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A new species of *Trimma* (Teleostei: Gobiidae) from the deep reefs of Vanuatu, western Pacific Ocean

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Abstract

A new species of pygmygoby, *Trimma citrum*, is described from a single male specimen from deep reefs (116 m, 380 feet) on the west coast of Tutuba Island, which is located at the southeast tip of Espiritu Santo Island, Vanuatu in the western Pacific Ocean. The new species is characterized by a scaled predorsal midline, the fifth pelvic-fin ray with one dichotomous branch point, unbranched pectoral-fin rays, the bony interorbital 41% pupil width, more than a single posterodorsal row of cheek scales, and 6 papillae in cheek row *c*. The fresh color pattern is diagnostic, with a plain lemon-yellow body, a white saddle on the dorsal caudal peduncle, and an indistinct collection of melanophores on the posterior caudal peduncle.

Key words: taxonomy, ichthyology, coral-reef fishes, gobies, mesophotic coral ecosystems

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Introduction

Trimma Jordan & Seale, 1906 (type species: *T. caesiura* Jordan & Seale, 1906 by original designation and also monotypic) currently contains 108 valid described species of small (usually <30 mm SL), often colorful gobiids, primarily associated with Indo-Pacific coral reefs (Winterbottom 2019, Winterbottom & Pyle 2022). These gobies, commonly called pygmygobies, 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 usually more anterior), 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). A comprehensive illustrated key to the 105 recognized valid species of pygmygobies at the time was provided in Winterbottom (2019), based on morphological and color-pattern characteristics, along with a review of the state of knowledge on the biology and biogeography of the known species, as well as comments on the mtDNA genetic variation for each species, when available.

Winterbottom (2011, citing unpublished data) estimated that there were, at that time, about 35 known but currently undescribed species in the genus, for a total count in the vicinity of 110 species.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 COI marker suggested that there may be a plethora of cryptic species in the genus that could double this number (Winterbottom et al. 2014b, 2020), depending in part on whether one accepts a >2% difference in the COI sequence as representative of specific differentiation in these fishes, and whether sufficient correlated morphological and/or color characters can be found. The latter study (2020), based on 849 samples of 87 of the then 107 described valid species, predicted some 192 haplogroups in the genus. Unfortunately, our morphological studies of many haplogroups listed in that paper under a single species name were too limited to be able to distinguish genovariants from species (see Victor 2015: 84).

In addition, continued exploration of deep coral reefs, known as mesophotic coral ecosystems (Pyle et al. 2019: i.e. MCEs, tropical coral-reef habitat at depths below ca. 30 m), has revealed many previously unknown fish species, as is the case here. Indeed, the most recently described *Trimma* species was collected from mesophotic reefs, more than 90 m deep, at Palau in the western Pacific Ocean (Winterbottom & Pyle 2022). We note that gobiid species that appear to be identical in the field often prove to be distinct species when detailed forms of evidence are applied, or may contain two or more COI haplogroups that are often relatively close to each other geographically.

Examination of the collections in the mesophotic zone made by RP and his colleagues by RW resulted in the recognition of at least three previously undescribed species from Vanuatu in the western Pacific. All three are currently known only from a single specimen, but only the species described here is in good enough condition to be formally described at this time.

Materials and Methods

Specimens were collected by divers using Cis-Lunar MK-5P, closed-circuit, mixed-gas rebreathers. Methods of gathering data and the format of the descriptions follow Winterbottom (2016, and references cited therein). The sequence of characters presented in the Abstract and Diagnosis follows the sequence of cascading characters from couplet 1 onwards in the key to the species of *Trimma* (Winterbottom 2019). Naming of the cephalic sensory-papillae rows follows Winterbottom (2011), as modified by Winterbottom et al. (2015). Lengths given are Standard Length (SL) in millimeters.

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™.

Trimma citrum, n. sp.

Lemon pygmygoby

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Figures 1 & 2.

Holotype. BPBM 40787, 29.3 mm SL male, Vanuatu, Tutuba Island, off west coast, -15.56091, 167.27495, near large boulder along steep slope, with rubble and sand, 116 m, rotenone & vacuum device, 22 October 2006, R.L. Pyle & B.D. Greene.

Diagnosis. A species of *Trimma* with a scaled predorsal midline; fifth pelvic-fin ray with one dichotomous branch point; unbranched pectoral-fin rays; bony interorbital 41% pupil width; more than a single posterodorsal row of cheek scales; 6 papillae in cheek row *c*; caudal peduncle with a white saddle dorsally, body plain yellow when fresh excepting white caudal spot; and a fairly heavy concentration of melanophores on last one-fifth of peduncle, not enough to form a recognizable dark spot or blotch.

Description. Dorsal-fin elements VI+I,8, second and third spines of first dorsal fin reaching to base of first ray of second dorsal fin, first ray of second dorsal fin broken, others branched except for posterior element of last ray, fin reaches posteriorly 37% distance between base of last ray and first exposed dorsal procurrent caudal-fin ray; anal-fin elements I,8, all rays branched except for posterior element of last ray, fin reaching posteriorly 31% distance between base of last ray and first exposed ventral procurrent caudal-fin ray; pectoral-fin elements 15, all rays unbranched, fin reaching posteriorly to vertical above urogenital papilla; pelvic-fin elements I,5, fifth



Figure 1. *Trimma citrum*, holotype, BPBM 40787, 29.3 mm SL male. Left lateral view of freshly collected specimen (A) and preserved (B). Dotted semicircle on dorsal part of caudal peduncle represents the position of the white spot in fresh material; red blotch on side between second dorsal and anal fins is a post-mortem artifact (A: B.D. Greene; B: R. Winterbottom).

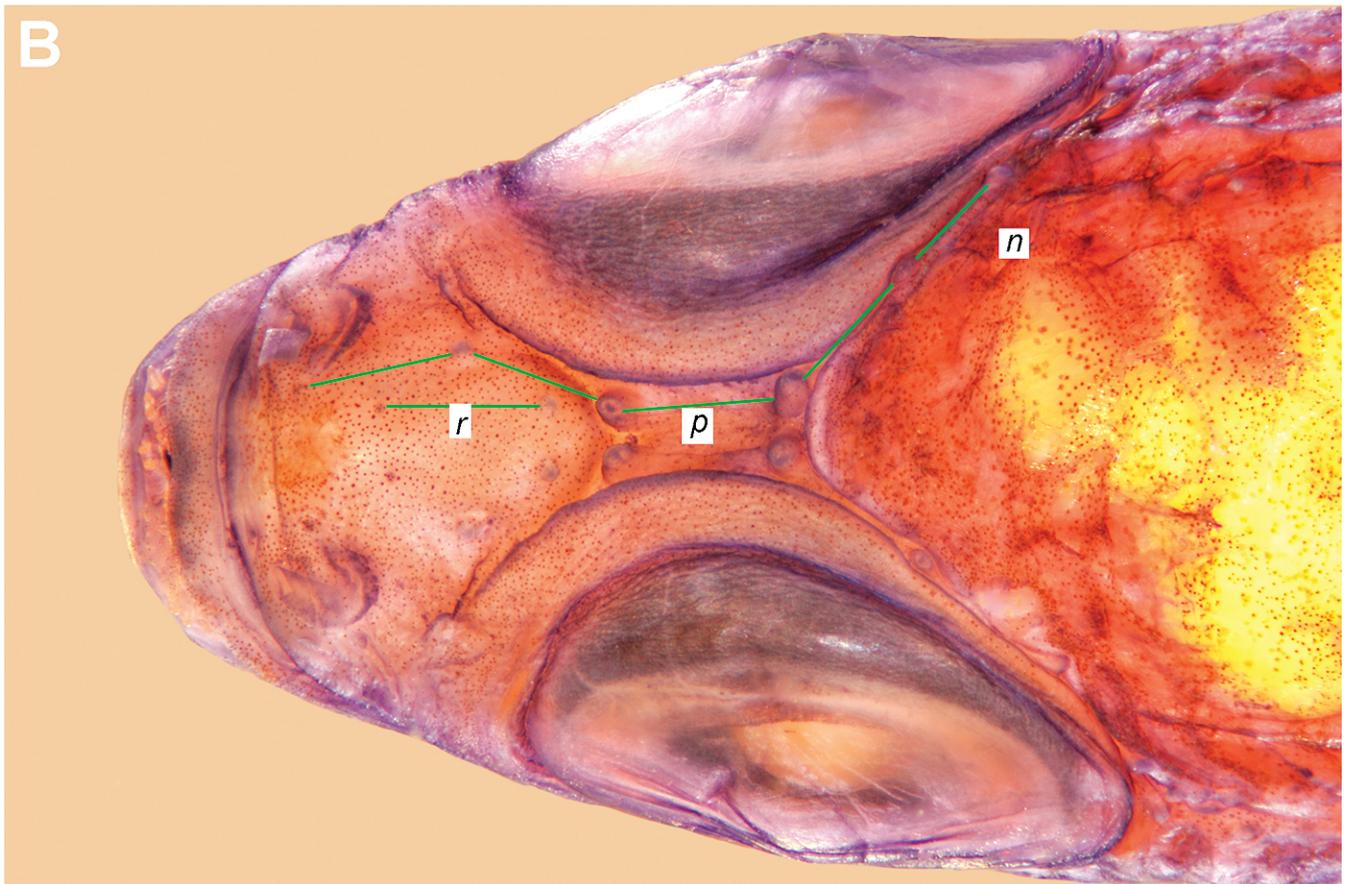
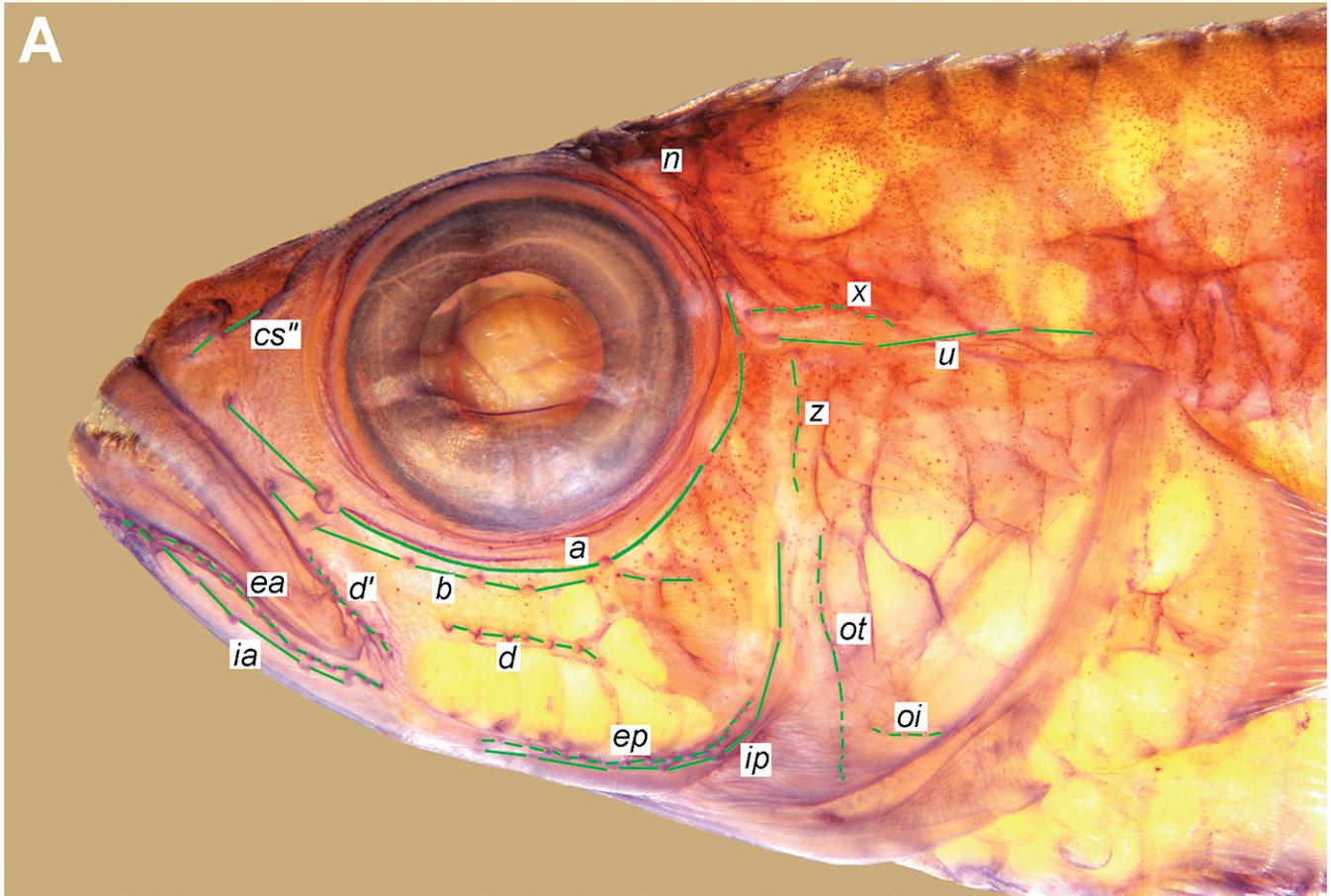


Figure 2. *Trimma citrum*, BPBM 40787, 29.3 mm SL male. Left lateral (A) and dorsal (B) views of head to show head papillae, specimen stained with cyanine blue; papillae in any given row connected by a thin green line (R. Winterbottom).

ray with one dichotomous branch point for a total of two branch tips, and about 60% length of fourth ray, which reaches posteriorly to about base of first anal-fin ray (tip of ray broken on both sides, preceding descriptions based on extrapolation); pelvic-fin rays 1–4 with one sequential branch point, basal membrane presence uncertain because of fragility of membrane (but is represented by at least a fold across midline), no visible frenum. Scales in mid-lateral series 23, anterior transverse scales 10, posterior transverse scales 9, cheek with 4 rows consisting of (from dorsal to ventral) 1, 4, 10, and 2 cycloid scales (Fig. 2A), opercle fully scaled with 4 horizontal rows of 5, 4, 3, 1 scales (scales abraded off, so not determined whether opercular scales are ctenoid or cycloid); predorsal midline crossed by 9 irregular scale rows with first scale apparently enlarged, anteriormost extent of scales to vertical with posterior margin of pupil, 3 vertical rows of cycloid scales on pectoral-fin base with 4 scales in each row; 9 cycloid scales in midline anterior to pelvic-fin base; ctenoid scales in area between pelvic-fin spine and ventral margin of pectoral-fin base and anteriormost row of body scales beneath axil of pectoral-fin base; scales immediately lateral to bases of paired fins; anterior few rows of scales in midline of belly cycloid. Body scales mostly ctenoid, but many scale counts based mainly on scale pockets. Circumpeduncular scales 12, scale rows in midline between base of last anal ray and first ventral procurrent caudal-fin ray 9. Upper jaw with outer row of curved, enlarged canines separated by gaps about equal to tooth length, decreasing in size and size of gap posteriorly to end at distal end of premaxilla, about two inner rows of small conical teeth at symphysis decreasing posteriorly to none; lower jaw with enlarged teeth as above to bend of dentary, about 5 inner rows of small, conical, straight teeth at symphysis, innermost row gradually increasing in size posteriorly to about half size of outer row, number of rows decreasing to one at coronoid process.

Tongue bluntly rounded shape. Gill opening extending anteroventrally to below anterior mid-pupil; gill rakers 5+17=22. Anterior naris in short tube reaching anteriorly to above upper lip, posterior opening pore-like with a raised rim, separated from bony front of orbit by twice its diameter, nasal sac raised and on anterior half of snout. Bony interorbital width 41% pupil diameter; moderate U-shaped interorbital trench with no median, raised, fleshy ridge; postorbital groove narrow with vertical sides, extending from papilla 4 to just ventral to papilla 5 of row *p* (Fig. 2B); epaxialis reaching anteriorly in midline to vertical above posterior 25% of pupil; no dermal ridge in midline of nape extending anteriorly from origin of first dorsal fin. Caudal-peduncle depth 35% caudal-peduncle length; head length 30% SL; horizontal eye diameter 35% HL; snout length 24% HL; cheek depth 17% HL.

Cephalic sensory papillae as in Fig. 2: number of papillae in each row: *a*=6; *b*=3; *c*=6; *cp*=1; *d*=7; *d'*=9; *e-anterior*=17; *e-posterior*=18; *i-anterior*=7; *i-posterior*=8; *p*=6; *r*=2; *f*=3; *cs''*=2; *g*= possibly absent, but scales abraded off; *n*=1; *x*=8; *u*=5; *z*=6; *ot*=14; *os*= abraded off; *oi*=5. Caudal fin with three dorsal and three ventral segmented unbranched rays, and 6 dorsal and 5 ventral segmented branched rays. Abdominal/caudal vertebral transition type unknown.

Color of fresh holotype. (Fig. 1A) Head and body lemon-yellow overall, with suffusions of red on upper snout, around anterior half of orbit, and, less obviously, nape; yellow mixed with widely scattered melanophores, slightly concentrated around scale pockets, over upper visceral cavity, and at mid-body along midlateral septum; also a slight concentration of melanophores, mixed with scattered larger melanophores, forming a very vague darker area on peduncle just anterior to caudal fin. A pupil-width, bright-white saddle present over dorsal part of caudal peduncle about three to 4 scale-widths anterior to first procurrent-fin ray. Dorsal fins with a basal black stripe, one-third pupil width, followed by a similar yellow stripe, and remaining fin membranes translucent with scattered iridocytes, including some black melanophores on distal third. Fin elements may be translucent or tinged with red (possibly caused by strobe light). Anal fin translucent with scattered iridocytes and a few melanophores basally at middle of fin. Caudal fin essentially translucent with a hint of red on unbranched rays (which could be due to strobe). Pectoral-fin rays red, pelvic-fin rays translucent, no membranes in either fin visible. Iris with a thin white line around pupil and a dark, wider margin around iris outer edge; remaining iris golden yellow mixed with melanophores and two diagonal purple stripes touching the anterodorsal and anteroventral margins of the pupil.

Color of preserved holotype. (Fig. 1B; note dark red blotch on body between second dorsal fin and anal fin is a post-mortem artifact) Head and body plain pale yellowish brown, with melanophores still visible, and a slight concentration of small and larger melanophores forming a vague, slightly darker blotch at end of peduncle. White peduncular saddle not present on preserved holotype (dotted semicircle in figure).

Etymology. The specific epithet is the Latin ‘*citrum*’ from the color of the fruit of the lemon tree (*Citrus limon*), a species of small evergreen tree in the flowering plant family Rutaceae, native to Asia (<https://en.wikipedia.org/wiki/Lemon>). The Latin ‘*citrus*’ may possibly be derived via Etruscan from the Ancient Greek κέδρος (*kédros*).

Distribution and habitat. The new species is currently known from a single specimen from deep water (116 m) off Tutuba Island, just southeast of Espiritu Santo Island, Vanuatu. The habitat was a limestone rock and rubble slope with scattered patches of sand and small holes, crevices, and caves, with some scattered scleractinian, gorgonian and soft corals. The water was clear, with low to moderate currents. No individuals were seen alive prior to capture.

Comparisons. This species comes out in Winterbottom’s (2019) key at couplet 41 because, sequentially, there are scales in the predorsal midline, the fifth pelvic-fin ray has at least one branch point, the pectoral-fin rays are all unbranched, the width of the bony interorbital is <50% pupil width, the interorbital trenches have sloping sides and the posterior interorbital trench does not extend to papilla row *x*, scales are present on the cheek, and the cheek has 6 or 7 papillae in row *c*.

The new species splits the key at couplet 41. It agrees with *Trimma meranyx* Winterbottom, Erdmann & Cahyani, 2014a (41a) in having 6 papillae in row *c* (vs. 7 in *Trimma rubromaculatum* Allen & Munday, 1995, at couplet 41b) and having a yellowish head and body, but differs from *T. meranyx* in having a yellow caudal peduncle (vs. black), a single, half-pupil diameter, white saddle on the dorsal margin of the peduncle (vs. usually two pupil-width white spots, one on the dorsal and one on the ventral margin in *T. meranyx*). It lacks the white body and large irregular spots and blotches of *T. rubromaculatum*.

Although a predominantly yellow coloration of the body is present in several species of *Trimma*, only two other species are lemon yellow on both the head and the body. They are *Trimma taylori* Lobel, 1979, and *Trimma winchi* Winterbottom, 1984. The new species differs from these two when freshly collected by the half-pupil diameter, white saddle across the dorsal caudal peduncle (vs. no white saddle). It differs further from *T. taylori* in having fewer dorsal and anal-fin rays (8 and 8 vs. 10 or 11 and 9 or 10, respectively); no branched pectoral-fin rays (vs. 9–11 branched rays); 9 scales in the predorsal midline (vs. 6–8); scales on the cheek and opercle (vs. such scales absent); 22 total gill rakers on the first gill arch (vs. 16–19); a moderate interorbital trench with sloping sides and a narrow but deep postorbital trench (vs. no trenches); and 6 (vs. 7) papillae in row *c*. It differs from *T. winchi* in having more rows of cheek scales (4 vs. 1 or 2); more rows of opercular scales (4 vs. 2); more gill rakers (22 vs. 16); a narrower and steeper-sided interorbital region (vs. broader with gently sloping sides); a narrow but deep postorbital trench (vs. a slight crease); and 6 (vs. 5) papillae in row *c*.

There are thus numerous trenchant morphological, meristic, and marking differences between these three species. The new species has not been sequenced for mtDNA COI as yet, but the extensive phenogram published by Winterbottom et al. (2020) lists *T. winchi* as a member of Block 28, which it shares with three other species, all separated by >13.6% sequence divergence. We find it potentially interesting that one of these species is *T. meranyx*. On the other hand, *T. taylori*, which consists of 5, or more probably, 6 haplogroups, falls into Block 26. That block is phenetically linked to a block of three other species, and is well separated from Block 28.

Clearly, we have barely scratched the surface of the mesophotic *Trimma* diversity, and many more new species can be expected as collectors more thoroughly explore this surprisingly diverse habitat.

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