coloration.—Body covered with scattered pigment, denser on dorsal half than lower half. Most of body light brown on upper half. Base of dorsal fin covered with dense pigment under skin, forming a darker stripe along fin base. A patch of scattered pepper-like dots on rear end of tail overlapping the dorsal- and anal-fin base, but not caudal fin. Anterior half of mouth roof pale, becoming dark gray in upper pharyngeal region; tongue pale; lower pharyngeal region gray; floor pale, with some gray pigment on posterior region. Gill chamber mostly pale, with middle slightly blackish. Gill rakers pale or slightly gray.

Specimen in AMS I.32433-005 is an adult male with denser pigment on body than the other specimens, especially the underside of head and abdomen; lateral-line tubes light brown, similar to that of dorsal surface of body; and black patch on tail relatively small and about 1 snout length before caudal-fin base.

Size.—Appears to be a small species; the largest specimen examined is AMS I.32433-005, 294 mm TL, a mature male with large testes.

Fig. 12. Fresh coloration of *Coloconger scholesi*. (A) CSIRO H 6577-02, 343 mm SL, Western Australia. (B) CSIRO H 6396-06, 503 mm TL, Western Australia.

Distribution.—Only known from the type locality and two additional specimens collected from northwestern New Caledonia and Papua Plateau off Queensland, Australia. It appears to be rare, as frequent trawls were made in the region, but only a few individuals were found in the collection. Bathymetric range 580–900 m, but the only specimen from deeper than 600 m was collected in a depth range of 650–900 m, so it likely has a narrow preferred depth range.

Remarks.—*Coloconger saldanhai* is quite distinct among its congeners in body coloration and tooth pattern, and overall appearance, which is more similar to *Ariosoma* or *Congriscus* at first sight. The pectoral fin is smallest among congeners, and results in the dorsal-fin origin being predominantly located above the posterior half of the pectoral fin.

MNHN 2014-1087 is a post-metamorphic juvenile with a ribbon-like body, rather compressed and deep. A row of large black dots is present beneath the skin of ventral midline of abdominal cavity, and another row of large dots along ventral midline of peritoneum, which is also visible from ventral surface of abdominal cavity. This specimen has all head and lateral-line pores (tubes), teeth, and the patch of pigments on rear end of tail well developed.

***Coloconger scholesi* Chan, 1967**

Figures 1B, 12–14; Tables 3–5

Coloconger scholesi Chan, 1967: 99, figs. 1–14 (Type locality: South China Sea, about 270 miles north of Kuching, Sarawak state, Borneo, East Malaysia, 6°1.8′N, 109°57.4′E, 450–456 fathoms [823–834 m]; holotype BMNH 1966.8.2.1). Castle, 1969: 6. Karrer, 1983: 41 (description). Castle, 1986: 163 (description). Smith, 1989: 417 (mentioned). Smith, 1999: 1670 (listed). Smith in Randall and Lim, 2000: 586 (listed). Quéro, 2001: 54 (description; key). Ho et al., 2021: 280 (comparison).

Coloconger japonicus Machida, 1984. Shao et al., 2008: 239 (listed). Ho et al., 2015: 143 (listed). Ho et al., 2021: 280 (comparison).

Material Examined

Paratype.—USNM 200650, 1, 410, R/V *Cape St. Mary*, 6.03°N, 109.96°E, South China Sea, Agassiz trawl, 823–834 m, 5 November 1964.

Non-type material.—Pacific Ocean: AMS I.17316-004, 1, 247, F/R/V *Kapala*, 33°41′S, 152°56′E, off Sydney, New South Wales, otter trawl, 810–813 m, 7 December 1972; AMS I.17858-005, 2, 395–625, F/R/V *Kapala*, 33°43′S, 151°55′E, off Sydney, New South Wales, 677 m, 19 October 1972; AMS I.17867-006, 1, 265, F/R/V *Kapala*, 33°41′S, 151°57′E, off Sydney, New South Wales, otter trawl, 720–731 m, 9 November 1972; AMS I.18838-001, 2, 258–265, F/R/V *Kapala*, 33°02′S, 152°31′E, off Newcastle, New South Wales, 20 m otter trawl, 450–457 m, 18 August 1975; AMS I.19859-004, 13, 232–305, F/R/V *Kapala*, 33°30′S, 152°05′E, off Sydney, New South Wales, prawn trawl, 822–825 m, 21 December 1976; AMS I.19860-001, 3, 247–352, F/R/V *Kapala*, 33°35′S, 152°01′E, east of Broken Bay, New South Wales, prawn trawl, 822–825 m, 20 December 1976; AMS I.20452-024, 5, 260–285, F/R/V *Kapala*, 33°32′S,152°00′E, off Broken Bay, New South Wales, 20-m Otter Trawl, 823 m, 19 August 1975; AMS I.20477-001, 3, 310–416, F/R/V *Kapala*, 33°11′S, 152°24′E, southeast of Newcastle, New South Wales, bottom trawl, 732 m, 7 December 1977; AMS I.20484-007, 1, 274, F/R/V *Kapala*, 34°31′S, 151°20′E, east of Wollongong, New South Wales, bottom trawl, 714 m, 21 November 1977; AMS I.20485-001, 1, 285, F/R/V *Kapala*, 33°40′S, 151°56′E, southeast of Broken Bay, New South Wales, bottom trawl, 713–731 m, 6 December 1977; AMS I.20967-012, 2, 245–402, 17°56′S, 147°14′E, east of Hinchinbrook Is., Queensland, 9-m prawn trawl, 822–878 m, 27 February 1979; AMS I.24037-015, 3, 260–293, F/R/V *Kapala*, 33°47′S, 151°55′E, east of Sydney, New South Wales, prawn trawl, 822 m, 7 December 1978; AMS I.26245-010, 3, 253–479, 33°41′S, 152°00′E, northeast of Port Jackson, New South Wales, demersal prawn trawl with dredge attached, 819–889 m, 11 February 1986; AMS I.32432-001, 2, 430–465, 18°07′46″S, 147°30′04″E, Coral Sea, east of Magnetic Passage, Queensland, beam trawl, 925–932 m, 25 August 1988; CSIRO H 1559-01, 1, 400, CSIRO H 1559-02, 1, 472, CSIRO H 1559-03, 1, 465, F/R/V *Soela*, 22°56′24″S, 154°24′42″E, south of Saumarez Reef, Saumarez Plateau, Queensland, lobster trawl, 678–695 m, 18 November 1985; CSIRO H 1560-01, 1, 600, CSIRO H 1560-02, 1, 510, F/R/V *Soela*, 16°55′54″S, 151°34′36″E, west of Lihou Reef and Cays, Queensland Plateau, Queensland, lobster trawl, 880 m, 6 December 1985; CSIRO H 1561-01, 1, 478, CSIRO H 1561-02, 1, 452, CSIRO H 1561-03, 1, 465, CSIRO H 1561-04, 1, 326, F/R/V *Soela*, 19°00′42″S, 150°41′12″E, northeast of Whitsunday Island group, Marian Plateau, Queensland, demersal

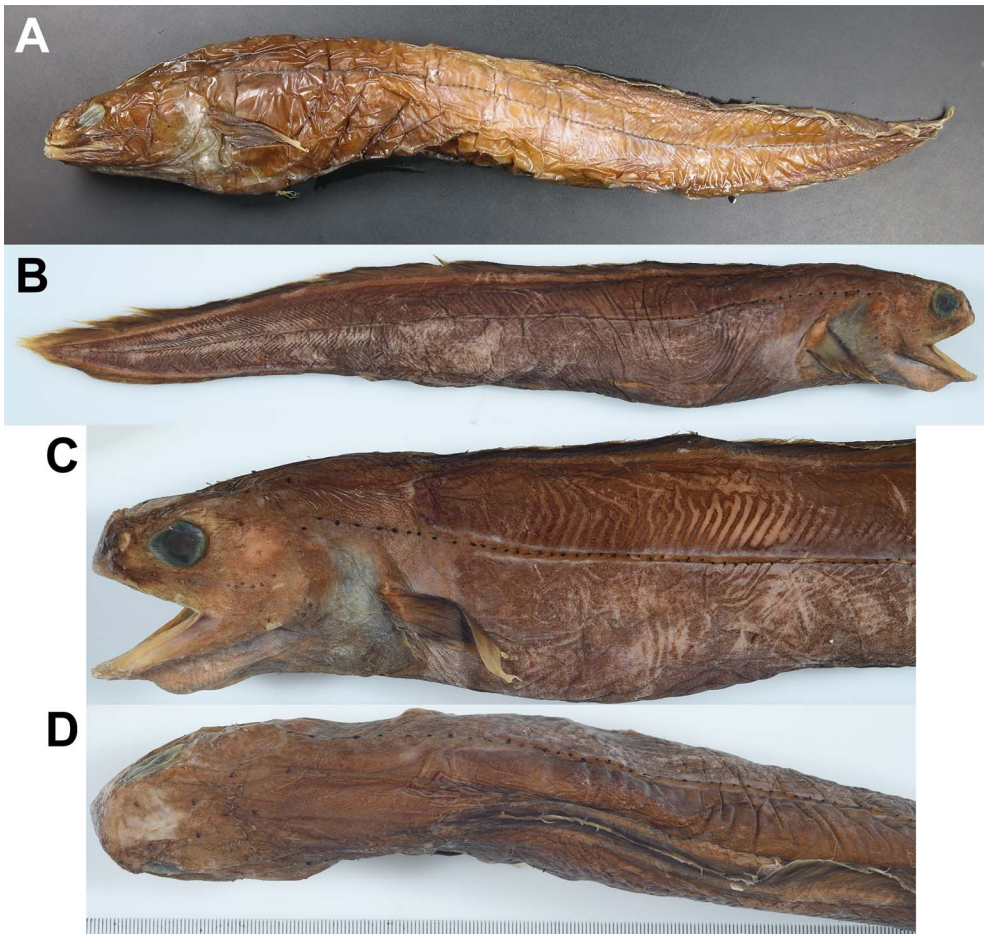

Fig. 13. Preserved coloration of *Coloconger scholesi*. (A) MNHN 1979-0054, 445 mm TL, Madagascar. (B–D) CSIRO H 1561-03, 465 mm TL, Queensland. (D) Dorsal view, anterior to left.

trawl, 752–751 m, 24 November 1985; MNHN 1995-0385, 1, MUSORSTOM 5, R/V *Coriolis*, sta. cp324, 21°15′00″S, 157°51′00″E, Chesterfield Islands, 970 m, 14 October 1986; MNHN 1995-0394, 2, 205–230, MUSORSTOM 5, R/V *Coriolis*, sta. cp367, 19°36′00″S, 158°52′58.8″E, Chesterfield Islands, 830–855 m, 19 October 1986; MNHN 1995-0408, 1, MUSORSTOM 5, R/V *Coriolis*, sta. cp384, 19°42′00″S, 158°49′58.8″E, Chesterfield Islands, 756–772 m, 21 October 1986; MNHN 1995-0411, 1, 535, MUSORSTOM 5, R/V *Coriolis*, sta. cp363, 19°48′00″S, 158°43′58.8″E, Chesterfield Islands, 586–700 m, 19 October 1986; MNHN 1995-0637, 1, 508, MUSORSTOM 7, R/V *Alis*, sta. cp565, 11°46′58.8″S, 178°25′01.2″W, Wallis and Futuna, 900 m, 20 May 1992; MNHN 2009-1430, 1, damaged, BOA 1, R/V *Alis*, sta. cp2432, 15°01′25.2″S, 166°53′45.6″E, Vanuatu, 630–705 m, 8 September 2005. South China Sea: ASIZ P 63790, 1, 492, R/V *Ocean Researcher I*, sta. CD193, 22°22′12.0″N, 120°06′36.0″E, Pingtung, southwestern Taiwan, South China Sea, 441 m, 29 August 2002; ASIZ P 64256, 1, 348, R/V *Ocean Researcher I*, sta. CD139, 22°13′12.0″N, 120°20′24.0″E, Pingtung, southwestern Taiwan, South China Sea, 821 m, 23 November 2001; MNHN 2005-0487, 1, 230, MUSORSTOM 3, R/V *Coriolis*, sta. cp106, 16°22′01.2″N, 120°18′00″E, Luzon, Philippines, 2 June 1985; NMMB-P 34023, 1, 435, Dong-sha Island, Taiwan, ca. 20°39′N, 117°05′E, commercial bottom trawl, ca. 500 m, 23 January 2019. Eastern Indian Ocean: AMS I.22809-018, 3, 212–287, F/R/V *Soela*, 18°40′S, 116°42′E, Northwest Shelf, 250 km northwest of Port Hedland, Western Australia, Engel trawl, 584–592 m, 4 April 1982; AMS I.22810-016, 3, 318–542, AMS I.22816-017, 3, 200–280, F/R/V *Soela*, 18°40′S, 116°30′E, Northwest Shelf, 250 km northwest of Port Hedland, Western Australia, Engel trawl, 694–736 m, 5 April 1982; CSIRO H 2562-03, 1, 563, F/R/V *Southern Surveyor*, 24°30′12″S, 111°50′54″E, west of Quobba Point, Western Australia, demersal trawl, 892–905 m, 28 January 1991; CSIRO H 3145-15, 1, 237.7, CSIRO H 3145-16, 6, 190–225, CSIRO H 3145-17, 1, 248.7, F/V *Surefire*, 17°52′S, 118°16′E, Rowley Shoals area, southwest of Imperieuse Reef, Western Australia, prawn trawl, 550 m, 22 February 1992; CSIRO H 6391-04, 1, 368.5, F/R/V *Southern Surveyor*, 22°03′34.2″S, 113°43′44.4″E, west of Exmouth Gulf, Western Australia, beam trawl, 658–754 m, 10 December 2005; CSIRO H 6396-06, 1, 503, F/R/V *Southern Surveyor*, 22°00′13.8″S, 113°40′44.4″E, west of Exmouth Gulf, Western Australia, beam trawl, 983–1010 m, 10 December 2005; CSIRO H 6411-18, 1, 490+, tail tip missing, F/V *Congasa*, 18°23′23.4″S, 116°47′27.6″E, southwest of Rowley Shoals, Western Australia, demersal trawl, 985–1043 m, 24 May 2006; CSIRO H 6428-09, 1, 286, CSIRO H 6428-10, 1, 300, F/V *Congasa*, 18°00′22.2″S, 118°06′59.4″E, southwest of Rowley Shoals, Western Australia, demersal trawl, 614–535 m, 20 May 2006; CSIRO H 6577-02, 1, 343, F/R/V *Southern Surveyor*, 14°36′43.2″S, 121°19′05.4″E, northwest of Cape Leveque, Western Australia, demersal trawl, 714–697 m, 27 June 2007. Western Indian Ocean: AMS I.28133-001, 2, R/V *Vityaz* II, 25°13′54″S, 35°32′06″E, Mozambique Channel, shrimp trawl, 980–1000 m, 25 November 1988; CAS 66593, 1, 382,

Fig. 14. Post-metamorphic juveniles of *Coloconger scholesi*. (A) MNHN 2014-1252, 241 mm TL, Madagascar. (B) MNHN 1979-0053, 248 mm TL, Madagascar.

R/V *Vitayz*, 25°13′54″S, 35°32′06″E–25°18′S, 35°27′30″E, off Mozambique, 980–1000 m, 2 May 1989; MNHN 1979-0051, 1, ca.530, MNHN 1979-0052, 1, 340, F/V *Vauban*, sta. ch035, 12°49′04.8″S, 48°56′09.6″E, northern Madagascar, 760–810 m, 14 September 1972; MNHN 1979-0053, 2, 248–332, F/V *Vauban*, sta. ch092, 21°26′02.4″S, 43°10′58.8″E, western Madagascar, 810–1020 m, 26 November 1973; MNHN 1979-0054, 2, 390–445, F/V *Vauban*, sta. ch102, 22°20′02.4″S, 42°58′58.8″E, western Madagascar, 810–1020 m, 26 November 1973; MNHN 1979-0055, 1, 510, F/V *Vauban*, sta. ch113, 22°19′01.2″S, 42°59′06″E, western Madagascar, 990–1010 m, 1 December 1973; MNHN 1979-0056, 3, 447–490, F/V *Vauban*, sta. ch124, 17°40′01.2″S, 43°12′00″E, western Madagascar, 1075–1115 m, 15 January 1975; MNHN 1987-1234, 1, 250, FAO 60, sta. 73/095, 25°19′01.2″S, 47°13′01.2″E, southern Madagascar, 600–620 m, 14 August 1973; MNHN 1987-1235, 1, 258, FAO 60, sta. 73/104, 18°46′01.2″S, 43°51′00″E, southern Madagascar, 600–620 m, 14 August 1973; MNHN 1989-0742, 1, 315, R/V *Alis*, sta. radiale 2, 04°21′00″S, 56°19′01.2″E, Seychelles, 600 m, October 1987; MNHN 1998-0601, 1, 281, FAO 60, sta. 73/095, 25°19′01.2″S, 47°13′01.2″E, southern Madagascar, 600–620 m, 14 August 1973; MNHN 2004-2474, 1, 488, MNHN 2004-2475, 1, 550, July 2002, Reunion, no other data; MNHN 2014-1149, 1, 496, R/V *Miriky*, sta. cp3251, 15°23′09.6″S, 45°57′45″E, northwestern Madagascar, 609–620 m, 8 July 2009; MNHN 2014-1252, 3, 241–310, R/V *Miriky*, sta. cp3268, 15°31′50.4″S, 45°43′20.4″E, northwestern Madagascar, 640–800 m, 11 July 2009; MNHN 2014-1708, 1, 341, R/V *Miriky*, sta. cp3278, 15°22′19.2″S, 45°57′10.2″E, northwestern Madagascar, 750–780 m, 12 July 2009; MNHN 2016-0142, 1, 356, F/V *Atalante*, sta. moz_cp3, Mozambique, 971 m, 10 August 2014; MNHN 2016-0160, 1, 270, MNHN 2016-0163, 1, 245, MNHN 2016-0164, 1, 333, F/V *Atalante*, sta. moz1_cp4, Mozambique, 806 m, 9 October 2014; MNHN 2016-0187, 1, 460+, sat. moz1_cp2, Mozambique, 869 m, perch trawl, 8 October 2014.

Tentatively identified specimens.—AMS I.19860-024, 1, 253, F/R/V *Kapala*, 33°35′S, 152°01′E, east of Broken Bay, New South Wales, prawn trawl, 822–825 m, 20 December 1976; AMS I.26245-018, 1, 236, 33°41′S, 152°00′E, northeast of Port Jackson, New South Wales, demersal prawn trawl with dredge attached, 819–889 m, 11 February 1986; AMS I.29747-007, 1, 212, F/R/V *Kapala*, 32°49′S, 152°47′E, east of Nelson Bay, New South Wales, prawn trawl, 840–935 m, 3 December 1988; CSIRO CA 3990, 1, 237, CSIRO CA 3991, 1, 357, F/R/V *Soela*, 33°43′S, 152°13′E, east of Sydney, New South Wales, demersal trawl, 900 m, 14 April 1981; CSIRO H 1558-01, 1, 235.5, F/R/V *Soela*, 16°55.90′S, 151°34.60′E, west of Lihou Reef and Cays, Queensland Plateau, Queensland, lobster trawl, 880 m, 6 December 1985.

Diagnosis.—Eye distinctly small, 15.4–22.3% HL; no intermaxillary teeth; mouth roof dark blue; snout slightly longer than eye diameter; dorsal-fin origin well behind pectoral-fin base.

Description.—Tables 3–5 provide complete morphometric and meristic data. Body moderately short, greatest body depth 6.6–10.7 in TL. Dorsal-fin origin well behind a vertical through upper end of pectoral-fin base, predorsal length 1.1–1.4 times HL, over anterior half to middle of pectoral fin, PO–DO 19.1–74.2% TL (mean 39.4% TL) pectoral-fin length. Rictus reaches posterior margin of eye or slightly beyond. Trunk subequal to or longer than tail length, trunk length 0.9–1.4 (mean 1.2) times tail length. Snout length typically greater than eye diameter, SN/ED 0.9–1.7 (mean 1.3; 2.0 in holotype in original description).

Dorsal-fin rays 203–241, anal-fin rays 98–116, dorsal-fin rays before anal-fin origin 78–108. Vertebrae: PDV 13–19, PAV 80–88, PHV 72–89, CV 67–74, TV 151–157 (two with 164–165). Lateral-line pores: PPLL 3–7, PDLL 6–11, PALL 70–80, TLL 141–150.

Head pores (based on MNHN 2016-0187): SO 8/8, 3 at tip of snout, 4th–5th above posterior nostril, 6th on interorbital space, 7th and 8th on nape. IO 17/17, 1st and 2nd behind anterior nostril, 6/7 pores along upper jaw, 3rd below space between eye and posterior nostril, 4th–5th in pair, 5 on cheek, 4 pores behind eye, in 2 pairs. POM 14/14, 6 along

lower jaw, 8 behind rictus, 8th–9th, 10th–11th, and 12th–13th arranged in pairs, respectively. ST 3, 1 on each side and one in middle.

Tooth pattern: no anterior intermaxillary teeth; single row of posterior intermaxillary teeth, connecting the uniformly single row of maxillary teeth. Lower jaw teeth in 2 regular rows, those of inner row clearly smaller and situated distinctly lower than those of outer row, mostly embedded within tissue.

Coloration.—Body uniformly dark brown. Sensory tubes on head and lateral line darkened. Mouth cavity mostly dark blue, except for small pale region on anterior portion of roof; tongue dark blue dorsally and paler ventrally; pharyngeal region and gill chamber dark blue to blackish. Peritoneum pale with fine black dots. Stomach and intestine black. Swim bladder silvery white without any pigment. Gonads creamy white. Smaller individuals light yellow to light brown, with 2 irregular rows of black dots beneath skin along ventral margin of abdominal cavity (clearly seen from ventral view), which are faded or covered by dark skin in larger specimens.

Size.—Appears to be a moderately large species, attaining 600 mm TL.

Distribution.—Widespread in Indo-west Pacific Ocean, from Indian Ocean off Mozambique, Madagascar, and Australia (Western Australia); South China Sea off Taiwan and the Philippines; and western Pacific Ocean off Australia (New South Wales and Queensland), Chesterfield Islands, Solomon Islands, Wallis and Futuna, Vanuatu, and possibly southern Japan (if *C. japonicus* considered a junior synonym). Bathymetric range 441–1,115 m.

Remarks.—Karrer (1983) examined one of the paratypes (BMNH 1966.8.2.2, 360 mm) and 11 non-type specimens. Karrer (1983) gave the following diagnostic characters (originally written in French): snout markedly larger than the eye diameter, oral commissure below the posterior margin of eye, single row of premaxillary teeth, single transverse row in the middle of the premaxillae (i.e., no anterior intermaxillary teeth) and a single maxillary row, and usually 3 supratemporal pores. She also reported it is relatively easy to distinguish *C. raniceps* from the other species of the genus, *C. scholesi*, living in the same area: the latter has an eye diameter smaller than the snout and the interorbital space, a postorbital space clearly greater than half of the head length, and a single row of premaxillary teeth.

Our examination of specimens collected from the Indo-west Pacific Ocean agrees well with Karrer's (1983) diagnoses. Although overlapping slightly, the specimens of *C. scholesi* have a smaller eye diameter (15.4–22.3% HL, mean 18.9%) that is clearly smaller than the snout length (19.7–27.9% HL, mean 24.2%) and the interorbital space (20.3–31.3% HL, mean 25.9%); the postorbital length (53.4–68.9% HL, mean 61.1%) is larger than that of *C. raniceps* (46.1–58.5% HL, mean 52.5%).

Many small specimens (<250 mm TL) are clearly metamorphic or post-metamorphic leptocephali with a ribbon-like and rather compressed body. The bodies are light brown in color. There are 2 irregular rows of black dots beneath the skin along the ventral margin of abdominal cavity. These dots are relatively small, irregular in shape, and more numerous compared to metamorphic leptocephali of other species. This may be a useful character to distinguish leptocephali of the species. Two other specimens (MNHN 1995-0394, 205–230 mm TL) from the Chesterfield Islands with a more or less rounded trunk also have 1–2 similar irregular dots along the midline of the abdominal cavity (beneath skin), which may indicate recent metamorphosis. There are also 12 specimens (190–326 mm TL) examined in CSIRO possessing such dots; three of them are 286, 300, 326 mm TL, which may suggest that this species undergoes metamorphosis at a relatively large size.

Ho et al. (2021) examined three specimens of *Coloconger japonicus* collected from the South China Sea. These specimens are reidentified as *C. scholesi* based on the small eye (16–19% HL), no anterior intermaxillary teeth, rictus reaching posterior margin of eye or slightly beyond, mouth cavity dark blue, and overlapping meristic counts. Further study may demonstrate these two species to be synonymous.

Ho et al. (2021) noticed that the composition of abdominal and caudal vertebrae in the type series of *C. japonicus* was possibly switched or likely the author counted the "abdominal vertebrae" as "precaudal vertebrae" (as in Karrer, 1983; =prehaemal vertebrae in this study), which is slightly fewer than the preanal vertebrae. Quéro (2001) appeared to adopt the original data in his key, but he misinterpreted the abdominal vertebrae as "preanal vertebrae," which resulted in large differences between *C. scholesi* and *C. japonicus* in his key. Examination of the type series of *C. japonicus* is necessary in order to understand its status. However, the whereabouts of the type series is unknown (H. Endo, pers. comm.) and thus not available for the present study.

A small number of specimens (see material examined above) are tentatively identified as this species (e.g., Fig. 15A–B) based on similar meristic and morphometric features; some of them were collected together with *C. scholesi*. However, the mouth cavities of these specimens are mostly pale without pigment. This could be a result of being juvenile specimens or being in formalin for an extended period (e.g., CSIRO CA 3990 and CSIRO CA 3991 are largely devoid of any pigmentation), but it is possible that they may represent an unknown species when more specimens become available.

DISCUSSION

Karrer (1983) provided a detailed description of *C. raniceps* and observations on the western Indian Ocean population of *C. scholesi*. She was probably the first taxonomist to provide a number of useful diagnostic characters to distinguish the two species, such as presence or absence of the anterior intermaxillary teeth, the tooth pattern on the jaws, the eye size, the position of the oral commissure (rictus), and the width of the post-ocular (=postorbital) space. In addition, she also discussed the intraspecific variation in the head pores. The following observations are either based on Karrer's (1983) observations or our own examination.

Head pores (tubes).—According to previous authors (e.g., Kanazawa, 1957, 1961; Chan, 1967; Machida, 1984), the number and arrangement of head pores are important characters to separate species. However, large variation in these

Fig. 15. *Coloconger* cf. *scholesi*, post-metamorphic juvenile. (A) CSIRO H 1558-01, 235.5 mm TL, Queensland. (B) Ventral view of abdominal margin showing pigmentation.

characteristics were reported by Karrer (1983) and Smith (1989) and confirmed in our observations herein. Table 3 provides the frequencies of different head pore series of all six species examined in the present study.

There are 6–12 SO, generally 7 or 8, in all species. In some cases, there are occasionally additional pore(s) accompanying the regular pores, and in some species, the pores on the interorbital and nape are arranged in pairs. Of these pores, there are always 1 or 2 pores above the posterior nostrils. Some are more consistent than others, whereas there are occasionally 1 pore on one side and 2 on the other in the same individual. *Coloconger cadenati* and *C. meadi* have about the same ratio of individuals with 1, 1 and 2, and 2 pores; *C. maculatus* has 2 pores in the only specimen, the holotype; *C. paucitubus* usually has 2 pores, but some individuals have only 1 pore, and one exceptional case has 5; *C. raniceps* has mostly 2 pores over the posterior nostril, with only a few exceptions that have 1 or rarely 3 pores on one side and 2 pores on the other; *C. saldanhai* has 2 pores in general, with one exception that has 1 pore on one side and 2 on the other; and *C. scholesi* have more with 2 pores than 1.

There are 8–26 IO in all species. The number of IO is highly variable among individuals of the same species and among species. There are usually 8–10 IO in *C. paucitubus*, although some individuals may have 11 or 12, and the pores do not tend to be in pairs. The other species generally have more pores, ranging from 9 up to 26, which tend to form pairs or groups.

There are 10–21 POM in all species, usually 5–8 along the lower jaw and various numbers behind the rictus. There are consistently 10–13 pores in *C. paucitubus*, except for a few individuals that have 15 or 18 on one side, the pores do not tend to be in pairs. The congeners have mostly 14 or more pores, with some commonly forming pairs or groups.

Previous authors recognized the number of ST as a diagnostic character, mainly 3 or 6 (arranged in 3 pairs) pores (Kanazawa, 1957, 1961), but Karrer (1983) argued that the number of ST is variable. In our study, there are consistently 3 ST in *C. cadenati*, *C. meadi*, and *C. paucitubus*; 4 in the holotype of *C. maculatus* (pair at middle); and mostly 3 and occasionally 4 (pair at middle) in *C. scholesi* and *C. saldanhai*. However, *C. raniceps* has a wide range of 3–8 ST, usually more than 4, and the arrangements vary among individuals, usually 2 or 3 pores on each side and 2 in the middle. Among all congeners, some individuals may have 1 or 2 additional pores in front of the middle pore, whereas some may have 4 or 5 pores in a line which are not arranged in three regular parts. These are not counted as ST.

The total number of head pores is highly variable, widely ranging from 27 to 58. There are mostly 30–34 pores in *C. paucitubus*, whereas the congeners tend to have more than 37 pores (a few exceptions may be present). Among congeners, *C. maculatus* has 37 or 39 ($n = 1$) pores and *C. saldanhai* has 35–41 ($n = 6$, with one exception which has 48/50); both have relatively few pores compared with their congeners.

Rictus (mouth gape).—Previous authors (e.g., Chan, 1967; Machida, 1984; Quéro, 2001; Ho et al., 2021) separated the species by rictus either reaching the posterior margin of the eye or pupil in different species. However, this character is not always consistent among the congeners. *Coloconger maculatus*, *C. raniceps*, and *C. saldanhai* have the rictus consistently below the posterior margin of the pupil, whereas *C. scholesi* has the rictus consistently below posterior margin of eye or occasionally beyond. The posterior reach of the rictus in *C. paucitubus* is slightly variable, usually reaching beyond posterior margin of pupil, quite close to posterior margin of eye, but sometimes not reaching posterior margin of pupil. In *C. cadenati*, the rictus tends to reach the posterior margin of eye, whereas in *C. meadi* it tends to reach posterior margin of pupil.

Intermaxillary teeth.—Previous authors (Karrer, 1983; Smith, 1989; Ho et al., 2021) had noticed either the presence or absence of anterior intermaxillary teeth and row(s) of posterior intermaxillary teeth connecting the maxillary teeth (as vomerine teeth in Alcock, 1889). Ho et al. (2021) mentioned that their specimens of '*C. japonicus*' do not have any trace of anterior intermaxillary teeth but do have a single row of teeth connecting the maxillary teeth. In this study, we found that at least two species do not have anterior intermaxillary teeth, *C. paucitubus* and *C. scholesi*. Without examining the types of *C. japonicus*, we are not able to verify the relationship of that species with *C. scholesi*, but if there are no anterior intermaxillary teeth in the type of *C. japonicus*, it is very likely a synonym of *C. scholesi*. *Coloconger cadenati* usually has 2 or 3 rows of teeth on anterior and 2 rows on posterior intermaxillary regions.

Kuronuma (1940) mentioned that their only specimen of *C. raniceps* has no premaxillary teeth. We are not able to verify their identification without examining the only voucher, whose whereabouts are unknown. However, based on the size of the eye and his drawing, it is likely they have identified the specimen correctly.

It should be mentioned that there are only one to few teeth present in the anterior intermaxillary portion in some individuals of *C. raniceps*. We also found a single example of *C. scholesi* that has one tooth in that region, whereas all the others have no trace of teeth.

Jaw teeth.—The arrangements of teeth on the jaw are slightly variable. There are consistently 2 or 3 closed rows of maxillary teeth (not forming a band) in *C. cadenati*, uniserial

anteriorly, and 2 or 3 rows of teeth posteriorly in *C. meadi* and *C. raniceps*; uniserial anteriorly, gradually becoming a relatively broad band of 3–4 rows of small teeth posteriorly in maxilla in *C. saldanhai*, and uniformly a single row of maxillary teeth in *C. maculatus* and *C. paucitubus*.

There are 2 complete rows of teeth on the lower jaw in *C. maculatus*, *C. paucitubus*, *C. raniceps*, and *C. scholesi*, with those in the inner row much smaller, shorter, and mostly embedded within tissue. There are consistently 3 closed rows of teeth on lower jaw in *C. cadenati* and mostly two regular rows of teeth, except for some 2–3 rows of small teeth posteriorly, in *C. meadi*. There are 2 rows of teeth on lower jaw of *C. saldanhai*; those teeth on anterior half of outer row are slightly larger than those on inner row, gradually becoming smaller than those on the inner row on the posterior half.

Eye size.—*Coloconger maculatus*, *C. raniceps*, and *C. saldanhai* have relatively large eyes, 4.5% TL or 28.7% HL in *C. maculatus*, 4.7–6.0% TL or 23.4–30.8% HL in *C. raniceps*, and 4.3–5.2 TL or 24.5–30.0% HL in *C. saldanhai*, whereas *C. scholesi* has the smallest eye among the congeners, 2.7–4.0% TL or 15.4–22.3% HL. *Coloconger paucitubus* has a moderately large eye, which is similar to that of *C. cadenati* and slightly smaller than that of *C. meadi* (Tables 1, 4).

Snout length versus eye diameter.—Although previous authors (e.g., Chan, 1967; Machida, 1984; Quéro, 2001; Ho et al., 2021) provided the relative snout length (SN) vs. eye diameter (ED) as a diagnostic character (e.g., SN > ED or SN < ED), we found that this character is variable, also sometimes subjective due to preservation condition. *Coloconger cadenati* was diagnosed as SN equal to ED, and we measured SN/ED 0.8–1.1 which is consistent. *Coloconger maculatus*, *C. meadi*, *C. raniceps*, and *C. saldanhai* were diagnosed by having SN < ED; however, we measured the SN/ED 0.9–1.0 in *C. meadi*, 0.6–1.0 in *C. raniceps*, and 0.7–1.1 in *C. saldanhai*. The only example with mostly SN > ED as a relatively consistent character is *C. scholesi* (also *C. japonicus*) which has SN/ED 0.9–1.7 (mean 1.3). *Coloconger paucitubus* has SN subequal to or longer than ED, with SN/ED ratio being 0.9–1.4.

Dorsal-fin origin.—The dorsal-fin origin is relatively anterior in *C. cadenati*, *C. meadi*, *C. maculatus*, and *C. raniceps*, whereas it is more posterior in *C. paucitubus*, *C. saldanhai*, and *C. scholesi* (and *C. japonicus*). As a result, there are 13–18 PDV in *C. paucitubus*, 13–14 in *C. saldanhai*, and 13–19 *C. scholesi*, reflected by the relatively posterior dorsal-fin origin, whereas there are 11–17 (mainly 13–15) in *C. meadi*, and 10–14 (usually 11 or 12) predorsal vertebrae in the other species.

Pectoral-fin length.—The pectoral fin is relatively short in *C. saldanhai* (6.1–8.4% TL, mean 7.5% TL), whereas the other species have mean values of pectoral-fin length from 8.8% TL to 9.8% TL.

Postorbital space.—Although previous authors (e.g., Karrer, 1983) mentioned that *C. raniceps* has a relatively small postorbital length, we found that *C. saldanhai* and *C. maculatus* have a smaller postorbital length, 7.9–9.2% TL (mean 8.7% TL) in *C. saldanhai* and 8.5% in *C. maculatus*, whereas the other species have mean values ranging from 9.8% TL to 11.3% TL, including *C. raniceps* (mean 10.2%).

Vertebral counts.—Although the number of total vertebrae are quite close among the congeners, *C. meadi* (147–163) and *C. scholesi* (151–157) have relatively more total vertebrae, whereas the other species have overlapping values ranging from 141 to 155. *Coloconger paucitubus* has a relatively low number of total vertebrae (141–148) but can be separated from most of the congeners based on other characters such as the low total head-pore counts.

It is also notable that two specimens identified as *C. scholesi* collected from the southern Indian Ocean have 164 and 165 total vertebrae, respectively, representing the highest numbers among all known congeners. It is possible that these two individuals may represent a new species or just regional variation. Nothing more can be said at this point.

The compositions of vertebral formulae are also similar among the congeners. However, *C. paucitubus*, *C. saldanhai*, and *C. scholesi* have relatively more PDV (13–19), reflected by the relatively posterior origin of the dorsal fin, whereas the other species have 10–14 (11–17 in *C. meadi*) PDV. There are relatively more PHV in *C. maculatus* (75), *C. paucitubus* (mainly 70–74, 2 with 66 and 68), and *C. scholesi* (72–89), whereas the other species have relatively few: 67–72 in *C. cadenati*, 65–68 in *C. raniceps*, 68–71 in *C. saldanhai*, and 69–72 in *C. meadi*.

Coloration.—The body color is generally dark gray, dark brown to uniformly black in adults. However, *C. saldanhai* exhibits a much paler body color with the base of the dorsal fin being dark blue (under the skin). *Coloconger maculatus* is bicolored, with the dorsal portion of the body brownish-gray and the abdominal region paler. These two species also have a large black blotch on the rear end of the tail, overlapping with the bases of the dorsal and anal fins, but not caudal fin, leaving the caudal fin translucent.

The sensory tubes are either entirely darkened or darkened distally in all congeners, except for *C. saldanhai*, which has these tubes colored the same as the body color. In large, mature individuals of other species (except for *C. maculatus*), pores on the anterior portion of the head may turn pale, which is distinct from the darkened body.

Mouth cavity and gill chamber.—The mouth cavity is typically dark blue on the roof, dark blue with broad pale margin on the tongue, and dark blue with a paler region on the floor in most species. Two species exhibit quite distinct coloration: *Coloconger raniceps* has the anterior half (or slightly smaller region) of mouth roof distinctly pale, and *C. saldanhai* has most of the roof pale, except for the pharyngeal region, which is dark blue. The mouth floor in these two species is generally pale, or slightly blackish in larger specimens. The gill chamber is always dark brown or dark blue in all congeners, except that of *C. saldanhai*, which is pale with scattered small dots, but dark in the inner region close to the pharyngeal region.

Morphology of Larvae

The information on larvae and transforming leptocephali of *Coloconger* is insufficient, and the larval form of *Coloconger* has never been identified. The related genus *Congriscus* has an unusually large and deep-bodied leptocephalus that was originally described under the name *Thalassenchelys* Castle

and Raju, 1975 (Kurogi et al., 2015; Chow et al., 2016). There is no evidence, however, that *Coloconger* has a similar larva.

Castle (1969: 7, text-fig. 2) described a metamorphic leptocephalus that he identified as *Coloconger raniceps*. The form of the head does indeed resemble *Coloconger*, although the number of myomeres (136) is lower than that of *C. raniceps* (141–151). The specimen, however, is too far advanced in development to show definitive larval characters. Castle (1967: 7, pl. 1, fig. 1) described another species of leptocephalus under the name *Ascomana eximia*, which has been suggested to be *Coloconger*. The approximately 700 mm TL holotype is beginning metamorphosis, however, and the form of the head is very different from *Coloconger*. Thus, the larval form of *Coloconger* remains unknown.

López et al. (2007) reported a genetic affinity between *Thalassenchelys* [=*Congriscus*] and *Coloconger* and suggested that the former might be the larval stage of the latter. However, they did not include *Congriscus* in their analysis. A subsequent analysis by da Silva et al. (2019) showed *Coloconger* in a related but distinct clade with *Congriscus*, *Nessorhamphus*, and *Derichthys*. The latter two genera have larvae that are very different from *Congriscus*, and there is no reason to assume that *Coloconger* would necessarily have a larva like *Congriscus*.

Adults of *Coloconger* occur on both sides of the Atlantic and appear to be relatively common, but nothing resembling *Congriscus* has ever been collected there. This is further evidence that *Coloconger* does not have a larval stage resembling *Congriscus*.

Metamorphic Leptocephali

One specimen, AMS I.29747-007 (212 mm TL), is clearly a metamorphic leptocephalus that has a well-developed head similar to that of adults and a ribbon-like, rather compressed body, with jaws, some part of skin, and tail tip damaged. It is identified as *C.* cf. *scholesi* based on the relatively small eye and relatively long snout, although the leptocephali of other species are unknown. The preanal length (~65.1% TL) is similar to those of adults. The head length is markedly small (~14.6% TL) and the body is not especially deep (deepest body ~14.6% TL). All fins are well developed, and positions of median-fin origins are similar to that of adults, except the caudal fin is missing. The pectoral fin is rather small, ~5.4% TL. The mouth cavity is uniformly pale without pigment. Dense light pigment covers the entire body, except it is absent from some areas of the head. It is notable that there are two irregular rows of large dots present on midline of abdominal cavity (beneath skin), as observed in juveniles; however, the rows end in a large cluster (somewhat fused) of dots around the anus, which is not observed in other specimens.

Castle (1969) documented a metamorphic leptocephalus of *C. raniceps* (221 mm TL, off southern India). The specimen has a rather posterior dorsal-fin origin, whereas all specimens examined by us have the dorsal-fin origin situated above the pectoral fin. However, its eye is clearly smaller than the snout length and there are two irregular rows of black dots on the ventral margin, which is more similar to *C. scholesi*, rather than *C. raniceps*.

Conclusions

We examined a large number of specimens deposited in fish collections around the world. Seven species of *Coloconger* are recognized: *C. cadenati*, *C. maculatus*, *C. meadi*, *C. raniceps*, *C. saldanhai*, *C. scholesi*, and a newly described species, *C. paucitubus*, leaving *C. japonicus* as an unresolved species. Detailed description and information, including variation and juvenile morphology, are provided for all species based on new data from the present study, except for *C. maculatus*, which is known only from the holotype. With the detailed taxonomy of Colocongridae, this work provides valuable information for developing knowledge of regional ichthyofauna and the global biodiversity information system.

DATA ACCESSIBILITY

AI STATEMENT

The authors declare that AI (ChatGPT) was used to correct the grammar of some sentences and paragraphs in the text. All text was written by the authors initially and reviewed by the authors before submission.

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