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Review of Australian Species of *Paracheilinus* Fourmanoir (Teleostei: Labridae), with Description of a New Species from the Great Barrier Reef and Coral Sea

Yi-Kai Tea[1,2] and Fenton Walsh[3]

Australian species of the cirrhilabrin labrid genus *Paracheilinus* are reviewed. Four species of *Paracheilinus* are reported from Australian waters: *P. amanda*, new species, from Flora, Holmes, and Osprey Reefs, Coral Sea, off northeast Queensland, and Harrier Reef, Great Barrier Reef; *P. filamentosus* from Lizard Island, Great Barrier Reef; *P. flavianalis* from Evans and Flinders Shoals, Timor Sea, off northeast Darwin, Northern Territory, and Ashmore, Scott, Seringapatam, and Hibernia Reefs in the north-western shelf of Western Australia; and *P. nursalim* from Flinders Shoal, Timor Sea, off northern Darwin, Northern Territory. *Paracheilinus amanda*, new species, has previously been confused for *P. rubricaudalis* from Melanesia, but molecular analysis of mitochondrial *COI* recovers both species as reciprocally monophyletic lineages, differing from each other by 1–1.2% in genetic distance. They further differ in aspects of live coloration of terminal phase (TP) males. Both species are allopatric and do not overlap in distribution. The new species is described on the basis of six specimens: the holotype and two paratypes from Harrier Reef, Great Barrier Reef, one paratype from Flora Reef, Coral Sea, and from two paratypes collected off Hula in southern Papua New Guinea, along the north-western margin of the Coral Sea. The discovery of *P. nursalim* in Australia represents a new and significant range extension from previous locality records of West Papua and Ambon Bay. *Paracheilinus* is rediagnosed, and keys, diagnoses, photographs, and Australian distribution records are presented for all species herein.

THE labrid tribe Cirrhilabrini includes just over 100 species of reef-associated fishes (Parenti and Randall, 2018; Tea et al., 2021) distributed throughout the Indo-Pacific. Five genera are currently recognized, viz., *Cirrhilabrus* (65 species; Tea et al., 2021, 2022a), *Paracheilinus* (20 species; Allen et al., 2016), *Pseudocheilinops* (1 species; Schultz et al., 1960), *Pseudocheilinus* (7 species; Randall, 1999), and *Pteragogus* (10 species; Parenti and Randall, 2018). The tribe also previously contained the monotypic genus *Conniella*, but the genus was recently placed within the synonymy of *Cirrhilabrus* on the basis of molecular and morphological data (Tea et al., 2021, 2022b). Except for *Pteragogus*, whose species are cryptically marked and well suited for camouflage in seagrass and macroalgal reefs, the cirrhilabrin labrids are typically very colorful and occur within or in the vicinity of coral reefs. Few, however, are as spectacular as those from the genera *Cirrhilabrus* and *Paracheilinus*, the latter especially so.

Species of *Paracheilinus* are small (usually under 70 mm SL), exuberantly colored fishes most known for their stunning nuptial displays, in which males temporarily "flash" iridescent colors, often complemented by rapid swimming and fully erect median fins. This behavior is most apparent a few hours before sunset, though males will readily display throughout the day, especially when spurred by agonistic encounters with conspecific and congeneric males (Allen et al., 2016). They are protogynous sequential hermaphrodites, forming large aggregations comprising anywhere between tens to hundreds of individuals, with females greatly outnumbering males. Like its sister genus *Cirrhilabrus*, *Paracheilinus* typically inhabit rubble slopes near the outer reef edges of coral reefs, swimming several meters above the bottom to pick off zooplankton and other tiny invertebrates. Although species of *Paracheilinus* are popular subjects for underwater photography, their preference for soft sediment and rubble slopes means that they are often overlooked in faunistic surveys. These habitats are often ignored by divers (De Brauwer et al., 2017; De Brauwer and Burton, 2018), resulting in the patchy distribution records for many species of *Paracheilinus*, as well as failure to detect potentially new ones.

Although *Paracheilinus* occurs widely throughout the Indo-Pacific, the distribution of its species is highly asymmetrical across this range. The highest diversity of species occurs in the Coral Triangle, particularly along the Indo-Australian Archipelago. In their review of the genus, Allen et al. (2016) recognized 20 species as valid, three of which they described as new. Thirteen of these occur in the Indo-Australian Archipelago, viz., *P. alfiani*, *P. angulatus*, *P. carpenteri*, *P. cyaneus*, *P. filamentosus*, *P. flavianalis*, *P. lineopunctatus*, *P. nursalim*, *P. paineorum*, *P. rennyae*, *P. togeanensis*, *P. walton*, and *P. xanthocirritus*. Four species occur in the Western Indian Ocean and the Red Sea, viz., *P. attenuatus*, *P. hemitaeniatus*, *P. piscilineatus*, and *P. octotaenia*. *Paracheilinus mccoskeri* is widespread in the Indian Ocean, ranging from the east African coast to the Andaman Sea, Sumatra, and Bali. The remaining two species are confined to oceanic islands of the western Pacific. They are *P. bellae* from the Ryukyus Archipelago and Micronesia, and *P. rubricaudalis* from Melanesia.

Despite the Indo-Australian Archipelago being the center of diversity for this genus, the distribution and occurrence of *Paracheilinus* in Australia and its remote territories are not

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well understood. Allen et al. (2016) reported *P. filamentosus*, *P. flavianalis*, and *P. rubricaudalis* as extant in Australia. Except for *P. flavianalis*, which was described from type material collected off the north-western shelf of Australia, the status of the other two species in Australia has been doubtful. Distribution records for *P. filamentosus* in Allen et al. (2016) include north-eastern Papua New Guinea, the Solomon Islands, and the northern Great Barrier Reef of Australia; however, the Australian record appears to be spurious, with no photographs or examined material corroborating this distribution. An extensive search of fish collections by the first author of this study yielded only a single, previously unexamined specimen of *P. filamentosus* collected within Australian waters, from Lizard Island in the northern Great Barrier Reef.

The status of *P. rubricaudalis* in Australia is similarly contentious. The species is known from Australia based only on a handful of specimens collected in the Coral Sea and the Great Barrier Reef. These specimens, however, differ from topotypical examples of *P. rubricaudalis* from Melanesia in live coloration of terminal phase (TP) males. The Australian specimens are compared with *P. rubricaudalis* from Fiji and northern Papua New Guinea, and are herein described as a new species, *P. amanda*.

Finally, examination of labrid specimens collected from Flinders Shoal, Timor Sea, approximately 300 kilometers north of Darwin in the Northern Territory yielded a specimen of *Paracheilinus* unassignable to any of the aforementioned species. Closer examination of color photographs and preserved material agrees well with *P. nursalim*, a species previously known only from Ambon in the Malukus and the Bird's Head Peninsula in West Papua.

The purpose of this study is to provide a review of *Paracheilinus* occurring in Australia, of which there are four: *P. amanda*, new species, from Flora, Holmes, and Osprey Reefs, Coral Sea, off northeast Queensland, and Harrier Reef, Great Barrier Reef; *P. filamentosus*, known from a single specimen collected from Lizard Island, northern Great Barrier Reef; *P. flavianalis* from Evans and Flinders Shoals, Timor Sea, off northern Darwin, Northern Territory, and Ashmore, Scott, Seringapatam, and Hibernia Reefs in the north-western shelf of Western Australia; and *P. nursalim* from Flinders Shoal, Timor Sea, off northern Darwin, Northern Territory. *Paracheilinus* is rediagnosed on the basis of new character accounts, and keys, diagnoses, photographs, and Australian distribution records are presented for all species.

MATERIALS AND METHODS

Meristics, morphometrics, coloration description, and specimen deposition.—Methods for counting and measuring follow Randall and Allen (2003) and Allen et al. (2016), except gill raker counts are presented as upper (epibranchial) + lower (ceratobranchial); the angle raker is included in the second count. Counts of lateral-line scales are given in two parts, the dorsoanterior series and the midlateral peduncular series. The latter series consists of a larger pored scale overlapping the caudal-fin base, which we include in the count. In the description of the new species that follows, data are presented first for the holotype, followed by the range of minimum–maximum values of the paratypes in parentheses where different. Where counts were recorded bilaterally, both counts are given and separated from each other by a slash; the first count presented is the left count. Morphometric values are expressed as percentage of standard length (SL; Table 1). Caudal-fin length was measured from the base of the hypural crease to the tips of the central rays (not including filaments where present). Caudal concavity is the horizontal distance between verticals at the tips of the shortest and longest caudal-fin rays. Osteological details were taken from cleared and stained specimens, and radiographs of examined specimens; for the new species, this includes the paratypes.

We follow the terminology provided by Allen et al. (2016) in determination of the male stripe pattern of *Paracheilinus*, which can be useful in diagnosing several species groups (Fig. 1). Note that these patterns do not necessarily reflect phylogenetic relationships within the genus. Where relevant, we refer to horizontal or near horizontal marks, mostly on the sides, as stripes, and curved or oblique marks on the head and fins as bands. Unless specified, color patterns are described from TP males.

Pattern A (*sensu* Allen et al., 2016; Fig. 1A1) consists of three bands on the head, two originating from the posterior edge of the orbit and extending to the opercle margin, and one originating on the upper lip and passing along the lower edge of the orbit to the lower margin of the opercle. The body pattern consists of two primary stripes that run along the middle portion of the side to the caudal peduncle with several shorter, intervening secondary stripes. Allen et al. (2016) made note of two variations in this basic pattern. The first consists of scattered small dark spots and broken dashes on the side of the body in the spaces between the primary stripes. This pattern is especially evident in females and young males, and are found in *P. cyaneus*, *P. nursalim*, and *P. walton*. To differentiate this from pattern A, we use the term pattern A′ (Fig. 1A2). The second variation applies only to *P. alfiani*, in which the two primary stripes are somewhat expanded and diffuse on the posterior half of the body. Since this character appears to be autapomorphic for *P. alfiani*, we do not propose secondary terminology for this pattern.

Pattern B (*sensu* Allen et al., 2016; Fig. 1B) consists of a series of anterior stripes and bands arranged in the following manner: a short band from front of orbit to snout tip, a band from upper lip, passing along the lower edge of orbit to the lower opercular edge and continuing on the side of the breast to above the pelvic fins, another upward-slanting band from the dorsoposterior corner of orbit to the opercular edge and continuing for a short distance on the adjacent upper body, and another from midposterior edge of orbit to middle opercular edge, and continuing on the side of body below the pectoral-fin base to the caudal peduncle. Three additional stripes are present above this main stripe: the first along the dorsal-fin base, from nape to upper edge of the caudal peduncle; the second and third much shorter, situated just below, in parallel but displaced from each other. The caudal fins of species bearing pattern B are rounded and consist of two concentric bands following the contours of the fin shape; the first situated on the basal third of the fin, and the second on the outermost edge. Allen et al. (2016) did not include the stripe along the dorsal-fin base and caudal fin as part of this pattern, but we here include it as an additional level of detail diagnosing pattern B.

The Western Indian Ocean species *P. attenuatus*, *P. hemitaeniatus*, and *P. piscilineatus* share an unusual coloration

Table 1. Proportional measurements for type specimens of *Paracheilinus amanda*, new species, expressed as percentage of the standard length.

	QM I.39758	AMS I.50116-001	WAM P.33973.001		ZRC 64175	
	Holotype	Paratypes				
Sex	Male	Male	Male	Male	Male	Female
Standard length (mm)	47.6	44.4	43.7	37.3	47.6	32.3
Body depth	31.3	26.1	29.1	28.2	27.5	28.5
Body width	15.1	13.7	12.6	14.5	14.3	12.7
Head length	32.4	30.6	31.6	33.5	33.8	35.6
Snout length	8.2	7.7	7.8	8.3	7.8	8.0
Orbit diameter	9.0	9.5	8.5	11.0	7.6	11.1
Interorbital width	9.7	9.7	9.8	11.0	9.7	8.4
Upper-jaw length	8.2	7.9	6.2	8.0	6.3	5.6
Caudal-peduncle depth	14.1	13.3	14.0	14.8	13.7	12.4
Caudal-peduncle length	18.1	18.5	14.2	14.7	16.0	16.4
Predorsal length	31.3	32.4	33.9	34.0	33.6	35.3
Preanal length	52.7	55.2	57.4	60.6	56.9	59.7
Prepelvic length	33.6	34.9	33.6	37.5	38.9	36.5
Dorsal-fin base	55.9	54.5	51.0	51.0	52.7	52.0
First dorsal spine	3.4	2.9	3.4	3.2	2.3	3.7
Longest dorsal spine (9^{th})	17.0	12.2	13.3	13.1	16.6	13.0
Longest dorsal ray (1^{st})	48.7	27.7	21.5	18.2	54.4	17.6
Last dorsal ray	9.0	9.5	8.0	6.4	13.9	10.5
Anal-fin base	28.4	26.6	28.6	27.6	27.5	23.2
First anal spine	6.3	6.8	5.0	4.3	7.4	3.7
Second anal spine	8.6	7.2	7.1	6.7	9.5	7.4
Third anal spine	10.9	9.0	9.2	9.1	10.5	8.4
First anal ray	15.8	11.0	12.4	12.3	16.6	11.5
Longest anal ray (6^{th}–7^{th})	23.9	14.2	17.4	13.4	26.9	12.4
Caudal-fin length	27.5	22.3	24.9	21.7	24.7	25.1
Pectoral-fin length	20.8	20.7	22.0	21.2	20.4	21.4
Pelvic-spine length	10.5	7.9	9.6	7.8	7.8	9.6
Pelvic-fin length	16.0	11.0	14.0	12.3	14.9	13.3

pattern in which the base of the pectoral fin is partially ringed in an arc, with the posterior end extending to the caudal peduncle in at least *P. attenuatus* and *P. piscilineatus*. Allen et al. (2016) made note of this pattern in the latter two species, though it also occurs in *P. hemitaeniatus*. While all three are easily identified based on other unique characters (see Allen et al., 2016), the sharing of the "shepherd's crook" stripe on the pectoral-fin base suggests its usefulness as a

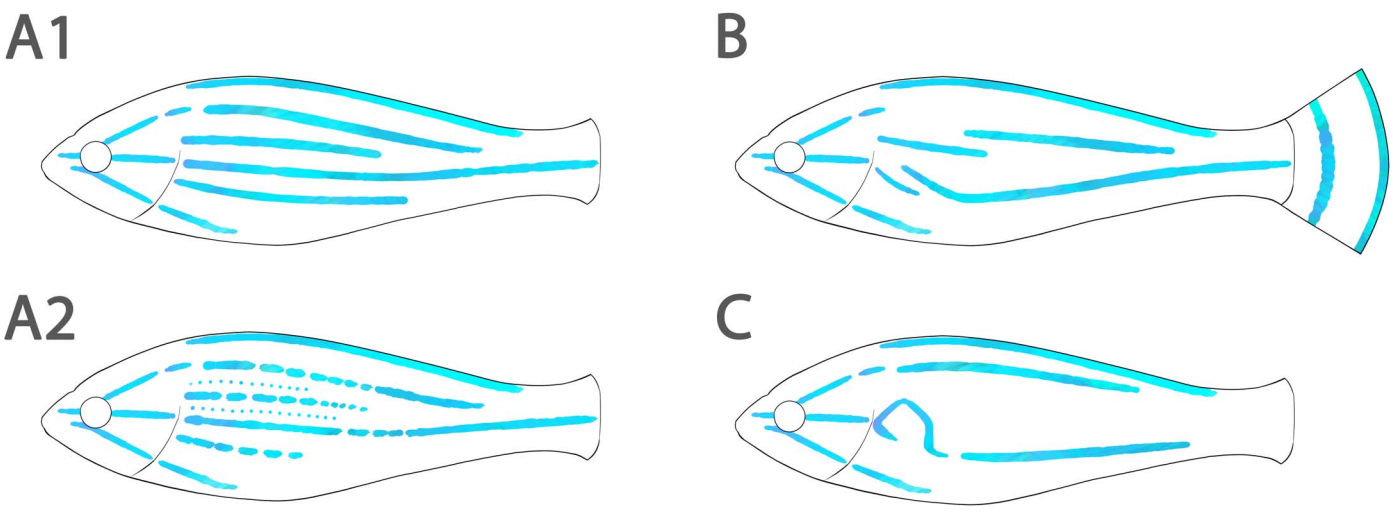

Fig. 1. Schematic diagrams illustrating the body stripe pattern in species of *Paracheilinus*. (A1) Pattern A; (A2) Pattern A'. Note spot-band pattern derived from Pattern A; (B) Pattern B. Note caudal-fin markings, which do not typically vary for species sharing Pattern B; (C) Pattern C. Note "shepherd's crook" marking at pectoral-fin base. Illustration by J. W. Soong.

diagnostic pattern separating them from the remaining species of *Paracheilinus*. We refer to this as pattern C (Fig. 1C). A further set of species possess body patterns that do not agree with patterns A, A', B, or C. They are *P. bellae*, *P. lineopunctatus*, *P. octotaenia*, and *P. rennyae*. These species are, however, easily recognized based on their unique coloration details and combination of morphological characters (see detailed diagnoses in Allen et al., 2016).

Type specimens of the new species are deposited in the Australian Museum, Sydney (AMS), Queensland Museum, Brisbane (QM), the Western Australian Museum, Perth (WAM) and the Zoological Reference Collection of the Lee Kong Chian Natural History Museum at the National University of Singapore (ZRC). Comparative specimens of *Paracheilinus* were examined from material deposited at AMS, QM, WAM, Museums Victoria, Melbourne (NMV), Museums and Art Galleries of the Northern Territory, Darwin (NTM), and ZRC. Institutional codes follow Sabaj (2020).

Taxon sampling, sequencing, and phylogenetic analysis.—Tissue samples of the new species were obtained from the right pelvic fin of the AMS paratype (AMS I.50116-001), preserved in 100% ethanol, and stored at –20°C prior to extraction. DNA was extracted using the DNeasy Blood and Tissue kit (Qiagen) following the manufacturer's protocol. Mitochondrial cytochrome c oxidase subunit I (*COI*) was amplified from extracted gDNA using the polymerase chain reaction (PCR). Primer sets and PCR conditions follow Chang et al. (2017). Sanger sequencing was outsourced to the Australian Genome Research Facility (Canberra, Australia). Forward and reverse contigs were aligned and trimmed separately using GENEIOUS Prime 2019.1.1 (Biomatters). The *COI* sequence of the new species was then combined with those of other species of *Paracheilinus* used in Allen et al. (2016), aligned using the MUSCLE v3.8.31 algorithm (Edgar, 2004), and re-analyzed using maximum likelihood (described below). *Cirrhilabrus isosceles* was used as the outgroup. The final sequence alignment consisted of 642 base pairs. The following newly generated sequences and their GenBank accession numbers not previously in Allen et al. (2016) were used in this study: *Paracheilinus amanda*, new species (OQ605966); *P. flavianalis* (OQ600543); and *P. rubricaudalis* (OQ600403–06). Accession numbers for all comparative *Paracheilinus* and outgroup taxa are as listed in Allen et al. (2016). The molecular sequence alignment file is provided in the supplemental material (see Data Accessibility).

We analyzed the molecular data set using maximum likelihood in IQ-TREE v2.1.3 (Nguyen et al., 2015). Branch support was assessed using ultrafast bootstrapping (UFBS) approximation with 1000 replicates (Hoang et al., 2017) and the Shimodaira-Hasegawa-like approximate likelihood-ratio test (SH-aLRT; Guindon et al., 2010) with 1000 replicates. Node values were taken as robust if they were recovered with support values of UFBS $\geq$ 95 and SH-aLRT $\geq$ 80 (Guindon et al., 2010; Bui et al., 2013). Substitution models were selected using the Bayesian information criterion implemented in ModelFinder (Kalyaanamoorthy et al., 2017). Uncorrected *p*-distance was calculated for the new species and comparative species of *Paracheilinus* using GENEIOUS Prime. We used median-joining (Bandelt et al., 1999) in PopART (Leigh and Bryant, 2015) to construct haplotype networks for select species of *Paracheilinus* based on a subset of the 642 mitochondrial *COI* alignment described above.

Taxonomy

Infraclass Teleostei
Order Labriformes
Family Labridae
Genus *Paracheilinus* Fourmanoir, 1955

Paracheilinus Fourmanoir in Roux-Estève and Fourmanoir, 1955: 100 (type species *Paracheilinus octotaenia* Fourmanoir, by original designation).

Diagnosis.—The following synapomorphy and combination of characters diagnose *Paracheilinus* from all other labrid genera.

Shape of pelvic girdle: *Paracheilinus* possesses a distinct pelvic girdle characterized by anterior narrowing of the central processes with the external ventral wings curling medially along the mid-line. This curling forms a shallow canal that extends along the anterior half to two-thirds the length of the pelvic girdle (described and illustrated in Tea et al., 2021). We consider this character a synapomorphy diagnosing *Paracheilinus*.

In addition to the aforementioned character, the following combination of additional characters distinguishes *Paracheilinus* from all other labrid genera: dorsal-fin rays IX (rarely VIII or X),11; anal-fin rays III,9 (rarely 8 or 10); pectoral-fin rays 14 (rarely 13 or 15); principal caudal-fin rays 13, the median 11 branched; lateral line interrupted, pored scales in the dorso-anterior series 11–17, pored scales in the midlateral posterior peduncular series 3–10; median predorsal scales 5 (rarely 4 or 6); rows of scales on cheek 2; total gill rakers 11–18; branchiostegal rays 5; vertebrate 9 + 16; scleral cornea of orbit over pupil bisected into two foci; lips small, without plicate folds, barely visible when mouth closed; three pairs of recurved canines anteriorly on upper jaw, third pair largest; single pair of canines anteriorly on lower jaw; sides of jaw with single row of small, closely set conical teeth; no canines at corner of mouth; palate without teeth; ventral margin and corner of preopercle thin and membranous, posterior bony edge smooth (sometimes very weakly serrated); snout, chin, and interorbital space naked; pelvic fin short, longest ray not reaching anal-fin origin; dorsal scleral surface of orbit and orbital rim of juveniles and initial phase (IP) specimens with white "eyebrow" markings.

Description.—Dorsal-fin rays IX (rarely VIII or X),11, segmented rays variably branched (see below); anal-fin rays III,9 (rarely 8 or 10), segmented rays variably branched (see below); pectoral-fin rays 14 (rarely 13 or 15), upper two unbranched; pelvic-fin rays I,5; principal caudal-fin rays 7 + 6, uppermost and lowermost unbranched; upper procurrent caudal-fin rays 4–5; lower procurrent caudal-fin rays 4–6; lateral line interrupted, with dorso-anterior series of pored scales 11–17 and midlateral posterior peduncular series 3–10; first pored scale on posterior peduncular series often pitted; last pored scale on posterior peduncular series enlarged and overlapping hypural crease; scales above lateral line to origin of dorsal fin 2; scales below lateral line to origin of anal fin 6; median predorsal scales 5 (rarely 4 or 6); circumpeduncular scales 14–16; total gill rakers 11–18; branchiostegal rays 5; vertebrae 9 + 16.

Mouth small, oblique, maxilla not reaching vertical at anterior edge of orbit; dentition typical of genus (see diagnosis);

lips small, without plicate folds, barely visible when mouth closed; gill rakers short, longest about a third length of longest filament on first gill arch; posterior nostril an oval opening about 2–3 times larger than cephalic sensory pores, about level with fleshy upper edge of orbit and slightly anterior to vertical at anterior bony rim of orbit; anterior nostril smaller, with a short fleshy rim anterior and slightly ventral to posterior nostril.

Head scaled except for anterior occipital region, interorbital space, snout, and chin; a row of elongate scales on dorsal- and anal-fin bases; basal half of caudal fin with large scales; axillary scale of pelvic fin slightly shorter than pelvic spine; midventral scaly process of pelvic fins slightly longer than pelvic spine; free ventral margin of preopercle extending forward to vertical at center of orbit, vertical posterior margin to level of lower edge of pupil; exposed bony edge of preopercle smooth without serrations (sometimes very weakly serrated on ventral bony edge).

Origin of dorsal fin above third lateral-line scale; dorsal-fin spines progressively longer; posterior soft-portion of dorsal fin with or without filaments, branching pattern variable (see below); origin of anal fin below base of first dorsal-fin soft ray; pelvic fins short, longest ray barely reaching anal-fin origin; caudal fin varying from truncate, rounded, emarginate (with or without lobes bearing filamentous extensions), or lanceolate (in one species).

Variable branching of dorsal- and anal-fin rays.—*Paracheilinus* is one of several labrid genera to possess filamentous dorsal-fin rays. The term "filament" is loosely defined, but generally refers to any filamentous prolongation of spinous or radial elements in the fins. In most filament-bearing labrid genera, those borne on the dorsal fin occur only in the unsegmented, spinous portion of the fin. These are, however, usually fibrous extensions of the cirri or flexible extensions of membranous tissue distal to the spinous element. *Paracheilinus* is unusual in having dorsal-fin filaments only in the segmented rays in the posterior portion of the fin. In *Paracheilinus*, the filaments are always prolongations of the radial elements and not fibrous or membranous extensions. Filaments can consist of a single segmented ray, or multiple adjacent rays bounded by membranous tissue. In the former condition, it is not uncommon for several species to develop more than one filament, but the filaments are usually separated from each other by deep incisions of the interradial membrane. The filaments in some species can be very long (up to 1.8 in SL in *P. nursalim*) and make for exceptionally spectacular displays when fully raised.

Within the genus, the following western Indian Ocean species form a monophyletic sister group to all remaining species of *Paracheilinus*. They are *P. attenuatus*, *P. octotaenia*, *P. hemitaeniatus*, and *P. piscilineatus*. This relationship is supported based on molecular sequence data (Allen et al., 2016). Except for *P. attenuatus*, which is unusual in possessing a single hair-like "naked" ray with no surrounding membranous tissue, the remaining species lack filaments entirely. No other cirrhilabrin genera possess segmented dorsal-fin filaments. The character therefore appears to be a derived condition unique to *Paracheilinus*, but not a synapomorphy diagnosing it. Given that there are several other non-filament bearing species nested within the genus, we consider the presence of segmented dorsal-fin filaments homoplasious within *Paracheilinus*. The only other labrids to somewhat approach this morphological condition are those in the hypsigenyin genera *Bodianus*, *Clepticus*, and *Semicossyphus*, where large males may develop pronounced or slightly filamentous segmented dorsal-fin rays, though never as dramatically as in *Paracheilinus*.

Fig. 2. *Paracheilinus paineorum* (non-Australian species) demonstrating filamentous prolongation of segmented dorsal- and anal-fin rays. In this specimen, nearly all dorsal-fin rays are unbranched. Note that the bifurcation at the tip of the first dorsal filament is not supported by branching of the segmented ray (it appears to be a result of a tear in the surrounding membrane). Note the presence of aberrant anal-fin filaments. Underwater photograph taken in Lembeh Strait, Indonesia, by N. DeLoach.

The degree of segmented dorsal-fin ray branching is further unusual in *Paracheilinus* and is highly variable within and between species. For species that possess filaments, the filamentous rays are usually unbranched, but those situated more posteriorly (in species bearing more than one filament) may exhibit weak primary or, rarely, secondary and tertiary branching. The last segmented dorsal-fin ray is always split to base regardless. If branching occurs in the filamentous rays, it is usually near the base, with the branched portions rarely extending the full length of the filament. This condition does not appear to be ontogenetic, as juveniles and IP males can also display variable branching of segmented dorsal-fin rays.

For species that lack filaments, segmented rays exhibit branching patterns typical of other labrids. In *Paracheilinus*, however, it is not uncommon for some of the anterior segmented rays to be completely unbranched, the number and positioning of which is variable. For example, in the holotype of the non-filament bearing *P. togeansis*, only the first segmented ray is unbranched, followed by branching of all proceeding rays (Kuiter and Allen, 1999). Underwater images of three separate individuals of *P. togeansis* published in Allen et al. (2016) demonstrate unbranching of the anteriormost three, four, and five segmented rays, respectively (Allen et al., 2016: figs. 49–50). An unpublished photograph (examined by the authors of this study) of *P. togeansis* photographed by Ned DeLoach shows yet a specimen with branching of all segmented dorsal-fin rays. More uncommonly, unbranched rays may occur in between branched rays (Allen et al., 2016: fig. 52). Rarely, filaments may develop on the anal fin, though the presence and number of anal-fin filaments are aberrant and are never diagnostic for

Fig. 3. *Paracheilinus amanda*, new species, aquarium specimen from Harrier Reef, the Great Barrier Reef. Specimen not retained. Photograph by K. Endoh.

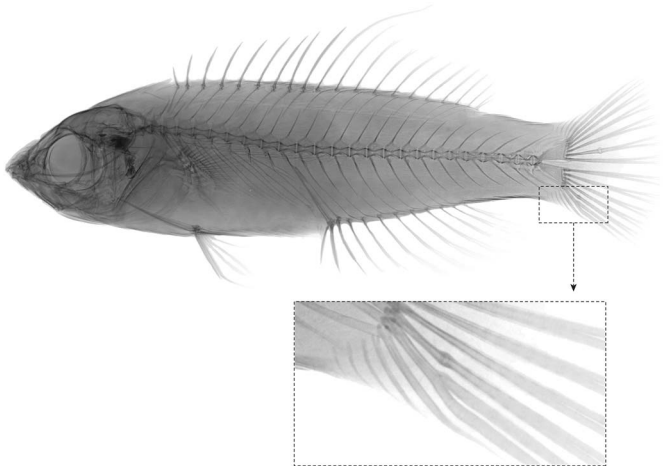

Fig. 4. X-ray of *Paracheilinus amanda*, new species, AMS I.50116-001, paratype, showing aberrant branching of lowermost principal caudal ray.

any of the known species (Fig. 2). These conditions become increasingly prevalent in hybrids (see fig. 5B in Allen et al., 2016).

While none of these conditions in isolation are unique among teleost fishes, the degree of variation displayed in ray branching pattern within a single genus is unusual. No other labrid genus displays such variability in the positioning, number, and extent of branched dorsal- and anal-fin rays in any given species. Given the labile nature of these characters, however, we do not at this time consider this a synapomorphy diagnosing the genus, though we acknowledge its potential usefulness in separating certain species from other labrid genera.

Etymology.—Combination of the Greek *para* meaning near or proximal to, and the labrid genus *Cheilinus*, in reference to its superficial resemblance to the genera *Cheilinus* and *Pseudocheilinus* (Roux-Estève, 1956); to the former in having the second anal-fin spine shorter than the third, and to the latter in having recurved outward pointing canines. *Paracheilinus* is, however, most closely related to *Cirrhilabrus*. Genus is masculine. Species of *Paracheilinus* are commonly known as flasher wrasses after their spectacular courtship displays.

Habitat and biology.—Small to medium (usually under 70 mm SL) brightly colored labrids frequently found swimming above rubble pans with *Halimeda* or *Padina* growth, in groups consisting anywhere between tens to hundreds of individuals with females greatly outnumbering males. Occurs between 5–70 m, but with most species inhabiting 15–40 m (Allen et al., 2016). Diet primarily zooplankton which they pick off the water column. Males of all species are known for flashing bright iridescent colors during acts of aggression or nuptial display. This display is often accompanied by rapid swimming and the erection of all median fins. When not displaying, the colors are muted (though still very striking) and the fins are folded against the body.

KEY TO THE SPECIES OF AUSTRALIAN *PARACHEILINUS*

1a. Body with stripe pattern A or A′; caudal fin truncate to slightly emarginate and with pronounced filamentous lobes; dorsal fin with four or more yellow to reddish orange filaments 2

1b. Body with stripe pattern B; caudal fin rounded and without filaments; dorsal fin with three or fewer red filaments (usually one) 3

2a. Body with stripe pattern A; ground color of body red to maroon in life; dorsal fin and filaments reddish orange at rest, richly yellow when in display; central portion of caudal fin with triangular hyaline region, upper and lower lobes red with metallic blue margins dorsally and ventrally (in life); spines and rays of median fins purple in preservation (northern Great Barrier Reef) ..... ***P. filamentosus***

2b. Body with stripe pattern A′; body with two black rectangular epaulettes, one below spinous portion of dorsal fin, one along lower caudal peduncle (dusky in preservation); ground color of body yellow orange in life; dorsal fin and filaments yellow at rest, filaments bright white when in display; central portion of caudal fin with intricate blue markings (in life); spines and rays of median fins translucent and without purple pigment in preservation (Timor Sea) ..... ***P. nursalim***

3a. Anal fin uniformly yellow or orangey yellow; dorsal fin with one to four filaments (usually one; Timor Sea) ..... ***P. flavianalis***

3b. Anal fin sharply bicolored, yellow basally, red distally; dorsal fin with one filament (Coral Sea and Great Barrier Reef) ..... ***P. amanda*, new species**

***Paracheilinus amanda*, new species**

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Amanda's Flasher Wrasse

Figures 3, 4, 5A1–A2, 6, 7; Tables 1–2

Paracheilinus rubricaudalis (non Randall and Allen, 2003): Allen et al., 2016: 73, fig. 47 (aquarium specimen from Great Barrier Reef; image reproduced here [Fig. 2]); also misidentified as *P. rubricaudalis* in molecular phylogeny.

Holotype.—QM I.39758, 47.6 mm SL, Harrier Reef, Great Barrier Reef, 15°08′S, 145°41′E, 20 m, T. Bennett, 27 October 2013.

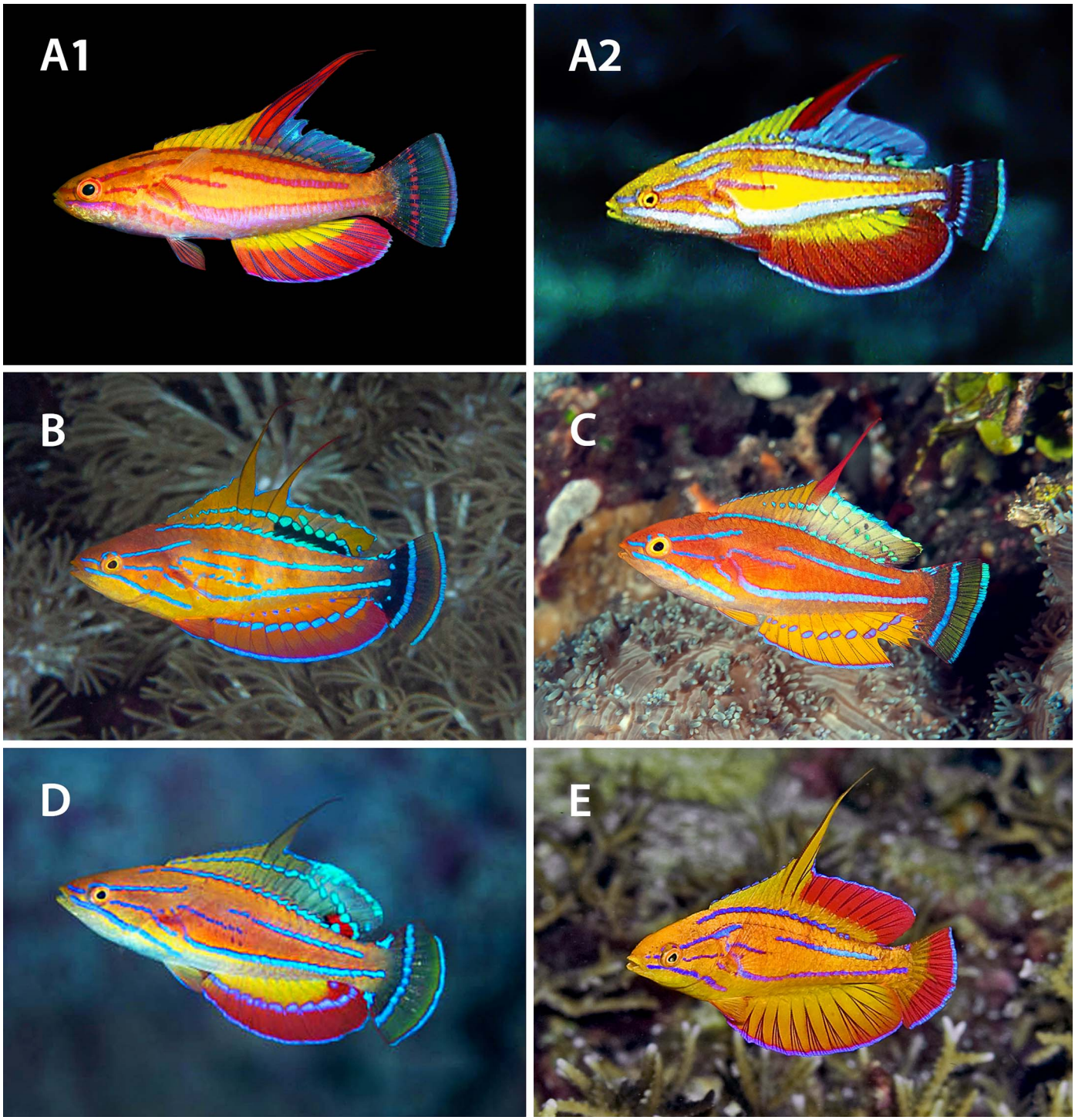

Fig. 5. A selection of *Paracheilinus* in life. (A1) *P. amanda*, new species, ZRC 64175, male paratype, 47.6 mm SL, off Hula, southern Papua New Guinea, Coral Sea; (A2) *P. amanda*, new species, underwater photograph from Osprey Reef, Coral Sea; (B) *P. carpenteri*, underwater photograph from Mabini, Batangas, Philippines. Note the darkened posterior dorsal- and caudal-fin bases and the presence of a second stripe behind the pectoral fin; (C) *P. flavianalis*, underwater photograph from Bali, Indonesia; (D) *P. mccoskeri*, underwater photograph from Khao Lak, Thailand; (E) *P. rubricaudalis*, underwater photograph from Mborokua, Solomon Islands. Note the reduced markings on caudal fin. Photographs by H. H. Tan (A1); T. Yamazumi (A2); T. Cameron (B); V. Chalias (C); T. Kawamoto (D); and N. DeLoach (E).

Paratypes.—AMS I.50116-001, 44.4 mm SL, Flora Reef, Coral Sea, 16°46′S, 147°46′E, 42 m, hand nets, T. Bennett, 2 February 2022 (GenBank accession number OQ605966); WAM P.33973.001, 2, 37.3–43.7 mm SL, Harrier Reef, Great Barrier Reef, 15°08′S, 145°41′E, 35–36 m, hand nets, T. Bennett, 1 September 2013; ZRC 64175, 2, 32.3–47.6 mm SL, 40–50 m, hand nets, G. Gaylan, J. M. Nugas, and J. Genoso, off Hula, southern Papua New Guinea, Coral Sea, 28 March 2023.

Diagnosis.—Dorsal-fin rays IX,11; anal-fin rays III,9; pectoral-fin rays 14; pelvic-fin rays I,5; pored lateral-line scales 14–17 + 5–7 = 19–24; gill rakers 5–6 + 11–12 = 16–18; body

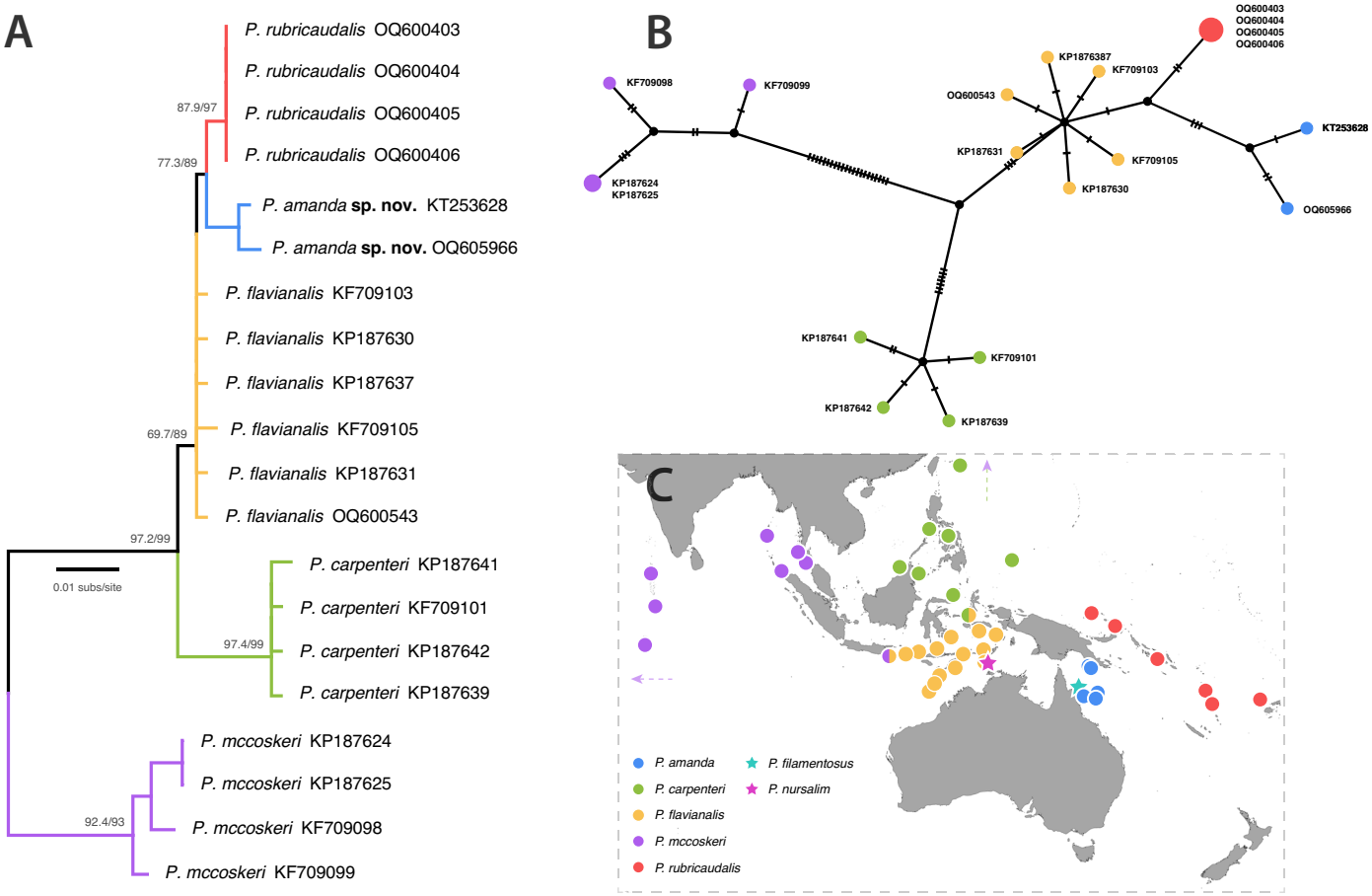

Fig. 6. (A) Maximum-likelihood phylogenetic relationships for select species of *Paracheilinus* inferred using mitochondrial *COI*. Support values at nodes correspond to SH-aLRT and UFBS support values, respectively. Scale bar indicates the number of substitutions per site. Outgroup taxa were pruned from the tree (see **Allen et al., 2016**). See Data Accessibility for tree file. (B) Median-joining haplotype network inferred using mitochondrial *COI*. Each circle represents a haplotype, and its size is proportional to its total frequency. Each black crossbar represents a single nucleotide change. (C) Geographical distribution for select species of *Paracheilinus*. Members of the *P. mccoskeri* species complex are represented by colored circles. Distribution records for *P. carpenteri* and *P. mccoskeri* are not shown in full—the former extends into southern Japan (indicated by the green broken arrow), and the latter extends into the western Indian Ocean (indicated by the purple broken arrow). Bicolored symbols indicate sympatry in that locality. Colored stars indicate distribution records for *P. filamentosus* and *P. nursalim* in Australia.

depth 3.2–3.8 in SL; head length (HL) 3.1–3.3 in SL; snout length 4.0 in HL; orbit diameter 3.0–3.6 in HL; interorbital width 3.0–3.4 in HL; least depth of caudal peduncle 2.3 in HL; caudal peduncle length 1.7–2.3 in HL; TP males with one elongate, red filamentous dorsal-fin ray, longest dorsal-fin soft ray 2.1–5.5 in SL; pelvic fin length 2.0–2.8 in HL; caudal fin of TP males round without filamentous lobes; body with stripe pattern B; basal third of anal fin bright yellow, remaining distal two-thirds orange red, demarcation of both colors with incomplete row of blue spots (usually completely absent).

Description.—Dorsal-fin rays IX,11; anal-fin rays III,9; last dorsal- and anal-fin rays split to base; pectoral-fin rays 14, upper two unbranched; pelvic-fin rays I,5; principal caudal-fin rays 7 + 6, uppermost and lowermost unbranched (lowermost principal caudal-fin ray aberrantly branched in AMS I.50116-001; Fig. 4); upper procurrent caudal-fin rays 5; lower procurrent caudal-fin rays 5 (4–5); lateral line interrupted, with dorsoanterior series of pored scales 17 (14–17) and midlateral posterior peduncular series 6 (5–7); first pored scale on posterior peduncular series often pitted; last pored scale on posterior peduncular series enlarged and overlapping hypural crease; 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 preventral scales 5 (3–6); transverse scale rows on cheek 2; circumpeduncular scales 16 (14–16); gill rakers 6 (5–6) + 11 (11–12) = 17 (16–18); vertebrae 9 + 16 (Fig. 4).

Body depth 3.2 (3.2–3.8) in SL; body width 2.1 (1.9–2.3) in body depth; head length 3.1 (2.8–3.3) in SL; snout length 4.0 (4.0–4.4) in HL; orbit diameter 3.6 (3.0–4.5) in HL; interorbital width 3.4 (3.0–4.5) in HL; least depth of caudal peduncle 2.3 (2.3–2.9) in HL; caudal-peduncle length 1.8 (1.7–2.3) in HL.

Mouth small, oblique, maxilla not reaching vertical at front edge of orbit, upper jaw 4.0 (3.9–6.4) in HL; three pairs of curved canine teeth anteriorly in upper jaw, progressively more laterally projecting, third (posteriormost) pair largest; single pair of canine teeth anteriorly in lower jaw, very strongly curved laterally; side of jaws with single row of small close-set conical teeth; no canine tooth at corner of mouth; no teeth on palate; fleshy flap on side of lower lip; gill rakers short, longest about one-third length of longest gill filaments on first gill arch; posterior nostril an oval opening about 2–3 times larger than cephalic sensory pores, about level with

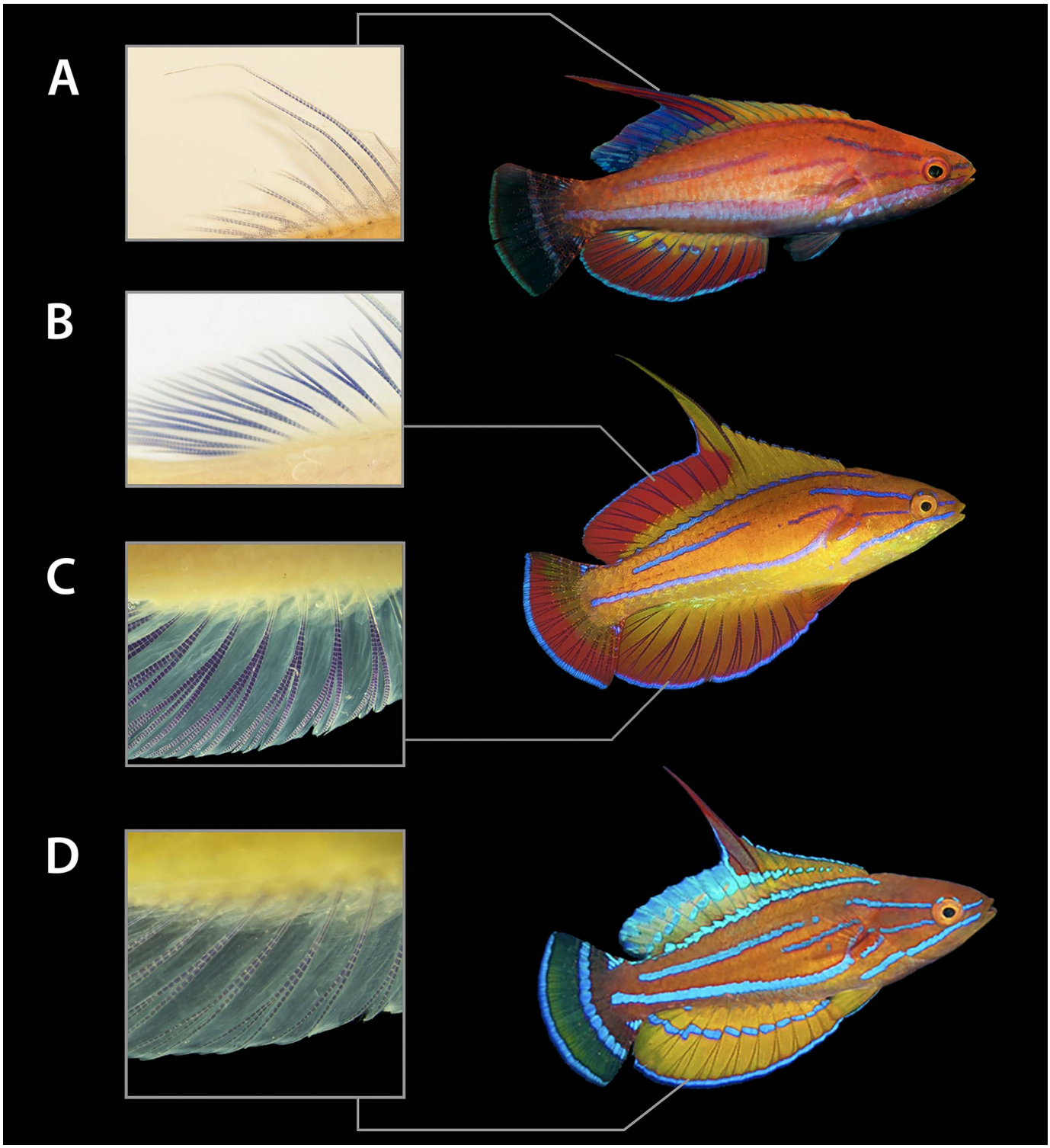

Fig. 7. *Paracheilinus amanda*, new species (above right), aquarium specimen from Harrier Reef, Great Barrier Reef; *P. rubricaudalis* (middle right) underwater photograph from Solomon Islands; and *P. flavianalis* (below right), underwater photograph from Bali. The purpling of median-fin rays in preserved specimens are shown in the lettered insets. (A) *Paracheilinus amanda*, QM I.39758, holotype; (B–C) *Paracheilinus rubricaudalis*, WAM P.33979.001; (D) *Paracheilinus flavianalis*, NTM S.18121-011. Live photographs of *P. amanda*, *P. rubricaudalis*, and *P. flavianalis* by F. Walsh, D. Brown, and K. Nishiyama, respectively. Live specimens not retained. Photographs of preserved specimens by T. Miskiewicz and Y. K. Tea.

fleshy upper edge of orbit and slightly anterior to vertical at anterior bony rim of orbit; anterior nostril smaller, with a short fleshy rim anterior and slightly ventral to posterior nostril; internarial space about 1.0 in orbit diameter.

Head scaled except for interorbital space, snout, and chin; a row of pointed scales on base of dorsal and anal fins; basal half of caudal fin with large scales; axillary scale of pelvic fin slightly longer than pelvic spine; midventral scaly process

Table 2. Summary of live coloration characters for select species of *Paracheilinus*. Unless specified, all characters apply only to TP males.

	Paracheilinus amanda, new species	*Paracheilinus carpenteri*	*Paracheilinus flavianalis*	*Paracheilinus mccoskeri*	*Paracheilinus rubricaudalis*
Body coloration	Pattern B	Pattern B, but with an additional stripe behind pectoral fin	Pattern B	Pattern B	Pattern B
Dorsal-fin filament	Always one; always red	2–6 (usually 3–4); yellow to red	1–4 (usually one); always red	Always one; always yellow	Always one; yellow to red
Posterior dorsal fin	Ground color yellow hyaline with extensive metallic blue markings	Ground color yellow to red base darkened with elongate black blotch	Ground color yellow hyaline with metallic blue markings on distalmost edge	Ground color yellow with extensive metallic blue markings	Bright red without any blue markings
Caudal fin	Typical of pattern B	Typical of pattern B, but base darkened with black	Typical of pattern B	Typical of pattern B	Typical of pattern B, but bright red and with the concentric bands attenuated or absent completely
Anal fin	Bicolored; basal third bright yellow, distal two-thirds bright orange red. Blue spots absent or incomplete when present.	Bicolored; basal third bright yellow, distal two-thirds bright orange red. Blue spots usually present, sometimes absent entirely.	Uniform yellow to yellowish orange, rarely suffused with red on the outer edge. Blue spots usually present, sometimes absent entirely.	Bicolored; basal third bright yellow, distal two-thirds bright orange red. Blue spots usually present, sometimes absent entirely.	Interradial membrane rich orange yellow. Anal-fin rays bright purple red.

of pelvic fins slightly shorter than pelvic spine. Free ventral margin of preopercle extending to vertical at center of orbit, vertical posterior margin to level of lower edge of orbit; exposed bony edge of preopercle smooth without serrations. Origin of dorsal fin above third lateral-line scale, predorsal length 3.2 (2.8–3.2) in SL; dorsal-fin spines progressively longer, first 9.6 (9.2–14.6) in HL, and ninth 2.1 (2.0–2.7) in HL; one to three elongate filamentous segmented rays on posterior dorsal fin in males, bound together by membrane, first longest, 2.1 (1.8–5.7) in SL; origin of anal fin below base of last dorsal-fin spine, preanal length 1.9 (1.7–1.9) in SL; first anal-fin spine 5.1 (4.5–9.6) in HL; second anal-fin spine 3.8 (3.6–5.0) in HL; third anal-fin spine 3.0 (3.0–4.3) in HL; longest anal-fin soft ray 4.2 (3.7–8.1) in SL; caudal fin rounded, 3.6 (3.6–4.6) in SL; pectoral-fin length 1.6 (1.5–1.7) in HL; pelvic-fin length 2.0 (2.0–2.8) in HL.

Coloration of males in life.—Based on color photographs of specimens when freshly dead, and live individuals photographed in aquaria (Figs. 3, 5A1–A2, 7): head and body orange to orange brown with body stripes following pattern B; stripes purplish blue to bright neon blue in life; iris bright orange with bright yellow ring around pupil; spinous portion of dorsal fin yellow; posterior soft dorsal fin hyaline overlain with bright metallic blue, sometimes breaking into indistinct spot-bands medially and on distal edge; first two to three interradial membrane spaces (including the filament) bright red; basal third of anal fin bright yellow, remainder distal portion of fin bright orange red, interphase of both colors usually without blue spots, or if present, usually incomplete and towards posterior portion of fin; distalmost edge of anal fin bright blue; caudal fin hyaline with a pair of concentric blue bands following contour of fin, first on basal third, second on outermost edge; pelvic fins reddish hyaline, bright blue on distalmost edge; pectoral fins hyaline.

Coloration of females in life.—Females typical of species in this species complex. Head and body orange to orange brown with body stripes following pattern B; stripes purplish blue to neon blue in life. Median fins yellow hyaline with indistinct blue markings.

Color in preservation.—Uniformly pale tan, except body stripe pattern now dark tan. All fins translucent hyaline. Segmented fin rays on median fins in the largest specimen (47.6 mm SL holotype) purple.

Habitat and distribution.—*Paracheilinus amanda* is known from Harrier Reef in the northern Great Barrier Reefs, as well as Flora, Holmes, and Osprey Reefs in the Coral Sea. It is also known from specimens collected off Taurama and Hula in southern Papua New Guinea, along the north-western margin of the Coral Sea. The identity and collection locality of the specimen of *P. rubricaudalis* used in the molecular phylogeny of Allen et al. (2016) is erroneous. The specimen is *P. amanda*, collected from Harrier Reef, not Ribbon Reef, alongside the WAM paratypes (WAM P.33973.001). The species frequents habitat typical of the genus, consisting of low-lying rubble pans between 20 to 50 m. It is replaced by the closely related *P. carpenteri* in Japan, Philippines, Brunei, eastern Sulawesi, and Palau, *P. flavianalis* in Indonesia (Bali eastwards in the Lesser Sunda Islands and the Moluccas), Timor Leste, West Papua, and north-western Australia, *P. mccoskeri* in the Indian Ocean, and *P. rubricaudalis* in wider Melanesia (northern Papua New Guinea, the Solomon Islands, Fiji, and Vanuatu).

Etymology.—The species is named in honor of Amanda Hay, ichthyology collections manager at the Australian Museum, Sydney. With over 25 years of experience in ichthyological collections and research, she has not only contributed significantly towards the study of Australasian fishes, but also supported and assisted the research endeavors of many ichthyologists of all career stages working at the Australian Museum. The name *amanda* is treated as a noun in apposition.

Comparisons and phylogenetic interpretation.—*Paracheilinus amanda* most closely resembles *P. carpenteri*, *P. flavianalis*, *P. mccoskeri*, and *P. rubricaudalis* (Fig. 5). The five species form a complex of largely allopatric species united in sharing stripe pattern B, hereafter referred to as the *P. mccoskeri* complex. Except for *P. carpenteri* and *P. flavianalis*, members of the *P. mccoskeri* complex typically possess a single dorsal-fin filament through prolongation of the anteriormost 1–3 segmented rays. Since all five species possess overlapping morphometric and meristic characters, separation of species is most reliable through comparison of live coloration of TP males, which typically involves a combination of coloration details of the dorsal filament(s), posterior dorsal fin, and anal fin. As with many species of *Paracheilinus*, intraspecific variation is typically very high, although some trends are evident within each species. This variation is further exacerbated by the proclivity for hybridization displayed in several species. As such, it is possible to encounter individuals that depart from the following character summaries.

In *P. amanda* (Figs. 3, 5A1–A2, 7), the anal fin is sharply bicolored, with the basal third yellow and the distal region bright orange red. The interphase of both colors on the anal fin is incompletely lined with bright blue spots (spots usually absent entirely). The dorsal fin is always with a single red filament, and the posterior portion of the dorsal fin is extensively decorated in metallic blue. The segmented rays of the median fins are deep purplish red in life, turning purple in alcohol.

In *P. carpenteri* (Fig. 5B), the anal fin is usually sharply bicolored (as with *P. amanda*) and usually, but not always, with a complete series of blue spots along the colored interphase. The dorsal fin is ornamented with 2–6 (usually 3–4) filaments that vary in color from yellow to red. The bases of the caudal fin and posterior dorsal fin are often blackened (the latter with an elongate black blotch). In addition to displaying the typical assortment of stripes in pattern B, there is always an additional short stripe behind the pectoral fin. Large males can sometimes have the body stripes broken and somewhat reticulate.

In the highly variable *P. flavianalis* (Figs. 5C, 7, 8, 9), the anal fin is never sharply bicolored, and is almost always uniformly yellow or orangey yellow (very rarely it may be washed with red near the distal edge, but this demarcation is always suffused; Fig. 8B). There is usually, but not always, a complete series of blue spots (cf individuals in Figs. 5C, 7, 8B, D) on the anal fin. The dorsal fin is ornamented with 1–4 (usually one) red filament(s). The segmented rays of the median fins turn purple in alcohol.

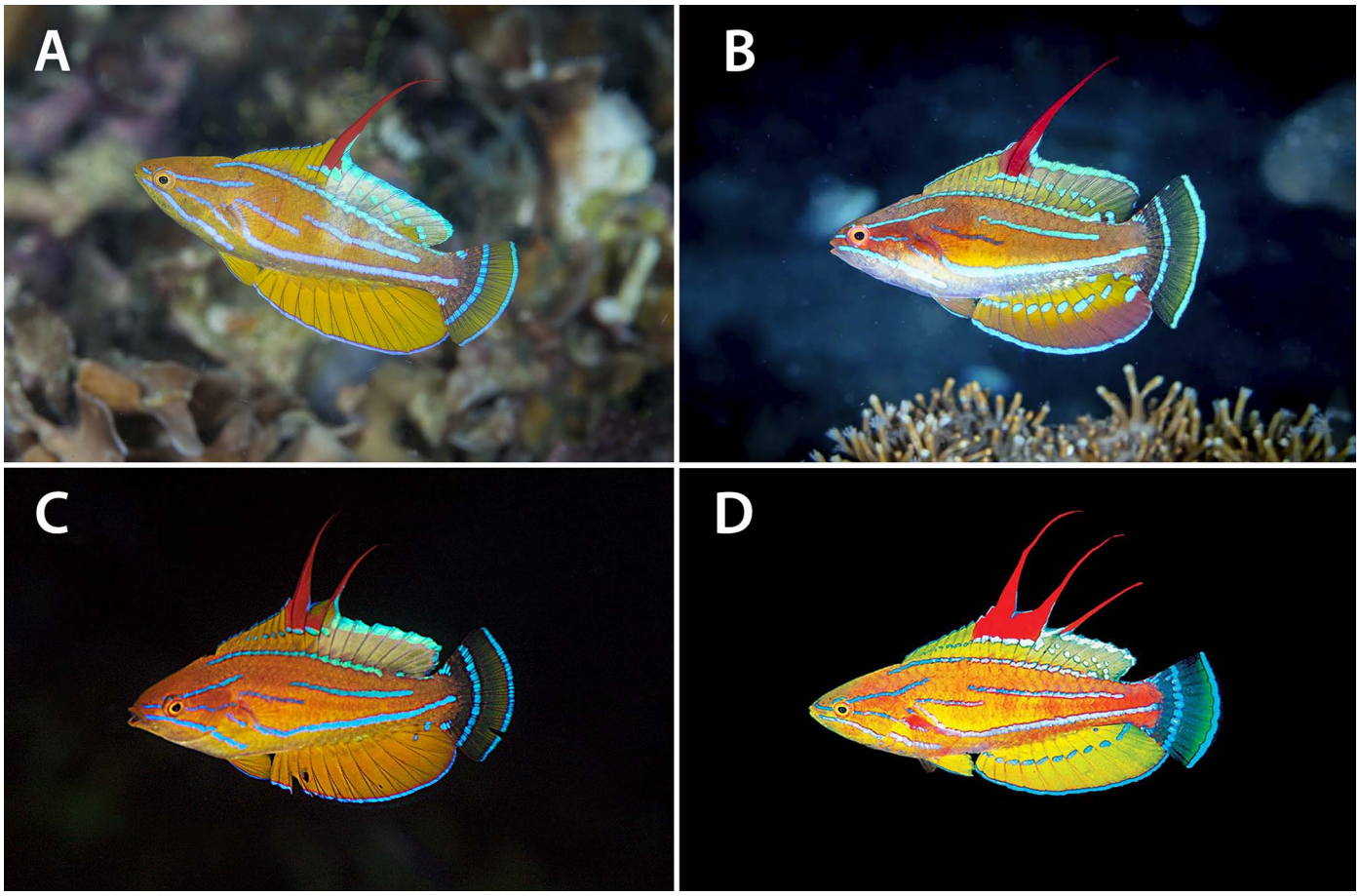

Fig. 8. Select individuals of *Paracheilinus flavianalis* demonstrating variability in the number of dorsal-fin filaments, coloration of anal fin, and spot band pattern on the anal fin. (A) Underwater photograph from Triton Bay, Indonesia; (B) underwater photograph from Wakatobi, Sulawesi, Indonesia; (C–D) underwater photographs from Bali, Indonesia. Photographs by R. Smith (A); J. Castellano (B); W. Osborn (C); and R. H. Kuiter (D).

In *P. mccoskeri* (Fig. 5D), the anal fin is usually, but not always, sharply bicolored (as with *P. amanda* and *P. carpenteri*), with the basal third yellow and the distal region bright orange red. Occasionally, individuals may have entirely yellow or red anal fins (the latter phenotype is more common in the western Indian Ocean). The interphase of both colors on the anal fin is usually, but not always, completely lined with bright blue spots. The dorsal fin is always with a single yellow filament, and the posterior dorsal fin is richly decorated in metallic blue on the distal edge.

Fig. 9. *Paracheilinus flavianalis*, underwater photograph from Hibernia Reef, Timor Sea, north-western shelf of Western Australia. Note sympatric *Cirrhilabrus morrisoni* and habitat consisting of extensive *Halimeda* growth. Photograph by G. R. Allen.

In *P. rubricaudalis* (Figs. 5E, 7), the interradial membranes of the anal fin are a rich orange yellow that contrast strongly with the bright purplish red segmented rays, giving the appearance of deep serrations on the fin. The anal fin is almost always without blue spots. The dorsal fin is always with a single yellow or red filament, and the posterior dorsal fin is bright red without metallic blue markings. The caudal fin is bright red and with the usual concentric bands attenuated or completely absent.

Among members of the *P. mccoskeri* complex, *P. rubricaudalis*, *P. amanda*, and *P. flavianalis* share the unusual property of having the segmented rays on their median fins turning purple in alcohol (Fig. 7). In contrast, the rays of *P. mccoskeri* and *P. carpenteri* are either translucent, or in large individuals, weakly blue green, in preservation. The unusual quality of purple fin rays and other osseous elements was briefly reviewed by Tea et al. (2022a) for species of *Cirrhilabrus*, but the condition has not been extensively reviewed for *Paracheilinus* and other labrid taxa. Several other species of *Paracheilinus* develop purpling of radial elements in alcohol (see Allen et al., 2016), including *P. filamentosus* (see below). Character summaries for all species of the *P. mccoskeri* complex are presented in Table 2.

Molecular phylogenetic analyses of mitochondrial *COI* recover the *P. mccoskeri* complex as monophyletic, suggesting that pattern B is synapomorphic for this complex and apomorphic within *Paracheilinus* (Fig. 6A). *Paracheilinus amanda*, *P. flavianalis*, and *P. rubricaudalis* form a monophyletic lineage within the *P. mccoskeri* complex, with the three sharing successive sister relationships to *P. carpenteri* and *P. mccoskeri* (Fig. 6A). This relationship is supported by a single morphological character (i.e., purpling of radial elements) and is mostly congruent to those described in Allen et al. (2016), except that in their study, *P. rubricaudalis* was not included in the analyses; the *P. rubricaudalis* in Allen et al. (2016) is *P. amanda* (GenBank accession number KT253628).

While the haplotype diversity for each species corresponds well with species-specific coloration pattern and geographical distribution (Fig. 6B), phylogenetic resolution based on mitochondrial *COI* was unsatisfactory for the lineage comprising *P. amanda*, *P. rubricaudalis*, and *P. flavianalis*. *Paracheilinus amanda* and *P. rubricaudalis* were recovered as monophyletic sister lineages, but the relationship of *P. flavianalis* could not be resolved due to low sequence variability in mitochondrial *COI*. This scenario is not uncommon for groups of coral reef fishes where sexual selection favors female mate choice and male coloration, leading to incongruent signals in morphological and molecular data, or those that have speciated only very recently (Victor and Randall, 2014; Hench et al., 2019). Pairwise comparison of mitochondrial *COI* reveals a genetic distance of 1–1.2% (uncorrected *p*-distance) between *P. amanda* and *P. rubricaudalis*, and between *P. amanda* and *P. flavianalis*. Genetic distances between *P. rubricaudalis* and *P. flavianalis* were less than 1%, suggesting that separation of both species occurred only very recently. All three species are allopatric (Fig. 6C). Notwithstanding the lack of phylogenetic resolution, *P. amanda* is at the very least distinct from all congeneric species on the basis of morphology and molecular sequence data.

Remarks.—The paratypes of the new species consist mostly of non-TP males, which may account for the larger variation in dorsal-fin filament lengths when compared with other members of its species complex (17.6–54.4% SL vs. 27.8–50.3% SL in our examined specimens of *P. flavianalis*; and 45.8–64.1% SL in our examined specimens of *P. rubricaudalis*). Live photographs of TP males and morphometric data from the two TP males in the type series (Figs. 3, 5A1, 5A2, 7), however, show proportionately longer dorsal-fin filaments in *P. amanda* compared to lengths typically displayed by related species. The width of the dorsal-fin filament appears to be broadest in *P. amanda*, consisting of three segmented rays (vs. one to two) at the base of the filament in all specimens examined in the type series. More comparative material is needed to determine if this character is restricted to this species.

The AMS paratype of *P. amanda* (AMS I.50116-001) has the lowermost principal caudal-fin ray deeply bifurcate and branched close to the base (Fig. 4). An X-ray of the specimen suggests that this branching is aberrant and likely a result of improper healing of an injury. The ray immediately above appears to have been injured in the same position.

Fig. 10. *Paracheilinus filamentosus*, AMS I.40666-002, 46.6 mm SL, freshly euthanized male, Lizard Island, northern Great Barrier Reef, Australia. Photograph by J. Leis.

Paracheilinus filamentosus Allen, 1974

Filamentous Flasher Wrasse
Figures 10, 11A–E

Paracheilinus filamentosus Allen, 1974: 452 (holotype AMS I.16994-001, Kranket Island, Madang, Papua New Guinea); Randall and Lubbock, 1981: 26, pl. 2C (generic revision, specimens from Papua New Guinea and the Solomon Islands [BPBM 16007], but not those from Indonesia and the Philippines); Kuiter and Tonozuka, 2004: 494 (field guide, Papua New Guinea and the Solomon Islands, but not those from Indonesia and Palau); Michael, 2009: 284 (field guide, underwater photograph from Papua New Guinea, but not those from Indonesia, Palau, the Philippines); Kuiter, 2010: 106, figs. B, C (underwater photographs from Papua New Guinea and the Solomon Islands, but not those from Indonesia); Allen and Erdmann, 2012: 706 (field guide, Papua New Guinea and the Solomon Islands, but not those from Brunei, Indonesia, Palau, the Philippines, and West Papua).

Diagnosis.—Dorsal-fin rays IX,11 (holotype VIII,11); anal-fin rays III,9; pectoral-fin rays 14; pelvic-fin rays I,5; pored lateral-line scales 14–17 + 5–10 = 19–27; gill rakers 5–6 + 7–10 = 12–16; body depth 3.0–3.5 in SL; head length 2.9–3.5 in SL; snout length 3.7–4.8 in HL; orbit diameter 3.1–4.9 in HL; interorbital width 3.4–4.6 in HL; least depth of caudal peduncle 1.9–2.5 in HL; caudal peduncle length 1.6–2.8 in HL; TP males with 4–7 elongate filamentous dorsal-fin rays, longest dorsal-fin soft ray 1.7–2.0 in SL; pelvic fin length 1.9–2.1 in HL; caudal fin of TP males with pronounced filamentous lobes; caudal-fin length 3.7–5.0 in SL; caudal concavity 2.3–6.4 in SL; body with stripe pattern A; dorsal fin reddish orange at rest, richly yellow when in display; ground color of body red to maroon in life; central portion of caudal fin with triangular hyaline region, upper and lower lobes red with metallic blue margins dorsally and ventrally (in life); spines and rays of median fins purple in preservation.

Remarks.—Allen (1979) described *P. filamentosus* on the basis of 23 specimens collected from Papua New Guinea and the Solomon Islands. He noted the holotype as having VIII,11 dorsal-fin rays (versus the usual IX,11) for the genus. An

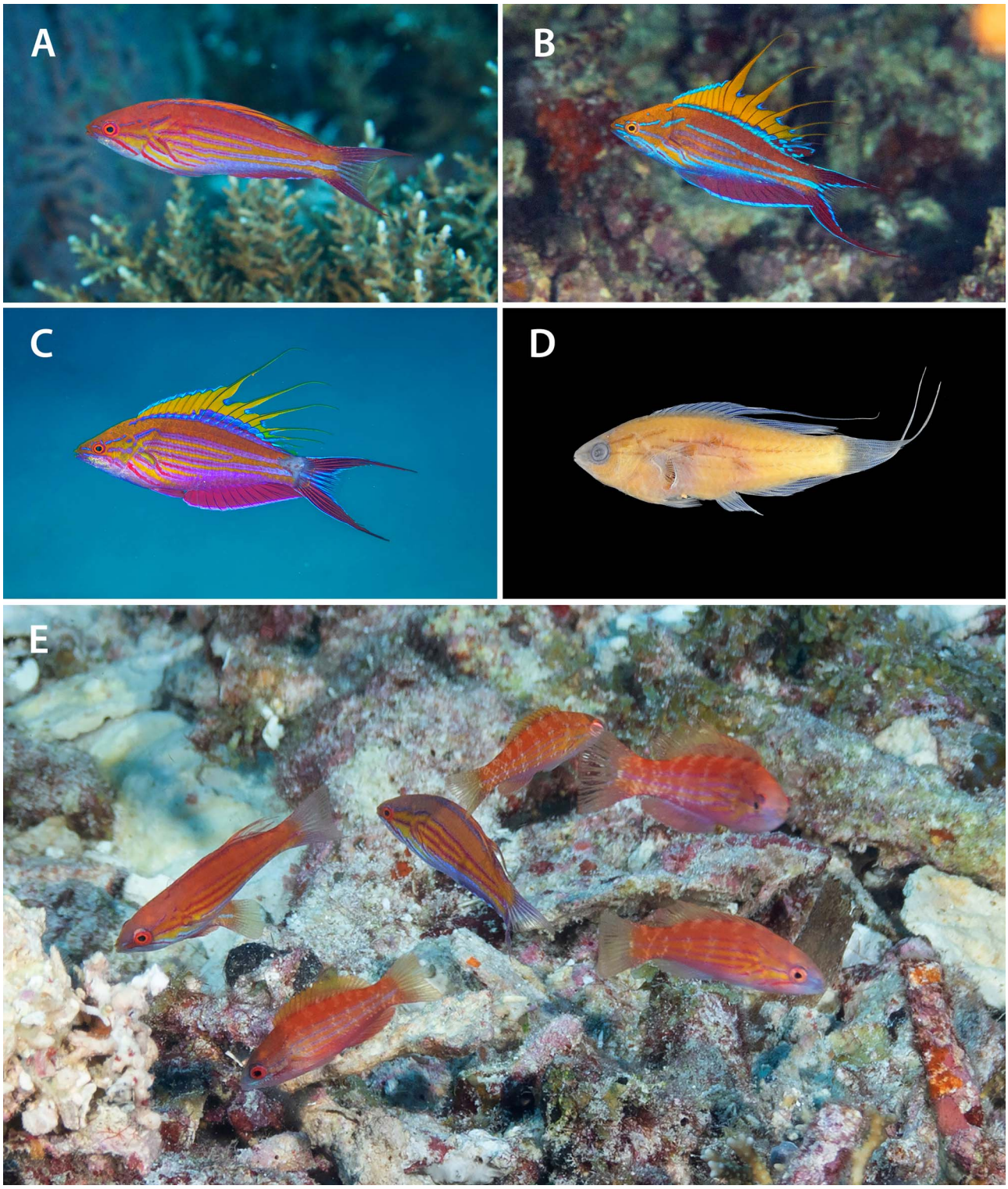

Fig. 11. *Paracheilinus filamentosus*, images of live and preserved specimens. (A) Male in resting colors, underwater photograph from Guadalcanal, Solomon Islands; (B) flashing male in nuptial colors, underwater photograph from Nggatokae, western Solomon Islands; (C) flashing male in nuptial colors, underwater photograph from the Solomon Islands; (D) AMS I.17479-001, 51.7 mm SL, male paratype, Tassafaronga Point, Guadalcanal, Solomon Islands. Note purple spines and rays in preservation; (E) harem comprising one TP male (middle) and several females and immature males, underwater photograph from Lovukol, central Solomon Islands. Photographs by M. Rosenstein (A–C, E) and Y. K. Tea (D).

additional seven specimens from Saparua, Moluccas, Indonesia, were designated as paratypes (USNM 209923) in an addendum published at the end of the original description. Subsequent work published by other authors expanded the known distribution of *P. filamentosus* to include Brunei, various localities across Indonesia, Palau, and the Philippines. In the most recent revision of the genus, Allen et al. (2016) restricted *P. filamentosus* to Papua New Guinea and

the Solomon Islands and recognized those from central Indonesia (from Java east to Komodo and Sulawesi) as *P. paineorum*, and those from southeastern South China Sea (the Anambas Islands and Brunei) as *P. xanthocirritus*. The distinction of *P. filamentosus* from *P. paineorum* and *P. xanthocirritus* is supported by differences in TP male coloration pattern and mitochondrial *COI* sequence data (Allen et al., 2016). Based on the collection locality of the USNM 209923 paratypes, the identity of the specimens should be *P. paineorum*, and not *P. filamentosus*.

In addition to Papua New Guinea and the Solomon Islands, Allen et al. (2016) reported on the occurrence of *P. filamentosus* in the far northern Great Barrier Reef of Australia. The record appears to be spurious, as no photographs or examined material from Australia were included in their study. The Australian distribution record was also omitted from the distribution map (fig. 18 in Allen et al., 2016). An extensive search of Australian museum fish collections conducted by the first author of the present study yielded only a single, previously unexamined specimen of *P. filamentosus* from Australia. The specimen was collected from Lizard Island, in the northern Great Barrier Reef. The Lizard Island specimen (Fig. 10; AMS I.40666-022) agrees well with *P. filamentosus* in meristic data, morphometrics, dorsal- and caudal-fin morphology, and aspects of live and preserved coloration details (Fig. 11). The Lizard Island specimen was compared with 12 paratypes and four non-type specimens housed at the Australian Museum (see list of examined material below). Unfortunately, the holotype (AMS I.16994-001) and four paratypes (AMS I.16995-001) of *P. filamentosus* could not be located. An ongoing effort to locate the missing types is currently being conducted by the authors.

One record of *P. filamentosus* from the Gulf of Carpentaria is listed on the Atlas of Living Australia, based on observations taken on the 2005 FRV *Southern Surveyor* expedition. The specimen that the observation was based off could not be located, and was likely unretained (J. Pogonoski, pers. comm.). Unpublished data indicated that the specimen weighed 19.5 g, which appears unlikely for a *Paracheilinus*. We do not consider this record as verifiable. At this time, *P. filamentosus* is known from Australia based solely on the Lizard Island specimen. Given the specific habitat of *Paracheilinus*, it is likely that this species occurs more widely across the northern Great Barrier Reef and the Coral Sea but has evaded detection due to observation and sampling bias. Indeed, the Lizard Island specimen was collected in *Halimeda* fields growing in coral rubble on outer reef slopes, a habitat not frequented by divers and fish collectors.

Etymology.—Named after the long filamentous segmented dorsal-fin rays. Although this character is not diagnostic of the species, it was at the time of its description. The only other species of *Paracheilinus* known at the time was *P. octotaenia*, a species lacking filaments completely.

Paracheilinus flavianalis Kuiter and Allen, 1999

Yellowfin Flasher Wrasse
Figures 5C, 8A–D, 9

Paracheilinus sp. 1—Kuiter and Debelius, 1994: 232 (field guide, underwater photograph from Indonesia).

Paracheilinus flavianalis Kuiter and Allen, 1999: 123 (holotype WAM P.30836-007, Scott Reef, north-western shelf of Western Australia); Kuiter and Tonozuka, 2004: 496 (field guide, underwater photos from Indonesia); Michael, 2009: 287 (field guide, underwater photos from Indonesia); Kuiter, 2010: 115 (field guide, underwater photos from Indonesia); Allen and Erdmann, 2012: 707 (field guide, underwater photo from Triton Bay, West Papua).

Diagnosis.—Dorsal-fin rays IX,11; anal-fin rays III,9; pectoral-fin rays 14; pelvic-fin rays I,5; pored lateral-line scales 14–17 + 5–10 = 19–27; gill rakers 4–6 + 7–10 = 11–16; body depth 3.1–3.5 in SL; head length 2.7–3.2 in SL; snout length 3.8–5.1 in HL; orbit diameter 3.0–4.6 in HL; interorbital width 3.7–4.9 in HL; least depth of caudal peduncle 1.9–3.0 in HL; caudal peduncle length 1.6–2.5 in HL; TP males with 1–4 (usually one) elongate, red filamentous dorsal-fin rays, longest dorsal-fin soft ray 1.8–3.6 in SL; pelvic fin length 1.9–2.9 in HL; caudal fin of TP males round without filamentous lobes; caudal-fin length 3.8–4.4 in SL; body with stripe pattern B; anal fin uniformly yellow or orangey yellow, basal third usually lined with a horizontal row of blue spots (sometimes incomplete or completely absent).

Remarks.—*Paracheilinus flavianalis* is most similar to *P. amanda*, *P. carpenteri*, *P. mccoskeri*, and *P. rubricaudalis* (see comparisons in description of *P. amanda* above). The members of this species complex are mostly allopatric, with *P. flavianalis* overlapping only very narrowly with *P. mccoskeri* in Bali and *P. carpenteri* in Sulawesi (Fig. 6C). It usually possesses a single red dorsal-fin filament, but individuals may possess anywhere between one to four filaments (Fig. 8). *Paracheilinus flavianalis* is known from southern and eastern Indonesia, from Bali eastwards across the Lesser Sunda Islands, southern Sulawesi, the Moluccas, and West Papua. It also occurs in Timor Leste. In Australia, it occurs in Evans and Flinders Shoals, Timor Sea, off northeast Darwin, Northern Territory, and Ashmore, Scott, Seringapatam, and Hibernia Reefs in the north-western shelf of Western Australia (Fig. 9).

Etymology.—The species is named *flavianalis* in reference to the characteristic yellow anal fin.

Paracheilinus nursalim Allen and Erdmann, 2008

Nursalim's Flasher Wrasse
Figures 12A–F

Paracheilinus nursalim Allen and Erdmann, 2008: 181 (holotype NCIP 6327, Triton Bay, West Papua, Indonesia); Michael, 2009: 284 (field guide, underwater photograph from Bird's Head Peninsula, West Papua, Indonesia); Kuiter, 2010: 109 (field guide, underwater photographs from Raja Ampat and Triton Bay, West Papua, Indonesia); Allen and Erdmann, 2012: 708 (field guide, underwater photographs from Triton Bay, West Papua, Indonesia).

Diagnosis.—Dorsal-fin rays IX,11; anal-fin rays III,9; pectoral-fin rays 14; pelvic-fin rays I,5; pored lateral-line scales 11–16 + 3–10 = 14–26; gill rakers 4–6 + 8–9 = 12–15; body depth 2.9–3.6 in SL; head length 2.8–3.3 in SL; snout length 3.8–4.9 in HL; orbit diameter 3.0–4.2 in HL; interorbital width 3.9–5.3 in HL; least depth of caudal peduncle 2.0–2.5 in HL; caudal

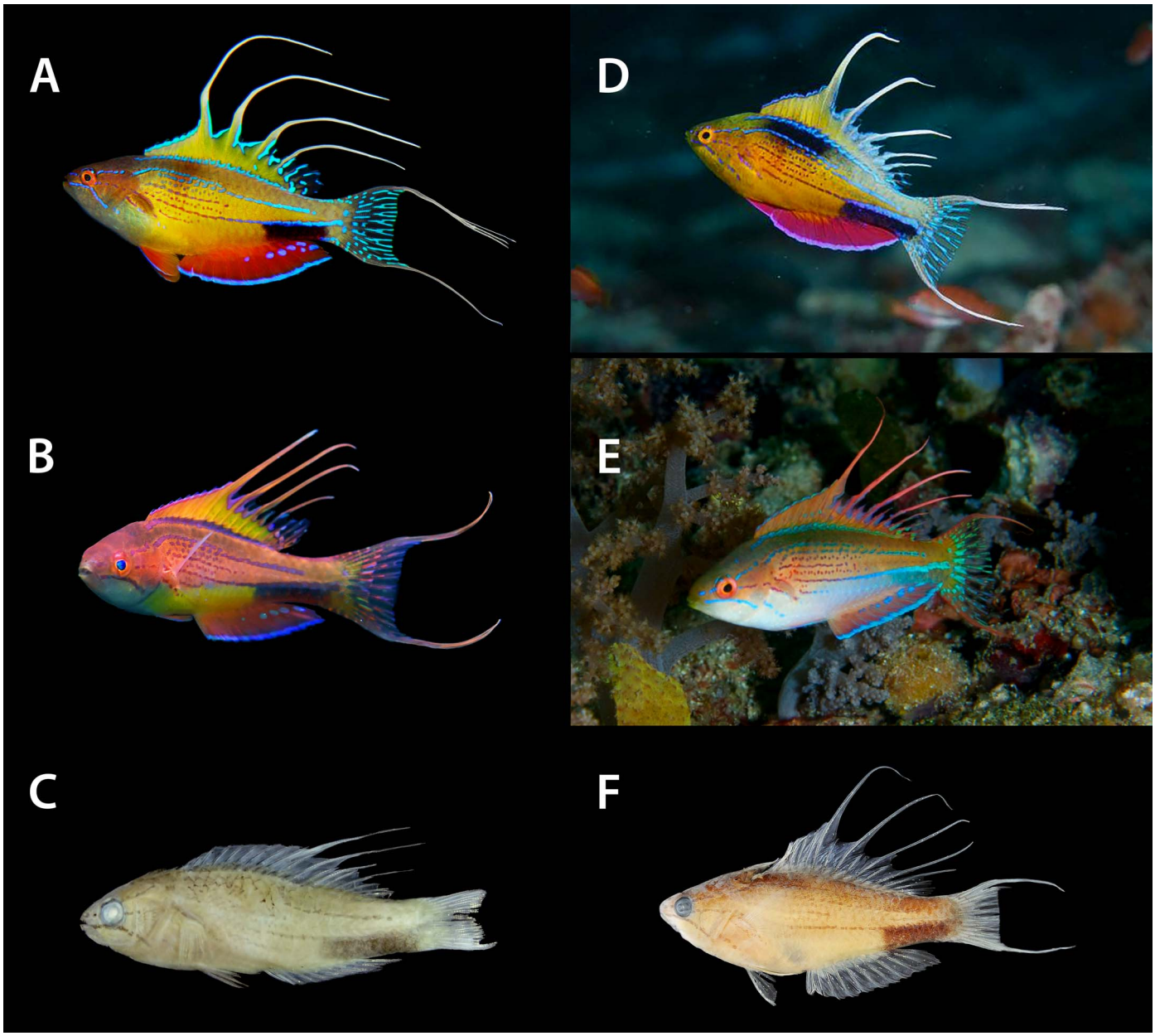

Fig. 12. *Paracheilinus nursalim*, images of live and preserved specimens from Flinders Shoal, Timor Sea, off Darwin, Northern Territory, Australia (A–C) and West Papua, Indonesia (D–F). (A) Flashing male in nuptial colors, aquarium specimen. Specimen not retained. (B) Male in resting colors, aquarium specimen. Specimen not retained. (C) Male in preservation, NTM S.18257-001, 53.1 mm SL, Flinders Shoal, Timor Sea. (D) Flashing male in nuptial colors, underwater photograph from Triton Bay, West Papua, Indonesia. (E) Male in resting colors, underwater photograph from Triton Bay, West Papua, Indonesia. (F) AMS I.44190-001, 46.0 mm SL, male paratype, FakFak Peninsula, West Papua, Indonesia. Photographs by K. Kohen (A); Y. K. Tea (B–C; F); E. Cheng (D); and L. Cheng (E).

peduncle length 1.5–2.3 in HL; TP males with 3–6 (rarely 3) elongate, yellow filamentous dorsal-fin rays (bright white when in display), longest dorsal-fin soft ray 1.8–2.3 in SL; pelvic fin length 1.6–2.0 in HL; caudal fin of TP males with very pronounced filamentous lobes, with filaments sometimes greater than SL; caudal-fin length 1.6–2.4 in SL; caudal concavity 0.8–1.5 in SL; body with stripe pattern A'; body with two black rectangular epaulettes, one below spinous portion of dorsal fin, one along lower caudal peduncle (dusky in preservation); ground color of body yellow orange in life; central portion of caudal fin with intricate blue markings.

Remarks.—This beautiful species was previously known only from the western Bird's Head Peninsula of West Papua, Indonesia, from Raja Ampat and Triton Bay (Fig. 12D–F). It has also been photographed in Ambon, approximately 500 km west of the Bird's Head Peninsula (Allen et al., 2016). The Ambon record was based only on a single photograph, and so it wasn't clear if a viable population existed outside of the Bird's Head Peninsula. The discovery of *P. nursalim* in the Timor Sea in northeastern Australia extends the known distribution of this species approximately 1,000 km south of Ambon, and approximately 1,200 km south of the Bird's

Head Peninsula. It is likely that the species occurs throughout this region but has escaped detection until recently.

Australian records of *P. nursalim* are based on specimens from Flinders Shoal, Timor Sea (Fig. 12A–C). Comparison of live photographs and a single retained specimen (Fig. 12C; NTM S.18257-001) agrees well with topotypical examples of *P. nursalim* on the basis of meristic data, morphometrics, dorsal- and caudal-fin morphology, and aspects of live and preserved coloration details. Comparisons were made with two paratypes of *P. nursalim* (Fig. 12F; AMS I.44190-001). Some of the Australian specimens appear to have the dorso-anterior black epaulette below the spinous portion of the dorsal fin reduced or absent completely, which is otherwise typical of this species (Fig. 12A–B). However, this pattern appears to vary even in specimens from Triton Bay (Fig. 12E). In all other aspects, they are inseparable from topotypical examples of *P. nursalim*. We attribute these differences in coloration to intraspecific variation, which is not uncommon for *Paracheilinus*.

Etymology.—Named *nursalim* at the request of Cherie Nursalim and Michelle Liem, who successfully bid to support the conservation of this species at the Blue Auction in Monaco on 20 September 2007, and who have given generously to support Conservation International's Bird's Head Seascape marine conservation initiative. The name honors their parents Sjamsul and Itjih Nursalim. The name *nursalim* is treated as a noun in apposition.

DISCUSSION

Four species of *Paracheilinus* are here reported as extant in Australia, all of which confined to or around tropical latitudes of Western Australia, Queensland, and the Northern Territory (Fig. 6C). Despite their widespread occurrences in these regions, representation of Australian species of *Paracheilinus* is poor in Australian fish collections. Only *P. flavianalis* is well represented in Australian collections and is known from the holotype (WAM P.30836-007) and 17 paratypes deposited in WAM (WAM P.31194-001 [14]) and NMV (NMV A20059 [3; erroneously reported as 2 specimens in Kuiter and Allen, 1999]). It is also known from additional material collected outside of Australia (see list of material examined).

Paracheilinus amanda is known primarily from the type series—the holotype at QM (QM I.39758) and five paratypes at AMS (AMS I.50116-001 [1]), WAM (WAM P.33973.001 [2]), and ZRC (ZRC 64175 [2]). Two additional non-type specimens are also deposited in WAM (WAM P.34513.001) and ZRC (ZRC 64174). We are aware of one specimen of *P. amanda* (incorrectly identified as *P. rubricaudalis*) currently deposited in the Indonesian Biodiversity Research Centre under the voucher number MB043301. The specimen was collected with the WAM paratypes from Harrier Reef, Great Barrier Reef, and not the Ribbon Reefs as reported in Allen et al. (2016). The specimen was not examined in this study, but mitochondrial *COI* sequence obtained from this specimen was used in our phylogenetic analyses and agrees well with sequences obtained from the AMS paratype of *P. amanda* (AMS I.50116-001). The species is also known from an underwater photograph taken at Osprey Reef in the Coral Sea (Fig. 5A2).

Paracheilinus filamentosus is known from Australia based on a single specimen collected from Lizard Island, Great Barrier Reef, currently deposited at AMS (AMS I.40666-022). Twelve paratypes (AMS I.17479-001 [1] and AMS I.17496-001 [11]) of *P. filamentosus* from the Solomons Islands are deposited at AMS. The holotype (AMS I.16994-001) from Papua New Guinea and four paratypes (AMS I.16995-001) from the Solomon Islands could not be located.

Although *Paracheilinus nursalim* is known from numerous photographs, only a single specimen is deposited in Australian fish collections. The specimen is a male collected from Flinders Shoal, Timor Sea, currently deposited at NTM (NTM S.18257-001).

Of the remote Australian Territories, *Paracheilinus* has been reported only from the territories of Ashmore and Cartier Islands (*P. flavianalis* [Allen, 1996; Kuiter and Allen, 1999]), and the Coral Sea (*P. amanda*, present study). Curiously, the genus has not been reported from the Christmas and Cocos (Keeling) Islands despite a history of intensive surveying (Allen, 2000; Allen et al., 2007; Hobbs et al., 2009, 2010, 2014; Hobbs and Allen, 2014), especially given the neighboring presence of *P. mccoskeri* and *P. flavianalis* in Bali, and *P. flavianalis* in the Lesser Sunda Islands and the Timor Sea. It is likely that the absence of *Paracheilinus* from this region, and other tropical regions of Australia, is a result of sampling bias, as most species tend to frequent somewhat deep rubble slopes in soft sediment habitats away from coral reefs.

A lot of 42 unidentified specimens of *Paracheilinus* collected from Tijou Reef, east coast of the Cape York Peninsula, Far North Queensland is deposited at AMS (AMS I.20779-049). However, these specimens could not be located, and as such were unavailable for study and their identities could not be verified.

MATERIAL EXAMINED

Paracheilinus amanda: QM I.39758, holotype, 47.6 mm SL, Harrier Reef, Great Barrier Reef; AMS I.50116-001, paratype, 44.4 mm SL, Flora Reef, Coral Sea; WAM P.33973.001, 2, paratypes, 37.3–43.7 mm SL, Harrier Reef, Great Barrier Reef; WAM P.34513.001, 54.3 mm SL, Harrier Reef, Great Barrier Reef; ZRC 64174, 47.2 mm SL, off Taurama, southern Papua New Guinea, Coral Sea; ZRC 64175, 2, paratypes, 32.3–47.6 mm SL, off Hula, southern Papua New Guinea, Coral Sea.

Paracheilinus carpenteri: BPBM 22424, holotype, 39.0 mm SL, Mactan Island, Philippines; BPBM 21165, 2, paratypes, 35.0–36.8 mm SL, Buyong Beach, Mactan Island, Philippines; BPBM 22116, paratype, 52.0 mm SL, Mactan Island, Philippines; BPBM 22465, 10, paratypes, 21.6–65.8 mm SL, Caban Island, Batangas, Philippines; BPBM 26507, 73.0 mm SL, Sumilon Island, Philippines.

Paracheilinus filamentosus: AMS I.17479-001, paratype, 51.7 mm SL, Honiara, Guadalcanal, Solomon Islands; AMS I.17481-013, 3, 23.0–37.1 mm SL (specimens cleared and stained), near Tassafaronga Point, Guadalcanal, Solomon Islands; AMS I.17496-001, 11, paratypes, 28.5–54.5 mm SL, Alite Reef, off Malaita, Solomon Islands; AMS I.17521-004, 45.0 mm SL, Honiara, Guadalcanal, Solomon Islands; AMS I.17524-004, 58.9 mm SL, Honiara, Guadalcanal, Solomon Islands; AMS I.17530-001, 40.2 mm SL, Alite Reef, off Malaita, Solomon Islands; AMS I.40666-022, 46.6 mm SL, Lizard Island, Great Barrier Reef, Queensland, Australia.

Paracheilinus flavianalis: NMV A20059, 3 (erroneously reported as 2 in Kuiter and Allen, 1999), paratypes, 50.4–51.2 mm SL,

aquarium specimens from Bali; AMS I. 46121-035, 66.2 mm SL, Christo Rei Beach, east of Dili, Timor Leste; AMS I.46121-041, 40.4 mm SL, Christo Rei Beach, east of Dili, Timor Leste; NTM S.17978-013, 35.9 mm SL, Evans Shoal, Timor Sea; NTM S.18121-011, 54.3 mm SL, Evans Shoal, Timor Sea; NTM S.18257-005, 31.7 mm SL, Flinders Shoal, Timor Sea; WAM P.31194.001, 5 (of 14), 25.0–34.9 mm SL, central lagoon at Seringapatam Reef, north-western Western Australia.

Paracheilinus lineopunctatus: AMS I.45300.194, 51.0 mm SL (specimen cleared and stained), aquarium specimen from the Philippines.

Paracheilinus mccoskeri: AMS I.18604-001, paratype, 37.8 mm SL, Moroni Reef, Ngazidja (Grand Comore), Comoros.

Paracheilinus nursalim: AMS I.44190-001, 2, paratypes, 40.6–46 mm SL, Fak Fak Peninsula, Pulau Panjang, Barat Province, West Papua, Indonesia; NTM S.18257-001, 53.1 mm SL, Flinders Shoal, Timor Sea.

Paracheilinus paineorum: AMS I.34501-029, 21.0–42.0 mm SL, Flores, Indonesia.

Paracheilinus rubricaudalis: WAM P.33979.001, 3, 40.8–52.7 mm SL, Pityilu Island, Manus Province, northern Papua New Guinea; WAM P.34665.001, 2, 41.8–43.9 mm SL, Jacquinot Bay, New Britain, Papua New Guinea.

ADDENDUM

At the time of writing, photographs of a species of *Paracheilinus* collected from American Samoa were sent to the senior author by B. D. Greene and R. L. Pyle. The specimens closely resemble *P. rubricaudalis* in coloration, but the genus (including *P. rubricaudalis*) is not known from this locality. These specimens were not available for examination at the time of writing, and so their identities could not be determined. They will be dealt with in a forthcoming manuscript.

DATA ACCESSIBILITY

The tree file and the molecular sequence alignment used to generate the maximum likelihood tree in this study are available at: https://www.ichthyologyandherpetology.org/i2023019. GenBank and BOLD accession numbers are included in the sequence alignment file. ZooBank publication urn:lsid:zoobank.org:pub:FFB033F3-092C-4654-92D4-8D4CA64BD832.

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LITERATURE CITED

Allen, G. R. 1974. A review of the labrid genus *Paracheilinus*, with the description of a new species from Melanesia. Pacific Science 28:449–455.

Allen, G. R. 1996. New records of reef and shore fishes from northwestern Australia. Records of the Western Australian Museum 18:109–112.

Allen, G. R. 2000. Fishes of Christmas Island, Indian Ocean. Records of the Western Australian Museum 59:83–95.

Allen, G. R., and M. V. Erdmann. 2008. *Paracheilinus nursalim*, a new species of flasher wrasse (Perciformes: Labridae) from the Bird's Head Peninsula of western New Guinea with a key to the species of *Paracheilinus*. Aqua, International Journal of Ichthyology 13:179–188.

Allen, G. R., and M. V. Erdmann. 2012. Reef fishes of the East Indies. Volume II, p. 425–856. Tropical Reef Research, Perth, Australia.

Allen, G. R., M. V. Erdmann, and N. L. A. Yusmalinda. 2016. Review of the Indo-Pacific Flasherwrasses of the genus *Paracheilinus* (Perciformes: Labridae), with descriptions of three new species. Journal of the Ocean Science Foundation 19:18–90.

Allen, G. R., R. Steene, and M. Orchard. 2007. Fishes of Christmas Island. Second edition. Christmas Island Natural History Association, Christmas Island, Indian Ocean, Australia.

Bandelt, H., P. Forster, and A. Röhl. 1999. Median-joining networks for inferring intraspecific phylogenies. Molecular Biology and Evolution 16:37–48.

Bui, Q. M., M. A. T. Nguyen, and A. von Haeseler. 2013. Ultrafast approximation for phylogenetic bootstrap. Molecular Biology and Evolution 30:1188–1195.

Chang, C. H., K. T. Shao, H. Y. Lin, Y. C. Chiu, M. Y. Lee, and P. L. Lin. 2017. DNA barcodes of the native rayfinned fishes in Taiwan. Molecular Ecology Resources 17:796–805.

De Brauwer, M., and M. Burton. 2018. Known unknowns: conservation and research priorities for soft sediment fauna that supports a valuable SCUBA diving industry. Ocean & Coastal Management 160:30–37.

De Brauwer, M., E. S. Harvey, J. L. McIlwain, J. P. A. Hobbs, J. Jompa, and M. Burton. 2017. The economic contribution of the muck dive industry to tourism in Southeast Asia. Marine Policy 83:92–99.

Edgar, R. C. 2004. MUSCLE: multiple sequence alignment with high accuracy and high throughput. Nucleic Acids Research 32:1792–1797.

Guindon, S., J. F. Dugayard, V. Lefort, M. Anisimova, W. Hordijk, and O. Gascuel. 2010. New algorithms and methods to estimate maximum-likelihood phylogenies: assessing the performance of PhyML 3.0. Systematic Biology 59:307–321.

Hench, K., M. Vargas, M. P. Höppner, W. O. McMillan, and O. Puebla. 2019. Inter-chromosomal coupling between vision and pigmentation genes during genomic divergence. Nature Ecology & Evolution 3:657–667.

Hoang, N. V., A. Furtado, P. J. Mason, A. Marquardt, L. Kasirajan, P. P. Thirugnanasambandam, F. C. Botha, and R. J. Henry. 2017. A survey of the complex transcriptome from the highly polyploid sugarcane genome using full-length isoform sequencing and de novo assembly from short read sequencing. BMC Genomics 18:395.

Hobbs, J. P. A., and G. R. Allen. 2014. Hybridization among coral reef fishes at Christmas Island and the Cocos (Keeling) Islands. Raffles Bulletin of Zoology 30:220–226.

Hobbs, J. P. A., A. M. Ayling, H. J. Choat, J. J. Gilligan, C. A. McDonald, J. Neilson, and S. J. Newman. 2010. New records of marine fishes illustrate the biogeographic importance of Christmas Island, Indian Ocean. Zootaxa 2422:63–68.

Hobbs, J. P. A., A. J. Frisch, G. R. Allen, and L. Van Herweerden. 2009. Marine hybrid hotspot at Indo-Pacific biogeographic border. Biology Letters 5:258–261.

Hobbs, J. P. A., S. J. Newman, G. E. A. Mitsopoulos, M. J. Travers, C. L. Skepper, J. J. Gilligan, G. R. Allen, H. J. Choat, and A. M. Ayling. 2014. Checklist and new records of Christmas Island fishes: the influence of isolation, biogeography and habitat availability on species abundance and community composition. Raffles Bulletin of Zoology 30:184–202.

Kaalyaanamoorthy, S., Q. M. Bui, T. K. F. Wong, A. von Haeseler, and L. S. Jermiin. 2017. ModelFinder: fast model selection for accurate phylogenetic estimates. Nature Methods 14:587–589.

Kuiter, R. H. 2010. Labridae Fishes: Wrasses. Aquatic Photographics, Seaford, Australia.

Kuiter, R. H., and G. R. Allen. 1999. Descriptions of three new wrasses (Teleostoi [sic]: Perciformes: Labridae: *Paracheilinus*) from Indonesia and north-western Australia with evidence of possible hybridization. Aqua, Journal of Ichthyology and Aquatic Biology 3:119–132.

Kuiter, R. H., and H. Debelius. 1994. Southeast Asia Tropical Fish Guide. IKAN Unterwasserarchiv, Frankfurt, Germany.

Kuiter, R. H., and T. Tonozuka. 2004. Pictorial Guide to Indonesian Reef Fishes. PT Dive & Dive's, Bali, Indonesia.

Leigh, J. W., and D. Bryant. 2015. PopART: full-feature software for haplotype network construction. Methods in Ecology and Evolution 6:1110–1116.

Michael, S. M. 2009. Wrasses and Parrotfishes: The Complete Illustrated Guide to Their Identification, Behaviors, and Captive Care. T.F.H. Publications, Neptune City, New Jersey.

Nguyen, L. T., H. A. Schmidt, A. von Haeseler, and Q. M. Bui. 2015. IQ-TREE: a fast and effective stochastic algorithm for estimating maximum-likelihood phylogenies. Molecular Biology and Evolution 32:268–274.

Parenti, P., and J. E. Randall. 2018. A checklist of wrasses (Labridae) and parrotfishes (Scaridae) of the world: 2017 update. Journal of the Ocean Science Foundation 30:11–27.

Randall, J. E. 1999. Revision of the Indo-Pacific labrid fishes of the genus *Pseudocheilinus* with descriptions of three new species. Indo-Pacific Fishes 28:1–34.

Randall, J. E., and G. R. Allen. 2003. *Paracheilinus rubricaudalis*, a new species of flasherwrasse (Perciformes: Labridae) from Fiji. Aqua, Journal of Ichthyology and Aquatic Biology 7:103–112.

Randall, J. E., and R. Lubbock. 1981. Labrid fishes of the genus *Paracheilinus*, with descriptions of three new species from the Philippines. Japanese Journal of Ichthyology 28:19–30.

Roux-Estève, R. 1956. Resultats scientifiques des campagnes de la Calypso. X. Poissons. Annales du Institut Océanographie (Monaco) 31:61–115.

Roux-Estève, R., and P. Fourmanoir. 1955. Poissons capturés par la mission de la "Calypso" en Mer Rouge. Annales du Institut Océanographie (Monaco) 30:195–203.

Sabaj, M. H. 2020. Codes for natural history collections in ichthyology and herpetology. Copeia 108:593–669.

Schultz, L. P., W. M. Chapman, E. A. Lachner, and L. P. Woods. 1960. Fishes of the Marshall and Marianas Islands. Volume 2. Families from Mullidae through Stromateidae. Bulletin of the United States National Museum 202:1–438.

Tea, Y. K., G. R. Allen, C. H. R. Goatley, A. C. Gill, and B. W. Frable. 2021. Redescription of *Conniella apterygia* Allen and its reassignment in the genus *Cirrhilabrus* Temminck and Schlegel (Teleostei: Labridae), with comments on cirrhilabrin pelvic morphology. Zootaxa 5061:493–509.

Tea, Y. K., A. Najeeb, J. Rowlett, and L. A. Rocha. 2022a. *Cirrhilabrus finifenmaa* (Teleostei, Labridae), a new species of fairy wrasse from the Maldives, with comments on the taxonomic identity of *C. rubrisquamis* and *C. wakanda*. ZooKeys 1088:65–80.

Tea, Y. K., X. Xu, J. D. DiBattista, N. Lo, P. F. Cowman, and S. Y. W. Ho. 2022b. Phylogenomic analysis of concatenated ultraconserved elements reveal the recent evolutionary radiation of the fairy wrasses (Teleostei: Labridae: *Cirrhilabrus*). Systematic Biology 71:1–12.

Victor, B. C., and J. E. Randall. 2014. *Pseudojuloides edwardi*, n. sp. (Perciformes: Labridae): an example of evolution of male-display phenotype outpacing divergence in mitochondrial genotype. Journal of the Ocean Science Foundation 11:1–12.