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A new pygmy hogfish (Labridae: *Bodianus*) of the subgenus *Trochocopus* from the tropical southern Pacific Ocean

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Abstract

Bodianus bennetti, n. sp. is described from a single specimen collected at 97 m depth at Flora Reef in the Coral Sea off the Queensland coast of Australia, as well as from images of individuals from Moorea, French Polynesia. The new hogfish is a member of the subgenus *Trochocopus*, whose members frequent deep-reef habitats and are amongst the smallest species of this speciose labrid genus. The new species closely resembles two red-striped species, the western Pacific *B. neopercularis* and the Indian Ocean *B. opercularis*, differing from them in consistently lacking a continuation of the ventral red body stripe onto the head. The species was first noticed by the prominent lemon-yellow rather than white intervening stripes (between the red stripes) in the first specimens, although subsequently the stripe color was observed to vary from lemon-yellow to white in the same individual. The mtDNA COI barcode sequence of the new species is compared to one of these two closely related species and five additional members of the subgenus, revealing the new species to be 4.3% divergent (K2P and uncorrected pairwise) from its nearest-neighbor sequence, *B. neopercularis* (based on a specimen from Micronesia).

Key words: ichthyology, taxonomy, systematics, coral-reef fishes, wrasse, Indo-Pacific Ocean.

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Introduction

Although many species within the diverse labrid genus *Bodianus* are capable of attaining moderate to large maximum lengths relative to other wrasses, the species of the subgenus *Trochocopus*, proposed by Gomon (2006) as a monophyletic lineage diverging early within the evolution of the genus, are noteworthy in being relatively small, attaining maximum lengths of only 60–180 mm SL. Prior to 1973, only two of these diminutive species had been formally named: *Bodianus opercularis* (Guichenot, 1847) and *B. sanguineus* (Jordan & Evermann, 1903). At present, the subgenus comprises eight known species. One reason for the fairly recent discoveries may be these species' predilection for living on deep reefs. With the increased exploration of tropical reef environments at greater diving depths, coupled with the growing demand for rare tropical aquarium fish, the number of species in this subgenus may very well increase in the near future.

In 2015, a tropical fish collector, based in Cairns, Queensland, collected a species bearing a close resemblance to *B. neopercularis*, and, at the same location, observed specimens of *B. sepiacaudus*– neither of which had previously been documented from Australian waters. A few days post-collection, the specimen resembling *B. neopercularis* began exhibiting a color change, with the white intervening stripes replaced by yellow. The mtDNA COI sequence of the specimen in question was compared to sequences from 6 of the 8 species of *Trochocopus*, confirming it to be genetically distinct. We provide a description of the new species and compare it with other closely related congeners.

Materials and Methods

Methods and terminology follow Gomon (2006). Lengths expressed are standard lengths (SL) unless stated as total length (TL). The holotype specimen is currently maintained in 70% ethanol in the fish collection of the National Museum Victoria (NMV). Specimens of other species of the subgenus examined as the basis for morphometric data reported in Table 1 are identified in Gomon (2006).

DNA extractions and sequencing, calculations of sequence divergences and the generation of the phenetic tree in Figure 3 were performed using the methodology described by Randall & Victor (2013: 44–45).

Bodianus bennetti, n. sp.

Lemon-striped Pygmy Hogfish

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Figures 1–2; Table 1.

Holotype. NMV A 31528-001, 109 mm SL, Australia, Coral Sea, Flora Reef off Queensland, outer reef slope, 16°46'30" S, 147°46'53" E, 97 m, Timothy Bennett, May 2015.

Diagnosis. A species of the subgenus *Trochocopus* with: ii,15 pectoral-fin rays; 42 + 2 lateral-line scales; 4.5 scales above lateral line, 13 scales below lateral line; 11 predorsal scales; 12 total gill rakers; shallow body, depth 25.0% SL; eye of moderate size, orbital diameter 7.0% SL; narrow interorbital space, 6.4% SL; shallow caudal peduncle, 13.2% SL; short posterior lobes on dorsal (11.1% SL) and anal (10.0% SL) fins; short pectoral fin, 18.0% SL; pelvic fin of moderate length, 16.1% SL, tip reaching midway between fin origin and anus; posterior corner of mouth below anterior extent of orbit; upper jaw with length of first prominent anterior canine about equal length of second; dental ridge smooth with regular series of granular teeth, single prominent canine at posterior end of jaw; lower jaw with first prominent anterior canine about half length of second; dental ridge with about 10 small erect canines increasing slightly in length from front to back, followed by about 8 shorter teeth; vomerine teeth

absent; pelvic fin short, tip reaching just beyond anus; body with three broad, red, lengthwise stripes separated by lemon-yellow or white stripes with lowermost red stripe not continuing anteriorly onto head, prominent black spot on middle red stripe on operculum behind eye and black pigmentation on membranes between first three or four dorsal-fin spines (Fig. 1); juveniles with prominent black spot at posterior end of middle red stripe on scaly caudal-fin base, which turns red in initial-phase adults and becomes more prominent in terminal-phase adults.

Description. Dorsal-fin rays XII,10; anal-fin rays III,12; caudal-fin rays 11 + 12 + 9; pectoral-fin rays ii,15; lateral-line scales 42 + 2; scales above lateral line 4.5; scales below lateral line 13; predorsal scales 11; total gill rakers 12; vertebrae 11 + 17= 28.

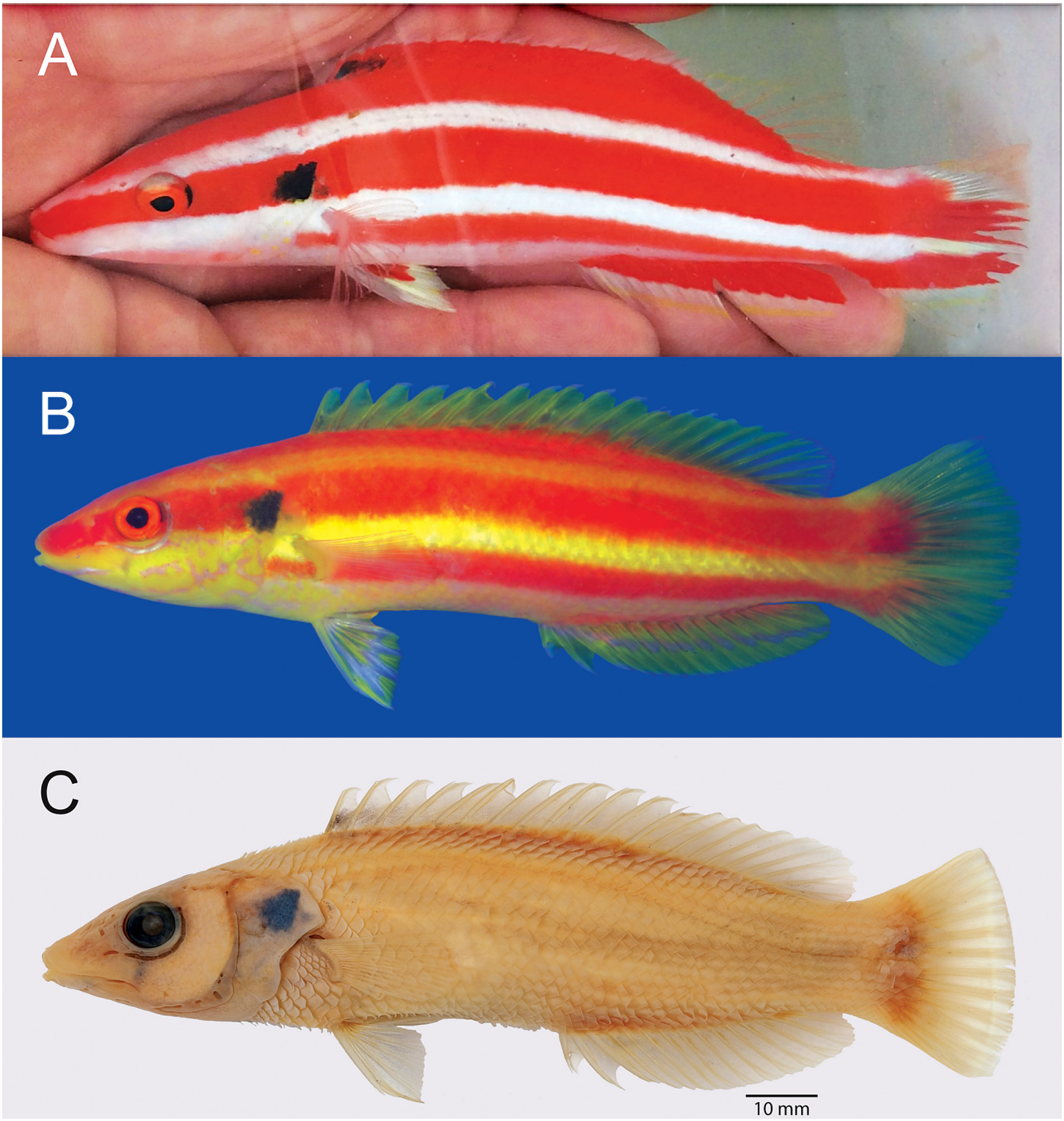

Figure 1. *Bodianus bennetti* n. sp., holotype, NMV A 31528-001, 109 mm SL, Coral Sea, Flora Reef off Queensland, Australia: A) alive (T. Bennett); B) fresh, photo reversed (T. Bennett); and C) preserved, photo reversed (D. Paul, NMV).

TABLE 1

Selected proportional morphometric values expressed as % of Standard Length for five species of *Bodianus*

(comparable ranges for described species from Gomon (2006), Table 2)

	B. bennetti, n.sp.	*B. masudai*	*B. neopercularis*	*B. opercularis*	*B. sepiacaudus*
Number of specimens	1	4	2	11	4
Standard length (mm)	109	84.5–145	83.3–97.2	44.0–112	70.0–73.2
Body depth	25.0	25.7–30.8	22.6–25.1	20.9–24.6	22.3–25.0
Caudal-peduncle depth	13.2	14.6–16.7	13.2–14.1	12.5–14.1	12.8–14.1
Caudal-peduncle length	9.4	–	–	–	–
Head length	35.9	36.0–37.9	35.2–36.9	35.2–37.9	34.8–36.9
Snout length	11.8	11.1–13.5	12.4–12.7	10.8–13.6	10.4–12.7
Orbital diameter	7.0	6.1–7.7	7.7–7.8	6.2–8.4	6.9–7.7
Interorbital width	6.4	6.2–6.5	5.5–6.8	5.0–6.2	5.1–5.9
Predorsal length	36.2	–	–	–	–
Preanal length	62.1	–	–	–	–
Prepelvic length	35.8	–	–	–	–
Dorsal-fin base	55.7	49.6–53.5	49.1–52.7	48.7–53.0	45.9–51.3
First dorsal-fin spine	6.2	5.6–6.3	5.6–6.0	5.0–6.1	4.9–6.1
Second dorsal-fin spine	7.3	6.8–7.5	6.1–6.5	6.2–7.8	5.9–7.4
Last dorsal-fin spine	11.0	11.2–11.9	9.6–12.1	10.7–12.2	9.3–11.6
Posterior lobe of dorsal fin	11.1	13.5–14.8	8.7–12.2	9.5–12.5	8.9–11.7
Anal-fin base	28.1	22.6–27.7	27.3–27.6	22.3–27.6	23.3–24.8
First anal-fin spine	5.5	5.1–5.6	5.5–5.6	4.6–5.7	4.0–6.3
Third anal-fin spine	11.4	10.0–12.4	11.8–12.0	9.5–13.2	9.4–11.3
Posterior lobe of anal fin	10.0	10.7–12.4	8.4–8.8	10.0–11.5	7.9–12.1
Pectoral-fin length	18.0	18.6–21.9	15.6–17.7	15.4–18.3	16.2–17.3
Pelvic-fin length	16.1	17.6–19.0	16.2–16.6	15.4–16.7	15.1–17.1
Uppermost caudal-fin rays	19.4	20.2–20.8	17.8–20.0	–	15.0–19.6
Medial caudal-fin rays	19.5	20.4–25.9	19.2–20.1	19.4–22.3	14.6–20.9

(See Table 1 for morphometric values) Body moderately slender, caudal peduncle of moderate depth; dorsal outline of snout, forehead and nape mostly straight in lateral profile; jaws not attenuate.

Scaly basal sheath on dorsal and anal fins very low, at most one scale in depth. Predorsal scales reaching forward on dorsal midline of head in advance of vertical at posterior margin of preopercle; scales lateral to midline not reaching in advance of those on dorsal midline. Cheek scales embedded, reaching forward almost to posterior corner of mouth, reaching markedly short of free preopercular edge posteriorly and ventrally, leaving broad naked preopercular margin; scales on subopercle reaching forward nearly to below anterior end of ventral preopercular edge; lower jaw naked. Lateral-line scales each with a single, unbranched laterosensory-canal tube flexed dorsoposteriorly near posterior edge of scale. Posterior edge of preopercle smooth. Posterior corner of mouth reaching just posterior to vertical through anterior extent of orbit. Gill rakers narrow, moderately long and simple on lower limb; rakers noticeably shorter on upper limb than on lower.

Upper jaw with first prominent anterior canine approximately equal length of second, first canine directed anteroventrally and curved ventrally; second canine curved ventrolaterally; dental ridge smooth with regular series of granular teeth, single prominent canine posteriorly directed strongly anteriorly and somewhat ventrolaterally. Lower jaw with first prominent anterior canine about half length of second; first canine directed dorsally and slightly mesially; second canine directed dorsolaterally; apex of dental ridge with about 10 small erect canines increasing slightly in length from front to back, followed posteriorly by series of distinctly shorter teeth. Vomerine teeth absent.

Posterior tip of dorsal fin broadly rounded, not reaching posterior edge of hypurals. Posterior tip of anal fin narrowly rounded, not quite reaching posterior edge of hypurals. Caudal fin slightly rounded. Posterior edge of pectoral fin truncate dorsally, broadly rounded ventrally. Pelvic fin short, tip reaching just beyond midpoint between origin of fin and origin of anal fin.

Color in life. Juveniles (Fig. 2A) apparently very similar to initial-phase adults described below, with black spot on membranes at front of dorsal fin extending onto membranes of subsequent few spines, and prominent black spot on scaly caudal-fin base at posterior end of second red stripe. Images of both yellow and white-striped very young individuals indicate individual variation in this feature.

Head and body of initial-phase adults (Figs. 1A & B, 2B) with prominent, broad, red and yellow or white stripes; dorsalmost red stripe on dorsal midline from rear of snout to posterior end of caudal peduncle, second stripe broadest, running from anterior part of snout, across eye, and continuing horizontally to caudal-fin base just above lateral midline where it can expand into darker red spot, and third stripe slightly narrower, from posterior margin of operculum or lower half of pectoral-fin base onto basal half of lower fifth of caudal fin; contrasting yellow or white stripes separating red stripes, upper stripe narrower, from tip of snout passing over eye extending to base of tail, middle stripe from edge of upper jaw across upper half of pectoral-fin base extending to caudal-fin base just below lateral midline, lower stripe apparently consistently white, covering underside of body below pectoral-fin base to lower side of caudal peduncle; yellow or white color of upper two stripes appear to be associated with mood of individual, with middle stripe appearing as a yellow-edged white stripe in some images of live fish.

Stripes on body continue onto head, except for lowermost red stripe, which extends anteriorly only to pectoral-fin base (Fig. 2) or, in holotype, to margin of opercle (Fig. 1); lower part of head, below eye, mainly white or with yellow band or yellow mottling; distinct blue-edged black spot, smaller than eye, on middle red stripe midway between free edge of opercle and preopercle; black patch on dorsoposterior surface of orbit. Dorsal fin with variably broad, red basal stripe and contrasting variably broad, yellow or white distal margin; blackish spot on membrane between first three or four spines. Anal fin similarly with variably broad, red basal stripe with a yellowish distal margin, broad yellowish marginal stripe, and narrower white intermediate stripe. Caudal fin translucent yellowish with continuation of prominent red and yellow or white stripes on caudal peduncle, at least basally, and blackish-to-red spot near posterior end of middle red stripe on scaly caudal-fin base. Pectoral fin yellowish to transparent. Pelvic fin white, with or without basal red blotch and/or yellow, narrow, lengthwise stripes and blotches.

Terminal-phase adults (Fig. 2C) apparently very similar to initial-phase adults, but with red spot on scaly caudal-fin base larger and more distinct.

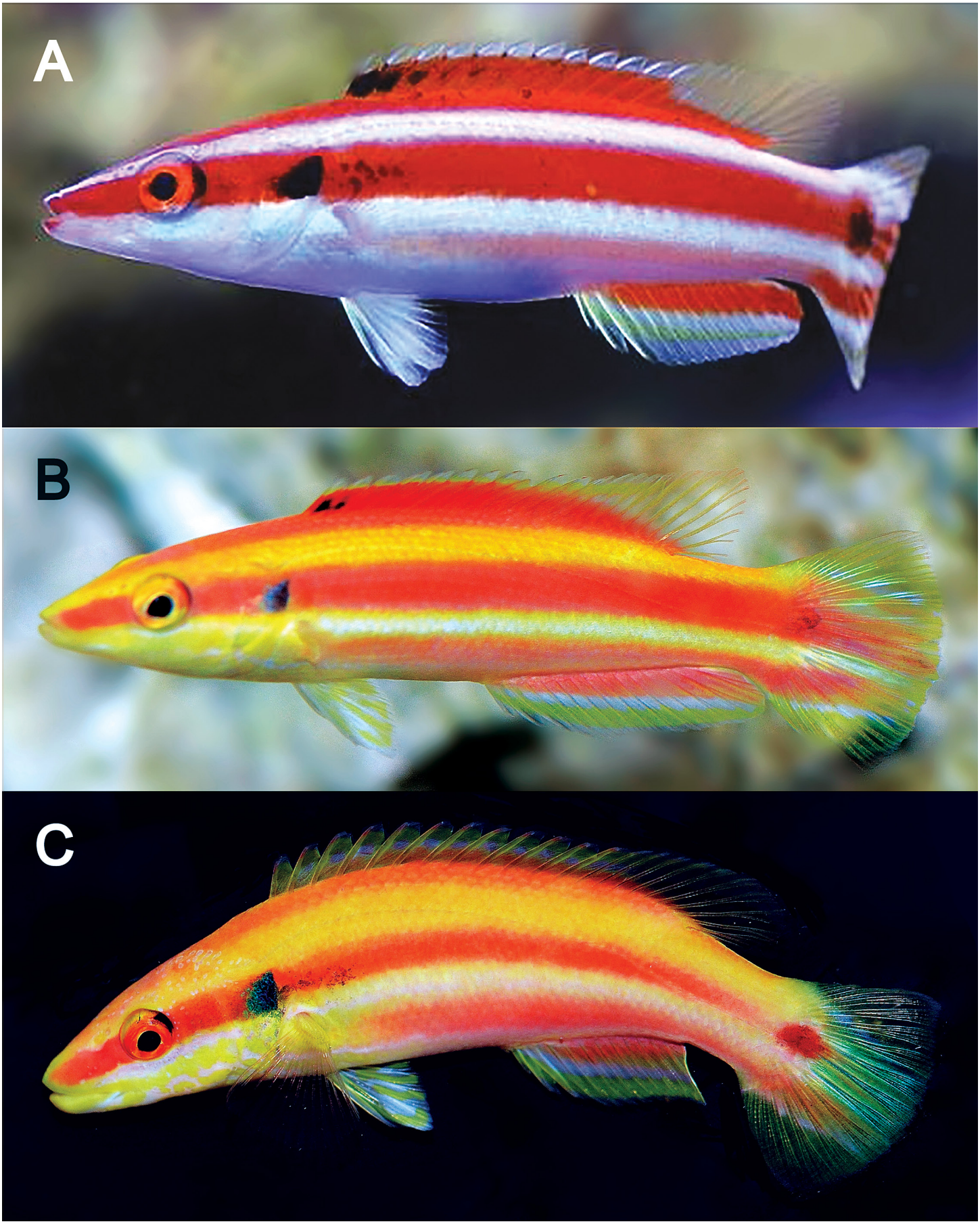

Figure 2. *Bodianus bennetti* n. sp., specimens not retained, aquarium trade from Moorea, French Polynesia: A) apparent juvenile, approximately 60 mm TL; B) apparent young initial-phase adult, approximately 75 mm SL; and C) apparent terminal-phase adult, approximately 150 mm TL (Yi-Kai Tea).

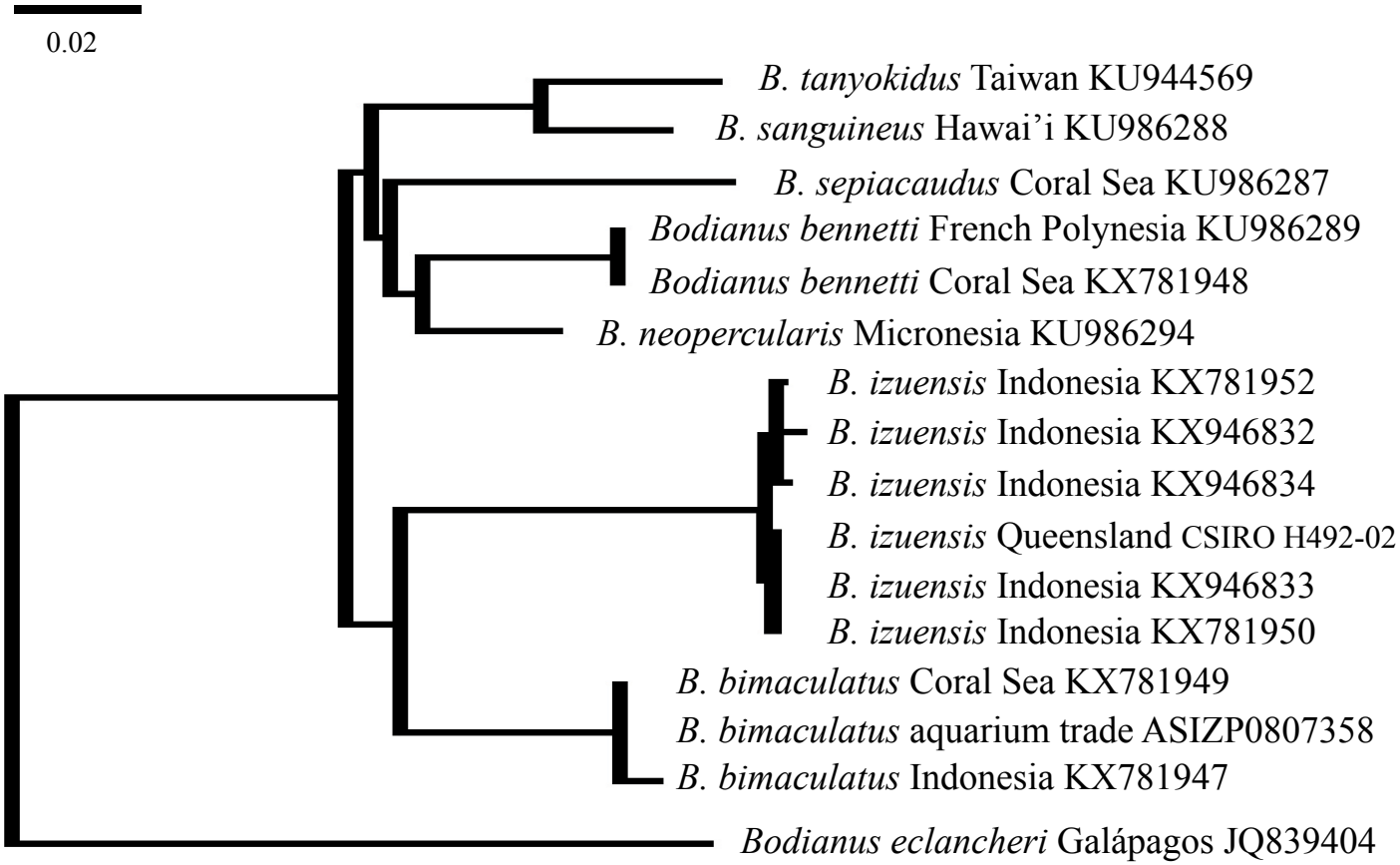

Figure 3. Neighbor-joining phenetic tree based on 15 COI mtDNA sequences of 7 species of *Bodianus* (*Trochocopus*) following the Kimura two-parameter model (K2P) generated by BOLD (Barcode of Life Database). The scale bar on the left represents a 2% sequence difference. Collection locations for specimens are indicated and associated GenBank numbers indicated (two unlisted sequences are identical to adjacent GenBank sequences); *Bodianus eclancheri* is used as an outgroup. Note FJ237633 in GenBank, listed as "*B. tanyokidus*", is misidentified and not *Bodianus*. The *B. bimaculatus* sequence, from the aquarium trade in Taiwan, was provided by Chang *et al*. (2016).

Color in preservative. Juveniles unavailable. Initial-phase adults (Fig. 1C) with pale body and fins; large anteriorly curved, dark spot on head between posterior edge of preopercle and posterior margin of opercular flap above level of pectoral-fin base. Dorsal fin with dusky pigment on membrane between first three spines. Terminal-phase adults unavailable.

Etymology. The specific name *bennetti* recognises Timothy Bennett, the collector of the holotype of the new species. Our proposed vernacular name, Lemon-striped Pygmy Hogfish, refers to both the unique yellow pattern present in many individuals and the great assistance generously provided by "Lemon" Yi-Kai Tea in documenting this species.

Distribution. *Bodianus bennetti* is known from the Coral Sea off the northeastern coast of Queensland as well as from Moorea in French Polynesia. The fish were observed on a gentle slope, over clean rubble, in a high-current area at 97 m at the type locality of Flora Reef and at 130 m in Moorea.

Genetic analysis. Sequences of the mitochondrial DNA marker COI, used in the Barcode of Life project and analyzed in the BOLD database (www.boldsystems.org), were obtained from tissues of two specimens of *B. bennetti*: the holotype from the Coral Sea and a specimen from Moorea, French Polynesia, which was not retained as a voucher. The two sequences are identical in all 652 bp. A comparison of the two with 13 sequences from 6 of the 8 currently recognized species in the subgenus *Trochocopus* (*B. opercularis* and *B. masudai* were not sequenced), using *Bodianus eclancheri* as an outgroup, places *B. bennetti* as sister to *B. neopercularis* with a divergence of 4.3% (K2P and uncorrected pairwise minimum interspecific distance; Fig. 3). The 7 species of

the subgenus form two major clusters, with *B. neopercularis*, *B. sanguineus*, *B. tanyokidus*, and *B. sepiacaudus* clustering with *B. bennetti*, while *B. bimaculatus* clusters separately with *B. izuensis*. The sequence divergences between pairs of species within the subgenus range from 3.94% to 10.12% (minimum interspecific distances by K2P). As we were unable to sequence *B. opercularis*, the presumed Indian Ocean sibling species of *B. bennetti*, the lower range of divergence within the subgenus cannot be fully assessed. The genetic results for the *Trochocopus* species are consistent with the findings from prior genetic analyses of the species of *Bodianus*: Randall and Victor (2013) compared 85 COI mtDNA sequences from twenty species of *Bodianus* (about half of the known species), including *B. bimaculatus*, and found relatively deep divergences between species and, in most cases, only minimal variation within species. They found a wider range of divergences across the genus as a whole, from 1.97% to 21.74% between pairs of species.

Although the specimens of *B. bennetti* from the Coral Sea and French Polynesia share mtDNA haplotypes, indicating present, or very recent, gene flow across the tropical southern Pacific Ocean, the status of the two populations cannot be fully assessed without additional sampling. Nevertheless, available images of three Moorea specimens have the anterior end of the lowermost red stripe at or just posterior to the lower end of the pectoral-fin base as well as the pelvic fin without a basal red blotch in individuals having white stripes (Fig. 2), while the lowermost red stripe begins at the opercular margin in the holotype and the pelvic fin has a red spot basally in individuals displaying white stripes (Fig. 1). Due to the paucity of available specimens, it is not possible to determine if this represents individual or geographical variation.

Comparisons. Morphologically, within the subgenus *Trochocopus*, *B. bennetti* resembles *B. masudai*, *B. neopercularis*, *B. opercularis*, and *B. sepiacaudus* in having prominent, broad, red, longitudinal stripes running the length of the head and body in large adults. Unlike on those congeners, the lowermost red stripe in *B. bennetti* does not extend onto the head. Instead, the stripe extends onto the head as, at most, a narrow yellow stripe with other yellow markings below the eye, or a pinkish hue below the eye when yellow is not expressed. The lateral-line scale count in *B. bennetti* of 42 is within the ranges of *B. neopercularis* (40–43) and *B. opercularis* (40–46), both of which have red-striped patterns that most closely match that of the new species, while *B. sepiacaudus* (35–40) and *B. masudai* (31) have fewer lateral-line scales and distinctive black pigmentation on the caudal fin (all but absent in the former three species).

Discussion. The vernacular name Lemon-striped Pygmy Hogfish may be somewhat misleading for this species, as the characteristic yellow stripes appear to be somewhat reflective of the "mood" or some other "psychological" state of the individual. Some evidence based on individuals maintained in aquaria supports the notion that non-stressed fish retain yellow stripes, while "distressed" individuals lose the yellow hue and display a stark red-and-white pattern. This hypothesis requires testing. Yellow stripes do feature in other species of the subgenus, including *B. masudai* (Gomon 2006: Plate 1I), *B. neopercularis* (Gomon 2006: Plate 2B), and *B. sanguineus* (Gomon 2006: Plate 2E), while *B. tanyokidus* (Gomon 2006: Plate 2I) and some individuals of *B. bimaculatus* (Gomon 2006: Plate 1C–E) have a more dominant yellow coloration overall.

Acknowledgments

Our sincere gratitude goes to Benjamin Victor for his immediate response to our request to compare a COI sequence from the holotype of *B. bennetti* with those of obviously closely related species and his proactivity in including other members of the tribe. He also provided the phenetic tree in Figure 3 (via BOLD), submitted the sequences to Genbank, and made numerous helpful comments about the manuscript. We are likewise extremely grateful to "Lemon" Yi-Kai Tea for his generosity in allowing us to use his photos and view photos of others in his possession, and his contacts with Rufus Kimura, who collected the Moorea specimens. Chia-Hao Chang and Kwang-Tsao Shao of the Biodiversity Research Center, Academia Sinica, Taiwan provided valuable information and sequences. Other specimens, tissues, sequences, and metadata were provided by Yi-Kai Tea, as well as Bob Ward, William White, Melody Puckridge, Alastair Graham, and Daniel Gledhill of CSIRO and Mark Erdmann of Conservation International Indonesia Marine Program, Bali. Many thanks to Lyle Squire of Cairns Marine for kindly donating the holotype. The photograph of the preserved holotype was provided by David Paul, NMV. The manuscript was reviewed by two anonymous reviewers.

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