Zoological Studies **62:** 8 (2023)
doi:10.6620/ZS.2023.62-08

Zoological Studies

Open Access

Terelabrus toretore sp. nov. (Perciformes: Labridae), a New Species of Striped Hogfish from Tahiti, with Range Extensions for Two Congeners

Bart Shepherd[1,*], Hudson T. Pinheiro[2,3], Tyler A.Y. Phelps[2], Gilles Siu[4], and Luiz A. Rocha[2]

[1]*Steinhart Aquarium, California Academy of Sciences, San Francisco, CA 94118, USA. *Correspondence: bshepherd@calacademy.org (Shepherd)*
[2]*Department of Ichthyology, California Academy of Sciences, San Francisco, CA 94118, USA. E-mail: htpinheiro@gmail.com (Pinheiro); tylerayphelps@gmail.com (Phelps); lrocha@calacademy.org (Rocha)*
[3]*Center for Marine Biology, University of São Paulo, São Sebastião, SP 11612-109, Brazil*
[4]*PSL Research University, EPHE-UPVD-CNRS, USR 3278 CRIOBE, Laboratoire d'Excellence "Corail", BP 1013, 98729 Papetoai, Moorea, French Polynesia. E-mail: gilles.siu@criobe.pf (Siu)*

Received 3 August 2022 / Accepted 14 December 2022 / Published 31 March 2023
Communicated by Felipe Ottoni

A new labrid fish, *Terelabrus toretore* sp. nov., the fifth species within the genus, is herein described from two specimens collected at a depth of 140 m from a mesophotic coral ecosystem in Tahiti, French Polynesia. *Terelabrus toretore* sp. nov. is characterized by having 43–44 scaled rows in longitudinal series; 42 pored lateral-line scales; 5+10 gill rakers; 10 scale rows below the lateral line; 8 posterior branches on the main supratemporal sensory canal; a relatively long snout (snout length 9.6–9.7% SL), and a coloration consisting of a yellow caudal fin and a wide, red, mid-lateral stripe with no blotching, the space above which is white anteriorly, becoming predominantly yellow from beneath the dorsal fin to the caudal peduncle. In addition to describing this new species, we document the first record of *Terelabrus rubrovittatus* from the Republic of Marshall Islands, and the first record of *Terelabrus zonalis* from Australia, along with the first description of its coloration. We present a molecular phylogeny of the genus based upon mitochondrial cytochrome *c* oxidase subunit I (*COI*) DNA sequences.

Key words: Biogeography, Ichthyology, Mesophotic coral ecosystems, Taxonomy, Teleostei.

BACKGROUND

There are currently four described species of striped hogfish within the genus *Terelabrus* Randall and Fourmanoir 1998, all of which were collected from mesophotic reefs (50–150 m depth; Rocha et al. 2018) in locations across the Pacific and Indian Oceans. *Terelabrus rubrovittatus* Randall and Fourmanoir 1998, the first member of the genus to be described, initially was known only from a single specimen caught in a trap at a depth of 100 m in New Caledonia. A second specimen was collected at a depth of 92 m in Papua New Guinea (Randall and Fourmanoir, 1998). Nearly 20 years later, the second species in the genus, *Terelabrus dewapyle* Fukui and Motomura 2015 was described from five specimens collected in southern Japan, Papua New Guinea, and Fiji. Again, the specimens were collected from mesophotic coral ecosystems at depths of 72–92 m. The following year, a third species was described from the Maldives: *Terelabrus flavocephalus* Fukui and Motomura 2016 was first seen in an underwater photograph and later described from a single specimen acquired from the marine aquarium trade. The most recently described species, *Terelabrus zonalis* Fukui 2018, is known only from two preserved specimens collected by trawl at a

Citation: Shepherd B, Pinheiro HT, Phelps TAY, Siu G, Rocha LA. 2023. *Terelabrus toretore* sp. nov. (Perciformes: Labridae), a new species of striped hogfish from Tahiti, with range extensions for two congeners. Zool Stud **62:**08. doi:10.6620/ZS.2023.62-08.

© 2023 Academia Sinica, Taiwan

depth of 73–84 m in the Philippines.

Terelabrus are small, fast swimming labrid fishes, characterized by an elongated, cylindrical body, large eyes and a body coloration typically consisting of alternating longitudinal stripes of red and yellow or white, which extend along the full length of the body. Important characters used to differentiate between the species include the number of scale rows in longitudinal series, the number of gill rakers, the number of posterior branches of the main supratemporal sensory canal, and color (Fukui 2018). As with numerous other new fishes that have been recently described from deep reefs, these species have been described using only a single or small number of specimens but are likely common in their habitat (Sih et al. 2017; Coleman et al. 2018; Pinheiro et al. 2019).

While conducting ichthyological surveys on mesophotic ecosystems in French Polynesia in early 2019, we collected two specimens of a presumed new species of *Terelabrus*. Later that year, we collected two specimens of another species of *Terelabrus* during a research expedition to the Marshall Islands. The latter species, upon closer examination of their coloration and morphology, was identified as *T. rubrovittatus*. Furthermore, in July 2020, Tahiti Private Expeditions, while testing an ROV on the northern coast of Moorea at depths to 300 m, took pictures of a previously unknown species of *Terelabrus*. Here we describe the species from French Polynesia as *Terelabrus toretore* sp. nov., and report *T. rubrovittatus* for the Marshall Islands for the first time, representing a large range extension for the species. We also document the first record of *T. zonalis* outside of the Philippines, a specimen collected on the Great Barrier Reef and held in the Queensland Museum, and describe its coloration for the first time. Finally, we present a phylogeny of the genus based upon mitochondrial DNA.

MATERIALS AND METHODS

All specimens were collected with hand nets while diving on mixed-gas closed-circuit rebreather (Hollis Prism 2) in French Polynesia (Tahiti, Moorea) and Micronesia (Majuro, Republic of Marshall Islands). Specimens were collected and immediately transported to a field laboratory, where they were photographed, tissues sampled, fixed in 10% formalin, and preserved in 75% ethanol. The preserved specimens were later measured and x-rayed at the California Academy of Sciences. Measurements were taken with digital calipers to the nearest 0.01 mm and rounded to one decimal place, following the conventions described in Fukui (2018) and Fukui and Motomura (2015 2016). All measurements were taken on the left side of the body with the aid of a dissecting microscope. Principal and procurrent caudal-fin ray counts are presented as upper + lower. Vertebral counts are presented as precaudal + caudal. The anterior-most vertebra with a haemal spine was counted as the first caudal vertebra, and the urostylar complex was counted as the last. Gill raker counts are presented as upper (epibranchial) + lower (ceratobranchial) rakers on the anterior face of the first arch; the angle raker is included in the second count. The anterior supraneural-dorsal ray-pterygiophore-neural spine interdigitation pattern is presented as a formula with "0" representing a supraneural, "/" a neural spine, and numerals indicating the number of spines borne by each pterygiophore (Anderson and Heemstra 2012; Williams et al. 2013). Measurements in the text are proportions of standard length (SL), unless otherwise noted. Values in parentheses are for the paratype, when different from the holotype. The holotype and paratype were deposited into the California Academy of Sciences ichthyological collection (CAS).

Mitochondrial cytochrome *c* oxidase subunit I (*COI*) DNA was sequenced and analyzed for the new species. DNA extraction and PCR amplification of the COI gene were performed following protocols detailed in Weigt et al. (2012). DNA sequences of other *Terelabrus* species and three outgroups were obtained from Genbank and the Barcode of Life Database, and aligned to new sequences obtained by our team for *Terelabrus flavocephalus* from the Maldives, *T. dewapyle* from the Philippines, and *T. rubrovittatus* from the Marshall Islands. Specimen voucher numbers and sequence accession numbers are given in table 1. Alignments of DNA sequences were done using a standard Geneious global alignment with free end gaps and 65% similarity in the program Geneious Prime 2022.2.2 (Biomatters, Auckland; Kearse et al. 2012).

In the most complete Labridae molecular phylogeny published to date, Aiello et al. (2017) show that *Terelabrus* is a member of the tribe Hypsigenyini (hogfishes and tuskfishes) with no clear close relative. Therefore we chose three members of that tribe (*Achoerodus viridis* Steindachner 1866; *Bodianus trilineatus* Fowler 1934; and *Lachnolaimus maximus* Walbaum 1792) as outgroups for our phylogeny. Analyses used a Bayesian approach performed with MrBayes 3.2.7 (Ronquist et al. 2012), with two runs and four chains (one cold, three heated) per run implemented in Geneious Prime. The Metropolis-coupled Markov Monte Carlo chains were run for 10 million generations, sampled every 1,000 generations, and the first 2,500 samples were discarded as burn-in (25%). The evolutionary model implemented by Mr. Bayes is GTR + I + G, and the outputs of the analyses

© 2023 Academia Sinica, Taiwan

were visualized with Geneous Prime. Topologies of three independent runs were identical.

RESULTS

Terelabrus toretore Shepherd, Pinheiro, Phelps, Siu and Rocha sp. nov.

Common name: Tahitian striped hogfish
(Figs. 1, 2, 3; Table 2)
urn:lsid:zoobank.org:act:62B6B7A8-D061-41C6-A08B-73B5EB77D13A

Type locality: Tahiti, French Polynesia.

Holotype: CAS-ICH 247318, field code: HTP927, GenBank OP721249. 58.3 mm SL, Tahiti, French Polynesia, -17.528673°S, -149.579084°W, depth of collection 140 m, collected with hand nets by HT Pinheiro, TAY Phelps, MV Bell, B Shepherd, and LA Rocha, 5 March 2019.

Paratype: CAS-ICH 247319, field code: HTP928, GenBank OP721250. 44.3 mm SL, same data as holotype.

Etymology: The species name, toretore, is the Tahitian word for striped and is used in reference to the body color pattern. To be used as a noun in apposition.

Diagnosis: *Terelabrus toretore* sp. nov. can be distinguished from the other four members of the genus by the following characters: 43–44 scaled rows in longitudinal series; 42 pored lateral-line scales; 5 + 10 gill rakers; 10 scale rows below lateral line; a relatively long snout (snout length 9.6–9.7% SL); 8 posterior branches on the main supratemporal sensory canal, and a coloration consisting of a yellow caudal fin, and a wide, red, mid-lateral stripe with no blotching, the space above which is white anteriorly, becoming yellow from beneath the dorsal fin to the caudal peduncle.

Description: Dorsal fin X, 11; anal fin III, 12; pectoral fin with 15 soft rays, all branched except first and second; pelvic fin I, 5; principal caudal rays 14; branched caudal rays 12; upper procurrent caudal rays 9, the most posterior segmented; lower procurrent caudal rays 8 (9), the most posterior segmented; scale rows in longitudinal series 43 (44); pored lateral-line scales 42; scale rows above lateral line to origin of dorsal fin 3; scale rows below lateral line to origin of anal fin 10; scale rows on cheek 5; gill rakers 5 + 10; formula for configuration of supraneural bones, anterior neural spines and anterior dorsal pterygiophores //0/1 + 1/1/1/1/1/1/1/1/1; vertebrae 11 + 17.

Body depth 13.9 (15.6); body width 9.3 (8.8); head length 33.8 (32.3); snout length 9.6 (9.7); orbit diameter 8.1 (7.7); interorbital width 4.6 (4.3); upper-jaw length 7.9 (8.1); postorbital length 14.1 (13.5); caudal-peduncle length 15.3 (17.6); caudal-peduncle depth 8.2 (8.6); pre-dorsal-fin length 32.8 (35.2); pre-anal-fin length 57.1 (57.3); pre-pelvic-fin length 32.6 (33.0); dorsal-fin base length 48.9 (50.1); first dorsal-fin spine length 4.8 (5.0); second dorsal-fin spine length 6.7 (5.9); third dorsal-fin spine length 7.9 (8.6); tenth dorsal-fin spine length 8.7 (9.5); longest dorsal-fin soft ray the eighth (seventh), its length 10.8 (12.2); anal-fin base length 29.2 (30.2); first anal-fin spine length 3.3 (2.7); second anal-fin spine length 6.5 (5.2); third anal-fin spine length 7.4 (6.8); longest anal-fin soft ray the fifth (sixth), its length 9.8 (9.3); pectoral-fin length 14.4 (15.3); pelvic-fin length 13.2 (11.5); least distance between anteroventral margin of orbit and maxilla 1.7 (1.6).

Body elongate, cylindrical, becoming more compressed posteriorly. Snout long and pointed. Eye very large, interorbital space slightly convex. Mouth terminal, gape oblique; posterior margin of maxilla does not extend to a vertical through the anterior margin of orbit; inner surface of upper lip with 5 oblique fleshy ridges with small dense papillae; inner surface of lower lip with two fleshy ridges without papillae; lower lip with thin flap extending ventrally on side of jaw. Teeth

Table 1. Sequence accession numbers (GenBank for all species, except *T. zonalis*, which is only accessioned in the Barcode of Life database) and specimen voucher numbers for sequences used in the phylogenetic analysis

Species	Sequence accession #	Specimen voucher #
Lachnolaimus maximus	JQ841241	BZLWD7678
Bodianus trilineatus	JF492970	ADC220.9-1
Achoerodus viridis	EF609278	BIOUG:BW-A1227
Terelabrus dewapyle	OP721251	CAS-ICH 243200
Terelabrus flavocephalus	OP721248	CAS-ICH 247321
Terelabrus rubrovittatus	OP721247	CAS-ICH 247320
Terelabrus toretore	OP721249	CAS-ICH 247318
Terelabrus toretore	OP721250	CAS-ICH 247319
Terelabrus zonalis	FOAQ440-21	QM I.41018

© 2023 Academia Sinica, Taiwan

in jaws affixed to outer edge of bony ridge; two pairs of large, slender, strongly-curved canine teeth anteriorly in each jaw, followed by ten smaller, slender canine teeth along each side of upper jaw, the two posteriormost slightly larger; a forward-projecting canine posteriorly on upper jaw (at corner of mouth); each of the pair of upper pharyngeal bones triangular with numerous, small, nodular teeth; row of ten conical teeth along each side of lower jaw, followed by row of seven small teeth. Tongue slender, its upper surface covered with small papillae. Gill rakers short, compressed; rakers on upper limb shorter than those on lower limb; longest raker on first gill arch about half length of longest gill filament; gill membranes free from isthmus.

Nasal organ in oval chamber with convex cutaneous roof; anterior nostril small with short membranous tube. Supratemporal canal with eight pored branches, four per side on both types. Scales thin, cycloid; lateral-line scales continuous, following dorsal contour of body; posterior scales descending toward lateral midline; last two pored scales on base of caudal fin larger than more anterior pored scales; each pored scale on anterior lateral line upwardly angled with a single terminal pore, upwards angle decreases progressively from below end of soft dorsal fin towards completely horizontal tubule at base of caudal fin. Lateral line scales notched at pore, with notches larger posteriorly. Scales become progressively smaller anteriorly. Scales in front of dorsal fin extending forward to vertical through preopercular margin, predorsal scales variable in size. Scales covering opercle, except for membrane. Largest scale behind orbit much smaller than those on opercle; scales of suborbital region smaller, extending forward to below anterior edge of pupil; rest of head naked. No scales on fins, except at base of caudal fin.

Preopercular margin smooth. Opercular membrane extending above upper base of pectoral fin. All dorsal-, anal-, and pelvic-fin soft rays branched; all pectoral-fin rays, except upper two, branched. Dorsal- and anal-fin spines slender. Pectoral fins weakly rounded, seventh ray the longest; pelvic fins short, second ray the longest;

Fig. 1. Coloration of freshly dead specimens of *Terelabrus toretore* sp. nov. (A) holotype CAS-ICH 247318 (SL 58.3 mm), and (B) paratype CAS-ICH 247319 (SL 44.3 mm).

© 2023 Academia Sinica, Taiwan

caudal fin rounded. Origin of dorsal fin slightly posterior to vertical through origin of pectoral fin; posterior tip of pectoral fin aligns with vertical between base of sixth and seventh dorsal-fin spines; origin of pelvic fin aligns with vertical through origin of lower base of pectoral fin; anus located beneath vertical between eighth and ninth dorsal-fin spine bases; origin of anal fin below base of ninth dorsal-fin spine.

Coloration: body white with two wide longitudinal red stripes extending from tip of snout to caudal peduncle; the greatest width of the mid-lateral red stripe about the same as diameter of orbit. Mid-lateral red stripe continuous, solid, and without bars or blotches. Upper red stripe extends from snout, above eye, to caudal peduncle, its width diminishing posteriorly. The space between the two red stripes begins just anterior to the orbit as a thin white line, which continues through the iris, extending the length of the body and becoming wider and more yellow posteriorly. At the caudal peduncle, this yellow region is approximately the same width as the mid-lateral red stripe. Dorsal surface of snout and head predominantly red; white under jaw, below orbit, on throat, lower half of operculum, and on belly from origin of pelvic fins to base of caudal peduncle. Pronounced dark blotch superimposed on mid-lateral red stripe on opercle, approximately the same diameter as pupil; dark blotch retains pigmentation through preservation. Less pronounced dark blotch on mid-lateral red stripe immediately posterior to eye. Pupil black; red and white longitudinal stripes on body continue through iris in life; iris red in fresh (dead) specimens. Pectoral fins hyaline, with faint red fin rays; pelvic fins white; dorsal fin hyaline with faint red and yellow coloration on

Fig. 2. Preserved coloration and radiograph of the holotype CAS-ICH 247318 (SL 58.3 mm). Photograph and radiograph by Jon Fong.

© 2023 Academia Sinica, Taiwan

spines and rays; caudal fin predominantly yellow with faint red markings on dorsal and ventral margins; anal fin hyaline with white and yellow coloration on spines and rays. Color in preservation: pale straw, except for spot of pigmentation on posterior operculum and faint spotting along midlateral red stripe.

Distribution and habitat: *Terelabrus toretore* sp. nov. is currently only known from Tahiti and Moorea, but is likely to be widely distributed in French Polynesia. *Terelabrus toretore* sp. nov. was found at depths around 120–140 m on rubble substrates of deep slopes and steep walls. The wall where the specimens were collected was a sheer vertical slope, even negative in some places, and presented narrow vertical caves and holes with an invertebrate fauna dominated by encrusting sponges, gorgonians and black corals. Several (always solitary) individuals of *Terelabrus toretore* sp. nov. were observed, swimming quickly a few centimeters above the reef.

Coloration of T. zonalis: Here we also present the first description of coloration of a fresh specimen of *T. zonalis* (Fig. 4). Body overall light pink dorsally, silvery-white ventrally. A series of regularly-spaced vertical bars, light pink in color and numbering

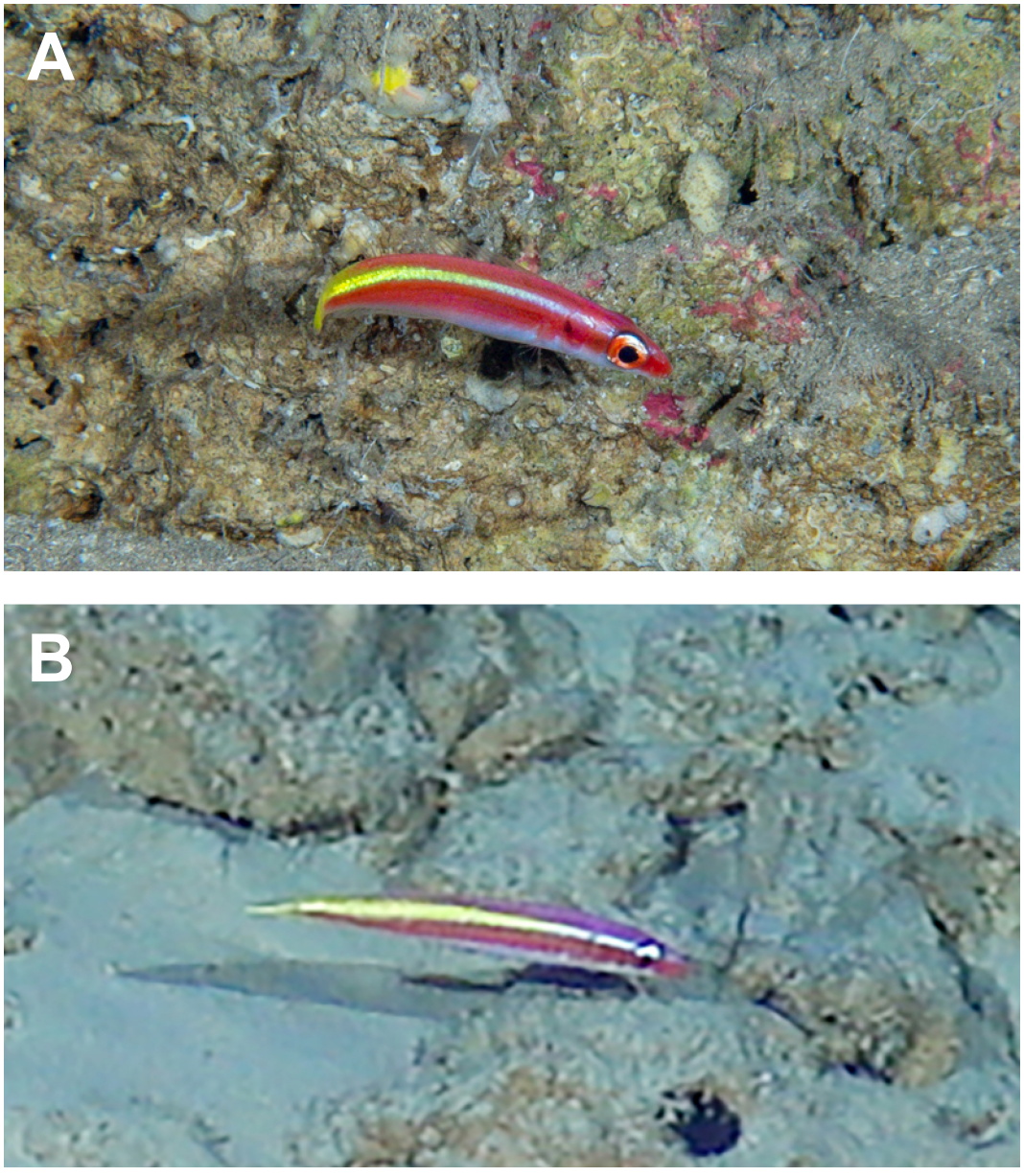

Fig. 3. Underwater photographs of *Terelabrus toretore* (specimens not collected): (A) Tahiti at 125 m depth, photo by L.A. Rocha; (B) Moorea at 252 m depth, photo by R. Holler (Tahiti Private Expeditions).

© 2023 Academia Sinica, Taiwan

approximately 25 in the photographed specimen, spans the length of the body from behind the pectoral fins to the caudal peduncle. These light pink bars are interspersed with the silvery-white body coloration. Head pink above orbit, silvery-white ventrally, with pronounced yellow stripe extending from upper lip through eye to operculum; three parallel yellow stripes behind eye, one aligned with the upper margin of eye, another with center, and the third with lower margin; middle and lower stripes continue on preopercle and operculum; upper one dorsally on head. Pupil black; iris red with yellow margin. Lower jaw, throat and belly

Table 2. Meristic counts and morphometric measurements of *Terelabrus toretore* sp. nov., and two specimens of *Terelabrus rubrovittatus*, a new record for Majuro (Republic of Marshall Islands)

	Terelabrus toretore sp. nov.		*Terelabrus rubrovittatus*	
	HOLOTYPE	PARATYPE		
	CAS-ICH 247318	CAS-ICH 247319	CAS-ICH 247320	
Standard length (mm)	58.3	44.3	71.3	41.2
Dorsal-fin rays	X, 11	X, 11	X, 11	X, 11
Pectoral-fin rays	15	15	15	15
Pelvic-fin rays	I, 5	I, 5	I, 5	I, 5
Anal-fin rays	III, 12	III, 12	III, 12	III, 12
Caudal-fin rays (branched)	14 (12)	14 (12)	14 (12)	14 (12)
Scale rows in longitudinal series	43	44	46	46
Pored lateral-line scales	42	42	43	43
Scale rows above lateral line	3	3	3	3
Scale rows below lateral line	10	10	12	12
Scale rows on cheek	5	5	5	4
Scale rows between orbit and preopercular margin	4	4	6	5
Pre-dorsal-fin scale rows	8	8	7	7
Gill rakers	5+10	5+10	4+9	5+9
Vertebrae	11+17	11+17	11+17	11+17
Body depth	13.9	15.6	14.4	15.5
Body width	9.3	8.8	9.0	8.3
Head length	33.8	32.3	29.2	31.3
Snout length	9.6	9.7	8.3	7.5
Orbit diameter	8.1	7.7	8.3	8.5
Interorbital width	4.6	4.3	6.9	5.8
Upper-jaw length	7.9	8.1	9.0	7.3
Postorbital length	14.1	13.5	15.4	13.6
Caudal-peduncle length	15.3	17.6	14.0	12.4
Caudal-peduncle depth	8.2	8.6	9.0	9.7
Pre-dorsal-fin length	32.8	35.2	30.7	35.0
Pre-anal-fin length	57.1	57.3	57.6	56.8
Pre-pelvic-fin length	32.6	33.0	32.4	31.6
Dorsal-fin base length	48.9	50.1	54.3	49.5
1st dorsal-fin spine length	4.8	5.0	5.5	5.1
2nd dorsal fin spine length	6.7	5.9	7.3	6.6
3rd dorsal-fin spine length	7.9	8.6	8.1	7.3
10th dorsal-fin spine length	8.7	9.5	9.5	7.8
Longest dorsal-fin soft ray length (number)	10.8 (8th)	12.2 (7th)	13.3 (8th)	9.0 (7th)
Anal-fin base length	29.2	30.2	28.6	28.6
1st anal-fin spine length	3.3	2.7	3.2	3.2
2nd anal-fin spine length	6.5	5.2	4.3	5.3
3rd anal-fin spine length	7.4	6.8	6.6	6.3
Longest anal-fin soft ray length (number)	9.8 (5th)	9.3 (6th)	10.0 (5th)	10.0 (5th)
Pectoral-fin length	14.4	15.3	15.7	16.7
Pelvic-fin length	13.2	11.5	13.6	11.9
Least distance between anteroventral margin of orbit and maxilla	1.7	1.6	1.8	1.9

© 2023 Academia Sinica, Taiwan

silvery-white. Pectoral fins hyaline; caudal fin pink with bright yellow stripes on dorsal and ventral margins; dorsal, pelvic and anal fins not visible in photo, coloration unknown. Single dark spot, slightly smaller than pupil and irregularly shaped, at upper margin of operculum just anterior to pectoral fin base.

Molecular Phylogenetics: Our analysis shows that the five presently described species *Terelabrus* cluster into a well-supported monophyletic group (Fig. 5). The Australasian *T. zonalis* and the Indian Ocean *T. flavocephalus* are closely related and well-separated from the three western and central Pacific species. The most widely distributed species (*T. rubrovitattus*) is sister to the pair formed by the western Pacific *T. dewapyle* and the south Pacific *T. toretore*.

DISCUSSION

Fukui's (2018) key to the species of *Terelabrus* employs the following characters as important diagnostics for the genus: number of scale rows in longitudinal series; number of pored lateral-line scales; number of gill rakers; the anatomy of the main supratemporal sensory canal, particularly the number of posterior branches; the number of dorsal and ventral caudal-procurrent rays; and coloration of fresh specimens. Accordingly, *Terelabrus toretore* sp. nov. differs from all its congeners by the total number of supratemporal pored branches (8 versus 4, 5, 6, 9 or 10) and snout length (greater than 9.5% of SL versus 6.4–8.5% of SL) (Table 3). The new species most resembles *T. zonalis* in the number of scale rows in longitudinal series (43–44), the number of lateral line scales (42), and scale rows below the lateral line (10). It can be distinguished from *T. zonalis* by the total number of gill rakers (15 in *T. toretore*, versus 11–12 in *T. zonalis*), by having a more slender body (body width 8.8–9.3% SL in *T. toretore*, versus 11.4–12.8% SL in *T. zonalis*), by having a longer snout (snout length 9.6–9.7% SL in *T. toretore*, versus 6.4–6.8% SL in *T. zonalis*), and by having a longer caudal peduncle (caudal peduncle length 15.3–17.6% SL in *T. toretore*, versus 12.2–12.6% SL in *T. zonalis*).

Terelabrus toretore sp. nov. resembles *T. rubrovittatus* in the number of gill rakers (14–15), but can be distinguished from it by the lower number of scale rows in longitudinal series (43–44 in *T. toretore*, versus 45–48 in *T. rubrovittatus*), the number of lateral line scales (42 in *T. toretore*, versus 43–45 in *T. rubrovittatus*), the number of scale rows below the lateral line (10 in *T. toretore*, versus 11–12 in *T. rubrovittatus*), by having a longer snout (snout length 9.6–9.7% SL in *T. toretore*, versus 5.9–8.5% SL in *T. rubrovittatus*), by a smaller interorbital width (4.3–4.6% SL in *T. toretore*, versus 5.3–6.6% SL in *T. rubrovittatus*), by its longer third dorsal-fin spine length (7.9–8.6% SL in *T. toretore*, versus 5.4–7.1%

Fig. 4. Queensland Museum specimen number QM I.41018 from the Great Barrier Reef Myrmidon Reef), Australia, identified as *Terelabrus zonalis* (SL 64.3 mm). Photograph by James Foster. This is the only known photograph showing the fresh coloration of this species.

© 2023 Academia Sinica, Taiwan

SL in *T. rubrovittatus*), longer third anal-fin spine length (6.8–7.4% SL in *T. toretore*, versus 5.0–5.9% SL in *T. rubrovittatus*), by the number of posterior branches on the main supratemporal sensory canal (8 in *T. toretore*, versus 4–5 in *T. rubrovittatus*), and by coloration. *Terelabrus toretore* sp. nov. has a yellow dorsal line between the two mid-lateral red stripes and a completely yellow caudal fin, compared to a white dorsal line between the two mid-lateral red stripes and the red mid-lateral line extending into the white caudal fin characterizing *T. rubrovittatus*.

In coloration, *Terelabrus toretore* sp. nov. most resembles *T. dewapyle* and *T. flavocephalus*. It can be distinguished by the number of scale rows in longitudinal series (43–44 in *T. toretore*, versus 41–42 in *T. dewapyle* and 46 in *T. flavocephalus*), the number of pored lateral-line scales (42 in *T. toretore*, versus 39–40 in *T. dewapyle* and 44 in *T. flavocephalus*), by the number of gill rakers (5+10 = 15 in *T. toretore*, versus 4–5 + 8–9 = 12–13 in *T. dewapyle*, and 4+9 = 13 in *T. flavocephalus*). In addition, it can be distinguished from *T. dewapyle* by the number of scale rows between the orbit and the preopercular margin (4 in *T. toretore*, versus 5–6 in *T. dewapyle*), by the number of scale rows below the lateral line (10 in *T. toretore*, versus 11–12 in *T. dewapyle*), by the number of posterior branches on the main supratemporal sensory canal (8 in *T. toretore* versus 4–6 in *T. dewapyle*), and in coloration: having

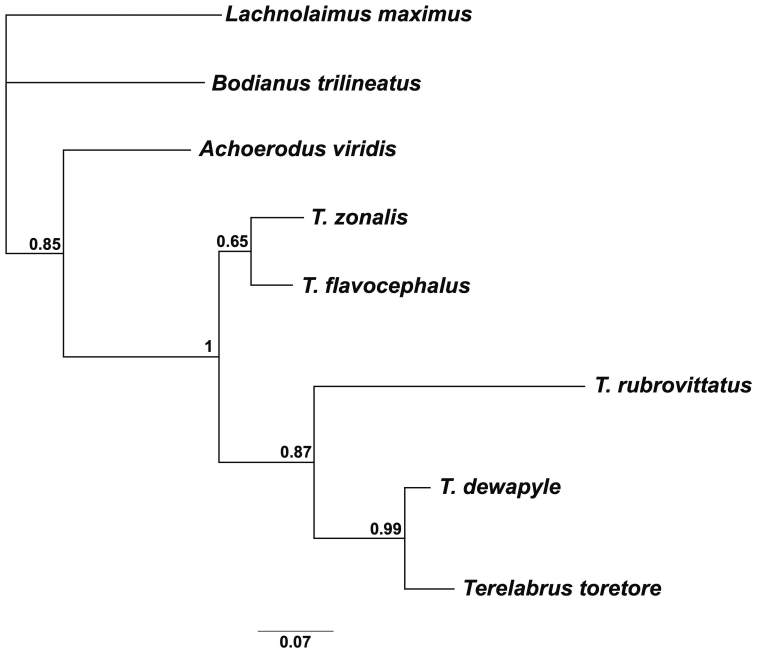

Fig. 5. Bayesian phylogenetic analysis of the genus *Terelabrus* based on mitochondrial DNA cytochrome oxidase subunit I (*COI*). Node support values next to the branches correspond to the posterior probabilities of the Bayesian analysis. Scale bar is the number of nucleotide substitutions per site.

Table 3. Comparison of selected characters among the species of *Terelabrus*

Species	Scale rows in longitudinal series	Pored lateral-line scales	Gill rakers	Scale rows below lateral line	Snout length (% SL)	Posterior branches on main supratemporal sensory canal
Terelabrus toretore sp. nov.	43–44	42	15	10	9.6 (9.7)	8
Terelabrus rubrovittatus (Randall and Fourmanoir 1998)	45–48	43–45	14–15	11–12	8.0 (5.9–8.5)	4–5
Terelabrus dewapyle (Fukui and Motomura 2015)	41–42	39–40	12–13	11–12	8.5 (6.6–7.9)	4–6
Terelabrus flavocephalus (Fukui and Motomura 2016)	46	44	13	10	7.8	9
Terelabrus zonalis (Fukui 2018)	44	42	11–12	10	6.4 (6.8)	10

© 2023 Academia Sinica, Taiwan

a predominantly yellow caudal fin which lacks the poorly defined posteromedial blackish blotch present on *T. dewapyle*. *Terelabrus toretore* sp. nov. has a longer snout (9.6–9.7% SL in *T. toretore*, versus 7.8% SL in *T. flavocephalus*). In coloration, it differs from *T. flavocephalus* by having a wider mid-lateral red stripe, by having more yellow in the space between the longitudinal red stripes, especially in the region from beneath the dorsal fin to the caudal peduncle, and by lacking red pigment on the centermost caudal-fin rays.

Here we also report range extensions for two species. First, two specimens of *Terelabrus rubrovittatus* were collected in the Republic of Marshall Islands (Fig. 6) by our team, and were initially presumed to be an undescribed species. After more detailed examination, we noted that the morphology closely matched *T. rubrovittatus*. We present the morphological characteristics and measurements here (Table 2) in order to increase the information available on this species within the published literature. Previously, *T. rubrovittatus* was only known from western Pacific and eastern Indian Ocean locations: New Caledonia, Vanuatu, Japan, and western Australia (Fukui and Motomura 2015). Our record substantially increases this

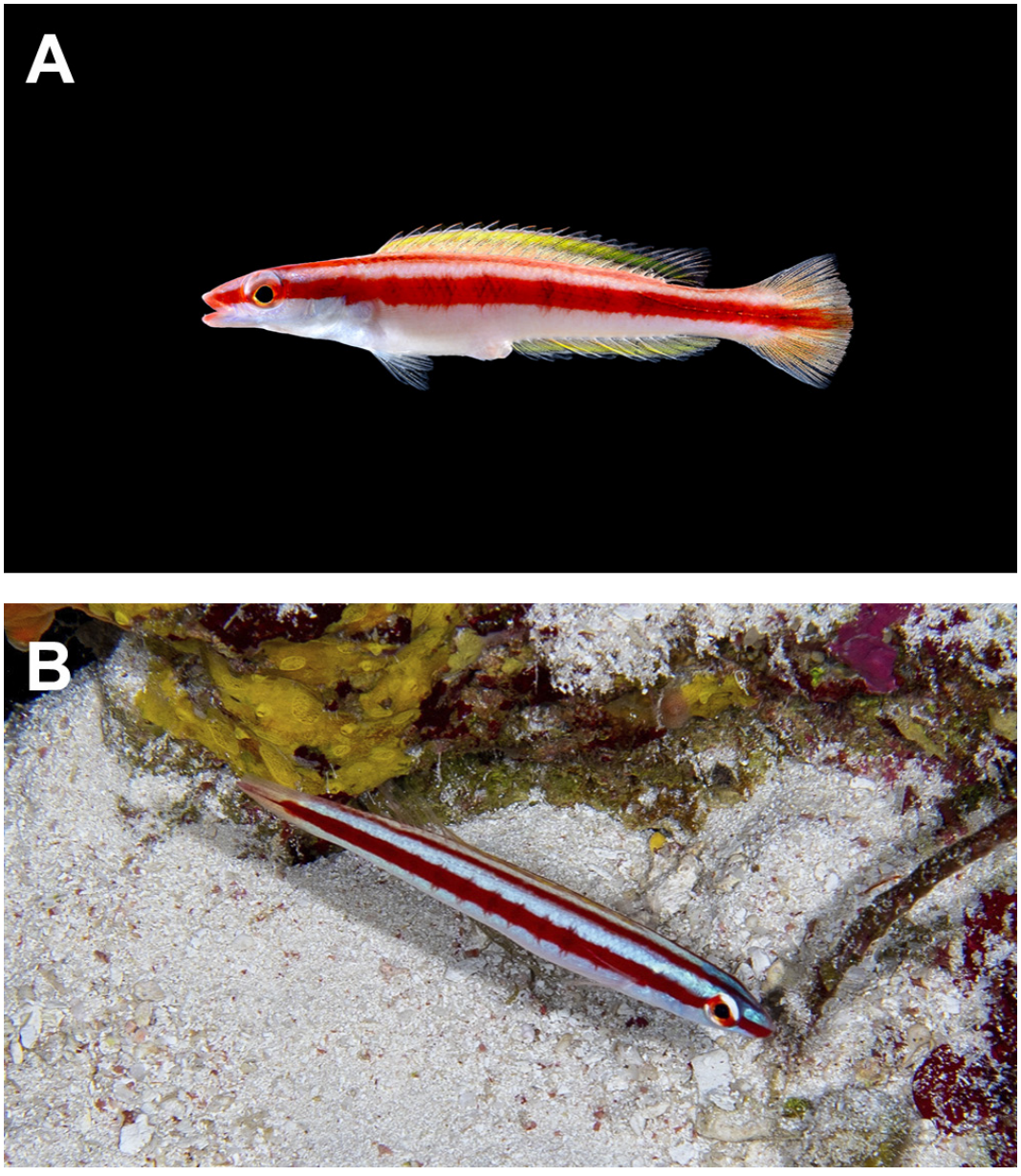

Fig. 6. New record of *Terelabrus rubrovittatus* for the Marshall Islands: (A) CAS-ICH 247320 (SL 71.3 mm) collected in Majuro at 125 m depth, photo by *T. Sinclair*-Taylor; (B) Underwater photograph at 130 m depth in Arno Atoll; specimen not collected, photo by L.A. Rocha.

© 2023 Academia Sinica, Taiwan

range, and suggests that the species might be widely distributed in the central Pacific (Fig. 7).

Second, when searching for *COI* DNA sequences of *Terelabrus*, we found one sequence of an unidentified species in the Barcode of Life Database: record number FOAQ440-21, specimen number BW-A16191, regurgitated by a *Pristipomoides multidens* taken by dropline at a depth of 135 m in the Great Barrier Reef (Myrmidon Reef), Australia. After obtaining a photograph (Fig. 4) and morphological data of the Australian specimen (QM I.41018) from Jeff Johnson of the Queensland Museum, we tentatively identified it as *Terelabrus zonalis* based on morphology (its characters best match *T. zonalis* in the key in Fukui 2018) and color (the specimen from Australia has multiple vertical silver bands along the sides of the body and lacks horizontal stripes, similar to the type specimens of *T. zonalis* and unlike all other species of *Terelabrus*). This species was originally described based on two specimens collected in the Philippines, and here we extend its range south to Australia and provide the first documentation of fresh coloration.

For genetic comparisons, we obtained sequences of four species: *Terelabrus flavocephalus* (CAS-ICH 247321 collected in the Maldives), *T. dewapyle* (CAS-ICH 243200 collected by our team in the Philippines), the specimen from Australia (QM I.41018) that morphologically matches *T. zonalis*, and two specimens that morphologically match *T. rubrovittatus* (Fig. 6, collected by our team in the Marshall Islands). We also downloaded two sequences of a *Terelabrus* identified as *T. rubrovittatus* from GenBank, accession numbers KY815657 (RAG2 gene) and KY815341 (12S ribosomal RNA), that were used in the phylogenetic study by Aiello et al. (2017). These sequences were obtained by Mark Westneat, who, upon request, sent us a *COI* sequence of the same specimen. When we aligned his sequence to our database, we realized it actually was a *Terelabrus flavocephalus*. He obtained the specimen from the aquarium trade at a time when only *T. rubrovittatus* was described, which is likely the reason for the misidentification.

The species that is genetically closest to *T. toretore* is *T. dewapyle*: the uncorrected pairwise genetic difference between them is 5.46% (Fig. 5). These two species seem to be allopatric, with *T. dewapyle* being found in the western Pacific and *T. toretore* at this point known only to occur in French Polynesia (although it is likely more widely distributed in the South Pacific). This sister-species relationship between western and south Pacific species has been observed before in other groups, such as *Cirrhilabrus* and *Centropyge* (DiBattista et al. 2012; Tea et al. 2020). The phylogeny also suggests a vicariant speciation event between the Indian Ocean *T. zonalis* and the western Pacific *T. flavocephalus*, probably driven by the exposure of the Sunda Shelf during lowstand sea-levels, a major driver for reef fish diversification in the Indo-Pacific (Ludt and

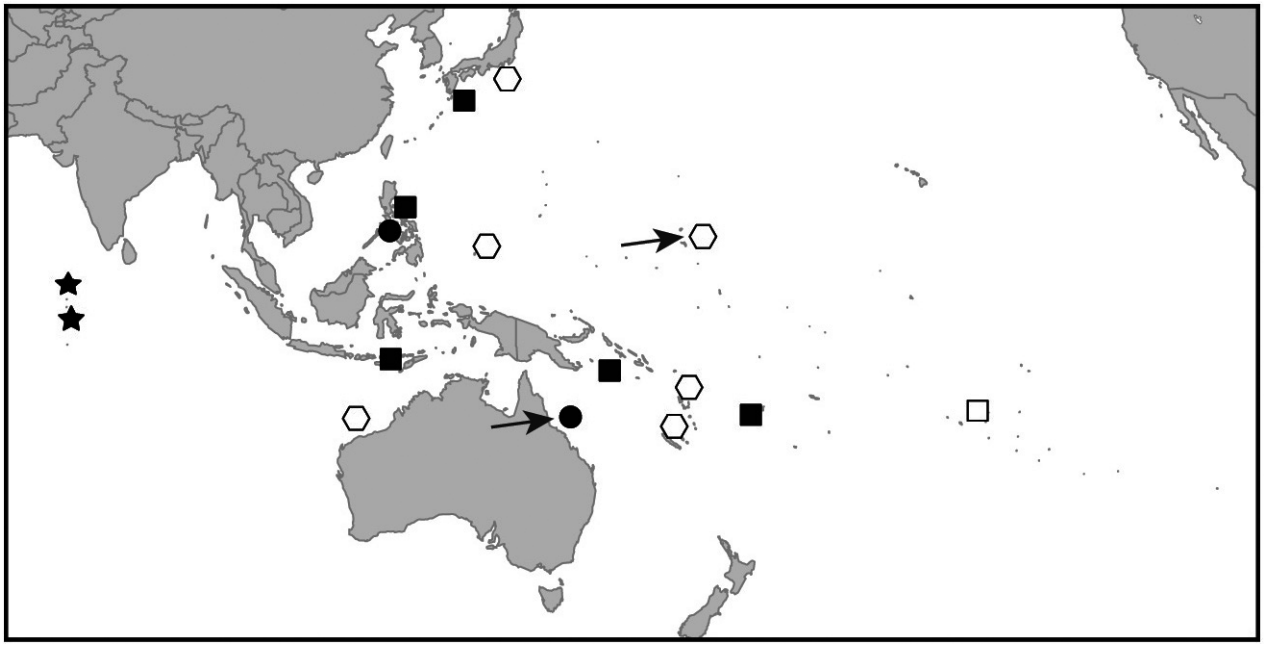

Fig. 7. Distribution of all known species of the genus *Terelabrus* (after Fukui 2018). Symbols represent specimen and photographic records for *T. flavocephalus* (black stars), *T. dewapyle* (black squares), *T. zonalis* (black circles), *T. rubrovittatus* (white hexagons), and *Terelabrus toretore* sp. n. (white square). The two new records from this study are indicated with arrows.

© 2023 Academia Sinica, Taiwan

Rocha 2015). However, these hypotheses need to be considered with caution, since the limited knowledge about the distribution of *Terelabrus* fishes is a major caveat for a deeper understanding of their evolutionary history and biogeography.

Acknowledgments: This work and the new species name were registered with ZooBank under urn:lsid:zoobank.org:pub:1715B77D-3692-4A1D-B3BC-5863FF813ACB. This work was funded by the generous support of donors to the California Academy of Sciences' Hope for Reefs Initiative. Our research in French Polynesia was conducted under permit number USR 3278 from the Ministry of Fisheries, and in the Republic of the Marshall Islands under permit from the Marshall Islands Marine Resources Authority. We are grateful to many colleagues who helped in the field, lab, and with discussions: MV Bell, M Bozinovic, C Castillo, D Catania, J Fong, M Lane, A Mecho, JE McCosker, A Shafer, B Stockwell, YK Tea, H Teavai-Murphy, N Yim and S Yong. Logistics, equipment and technical diving support was provided by Hollis Rebreathers LLC, L Roattino, C Cicculo, and SubTecnologie. We would like to thank J Johnson for examining and providing the photo and information about the Australian specimen of *T. zonalis*, J Fong for taking the radiograph and photograph of the preserved holotype, T Sinclair-Taylor for photographing the Marshall Islands specimen, R Holler for providing the photograph of a living specimen in Moorea, J Foster for taking the photograph of *T. zonalis*, M Westneat for providing a *COI* sequence of *Terelabrus*, and C Rocha for obtaining DNA sequences of the type specimens. HTP thanks Fundação de Amparo à Pesquisa do Estado de São Paulo (2019/24215-2 and 2021/07039-6) for fellowship and funding. We thank the reviewers for their many helpful comments and questions.

Authors' contributions: BS, HTP, TAP and LAR conducted fieldwork and collected the specimens. GS conducted and supported fieldwork in French Polynesia. LAR and BS conducted the morphometric examinations. BS, LAR and HTP produced and analyzed the data and wrote the manuscript. All authors read, edited, and approved the final version of the manuscript.

Competing interests: the authors declare that they have no competing interests.

Availability of data and materials: DNA sequences are available in GenBank.

Consent for publication: not applicable.

Ethics approval consent to participate: not applicable.

REFERENCES

Aiello BR, Westneat MW, Hale ME. 2017. Mechanosensation is evolutionarily tuned to locomotor mechanics. Proceedings of the National Academy of Sciences of the USA **114(17):**4459–4464. doi:10.1073/pnas.1616839114.

Anderson WD, Heemstra PC. 2012. Review of Atlantic and eastern Pacific Anthiine fishes (Teleostei: Perciformes: Serranidae), with descriptions of two new genera. Transactions of the American Philosophical Society, New Series **102(2):**1–173.

Coleman RR, Copus JM, Coffey DM, Whitton RK, Bowen BW. 2018. Shifting reef fish assemblages along a depth gradient in Pohnpei, Micronesia. PeerJ **6:**e4650. doi:10.7717/peerj.4650.

DiBattista JD, Waldrop E, Bowen BW, Schultz JK, Gaither M, Rocha LA. 2012. Twisted sister species of Pygmy Angelfishes: Discordance between taxonomy, coloration, and phylogenetics. Coral Reefs **31:**839–851. doi:10.1007/s00338-012-0907-y.

Fukui Y. 2018. A new species of *Terelabrus* (Perciformes: Labridae) from the Philippines with a key to species of *Terelabrus* and new record of *Terelabrus dewapyle*. Zootaxa **4526(1):**84–90. doi:10.11646/zootaxa.4526.1.6.

Fukui Y, Motomura H. 2015. A new species of deepwater wrasse (Labridae: *Terelabrus*) from the western Pacific Ocean. Zootaxa **4040(5):**559–568. doi:10.11646/zootaxa.4040.5.4.

Fukui Y, Motomura H. 2016. *Terelabrus flavocephalus* sp. nov., a new hogfish (Perciformes: Labridae) from the Maldives, Indian Ocean. Ichthyol Res **63:**529–535. doi:10.1007/s10228-016-0523-x.

Kearse M, Moir R, Wilson A, Stones-Havas S, Cheung M, Sturrock S, Buxton S, Cooper A, Markowitz S, Duran C, Thierer T, Ashton B, Meintjes P, Drummond A. 2012. Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. Bioinformatics **28:**1647–1649. doi:10.1093/bioinformatics/bts199.

Ludt WB, Rocha LA. 2015. Shifting Seas: the impacts of Pleistocene sea level fluctuations on the evolution of tropical marine taxa. J Biogeogr **42:**25–38. doi:10.1111/jbi.12416.

Pinheiro HT, Shepherd B, Castillo C, Abesamis RA, Copus JM, Pyle RL, Greene BD, Coleman RR, Whitton RK, Thillainath E, Bucol AA, Birt M, Catania D, Rocha LA. 2019. Deep reef fishes in the world's epicenter of marine biodiversity. Coral Reefs **38:**985–995. doi:10.1007/s00338-019-01825-5.

Randall JE, Fourmanoir P. 1998. *Terelabrus rubrovittatus*, a new genus and species of labrid fish from New Caledonia and New Guinea. Bulletin of Marine Science **62:**247–252.

Rocha LA, Pinheiro HT, Shepherd B, Papastamatiou YP, Luiz OJ, Pyle RL, Bongaerts P. 2018. Mesophotic coral ecosystems are threatened and ecologically distinct from shallow water reefs. Science **361:**281–284. doi:10.1126/science.aaq1614.

Ronquist F, Teslenko M, van der Mark P, Ayres DL, Darling A, Höhna S, Larget B, Liu L, Suchard MA, Huelsenbeck JP. 2012. MRBAYES 3.2: Efficient Bayesian phylogenetic inference and model selection across a large model space. Syst Biol **61:**539–542. doi:10.1093/sysbio/sys029.

Sih TL, Cappo M, Kingsford M. 2017. Deep-reef fish assemblages of the Great Barrier Reef shelf-break (Australia). Scientific Reports **7:**1–18. doi:10.1038/s41598-017-11452-1.

Tea YK, Pyle RL, Rocha LA. 2020. A New Species of Fairy Wrasse (Teleostei: Labridae: *Cirrhilabrus*) from Mesophotic Coral Ecosystems of the Verde Island Passage, Philippines. Copeia **108:**91–102. doi:10.1643/CI-19-297.

© 2023 Academia Sinica, Taiwan

Weigt LA, Baldwin CC, Driskell A, Smith DG, Ormos A, Reyier EA. 2012. Using DNA Barcoding to Assess Caribbean Reef Fish Biodiversity: Expanding Taxonomic and Geographic Coverage. PLoS ONE **7:**e41059. doi:10.1371/journal.pone.0041059.

Williams JT, Delrieu-Trottin E, Planes S. 2013. Two new fish species of the subfamily Anthiinae (Perciformes, Serranidae) from the Marquesas. Zootaxa **3647(1):**167–180. doi:10.11646/zootaxa.3647.1.8.

© 2023 Academia Sinica, Taiwan