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Cirrhilabrus efatensis, a new species of wrasse (Teleostei: Labridae) from Vanuatu, South Pacific Ocean

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Abstract

The new labrid species, *Cirrhilabrus efatensis*, is described from six specimens, 42.7–69.4 mm SL, collected from Éfaté Island in Vanuatu in the South Pacific Ocean. The new species, along with *C. bathyphilus* and *C. nahackyi*, form a small complex of allopatric closely related species in the southeastern Pacific Ocean, distinguished by a combination of features of the color pattern of terminal-phase males: black anteriormost dorsal-fin spines and membranes, a relatively uniform red-to-orange body color, a yellow anal fin with a blue-violet outer margin, and a dusky nape. The new species differs from *C. bathyphilus* and *C. nahackyi* in having a bright-red head and anterior body delimited abruptly from the orange posterior body. The mtDNA barcode COI sequence for *C. efatensis* is the same as that of *C. bathyphilus* and *C. nahackyi*, not surprising in view of the prevalence of shared haplotypes among some members of species complexes in *Cirrhilabrus* and *Paracheilinus*. The new species is apparently endemic to Vanuatu, adjacent to the range of *C. bathyphilus* in the Coral Sea, but not overlapping, and is likely another example of microendemism for the genus.

Key words: taxonomy, ichthyology, systematics, coral-reef fishes, fairy wrasse, DNA barcoding, endemism.

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Introduction

The labrid genus *Cirrhilabrus* Temminck & Schlegel, 1845 comprises a large set of small, brightly colored, sexually dimorphic coral-reef fishes spanning the tropical Indo-Pacific region. Prior to 1974, only six species had been described: *Cirrhilabrus cyanopleura* (Bleeker, 1851); *C. solorensis* Bleeker, 1853; *C. temminckii* Bleeker, 1853; *C. jordani* Snyder, 1904; *C. ryukyuensis* Ishigawa, 1904; and *C. exquisitus* Smith, 1957. In a recent paper describing *C. marinda* from Indonesia, Allen, Erdmann & Dailami (2015) listed 51 known species for the genus. Since then, several new species have been described: *C. isosceles* by Tea, Senou & Greene (2016); *C. hygroxerus* by Allen & Hammer (2016); and *C. rubeus* and *C. africanus* by Victor (2016), bringing the total species count to 55. These discoveries have resulted in *Cirrhilabrus* containing a species number second only to *Halichoeres* Rüppell, 1835 amongst the wrasses of the family Labridae. Recent molecular studies have, however, suggested that *Halichoeres* is likely polyphyletic, and should be extensively subdivided (Barber & Bellwood 2005), which would make *Cirrhilabrus* unequivocally the most speciose wrasse genus.

Some nominal species of *Cirrhilabrus* with widespread distributions exhibit considerable variation in color patterns throughout their range, e.g. Randall & Kuiter (1989) for C. *punctatus* and Kuiter (2010) for *C. exquisitus*. In many cases, closer examination reveals concordance in genetic divergences and color patterns, leading to splitting the nominal species into complexes of allopatric species, e.g. the *C. rubriventralis* complex (Victor 2016). Some members of species complexes do not diverge in mtDNA sequences, presumably a result of recent speciation and/or continuing gene flow between populations, e.g. in the *C. marinda* complex (Allen, Erdmann & Dailami 2015) and the *C. humanni* complex (Allen & Hammer 2016). The same phenomenon has been reported among the related labrids of *Paracheilinus* (Allen, Erdmann & Yusmalinda 2016).

Randall & Nagareda (2002) described *C. bathyphilus*, from the Coral Sea, as the 41st member of the genus. More recently, Walsh & Tanaka (2012) described *C. nahackyi* as the second member of the *C. bathyphilus* complex, from Fiji and Tonga. In the description of *C. nahackyi*, the authors included a photograph of a terminal-phase male (TP male) from Vanuatu which showed a considerable color-pattern difference from type-location *C. bathyphilus* and hinted at a future paper resolving the taxonomic status of the fish. Recently, additional specimens have been made available, allowing for the description herein of the 56th member of the genus.

Materials and Methods

Type specimens are deposited at the Queensland Museum, Australia (QM), Australian Museum, Sydney (AMS), Zoological Reference Collection of the Lee Kong Chian Natural History Museum at the National University of Singapore (ZRC), National Museum of Natural History, Washington, D.C. (USNM), and University of Miyazaki, Japan (MUFS).

All measurements were made point to point with digital calipers, recorded to the nearest 0.1 mm. Lengths given for specimens are standard length (SL), the straight-line distance 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 from the same anterior point to the fleshy edge of the orbit. Body depth is the greatest depth measured to the base of the dorsal-fin spines, and body width is the greatest width just posterior to the opercular flap. Orbit diameter is the greatest fleshy diameter and the interorbital width is least bony width. Caudal peduncle length is measured horizontally from the rear of the anal fin to the base of the caudal fin and caudal peduncle depth is the least depth. Predorsal, pre-anal and prepelvic lengths are taken from the upper lip to the anterior origin of the respective fin. Lengths of each fin spine and rays are taken from the base of each element.

Pectoral-fin ray counts include the short rudimentary upper ray. The lateral line scale counts are given in two parts, the anterior count from the upper end of the opecular flap to below the soft portion of the dorsal fin. The second or posterior lateral line count is from the midlateral pedunclar portion to the base of the caudal fin (a single scale usually located posterior to the base of the caudal fin is included). Gill raker counts include rudiments and only a total count is given, as it is difficult to determine which gill raker is at the angle.The vertebral count was determined using an x-radiograph of the holotype.

Cirrhilabrus efatensis, n. sp.

Hooded Fairy-wrasse

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Figures 1–4, 7A1, 7A2 & 9A; Table 1.

Holotype. QM I.40671, male, 69.4 mm SL, Vanuatu, Éfaté Island, storm damaged rubble slope, 30–50 m, hand-net, L. Sharon, March 2005.

Paratypes. USNM 387559, male, 60.0 mm SL, same data as holotype; QM I.38235, female, 43.9 mm SL, same data as holotype; MUFS 23366, female, 42.7 mm SL, same data as holotype, ZRC 55599, male, 43.4 mm SL, Vanuatu, Éfaté Island, 45 m, rubble slopes, C. Dumaran, 6 June 2016; AMS I.47280-001, male, 48.9 mm SL, Vanuatu, Éfaté Island, 45 m, rubble slope, C. Dumaran, 6 June 2016.

Diagnosis. Dorsal-fin rays XI,9; anal-fin rays III,9; pectoral-fin rays 15; lateral-line scales 15–17+5–6; median predorsal scales 5; horizontal scale rows on cheek below eye 2; gill rakers 14 (14–16); body depth 2.9–3.7 in SL; body width 1.95–2.6 in body depth; head length 2.5–3.2 in SL; snout length 3.7–4.1 in HL; pelvic fin short, not reaching origin of anal fin, 4.55–6.1 in SL; caudal fin truncate to rounded in females to doubly emarginate in males; eye large, orbit diameter 3.25–3.85 in HL; abdomen pale yellow, head and anterior portion of body red, posterior body orange-yellow (color in alcohol pale), males with black submarginal band in caudal fin and soft portion of dorsal fin and first membrane of spinous dorsal-fin black. Largest specimen 69.4 mm SL.

Description. Dorsal-fin rays XI,9; anal-fin rays III,9 (last soft ray missing in holotype); dorsal- and anal-fin soft rays branched except first ray unbranched; last dorsal- and anal-fin ray branched to base; pectoral-fin rays 15, upper two unbranched; pelvic-fin rays I,5; principal caudal-fin rays 13 (upper and lowermost unbranched), upper and lower procurrent caudal-fin rays 5–6, posteriormost segmented; lateral line interrupted, with dorsoanterior series of pored scales 17 (15–17) and midlateral posterior peduncular series 5 (5–6); scales above lateral line to origin of dorsal fin 2; scales below lateral line to origin of anal fin 6; median predorsal scales 5; median preprelvic scales 6; horizontal rows of scales on cheek 2; circumpeduncular scales 16; gill rakers 14 (14–16); branchiostegal rays 5; vertebrae 9 + 16.

Figure 1. *Cirrhilabrus efatensis*, TP male holotype, QM I.40671, 69.4 mm SL, Éfaté Island, Vanuatu (F. Walsh).

Figure 2. *Cirrhilabrus efatensis*, fresh TP male paratype, ZRC 55599, 43.4 mm SL, Éfaté Island, Vanuatu (Y.K. Tea).

Body depth 3.05 (2.9–3.7) in SL; body compressed, width 2.2 (1.95–2.6) in body depth; head length 3.0 (2.5–3.2) in SL; dorsal profile of head convex; snout moderately pointed, length 3.85 (3.7–4.1) in HL; orbit diameter 3.85 (3.25–3.85) in HL; interorbital space convex, least bony width 3.95 (3.75–4.7) in HL; caudal-peduncle depth 2.2 (2.1–2.5) in HL; caudal-peduncle length 2.1 (1.9–2.45) in HL.

Mouth terminal and oblique, forming angle of approx. 25° to horizontal axis of body; mouth small, maxilla extending just posterior to a vertical through anterior nostril, upper-jaw length 3.85 (4.0–4.7) in HL; dentition typical of genus, three pairs of canine teeth anteriorly at side of upper jaw, anterior pair forward projecting, next two pairs increasing in length and more recurved and laterally projecting; upper jaw with closely set, small, conical teeth (15 in holotype posterior to third canine); lower jaw with single pair of forward and laterally projecting canines and closely set, small, conical teeth (20 in holotype). Tongue short and rounded. Gill rakers short, longest on first gill arch less than one-half length of longest gill filaments.

Posterior margin of preopercle with 38 small serrae (33–42, first 3 paratypes); edge of preopercle free from behind center of eye to below anterior edge of pupil; lower margin of the preopercle rounded, thin, and membranous.

Posterior nostril subtriangular with a short rim, located just below upper-eye level and just anterior to front edge of eye; anterior nostril a very short membranous tube, slightly higher posteriorly, located anteroventral to posterior nostril, diameter about equal to sensory pores of cephalic lateralis system. Suborbital pores from middle of eye to below front edge of eye 12 (10–12); pores along free edge of preopercle 8; pores on mandible to front of chin 4.

Scales cycloid; head scaled except interorbital space, snout, and chin; opercle covered by 7 large scales; cheek with two horizontal rows of scales below eye; naked lower flange of preopercle thin, greatest width at angle about 2.5 in orbit diameter in holotype; base of dorsal and anal fins with a single row of large elongated scales, one per membrane; last pored scale on lateral line at base of caudal fin enlarged and pointed; terminal scale on midline just posterior to last pored scale very enlarged and pointed; no scales on paired fins; pelvic fins with a median ventral process of two elongate scales about three-fourths length of pelvic-fin spine, thin axillary scale of each pelvic fin about three-fourths the length of pelvic-fin spine.

Origin of dorsal fin above third lateral-line scale; predorsal distance 3.3 (2.65–3.2) in SL; first dorsal-fin spine short 3.85 (3.4–4.45) in head length; other dorsal-fin spines subequal, the longest 2.3 (2.2–2.75) in head length; interspinous membranes of dorsal fin extending well above spine tips in males; first soft dorsal-fin ray longest 1.9 (2.0–2.6) in head length; origin of anal fin vertically below last dorsal-fin spine; preanal length 1.6 (1.6–1.7)

Figure 3. *Cirrhilabrus efatensis*, fresh TP male, Espiritu Santo, Vanuatu (specimen not retained)(B.D. Greene).

in SL; first anal-fin spine 4.2 (4.45–5.45) in HL; second anal-fin spine 3.55 (3.3–4.05) in HL; third anal-fin spine 2.8 (2.8–3.45) in HL; seventh or eighth anal soft rays longest, 2.0 (2.15–2.85) in H:; caudal fin 3.55 (3.2–4.0) in SL, rounded in females; caudal fin of males strongly double emarginate, caudal fin slightly concave in males 19.0 (8.5–10.45) in head length; third pectoral-fin ray 1.4 (1.4–1.65); pelvic fin short, extending just beyond anus, longer in males than females, second ray longest 1.6 (1.5–2.25) in HL, 4.75 (4.55–6.1) in SL.

Color in life. (Figs. 1–4, 7A1, 7A2 & 9A) TP males with head and body bright red dorsoanteriorly, extending ventrally to about three-quarters of body depth and just below eye; pale yellow ventrally; nape dusky; posterior body yellow-orange, anterior abruptly red mid-dorsally, scales along posterior dorsum with a single red spot centrally, a thin red stripe along the lateral line; iris bright red; dorsal fin red with an irregular broad, black, outer margin, more pronounced on soft portion, a narrow translucent-to-violet outer margin, a few small violet blue blotches centrally on spinous-fin membrane, first and second dorsal-fin spines and interspinous membranes black; caudal fin red, with faint violet-blue blotches, outer margin black with a blue submarginal band; anal fin yellow, outer margin blue, bordered on inner edge with a narrow, red, submarginal line; pelvic fins translucent yellow; pectoral fins transparent. Females yellowish orange, pale yellow ventrally; body with a series of 4 or 5 thin stripes dorsally, usually threaded with small white spots; nape with a series of fine white lines; dorsal fin translucent red, first and second dorsal-fin spines and interspinous membrane black; caudal fin translucent red; anal fin translucent yellow; pelvic fins translucent; pectoral fins transparent.

Color in alcohol. Black markings on nape and fins remain; red and orange color becomes pale yellowish to tan; yellow color becomes paler yellowish.

Etymology. The specific epithet refers to Éfaté Island in central Vanuatu, the type location of the species. The vernacular name of "Hooded Fairy Wrasse" is suggested for its unique "hooded" appearance, brought upon by the strongly contrasting head and body coloration.

Distribution and habitat. *Cirrhilabrus efatensis* is currently known only from Éfaté Island and Espiritu Santo in central and northern Vanuatu. The new species is found in depths between 30–60 m, above gently sloping bottoms with scattered low outcrops of rocks and rubble.

TABLE 1

Proportional measurements of selected type specimens of *Cirrhilabrus efatensis*, n. sp. as percentages of the standard length

	holotype	paratypes				
	QM I.40671	USNM 387559	QM I.38235	MUFS 23366	ZR 55599	AMS I.47280-001
Sex	male	male	female	female	male	male
Standard length (mm)	69.4	60.0	43.9	42.7	43.4	48.9
Body depth	32.6	30.8	32.8	34.2	27.2	29.4
Body width	14.7	14.7	12.8	13.1	13.6	15.1
Head length	33.1	32.7	35.1	39.8	31.3	32.1
Snout length	8.6	8.0	9.1	9.8	8.5	8.4
Orbit diameter	8.6	8.5	10.0	10.3	9.7	9.2
Interorbital width	8.4	8.7	8.2	8.4	7.1	7.2
Upper-jaw length	8.6	8.2	8.7	8.4	7.8	7.6
Caudal-peduncle depth	15.0	15.0	14.8	15.9	13.8	15.1
Caudal-peduncle length	15.9	15.0	14.6	16.4	16.4	14.1
Predorsal length	30.3	31.3	34.2	37.5	33.9	31.3
Preanal length	62.7	60.0	62.9	62.8	59.9	59.3
Prepelvic length	36.0	34.3	35.3	37.0	35.9	36.2
Dorsal-fin base	61.1	60.0	55.6	58.1	57.8	60.5
First dorsal-fin spine	8.6	8.8	9.1	8.9	9.2	7.6
Longest dorsal-fin spine	14.4	14.8	14.6	14.5	13.6	12.7
Longest dorsal-fin ray	17.4	16.2	13.7	15.5	14.7	14.7
Anal-fin base	damaged	26.0	25.1	26.7	26.3	27.8
First anal-fin spine	7.9	6.0	7.7	8.9	6.7	6.1
Second anal-fin spine	9.4	8.7	9.1	9.8	9.4	8.4
Third anal-fin spine	11.8	11.7	11.2	11.5	9.7	9.6
Longest anal-fin ray	16.6	15.2	14.6	15.5	11.1	13.7
Caudal-fin length	28.2	26.7	30.1	31.4	28.6	25.2
Caudal-fin concavity	1.7	-	-	-	3.7	3.1
Pectoral-fin length	23.9	23.3	22.8	25.3	19.1	19.8
Pelvic-fin spine length	11.5	11.7	11.8	12.2	11.5	11.2
Pelvic-fin length	21.0	22.0	16.4	17.8	20.3	19.4

Figure 4. *Cirrhilabrus efatensis*, TP male and female, approx. 90 mm and 60 mm TL respectively, aquarium specimens from Éfaté Island, Vanuatu (image reversed, specimens not retained)(K. Kohen).

Comparisons. *Cirrhilabrus efatensis* is, at present, one of three species forming a closely related species complex with allopatric distributions centered largely within northeastern Australia and Melanesia (Fig. 5). The complex comprises *C. bathyphilus* (Fig. 6) from the Coral Sea, Great Barrier Reef, New Caledonia and southern Vanuatu; and *C. nahackyi* (Fig. 7C1) from Fiji and Tonga. Despite the close proximity of *C. efatensis* and *C.*

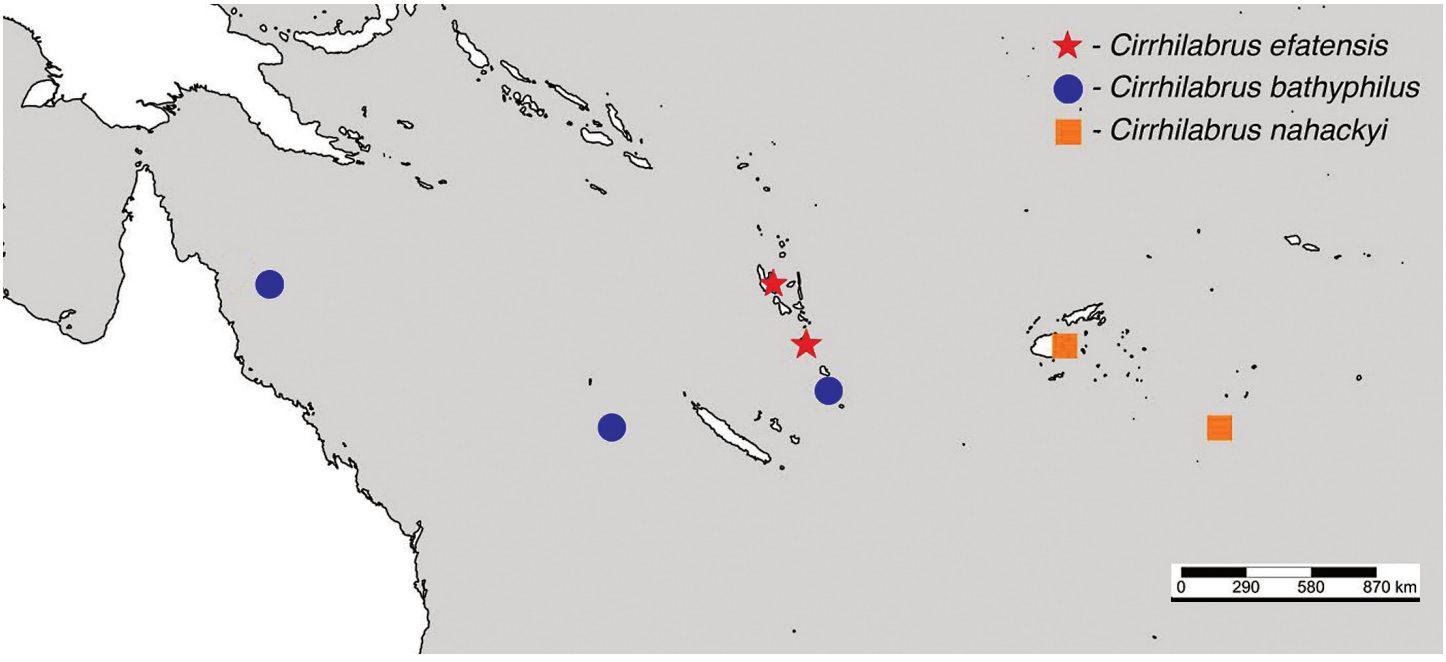

Figure 5. Distribution map showing locality records for members of the *Cirrhilabrus bathyphilus* species complex.

Figure 6. *Cirrhilabrus bathyphilus*, TP male holotype, AMS I.41103-001, 48.7 mm SL, Coral Sea, Holmes Reef (F. Walsh).

bathyphilus in Vanuatu, the two species have not been documented to occur together at any one location, with *C. bathyphilus* replacing *C. efatensis* in the southernmost portion of the archipelago. Examples of allopatric species of *Cirrhilabrus* with a similar pattern of marginally close distribution ranges have been demonstrated in *C. morrisoni*, *C. humanni*, and *C. hygroxerus* (Allen & Hammer 2016), as well as *C. marinda* and *C. condei* (Allen, Erdmann & Dailami 2015), some referred to by Victor (2016) as microendemics.

Another species, *Cirrhilabrus marjorie* Allen, Randall & Carlson, 2003, has been proposed to be part of this species complex. In the original description of *C. bathyphilus*, Randall & Nagarada (2002) discussed an undescribed *Cirrhilabrus* species from Vanua Levu, Fiji and suggested that it was probably closely related to *C. bathyphilus* based on color patterns and caudal-fin shape. Allen, Randall & Carlson (2003) noted some significant differences between *C. marjorie* and *C. bathyphilus*, e.g. in gill-raker count (18–19 for *C. marjorie* vs. 13–15 for *C. bathyphilus*), caudal-fin shape, dorsal- and caudal-fin color patterns, as well as habitat and depth preferences. As a result, they proposed *C. marjorie* may be a member of the *C. exquisitus* species complex, particularly on the basis of its double-emarginate caudal fin. However, Tea, Senou & Greene (2016) demonstrated the unreliability of caudal-fin shapes for inferring taxonomic relationships in *Cirrhilabrus*, noting unrelated species that share shapes and closely related species that differ greatly in caudal-fin shape. While no comparative morphological or genetic studies have been conducted for *C. marjorie* at present, we believe it is more likely allied instead to *C. walindi* Allen & Randall, 1996 from Papua New Guinea and the Solomon Islands, and *C. cenderawasih* Allen & Erdmann, 2006 from Indonesia.

The TP males of the *C. bathyphilus* species complex share a set of characteristic markings (Fig. 7), in particular, having black anteriormost dorsal-fin spines and membranes. TP males often have fuliginous napes, and, with the exception of *C. nahackyi*, possess very strong, double-emarginate caudal fins, edged in black. In *C. nahackyi*, the first and second dorsal-fin spines are elongated, forming a short pennant; this feature is absent in *C. efatensis* and *C. bathyphilus*. *Cirrhilabrus efatensis* can be readily separated from *C. bathyphilus* by color pattern. In the rather variable *C. bathyphilus*, the red anterior body fades gradually into the posterior orange body, either as a gradual suffusion, or as a linear streak (Fig. 8). This suffusion is absent in *C. efatensis*; instead, *C. efatensis* has the two color tones delimited abruptly mid-dorsally.

Figure 7. Live color patterns in *Cirrhilabrus* species (TP males in A1-C1, initial phase in A2-C2) A: *C. efatensis* (A1= paratype, USNM 387559, male, 60.0 mm SL; A2 = paratype, QM I.38235, female, 43.9 mm SL) B: *C. bathyphilus* (B1= QM I.38236, male, 67.5 mm SL; B2 = aquarium specimen, Tanna Island, Vanuatu) C: *C. nahackyi* (C1 = paratype, QM. I.38241, male, 65.0 mm SL, Tongatapu, Tonga; C2 = paratype, QM. I.38242, female, 31.8 mm SL, Bega Lagoon, Fiji)(A1, A2, B1, C2 by F. Walsh; B2 by P. Schmeidel; C1 by H. Tanaka).

All three species possess a black dorsal-fin band in TP males. In *C. nahackyi*, this band is restricted to the anterior soft portion of the fin; in *C. efatensis* and *C. bathyphilus*, the black dorsal-fin band appears highly variable, ranging from almost completely absent to a prominent broad band, extending the full length of the fin (Fig. 8).

The three species in this complex also share similarities in the coloration during nuptial displays, specifically, the lightening and iridescence of the dorsum, turning bright lilac at the height of excitation. In *C. efatensis*, this is restricted to only the posterior body, while the dorsal and caudal fins intensify to deep red with a bright magenta wash (Fig. 9A). The lilac shading during the nuptial display is present in *C. bathyphilus* along the entire dorsum (Fig. 9B), though less extensive in its intensity as compared to *C. efatensis*. The lilac display coloration is most extensive, but also less vibrant, in *C. nahackyi*, obscuring nearly the entire body except the head (Fig. 9C).

All three species in this complex share very similar meristic and morphometric data. Slight differences may exist (but counts measurements are by different observers), i.e. *C. efatensis* with a gill raker count of 14–16 vs. 13–15 in *C. bathyphilus* and 14–15 in *C. nahackyi*. Snout lengths apparently differ slightly, with *C. efatensis* with 8.0–9.7% SL, vs. 8.7–10.3% SL in *C. bathyphilus* and 8.3–9.2% SL in *C. nahackyi*.

The mtDNA barcode marker COI is often used to assess whether populations are genetically isolated from

Figure 8. Variability in *Cirrhilabrus bathyphilus* TP males. Note variability in the red anterior body coloration, appearing as either a suffused wash (A, B), or a somewhat more distinct streak (C, D), but never abruptly delimited as in *C. efatensis*. Arrows highlight variability in the black markings on the dorsal-fin margin (A: E. Fleishauer; B & C: F. Walsh; D: H. Tanaka).

relatives and to quantify the genetic divergence between species: among coral-reef fishes, species have been found to typically diverge more than 2% from their closest relatives (Ward, Hanner & Hebert 2009), but with many exceptions. Very close, or even shared, mtDNA lineages occur frequently among species complexes of labrids with particularly colorful mating displays, and may represent recent radiations where there has been insufficient time to accumulate and fix mutations among populations or where there is some hybridization preventing divergence in mtDNA lineages (Victor 2015). The COI sequence for *C. efatensis* is the same as the sequence for *C. nahackyi* and *C. bathyphilus* (GenBank accession number KX037921), making this species complex another example of shared mtDNA haplotypes between closely related species in *Cirrhilabrus*.

Other material examined. *Cirrhilabrus bathyphilus*: AMS I.41103-001 (holotype), male, 48.7 mm SL, Holmes Reef, Coral Sea, Australia; QM I.38236, male, 67.5 mm SL, Tanna Island, Vanuatu; QM I.38236, female, 37.8 mm SL, Tanna Island, Vanuatu; USNM 387560 male, 68.0 mm SL, Tanna Island, Vanuatu.
Cirrhilabrus nahackyi: QM I.38421 (holotype), male, 55.6 mm SL, Bega Lagoon, Viti Levu, Fiji Islands; QM I.38242 (paratype), female, 31.8 mm SL, Bega Lagoon, Viti Levu, Fiji Islands.

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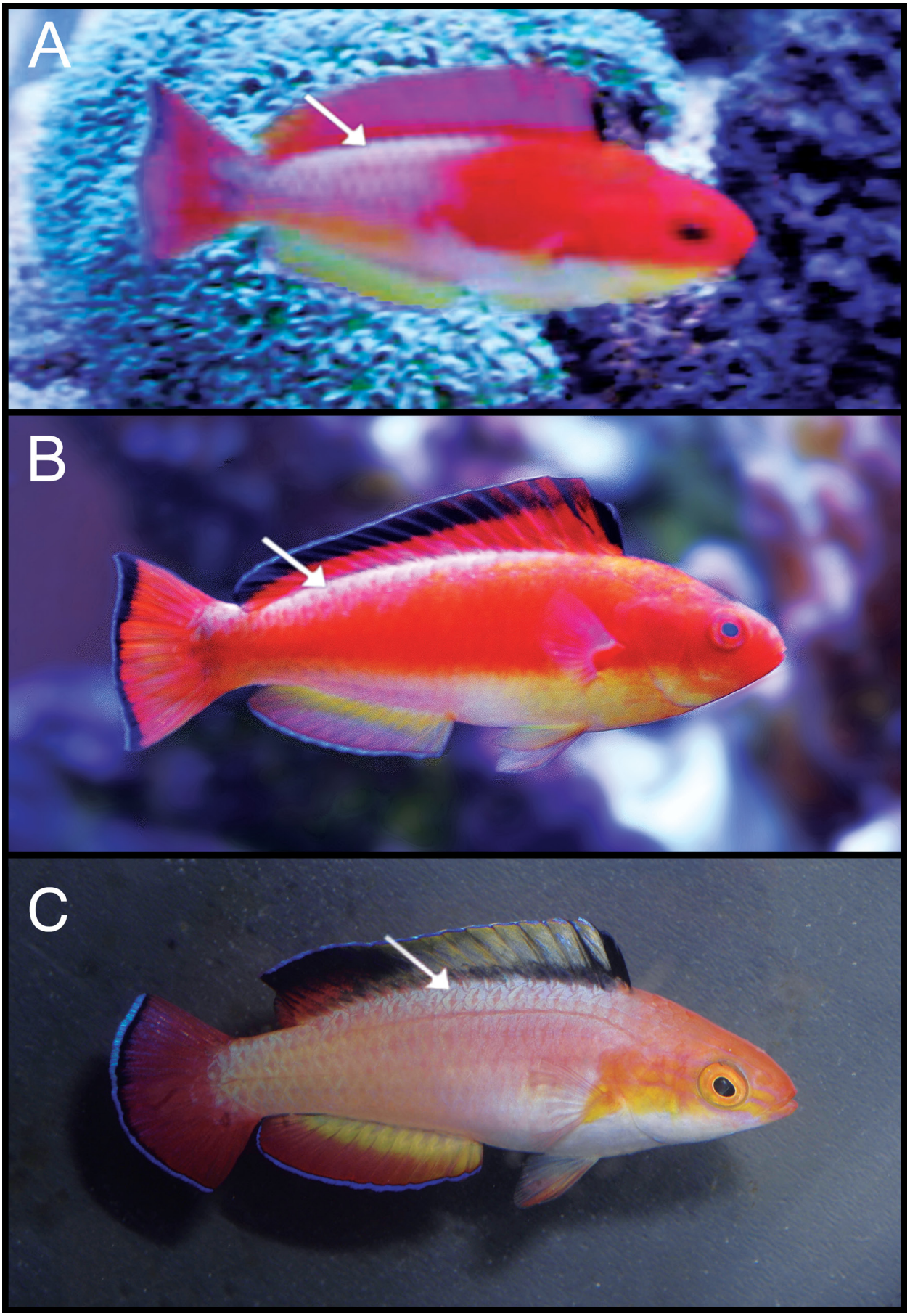

Figure 9. Nuptial displays in *Cirrhilabrus* TP males A: *C. efatensis*, Éfaté Island, Vanuatu; B: *C. bathyphilus*, Coral Sea, Australia; C: *C. nahackyi*, Tonga (but note the absence of the usual dorsal-fin pennant here, otherwise present in TP males of this species). (A & B: Y.K. Tea; C: K. Endoh).

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