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Two new species of *Trimma* pygmy gobies (Teleostei: Gobiidae) from Papua New Guinea

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Abstract

Two new species of pygmy goby of the Indo-Pacific genus *Trimma* are described. They are members of the *erdmanni-chledophilum* species group, which, according to recent genetic studies, is composed of diverse haplogroups representing several undescribed species. *Trimma pamae,* n. sp. is described from 6 specimens, 19.9–21.3 mm SL, collected from two sites in eastern Papua New Guinea. Diagnostic features include 9 segmented dorsal and 8 anal-fin rays; the second dorsal-fin spine long and filamentous; each segmented pelvic-fin ray with a single dichotomous branch point, the fifth ray 45–67% length of the fourth ray; the predorsal midline, cheek, and opercle scaleless; and the color in life mainly orange-red with distinctive blue stripes on the head behind the eye and on the midline of the snout. *Trimma tufiensis* n. sp. is described from two specimens, 19.3 and 19.9 mm SL, collected in the vicinity of Tufi, Oro Province, Papua New Guinea . It has similar diagnostic features as *T. pamae*, but lacks the blue stripes. Comparisons of mtDNA barcode sequences reveal the two new species are distinct lineages within the monophyletic group, with *T. pamae* 7.5% divergent from the nearest congener and *T. tufiensis* 3.8% from its sister species *Trimma chledophilum*.

Key words: taxonomy, ichthyology, coral-reef fishes, cryptobenthic, DNA barcoding, western Pacific Ocean, cryptic species

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Introduction

The genus *Trimma* Jordan & Seale, 1906 contains tiny gobiid fishes, commonly called pygmy gobies, that inhabit Indo-Pacific coral reefs and surrounding sand and silty bottoms. They are particularly speciose throughout the Indo-Australian Archipelago and surrounding areas with nearly 80 recorded species native to that region (Allen & Erdmann 2024). Although very abundant and often brightly colored, they are seldom noticed due to their small size (mostly < 30 mm SL) and cryptic habits.

Winterbottom (2019) provided a diagnosis for the genus and a key to the 105 valid species that were known. Since that review, the total number of species has increased to 115 species (Fricke et al. 2025), distinguished by both morphological and color-pattern features. The genus can be distinguished from the myriad other small gobies associated with tropical reef environments worldwide by their lack of cephalic sensory-canal pores; a much reduced pattern of cephalic sensory papillae (free neuromasts); a relatively wide gill opening extending anteriorly to below the vertical limb of the preopercle or, more usually, anterior to that point; 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).

More than anyone else, our current knowledge of the genus is attributable to Richard Winterbottom of the Royal Ontario Museum, Canada, and his co-workers, who have published descriptions of about 65% of the recognized species. Their important body of work has also elaborated the genetic relationships within the group, although research is ongoing and there is still much to learn. At present, the relatedness within the genus has been assessed by sequencing the mitochondrial gene cytochrome c oxidase, COI, considered the "DNA barcode" marker widely used for fish species identifications. The database of COI sequences, BOLD (the Barcode of Life Data System, hosted by the Centre for Biodiversity Genomics at the University of Guelph in Canada) has assembled over a thousand *Trimma* sequences with 116 named taxa (some are cf. species) and well over 150 BINs, or algorithmically derived lineages.

Winterbottom et al. (2014, 2020) conducted a phenetic analysis of relationships within the genus based on mtDNA COI sequences for 87 species, which revealed 155 distinct lineages, defined by a greater than 2% sequence divergence. That threshold is often cited as a criterion for species-level differences, but there are numerous exceptions and it is mainly a factor to be taken into account in the evaluation of species status, which requires phenotypic differences, i.e. morphological or color-pattern correlations. Nevertheless, the results showed that many named species are likely composed of multi-species complexes containing numerous undescribed taxa.

The present study describes two such species from Milne Bay, Papua New Guinea that are related to *Trimma chledophilum* Allen, 2015 and *Trimma erdmanni* Winterbottom, 2011. The type specimens of the two new species were collected by the authors during reef-fish surveys at eastern Papua New Guinea between 2016 and 2025. Both new species co-occur in the unique volcanic fjords in the vicinity of Tufi, Oro Province (Fig. 1), where we conducted an ichthyological survey during March 2025.

Materials and Methods

Type specimens are deposited at the Western Australian Museum, Perth (WAM), Australia. The methods of counting and measuring and general format of the new species descriptions follow those of Winterbottom (2002, 2011). The range of counts and measurements for paratypes are indicated in parentheses, if different from the holotype. Specimens were stained with Cyanine Blue 5R (acid blue 113) solution (Akihito et al. 1993, 2002, Saruwatari et al. 1997), which greatly facilitated examination of branching patterns of fin rays and patterns of cephalic sensory papillae rows. The row nomenclature (i.e. italicised abbreviations) for cephalic sensory papillae is based on the explanation and illustrations of Winterbottom et al. (2015). Lengths are given as standard length (SL), measured from the median anterior point of the upper lip to the base of the caudal fin (posterior end of the hypural plate); head length is measured from the median anterior point of the upper lip to the posterior end of the opercular membrane; snout length is measured from the median anterior point of the upper lip to the nearest fleshy edge of the eye; eye diameter is the greatest fleshy diameter; pupil width is measured horizontally; interorbital width is the least bony width; caudal-peduncle depth is the least depth, and caudal-peduncle length

Figure 1. Volcanic fjord habitat of new *Trimma* spp., vicinity of Tufi, Oro Province, Papua New Guinea (M.V. Erdmann).

is the horizontal distance between verticals at the rear base of the anal fin and the caudal-fin base. Lateral scale counts are made along the midlateral row from the scale just behind the fleshy pectoral-fin base ("armpit") to the scale reaching or covering the posterior margin of the hypural plate; transverse scales are counted in a diagonal row from the origin of the anal fin upwards and forwards for the anterior count and upwards and backwards for the posterior count; gill rakers are counted on the first gill arch, those on the upper limb listed first.

DNA was extracted from fin-clip samples that were obtained in the vicinity of Tufi, Papua New Guinea during the 2025 survey. The extraction process was facilitated by the use of a QIAGEN Blood and Tissue DNeasy Kit following manufacturers recommendations. The COI gene was amplified using COI-1-FF2d and COI-1-FR1d primers and thermocycling conditions as per Ivanova et al. (2007). ExoSAP-IT from USB (Cleveland, Ohio) was used to purify the PCR products. The cleaned products were quantified with a QubitTM dsDNA BS assay Kit on a Qubit 3 Fluorometer (Thermo Fischer Scientific) and sequenced in both directions by Macrogen, Korea using Applied Biosystems BigDye Terminator v3.1 reagents and the Applied Biosystems 3730 DNA analyser. Additional sequences for *Trimma* spp. previously collected by MVE were sourced from BOLD.

Sequences were aligned and edited using Geneious Prime 2023.1.1 (https://www.geneious.com) and trimmed for downstream analysis (fragment size 652 bp). Genetic analyses were conducted in MEGA11: Molecular Evolutionary Genetics Analysis version 11 (Tamura et al. 2021). Methods follow those used for BOLD species analysis, whereby the Kimura 2-parameter substitution model (Kimura 1980) was used for pairwise genetic distances amongst individual and groups and visual representation of relationships with neighbour joining tree estimation.

Figure 2. *Trimma pamae*, n. sp., preserved male holotype, WAM P. 35993-001, 20.1 mm SL, Tufi, Oro Province, Papua New Guinea (G.R. Allen) (image reversed).

Trimma pamae, n. sp.

Pam's Pygmy Goby

urn:lsid:zoobank.org:act:0EC98523-9BF5-43B1-96D5-638C9A41E805

Figures 2–6 & 9C

Holotype. WAM P.35993-001, male, 20.1 mm SL, Papua New Guinea, Oro Province, Tufi Inlet, off Tufi Resort wharf, -9.081°, 149.316°, 30 m, clove oil and hand net, M.V. Erdmann & W.M. Brooks, 9 March 2025.

Paratypes. WAM P.34857-004, 3 males, 20.6–21.3 mm SL, Papua New Guinea, Milne Bay Province, Sideia Island, patch reef 300 m from shore, -10. 596°, 150.768°, 14–20 m, clove oil, M.V. Erdmann, 11 May 2018; WAM P.35993-002, 2 specimens, male, 19.9 mm SL & female, 20.7 mm SL, collected with holotype.

Diagnosis. A species of *Trimma* with the following combination of characters: dorsal-fin elements VI+I,9, second spine usually filamentous and variable in length, extending nearly to caudal-fin base when fully developed; anal-fin elements I,8; fifth pelvic-fin ray branched, 45–67% length of fourth ray; bony interorbital 39–55% pupil diameter; midline of predorsal broadly scaleless; cheek and opercle scaleless; mainly orange red in life except

Figure 3. *Trimma pamae*, n. sp., preserved male paratype, WAM P. 34857-004, 21.3 mm SL, lateral view of left side showing scale pattern, Tufi, Oro Province, Papua New Guinea. Specimen stained with cyanine blue (G.R. Allen).

prepelvic area and belly whitish to pinkish; a pair of distinctive blue-to-silvery stripes behind eye and similarly colored narrow stripes on lateral snout and dorsal midline of head; fins generally unmarked and translucent, but sometimes with inconspicuous, pale, reddish spots scattered on dorsal and caudal fins.

Description. Dorsal-fin elements VI+I,9, second spine elongate and filamentous, reaching base of last ray of second dorsal fin in holotype when adpressed or slightly beyond this point in some paratypes (male paratype, 20.6 mm SL from Sideia with no elongate spines and third spine longest), segmented rays of second dorsal fin branched, except branching of first ray not conspicuous in holotype and paratypes from Tufi due to damaged fin tips; anal-fin elements I,8, segmented rays branched except first ray unbranched in holotype and all except one paratype; pectoral-fin rays 16 (16 in one paratype, 16 and 17 on left and right side of one paratype, and 17 in all three paratypes from Sideia), middle 7–12 rays branched; pelvic-fin rays I,5, each ray with single dichotomous branch point, fifth ray 58% (45–67%) length of fourth ray, frenum absent, basal membrane poorly developed and greater than 5% length of fourth ray.

Most of body covered with ctenoid scales (Fig. 3); lateral scales 24 (one paratype with 23); anterior transverse scales 9; posterior transverse scales 8; midline of predorsal broadly scaleless; pectoral-fin base with cycloid scales; midline of prepelvic with 5 or 6 cycloid scales; body scales ctenoid except for cycloid scales on anterior belly midline, on pectoral-fin base and immediately below, on sides of nape, and along base of first dorsal fin; body scales extend anteriorly on sides of nape to about level of preopercle margin.

Teeth of upper jaw consisting of an outer row of curved, widely separated, enlarged canines (about 8 or 9 on each side), decreasing in size posteriorly, and an inner band of several irregular rows of smaller conical teeth, widest at symphysis, number of rows decreasing posteriorly; lower jaw with an outer row of curved, widely separated, enlarged canines (5 or 6 on each side), ending at bend of dentary, and several rows of small, curved conical teeth, widest at symphysis and narrowing to a single row posteriorly; innermost row of teeth at bend of dentary notably larger than intermediate rows. Tongue truncate with rounded anterior corners. Gill opening extending ventrally to below rear margin of eye; outer gill rakers of first gill arch 5+16 (4–5+15–17). Anterior nasal opening a short tube, posterior nasal opening pore-like with an elevated rim, nasal sac slightly raised, with nasal apparatus confined to the anterior half of the snout. A relatively deep, U-shaped, interorbital trench; bony interorbital width 39% (39–55%) pupil diameter; epaxial musculature reaching anteriorly to above posterior margin of pupil.

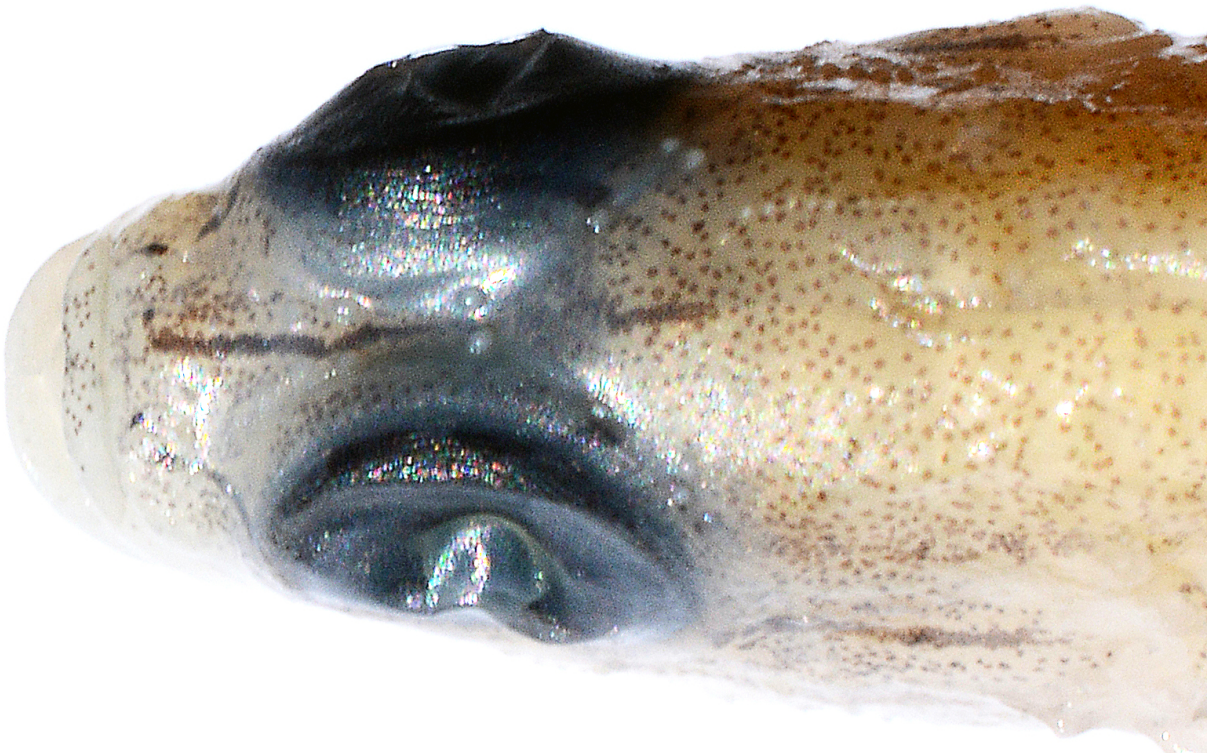

Figure 4. *Trimma pamae*, n. sp., preserved male holotype, WAM P. 35993-001, 20.1 mm SL, dorsal head showing diagnostic mid-dorsal dark stripe, Tufi, Oro Province, Papua New Guinea (G.R. Allen).

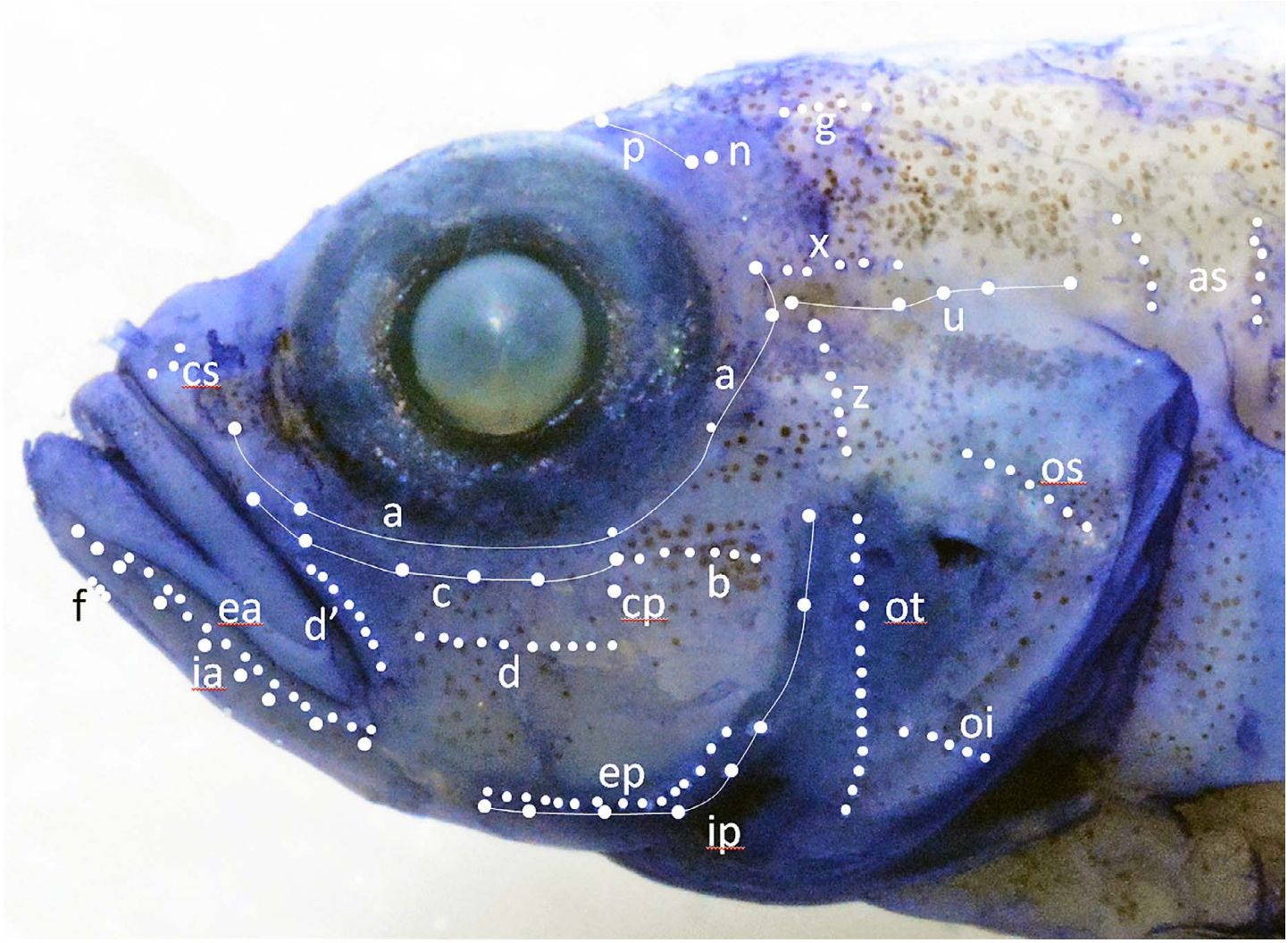

Figure 5. *Trimma pamae*, n. sp., preserved male paratype, WAM P. 34857-004, 21.3 mm SL, lateral view of head with sensory papillae (white dots) based on composite reconstruction of holotype and several paratypes. Specimen stained with cyanine blue (G.R. Allen).

Pattern of cephalic sensory papillae as shown in Fig. 5 with range of numbers in each row (in parentheses) as follows: *a* (6), *b* (5–7), *c* (5–6), *cp* (1), *d* (6–10), *d'* (6–9), *ea* (14–18), *ep* (12–17), *ia* (6–9), *ip* (7–8), *r* (2), *f* (3–4), *cs"* (3), *g* (5–9), *x* (5–7), *z* (5–8), *ot* (14–17), *os* (3–9), *oi* (3–5), *p* (6), and *sm* (1). Most papillae are conspicuous when specimen stained with cyanine blue unless abraided, although some are difficult to detect due to much smaller size (e.g. anteriormost papillae of *p* and *r* rows. Papillae pattern on dorsal surface of head similar to that illustrated for *T. tufiensis* (see below).

Measurements (holotype presented first followed by parentheses with range for paratypes and mean for all types): head length as percentage of SL 31.8 (28.3–32.8, 30.7); eye diameter as percentage of head length 39.1 (38.9–45.7, 40.7); snout length as percentage of head length 18.9 (16.4–21.8, 19.4); bony interorbital as percentage of pupil diameter 39.4 (41.4–50.5, 43.1); caudal-peduncle length as percentage of SL 27.3 (24.3–27.6, 25.5); caudal-peduncle depth as percentage of caudal-peduncle length 42.2 (41.7–49.6, 44.6); and longest spine (usually second) of first dorsal fin as percentage of SL 43.8 (20.8–56.7, 39.2).

Color in life. (Fig. 6) Most of body and upper half of head generally bright orange red, although portion above vertebral column duller red; lower half of head, prepelvic area, and belly whitish to pinkish; a broad, dark-red stripe on side of snout, passing through lower eye and continuing behind eye to rear margin of opercle, similar stripe originating on middle of snout and continuing behind upper eye to uppermost margin of opercle, both red stripes separated on each side of snout by a narrow blue-to-silvery stripe and, behind eye by a wider blue-to-silvery stripe, a second blue-to-silvery stripe behind upper rear margin of eye, an additional somewhat diffuse blue-to-silvery stripe from middle portion of upper jaw to lower edge of eye, sometimes extending to opercle margin,

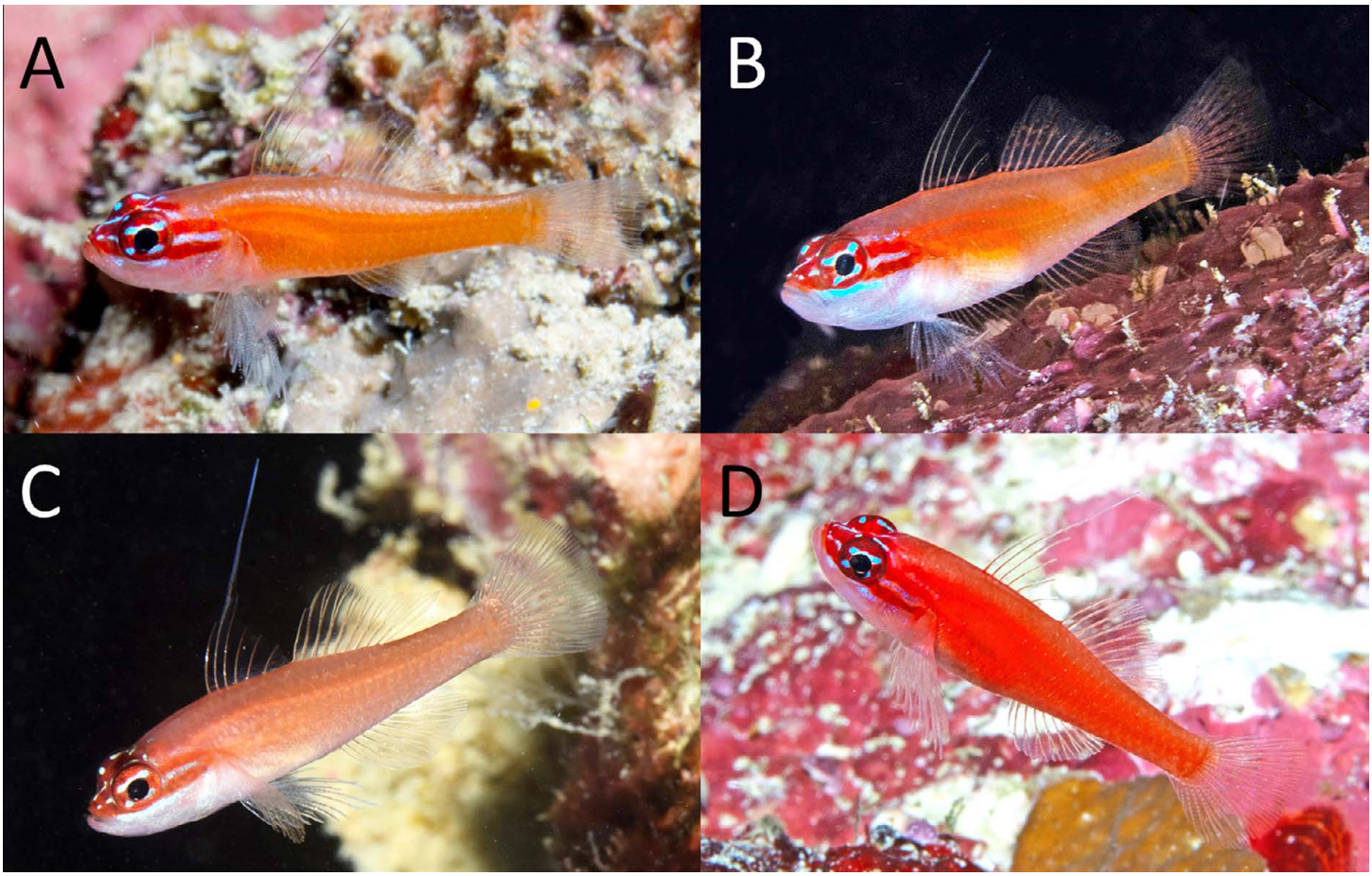

Figure 6. *Trimma pamae*, n. sp., underwater photographs of live individuals, approx. 18–22 mm SL: (A, B & D) Tufi, Papua New Guinea in 25–30 m; (C) Sideia, Papua New Guinea in 15 m (A, B & D, M.V. Erdmann; C, G.R. Allen).

directly below and in contact with lower postorbital red stripe; a narrow blue-to-silvery stripe on mid-dorsal snout extending through interorbital trench to beginning of nape; iris red with a pair of blue-to-silvery stripes at level of upper and lower edge of pupil (Fig. 9C), inner dorsal scleral margin of iris with a pair of blue-to-silvery markings; fin rays generally pink with translucent membranes, but mature adults sometimes with inconspicuous, pale, reddish spots scattered on dorsal and caudal fins. Notably, Winterbottom et al (2020) described a matching color pattern in detail; referring to *T. pamae* as "*T. chledophilum* Group 2b".

Color in alcohol. (Figs. 2 & 4) Generally pale yellowish white with numerous brown melanophores on head and sides except midlateral zone with relatively few melanophores; a pair of red stripes behind eye in live individuals persists as relatively faint brown markings extending onto opercle; a distinctive dark stripe on dorsal surface of snout and interorbital as shown in Fig. 6; fins translucent whitish with strong concentration of melanophores on membranes of all fins except pectorals.

Etymology. The new species is named *pamae* to honor the memory of Pamela Rorke Levy, the late wife and companion of co-author Matt Brooks and an active diving member of the initial expedition that uncovered this beautiful new species.

Distribution and habitat. The new species is currently known only from two sites in eastern Papua New Guinea (Fig. 7), including the type locality at Tufi, Oro Province and a small patch reef off Sideia Island, Milne Bay Province, which lies about 230 km SE of Tufi. The type locality is situated in the unique fiord-like environment of the Tufi coastline (Fig. 1). It is one of many steep-sided inlets that penetrate up to 4–5 km inland. These were formed by lava flows from a nearby volcano and some support rich coral growth, particularly in the outer zone nearest to the open sea. The habitat where the type specimens were collected consisted of a silt-bottom area situated off the jetty of Tufi Resort at depths of about 25-35 m. Most of the individuals we observed were hovering in midwater a short distance above the bottom, either solitarily or in small groups. The Sideia paratypes were collected in shallower depths (14–20 m), mainly from the recesses of overhangs and ledges towards the base of the relatively steep reef slope.

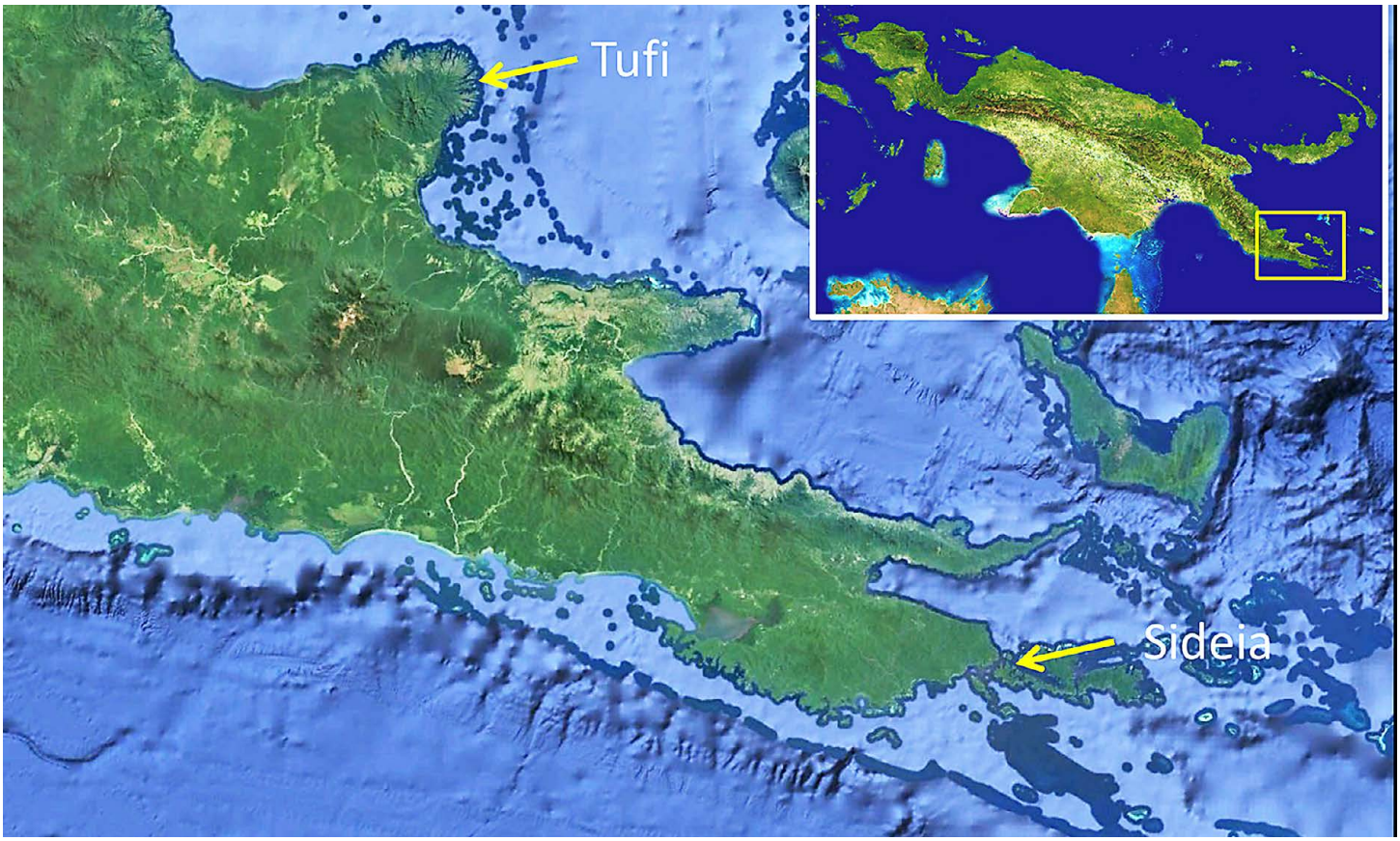

Figure 7. Map of eastern Papua New Guinea (index map of New Guinea at upper right) showing collections sites for *Trimma pamae* and *T. tufiensis*.

Comparisons. *Trimma pamae* is a member of the *erdmanni-chledophilum* group, 4 species characterized by sharing 9 segmented dorsal-fin rays, 8 segmented anal-fin rays, a scaleless predorsal midline (except partially scaled in a few *T. erdmanni* specimens), usually a scaleless cheek and opercle, the first 4 pelvic-fin rays with 1 or 2 sequential branch points, the fifth ray with a single branching point, 23 or 24 lateral scales, 8 or 9 posterior transverse scales, and an overall reddish-orange coloration in life.

Trimma erdmanni, specifically from the type location in West Papua (Figs. 8 & 9A), differs from *T. pamae*

Figure 8. *Trimma erdmanni*, underwater photograph, approx. 20 mm SL, Raja Ampat Islands, West Papua, Indonesia (G.R. Allen).

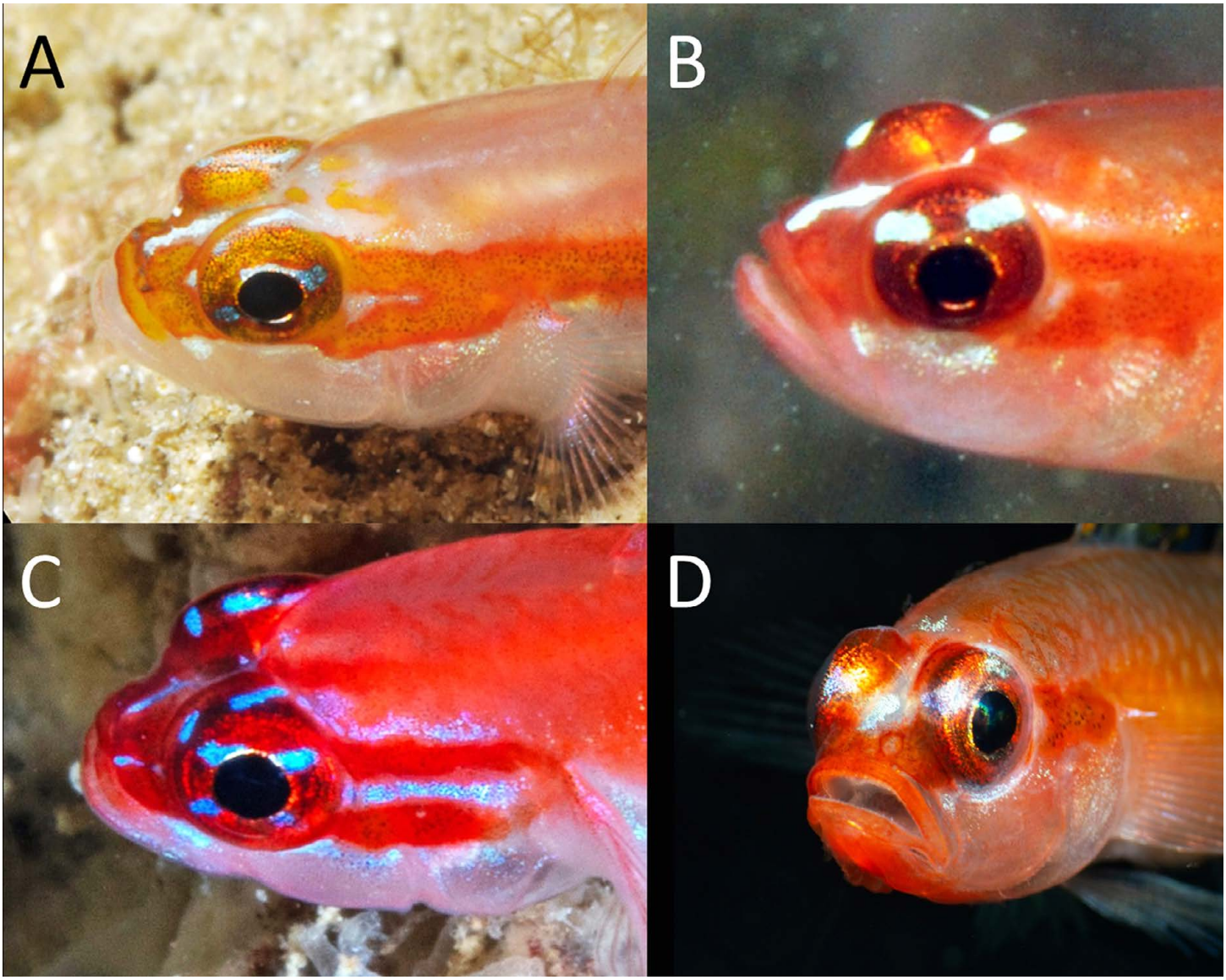

Figure 9. *Trimma* spp. comparison of color patterns on head of live individuals, approx. 18–22 mm SL: A) *T. erdmanni*, West Papua, Indonesia; B) *T. chledophilum*, Milne Bay, Papua New Guinea; C) *T. pamae*, Sideia Island, Papua New Guinea; and D) *T. tufiensis*, Tufi, Papua New Guinea (A & B, G.R. Allen; C & D, M.V. Erdmann).

and both *T. chledophilum* and *T. tufiensis* in having a shorter second dorsal-fin spine that when fully developed and adpressed extends to the base of the eighth segmented ray of the second dorsal fin, vs. extending to the caudal peduncle in the latter three members. It also possesses subtle color differences from other members, most notably the yellowish cast on the snout, iris, and nape; a bifurcate orange stripe behind the eye; a short bluish band anteriorly and posteriorly across the middle of the iris; and the lack of prominent white markings on the outer dorsal surface of the iris. Moreover, the red-orange lateral band is a conspicuous feature along the side of the body that is lacking in both *T. chledophilum* and *T. pamae*. Although there is a similar band in *T. tufiensis*, it is not as well contrasted along the margins as in *T. erdmanni* and differs by being expanded at the caudal-fin base to form a distinctive vertically ovate area with a diffuse dark marking on the ventral section.

The most conspicuous difference between *T. pamae* and other members of the *erdmanni-chledophilum* species group is the pattern of iridescent blue stripes on the head (Fig. 9), which for *T. pamae* include a stripe immediately below the eye, a pair of short stripes behind the eye, an additional pair across the mid-portion of the iris, and a short narrow stripe on the midline of the snout and interorbital.

Figure 10. *Trimma tufiensis*, n. sp., underwater male paratype, WAM P. 35994-005, 19.9 mm SL, Tufi, Oro Province, Papua New Guinea (M.V. Erdmann).

Trimma tufiensis, n. sp.

Tufi Pygmy Goby

urn:lsid:zoobank.org:act:33ACB834-8190-4C8C-AC66-E14BAA8C3EDC

Figures 10–15A & 16B

Holotype. WAM P.35994-004, female, 19.3 mm SL, Papua New Guinea, Oro Province, Tufi district, McLaren Fjord, -9.062°, 149.323°, 42 m, clove oil and hand net, M.V. Erdmann, N.K. Ichida & W.M. Brooks, 7 March 2025.

Paratype. WAM P.35994-005, male, 19.9 mm SL, collected with holotype.

Diagnosis. A species of *Trimma* with the following combination of characters: dorsal-fin elements VI+I,9, second spine filamentous, in male extending to anterior portion of caudal peduncle; anal-fin elements I,8; fifth pelvic-fin ray branched, 54–56% length of fourth ray; bony interorbital 40–47% pupil diameter; midline of predorsal scaleless; cheek and opercle scaleless; papillae row *f* of chin containing 4–6 papillae on each side; translucent pinkish in life with broad orange stripe on middle of side, gradually tapering in width and terminating in vertically ovate red-orange area at base of caudal fin; dorsal surface of snout with white blotch or triangular marking confluent with white diagonal stripe across outer surface of upper iris; fins mainly translucent except dorsal and caudal fin of male with red-orange spots arranged in transverse bands and diffuse reddish area on middle portion of anal fin.

Description. Dorsal-fin elements VI+I,9, second spine elongate, reaching base of fifth segmented ray of second dorsal fin in female holotype and to anterior portion of caudal peduncle of male paratype when adpressed,

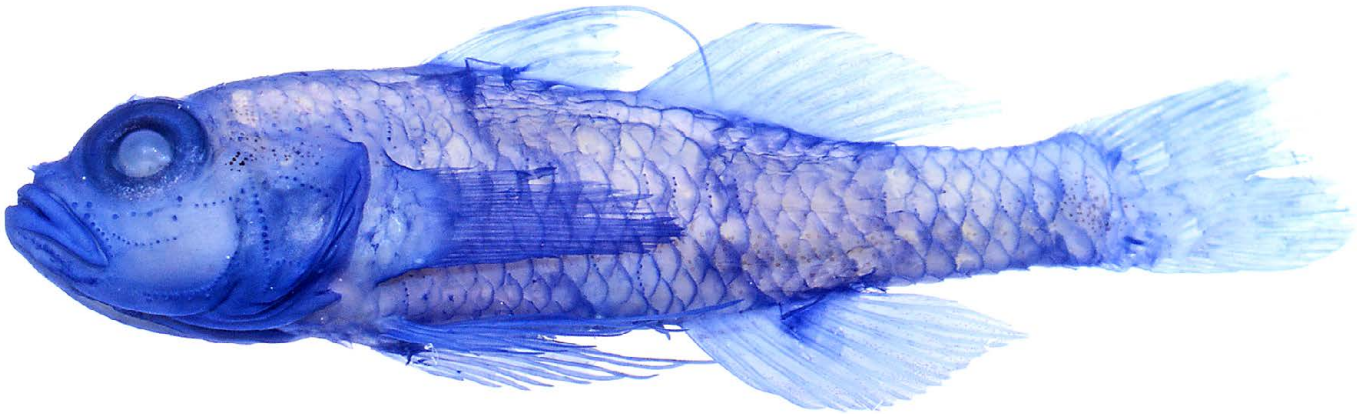

Figure 11. *Trimma tufiensis*, n. sp., preserved male paratype, WAM P. 35994-002, 19.9 mm SL, lateral view of right side (reversed) showing scale pattern, Tufi, Oro Province, Papua New Guinea. Specimen stained with cyanine blue (G.R. Allen).

segmented rays of second dorsal fin branched; anal-fin elements I,8, segmented rays branched except first ray unbranched in paratype; pectoral-fin rays 16 (15 on left side of paratype), middle 7 or 8 rays branched; pelvic-fin rays I,5, each ray with a single dichotomous branch point, fifth ray 54 % (56 %) length of fourth ray, frenum absent, basal membrane poorly developed and greater than 5% length of fourth ray.

Most of body covered with ctenoid scales (Fig. 11); lateral scales 23 (24); anterior transverse scales 9 (10); posterior transverse scales 8; midline of predorsal scaleless; pectoral-fin base with cycloid scales; midline of prepelvic with 6 cycloid scales, body scales ctenoid except for cycloid scales on anterior belly midline, on pectoral-fin base and immediately below, on sides of nape, and along base of first dorsal fin; body scales extend anteriorly on sides of nape nearly to posterior margin of eye.

Teeth of upper jaw consisting of an outer row of curved, widely separated, enlarged canines (about 8 on each side), decreasing in size posteriorly, and an inner band of several irregular rows of smaller conical teeth, widest at symphysis, number of rows decreasing posteriorly; lower jaw with an outer row of curved, widely separated, enlarged canines (5 on each side), ending at bend of dentary and several rows of small, curved, conical teeth, widest at symphysis narrowing to a single row posteriorly; innermost row of teeth at bend of dentary notably larger than those of intermediate rows. Tongue truncate with rounded anterior corners. Gill opening extending ventrally to below level of posterior margin of eye; outer gill rakers of first gill arch 4+16. Anterior nasal opening a short tube, posterior nasal opening pore-like with an elevated rim, nasal sac slightly raised, with nasal apparatus confined to the anterior half of the snout. A relatively deep, U-shaped, interorbital trench; bony interorbital width 47% (40%) pupil diameter; epaxial musculature reaching anteriorly to above posterior margin of pupil.

Figure 12. *Trimma tufiensis*, n. sp., preserved female holotype, WAM P. 35993-001, 19.3 mm SL, Tufi, Oro Province, Papua New Guinea (G.R. Allen).

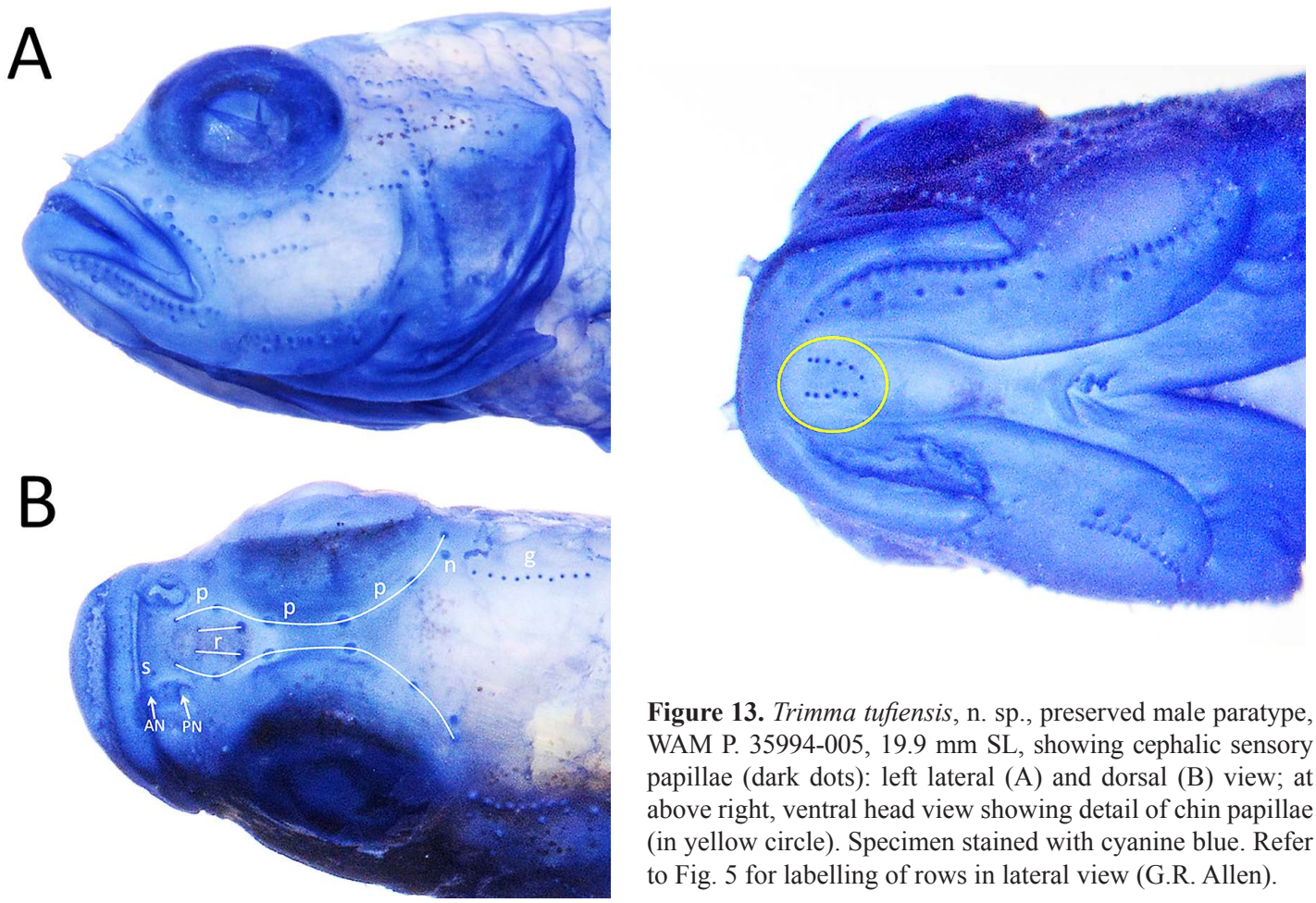

Figure 13. *Trimma tufiensis*, n. sp., preserved male paratype, WAM P. 35994-005, 19.9 mm SL, showing cephalic sensory papillae (dark dots): left lateral (A) and dorsal (B) view; at above right, ventral head view showing detail of chin papillae (in yellow circle). Specimen stained with cyanine blue. Refer to Fig. 5 for labelling of rows in lateral view (G.R. Allen).

Pattern of cephalic sensory papillae as shown in Fig. 13 with range of numbers in each row (in parentheses) as follows: *a* (6), *b* (6–7), *c* (5–6), *cp* (1), *d* (8–10), *d'* (8), *ea* (15–16), *ep* (16–19), *ia* (8), *ip* (8), *r* (2), *f* (4–6), *cs"* (3), *g* (6–10), *x* (6–8), *z* (6–7), *ot* (14–18), *os* (7–8), *oi* (4–6), *p* (6), and *sm* (1). Most papillae conspicuous when specimen stained with cyanine blue, although some difficult to detect due to much smaller size (e.g. anteriormost papillae of *p* and *r* rows).

Measurements (holotype presented first followed by paratype in parentheses: head length as percentage of SL 31.8 (31.0); eye diameter as percentage of head length 36.5 (39.1); snout length as percentage of head length 19.5 (19.4); bony interorbital as percentage of pupil diameter 46.6 (40.4); caudal-peduncle length as percentage of SL 30.0 (27.5); caudal-peduncle depth as percentage of caudal-peduncle length 39.2 (42.7); and longest spine (second) of first dorsal fin as percentage of SL 23.0 (34.0).

Color in life. (Figs.10, 14, 15A & 16A) Body mostly translucent pinkish with a broad orange stripe on middle of side, gradually tapering in width and terminating in a vertically ovate, red-orange area with a faint dark spot on lower portion at base of caudal fin; lower half of head, prepelvic area, and belly whitish to pinkish; a broad red stripe on side of snout, passing through lower two-thirds of eye and joining main body stripe immediately behind eye; dorsal surface of snout with variable white markings, forming either an isolated blotch (Fig. 9D) or a triangular marking confluent with dorsal portion of iris (Figs. 15A & 16B); iris dusky orange-red with a conspicuous white marking across outer face of dorsal sclera; fins mainly translucent except outer margins of median fins bluish and dorsal and caudal fin of mature adults with red-orange spots arranged in transverse bands and diffuse reddish area covering middle portion of anal fin.

Color in alcohol. (Fig. 12) Generally pale yellowish white with scattered, minute, brown melanophores on upper head just behind eye and on sides except midlateral zone of relatively few melanophores; faint dark markings on side and dorsal surface of snout, and middle of forehead immediately behind interorbital space; fins translucent whitish with scattered melanophores on membranes of all fins except pectorals.

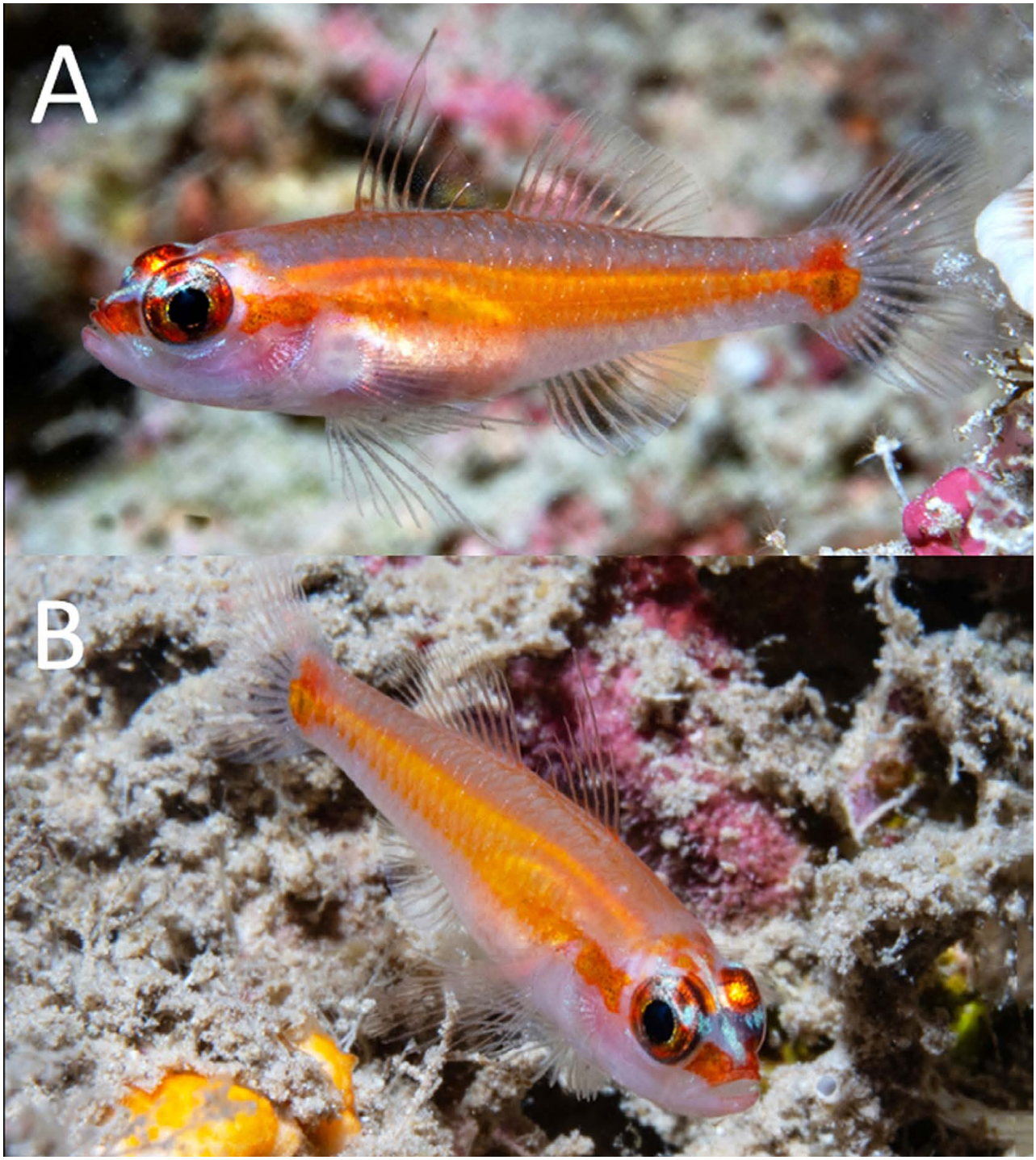

Figure 14. *Trimma tufiensis*, n. sp., underwater photographs of the live holotype before capture, WAM P. 35993-001, 19.3 mm SL, Tufi, Oro Province, Papua New Guinea (M.V. Erdmann).

Etymology. The new species is named *tufiensis* with reference to the type locality.

Distribution and habitat. *Trimma tufiensis* is currently known only from the type locality situated in the Tufi area of eastern Papua New Guinea (Fig. 7). The type locality is situated in the unique fjord-like environment of the Tufi coastline (Fig. 1). The habitat consisted of a sloping silt-bottom area at depths of about 35–45 m. Most of the observed individuals were hovering in midwater a short distance above the bottom, either solitarily or in small groups.

Comparisons. The new species is most similar to *T. chledophilum* which is very similar morphologically and exhibits similar overall coloration. However, there are several subtle color differences that distinguish the two. The orange lateral band on the middle of the side is more conspicuous in *T. tufiensis*, compared to the general reddish-orange coloration without distinct delineation of the band in *T. chledophilum*. In addition, the white

markings on the snout and interorbital region are less distinct and reduced in *T. tufiensis*. The white markings on the upper iris (Figs. 9 & 16) are composed of two (rarely three) elements in *T. chledophilum*, whereas in *T. tufiensis* a single white marking encompasses the entire upper iris, although it is sometimes partially divided by a small red section.

Although our sample size of two specimens is small and additional material is required for a confident evaluation, the new species appears to have an unusually high number of papillae in row *f* (underside of the chin, Fig. 13). There are 4 papillae on each side (8 total) of the holotype and 6 on each side (12 total) of the paratype compared to three (6 total) on the holotype and all 16 paratypes of *T. chledophilum*.

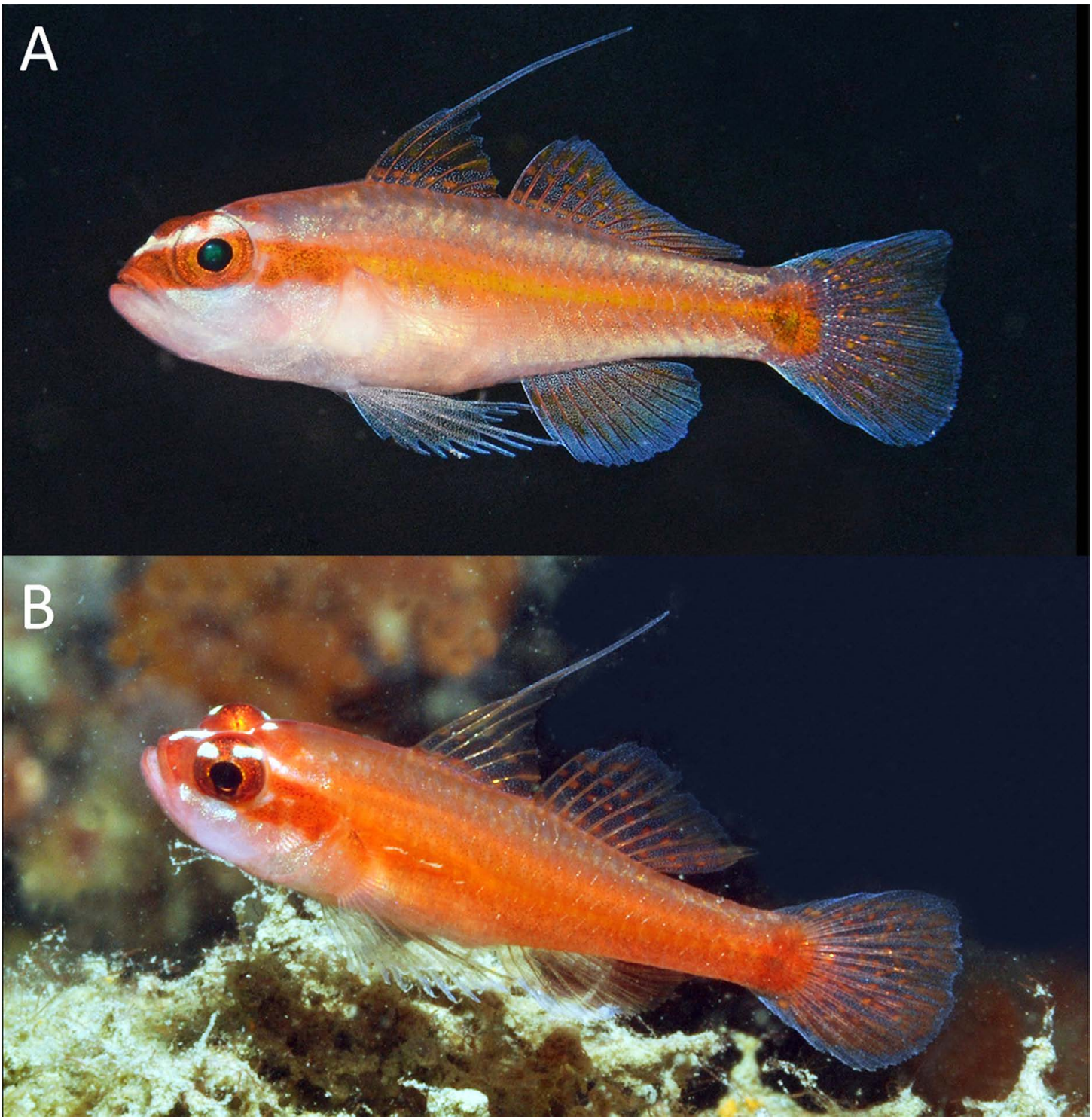

Figure 15. *Trimma* spp. comparison underwater photographs, approx. 20 mm SL: A) *T. tufiensis*, Tufi, Oro Province, Papua New Guinea; B) *T. chledophilum*, Milne Bay, Papua New Guinea, G.R. Allen).

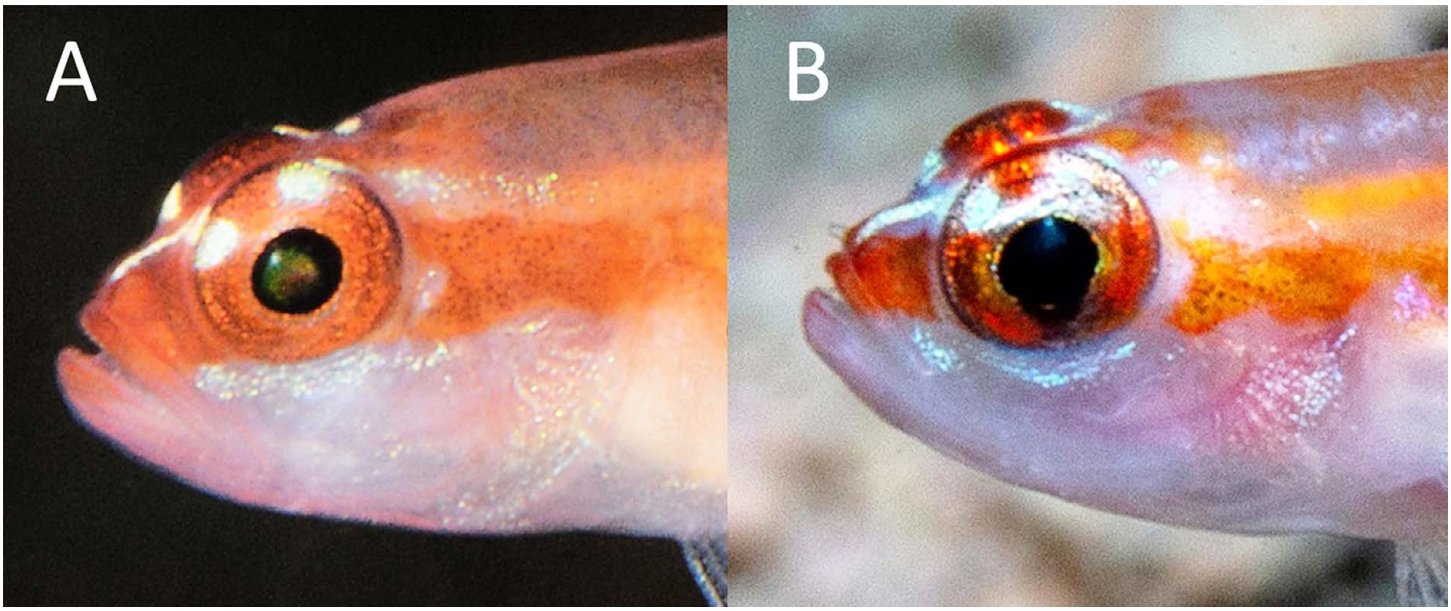

Figure 16. *Trimma* spp. comparison of head and eye color patterns: A) *T. chledophilum*, Milne Bay, Papua New Guinea; B) *T. tufiensis*, Tufi, Oro Province, Papua New Guinea (A, G.R. Allen; B) M.V. Erdmann).

Genetic analysis. The phenetic tree of mtDNA COI sequences for the species group shows a monophyletic grouping. The two new species form distinct monophyletic clades nested within the complex, well separated from each other and the other lineages and species. The genetic results correlate with the species delineation for the species (Fig. 17 & Table 1). *Trimma pamae* showed a minimum interspecific distance of 7.5% to the other lineages and species (closest to Raja Ampat and Rabaul), a similar magnitude to most pairwise species comparisons within the *erdmanni-chledophilum* group, as well as among other *Trimma* species reported in Winterbottom et al. (2020). The maximum intraspecific distance in the group was in *T. pamae*, between the two geographically separated samples from Tufi and Sideia. However, the pairwise comparisons between the two sites for *T. pamae* ranged from 0.15–1.0% so this is unlikely to represent significant differentiation between populations. Notably, two

TABLE 1

Variation in mtDNA COI sequences of the 11 lineages in the *Trimma erdmanni-chledophilum* group

K2P distances: minimum interspecific and maximum intraspecific distances (%)

	species	n	location	1a	1b	1c	2a	*tufi*	*pam*	1d	1e	1f	1g	1h
1a	***T. erdmanni***	5	Indonesia CB	0.5	4.5	6.5	9.8	9.1	9.8	10.1	10.2	9.9	9.8	9.3
1b	***T. erdmanni***	8	Indonesia RA		0.3	5.1	9.1	7.6	7.5	8.4	9.1	8.4	9.3	8.8
1c	***T. erdmanni***	3	Indonesia & Phil			0.3	11.0	9.9	9.5	10.6	11.0	10.6	11.2	10.3
2a	***T. chledophilum***	8	PNG Milne Bay				0.5	3.7	8.6	8.1	9.1	8.8	8.4	8.6
	***T. tufiensis*, n.sp.**	3	Tufi, PNG					0.3	8.1	6.1	8.1	7.6	7.5	7.3
2b	***T. pamae*, n.sp.**	5	Tufi MB PNG						1.0	7.7	11.3	10.9	11.3	11.1
1d	***T. erdmanni***	3	PNG Rabaul							0	10.1	10.0	9.5	9.5
1e	***T. erdmanni***	2	Indonesia LS								0	2.7	2.5	3.3
1f	***T. erdmanni***	3	Indonesia Alor									0	2.4	2.8
1g	***T. erdmanni***	2	Indonesia SB										0	2.5
1h	***T. erdmanni***	2	Indonesia HS											0.5

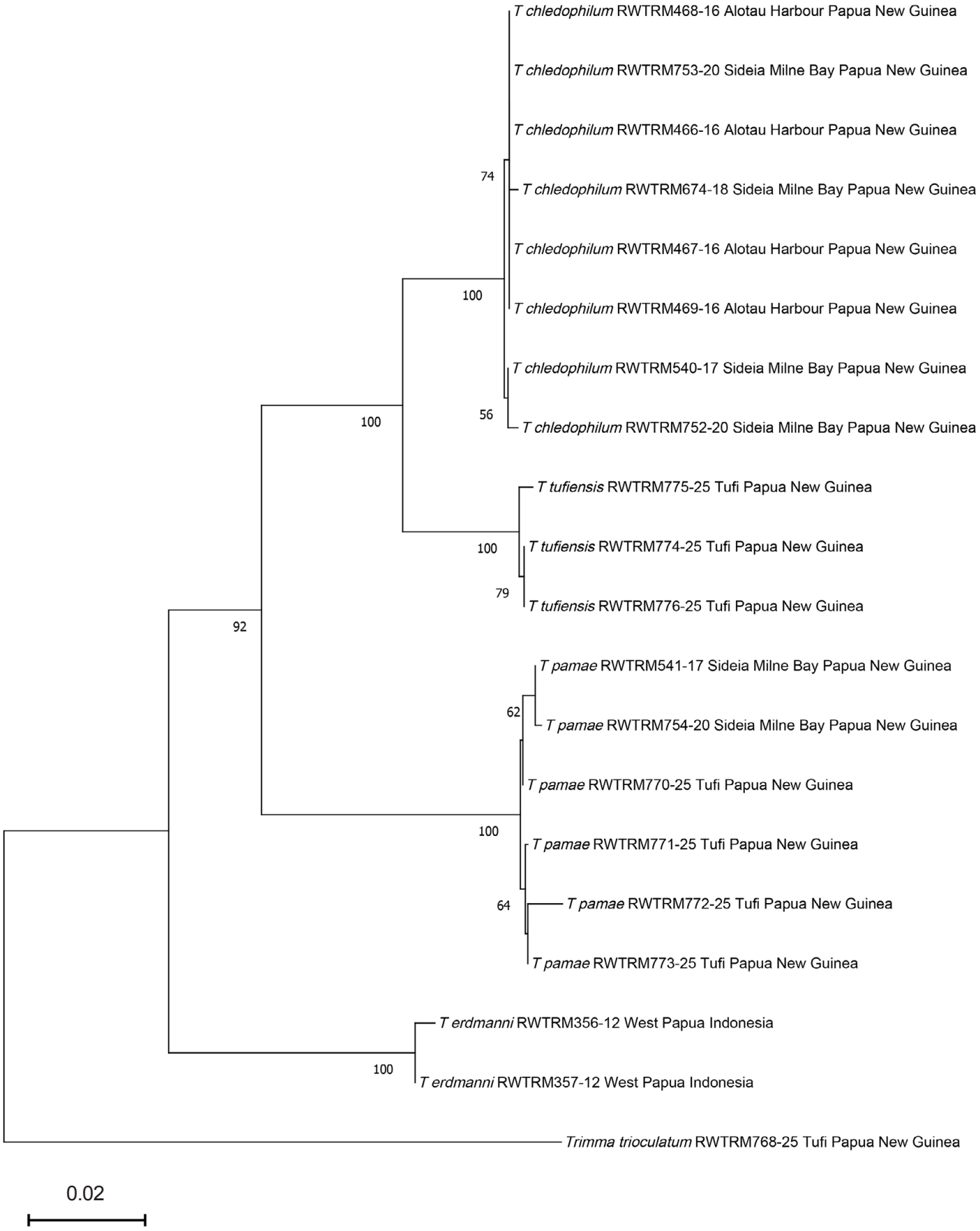

Figure 17. The neighbor-joining tree for mtDNA COI sequences of select *Trimma* lineages and species in the *erdmanni-chledophilum* species group based on p-distances with uniform rates among sites (see Table 1 for distances among all 11 known lineages). *Trimma trioculatum* Winterbottom, Erdmann & Cahyani, 2015 is used as the outgroup. The location of the collection and BOLD process ID numbers are indicated.

of the samples within the *T. pamae* clade were in the BOLD database identified as "*T. chledophilum* Group 2b" (RWTRM541-17, RWTRM754-20). These specimens match the new description, supporting the species delination of *T. pamae*.

Trimma tufiensis forms a sister clade to *T. chledophilum* with a 3.8% genetic difference separating the clades. While not as deep a divergence as for the other species pairwise comparisons, it is greater than the 2% once proposed as an interesting threshold, observed retrospectively for COI among large groups of sequenced fish species, but 2% is definitely not a "criterion for species", a common misconception.

According to Winterbottom et al. (2020), the *erdmanni-chledophilum* species group is composed of multiple haplogroups, including 8 within nominal *T. erdmanni* and two within nominal *T. chledophilum*, some of which may exhibit sufficient phenotypic differences, along with the genetic separation, to warrant species recognition (e.g., their "*T. chledophilum* Group 2b" proved to be *T. pamae*). Winterbottom et al. (2020) comment on the apparent proclivity for speciation in this group, noting that their strong habitat preference for silty reef environments that are frequently widely separated and disjunct in the otherwise continuously distributed clear-water reef habitats of Indonesia and Papua New Guinea, may provide a frequent barrier to dispersal that often leads to allopatric speciation.

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References

Akihito, Sakamoto, K., Ikeda, Y. & Sugiyama, K. (2002) Gobioidei. *In*: Nakabo, T. (Ed.), *Fishes of Japan with pictorial keys to the species. English edition*, *Vol. II.* Tokai University Press, Tokyo, Japan, pp. 1139–1310.

Akihito, Sakamoto, K., Iwata, A. & Ikeda, Y. (1993) Cephalic sensory organs of the gobioid fishes. *In*: Nakabo, T. (Ed.), *Fishes of Japan with pictorial keys to the species*. Tokai University Press, Tokyo, Japan, pp. 1088–1116.

Allen, G.R. (2015) Four new species of *Trimma* (Pisces: Gobiidae) from Papua New Guinea and Indonesia. *Journal of the Ocean Science Foundation*, 14, 28–48. https://doi.org/10.5281/zenodo.1037603

Allen, G.R. & Erdmann, M.V. (2024) *Reef Fishes of the East Indies. Second Edition. Volume III*. Tropical Reef Research, Perth, Australia, pp. 946–1466.

Fricke, R., Eschmeyer, W.N. & van der Laan, R. (Eds.) (2025) *Eschmeyer's Catalog of Fishes: Genera, Species, References, electronic version (9 December 2025)*, San Francisco, CA, USA. Available at http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (last accessed 13 December 2025).

Ivanova, N.V., Zemlak, T.S., Hanner, R.H. & Hebert, P.D.N. (2007) Universal primer cocktails for fish DNA barcoding. *Molecular Ecology Notes*, 7, 544–548.

Jordan, D.S. & Seale. A. (1906) The fishes of Samoa. Description of the species found in the archipelago, with a provisional check-list of the fishes of Oceania. *Bulletin of the Bureau of Fisheries*, 25 (for 1905), 173–488.

Kimura M. (1980) A simple method for estimating evolutionary rate of base substitutions through comparative studies of nucleotide sequences. *Journal of Molecular Evolution*, 16, 111–120.

Saruwatari, T., Lopez, J.A. & Pietsch, T.W. (1997) Cyanine blue: a versatile and harmless stain for specimen observations. *Copeia*, 1997 (4), 840–841. https://doi.org/10.2307/1447302

Tamura K., Stecher G., and Kumar S. (2021) MEGA 11: Molecular Evolutionary Genetics Analysis Version 11. *Molecular Biology and Evolution*, 38, 3022–3027. https://doi.org/10.1093/molbev/msab120.

Winterbottom, R. (2002) Two new species of *Trimma* (Gobiidae) from the central western, and south Pacific. *Aqua, International Journal of Ichthyology*, 5 (5), 45–52.

Winterbottom, R. (2011) Six new species of the genus *Trimma* (Percomorpha: Gobiidae) from the Raja Ampat Islands, Indonesia, with notes on cephalic sensory papillae. *Aqua, International Journal of Ichthyology*, 17 (3), 127–162.

Winterbottom, R. (2019) An illustrated key to the described valid species of *Trimma* (Teleostei: Gobiidae). *Journal of the Ocean Science Foundation*, 34, 1–61. https://doi.org/10.5281/zenodo.3525430

Winterbottom, R., Burridge, M., Erdmann, M.V., Hanner, R.H., Zur, M., Steinke, C. & Choffe, K. (2020) The cryptic cornucopia revisited– an extended analysis of the COI gene in the gobiid fish genus *Trimma* (Percomorpha: Gobiiformes). *Journal of the Ocean Science Foundation*, 36, 91–132. https://doi.org/10.5281/zenodo.4403739

Winterbottom, R., Erdmann, M.V. & Cahyani, N.K.D. (2015) New species of *Trimma* (Actinopterygii; Gobiidae) from Indonesia, with comments on head papillae nomenclature. *Zootaxa*, 3973 (2), 201–226. https://doi.org/10.11646/zootaxa.3973.2.1

Winterbottom R., Hanner R.H., Burridge, M. & Zur, M. (2014) A cornucopia of cryptic species—a DNA barcode analysis of the gobiid fish genus Trimma (Percomorpha, Gobiiformes). *ZooKeys*, 381, 79–111. https://doi.org/10.3897/ZooKeys.381.6445