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Redescription of *Conniella apterygia* Allen and its reassignment in the genus *Cirrhilabrus* Temminck and Schlegel (Teleostei: Labridae), with comments on cirrhilabrin pelvic morphology

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Abstract

Conniella apterygia is redescribed from re-examination of the holotype, two paratypes, and six additional specimens. The genus is closely allied to *Cirrhilabrus*, sharing similarities in general morphological and meristic details, but is separated from *Cirrhilabrus* and most other labrid fishes in lacking pelvic fins and a pelvic girdle. Recent molecular phylogenetic studies have provided strong evidence for the deep nesting of *Conniella* within *Cirrhilabrus*, contradicting its generic validity and suggesting that the loss of pelvic elements is autapomorphic. Consequently, the species is redescribed and assigned to the genus *Cirrhilabrus*, as *Cirrhilabrus apterygia* **new combination**. The pelvic morphologies of related cirrhilabrin labrids are discussed, and a new synapomorphy is identified for *Paracheilinus*.

Key words: coral-reef fishes; taxonomy; ichthyology; apomorphy; fairy wrasse; morphology

Introduction

Allen (1983) described *Conniella apterygia* from three specimens collected at Clerke Reef, Bedwell Island, Rowley Shoals, Western Australia. The species is unusual among labrid fishes in lacking pelvic fins and a pelvic girdle, a peculiarity that provided sole justification for the erection of a new genus and its accompanying species. *Conniella* has been regarded as closely allied to *Cirrhilabrus* Temminck & Schlegel, 1845 (Allen 1983; Randall 1999), and although the absence of pelvic elements serves to distinguish the two genera, both are united by the following character combination that distinguishes them from related genera: dorsal-fin rays XI,9; dorsal-fin spines tipped with fibrous cirri; lateral line interrupted; upper jaw with three pairs of enlarged canines; and preopercle margin serrated.

Further justification for the recognition of *Conniella* as a distinct genus from *Cirrhilabrus* has been scant. Similarly, there has been a lack of systematic studies of related "pseudocheilines" *sensu* Westneat (1993), originally proposed as an informal group within the Labridae comprising the following genera: *Cirrhilabrus*; *Paracheilinus* Fourmanoir, 1955 [in Roux-Estève & Fourmanoir 1955]; *Pseudocheilinus* Bleeker, 1862; *Pseudocheilinops* Schultz, 1960 [in Schultz *et al*. 1960]; and *Pteragogus* Peters, 1855. Further, there has been no consistent use of terminology for the genera above, and few studies have included adequate representation of all component genera.

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Westneat (1993) united the five genera based on the following four synapomorphies: third premaxillary canine elongate and recurved; anterior portion of ceratohyal bearing a ventral hook; nasal with posterior flange; and scleral cornea bisected into two foci. *Conniella* was not included in the study, but the genus was later briefly considered by Randall (1999) as a member of the Cirrhilabrini in his revision of the genus *Pseudocheilinus*. Besides the use of "pseudocheilines," other collective group names for these fishes have been proposed, such as the cirrhilabroid fishes (Springer & Randall 1974), the Cirrhilabrini (Randall, 1999), and the Pseudocheilini (Cowman *et al*. 2009; Bannikov & Carnevale 2010; Almeida *et al*. 2017). The lattermost appears to be a noun formed either from the stem genus-group name *Pseudocheilinus* or from the collective "pseudocheilines," used as a scientific name for a supra-generic taxon, and ending in a family-group name suffix, but without a diagnosis. Of the names used, only Cirrhilabrini meets the requirements for a validly proposed family-group name (International Commission on Zoological Nomenclature 1999: Arts. 11.7, 13, 29). However, it was overlooked by Van der Laan *et al.* in both their original (2014) and updated (2021) list of family-group names. Because the other names do not meet those requirements (i.e., the name is used only as a collective adjective), and as we are unaware of any other family-group names based on any of the included genera or their synonyms, we recognise Cirrhilabrini Randall, 1999 as a valid tribe for the group.

In addition to morphological similarities between *Conniella* and *Cirrhilabrus*, recent phylogenomic studies on cirrhilabrin relationships reveals that *Conniella* is deeply nested within *Cirrhilabrus* (Tea *et al*. 2021b). Because the generic recognition of *Conniella* would result in a non-monophyletic *Cirrhilabrus*, we propose subsuming it within the synonymy of *Cirrhilabrus*. *Cirrhilabrus apterygia* **new combination** is redescribed based on the holotype, two paratypes, and six additional specimens. The pelvic morphology of the cirrhilabrins is briefly discussed, and a new synapomorphy is proposed for *Paracheilinus*.

Materials and methods

Methods for counting and measuring follow Randall & Masuda (1991), except gill rakers 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 includes the larger pored scale overlapping the caudal-fin base, which we incorporate in the count. In the following description, data are presented first for the holotype, followed by the minimum-maximum values from paratypes and additional specimens in parentheses where different. Where counts were recorded bilaterally, both counts are given and separated by a slash; the first count presented is from the left side. Morphometric values are expressed as percentages of standard length (Table 1).

Osteological details were taken from micro-computed tomographic (μCT) data and examination of cleared and stained specimens. To maximise scan resolution around the pelvic girdle, scans of the anterior half of *Conniella apterygia* (NMV A 29675-010) and *Cirrhilabrus solorensis* (AMS I.46121-036) were made on a GE Phoenix V|tome|x S industrial μCT scanner at the University of New England, Armidale. A scan of the anterior half of *Paracheilinus octotaenia* (uf:fish:186029) was downloaded from Morphosource.org (ark:/87602/m4/M168033) and used for comparison. Segmentation and visualisation of all scans were performed using 3D Slicer 4.11 (Fedorov *et al*. 2012; Slicer.org 2021), following methods described in Buser *et al*. (2020). All new scan data were archived on Morphosource.org (ark:/876002/m4/392169 and ark:/87602/m4/392175).

Methods of dissection follow Weitzman (1974). Terminology for the pelvic girdle follows Stiassny & Moore (1992). Institutional codes follow Sabaj (2020). We follow Randall (1999) in recognising Cirrhilabrini as a valid tribe that includes *Cirrhilabrus*, *Paracheilinus*, *Pseudocheilinus*, *Pseudocheilinops*, and *Pteragogus* (see justification in Introduction).

Identity of *Conniella apterygia*

The general morphology, meristic values, dentition, serrations on the preopercle, and fin shape of *Conniella apterygia* are in general agreement with the genus *Cirrhilabrus*. In particular, the lanceolate caudal fin is unusual among cirrhilabrin genera, but typical for several species of *Cirrhilabrus*. Elongation of the central principal caudal-fin rays also occurs for one species of *Paracheilinus* (*P. attenuatus* Randall, 1999). However, *Conniella apterygia* differs from *P. attenuatus* and all other species of *Paracheilinus* in having XI,9 dorsal rays (versus IX,11), serrations on the preopercle, and in lacking filamentous segmented dorsal-fin rays.

The absence of pelvic fins and the pelvic girdle has been the sole justification separating *Conniella* from *Cirrhilabrus*. Owing to the rarity of *Conniella*, complete representation of the cirrhilabrins has been lacking in both morphological and molecular studies. These relationships have recently been investigated for the first time using a large phylogenomic dataset, revealing *Conniella* to be deeply nested within *Cirrhilabrus* (Tea *et al*. 2021b). Due to the current lack of a morphological diagnosis supporting *Conniella*, and its nested position within *Cirrhilabrus* in the molecular phylogeny of Tea *et al.* (2021b), we recommend placement of *Conniella* within the synonymy of *Cirrhilabrus*.

Cirrhilabrus apterygia **(Allen, 1983), new combination**

Connie's Wrasse

Other names: Mutant Wrasse; Rowley Shoals Wrasse

Figures 1, 2A–B, 2E–F, 3A, 4B; Table 1.

Conniella apterygia Allen 1983 (Holotype WAM P.27659-006; type locality Bedwell Island, Clerke Reef, Rowley Shoals, Western Australia): Allen & Russell 1986 (checklist; Rowley Shoals, Scott Reef, and Seringapatam Reef).—Allen & Steene 1987: 151, pl 87-1 (colour photograph).—Parenti & Randall 2000 (annotated checklist of labroid fishes).—Hoese *et al*. 2006 (checklist; Zoological Catalogue of Australia).—Kuiter 2010: 154 (colour photographs A–F; specimens photographed from Rowley Shoals).—Allen 2018: 211, pl 74-14 (illustration).—Parenti & Randall 2018 (annotated checklist of labroid fishes).—Swainston 2020: 630 (checklist of Australian labrid species).—Tea *et al.* 2021b (included as part of a phylogenomic study of *Cirrhilabrus*).

Diagnosis. A species of *Cirrhilabrus* distinguished from all other congeners based on the following combination of colouration and morphological characters: absence of pelvic fins and pelvic girdle; lateral line with 21–26 pored scales (16–17 in the dorsoanterior series, 5–9 in the posterior peduncular series); caudal fin rhomboidal to lanceolate in males; both sexes with eight to ten stripes, purple in life and in preservation; preopercle purple in preservation.

Description. Dorsal-fin rays XI,9 (one specimen with X,9); all soft rays branched except first ray unbranched (one specimen with first ray branched); anal-fin rays III,9; all soft rays branched except first ray unbranched; last dorsal and anal-fin ray branched to base; pectoral-fin rays 15 (one specimen with 15/13), upper two unbranched; principal caudal-fin rays 7+6, uppermost and lowermost unbranched; upper procurrent caudal-fin rays 6, lower procurrent caudal-fin rays 6; lateral line interrupted, with dorsoanterior series of pored scales 17 (16–17) and midlateral posterior peduncular series 9 (5–9); 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; rows of scales on cheek 2; circumpeduncular scales 16; gill rakers 7 (6–7) + 9 (9–11) = 16 (15–18); pseudobranchial filaments 12 (10–12); vertebrae 9+16; epineurals 12 (Fig. 4B).

Body moderately elongate and compressed, depth 3.6 (3.2–3.8) in SL, width 2.2 (2.0–2.5) in depth; head length (HL) 3.1 (3.0–3.5) in SL; snout pointed, its length 4.3 (3.2–3.9) in HL; orbit diameter 3.8 (3.0–3.6) in HL; depth of caudal peduncle 2.1 (2.0–2.4) in HL. Mouth small, terminal, and oblique, with maxilla almost reaching vertical at front edge of orbit; dentition typical of the genus with three pairs of canine teeth present anteriorly at side of upper jaw, first forward-projecting, next two strongly recurved and outcurved, third longest; an irregular row of very small conical teeth medial to upper canines; lower jaw with a single stout pair of canines anteriorly which protrude obliquely outward and are slightly lateral to medial pair of upper jaw; no teeth on roof of mouth.

Posterior margin of preoperculum with 44/45 (32–45) very fine serrations; margins of posterior and ventral edges of preoperculum free to about level of middle pupil. Anterior nostril in short membranous tube, located nearer to orbit than snout tip; posterior nostril larger, roughly ovoid to rectangular, located just medial and anterior to upper edge of eye. Scales cycloid; head scaled except snout and interorbital space; 6 (6–7) large scales on opercle; a broad naked zone on membranous edge of preopercle; a row of large, elongate, pointed scales along base of dorsal fin, one per element, scales progressively shorter posteriorly on soft portion of fin; anal fin with a similar basal row of scales; last pored scale of lateral line (posterior to hypural plate) enlarged and pointed; one scale above and below last pored scale also enlarged; pectoral fins naked except for a few small scales at fleshy base.

TABLE 1. Proportional measurements for select specimens of *Cirrhilabrus apterygia*, expressed as percentage of the standard length.

	WAM P.27659-006	WAM P.27668-003	WAM P.28036-003	WAM P.28037-006	NMV A 29675-009	NMV A 29675-010		
	Holotype	Paratype	Non-types					
Sex	Male	Male	Male	Female	Male	Male	Male	Female
Standard length (mm)	55.1	57.7	54.5	47.3	54.9	52.3	50.1	45.0
Body depth	27.6	31.4	28.8	29.6	27.5	27.0	28.3	26.2
Body width	12.7	14.9	12.3	15.0	13.3	13.2	11.4	12.4
Head length	31.8	28.8	30.6	31.1	31.5	33.5	32.3	32.9
Snout length	7.4	8.5	9.7	8.2	9.5	9.8	8.4	9.1
Orbit diameter	8.3	9.0	8.4	9.1	9.8	10.3	10.8	10.7
Interorbital width	7.1	9.2	8.3	9.1	8.6	9.6	9.0	7.1
Upper-jaw length	6.4	5.2	5.7	4.0	6.0	6.1	5.8	5.6
Caudal-peduncle depth	15.1	14.7	14.7	14.8	14.4	14.7	13.8	13.8
Caudal-peduncle length	16.9	15.6	14.5	15.6	13.8	14.7	12.8	13.8
Predorsal length	32.8	31.5	31.2	31.9	35.3	35.8	37.1	35.6
Preanal length	60.1	56.1	58.5	64.1	61.0	68.3	61.5	63.3
Dorsal-fin base	57.0	65.2	56.1	55.0	59.0	49.9	55.3	65.4
First dorsal spine	8.5	4.3	4.2	4.9	5.3	4.8	5.2	5.3
Longest dorsal spine	12.7	damaged	12.3	11.8	12.0	11.3	11.6	9.8
Longest dorsal ray	17.4	17.0	18.2	12.7	16.4	13.2	13.6	damaged
Anal-fin base	26.7	28.8	27.9	24.9	25.9	28.3	24.2	22.2
First anal spine	6.2	3.5	4.2	4.7	5.5	4.4	3.2	4.4
Second anal spine	9.1	5.5	6.6	8.7	8.4	8.6	7.6	9.6
Third anal spine	11.1	8.8	9.5	10.4	10.6	9.2	9.2	10.0
Longest anal ray	21.8	20.3	20.7	15.0	14.2	damaged	15.4	damaged
Caudal-fin length	damaged	38.6	28.3	28.3	31.9	damaged	29.9	27.8
Pectoral-fin length	20.9	20.1	20.4	20.3	21.3	21.6	21.0	22.2

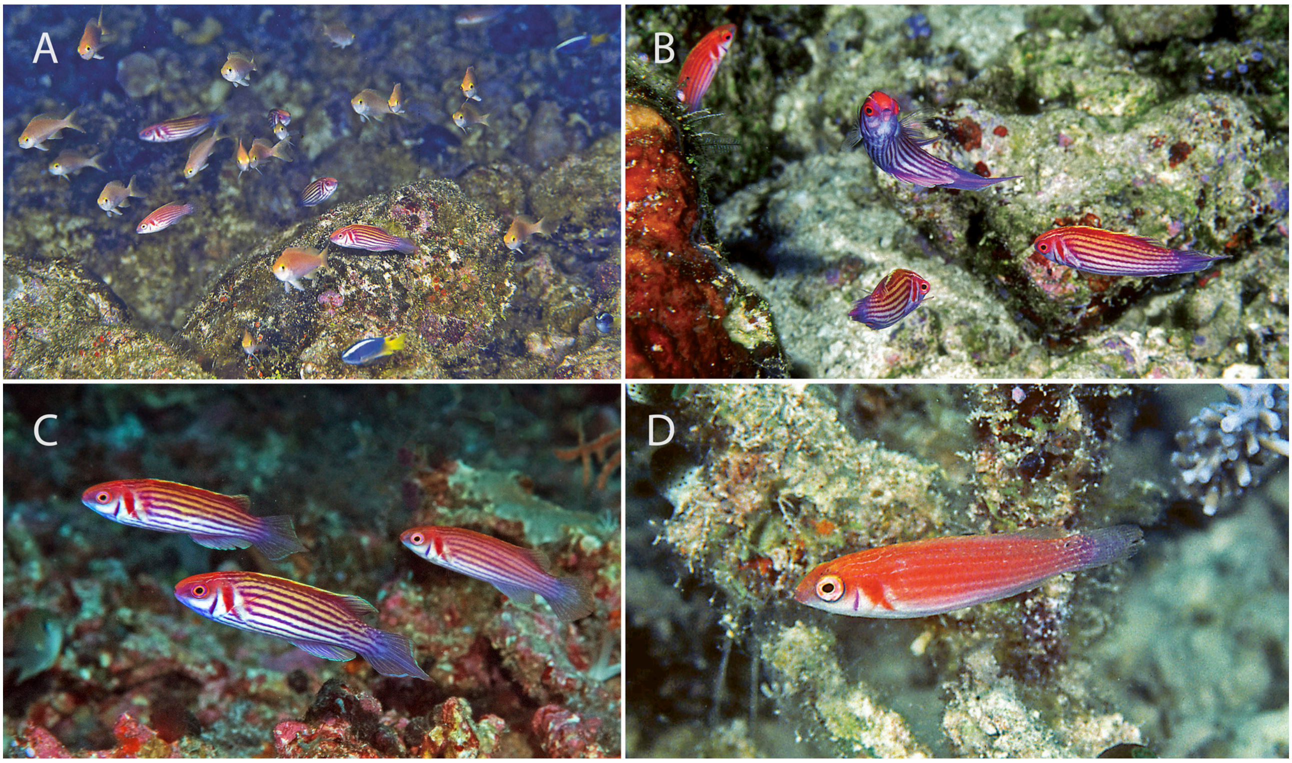

FIGURE 1. *Cirrhilabrus apterygia*, underwater photograph from Rowley Shoals, Western Australia. (A–C) Males and females in loose groups; (D) juvenile, approximately 35 mm total length. Note mixed aggregations of *Pseudanthias engelhardi* and *Chrysiptera caeruleolineata* in (A). Note individual showing ventral stripes from isthmus to anal-fin origin in (B). Photographs by R.H. Kuiter (A, B, D) and G.R. Allen (C).

Origin of dorsal fin above second or third lateral-line scale, predorsal length 3.0 (2.7–3.2) in SL; first 1–5 dorsal-fin spines progressively longer, sixth to ninth subequal, 10th to 11th longest, 2.5 (2.5–3.4) in HL; interspinous membranes of dorsal fin in males extend beyond dorsal-fin spines, with each membrane extending in a pointed cirrus beyond spine; 8th to 9th dorsal-fin soft ray longest, 1.8 (1.7–2.5) in HL, remaining rays progressively shorter; origin of anal fin below base of 9th dorsal-fin spine; third anal-fin spine longest, 2.9 (1.7–2.5) in HL; interspinous membranes of anal fin extended as on dorsal fin; anal-fin soft rays relatively uniform in length, 7th to 9th longest, 1.5 (1.4–2.2) in HL; dorsal- and anal-fin rays just reaching past caudal-fin base; caudal fin of males rhomboidal to lanceolate; pectoral fins short, reaching vertical between bases of 6th or 7th dorsal-fin spines, longest ray 1.5 (1.4–1.5) in HL; pelvic fins and pelvic girdle.

Colouration of males in life. Based on colour photographs of specimens when freshly dead, and photos of live individuals taken in the field (Figs. 1A–C, 2A–B, & 3A): head orange-purple above, often magenta washed, abruptly white to cream below lower limit of orbit; interorbital region and nape orange-red, with four to five thin white lines from just above nostrils to dorsal-fin origin; lavender stripe present from lower edge of maxilla to anterior orbit; iris lavender, with orange ring around pupil; distal edge of orbit yellow; lower margin of cheek to outer margin of preopercle bright purple; interopercle purple; operculum white, broadly edged posteriorly with a reddish purple bar, connecting ventrally with oblique reddish purple wedge over pectoral-fin base; body cream to pale yellow above, gradually lightening to white ventrally; body with eight to ten bright purple stripes, first six starting a short distance behind reddish purple opercular and pectoral-fin markings, so as to form an intervening white wedge of similar width; remaining stripes originating from lower edge of opercle and isthmus; all stripes terminate at base of caudal fin, except ventralmost two to three stripes terminating at anal-fin origin; dorsal fin translucent yellow; anterior spinous dorsal fin with two submarginal, parallel yellow stripes breaking into indistinct spots and short stripes toward soft dorsal fin; outermost margin of dorsal fin narrowly bright blue; scales at base of dorsal fin magenta to fuchsia; caudal fin translucent pink to yellow with a pair of prominent blue chevrons converging at caudal-fin terminus, central region often with yellow and blue spots and short stripes; anal fin similar to dorsal fin; pectoral fins translucent pink, distal edge more strongly coloured.

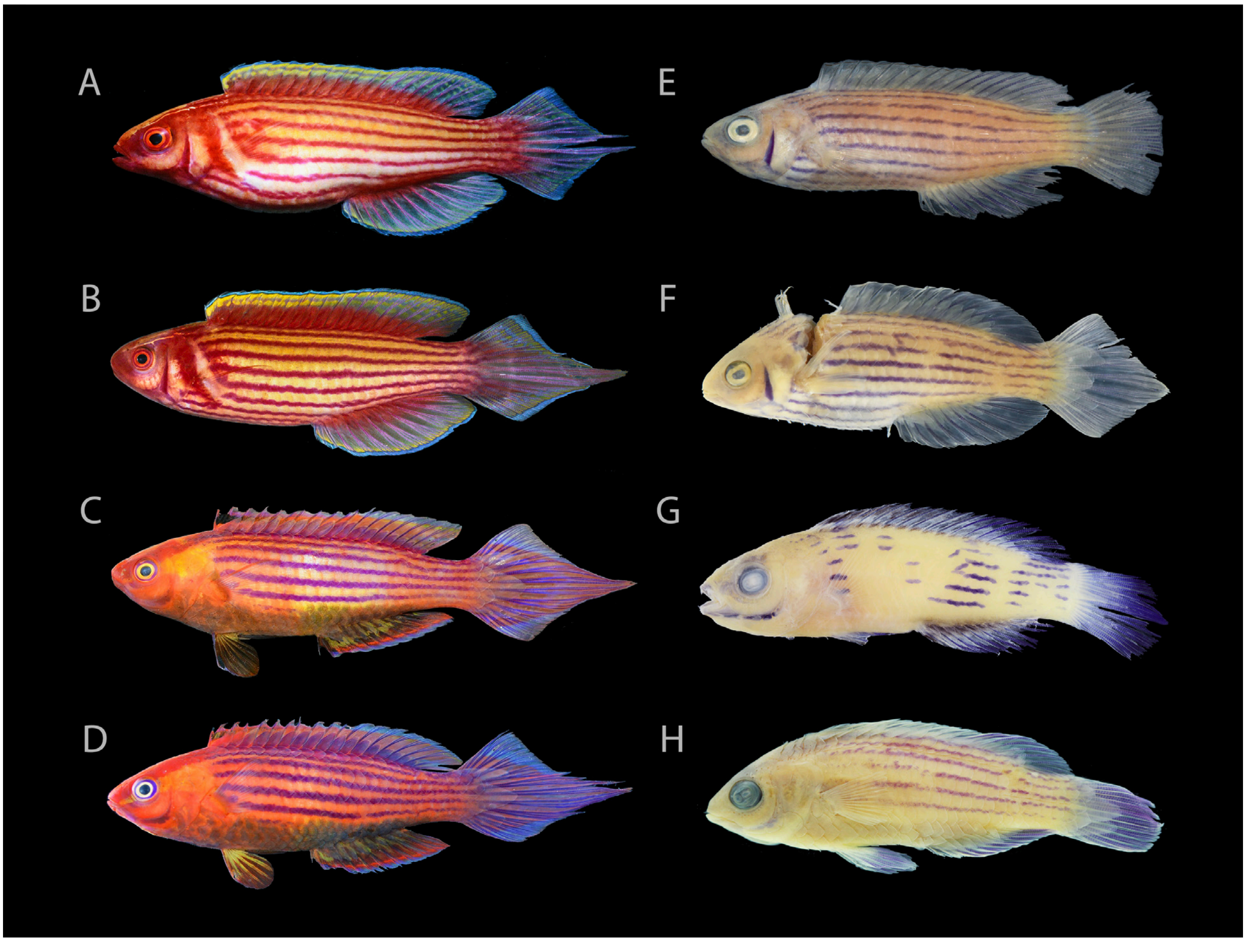

FIGURE 2. A selection of freshly euthanised (A–D) and preserved *Cirrhilabrus* species (E–H). (A) *Cirrhilabrus apterygia*, WAM P.28037-006, 67 mm SL, male, Clerke Reef, Rowley Shoals, Western Australia; (B) *Cirrhilabrus apterygia*, USNM FIN 29616, 75.0 mm SL, male, Mermaid Reef, Rowley Shoals, Western Australia; (C) *Cirrhilabrus earlei*, BPBM 41386, approximately 100 mm SL, male, Pohnpei, Micronesia; (D) *Cirrhilabrus earlei*, BPBM 41387, approximately 100 mm SL, male, Pohnpei, Micronesia; (E) *Cirrhilabrus apterygia*, WAM P.27659-006. 55.1 mm SL, male holotype, Clerke Reef, Rowley Shoals, Western Australia; (F) *Cirrhilabrus apterygia*, WAM P.27668-003, 57.7 mm SL, male paratype, same data as holotype; (G) *Cirrhilabrus earlei*, ZRC 60866, 69.4 mm SL, male, Marshall Islands, Micronesia (image right side reversed); (H) *Cirrhilabrus earlei*, CAS 213114, 56.5 mm SL, male paratype, Augulpelu Reef, Palau. Note damage from spear in (F), and missing scales in (G). Photographs by G.R. Allen (A); J.E. Randall (B); B. D. Greene (C–D); Y.K. Tea (E–F); H.H. Tan (G); and B.W. Frable (H).

Colouration of females and juveniles in life. Based on colour photographs of specimens when freshly dead, and photos of live individuals taken in the field (Fig. 1B–D): similar to males, except bars and stripes on body less pronounced, and body colouration pinkish; caudal fins of females rounded or weakly rhomboidal and without blue chevron markings; distal edge of caudal peduncle with a very small black spot.

Colouration in alcohol. Based on colour photographs of preserved specimens (Fig. 2E–F): similar to life, except body uniformly tan; several osseous elements remain purple, including purple scale markings on body, median-fin spines and rays, infraorbitals, maxilla, premaxilla, dentary, anguloarticular, and preopercle; black spot on distal edge of caudal peduncle in females and juveniles remains.

Habitat and distribution. *Cirrhilabrus apterygia* occurs on offshore reefs off northwestern Western Australia, including Rowley Shoals, Scott, and Seringapatam Reefs. ROV dive footage from the RV Falkor's Australian Mesophotic Coral Exploration cruise indicates that the species also occurs on Ashmore Reef, 840 km west of Darwin, Northern Territory. It frequents rubble bottoms covered with macroalgae cover at depths between 20–60m, but also occurs in mesophotic coral ecosystems as deep as 140 m.

Etymology. Allen (1983) named the species *apterygia*, meaning "without fins," in reference to the distinctive lack of pelvic fins and associated elements. To be treated as a noun in apposition. We retain the use of Connie's Wrasse as the preferred common name, after Connie Lagos Allen, wife of the second author, for whom the junior synonym *Conniella* was named. The species is also commonly referred to as the mutant wrasse, alluding to its atypical pelvic morphology, as well as the eponymous Rowley Shoals Wrasse, after its type locality.

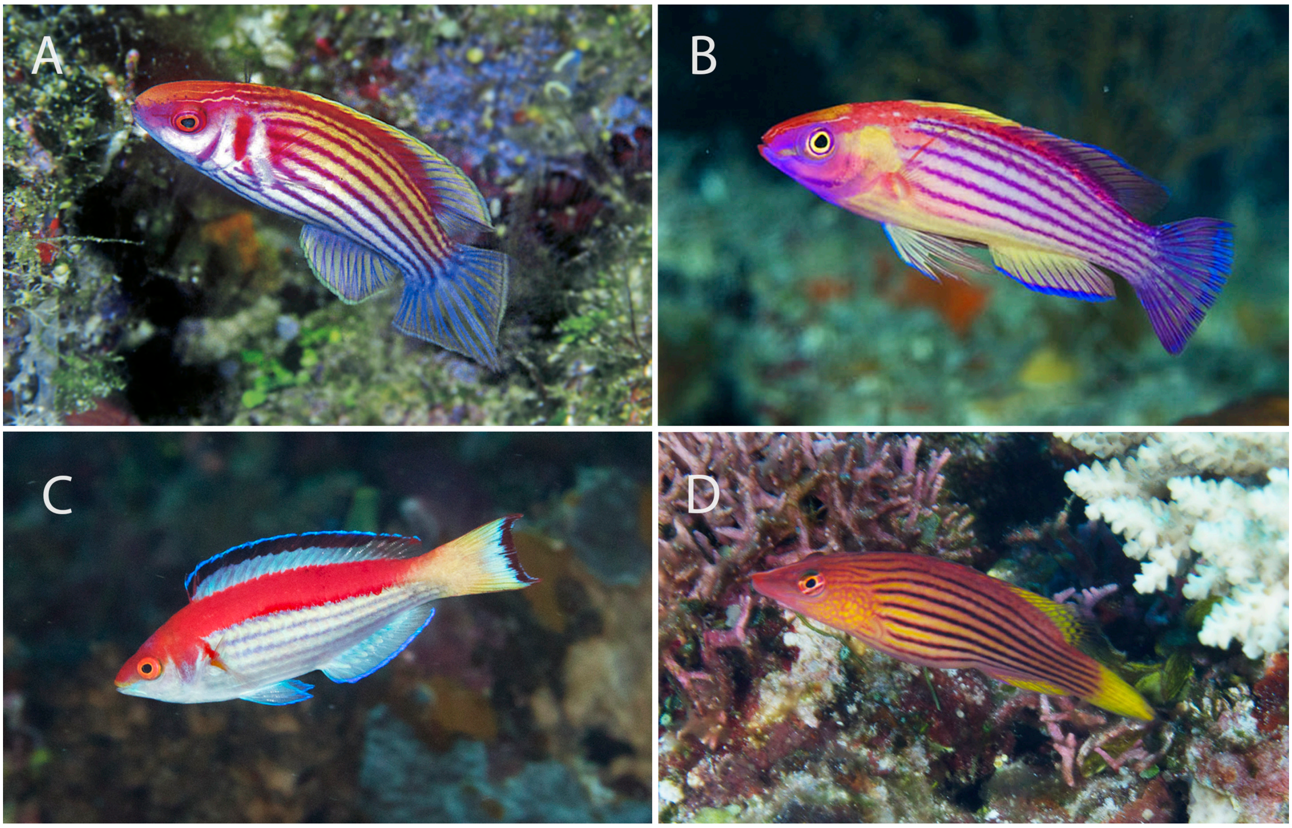

FIGURE 3. A selection of cirrhilabrin labrids with horizontal striped patterns. (A) *Cirrhilabrus apterygia*, underwater photograph from Rowley Shoals; (B) *Cirrhilabrus earlei*, underwater photograph from Koror, Palau; (C) *Cirrhilabrus marjorie*, underwater photograph from Vanua Levu, Fiji; (D) *Pseudocheilinus octotaenia*, underwater photograph from Levuka, Fiji. Photographs by R.H. Kuiter (A); K. Nishiyama (B); and M. Rosenstein (C–D).

Material examined. ***Cirrhilabrus apterygia***: WAM P.27659-006 (holotype), 55.1 mm SL, male, outer reef slope east of Bedwell Island, Clerke Reef, Rowley Shoals, Western Australia, 32 m, 22 July 1982 (Fig. 2E); WAM P.27668-003 (paratype), 57.7 mm SL, male, same data as holotype except collected at 35 m, 27 July 1982 (Fig. 2F); WAM P.27668-015 (paratype), 31.2 mm SL, female, same data as male paratype (specimen cleared and stained; Fig. 4B); WAM P.28036-003, 54.5 mm SL, male, Clerke Reef, outer reef 1 km off southern tip of Bedwell Island, Rowley Shoals, Western Australia, 20–35 m, 13 August 1983; WAM P.28037-006, 47.3 mm SL, male, same data as WAM P.28036-003 except collected at 45–50 m, 14 August 1983; NMV A 29675-009, 54.9 mm SL, male, Cunningham Island, Imperieuse Reef, Rowley Shoals, Western Australia, 108–140 m, 16 June 2007; NVM A 29675-010, 3 specimens, 45.0–52.3 mm SL, two males and one female, same data as NVM A 29675-009. ***Cirrhilabrus earlei***: ZRC 60866, 69.4 mm SL, male, Marshall Islands, Micronesia (Fig. 2G); CAS 213114 (paratype), 56.5 mm SL, male, Augulpelu Reef, Palau (Fig. 2H). ***Cirrhilabrus rubrimarginatus***: AMS I.45300.288, 43.8 mm SL, (specimen cleared and stained; Fig. 4A). ***Cirrhilabrus naokoae***: AMS I.45300.513, 49.1 mm SL, (specimen cleared and stained). ***Paracheilinus lineopunctatus***: AMS I.45300.194, 51.0 mm SL, (specimen cleared and stained; Fig. 4C). ***Paracheilinus mccoskeri***: AMS I.45300.185, 5 specimens, 31.0–54.5 mm SL, (specimens cleared and stained). ***Pseudocheilinus ocellatus***: AMS I.45300.485, 48.8 mm SL, (specimen cleared and stained). ***Pseudocheilinops ataenia***: AMS I.45300.056, 2 specimens, 24.1–34.7 mm SL (specimen cleared and stained). ***Pteragogus flagellifera***: AMS I.187755-034, 52.0 mm SL, (specimen cleared and stained).

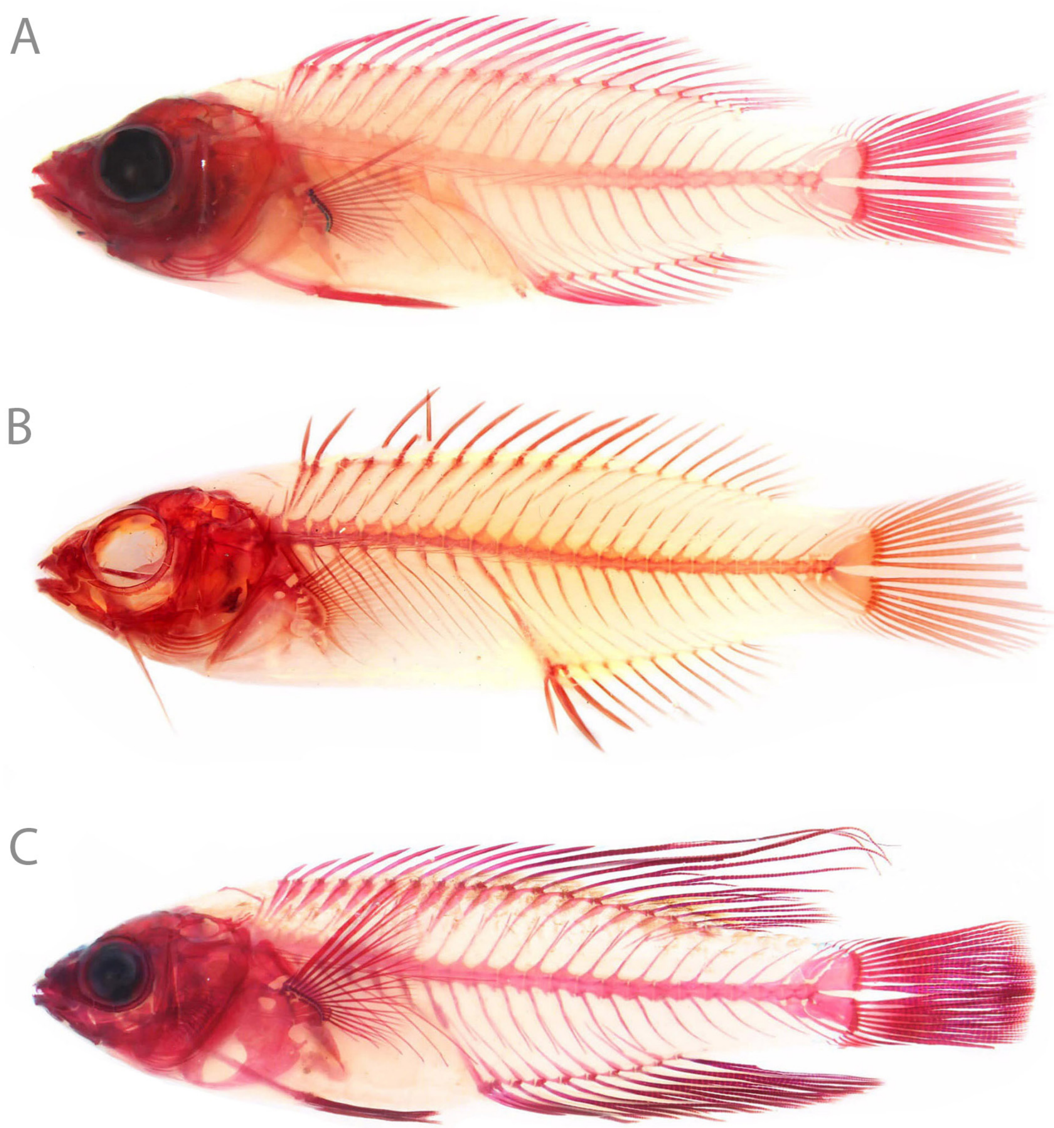

FIGURE 4. Cleared and stained pseudocheiline labrids. (A) *Cirrhilabrus rubrimarginatus*, AMS I.45300.288, 43.8 mm SL; (B) *Cirrhilabrus apteyrgia*, WAM P.27668-015, 31.2 mm SL, female paratype, Clerke Reef, Rowley Shoals, Western Australia; (C) *Paracheilinus lineopunctatus*, AMS I.45300.194, 51.0 mm SL. Note displaced urohyal in (B).

Comparison with other *Cirrhilabrus* species

Cirrhilabrus apterygia belongs to the *Cirrhilabrus jordani* complex of fairy wrasses (Tea *et al*. 2021b), a lineage whose species are diagnosed based on the following combination of characters: pelvic fins relatively short (not or barely reaching anal-fin origin; absent in *C. apterygia*); a pair of stripes on head (in both sexes; strongly evident during male nuptial display); and dorsal and anal fins without obvious stripes or spots. Tea and Gill (2017) previously included *C. claire* Randall & Pyle, 2001 as a member of the *C. jordani* complex, though its phylogenetic position remained unclear and was only recently resolved based on a large molecular dataset (as a member of the *C. lineatus* complex; Tea *et al*. 2021b). The taxonomy of the related *C. rubrisquamis* Randall & Emery, 1983 from the western Indian Ocean is muddled, and the name is currently applied to several fishes with notable differences in colour pattern and morphology (in prep. by the first author). Until this situation is resolved, we use *C. rubrisquamis sensu lato* to refer to the nominal taxon, as well as any others presently lumped under this name. The *C. jordani* complex is tentatively redefined to include the following species: *Cirrhilabrus apterygia*, *C. blatteus* Springer & Randall, 1974, *C. earlei* Randall & Pyle, 2001, *C. jordani* Snyder, 1904, *C. lanceolatus* Randall & Masuda, 1991, *C. roseafascia* Randall & Lubbock, 1982, *C. rubrisquamis sensu lato*, *C. sanguineus* Cornic, 1987, *C. shutmani* Tea & Gill, 2017, and *C. wakanda* Tea, Pinheiro, Shepherd & Rocha, 2019.

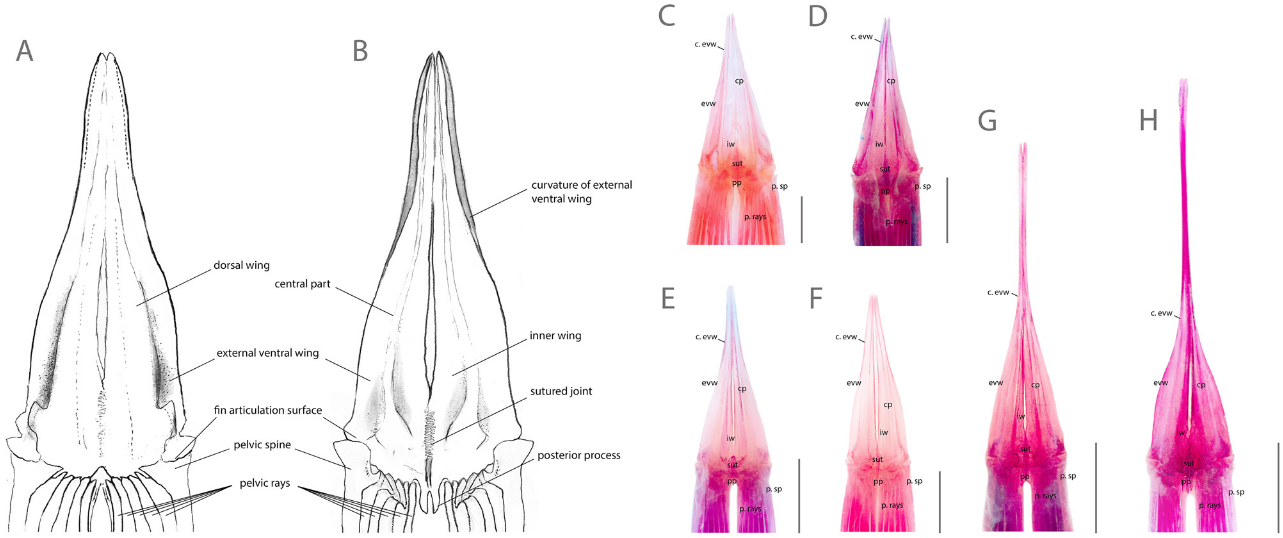

FIGURE 5. Schematic diagram of *Cirrhilabrus* pelvic girdle anatomy in (A) dorsal view and (B) ventral view. Cleared and stained pelvic girdles of: (C) *Pteragogus flagellifera*, AMS I.187755-034; (D) *Pseudocheilinops ataenia*, AMS I.45300.056; (E) *Pseudocheilinus ocellatus*, AMS I.45300.485; (F) *Cirrhilabrus rubrimarginatus*, AMS I.45300.288; (G) *Paracheilinus lineopunctatus*, AMS I.45300.194; (H) *Paracheilinus mccoskeri*, AMS I.45300.185. Scale bars represent 2.5 mm. Abbreviations: pp, posterior process; sut, suture; p. rays, pelvic rays; p. sp, pelvic spine; iw, inner wing; cp, central part; evw, external ventral wing; c. evw, curvature of external ventral wing.

Of the aforementioned species, *C. apterygia* appears most closely related to *C. earlei* (Figs 2C–D & 3B). Both species share a similar, purple-striped pattern, a rhomboidal to lanceolate caudal fin in males, and essentially the same meristic data. The horizontal-striped pattern is unusual for species of *Cirrhilabrus*, and aside from *C. apterygia* and *C. earlei*, and is also found in the distantly related *C. marjorie* Allen, Randall & Carlson, 2003 (Fig. 3C). However, *Cirrhilabrus apterygia* is readily separated from *C. earlei* and all congeners in lacking pelvic fins and in having horizontal stripes that run along the isthmus to the anal-fin origin. On the basis of molecular sequence data, *C. apterygia* is more closely related to *C. rubrisquamis sensu lato*, *C. wakanda*, *C. sanguineus*, and *C. blatteus* from the western Indian Ocean (Tea *et al*. 2021b). Several species of *Pseudocheilinus* (in particular *P. octotaenia* Jenkins, 1901; Fig. 3D) superficially resemble *C. apterygia* in colour pattern, but members of *Pseudocheilinus* are readily separated from *Cirrhilabrus* in having 6 (versus 5) branchiostegals, a longer second anal-fin spine than third (except in *C. laboutei* Randall & Lubbock, 1982), and the posterior margin of the preopercle smooth (except finely serrate on lower margin in *P. hexataenia* Bleeker, 1857).

The scales and several osseous elements of *C. apterygia* are unusual in that they retain and/or develop purple pigmentation in preservation (Fig. 2E–F). This characteristic is most obvious in the pigmented body scales, dorsal-fin spines and rays, the preopercle, and several craniofacial bones. The phenomenon was first noted by Springer & Randall (1974) in *C. blatteus*, and later again by Randall (1995) in *C. rubrisquamis sensu lato* and *C. sanguineus*. Randall (1999) also made note of bone purpling in the opercle of the lesser known *Pseudocheilinus dispilus* Randall ,1999, and in fin rays and spines of some (but not all) individuals of *P. ocellatus* Randall, 1999. Tea *et al.* (2018, 2019) reported purple craniofacial bones and scales for *C. earlei* (Fig. 2G–H) and *C. wakanda*. The phenomenon was previously known only for several species of cirrhilabrin labrids but was recently found to occur in at least two species of *Plectranthias* (*Plectranthias purpuralepis* Tang, Lai & Ho, 2020 and *Plectranthias* sp. 1 [Tang *et al.* 2020; Gill *et al*. 2021, respectively]). Here we further expand this to include *C. apterygia*, *C. lanceolatus,* and *C. roseafascia* – the latter two species were not previously known to develop purple colouration in preservation (evident in some freshly preserved males). The mechanism responsible for the persistence of purple in preservation is still unclear, as are its distribution across acanthomorph taxa and its potential implications for phylogenetic inference. At least within *Cirrhilabrus*, the character appears plesiomorphic for the *C. jordani* complex, occurring in all species except *C. jordani* and *C. shutmani*.

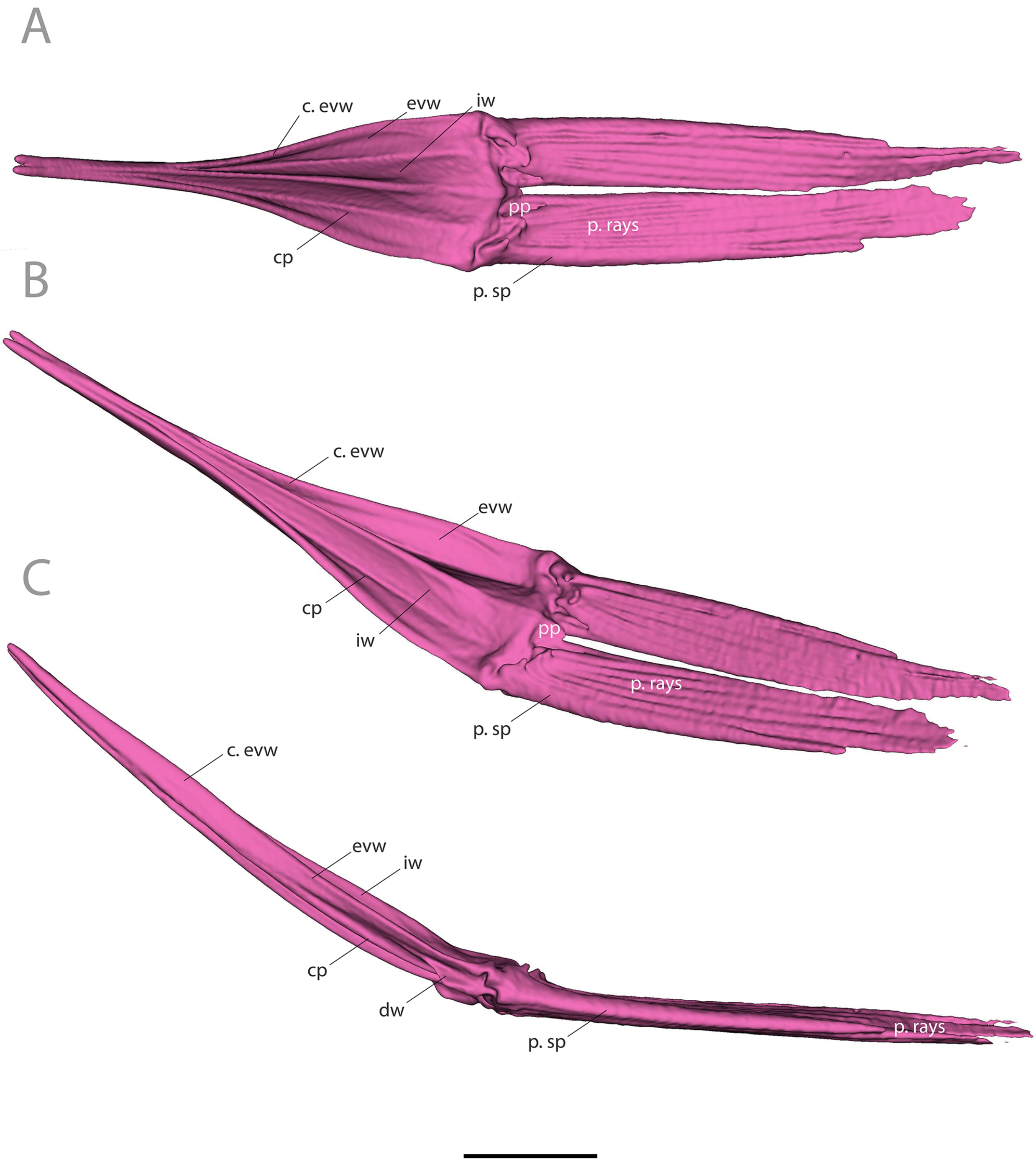

FIGURE 6. µCT scanned pelvic girdle of *Paracheilinus octotaenia* (uf:fish:186029; MorphoSource). (A and B) ventral view; (C) lateral view (left side). Scale bar represents 2.5 mm. Abbreviations: pp, posterior process; p. rays, pelvic rays; p. sp, pelvic spine; dw, dorsal wing; iw, inner wing; cp, central part; evw, external ventral wing; c. evw, curvarture of external ventral wing.

Cirrhilabrin pelvic girdle

The pelvic girdle of the cirrhilabrin labrids consists of bilaterally paired basipterygia, each articulating with one spine and five segmented rays on their posterior margins. The medial processes of the two halves are strongly united by bony interdigitating sutures (as described by Stiassny & Moore 1992). The central processes are separated by a narrow gap before uniting anteriorly. In most cases, anterior processes are almost imperceptible or absent entirely. No apparent ventral wings are present. The external ventral wings are well developed, tapering anteriorly, and with the edges curling ventrally (except for *Paracheilinus*; see below).

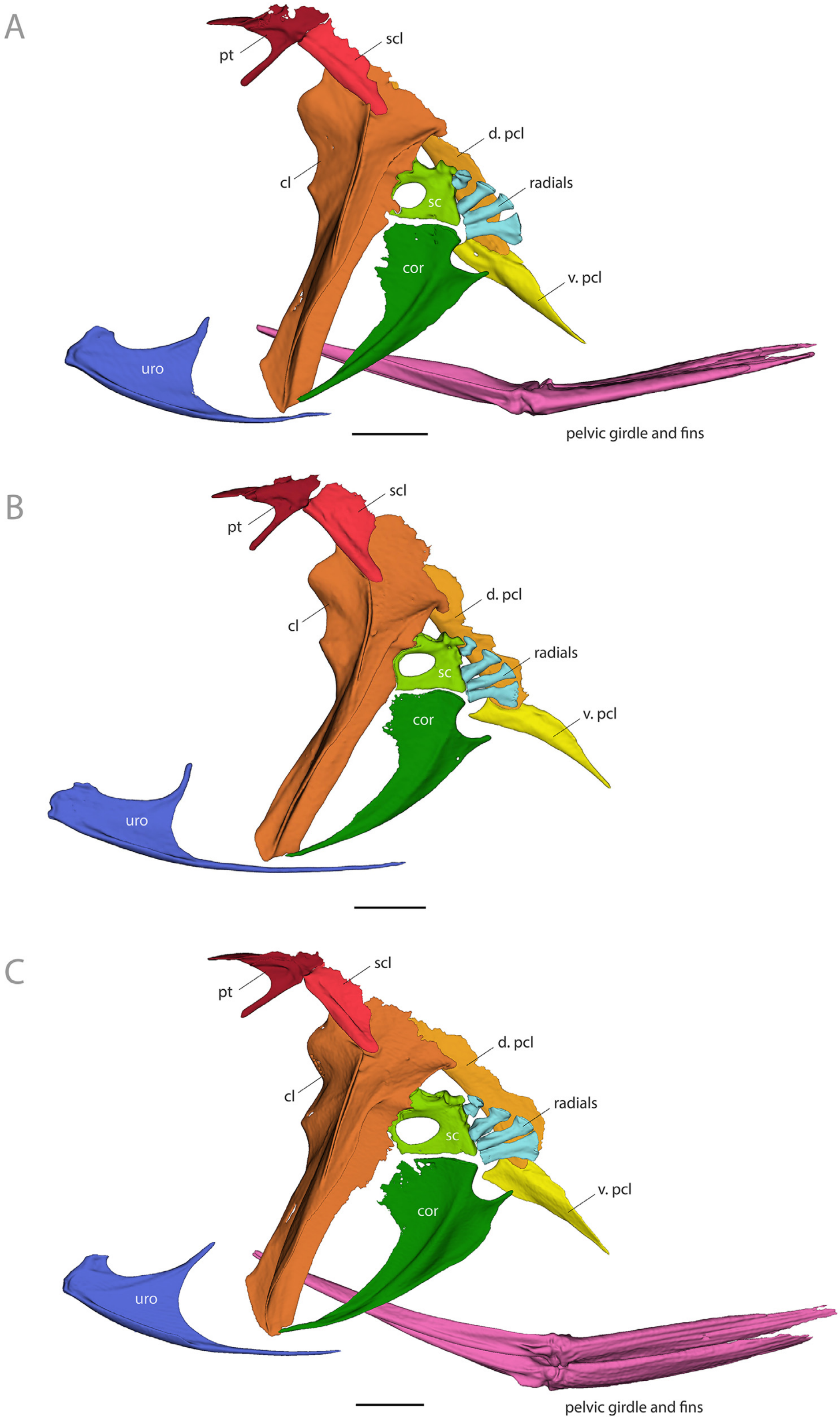

FIGURE 7. µCT scanned pectoral girdle and associated structures of cirrhilabrin labrids (left facing lateral view). (A) *Cirrhilabrus solorensis*, AMS 1.46121-036 (ark:/87602/m4/392169; MorphoSource); (B) *Cirrhilabrus apterygia,* NMV A 29675-010 (ark:/87602/m4/392175; MorphoSource); (C) *Paracheilinus octotaenia*, (uf:fish:186029; MorphoSource). Scale bars represent 2 mm. Abbreviations: uro, urohyal; cor, coracoid; sc, scapula; cl, cleithrum; d. pcl, dorsal postcleithrum; v. pcl, ventral postcleithrum; scl, supracleithrum; pt, posttemporal.

TABLE 2. Valid species of *Cirrhilabrus* in chronological order of date described. Species are listed alphabetically if more than one species are described within the same year.

	Species	Authorship	Type locality	Synonyms
1	*cyanopleura*	(Bleeker, 1851)	Batavia [Jakarta], Indonesia	*Cheilinoides cyanopleura* (Bleeker, 1851); *Cirrhilabrus heterodon* Bleeker, 1871
2	*solorensis*	Bleeker ,1853	Lawajong, Solor, Indonesia	
3	*temminckii*	Bleeker, 1853	Japan	
4	*jordani*	Snyder, 1904	Between Maui and Lanai, Hawaii, United States	
5	*ryukyuensis*	Ishikawa, 1904	Naha, Okinawa, Japan	
6	*exquisitus*	Smith, 1957	Pinda, Mozambique	
7	*blatteus*	Springer & Randall, 1974	Gulf of Eilat [Aqaba], Red Sea	
8	*rubriventralis*	Springer & Randall, 1974	Gulf of Eilat [Aqaba], Red Sea	
9	*filamentosus*	(Klausewitz, 1976)	Java Sea (imported from Jakarta)	*Cirrhilabrichthys filamentosus* (Klausewitz, 1976)
10	*melanomarginatus*	Randall & Shen, 1978	Mao Pi Tou, Taiwan	*Neocirrhilabrus oxyurus* (Cheng & Wang ,1979)
11	*rubripinnis*	Randall & Carpenter, 1980	Caban Island, Batangas, Luzon, Philippines	
12	*flavidorsalis*	Randall & Carpenter, 1980	Manterawoe [Monthage] Island, Sulawesi, Indonesia	
13	*lubbocki*	Randall & Carpenter, 1980	Mactan Island, Cebu, Philippines	
14	*laboutei*	Randall & Lubbock, 1982	Bulari Pass, New Caledonia	
15	*lineatus*	Randall & Lubbock, 1982	Mato Pass, New Caledonia	
16	*roseafascia*	Randall & Lubbock, 1982	Bulari Pass, New Caledonia	
17	*apterygia*	(Allen, 1983)	Rowley Shoals, Australia	
18	*rubrisquamis*	Randall & Emery, 1983	Peros Banhos Atoll, Chagos Archipelago	
19	*sanguineus*	Cornic, 1987	Flic en Flac, Mauritius	
20	*balteatus*	Randall, 1988	Enewetak Atoll, Marshall Islands	
21	*johnsoni*	Randall, 1988	Kwajalein Atoll, Marshall Islands	
22	*luteovittatus*	Randall, 1988	Enewetak Atoll, Marshall Islands	
23	*rhomboidalis*	Randall, 1988	Kwajalein Atoll, Marshall Islands	
24	*scottorum*	Randall & Pyle, 1989	Tahiti, Society Islands, French Polynesia	
25	*punctatus*	Randall & Kuiter, 1989	One Tree Reef, Great Barrier Reef, Australia	
26	*lunatus*	Randall & Masuda ,1991	Sesoko Island, Okinawa, Japan	

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TABLE 2. (Continued)

	Species	Authorship	Type locality	Synonyms
27	*lanceolatus*	Randall & Masuda, 1991	Sesoko Island, Okinawa, Japan	
28	*katherinae*	Randall, 1992	Miyake-jima, Izu Islands, Japan	
29	*rubrimarginatus*	Randall, 1992	Sesoko Island, Okinawa, Japan	
30	*randalli*	Allen, 1995	Mermaid Reef, Rowley Shoals, Australia	
31	*condei*	Allen & Randall, 1996	Rausch Pass, Madang, Papua New Guinea	
32	*pylei*	Allen & Randall, 1996	"China Reef," Milne Bay Province, Papua New Guinea	
33	*walindi*	Allen & Randall, 1996	Grabo Reef, Kimbe Bay, New Britain, Papua New Guinea	
34	*adornatus*	Randall & Kunzmann, 1998	Pulau Ular, Padang, Sumatra, Indonesia	
35	*aurantidorsalis*	Allen & Kuiter, 1999	Batudaka Island, Togean Islands, Indonesia	
36	*tonozukai*	Allen & Kuiter, 1999	Tumbak Island, Banggai Islands, Indonesia	
37	*morrisoni*	Allen, 1999	Hibernia Reef, western Timor Sea	
38	*joanallenae*	Allen, 2000	Rubiah Islet, Weh Island, Sumatra, Indonesia	
39	*katoi*	Senou & Hirata, 2000	Hachijo-jima, Izu Islands, Japan	
40	*claire*	Randall & Pyle, 2001	Rarotonga, Cook Islands	
41	*earlei*	Randall & Pyle, 2001	Ngemelis Island, Palau	
42	*walshi*	Randall & Pyle, 2001	Taumu Bank, Tutuila, American Samoa	
43	*bathyphilus*	Randall & Nagareda, 2002	Holmes Reef, Coral Sea, Australia	
44	*marjorie*	Allen, Randall & Carlson, 2003	Wakaya Island, Lomaiviti Group, Fiji	
45	*brunneus*	Allen, 2006	Kaniungan Besar Island, East Kalimantan, Indonesia	
46	*cenderawasih*	Allen & Erdmann, 2006	Pulau Kumbar, Cenderawasih Bay, Indonesia	
47	*beauperryi*	Allen, Drew & Barber, 2008	Kwato Island, Milne Bay Province, Papua New Guinea	
48	*naokoae*	Randall & Tanaka, 2009	Medan, Sumatra, Indonesia	
49	*nahackyi*	Walsh & Tanaka, 2012	Viti Levu, Fiji	

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TABLE 2. (Continued)

	Species	Authorship	Type locality	Synonyms
50	*humanni*	Allen & Erdmann, 2012	Pura Island, Alor Strait, Indonesia	
51	*squirei*	Walsh, 2014	Holmes Reef, Coral Sea, Australia	
52	*marinda*	Allen, Erdmann & Dailami, 2015	Ayau Atoll, Raja Ampat Islands, Indonesia	
53	*isosceles*	Tea, Senou & Greene, 2016	Iriomote-jima, Ryukyu Islands, Japan	
54	*hygroxerus*	Allen & Hammer, 2016	Eastern Timor Sea, Australia	
55	*rubeus*	Victor, 2016	Sri Lanka	*Cirrhilabrus rubriventralis* (non Springer, & Randall, 1974)
56	*africanus*	Victor, 2016	Kenya, Africa	*Cirrhilabrus rubriventralis* (non Springer, & Randall, 1974)
57	*efatensis*	Walsh, Tea & Tanaka, 2017	Efate Island, Vanuatu	
58	*shutmani*	Tea & Gill, 2017	Didicas Volcano, Babuyan Islands, Cagayan, Philippines	
59	*greeni*	Allen & Hammer, 2017	Eastern Timor Sea, Australia	
60	*cyanogularis*	Tea, Frable & Gill, 2018	Banguingui Island, Sulu Archipelago, Philippines	
61	*wakanda*	Tea, Pinheiro, Shepherd & Rocha, 2019	Zanzibar, Tanzania, Africa	
62	*briangreenei*	Tea, Pyle & Rocha, 2020	Maricaban Island, Philippines	*Cirrhilabrus pylei* (non Allen & Randall, 1996)
63	*aquamarinus*	Tea, Allen & Dailami, 2021a	Wakatobi, Indonesia	*Cirrhilabrus solorensis* (non Bleeker, 1853)
64	*chaliasi*	Tea, Allen & Dailami, 2021a	Bali, Indonesia	*Cirrhilabrus cyanopleura* (non Bleeker, 1851); *Cirrhilabrus ryukyuensis* (non Ishikawa, 1904); *Cirrhilabrus solorensis* (non Bleeker, 1853)

Comparisons. The basic shape of the cirrhilabrin pelvic girdle is similar to those of other labrids (Russell 1988; Bellwood 1994), lying sub-thoracically in a dorsally inclined position away from the ribs. A strong ligamentous association between the pelvic girdle and the ventral postcleithrum (i.e., postcleithral ligament) is present. Although narrowing of the anterior pelvic girdle is typical of other labrids, the extent of external ventral wing curling requires further investigation across other labrid groups. In *Paracheilinus*, this condition is modified such that the external ventral wing curvature converges along the mid-line, forming a shallow canal that extends along the anterior half to two-thirds the length of the pelvic girdle (Figs. 5G–H & 6). We interpret this derived condition as a synapomorphy uniting *Paracheilinus*. Although not immediately associated, the anterior tip of the pelvic girdle lies at a vertical with the lower ramus of the urohyal. The general "bat wing shape" *sensu* Kusaka (1974) of the cirrhilabrin urohyal is not unlike those of other labrids, but with the lower ramus tapered and elongate, and with about the distal third extending past the cleithrum and the coracoids (Fig. 7). Among labrids, this character is shared with several other groups, including the cheilines (Westneat 1993) and several julidine genera (*Halichoeres* Rüppel, 1835, *Stethojulis* Günther, 1861, and *Thalassoma* Swainson, 1839; Kusaka 1974).

In *Cirrhilabrus apterygia*, the pelvic girdle, fin rays, and all ligamentous associations with the pectoral girdle are lost. Among labrid fishes, only the odacine *Siphonognathus argyrophanes* Richardson, 1858 is reported to lack pelvic fins and girdles, a condition which we interpret here as homoplasious and autapomorphic for the two species. Mechanisms for the loss of pelvic elements in *C. apterygia* are unknown, though similar abnormalities have been reported in other species of *Cirrhilabrus* (Tea *et al.* 2021b). These may occur naturally as rare congenital defects, but with these mutations fixed in the range-restricted *C. apterygia* as a result of genetic drift. The study of pelvic anatomy in labrid fishes has received comparatively little attention, and more work is needed to explore pelvic homology across different labrid groups and their implications for phylogenetic relationships.

Valid species of *Cirrhilabrus*

Allen *et al.* (2015) listed 51 valid species of *Cirrhilabrus*. The genus has since grown to include 63 species, with the present recognition of *Cirrhilabrus apterygia* bringing the number of valid species to 64. Although a comprehensive taxonomic treatment of the genus is lacking, systematic studies have been done in parts. These include diagnoses of species complexes (see Tea *et al.* 2016; Walsh *et al.* 2017; Tea & Gill 2017; Tea *et al.* 2018; Tea *et al.* 2020), taxonomic revisions (Victor 2016; Tea *et al.* 2021a), and molecular phylogenomic studies (Tea *et al.* 2021b). The need for a generic revision of *Cirrhilabrus* is made clear by the rapidly growing body of literature in recent years, with the number of valid species now exceeding that of any other labrid genus. This number is expected to grow, with several species in need of closer taxonomic evaluation (e.g., the pan Indo-Pacific *Cirrhilabrus exquisitus* and the western Indian Ocean *Cirrhilabrus rubrisquamis sensu lato*, in prep. by the first author). Until then, we provide a table of recognised species of *Cirrhilabrus*, including their synonyms and type localities (Table 2).

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