Journal of the
Ocean Science Foundation

2024, Volume 41

A new species of *Trimma* (Teleostei: Gobiidae) from the Seychelles, Indian Ocean

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Abstract

A new species of pygmygoby, *Trimma cavicapum*, is described from St. Francois Atoll, in the Alphonse Group of the outer islands of Seychelles, Indian Ocean. The new species was at first thought by the senior author to be the same as, or very close to, *T. dalerocheila*, a species which has an essentially red background coloration, and white/pale blue lines on the head and which has been recorded from the Seychelles. Two specimens obtained by the junior authors for COI analysis shows that the new species differs considerably in the DNA sequence of that gene, and closer examination of the morphology and color pattern revealed further differences. The live color pattern of this species is diagnostic, with a plain yellow or tan body with three bright blue stripes (one medial, two bilateral) on the head on a yellow to strongly pink/red background. It occurs in pairs or small groups, inhabiting crevices and/or caves on steep sloping reefs below 20 m, and has recently also been photographed at Astove Island.

Key words: taxonomy, ichthyology, bluestripe pygmygoby, coral-reef fishes, gobies, DNA barcoding

Citation: Winterbottom, R., Brighton, E. & Mason-Parker, C. (2024) A new species of *Trimma* (Teleostei: Gobiidae) from the Seychelles, Indian Ocean. *Journal of the Ocean Science Foundation*, 41, 37–45.

doi: https://doi.org/10.5281/zenodo.12594852

urn:lsid:zoobank.org:pub:224F9998-68FF-43C4-BD89-618616441F3B

Date of publication of this version of record: 18 July 2024

Introduction

Trimma Jordan & Seale, 1906 (type species: *Trimma caesiura* Jordan & Seale, 1906) currently contains 112 valid described species of these small (usually < 30 mm standard length [SL]), often colorful gobiids, primarily associated with Indo-Pacific coral reefs (Winterbottom 2019, Winterbottom et al. 2023). Members of the genus may be recognized by the lack of cephalic sensory-canal pores; a much reduced cephalic sensory papillae (free neuromasts) pattern; a wide gill opening extending anteriorly to below the vertical limb of the preopercle or, more usually, anterior to this; a lack of spicules (odontoids) on the outer gill rakers of the first gill arch; fewer than 12 dorsal and anal-fin rays; and a fifth pelvic-fin ray that is equal to or more than 40% the length of the fourth pelvic-fin ray (Winterbottom 2019).

Winterbottom (2011, citing unpublished morphological data) estimated that there were, at that time, about 35 known, but currently undescribed, species in the genus, for a total count in the vicinity of 110 species. However, recent research involving the cytochrome c oxidase I (COI) gene suggested that there may be a plethora of cryptic species that could double this number (Winterbottom et al. 2014, 2020), depending in part on whether one accepts a > 2% difference in the COI gene as representative of specific differentiation in these fishes, and whether any correlated morphological and/or color characters can be documented. (The 2% guideline as used in those studies is approximately equivalent to the more sophisticated RESL analysis used to distinguish haplogroup clusters that can subsequently be enumerated with Barcode Index Numbers or BINs, as suggested by Ratnasingham & Hebert (2013)). The second barcode study (Winterbottom et al. 2020), based on 849 samples of 87 of the 107 described valid species at that time, predicted some 192 haplogroups in the genus. Continued exploration of deep coral reefs, known as mesophotic coral ecosystems, or MCEs, i.e. tropical coral-reef habitat at depths below ca. 30 m (Pyle et al. 2019), has unveiled many previously unknown species, including three recently described species of *Trimma* (Wada et al. 2022, Winterbottom & Pyle 2022a, 2022b). A further complication is that species which appear to be identical in the field may prove to be distinct species when detailed forms of evidence are applied (see, e.g., Winterbottom 2016). Despite the plethora of recently described deep species, we describe here a new species from the relatively shallow waters of the Alphonse Group (Alphonse and St. Francois Atolls), lying 87 km south of the main Amirante Bank, in the outer islands of the Seychelles, Indian Ocean. The description is based on diagnostic morphological and color pattern differences and supported by a divergence in the sequence of the COI gene.

Materials and Methods

All specimens are deposited in the ROM (Royal Ontario Museum, Toronto, Ontario).

Methods of gathering data and the format of the descriptions follow Winterbottom (2016, and references cited therein). The sequence of characters presented in the Diagnosis follows the sequence of cascading characters from couplet 1 onwards in the key to the species of *Trimma* (Winterbottom 2019). Naming of the rows of cephalic sensory papillae follows Winterbottom (2011), as modified by Winterbottom et al. (2015). Lengths given are Standard Length (SL) in millimeters; values for the holotype are in bold and the mean and number of specimens from which data were recorded are given in parentheses where appropriate. Locality data are given in decimal degrees. Counts and measurements were input directly into an Excel file with Mitutoyo digital calipers using WinWedge 3.01™ software. Photographs of the head papillae were produced from multiple digital images taken with a Canon EOS Rebel XS camera attached to a Zeiss SV-12 dissecting microscope using Zeiss AxioVision 4.8™ software and automatic increments. The image stack was then collated into a single image using Helicon Focus 5.1™ (HeliconSoft) and edited in Adobe LightRoom 4™ and Adobe PhotoShop CS6™.

For the COI sequence analysis, we used the same primers and methodology as were used for the reanalyses of *Trimma* COI sequences by Winterbottom et al. (2020), viz. the universal COI primers LCO1490 and HCO2198 (Folmer et al. 1994).

Trimma cavicapum, n. sp.

Bluestripe Pygmygoby

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Figures 1–5

Holotype. ROM 114721, 20.7 mm SL female, Seychelles, Amirantes, Alphonse Group, about 1.7 km south of Bijoutier Islet at Saint Francois Atoll, -7.0836°, 52.7328°, reef slope, crevices containing a mix of red coralline algae, *Halimeda* sp., *Tubastrea coccinea*, sponges and ascidians, 22–28 m, clove oil, E. Brighton, 19 April 2023.

Paratypes. ROM 110174, 19.5 female; and two tissued specimens ROM T33012 and T33013; all collected with holotype. ROM 110170, 2 (15.7–16.0 mm), Seychelles, Alphonse Group, 'Theatre' dive site, SW of Bijoutier, St Francois Atoll, -7.0836°, 52.7328°, 27 m, E. Brighton, 17 February 2024.

Non-type material. Three tissued specimens ROM T11277 (13.8 mm SL), T11278 (10.8 mm SL) and T11279 (13.1 mm SL), Seychelles, Amirantes, Alphonse Group, reef slope, 15–20 m, C. Mason-Parker & E. Brighton, 11 March 2022 (these three tissued specimens failed to amplify).

Diagnosis. A species of *Trimma*, following dichotomous key sequence of Winterbottom (2019): no scales in predorsal midline; fifth pelvic-fin ray unbranched; 6 papillae in row c on cheek; at least some inner pectoral-fin rays branched; no red bars across body; an interorbital trench that fades out between fifth and sixth papillae of row p; and second spine of first dorsal fin extending posteriorly only to interspace between two fins. These characters, when applied in above sequence, lead to *T. maiandros* (couplet 95b, p. 45 in key), a species found from Cocos (Keeling) in eastern Indian Ocean eastward to Marshall Islands, and from Ryukyu Islands to Great Barrier Reef of Australia. In life, three blue stripes on head, one dorsal midline, second from top of orbit to near upper lip, and third across dorsal margin of preoperculum, lower part of iris, and across lips meeting counterpart at ventral midline; intervening area on head red dorsally grading to yellow and light purplish ventrally; body with many melanophores on a dirty yellow background. In preservative, blue lines on head are black.

Description. (based on holotype, 3 paratypes plus some values from two non-type specimens (10.8–20.7, 15.7, 6) Dorsal-fin elements VI + I,10–**11** (10.6, 5), second spine of first dorsal fin extending to interspace between two dorsal fins to base of first ray of second dorsal fin, third dorsal spine reaching posteriorly to interspace to base of spine of second dorsal fin, all rays of second dorsal fin branched except for first ray and posterior element of last ray, fin reaches posteriorly 50–**55**–57% (53.5%, 4) distance between base of last ray and first exposed dorsal procurrent caudal-fin ray; anal-fin elements I,10, first ray and posterior half of last ray unbranched, fin reaching posteriorly 40–**51**% (47.3%, 4) distance between base of last ray and first exposed ventral procurrent caudal-fin ray; pectoral-fin rays **17**–19 (17.8, 5), with **3** or 4 dorsal (3.8, 4) and 5–**7** ventral (6.0, 4) unbranched rays, and **7**–10 branched (8.0, 4) rays in central portion of fin, fin reaching posteriorly to vertical above urogenital papilla to anal-fin spine base; pelvic fin I,5, fifth ray unbranched and 60–**63**–70% (62.7%, 5) length of fourth ray,

Figure 1. *Trimma cavicapum*, freshly collected specimen, Alphonse Group, Seychelles (E. Brighton).

which reaches posteriorly to between bases of anal-fin spine and third anal-fin ray, pelvic-fin rays 1–4 with one sequential branch point; basal membrane represented by fold between pelvic-fin-spine bases; no frenum; caudal fin with two or three dorsal and three ventral segmented unbranched rays and 6 dorsal and 5 ventral segmented branched rays (2).

Scales in mid-lateral series 23, anterior transverse scales 9 (4), posterior transverse scales 8–9 (8.3, 4), cheek and opercle scaleless; predorsal midline without scales, wedge of primarily cycloid scales from above upper gill opening, grading anteriorly to a single row to about two scale-widths behind upper pupil in adults (ca. 20 mm SL), a 13.8 mm SL subadult with scales passing dorsally from end of opercular membrane to close to midline, then passing directly posteriorly to edge of first dorsal fin. Cycloid scales in three vertical rows on pectoral-fin base with two or three scales in innermost row, 4 in middle row and 5 in outer row, 6 scales in midline anterior to pelvic-fin base; between pelvic spine and ventral margin of pectoral-fin base; anterior few rows of scales in midline of belly; and anteriormost row of body scales beneath axil of pectoral-fin base. In smaller specimens (ca. 13 mm SL), primarily ctenoid scales pass directly dorsally from end of opercle to close to midline of nape, then pass directly posteriorly to lateral margin of first dorsal fin, leaving midline without scales. Body scales ctenoid. Circumpeduncular scales 12; scale rows in ventral midline between base of last anal-fin ray and first procurrent caudal-fin ray 8.

Upper jaw with outer row of spaced, slightly enlarged and curved canine teeth which decrease in size posteriorly and reach distally to bend of premaxilla, space between adjacent teeth about equal to canine height, an irregular inner row of smaller straight teeth reaching to distal tip of premaxilla. Lower jaw with outer row of about 5 or 6 similarly spaced, slightly enlarged and curved canines, about two irregular inner rows of smaller teeth, grading to single row at posterior tip of coronoid process of dentary. Tongue broadly rounded. Gill opening extending anteroventrally to below posterior one-third of pupil; gill rakers 2–**3**–4 + **12** = 14–**15**–16 (3.4 + 12.4 = 15.8, 5). Anterior naris a tube, reaching anteriorly to above upper lip, posterior opening pore-like with raised rim, separated from bony front of orbit by three times diameter of opening, nasal sac slightly raised. Bony interorbital width **39**–45% pupil diameter (41.4%, 5); interorbital trench with rather broad U-shaped profile with sloping sides (Fig. 2B); epaxialis musculature reaching anteriorly in midline to vertical above posterior portion of pupil; an incomplete dermal crest in midline of nape extending anteriorly from origin of first dorsal fin to about midway along predorsal region (Fig. 2B). Caudal peduncle depth as percentage of caudal peduncle length **42**–63 (53%, 4); head length as percentage of SL **29**–32 (30%, 4); horizontal eye diameter 37–**42** (40%, 4); snout length 25–**30** (27%, 4); cheek depth 23–**30**–32 (28%, 4), all percentage of head length. Abdominal/caudal vertebral transition type unknown, but probably type B.

Cephalic sensory papillae as in Fig. 2A & B.

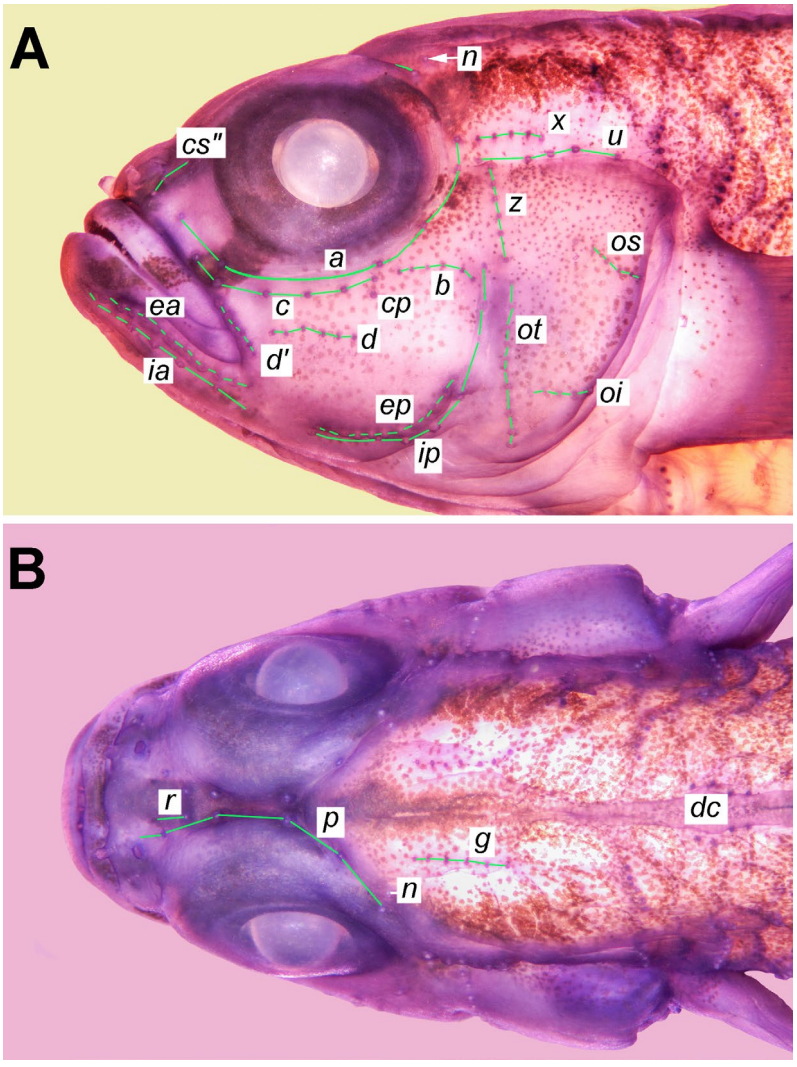

Figure 2. *Trimma cavicapum*, holotype, 20.7 mm SL female, ROM 114721. Left lateral (A) and dorsal (B) views of the head to show head papillae, specimen stained with cyanine blue, papillae in any given row connected by a thin green line; *dc* is dermal crest (photo and image collation: R. Winterbottom).

Number of papillae in each row: *a* = 6 (6); *b* = 4–**5**–6 (5.0, 4); *c* = 6 (6); *cp* = 1 (6); *d* = **6**–8 (6.6, 5); *d′* = 5–**6**–7 (6.2, 5); *e-anterior* = 11–**13** (12.2, 5); *e-posterior* = 10–**13**–14 (12.2, 5); *i-anterior* = 7–**8** (7.8, 4); *i-posterior* = 7–**8** (7.8, 4); *p* = 6 (5); *r* = 2 (5); *f* = 3 (5); *cs”* = 3 (5); *g* = 6 (4); *n* = 1 (4); *x* = 5–**6** (5.4, 4); *u* = 5 (4); *z* = 5–**6** (5.5, 4); *ot* = 12–**13** (12.5, 4); *os* = 5–**6**–7 (6.0, 4); *oi* = 4–**5**–6 (5.0, 4).

Color pattern live. (based on several images from the Alphonse Group, two reproduced here as Fig. 3) Body brownish-yellow to dull orange, head with more pink and yellow suffusions. Head with a median, central, blue stripe about one-quarter pupil width from anterior part of nape to upper lip, stripe may be laterally expanded between orbits; two similar, but bilateral, blue stripes, first from anterior nape over top of iris to upper lip or just posterior to this, second stripe along dorsal margin of opercle, lower iris, to join in midline just behind lower lip; elongate median blue streaks in ventral midline in gular region. Bases of dorsal and anal fins with half-

Figure 3. *Trimma cavicapum*, live specimens underwater, not collected, Alphonse Group, Seychelles, March 2022 (C. Mason-Parker).

pupil width dark stripe, with dull yellow spots on shafts of fin rays in second dorsal fin just above dark line, rest of median fin membranes hyaline, as are pectoral and pelvic-fin membranes. Middle portion of iris brown with numerous melanophores.

Color pattern freshly collected. (Fig. 1) Similar to live coloration (Fig. 3), but orange and yellow less distinct and lateral stripes on head almost black. Pectoral and caudal fins essentially hyaline, color of other fins present but patterns not discernable.

Color pattern preserved. (Fig. 4) All blues, yellows, and reds lost. Body uniform straw-yellow, with many melanophores with diffuse margins in no particular pattern on anterior portion of body (Fig. 4), gradually fewer posteriorly, belly pale. Head with less dense melanophores, particularly on cheek, area above opercle and pectoral-fin base; blue lines on head appear black; lower stripe tapering and poorly developed posterior to orbit, with pigment not visible on posterior two-thirds of iris; middle stripe narrower on snout, widening out posterior to orbit, with no pigment visible on iris; median stripe broader on snout, widening again as it passes orbit, then narrowing to half its width in predorsal region, both median and middle stripe ending at a vertical with posterodorsal edge of opercle; gular midline with two slightly elongate black blotches, posterior blotch flanked laterally by a pair of short stripes over dentary to joint of lower jaw. Membranes of both dorsal and anal fins heavily invested with melanophores with darker basal line in both fins; pelvic and caudal-fin membranes also pigmented but more lightly; pectoral-fin membrane hyaline.

Etymology. The name "cavicapum" is proposed as an arbitrary combination of letters derived from the Latin for blue (*caerulus*), stripe (*virgatus*) and head (*caput*), i.e. cavicapum (pronounced 'cavi' + 'cap' + 'um'). The suggested common name is bluestripe pygmygoby. The specific epithet is treated as a noun in apposition.

Distribution and habitat. Positively recorded from the Alphonse Group of atolls, the southernmost islands in the Amirante chain, separated from the main Amirante ridge by 87 km of deep ocean (>1000 m). Recently, it has also been photographed at Astove Island, 645 km to the southwest (the photograph was verified by the second author, Fig. 5).

Figure 4. *Trimma cavicapum*, preserved paratype, 19.5 mm SL female, ROM 110174; left lateral view of body midsection showing melanophore shapes, sizes, and distribution, Alphonse Group, Seychelles (R. Winterbottom).

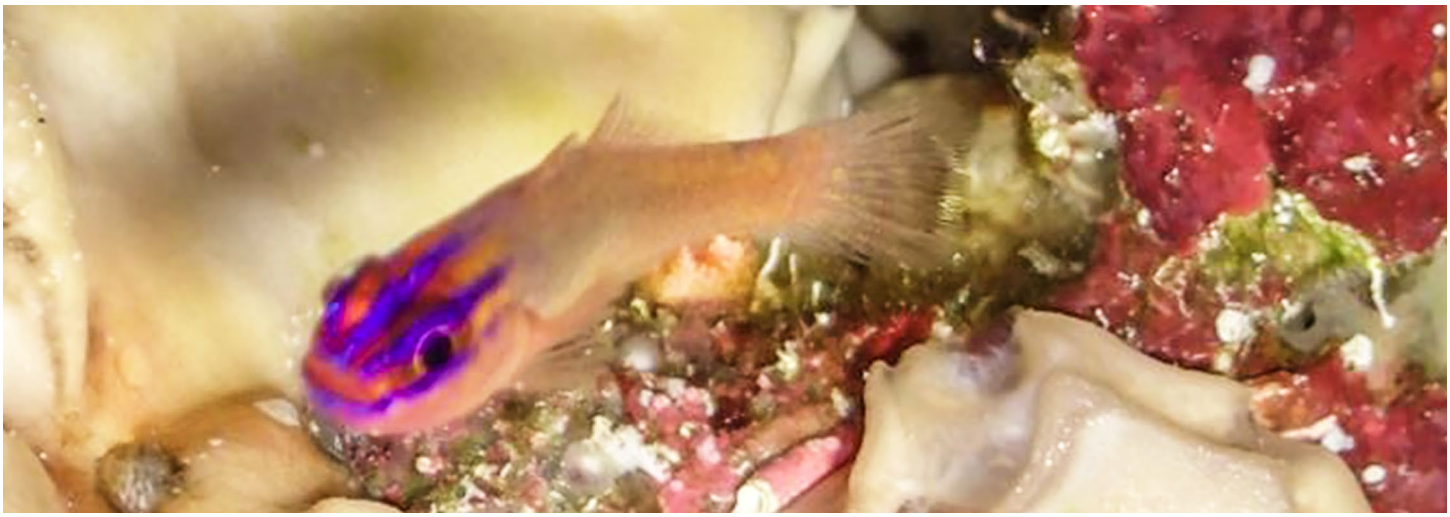

Figure 5. *Trimma cavicapum*, underwater, not collected, Astove Atoll, Seychelles, February 2024 (J. Karhu).

All sightings suggest the species inhabits crevices and caves in steep sloping reefs deeper than 18–20m. The species has only been seen in such steep-sloping, coral-rich habitats on outer reefs facing open ocean; the species was not observed during exploration of similar depth ranges around the same atolls in areas with different bathymetry and substrate type (very little coral, dominated by rock and algae, with gradual slopes). The species has not been observed farther north in the Amirante Islands.

Comparisons. This species keys out to couplet 95b, *Trimma maiandros* Hoese et al. 2011, in Winterbottom (2019), and both have a considerable amount of bright blue pigment on the head when alive (also on the body in the latter). The new species has, in the key sequence, no scales in or overlapping the predorsal midline (to couplet 82), an unbranched fifth pelvic-fin ray (to 83), the cheek with 6 papillae in row *c* (to 90), at least some pectoral-fin rays branched (to 92), the body without red bars or half-bars in life or patterned melanophores in preservative (to 94), the posterior interorbital trough poorly developed, ending before the last papilla of row *p* (to 95), and the second spine of the first dorsal fin reaching at most to the first ray of the second dorsal fin, plus the caudal peduncle without saddles (= *T. maiandros*, at 95b). The new species differs from *T. maiandros* in having 11 dorsal-fin rays (vs. 8 or 9, 1 in 300 specimens with 10), 10 anal-fin rays (vs. 8), 7–10 branched pectoral-fin rays (vs. none to 5), fifth pelvic-fin ray 60–70% length of fourth ray (vs. 25–50%), and significantly in color pattern, with blue confined to a total of 5 head stripes in the new species (vs. no blue stripes but a ring around the eye and a series of inverted Y-shaped blue saddles on the body with yellow or orange-yellow interspaces in *T. maiandros*).

The other species in couplet (95), *Trimma bisella* Winterbottom, 2000, has a much longer second dorsal-fin spine (to or beyond middle of second dorsal fin when adpressed); 4 narrow red bars on the head (at the front of the eye, over the cheek, along the vertical limb of the preopercle, and at the end of the opercle, with the latter two reaching the dorsal midline); a pupil-width, white, dorsal saddle at the end of the caudal peduncle; and is currently only know from Mauritius (couplet 95a). In addition, it has no trace of any blue on the head. No tissues of *T. bisella* are available for COI analysis.

The senior author initially felt that the new species might be a color morph of *Trimma dalerocheila* Winterbottom, 1984. Although that species does occur in Seychelles, *T. dalerocheila* has a bright red head with white, rather than blue, stripes in life; a single branch in the fifth pelvic-fin ray (vs. unbranched); and usually fewer branched rays in the pectoral fin (4–8 vs. 7–10). In addition, *T. dalerocheila* comes out in Block 18 (vs. Block 9) of Winterbottom et al.'s (2020) analysis of the COI gene (Fig. 6 and see below).

Discussion. *Trimma cavicapum* was seen in pairs or small groups in crevices and caves on steep, sloping outer reefs below 20 m. The benthos in the crevices was usually a mix of red coralline algae, *Halimeda* sp., sponges, *Tubastrea coccinea* and ascidians. Individuals were observed displaying 'hovering' behavior, alternating between resting on the substrate and rising 15–20 cm above the reef, always returning to the initial starting position. This behavior is common among the sedentary (vs. schooling) species of the genus. The new species has currently been observed at only three atolls in the southern outer islands of the Seychelles: at Alphonse Atoll (three sites) and St Francois atoll (one site) where most of the sightings have occurred at a dive site called the 'Theatre'. The species

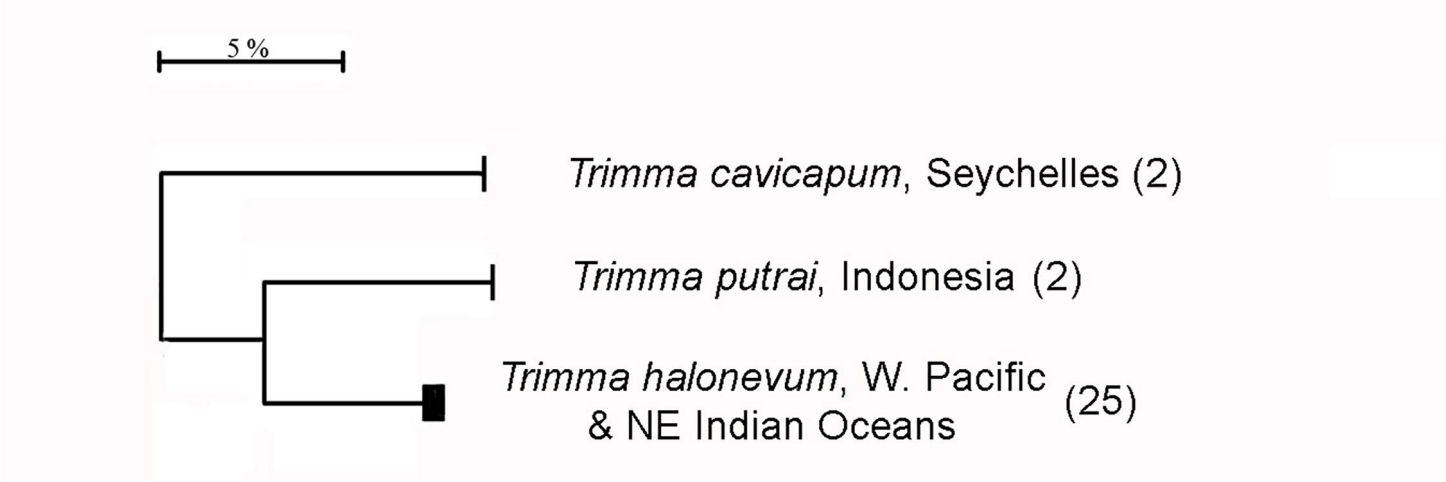

Figure 6. A Neighbour-Joining analysis based on the barcode mtDNA COI sequences of the species included in Block 9, following nomenclature of Winterbottom et al. (2020). The bar width represents 5% nucleotide substitutions; the width of the vertical end bars represents the approximate percentage of intragroup variation; the number in brackets behind the species name represents the number of specimens included in the analysis.

has also been observed and photographed at Astove Island on the western reef where the bathymetry is a very steep, sloping 'wall' dominated by scleractinian corals and calcareous algae (see under "Distribution").

No specimens of the new species were identified as males using the shape of the external genitalia. Dissections were not performed to try and sex the specimens by that method.

The partial COI gene sequences of the two representatives of *T. cavicapum* differ considerably from their 'closest' phenetic partners, *Trimma halonevum* Winterbottom, 2000 and *Trimma putrai* Winterbottom et al., 2019, with a minimum interspecific distance of about 18% of the base pairs (Fig. 6). *Trimma halonevum* (n = 25, intraspecific distance = 1.6%) and *T. putrai* (n = 2, intraspecific distance = 0.2%) are separated by a minimum distance of 10.8% (Winterbottom et al. 2020; Block 9). The former has been recorded from the Maldives through to Japan, the Philippines, and the Solomon Islands; the latter species seems confined to the deep reefs of Bali, Flores, Raja Ampat, and Timor Leste (Winterbottom 2019).

Two haplogroups of *T. maiandros*, from Palau and Samoa, were placed into their own group (Block 25) but differ by 6.7% (Winterbottom et al., 2020). No other species were included in that block. No morphological differences were noted between the two haplogroups. *Trimma maiandros* is widely distributed in the western Pacific and into the eastern part of the Indian Ocean, at Cocos Keeling Islands, eastward to Samoa and the Marshall and Mariana Islands, north to Japan, and south to the Great Barrier Reef, Australia.

Acknowledgments

The species was first recorded as part of the SeyCCAT BGF5 project '*Rapid Assessment of Fish Biodiversity in Shallow Water Habitats (<40m) of the Alphonse group, Outer Islands, Seychelles*', a collaboration between the Alphonse Foundation, the Marine Conservation Society Seychelles, Blue Safari Seychelles, and the Island Conservation Society. The project benefited from the financial support of the Seychelles Conservation and Climate Adaptation Trust (SeyCCAT). We thank the Ministry of Agriculture, Climate Change, and Environment (MACCE) of the Republic of Seychelles for permission to export and describe the *Trimma* specimens, and to Julio Karhu for permission to reproduce his photo of the new species from Astove Atoll (Fig. 5).

RW expresses many thanks to Marg Zur (ROM), who gathered comparative data from a wide range of *Trimma* species for over 30 years, thus providing an invaluable comparative resource. A big "thank you" to Nathan Lutjan (ROM, Department of Ichthyology) and his students for doggedly, and successfully, elucidating the COI sequences of two specimens of the new species, and to Jayme Sones and Paul Hebert (Guelph University, Biodiversity Institute of Ontario) for uploading the COI files to BOLD. The first author's research and fieldwork on Indo-Pacific reef and mangrove fishes over the last 45 years has been financially supported by the ROM Foundation, the ROM's Department of Natural History, and an NSERC Discovery Grant (7619)—his deep gratitude to these agencies. The manuscript was reviewed by Gerald R. Allen and Mark V. Erdmann.

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