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Coradion calendula, a new butterflyfish from Australia (Teleostei: Chaetodontidae)

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Abstract

The new butterflyfish, *Coradion calendula*, is described on the basis of 44 specimens collected off Western Australia, the Northern Territory, and north Queensland, Australia. The new species is most similar to *Coradion chrysozonus*, with which it shares IX dorsal-fin spines, a single ocellated spot on the soft-rayed portion of the dorsal-fin, and a single dark band on the frontal surface of the thorax. The new species is distinguished from *C.*

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chrysozonus by slightly higher ranges of dorsal-fin soft rays 28–32, mode 29 (vs. 27–30, mode 28) and anal-fin soft rays 20–22, mode 21 (vs. 18–21, mode 20); an orange band on the caudal peduncle in fresh specimens (lost after preservation) with a saddle-like blackish dorsal streak (vs. a broad brown -to-black circumpeduncular band in both fresh and preserved specimens); a sharply pointed pelvic fin with an almost straight posterior contour when spread (vs. a rounded pelvic fin with an expanded posterior contour); and a dark band on each interopercle joining on the ventral midline, with their anterior margins forming a sharply pointed “V” in ventral view (vs. separated by a relatively wide interspace). Despite well-defined morphological and coloration differences, the mtDNA difference between the two species was relatively low, 0.8–1.9% (mean 1.3%) and 2.9–7.5% (mean 4.8%) pairwise sequence difference in COI and control region genes, respectively. Morphological and color-pattern characters and mtDNA lineage were not concordant in some specimens from northern Australia, where the two species overlap, suggesting that the two species hybridize at their common biogeographic borders.

Key words: taxonomy, ichthyology, morphology, coral-reef fishes, mtDNA, biogeography, western Pacific Ocean.

Introduction

The genus *Coradion* (family Chaetodontidae) was established by Kaup (1860) for *Chaetodon bennetti* Cuvier in Cuvier & Valenciennes, 1831 and *Chaetodon chrysozonus* Cuvier (ex. Kuhl & Van Hasselt) in Cuvier & Valenciennes, 1831. Subsequently, Bleeker (1876) designated *Ch. chrysozonus* as the type species of *Coradion*. The genus is diagnosed by a relatively short snout; brush-like teeth with thickened lips; usually VIII–X dorsal-fin spines; fewer than 60 scales in the complete lateral line, ending at the caudal-fin base; and no supraorbital horns (Ahl 1923, Burgess 1978, Pyle 2001). Three valid species of *Coradion* have been recognized in the Indo-West Pacific region (see Burgess 1978, Blum 1989, Pyle 2001, Kuitert 2002), viz., *Coradion chrysozonus*; *Coradion altivelis* McCulloch, 1916; and *Coradion melanopus* (Cuvier in Cuvier & Valenciennes, 1831).

Coradion chrysozonus is distributed in the eastern Indian and western Pacific Oceans, from the Andaman Sea east to the Solomon Islands, and from Australia north to Taiwan and the Ogasawara Islands, Japan (Pyle 2001). The species is common in Southeast Asia, and has often been photographed by divers (many underwater photographs available in GBIF), in addition to occurring in fish markets (see White et al. 2013, Uejo 2017). In their atlases of trawled fishes from southern Indonesia and northwestern Australia, Gloerfelt-Tarp & Kailola (1984) and Sainsbury et al. (1984) reported *C. chrysozonus*, but their photographed specimens show a significant difference in the color pattern of the caudal-peduncle band compared with specimens from other localities (broadly orangish in the former vs. blackish in the latter). Further examinations of specimens of both forms (having all been previously identified as *C. chrysozonus*) from Australia and Southeast Asian countries, including Singapore, Malaysia and the Philippines, revealed that they are also distinguished by pelvic-fin shape, modal numbers of dorsal-fin and anal-fin soft rays, and the shape of a black band on the preopercle. The two forms also belong to distinct genetic lineages inferred from sequences of the partial mitochondrial cytochrome oxidase subunit I COI and mtDNA control region (CR) genes. Although intermediate morphotypes were found from the Arafura Sea and vicinity of Torres Strait, where the two morphotypes occur sympatrically, multiple morphological and coloration differences suggest that the two forms represent distinct species. Examination of *Ch. chrysozonus* lectotype photographs, and the original descriptions of the other nominal species of *Coradion* and the closely related nominal species *Chaetodon labiatus* Cuvier in Cuvier & Valenciennes, 1831, confirmed that the Australian species with an orange caudal-peduncle band had not been recognized and is described here as a new species.

Materials and Methods

Methods of counts and measurements generally follow Uejo et al. (2020), with the following additional measurements: body depth at pelvic-fin origin as distance between pelvic-fin and dorsal-fin origins; body depth at anal-fin origin as distance between anal-fin and dorsal-fin origins; body width at pelvic-fin origin as distance between both pelvic-fin origins; distance between interopercular bands as least distance between dark band on

each interopercle, taken at ventroposterior margin of interopercles (see Fig. 1); lengths of first and fifth pelvic-fin soft rays taken from pelvic-fin origin to distal tip of longest branch of each ray (first ray=longest ray); pelvic-fin base length taken from pelvic-fin origin to fifth pelvic-fin soft-ray base. The last two soft rays of the dorsal and anal fins are counted as single rays. The formula for configuration of the supraneural bones, neural spines and dorsal pterygiophores follows Ahlstrom et al. (1976), and the numbering of vacant interneural spaces follows Birdsong et al. (1988). Osteological characters of the new species were examined from X-ray photographs of the following specimens: holotype, CSIRO H8224-20; 7 paratypes and one non-type specimen, CSIRO CA276, CSIRO CA3049, CSIRO H3307-12, CSIRO H3308-03, KAUM-I. 131658, KAUM-I. 131660, KAUM-I. 131661 and NSMT-P 121525. Standard length is abbreviated as SL. In the description of the new species, data and condition of the holotype are given first, followed by those of other specimens in parentheses (if different). Institutional codes follow Sabaj (2020). Photographs of examined specimens are also given in Supplemental Figures S1 and S2 (archived in Zenodo; see p. 25), and referred to as Figs. S1 and S2, respectively, in the text. Counts and measurements of examined specimens of *C. calendula* and *C. chrysozonus* are provided in an MS-Excel file, Dataset_Coradion (archived in Zenodo; see p. 25). Distributional records of *C. calendula* and *C. chrysozonus* include photographic records registered in GBIF, iNaturalist, USNM Fish Illustration Collection, Yasuda & Zama (1975), and Kuitert (2002) (all references listed in Dataset_Coradion). The distribution map was prepared using QGIS 3.10 (QGIS Development Team 2021), with data from ETOPO1 (NOAA National Geophysical Data Center 2009) and Natural Earth (free vector and raster map data at naturalearthdata.com).

The following comparative specimens were examined. Those indicated by an asterisk were fully counted and measured; those with two asterisks were used only for dorsal-fin and anal-fin-ray counts; and those with three asterisks were examined solely from photographs (dorsal-fin and anal-fin-ray counts and coloration determined whenever possible). Morphological data on the primary type specimens of *Chaetodon guttatus* Gronow in Gray, 1854 and *Coradion fulvocinctus* Tanaka, 1918 were based on photographs of the specimens and their original descriptions. Comparative morphological data on *C. altivelis* and *C. melanopus* were based on literature accounts, including major taxonomic studies on Chaetodontidae (e.g., Burges 1978, Pyle 2001), the original descriptions of each nominal species, and examination of comparative material.

Coradion altivelis, 10 specimens, 57.5–143.2 mm SL: Holotype of *C. fulvocinctus*. ***ZUMT 59858, 140 mm SL, Japan, Wakayama, Tanabe. Other specimens. **AMS I.22804-011, 2 specimens, 107.1–112.1 mm SL, Australia; **KAUM-I. 26272, 97.2 mm SL, **KAUM-I. 26273, 57.5 mm SL, **KAUM-I. 58280, 125.6 mm SL, **KAUM-I. 77859, 96.0 mm SL, **KAUM-I. 79731, 114.8 mm SL, **KAUM-I. 110128, 143.2 mm SL, Japan; **KAUM-I. 115221, 138.4 mm SL, Taiwan.

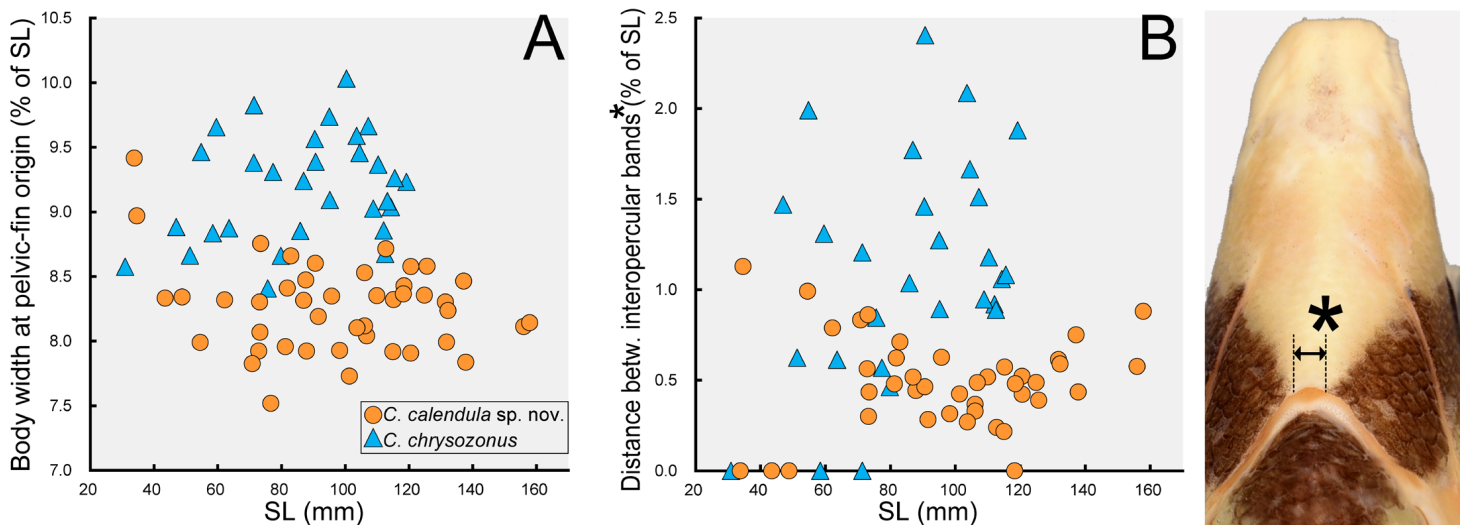


Figure 1. Relationships between body width at pelvic-fin origin (A) and distance between interopercular bands (B) (all as % of SL) and SL (mm) in *Coradion calendula* sp. nov. (circles) and *C. chrysozonus* (triangles). Photograph on right (ventral view of head and thorax of *C. chrysozonus*) indicates distance between interopercular bands (asterisk).

Coradion chrysozonus, 49 specimens, 30.9–119.2 mm SL: Lectotype of *Chaetodon chrysozonus*. ***RMNH.PISC.D. D493 (dry), ca. 120 mm SL, Indonesia, Java. Paralectotypes of *Chaetodon chrysozonus*. ***MNHN 0000-9689, 107 mm SL, ***RMNH.PISC. D.491 (dry), 80 mm SL, ***RMNH.PISC.D. D492 (dry), 100 mm SL, ***RMNH.PISC.D. D494 (dry), 100 mm SL, Indonesia, Java; ***MNHN A3832 (dry), 109 mm SL, locality unknown. Other specimens. AUSTRALIA: *AMS I.17282-001, 58.4 mm SL, Queensland (Qld), Moreton Bay, Stradbroke Island, -25.833°, 152.75°; *AMS I.20771-005, 2 specimens, 46.9–63.6 mm SL, Qld, E of Cape York, -11.616°, 142.933°, 16–18 m; *AMS I.20752-012, 51.3 mm SL, Qld, Lizard Island, -14.5°, 145.366°, 20 m; ***AMS I.44733-007, 107.2 mm SL, Qld, Lizard Island, -14.745°, 145.505°E, 0–10 m; *CSIRO H3308-03, 75.6 mm SL, Qld, Shelburne Bay, -11.813°, 143.006°, 10 m; *CSIRO H6914-05, 77.3 mm SL, Qld, Torres Strait, W of Mulgrave Island, -10.051°, 141.603°, 16 m; *KAUM-I. 167700, 79.8 mm SL, Qld, Great Barrier Reef, Arthur Patches, -17.384°, 146.340°, 16 m. INDONESIA: *CSIRO H8921-01, 71.3 mm SL, Lombok; *HUMZ 193313, 119.2 mm SL, *HUMZ 193314, 103.6 mm SL, Bintan Island. SOUTH CHINA SEA: *HUMZ 33374, 54.7 mm SL, *HUMZ 38459, 108.8 mm SL, *HUMZ 38491, 85.9 mm SL, *HUMZ 38623, 59.6 mm SL, *HUMZ 38630, 90.7 mm SL, *HUMZ 129298, 112.0 mm SL, off Borneo. THAILAND: *HUMZ 225238, 71.3 mm SL, Ranong. MALAYSIA: ***KAUM-I. 12193, 145.0 mm SL, *KAUM-I. 80153, 30.9 mm SL, Sabah; *KAUM-I. 16640, 114.3 mm SL, *KAUM-I. 79809, 110.3 mm SL, **UMTF 4515, 114 mm SL, **UMTF 4517, 110 mm SL, **UMTF 5657, 110 mm SL, **UMTF 5658, 100 mm SL, **UMTF 5772, 129 mm SL, **UMTF 9982, 116 mm SL, **UMTF 9983, 65 mm SL, Terengganu. **UMTF 7293, 101 mm SL, **UMTF 9962, 86 mm SL, Sabah. **UMTF 8396, 125 mm SL, **UMTF 8744, 147 mm SL, Pahang. PHILIPPINES: *KAUM-I. 56030, 86.9 mm SL, ***UPVMI 854, 86.2 mm SL, Panay Island; *ZUMT 42151, 90.4 mm SL, *ZUMT 42156, 100.4 mm SL, *ZUMT 42250, 113.2 mm SL, precise locality unknown. SINGAPORE: *KAUM-I. 132465, 95.0 mm SL, *KBF-I 569, 115.1 mm SL, *NSMT-P 135912, 104.5 mm SL. LOCALITY UNKNOWN: *HUMZ 17944, 95.1 mm SL, *HUMZ 33569, 112.5 mm SL, most likely from South China Sea.

Coradion sp.: ***BMNH 1853.11.12.72 (dry), holotype of *Chaetodon guttatus*, Indian Ocean; ***RMNH.PISC. S.27 (skeleton), ca. 100 mm SL, Indonesia, Java.

A landmark-based geometric morphometric analysis (GMA) was used to assess intraspecific and interspecific variations in pelvic-fin shape among *C. chrysozonus* and *C. calendula*. Eight landmarks on the pelvic fin were coordinated (Fig. 2A, Table 1). Analyses based on photographs and linear measurements were conducted to evaluate the effects of preservation on specimen condition. For the photograph-based GMA, the landmarks were coordinated from photographs of 18 and 25 preserved specimens of *C. chrysozonus* and *C. calendula*, respectively, using tpsDig2 software (Rohlf 2018). Preserved specimens with naturally spread pelvic-fin soft rays, compared with fresh and live conditions, were used, the pelvic fin being spread using pins against the

TABLE 1

Landmarks used in geometric morphometric analysis (GMA) of pelvic-fin shape

Landmarks (LM)	Definition	Coordinate definition for liner measurement-GMA
1	origin of pelvic-fin spine	origin (coordinate: 0, 0)
2	tip of pelvic-fin spine	LM1 to 2: pelvic-fin spine length (80° to LM1 to 8)
3	tip of longest branch of 1st pelvic-fin soft ray	LM1 to 3: 1st pelvic-fin soft ray length (75° to LM1 to 8)
4	tip of longest branch of 2nd pelvic-fin soft ray	LM1 to 4: 2nd pelvic-fin soft ray length (60° to LM1 to 8)
5	tip of longest branch of 3rd pelvic-fin soft ray	LM1 to 5: 3rd pelvic-fin soft ray length (45° to LM1 to 8)
6	tip of longest branch of 4th pelvic-fin soft ray	LM1 to 6: 4th pelvic-fin soft ray length (30° to LM1 to 8)
7	tip of longest branch of 5th pelvic-fin soft ray	LM1 to 7: 5th pelvic-fin soft ray length (15° to LM1 to 8)
8	base of 5th pelvic-fin soft ray	LM1 to 8: pelvic-fin base length

See also Fig. 2

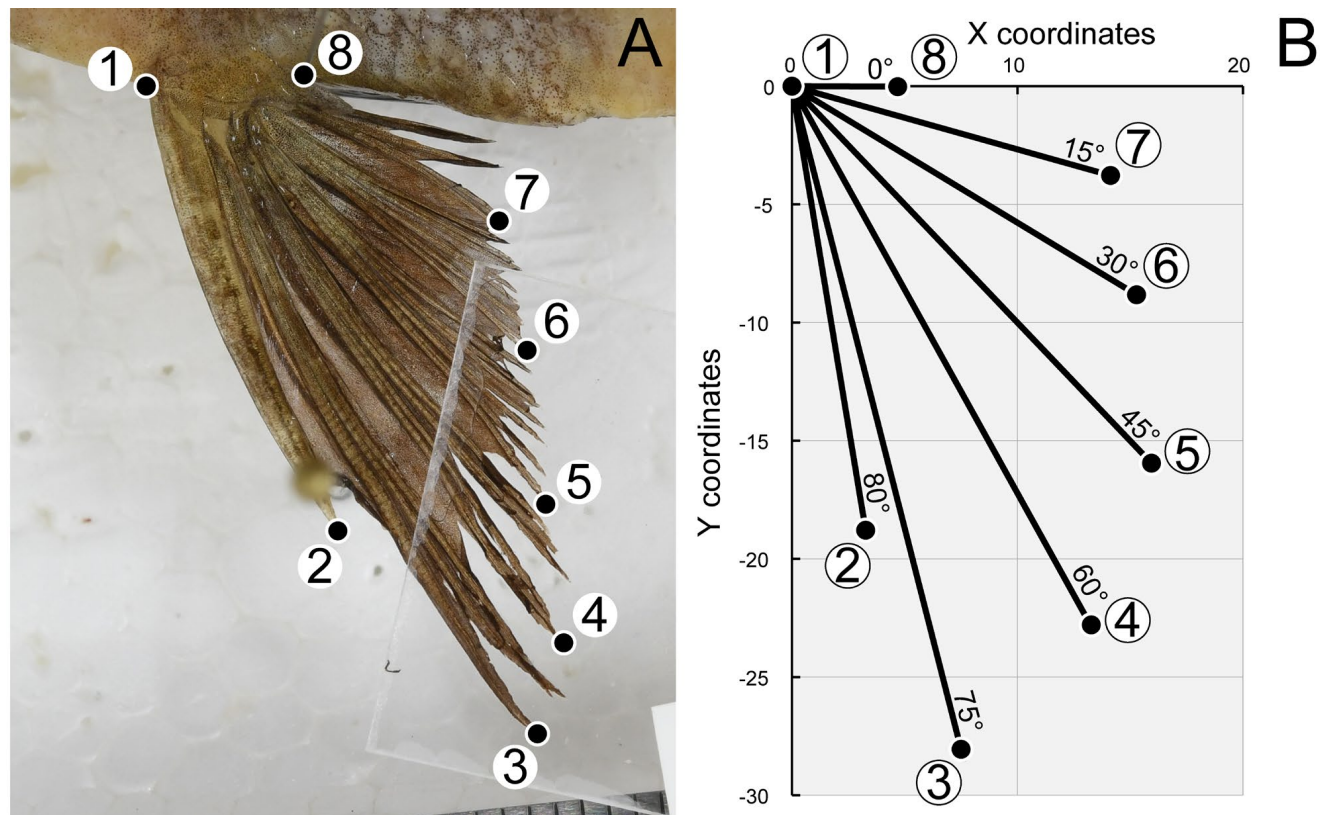


Figure 2. Position and definition of eight landmarks used in photograph (A) and linear-measurement (B) based geometric morphometric analyses (GMA) of pelvic-fin shape. Landmarks (LM) represent: (1) origin of spine; (2) tip of spine; (3) tip of longest branch of 1st soft ray; (4) tip of longest branch of 2nd soft ray; (5) tip of longest branch of 3rd soft ray; (6) tip of longest branch of 4th soft ray; (7) tip of longest branch of 5th ray; (8) base of 5th soft ray. For linear-measurement based GMA (B), degrees between each ray defined as 80° (LM2; spine), 75° (LM3; 1st soft ray), 60° (LM4; 2nd soft ray), 45° (LM5; 3rd soft ray), 30° (LM6; 4th soft ray), and 15° (LM7; 5th soft ray) to base of pelvic fin (between LMs 1 and 8; as 0° base line). See also Table 2.

pelvic-fin spine, forming an angle of about 80–75° to the body axis. For the linear measurement-based GMA, measurements of the pelvic-fin spine, each soft ray, and the base of the pelvic fin taken from 18 and 33 preserved specimens of *C. chrysozonus* and *C. calendula*, respectively (see Dataset_Coradion), were used. The coordinate of landmarks was calculated by MS-Excel software from the measurements with fixed definitions (Fig. 2B, Table 1). Species-grouping of the samples was based on the primary identification based on morphological examination of specimens. The coordinate of landmarks (as TPS file) imported into MorphoJ (Klingenberg 2011) was aligned by Procrustes superimposition, and a covariance matrix generated. Principal component analyses were then performed by MorphoJ. Other statistical analyses were performed by R software version 4.1.3 (R Core Team 2013).

For mtDNA analysis of *Coradion*, sequences of the partial mitochondrial gene coding for the cytochrome oxidase subunit I (COI) and control region (CR) were analyzed. BOLD (Barcode of Life Data System) ID and INSDC (International Nucleotide Sequence Database Collaboration) accession numbers of sequences used in this study are shown in Table 2. Total DNA was extracted from pectoral-fin tissue preserved in 99.5% ethanol, using the Wizard Genomic DNA Purification Kit (Promega Inc.) according to the manufacturer's protocols. The partial COI gene was amplified using the primers designed by Ward et al. (2005) (FishF1–5'-TCAACCAACCACAAAGACATTGGCAC-3' and Fish R1–5'-TAGACTTCTGGG TGGCCAAAGAATCA-3'), and the partial CR gene using the primers designed by Lee et al. (1995) (forward CRA–5'-TTCCACCTCTAACTCCCAAAGCTAG-3' and reverse CRE–5'-CCTGAAGTAGGAACCAGATG-3'). The PCR proceeded for 30 cycles, with denaturation for 30 sec (94°C for COI, and 95°C for CR), annealing for 30 sec (48°C for COI, and 53°C for CR) and extension at 72°C (30 sec for COI, and 45 sec for CR), using the GoTaq Green Master Mix (Promega Corporation). PCR products were purified with Sephadex G-50 Fine (Cytiva). Automated sequencing was performed in both directions, using the BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems), and analyzed on a model 3730xl DNA

Analyzer (Applied Biosystems). The sequences (526 bp for COI, and 374 bp for CR) were aligned using Clustal X (Thompson et al. 1997) with previously determined sequences of *Coradion*, deposited at BOLD and GenBank. From the aligned sequences, the best evolutionary models for analyses based on COI and CR were found by MEGA X software (Kumar et al. 2018), and Hasegawa-Kishino-Yano model (Hasegawa et al. 1985) and Tamura 3-parameter model (Tamura 1992) were selected for COI and CR analyses, respectively, with Gamma Distributed model. A maximum likelihood (ML) tree was reconstructed using MEGA X, and branch support measured using nonparametric bootstrapping with 1,000 replications, based on the same algorithm (Felsenstein 1981).

TABLE 2

Samples included in molecular analysis of partial mitochondrial cytochrome oxidase subunit I (COI) and control region (CR) genes

Identification	Specimen	BOLD ID (COI)	Accession No INSDC (COI)	Accession No INSDC (CR)	Locality
<i>C. chrysozonus</i>	AMS I.44733-007	LIFS826-08	KP194627	LC726094*	Lizard I., Australia
<i>C. chrysozonus</i>	CSIRO H6914-05	FOAL954-10	HQ956571	LC726095*	Torres Strait, Australia
<i>C. chrysozonus</i>	CSIRO H8921-01	FOAH960-08	n/a	LC726096*	Lombok, Indonesia
<i>C. chrysozonus</i>	KAUM-I. 56030	n/a	LC664759*	LC726097*	Panay, Philippines
<i>C. chrysozonus</i>	KAUM-I. 79809	n/a	LC664760*	LC726098*	Terengganu, Malaysia
<i>C. chrysozonus</i>	KAUM-I. 80153	n/a	LC664761*	LC726099*	Sabah, Malaysia
<i>C. chrysozonus</i>	KAUM-I. 167700	n/a	LC726093*	LC726100*	Great Barrier Reef, Australia
<i>C. chrysozonus</i>	UMTF 8396	n/a	OP364402*	n/a	Pahang, Malaysia
<i>C. chrysozonus</i>	UMTF 8744	n/a	OP364403*	n/a	Pahang, Malaysia
<i>C. chrysozonus</i>	UMTF 7293	n/a	OP364404*	n/a	Sabah, Malaysia
<i>C. chrysozonus</i>	UMTF 9962	n/a	OP364401*	n/a	Sabah, Malaysia
<i>C. chrysozonus</i>	UMTF 5657	n/a	OP364405*	n/a	Terengganu, Malaysia
<i>C. chrysozonus</i>	UMTF 5658	n/a	OP364406*	n/a	Terengganu, Malaysia
<i>C. calendula</i>	CSIRO H6919-09	FOAL951-10	HQ956569	LC726101*	Torres Strait, Australia
<i>C. calendula</i>	CSIRO H8200-41	n/a	LC726091*	LC726102*	WA, Australia
<i>C. calendula</i>	CSIRO H8200-42	n/a	LC726092*	LC726103*	WA, Australia
<i>C. calendula</i>	CSIRO H8224-20	FOAO1266-18	n/a	n/a	WA, Australia
<i>C. calendula</i>	CSIRO H8763-26	FOAQ611-21	n/a	LC726104*	Gulf of Carpentaria, Australia
<i>C. calendula</i>	CSIRO H8922-01	FOAL958-10	HQ956574	n/a	Torres Strait, Australia
<i>C. altivelis</i>	CSIRO unreg.	FOAH412-08	n/a	n/a	Qld, Australia
<i>C. altivelis</i>	CSIRO H6941-06	FOAL962-10	n/a	n/a	Qld, Australia
<i>C. altivelis</i>	CSIRO H6941-07	FOAL943-10	n/a	n/a	Qld, Australia
<i>C. altivelis</i>	NMV A29676-014	FOAG410-08	n/a	n/a	WA, Australia
<i>C. altivelis</i>	CSIRO H6573-03	FOAG412-08	n/a	n/a	WA, Australia
<i>C. altivelis</i>	ASIZP 65881	FTW718-09	n/a	n/a	Taiwan
<i>C. altivelis</i>	ASIZP 65805	FTW730-09	n/a	n/a	Taiwan
<i>C. altivelis</i>	ASIZP 67423	FTWS175-09	n/a	n/a	Taiwan

*determined in this study; n/a, not available

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Orange-tailed Coralfish

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Figures 3A–C, 4A, B, 5A–C, 6A, 7F, 8, 9A–F, 17D, G; Tables 3–5.

Coradion chrysozonus not of Cuvier & Valenciennes: Gloerfelt-Tarp & Kailola 1984: 222, unnumbered fig. [figured specimen: CSIRO CA998 (not examined); southern Indonesia and northwestern Australia; atlas, short description]; Sainsbury et al. 1984: 246, unnumbered fig. [figured specimen: CSIRO CA3049 (designated here as paratype); northwestern Australia from NW shelf to Gulf of Carpentaria; atlas, short description]; Allen & Steene 1987: 127, pl. 63-6 (North West Cape, Western Australia; atlas).

Holotype. CSIRO H8224-20, 87.8 mm SL, Australia, Western Australia, WNW of Port Hedland, -20.166°, 117.9°, 34 m, A. Graham & J. Pogonoski (CSIRO), demersal trawl, 18 October 2017.

Paratypes. 40 specimens, 33.8–157.8 mm SL, all from Australia: WESTERN AUSTRALIA (WA): AMS I.22800-021, 9 specimens, 43.4–137.8 mm SL, 80 km north of Port Hedland, Northwest Shelf, -19.6°, 118.1°, 52–54 m, J. Paxton & M. McGrouther, Engel bottom trawl, 26 March 1982; CSIRO CA276, 112.7 mm SL, N of Cape Lambert, -19.816°, 117.25°, 61 m, CSIRO, demersal trawl, 18 May 1978; CSIRO CA3049, 81.2 mm SL, NW of Port Hedland, -20.033°, 117.966°, 36 m, CSIRO, demersal trawl, 16 October 1982; CSIRO H8200-41, 48.8 mm SL, CSIRO H8200-42, 120.5 mm SL, SW of Lagrange Bay, -18.702°, 121.039°, 49–51 m, R/V *Investigator*, demersal trawl, 11 October 2017; HUMZ 6279, 106.1 mm SL, HUMZ 6281, 106.1 mm SL, HUMZ 6282, 73.2 mm SL, HUMZ 6283, 62.1 mm SL, HUMZ 6287, 103.7 mm SL, HUMZ 6288, 101.3 mm SL, -18.65°, 116.516°, -19.933°, 119.483°, 16–115 m, O. Okada, FRV *Osyoro-maru*, bottom trawl, December 1962; KAUM-I. 131657, 98.3 mm SL, KAUM-I. 131658, 54.4 mm SL, KAUM-I. 131659, 76.6 mm SL, SW of Lagrange Bay, -18.435°, 121.003°E, 51 m, A. Graham & J. Pogonoski, R/V *Investigator*, bottom trawl, 11 October 2017; KAUM-I. 131660, 70.8 mm SL, KAUM-I. 131661, 90.6 mm SL, WSW of Port Hedland, -20.100°, 117.543°, 34 m, A. Graham & J. Pogonoski, R/V *Investigator*, bottom trawl, 18 October 2017; NSMT-P 121516, 155.9 mm SL, NW coast of Australia, -18.47°, 119.32°, 128 m, R/V *Tanshu-maru*, bottom trawl, 27 May 1972; NSMT-P 121518, 114.9 mm SL, NW coast of Australia, -20.37°, 115.84°, 42–48 m, R/V *Tanshu-maru*, bottom trawl, 1973; NSMT-P 121519, 86.9 mm SL, NW coast of Australia, -20.22°, 115.97°, 52 m, R/V *Tanshu-maru*, 10 May 1972; NSMT-P 121520, 73.1 mm SL, NW coast of Australia, -20.25°, 115.72°, 65 m, R/V *Tanshu-maru*, bottom trawl, 8 May 1972; NSMT-P 121522, 82.9 mm SL, NW coast of Australia, -20.22°, 115.97°, 52 m, R/V *Tanshu-maru*, bottom trawl, 10 May 1972; NSMT-P 121523, 124.8 mm SL, NW coast of Australia, -19.77°, 116.00°, 83–102 m, R/V *Tanshu-maru*, bottom trawl, 18 May 1973; NSMT-P 121524, 157.8 mm SL, NW coast of Australia, -19.34°, 117.09°, 73–74 m, R/V *Tanshu-maru*, bottom trawl, 18 May 1973; NSMT-P 121525, 125.6 mm SL, NSMT-P 121526, 118.4 mm SL, NSMT-P 121527, 118.2 mm SL, NW coast of Australia (no further data). NORTHERN TERRITORY (NT): AMS I.21955-019, 81.8 mm SL, Arafura Sea, -10.416°, 136.05°, 52 m, CSIRO, R/V *Soela*, demersal prawn trawl, 22 Nov. 1980; CSIRO CA1003, 72.8 mm SL, NW of Fog Bay, -12.333°, 129.066°, 88 m, CSIRO, demersal trawl, 1 July 1980; CSIRO H8763-26, 115.1 mm SL, Gulf of Carpentaria, SE of Vanderlin Island, -15.997°, 137.522°, 11 m, F/V *Dolphin Pearl*, prawn trawl, 13 February 2021. QUEENSLAND (Qld): CSIRO H3307-12, 34.6 mm SL, SE of Hannibal Island, -11.716°, 143.016°, 17 m, G. Yearsley (CSIRO), demersal trawl, 14 January 1993; CSIRO H6919-09, 91.6 mm SL, Torres Strait, SW of Prince of Wales Island, -10.910°, 141.658°, 18 m, FRV *Gwendoline* May, 14 January 2004; CSIRO H8922-01, 33.8 mm SL, Torres Strait, NE of Dungeness Island, -9.721°, 143.192°, 23 m, FRV *Gwendoline* May, 24 January 2004.

Non-type specimens. Three specimens, 73.4–95.7 mm SL, all from Australia: AMS I.21848-003, 2 specimens, 87.6–95.7 mm SL, NT, Arafura Sea, -11.3°, 134.033°, 40–44 m, CSIRO, R/V *Soela*, Engel trawl, 18 November 1980; CSIRO H6145-07, 73.4 mm SL, Qld, Torres Strait, NW of Prince of Wales, -10.55°, 141.616°, 17 m, D. Gledhill (CSIRO) and I. Jacobsen (Uni Qld), demersal trawl, 16 January 2004.

TABLE 3

Counts and proportional measurements (as percentages of SL) of examined specimens of
Coradion calendula sp. nov. and *C. chrysozonus*

	<i>C. calendula</i> sp. nov.			<i>C. chrysozonus</i>	
	HT CSIRO H8224-20	PT+NT n = 43	modes	NT n = 29	modes
Dorsal-fin rays	IX, 31	XIII or IX, 28–32	IX, 29	XIII or IX, 27–30*	IX, 28*
Anal-fin rays	III, 22	III, 20–22	III, 21	III, 18–21*	III, 20*
Pectoral-fin rays**	16	15–17	16	15–17	16
Pored lateral-line scales**	damaged	43–46	46	40–49	45
SL (mm)	87.8	33.8–157.8	means	30.9–119.2	means
Maximum body depth (% of SL)	66.6	63.7–75.3	69.9	65.9–80.2	72.9
Body depth at pelvic fin origin	67.3	62.3–76.7	68.8	63.0–75.3	70.8
Body depth at anal fin origin	77.0	73.6–87.6	79.3	75.0–86.2	81.0
Body width at pectoral-fin base	15.2	12.7–16.7	14.5	13.7–17.8	15.3
Body width at pelvic fin origin	7.9	7.5–9.4	8.3	8.4–10.0	9.2
Distance betw. interopercular bands	0.4	0.0–1.1	0.5	0.0–2.4	1.1
Head length	36.9	33.0–38.9	36.3	34.7–39.2	36.6
Orbit diameter	11.1	9.0–14.9	10.9	10.2–14.0	11.6
Snout length	12.1	10.3–13.5	12.0	10.4–13.4	11.9
Postorbital length	16.9	15.9–18.8	17.6	16.0–18.4	17.2
Interorbital width at mid-orbit	8.8	8.2–10.4	9.2	8.9–10.4	9.7
Pre-dorsal fin length	48.7	45.8–56.0	50.5	46.7–57.1	51.9
Pre-anal fin length	72.8	64.6–75.9	70.2	67.8–75.2	70.9
Pre-pelvic fin length	47.0	41.9–49.5	46.2	42.3–47.9	45.7
1st dorsal-fin spine length	7.9	6.2–12.6	8.4	5.6–14.4	8.6
2nd dorsal-fin spine length	14.3	10.4–24.7	14.4	11.1–24.8	15.6
3rd dorsal-fin spine length	19.8	13.4–32.9	19.7	14.5–33.9	21.9
4th dorsal-fin spine length	24.4	16.4–38.2	23.9	18.5–38.5	26.1
5th dorsal-fin spine length	28.3	18.3–43.4	26.6	19.1–40.1	28.6
6th dorsal-fin spine length	28.8	20.3–46.4	28.1	19.8–41.5	30.1
7th dorsal-fin spine length	26.6	22.4–45.7	28.9	21.4–41.4	30.3
8th dorsal-fin spine length	27.9	23.0–44.5	28.9	22.7–40.5	31.0
9th dorsal-fin spine length	28.7	23.2–43.3	29.9	24.9–39.5	30.1
1st dorsal-fin soft ray length	31.3	27.0–40.6	31.5	25.1–40.6	32.9
1st anal-fin spine length	10.5	7.4–17.5	10.4	8.0–16.7	11.3
2nd anal-fin spine length	20.4	14.4–29.1	19.2	16.3–27.5	20.9
3rd dorsal-fin spine length	23.0	16.8–33.5	22.9	19.5–31.3	24.2
1st anal-fin soft ray length	28.5	24.3–35.5	28.1	23.8–35.0	29.1
Pectoral fin length	29.6	24.8–35.7	28.7	25.9–32.8	29.5
Pelvic-fin spine length	23.7	21.3–32.6	24.6	21.2–30.7	25.9
1st (longest) pelvic-fin soft ray length	41.3	34.4–49.5	40.7	32.8–46.8	40.6
2nd pelvic-fin soft ray length	34.0	30.3–40.9	33.9	30.7–40.4	35.6
3rd pelvic-fin soft ray length	28.2	24.1–35.1	27.4	27.3–34.8	30.3
4th pelvic-fin soft ray length	21.2	18.6–27.8	21.2	21.3–28.2	24.3
5th pelvic-fin soft ray length	17.7	15.2–22.9	17.6	17.7–22.6	20.1
Pelvic-fin base length	5.4	5.5–6.7	6.0	5.4–8.3	6.5
Caudal peduncle length	11.4	11.0–13.7	11.9	11.2–13.1	12.1
Caudal peduncle depth	6.4	6.0–10.2	7.7	5.1–10.1	7.5
Caudal fin length	25.8	22.1–32.9	25.4	22.9–29.6	26.0

Modes and means for all specimens; HT, PT and NT indicate holotype, paratype and non-type specimens, respectively

*based on 48 & 42 specimens, including type specimens, for dorsal- and anal-fin rays, respectively; **counts on both sides combined

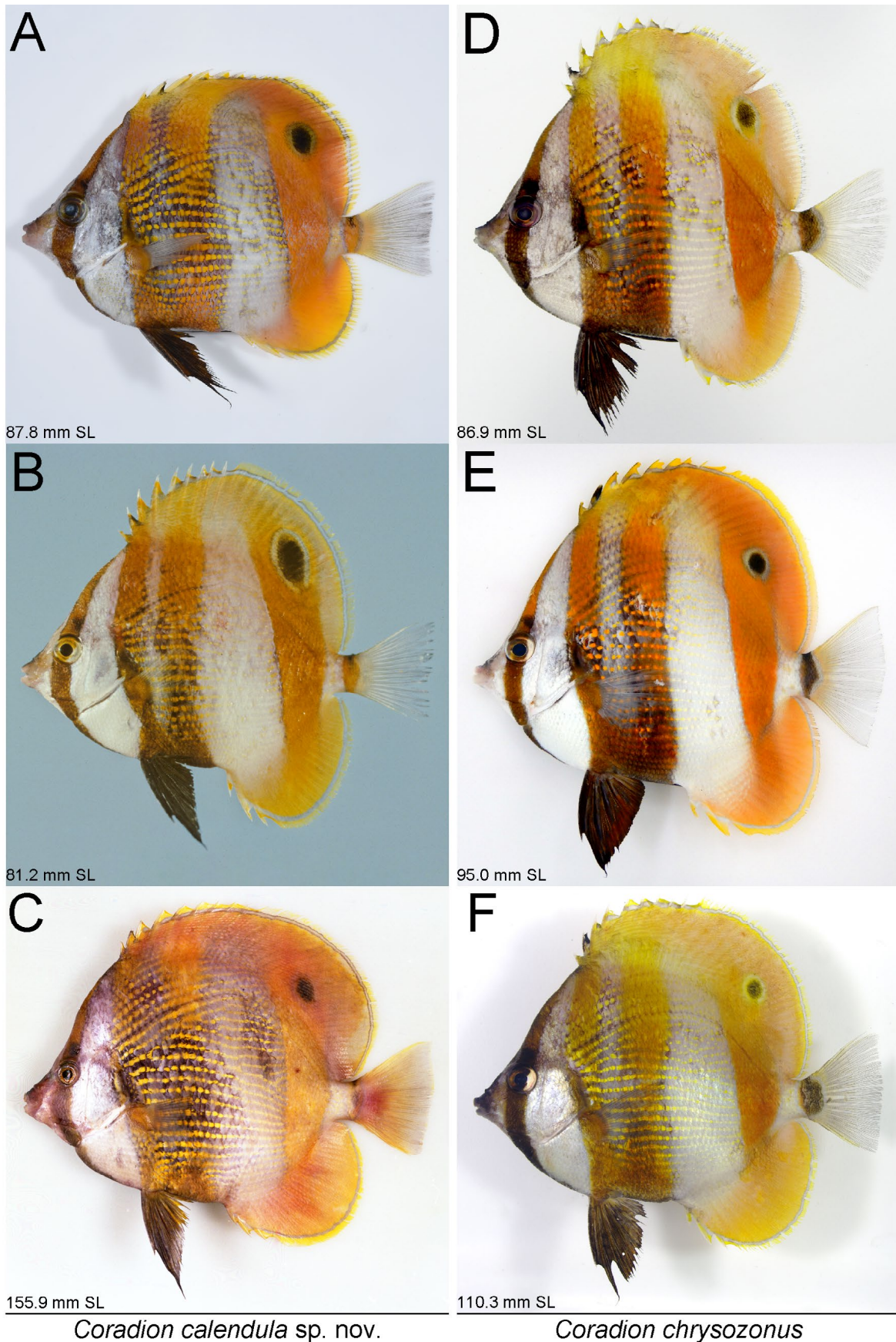


Figure 3. Photographs of fresh specimens of *Coradion calendula* sp. nov. (A–C) and *C. chrysozonus* (D–F). A: CSIRO H8224-20, holotype, 87.8 mm SL, Western Australia; B: CSIRO CA3049, paratype, 81.2 mm SL, Western Australia; C: NSMT-P 121516, paratype, 155.9 mm SL, Western Australia; D: KAUM-I. 56030, 86.9 mm SL, Philippines; E: KAUM-I. 132465, 95.0 mm SL, Singapore; F: KAUM-I. 79809, 110.3 mm SL, Malaysia. Photos by John Pogonoski (CSIRO) (A), CSIRO (B) and Far Seas Fisheries Research Laboratory, Japan (C).

Photographic records. iNaturalist users & Ueda K (2021a), Australia, WA, Carnarvon (-23.040°, 113.7393°); iNaturalist users & Ueda K. (2021b), Australia, WA, Exmouth (-21.9352°, 114.1523°); USNM FIN 27791 (USNM Fish Illustration Collection), Australia, WA, Dampier Archipelago, Kendrew Island, J.E. Randall, 13 October 1973 (<http://n2t.net/ark:/65665/36750b5d1-95ff-4c37-80e9-a4ad267d86bc>).

Diagnosis. A species of *Coradion* distinguished from all congeners by a combination of dorsal-fin rays IX, 28–32 (mode 29); anal-fin rays III, 20–22 (mode 21); a single ocellated spot on soft-rayed portion of dorsal fin; no ocellated spot on anal fin; band on caudal peduncle usually orange when fresh (obscured in preserved specimens) with a short, saddle-like, blackish dorsal streak; a sharply pointed pelvic fin with an almost straight posterior contour when spread (most obviously in large specimens >10 cm SL); and a dark band on each interopercle joining on ventral midline with anterior margins forming a sharply pointed “V” in ventral view.

Description. (counts and proportional measurements in Tables 3 & 4) Body oval in lateral view, strongly compressed; head moderately large; caudal peduncle short, low (Figs. 3A–C, 4A & B). Dorsal profile of frontal steep, forming angle of about 60° (50–60°) to body axis, profile of nape (just before dorsal-fin origin) gently sloped, forming angle of about 50° (40–50°), in lateral view; ventral profile of head similar to dorsal profile but gently curving from snout tip to anal-fin origin. Snout pointed, short, not tubular, its length 33% (28–37%) of head length; mouth small, slightly diagonal, gape forming angle of about 30° to body axis, upper jaw slightly protruding; both lips fleshy; upper jaw with long brush-like teeth, canted inward, and short brush-like teeth densely covering mouth roof; lower jaw with minute, elongate, prickle-like teeth; nostrils just anterior to orbit at mid-orbital level; anterior nostril a short membranous tube with a small triangular skin flap, tip reaching posterior nostril when laid back; posterior nostril slightly larger, slit-like, with low fleshy rim. Ventral margin of lacrimal finely serrated, with about 20 (5–29) serrae; margin of preopercle finely serrated, with 23 (15–70) serrae ventrally and 56 (24–60) posteriorly; posterior margin of preopercle straight (without notches), posteroventral corner almost right-angled, without protruding spine; posterior margin of interopercle with about 20 (6–38) serrae; margins of subopercle and opercle smooth; exposed margins of posttemporal, supracleithrum and cleithrum finely serrated, with 7 (5–25), 17 (10–27) and 21 (5–27) serrae, respectively; orbital rim finely serrated. Interopercles large, expanded ventrally

TABLE 4

Frequency distribution of dorsal-fin and anal-fin soft rays on examined specimens of *Coradion calendula* sp. nov. and *C. chrysozonus*

	Dorsal-fin soft rays								
	27	28	29	30	31	32			
<i>C. calendula</i>		6	22	11	3*	1			
<i>C. chrysozonus</i>	7	24	12*	5					
	Anal-fin soft rays								
	18	19	20	21	22				
<i>C. calendula</i>			12	28	4*				
<i>C. chrysozonus</i>	1	8	27	6*					
	Combination of dorsal-fin and anal-fin soft rays								
	27, 18	27, 19	27, 20	28, 19	28, 20	28, 21	29, 19	29, 20	29, 21
<i>C. calendula</i>					2	4		9	12
<i>C. chrysozonus</i>	1	1	3	4	18		2	4	4*
	Combination of dorsal-fin and anal-fin soft rays (cont.)								
	29, 22	30, 19	30, 20	30, 21	30, 22	31, 20	31, 21	31, 22	32, 22
<i>C. calendula</i>	1			10	1	1	1	1*	1
<i>C. chrysozonus</i>		1	1	2					

*including primary type specimens

and united by skin membrane; from ventral view, posterior interopercular margin with deep, triangular notch receiving anteroventral projection of thorax when head in natural position (Fig. 5A–C).

Lateral-line origin between posttemporal and supracleithrum bony crests, forming broad arc, gradually rising to below fourth dorsal-fin soft-ray base, thereafter curving progressively downward following close to dorsal contour of body, before running horizontally on caudal peduncle and terminating at caudal-fin base (based on paratypes; posteriormost portion damaged in holotype). Body scales moderately large, ctenoid, with about 60 spinules on posterior exposed margin; those on thorax, abdomen, and dorsal and anal fins smaller; dorsal and anal fins mostly covered by scales (absent on distal margins); small scales covering caudal-fin base but not extending posteriorly onto center of fin; outer surface of pectoral-fin base densely covered by small scales, axilla naked; outer surface of pelvic-fin base naked but cluster of somewhat elongate scales forming axillary scaly sheath, inner surface of fin base covered with scales (extending slightly onto soft rays). Head entirely covered with small finely ctenoid scales, except anterior edges of both jaws, including maxilla, and around nostrils.

Origin of dorsal fin slightly posterior to upper end of gill opening; first to sixth dorsal-fin spines blade-like, moderately broad (lateral view); first dorsal-fin spine shortest; sixth (sixth to ninth) spine longest, longest spine length 43% (33–62%, decreasing with growth) of maximum body depth, sixth to ninth spines subequal in length; first soft ray slightly longer than last spine; all soft rays branched, dorsal profile of spinous and soft-rayed portions forming broad, gently rounded arc (without notch or pointed top). Anal-fin origin below third dorsal-fin soft ray base; anal-fin spines blade-like, becoming gradually longer posteriorly; second spine broadest, but shorter

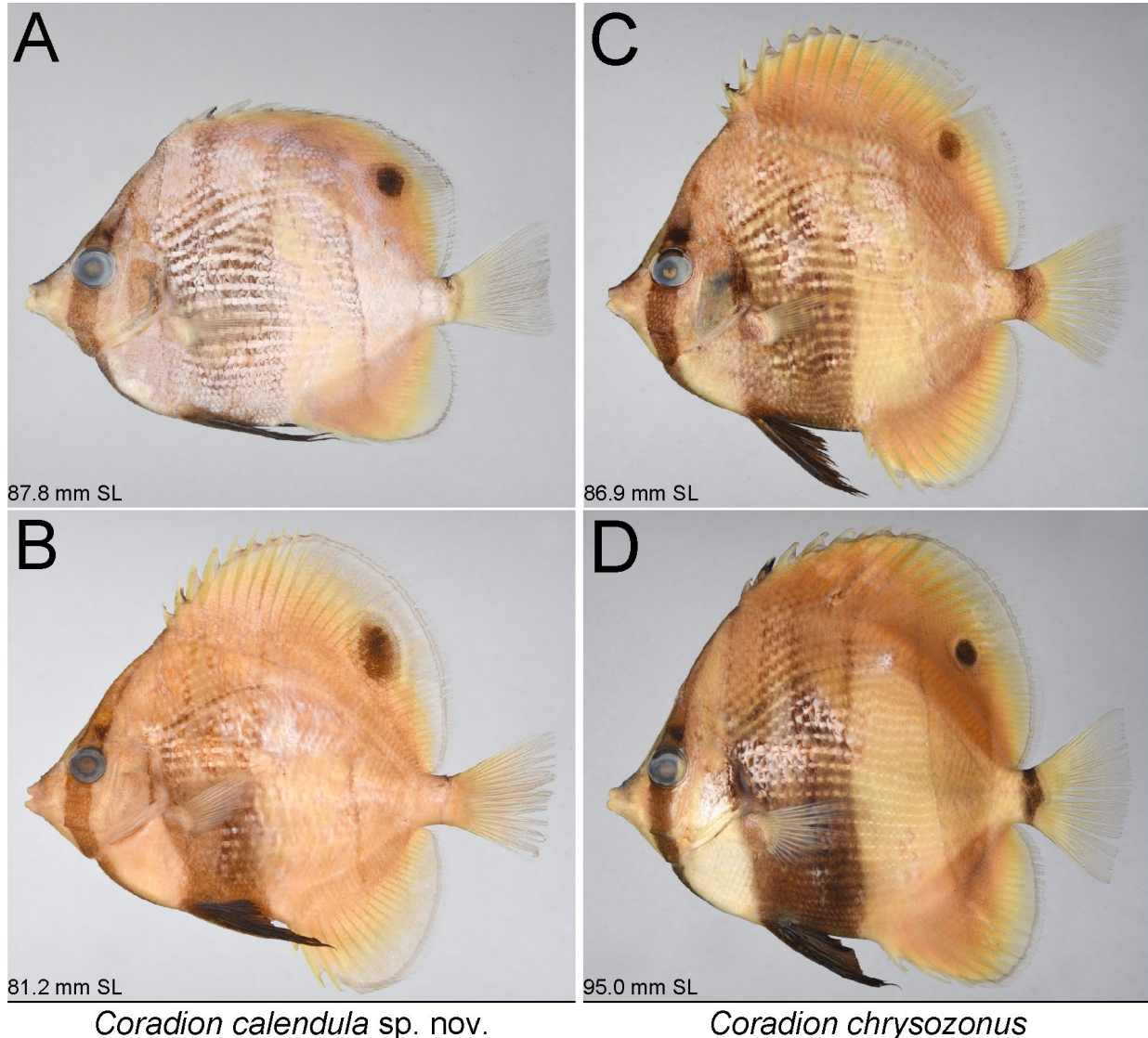


Figure 4. Preserved specimens of *Coradion calendula* sp. nov. (A, B) and *C. chrysozonus* (C, D). A: CSIRO H8224-20, holotype, 87.8 mm SL, Western Australia; B: CSIRO CA3049, paratype, 81.2 mm SL, Western Australia; C: KAUM-I. 56030, 86.9 mm SL, Philippines; D: KAUM-I. 132465, 95.0 mm SL, Singapore.

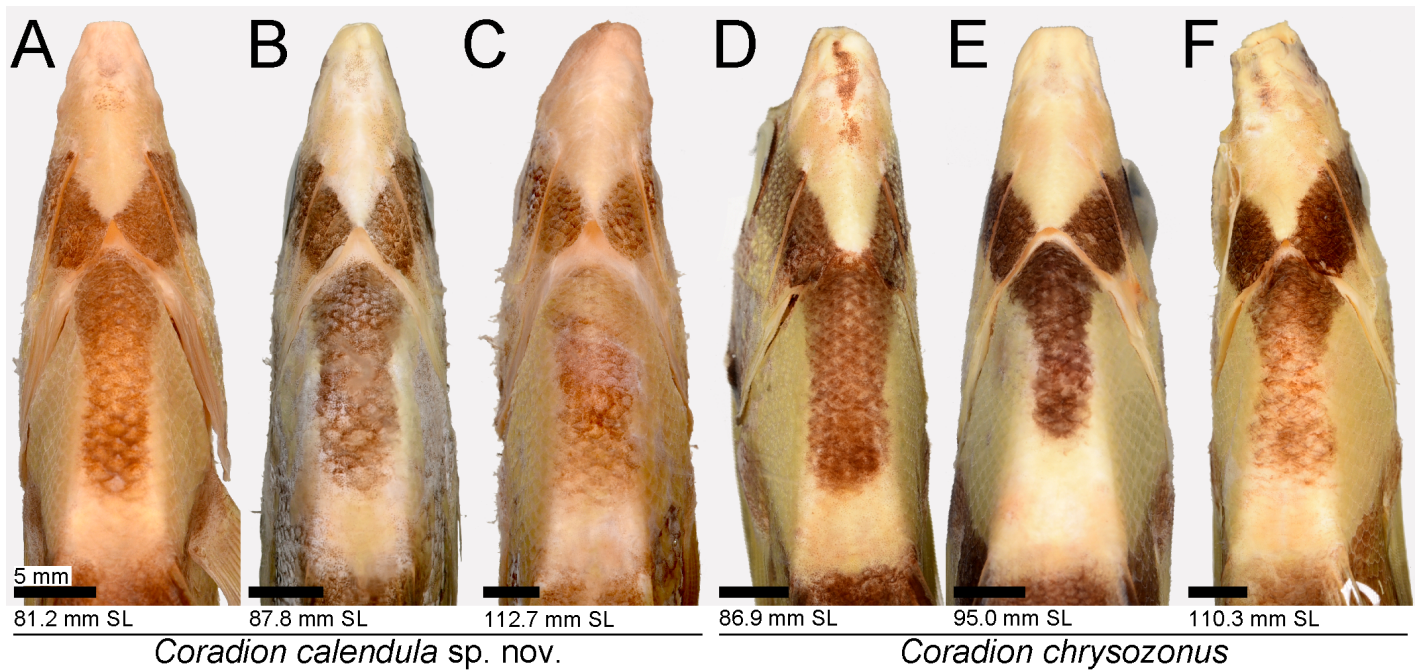


Figure 5. Ventral views of head and thorax of preserved specimens of *Coradion calendula* sp. nov. (A–C) and *C. chrysozonus* (D–F). A: CSIRO CA3049, paratype, 81.2 mm SL; B: CSIRO H8224-20, holotype, 87.8 mm SL; C: CSIRO CA276, paratype, 112.7 mm SL; D: KAUM-I. 56030, 86.9 mm SL; E: KAUM-I. 132465, 95.0 mm SL; F: KAUM-I. 79809, 110.3 mm SL. Bars indicate 5 mm.

than third (longest) spine; third spine length 35% (25–45%, decreasing with growth) of body depth; first soft ray distinctly longer than third spine; all soft rays branched, profile of spinous and soft-rayed portions forming broad arc similar to that of dorsal fin. Pectoral fin moderately long, rounded, upper origin below first dorsal-fin spine base; all rays branched, except for two uppermost and lowermost; fourth (or third) ray longest, its distal tip extending to anal-fin origin. Pelvic spine strong, compressed dorsally and ventrally, blade-shaped; origin of pelvic fin below lower origin of pectoral-fin base; all rays branched, first ray longest, its outer branch slightly filamentous; posterior contour of spread pelvic fin almost straight, vertical to body axis (Fig. 6A); depressed pelvic-fin tip extending well beyond a vertical through third anal-fin spine base. Caudal fin truncate, posterior margin almost straight (dorsal and ventral corners rounded in small paratypes).



Figure 6. Pelvic fins of preserved specimens of *Coradion calendula* sp. nov. (A, CSIRO H8224-20, holotype, 87.8 mm SL) and *C. chrysozonus* (B, KAUM-I. 56030, 86.9 mm SL). Bars indicate 10 mm.

Vertebrae 10+14; anterior-supraneural dorsal-ray-pterygiophore neural-spine interdigitation pattern: 0/0+2/1; seventh (or sixth) interneural space vacant.

Color fresh and in life. (Figs. 3A–C, 7F, 8, see also Fig. S1A–J) Ground color of head and body white; center of body scales vivid yellow, dorsal and ventral margins white, forming many yellow dotted lines on trunk, and dorsum above lateral line and about two lines just below lateral line running diagonally upward; lower lines on trunk horizontal to body axis, dots on abdomen becoming smaller and denser due to decreasing size of abdominal

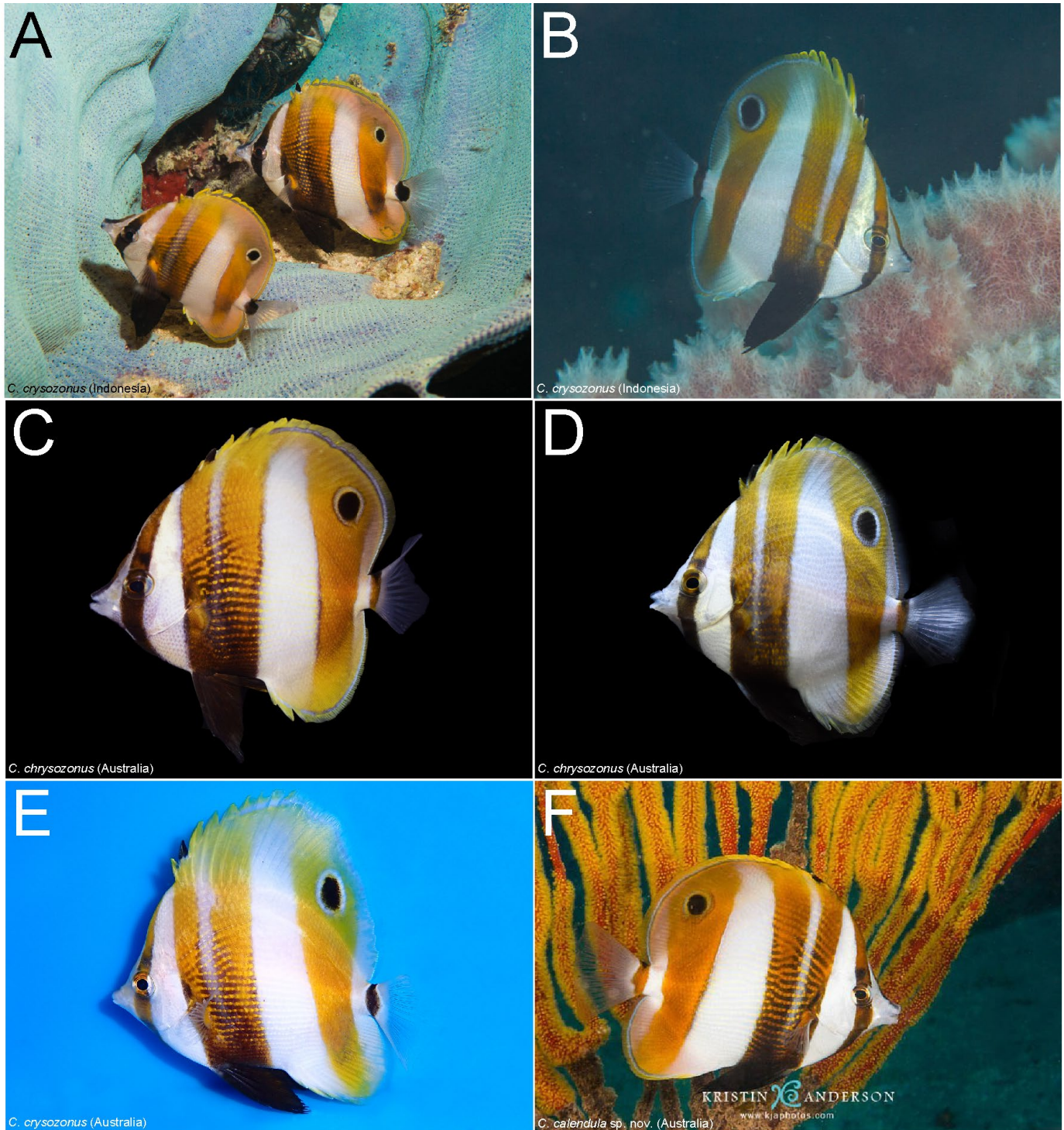


Figure 7. Underwater or aquarium photographs of *Coradion chrysozonus* (A–E) and *C. calendula* sp. nov. (F). A: Wagemag Bay, Raja Ampat, Indonesia, by Lesley Clements, iNaturalist (<https://www.inaturalist.org/observations/25869601>), CC BY-NC 4.0 license; B: Bitung, Sulawesi Utara, Indonesia, by Mark Rosenstein, modified from iNaturalist (<https://www.inaturalist.org/observations/262626>) CC BY 4.0 license; C, D: Great Barrier Reef, Australia, by Yi-Kai Tea; E: KAUM-I. 167700, 79.8 mm SL, Arthur Paches, Great Barrier Reef, Australia, by Fenton Walsh; D: Exmouth, WA, Australia, by Kristin Anderson, iNaturalist (<https://www.inaturalist.org/observations/12728917>) CC BY 4.0 license.

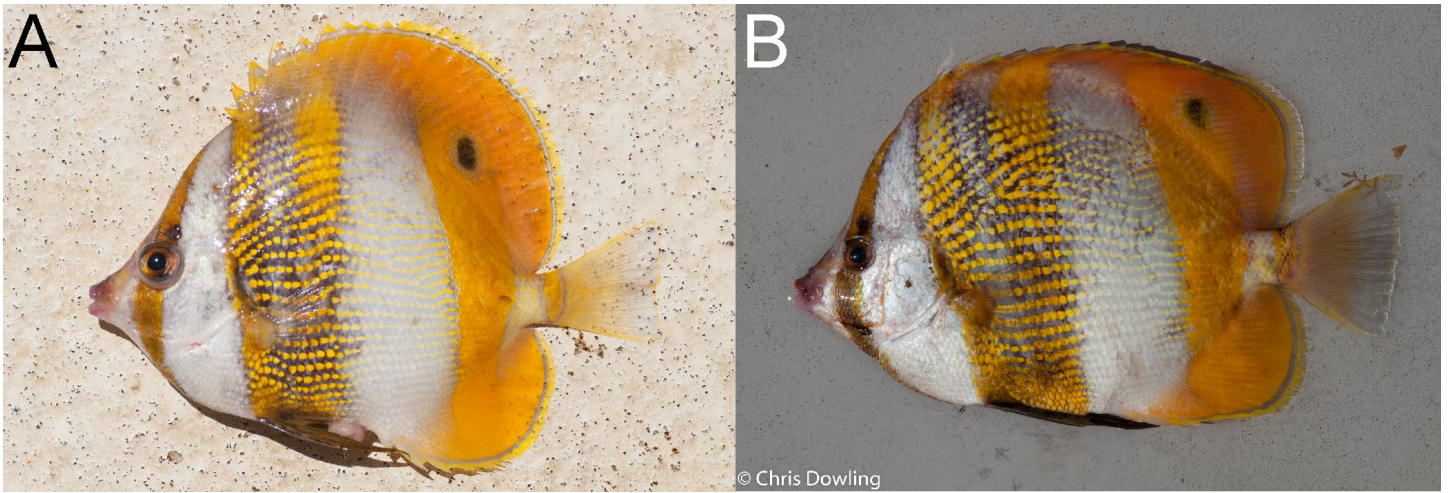


Figure 8. *Coradion calendula* sp. nov. collected by bottom trawl off WA, Australia (specimens not retained). A: vicinity of Bigge Island, Kimberly; B: off Karratha, North West Shelf. ©Chris Dowling.

scales; center of scales on thorax (anterior to line between upper origin of pectoral-fin base and pelvic-fin origin) pale yellow, not forming distinct lines; head scales lacking yellow markings. Lateral side of head and body with four vertical bands; anteriormost brown with narrow blackish edges, saddling nape and almost reaching dorsal-fin origin (front and lateral views), ventrally descending through eye, suborbital area and lateral surface of interopercle, before meeting opposite band on mid-point of posteroventral margin of interopercles, continuing

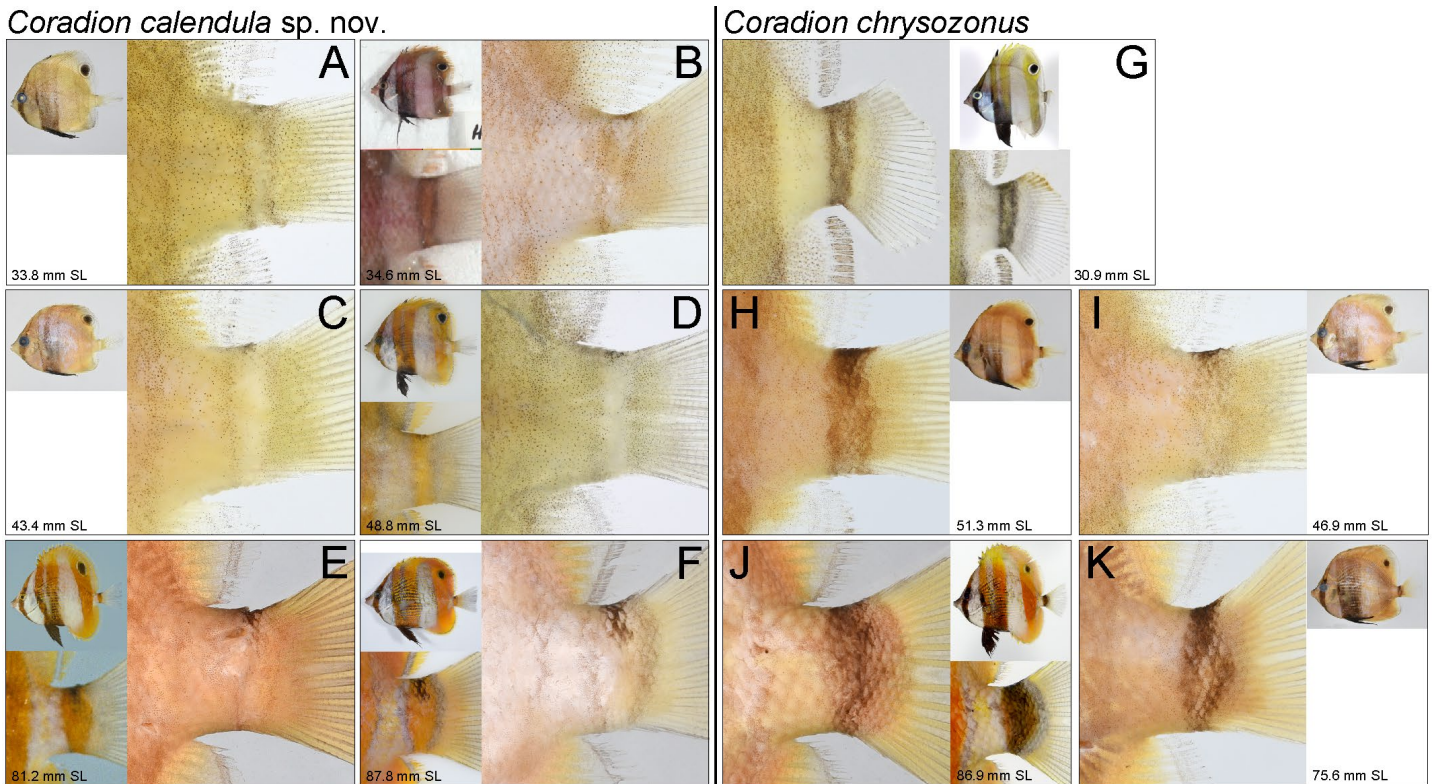


Figure 9. Caudal-peduncle bands in preserved specimens of *Coradion calendula* sp. nov. (A–F) and *C. chrysozonus* (G–K) (photographs of fresh specimens included if available). A: CSIRO H8922-01, 33.8 mm SL, Torres Strait, Qld; B: CSIRO H3307-12, 34.6 mm SL, Hannibal Island, Qld; C: AMS I.22800-021, 1 of 9 specimens, 43.4 mm SL, Northwest Shelf, WA; D: CSIRO H8200-41, 48.8 mm SL, off Lagrande Bay, WA; E: CSIRO CA3049, 81.2 mm SL, off Port Hedland, WA; F: CSIRO H8224-20, holotype, 87.8 mm SL, off Port Hedland, WA; G: KAUM-I. 80153, 30.9 mm SL, Sabah, Malaysia; H: AMS I.20752-012, 51.3 mm SL, Lizard Island, Qld; I: AMS I.20771-005, 1 of 2 specimens, 46.9 mm SL, off Cape York, Qld; J: KAUM-I. 56030, 86.9 mm SL, Panay Island, Philippines; K: CSIRO H3308-03, 75.6 mm SL, Shelburne Bay, Qld. Photos (fresh specimens) by Gordon Yearsley (CSIRO) (B), CSIRO (D, E) and John Pogonoski (CSIRO) (F).

as a single band on anteroventral surface of thorax (edge apparent in lateral view), and terminating at anterior of pelvic-fin origin [in frontal view, ventral head and thorax with Y-shaped dark band—see marking pattern: Fig. 5A–C (preserved condition)]; second orange band on anterior part of trunk, very broad (more than twice orbit diameter), extending from between origins of first and eighth dorsal-fin-spine bases onto abdomen between pelvic-fin origin and near anus, anterior margin through posterior edge of opercle and pectoral-fin base, profiles of anterior and posterior margins almost straight, whitish space within band below third, fourth, and fifth dorsal-fin-spine bases (extending dorsally onto dorsal fin for about half spine length) and reaching abdomen (above pelvic fin) ventrally; third orange band very broad (about twice orbit diameter), with pale blue (or whitish) edges, anterior margin extending obliquely (about 80° to body axis) from seventh dorsal-fin soft ray base to fifth anal-fin soft-ray base, posterior portion including entire dorsal-fin and anal-fin soft-rayed portions; posteriormost band on caudal peduncle, moderately broad (about half orbit diameter in 80–90 mm SL specimens), entirely orange with pale blue (or whitish) edges [anterior margin immediately behind third band (white area between bands very narrow), posterior margin along caudal-fin base], and single short saddle-like, blackish dorsal streak, its ventral tip not reaching (or just reaching but not extending below) lateral midpoint of caudal peduncle.

Snout brownish laterally and dorsally; iris brown (similar color as head band), pupil black. Dorsal fin entirely orange, with a single, narrow, pale-blue submarginal line; single moderately large (subequal to orbit; about twice orbit diameter if oval), circular (to strongly oval; Fig. 3B), black, ocellated spot, with pale-blue margin, on soft-rayed portion. Anal-fin spines, soft rays and membranes entirely orange with similar pale-blue submarginal line. Submarginal lines of dorsal-fin and anal-fin, and anterior border line of caudal-peduncle band, all apparently connected in lateral view. Pectoral-fin base broadly orange, rays and membranes translucent. Pelvic fin, including spine, dark brown (sometimes yellow tinged in large specimens; Fig. 3C). Caudal fin translucent, uppermost and lowermost rays and anterior half of membrane pale orange, gradually becoming dusky posteriorly (more yellowish in large specimens). Live individuals have almost the same color patterns as fresh specimens (see iNaturalist users & Ueda K. 2021a, b).

Color in alcohol. (Figs. 4A & B, 9A–F) Similar to fresh color pattern: head and body ground color brownish, yellow and orange coloration obscured, dark coloration retained; submarginal bluish lines on dorsal and anal fins, and bluish edges of body bands retained as blackish lines; pelvic fin uniformly dark brown (or black). Orange area of caudal-peduncle band becomes pale white, lacking melanophores (Fig. 9A–F).

Etymology. The specific name *calendula* is treated as a noun in apposition, being the generic name of plants in the daisy family Asteraceae (often known as marigolds), alluding to the characteristic orange band on the caudal peduncle of the new species..

Distribution and habitat. *Coradion calendula* is distributed off northwestern and northern Australia, from the NW shelf (WA) east to northern Cape York Peninsula (Qld), in the vicinity of the Torres Strait (Fig. 10). The species has also been collected from Kendrew Island, Dampier Archipelago, WA (USNM FIN 27791). Two underwater photographic records (iNaturalist and GBIF) and those of trawled specimens (provided by Chris Dowling; Fig. 8) from WA were also identified as this species. No other distribution records for the new species were found amongst underwater photographs (registered as *C. chrysozonus*) provided by GBIF from Southeast Asia and the northeastern coast of Australia facing the Coral Sea, indicating that *C. calendula* is probably not distributed in shallow waters accessible to scuba divers.

All examined specimens of *C. calendula* were collected by demersal trawl from 11–128 m deep (Fig. 11A, B) off northwestern Australia, most of the specimens being obtained from depths greater than 34 m (Fig. 10B). However, since Allen & Steene (1987) published a photograph of a 6 cm-SL juvenile (as *C. chrysozonus*) from North West Cape, WA, in a depth of 3 m, it is clear that juveniles of *C. calendula* also occur in shallow coastal waters in that region. In fact, the collection depth of examined specimens of *C. calendula* generally tended to be shallower towards the northeast, and specimens collected from 11–23 m depth in the Gulf of Carpentaria and in the Torres Strait (135°–145° E), corresponded to the maximum depths recorded from those areas (Fig. 10B). The closely allied congener, *C. chrysozonus*, distributed widely in the eastern Indian and western Pacific Oceans, occurs sympatrically (at similar depths) with *C. calendula* in the Torres Strait area (Fig. 10A), although the general depth preference of the two species differs in their main distributional areas: *C. chrysozonus* inhabits

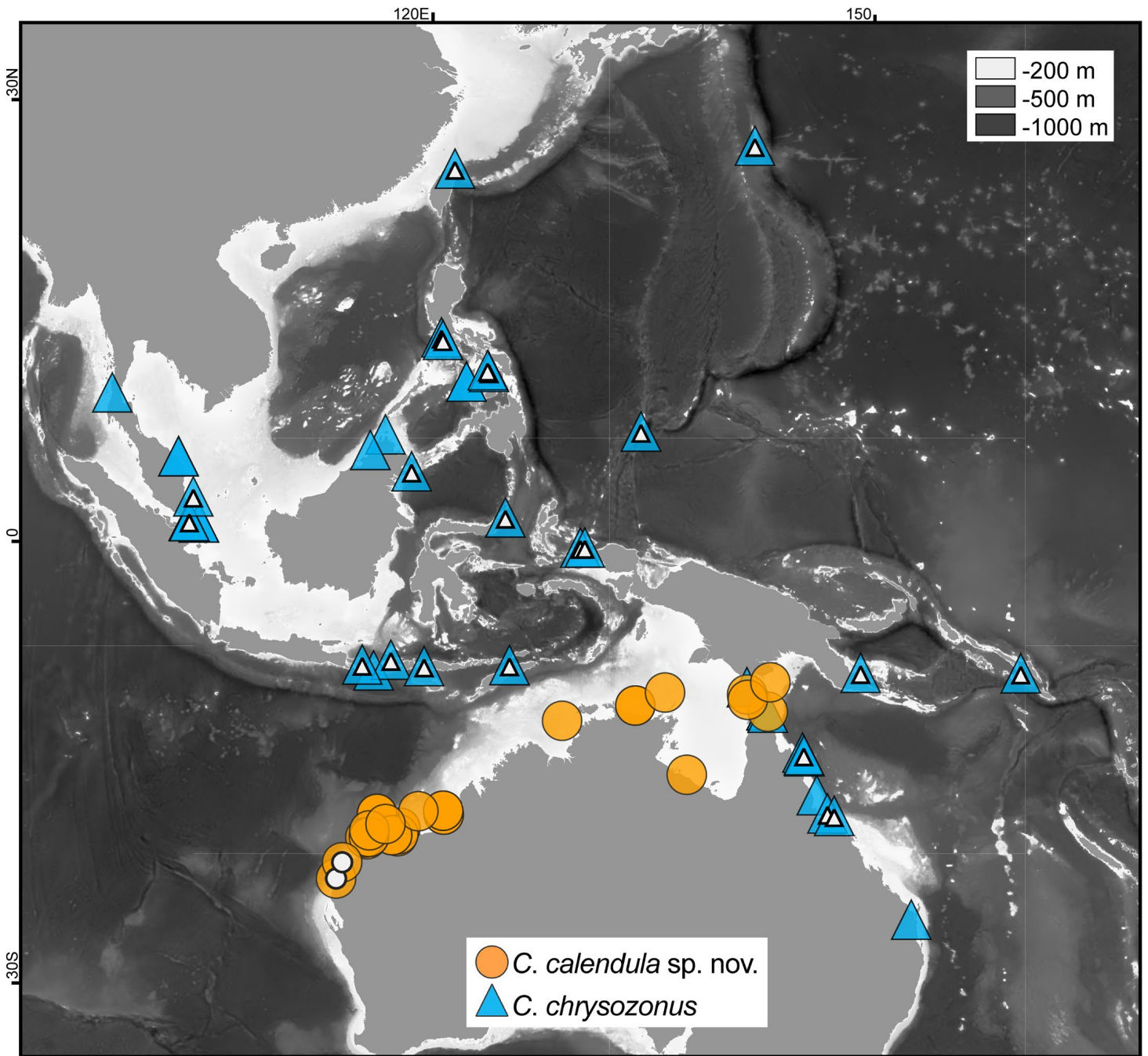


Figure 10. Map showing distributions of *Coradion calendula* sp. nov. (circles) and *C. chrysozonus* (triangles). Open symbols: literature-based or photographic records; closed symbols: specimen-based records.

shallower waters from 3–60 m (Allen & Erdmann 2012), Australian specimens examined herein (n=6) from 0–20 m. Moreover, the collection depth of the examined specimens of *C. calendula* (mostly from the NW shelf) tended to be deeper with increasing specimen size, although examples from the Gulf of Carpentaria and Torres Strait did not conform to that allometric growth/habitat depth relationship (Fig. 11C).

Individuals of *C. chrysozonus* feed on sponge tissue and benthic invertebrates (Nagelkerken et al. 2009). Since no differences in dentition were apparent between the two species, *C. calendula* likely has a similar dietary habit. However, because the pelvic fins are associated with maneuverability while swimming, rather than propulsion (Harris 1938), the difference in pelvic-fin shape between large adults of *C. calendula* and *C. chrysozonus* (see below) may reflect a difference in their habitat, such as structural complexity of the coral reef. The larvae of *Coradion* are not well known (Leis & Carson-Ewart 2004); those illustrated by Oka & Kinoshita (2014) are identified as either *Chelmon* Cloquet, 1817 or *Coradion*.

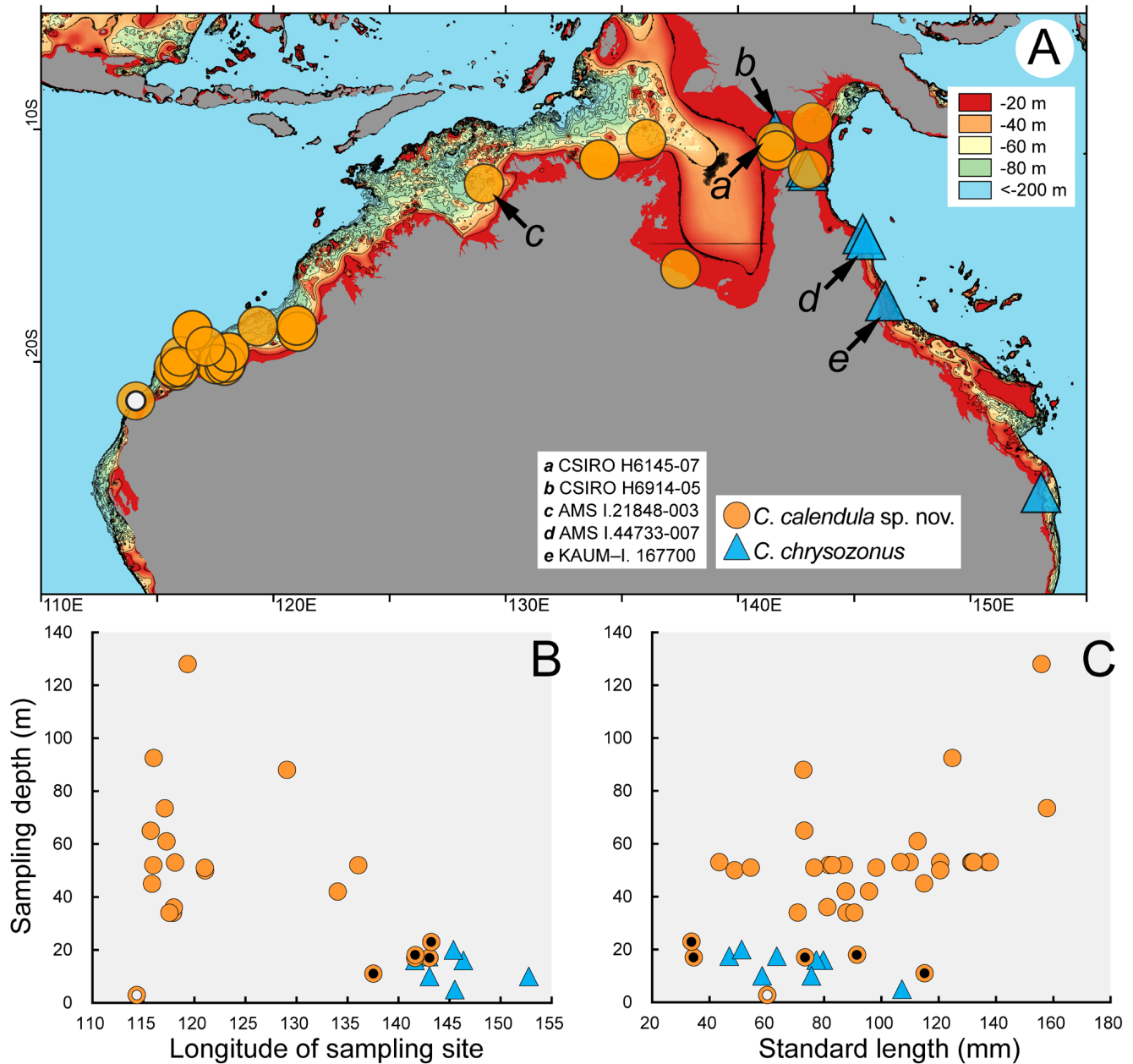


Figure 11. Distributional map (A), and relationships of sampling depth (m) to longitude (degree) of sampling site (B) and standard length (mm) (C) in *Coradion calendula* sp. nov. (circles) and *C. chrysozonus* (triangles). Thin lines in (A) indicate the 20 m bathymetric line; symbol for *C. calendula* with white center indicates record by Allen & Steene (1987) (also in B and C); letters indicate localities of (a) CSIRO H6145-07, (b) CSIRO H6914-05, (c) AMS I.21848-003 (1 of 2 specimens), (d) AMS I.44733-007, and (e) KAUM-I. 167700. In B and C, plots of *C. calendula* with black centers indicate specimens from Gulf of Carpentaria and Torres Strait. Specimens without sampling depth information not used in B and C.

Taxonomic status of *Chaetodon labiatus*. Three valid species of *Coradion*, including *Co. altivelis*, *Co. chrysozonus* and *Co. melanopus*, are readily distinguished from each other by the number of dorsal-fin spines, shape of the dorsal fin, and color pattern (see Pyle 2001, Allen & Erdmann 2012). Although Kuiter (2002) reported *Coradion* cf. *altivelis* from the Andaman Sea and Indonesia, its taxonomic status is uncertain.

Chaetodon guttatus Gronow in Gray, 1854, described solely from the holotype (BMNH1853.11.12.72; Fig. 12A) from the Indian Ocean (precise locality unknown), is invalid, being preoccupied by *Chaetodon guttatus* Bloch, 1787 (Siganidae) (see Fricke et al. 2021). The holotype is identifiable as either *Co. chrysozonus* or the present new species but further identification is impossible due to its poor condition. *Coradion fulvocinctus* Tanaka, 1918, described from the holotype (ZUMT 59858, 140 mm SL; Fig. 12B) from Wakayama Prefecture, Japan, is synonymized under *Co. altivelis* (see Burgess 1978, Allen 1985, this study). Although the holotype

of *Co. fulvocinctus* has IX dorsal-fin spines (typically VIII in *Co. altivelis*; see Pyle 2001), other characters, including a high dorsal fin without an ocellated spot and the absence of a band on the frontal surface of the thorax, are consistent with *Co. altivelis*.

The remaining nominal species assigned to *Coradion*, *Chaetodon labiatus* Cuvier (ex. Kuhl & Van Hasselt) in Cuvier & Valenciennes, 1831 has been regarded as a junior synonym of *Co. chrysozonus*. However, type specimen(s) of the former are not known (Bauchot 1963). To clarify the status of the present new species (see below), the synonymization of *Ch. labiatus* with *Ch. chrysozonus* is reviewed here. In 1820–1823, Heinrich Kuhl and Johan Coenraad van Hasselt collected many fish specimens in Indonesia, which were sent to Leiden, whereupon C.J. Temminck arranged for the fish collections and drawings made by Kuhl and Van Hasselt to be studied by George Cuvier and Achille Valenciennes (Alfred 1961, Roberts 1993). Cuvier and Valenciennes described many new fish species based on this material in their volumes of *Histoire Naturelle des Poissons*, among them being *Chaetodon chrysozonus* Cuvier in Cuvier & Valenciennes (1831) (on page 82) and *Chaetodon labiatus* (page 83) (based on Kuhl and Van Hasselt's material from Java, and accompanied by a detailed description of fresh

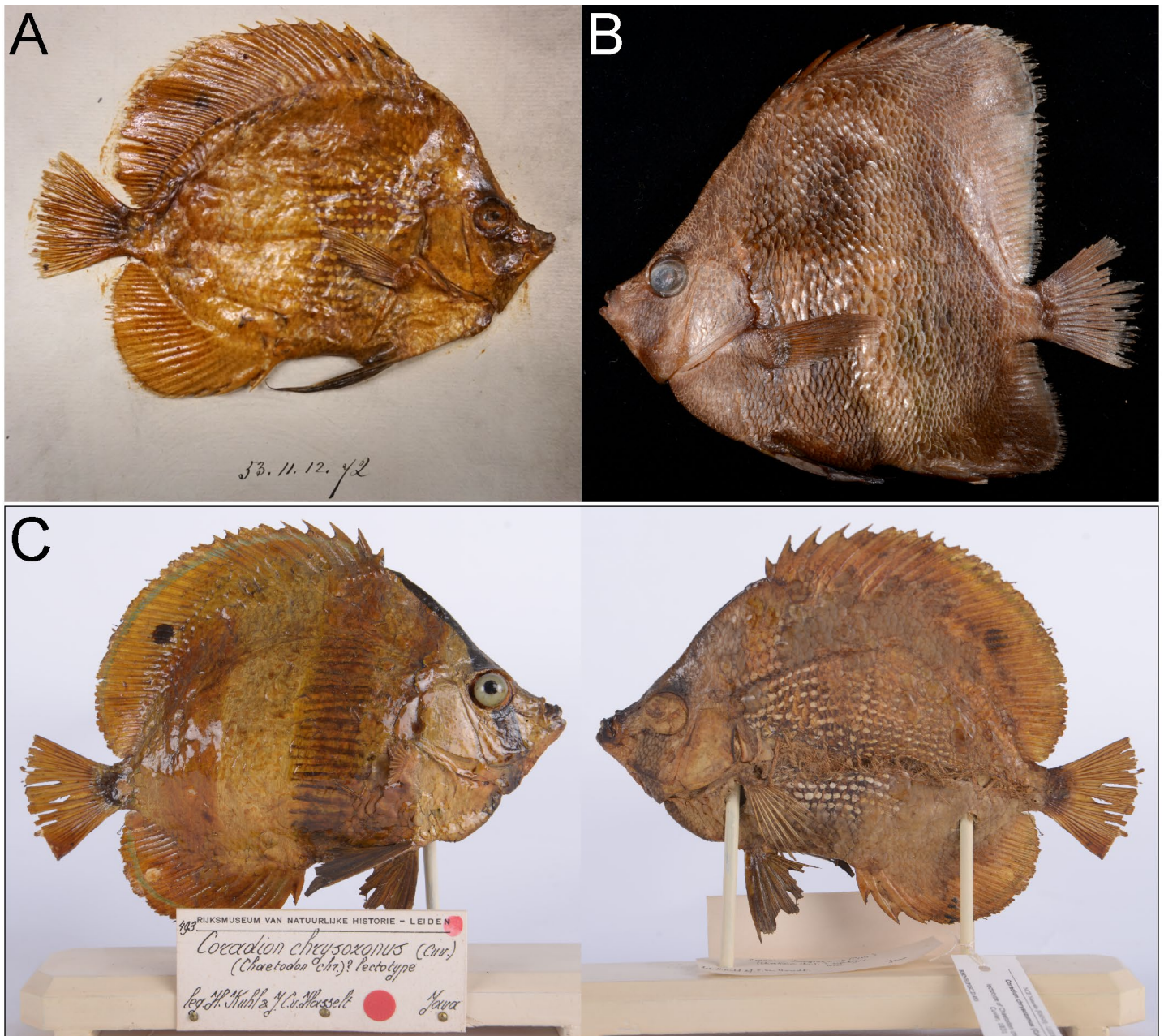


Figure 12. Holotype of *Chaetodon guttatus* (A), BMNH 1853.11.12.72, SL not determined; holotype of *Coradion fulvocinctus* (B), ZUMT 59858, 140 mm SL; and lectotype of *Chaetodon chrysozonus* (C), RMNH.PISC.D. D493, ca. 120 mm SL. Photos by Keita Koeda (formerly ZUMT) (B); Esther Dondorp (RMNH) (C).

color for each species). Although Cuvier distinguished *Ch. labiatus* from *Ch. chrysozonus* by minor color pattern differences, subsequent researchers (e.g., Bleeker 1877) synonymized the two species. Subsequently, Bauchot (1963) reviewed the chaetodontid type specimens described by Cuvier, listing six syntypes of *Ch. chrysozonus*, including five Kuhl and Hasselt (Java) specimens (MNHN 0000-9689, RMNH.PISC.D. D491–D494), and a single old MNHN specimen lacking locality data (MNHN A3832). The last-mentioned was included in the description of *Ch. chrysozonus*, with reference to a manuscript name, “*Chaetodon enneacanthus*”, which is unavailable due to the lack of a description (see ICZN 1999 Art. 12.1, Fricke et al. 2021). Bauchot (1963) selected RMNH.PISC.D. D493 as the lectotype (Fig. 12C, D), the other syntypes automatically becoming paralectotypes (Fig. S2A–E). In contrast, Bauchot (1963) could not determine the location of the type specimen(s) of *Ch. labiatus*.

Cuvier’s description of *Ch. labiatus* stated that it was based on Kuhl and Hasselt’s material, the detailed fresh color description and type specimen measurement (5 inches) supporting this. The type specimen(s) of *Ch. labiatus* are likely to have been included in the five aforementioned Javan specimens, including the lectotype of *Ch. chrysozonus*. Based on their photographs, the five specimens are identifiable as representing a single species, regarded herein as *Coradion chrysozonus* and not *Co. calendula*, by virtue of having a broad black band on the caudal peduncle and/or a relatively wide interspace between head bands on the mid-ventral portion of the interopercle (see Comparisons). A skeletal specimen of *Coradion* labeled “Kuhl and Hasselt’s collection” is held at RMNH (RMNH.PISC.S.27; Fig. S2F). Although the specimen may be a syntype of either *Ch. chrysozonus* or *Ch. labiatus*, Bauchot (1963) did not mention it. In any case, the dorsal-fin-ray count of IX, 29 is equivocal. However, because Cuvier clearly described *Ch. labiatus* as similar to *Ch. chrysozonus* in having a black ocellus (band) laterally on the caudal peduncle, a diagnostic character of *Co. chrysozonus* (vs. an orange band in *Co. calendula*), along with other color descriptions of *Ch. labiatus* also being largely consistent with *Co. chrysozonus*, *Chaetodon labiatus* is herein regarded as a junior synonym of *Chaetodon chrysozonus*. A single specimen (CSIRO H8921-01) of *Co. chrysozonus* from Lombok, vicinity of Java, was morphologically and genetically identified as the species; photographic records of *Co. chrysozonus* from Indonesian waters all have the typical color pattern of the species.

Comparisons. *Coradion calendula* and *C. chrysozonus* share the following diagnostic characters: IX dorsal-fin spines [vs. usually VIII (IX in ZUMT 59858) in *C. altivelis*; and X in *C. melanopus*]; dorsal-fin contour rounded, not elevated (vs. elevated in *C. altivelis*); interopercular bands connected to a single broad band on frontal surface of thorax (Fig. 5) (vs. band on thorax absent in *C. altivelis* and *C. melanopus*); dorsal fin ocellated spot present throughout life (vs. obscured in large adult *C. altivelis*); and anal-fin ocellated spot absent (vs. present in *C. melanopus*) (Burgess 1978, Pyle 2001, this study). Comparisons of morphology (configuration of fin rays, body proportions, and pelvic-fin shape), color pattern, and mtDNA COI and CR sequences between *C. calendula* and *C. chrysozonus* are discussed below.

Configuration of median fin soft rays. *Coradion calendula* has a slightly higher range of dorsal- and anal-fin soft rays [28–32 (modally 29) and 20–22 (modally 21), respectively], compared with *C. chrysozonus* [27–30 (28) and 18–21 (20); Table 4]. Fig. 13 indicates that a combination of the soft-ray numbers of both fins accentuates the difference between the two species. Twelve of 43 specimens (28%) of *C. calendula* have 29 dorsal- and 21 anal-fin soft rays [vs. 4 of 41 specimens (10%) of *C. chrysozonus* with the same conformation], whereas 18 of 41 specimens (44%) of *C. chrysozonus* specimens have 28 dorsal- and 20 anal-fin soft rays, compared with two of 43 specimens (5%) of the former. No significant relationship was apparent between soft-ray numbers and geographic locality.

Body proportions. *Coradion calendula* also differs from *C. chrysozonus* in having a slightly narrower body at the pelvic-fin origin (width 7.5–8.8% of SL in the former vs. 8.4–9.8% of SL in the latter; Fig. 1A) in specimens >40 mm SL. Furthermore, the bands on the interopercular ventral surfaces form a sharply pointed “V” in *C. calendula* (Fig. 5A–C) but are more separated in *C. chrysozonus* (Fig. 5D–F) [interspace width of bands in the former slightly narrower than in the latter (0.0–0.9% of SL vs. 0.5–2.4% of SL in specimens >80 mm SL; Fig. 1B)]. The difference in the interopercular bands is probably related to differences in the anteroventral projection of the thorax (sharply peaked in *C. calendula* vs. broader and more rounded in *C. chrysozonus*).

Pelvic-fin shape. The pelvic-fin shape was found to differ between large specimens (>80 cm SL) of the two species, the posterior contour of the spread fin (angle between the spine and body axis 80–90°) being almost straight

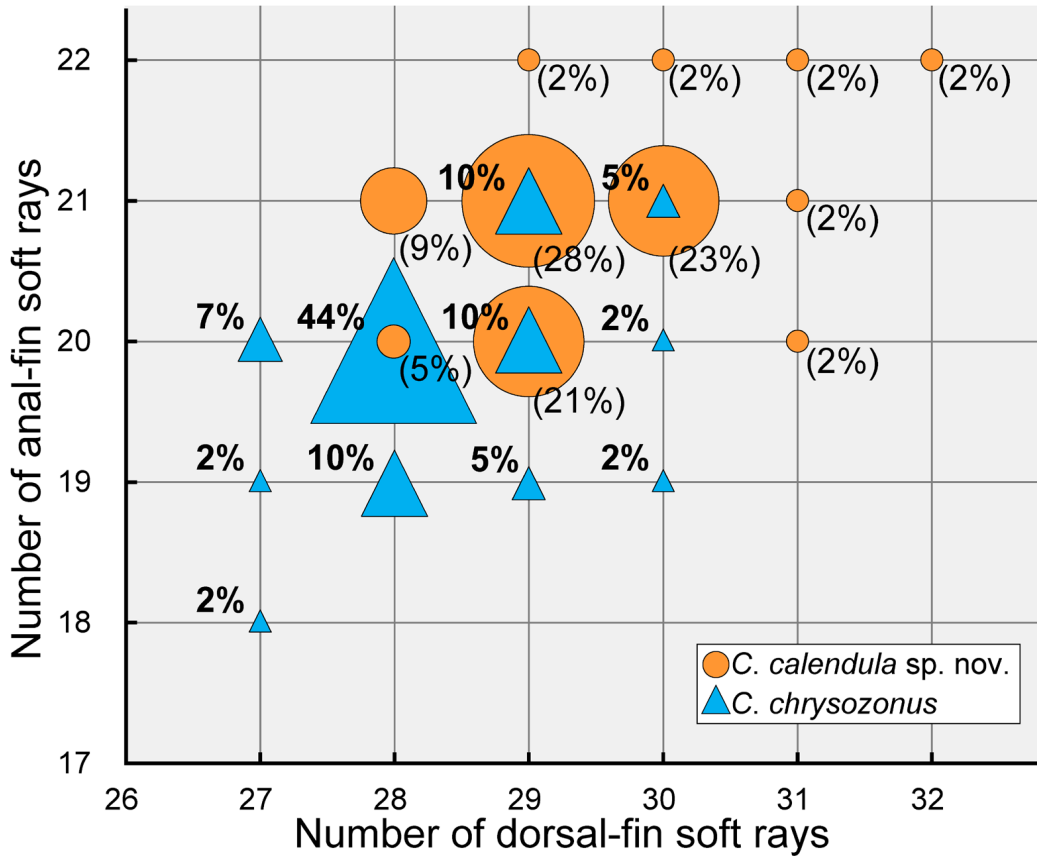


Figure 13. Relationship between numbers of dorsal- and anal-fin soft rays in *Coradion calendula* sp. nov. (circles) and *C. chrysozonus* (triangles). Symbol size corresponds to number of specimens. Percentage values for *C. calendula* shown in parentheses; for *C. chrysozonus* shown in bold type.

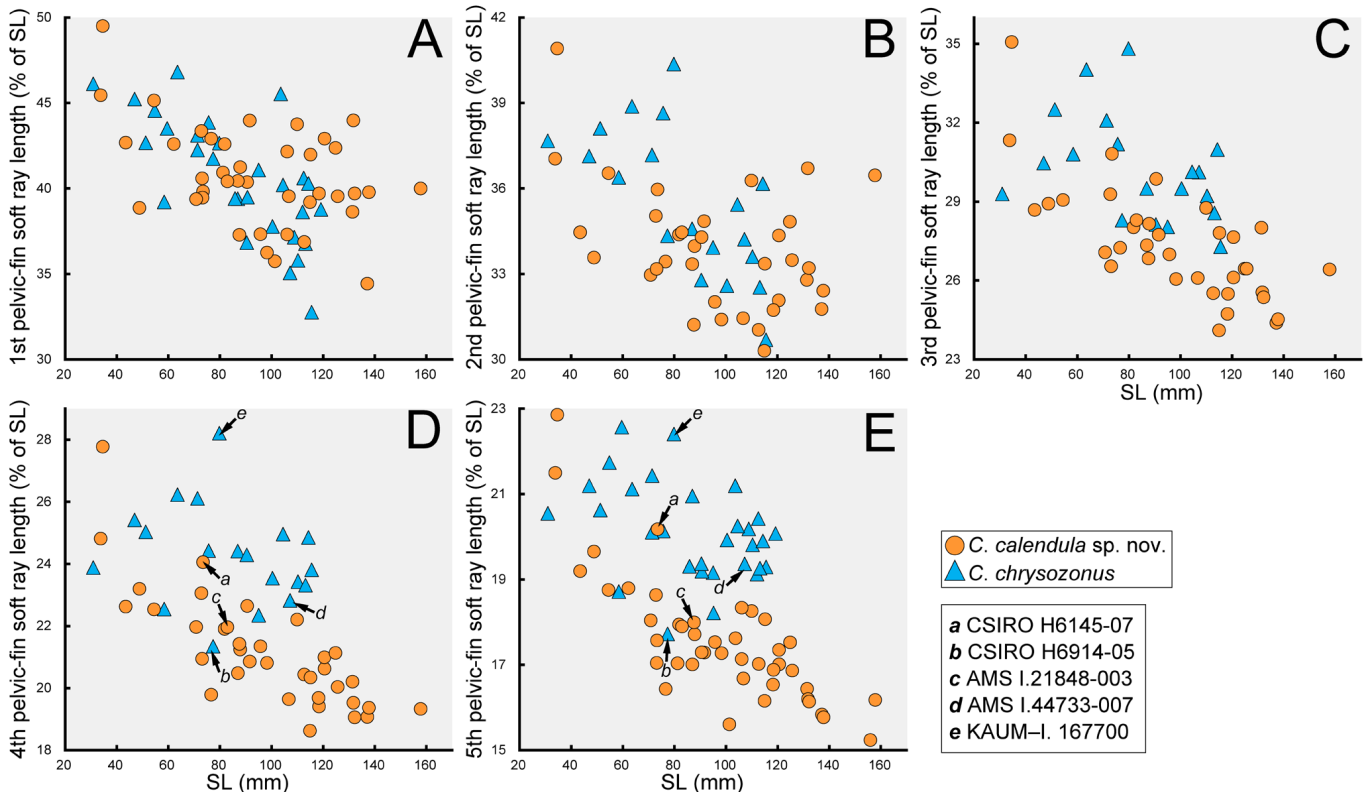


Figure 14. Relationships between length of 1st (A), 2nd (B), 3rd (C), 4th (D), and 5th (E) pelvic-fin soft rays (all as % of SL) and SL (mm) in *Coradion calendula* sp. nov. (circles) and *C. chrysozonus* (triangles). In D and E, arrows indicate (a) CSIRO H6145-07; (b) CSIRO H6914-05; (c) AMS I.21848-003 (1 of 2 specimens); (d) AMS I.44733-007; (e) KAUM-I. 167700.

in *C. calendula* (Fig. 6A), but rounded and expanded posteriorly in *C. chrysozonus* (Fig. 6B). This difference was confirmed by traditional linear measurements, which indicated differences in relative lengths of the third, fourth and fifth pelvic-fin soft rays (% of SL) between the two species (Fig. 14C, D, E; Table 5), particularly in the fifth soft-ray length (15.2–18.3%, mean 17.0% in 81.2–157.8 mm SL-specimens of *C. calendula* vs. 18.2–21.2%, mean 19.9% in 79.8–119.2 mm SL-specimens of *C. chrysozonus*; Fig. 14E). In contrast, no differences were found in the first and second soft-ray lengths between the two species (Fig. 14A, B).

In the Principal Component Analysis (PCA), using traditional linear measurement-based geometric morphometric analysis (LM-GMA) (Fig. 14A), the first two principal components (PC) accounted for 82% of the total variance of the examined specimens, with 67% explained by PC1 and 15% explained by PC2. Among all of the principal components, the ranges of PC1 scores for *C. calendula* vs. *C. chrysozonus* differed significantly (Mann-Whitney U-test; $p < 0.001$). The loadings indicated that PC1 was influenced by landmark 3 (LM3: first soft-ray tip) and LMs 5–7 (third to fifth soft-ray tips), being related to the shape of the distal tip and posterior margin of the fin (see deformations implied by PC1 score in Fig. 15A). Plots of specimens examined for this analysis were moderately separated into two main clusters on PC1, with *C. calendula* forming a group with lower PC1 scores, and *C. chrysozonus*, a group with higher PC1 scores (Fig. 15A). The scatterplot of PC1 scores and SL (mm) indicated a correlation between them, with positive and negative allometries in *C. chrysozonus* and *C. calendula*, respectively (Fig. 15C). This indicated that small specimens (< ca. 80 mm SL) of both species shared a similarly shaped pelvic fin (see Fig. 15F, G). For larger specimens, *C. chrysozonus* have the fin's posterior contour expanded without a sharply pointed distal tip, vs. the contour not expanded and with a sharply pointed distal tip in *C. calendula* (see Fig. 15H, I).

In the PCA using photograph-based geometric morphometric analysis (P-GMA), the first four principal components accounted for 76% of the total variance. The ranges of PC1 and PC4 scores differed significantly between the two species (Mann-Whitney U-test; $p < 0.001$ for PC1 and $p = 0.008$ for PC4), PC1 and PC4 explaining 28% and 13% of the total variance. The loadings showed that PC1 was related to the shape of the distal tip and posterior margin of the fin (as did PC1 of LM-GMA). PC4 heavily loaded the position of LM6 (fourth soft ray tip; backward to forward), which was also related to the posterior fin contour. The plots of specimens examined for this analysis formed essentially two main clusters on both PC1 and PC4, with *C. calendula* forming a group with relatively lower PC1 and higher PC4 scores, and *C. chrysozonus*, with higher PC1 and lower PC4 scores (Fig. 15B). A weak negative correlation was found between PC1 score and SL (mm) in *C. calendula* specimens, but not in *C. chrysozonus* (Fig. 15D). PC4 scores decreased with growth (SL) in both species, the above negative correlation being stronger in *C. chrysozonus* compared with *C. calendula* (Fig. 15E).

TABLE 5

Comparisons of pelvic-fin soft ray lengths (PL; all % of SL) between
Coradion calendula sp. nov. and *C. chrysozonus*

	<i>C. calendula</i> sp. nov.		<i>C. chrysozonus</i>	
	Specimens >80 mm SL	All specimens	Specimens >80 mm SL	All specimens
SL (mm)	81.2–157.8	33.8–157.8	79.8–119.2	30.9–119.2
1st PL	34.4–44.0 (28)	34.4–49.5 (40)	32.8–45.5 (18)	32.8–46.8 (29)
2nd PL	30.3–36.7 (25)	30.3–40.9 (35)	30.7–40.4 (11)	30.7–40.4 (19)
3rd PL	24.1–29.9 (26)	24.1–35.1 (36)	27.3–34.8 (11)	27.3–34.8 (19)
4th PL	18.6–22.7 (26)	18.6–27.8 (36)	22.3–28.2 (11)	21.3–28.2 (19)
5th PL	15.2–18.3 (32)	15.2–22.9 (44)	18.2–22.4 (19)	17.7–22.6 (30)

Number of specimens in parentheses

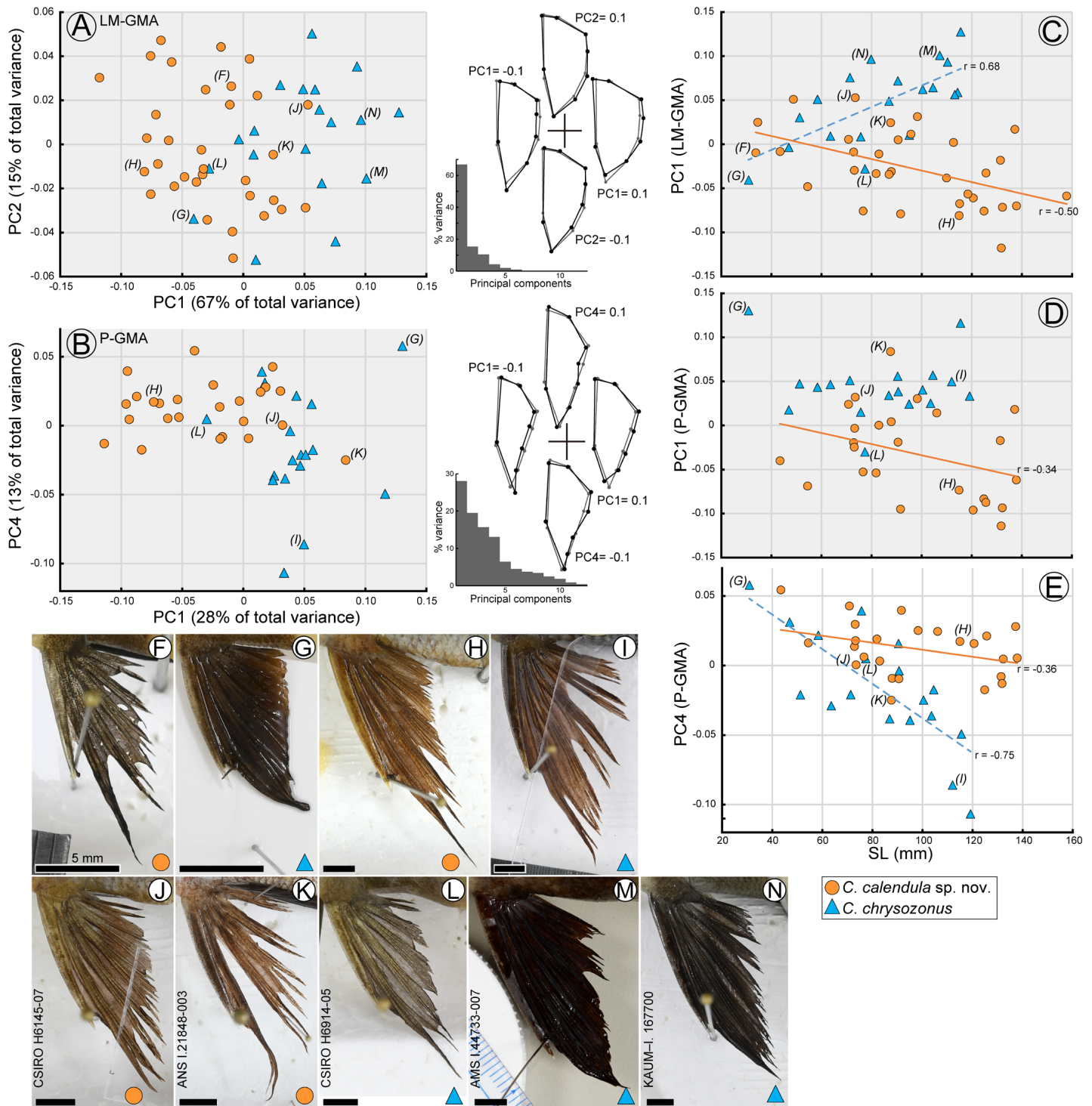


Figure 15. Scatterplots of principal component 1 (PC1) and PC2 from geometric morphometric analyses based on liner-measurements (LM-GMA) (A) and photographs (P-GMA) (B), with column graphs showing variance (%) of PC1–12, and wireframe visualization of variation along PC1 and PC2 from LM-GMA and PC1 and PC4 from P-GMA (gray landmarks represent configuration of average shape, black landmarks represent one approximate extreme of variation on that axis); relationships of PC1 from LM-GMA (C), PC1 from P-GMA (D), and PC4 from P-GMA (E) to SL (mm); and pelvic fins of preserved specimens of *Coradion calendula* sp. nov. (circles; F, H, J, K) and *C. chrysozonus* (triangles; G, I, L–N). F: CSIRO H8922-01, 33.8 mm SL, Torres Strait, Qld (right side reversed; not used for P-GMA); G: KAUM-I. 80153, 30.9 mm SL, Malaysia; H: NSMT-P 121518, 114.9 mm SL, NW coast of Australia; I: HUMZ 129298, 112.0 mm SL, South China Sea (not used for LM-GMA); J: CSIRO H6145-07, 73.4 mm SL, Torres Strait, Qld; K: ANS I.21848-003, 1 of 2 specimens, 87.6 mm SL, Arafura Sea, NT; L: CSIRO H6914-05, 77.3 mm SL, Torres Strait, Qld; M: AMS I.44733-007, 107.2 mm SL, Lizard Island, Qld (not used for P-GMA; photo by Kyoji Fujiwara); N: KAUM-I. 167700, 79.8 mm SL, Great Barrier Reef, Qld. Italic type (F–N) in scatterplots correspond to similarly-labelled pelvic-fin photographs. Photographs of G–L used for P-GMA. Bars in photographs indicate 5 mm.

The PCA utilizing both LM- and P-GMA confirmed the differences in pelvic-fin shape between large specimens of the two species noted during the direct visual examination. As stated above, the difference in pelvic-fin shape (reflected also in fin-surface area) may be related to a habitat difference between the species. A similar difference in pelvic-fin shape (rounded vs. straight posterior contour) occurs also in the chaetodontid genus *Chelmon* [*Chelmon mulleri* Klunzinger, 1879 vs. *Chelmon marginalis* Richardson, 1842 and *Chelmon rostratus* (Linnaeus, 1758)] (see Burgess 1978, Randall's Fish Photos: <http://pbs.bishopmuseum.org/images/JER/>). In the PCA plots, morphologically and genetically intermediate specimens (discussed below; Fig. 15J–M) were mainly found in areas where the two species groups overlapped.

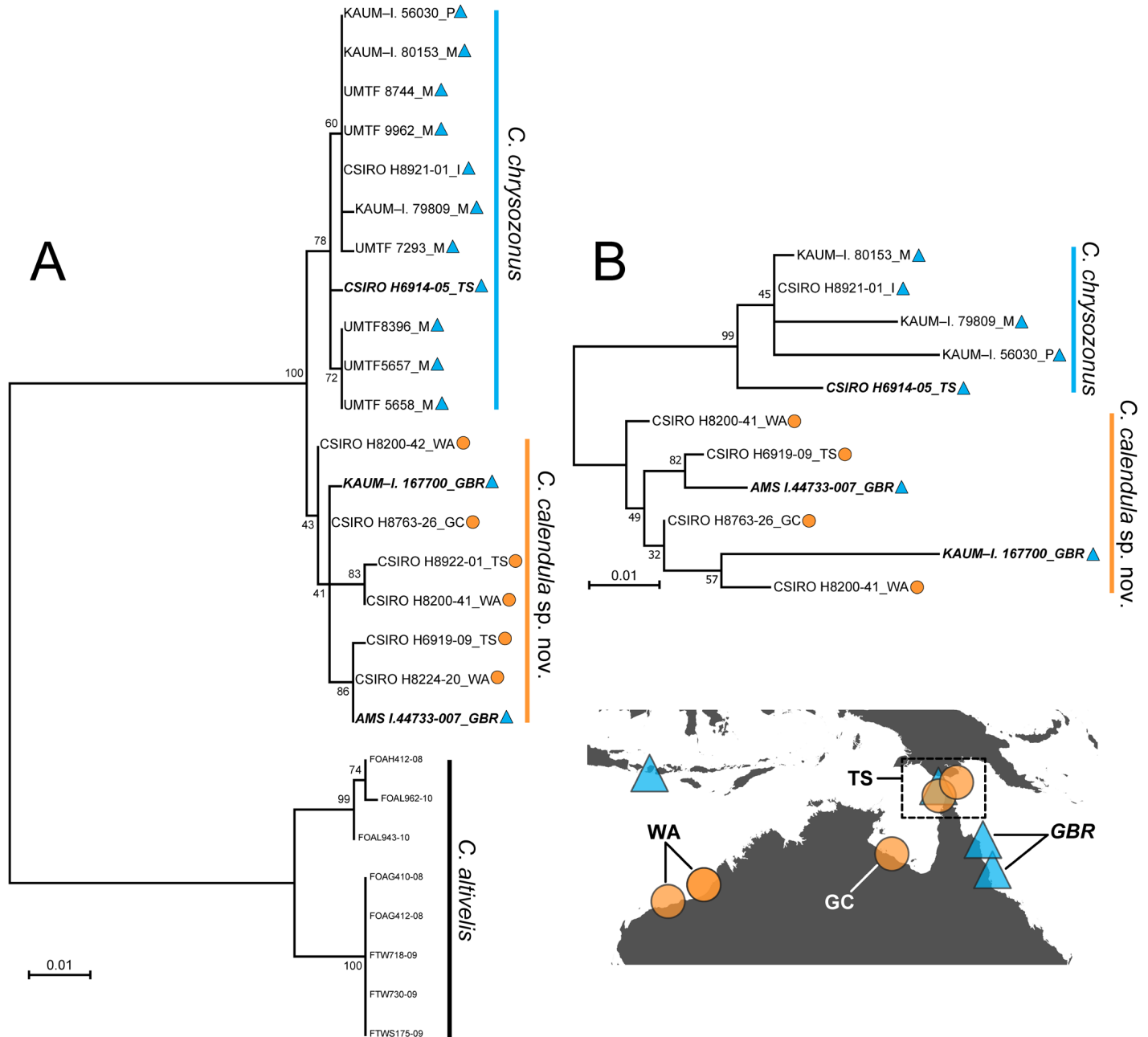


Figure 16. Molecular phylogenetic trees by Maximum likelihood method based on mtDNA COI (526 base pairs) (A) and control region (374 base pairs) (B) sequences of *Coradion calendula* sp. nov., *C. chrysozonus*, and *C. altivelis* (not available for B). Numbers at branches indicate bootstrap probabilities in 1000 bootstrap replications. Samples represented by catalog number of specimens (*C. calendula* and *C. chrysozonus*) or accession number (*C. altivelis*), locality, and identification based on specimens (circles and triangles indicate *C. calendula* and *C. chrysozonus*, respectively). Locality abbreviations: P: Philippines; M: Malaysia; I: Indonesia; TS: Torres Strait; WA: North West Shelf, Western Australia; GBR: Great Barrier Reef; GC: Gulf of Carpentaria. Localities in Australia shown on map (right-bottom). Morphologically and genetically intermediate specimens indicated by bold type (italics).

Color pattern. The color pattern of *C. calendula* includes an orange caudal-peduncle band when fresh (obscured in preserved specimens) with a small, saddle-like, blackish dorsal streak, compared with a broad, brown-to-black circumpeduncular band (pentagonal or oval in lateral view) in large adult *C. chrysozonus* (Figs. 3, 4, 7, 9, & S1).

Small juveniles (<80 mm SL) of the two species, even if preserved, can be identified by the color and shape of the caudal-peduncle band. A fresh 49.8 mm-SL specimen of *C. calendula* has a pale-yellow band (Fig. 9D), whereas a 34.6 mm-SL specimen has a dusky orange band (Fig. 9A). However, the fresh color of small juvenile *C. chrysozonus* is available only for a 30.9 mm-SL specimen, which has a gray-margined, yellow-green band on the caudal peduncle (Fig. 9G). Although the fresh coloration of 40–60 mm-SL examined specimens of *C. chrysozonus* was not recorded, underwater photographs (Fig. 7B–D) indicated that juveniles of the species have a blackish or brownish caudal-peduncle band, rather than orange or yellow. Preserved juvenile specimens of *C. calendula* all have a whitish band margined by dense melanophores on the caudal peduncle (Fig. 9A–D), with no melanophores within the band (although some are present in 30 mm-SL specimens, they are not densely distributed; Fig. 9A, B). In contrast, all juvenile specimens of *C. chrysozonus* have a uniformly pigmented dark band on the caudal peduncle. Although the band sometimes became paler in preserved specimens (Fig. 9I), the posterior portion of the peduncle has minute densely scattered melanophores.

Molecular analysis. Despite the well-defined morphological and color-pattern differences between *C. calendula* and *C. chrysozonus*, the COI and CR mtDNA sequences are not markedly different (Fig. 16), although most samples of the two species fell into separate clades in the COI and CR regions (with relatively low probabilities for COI). The sequence differences (uncorrected p-distance) between the two clades in the COI and CR regions are 0.008–0.019 (mean 0.013) and 0.029–0.075 (mean 0.048), respectively, that in the COI region being much less than that between *C. altivelis* and the above two species (0.097–0.106, mean 0.101). Several individuals with discordant phenotypic identification (morphology and color pattern) and mtDNA lineage may represent hybrids.

A specimen of *C. chrysozonus* (CSIRO H6914-05; Fig. 17C, F) from Torres Strait, Australia, possessed a brownish caudal-peduncle band, as found in *C. chrysozonus*. However, the pelvic-fin shape of the former was consistent with that of *C. calendula*, rather than *C. chrysozonus* (see scatterplots of Figs. 14D, E, 15). This

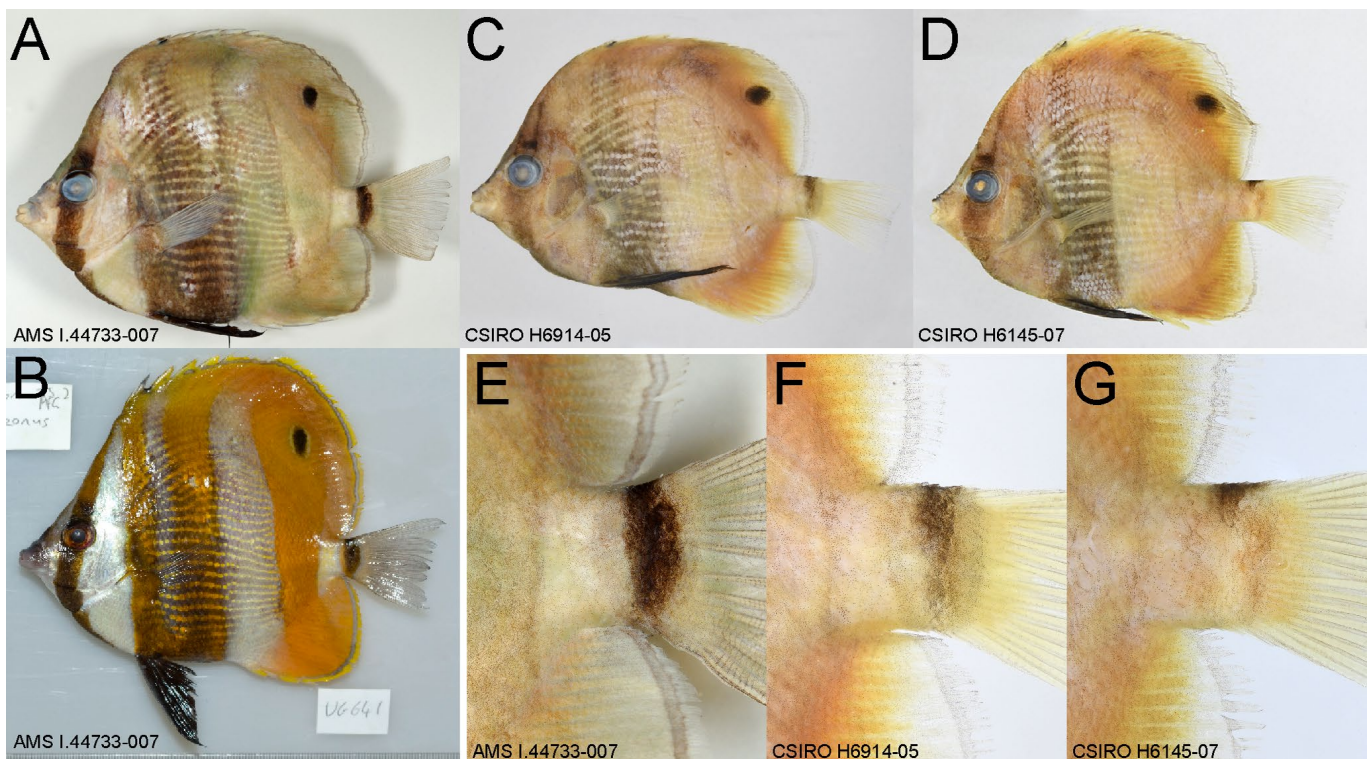


Figure 14. Preserved (A, C–G) and fresh (B) specimens of *Coradion chrysozonus* (A–C, E, F) and *C. calendula* sp. nov. (D, G). A, B, E: AMS I.44733-007, 107.2 mm SL, Lizard Island, Qld; C, F: CSIRO H6914-05, 77.3 mm SL, Torres Strait, Qld; D, G: CSIRO H6145-07, 73.4 mm SL, Torres Strait, Qld. Photos by K. Fujiwara (A and E) and AMS (B).

morphologically intermediate specimen fell within the clade of *C. chrysozonus*, based on both the COI and CR regions (Fig. 16). In contrast, examples of *C. chrysozonus* (AMS I.44733-007 and KAUM-I. 167700; Figs. 7E, 17A, B, E, S1X) from northeastern Australia possessed morphological and coloration characteristics of that species, but were included in the mtDNA lineage of *C. calendula*. Other examples of morphologically intermediate specimens tentatively identified as *C. calendula* [AMS I.21848-003 (1 of 2 specimens, 87.6 mm SL) and CSIRO H6914-05 (Fig. 17D, G)] are summarized in Table 6, although they were not available for DNA analyses. All of the morphologically and genetically intermediate specimens examined in this study had been collected from the Arafura Sea, Torres Strait, and Great Barrier Reef, where both species occur sympatrically (Figs. 11, 16).

Taxonomic status. Mitochondrial lineages inferred from the COI and CR sequences are consistent with two species, although the difference between the two lineages was not large and several possible hybrids were recognized. However, close examination of specimens resulted in the recognition of two forms with consistent differences in the color of the caudal-peduncle band, the interopercle band pattern, morphology (body proportions and pelvic-fin shape), and the modal number of dorsal-fin and anal-fin rays. These findings are consistent with two distinct species, and we describe the NW Australian population as a new species.

Although *C. calendula* inhabits relatively deep water (to ca. 130 m depth) on the NW shelf, the population at the northeastern extreme of the distributional range inhabits shallower water (ca. 20 m depth), due to the decreasing maximum depth of shallow coastal waters off northern Australia, including Torres Strait and adjacent areas. Such a shift in habitat depth allows an overlap in the depth ranges of *C. calendula* and *C. chrysozonus*, thereby driving hybridization between the two closely related species in that area.

TABLE 6

Condition of selected diagnostic characters and mitochondrial lineages in specimens of *Coradion calendula* sp. nov. and *C. chrysozonus* from Northern Australia

Specimen	Locality	Present ID	Morphology	Color Pattern	mtDNA lineage	
			P2 shape (Fig. 14)	CPB (Fig. 16)	COI (Fig. 17A)	CR (Fig. 17B)
AMS I.21848-003*	Arafura Sea	<i>C. calendula</i>	<i>chrysozonus</i>	<i>calendula</i>	n/a	n/a
CSIRO H6145-07	Torres Strait	<i>C. calendula</i>	<i>chrysozonus</i>	<i>calendula</i>	n/a	n/a
CSIRO H6914-05	Torres Strait	<i>C. chrysozonus</i>	<i>calendula</i>	<i>chrysozonus</i>	<i>chrysozonus</i>	<i>chrysozonus</i>
AMS I.44733-007	Lizard I.	<i>C. chrysozonus</i>	<i>chrysozonus</i>	<i>chrysozonus</i>	<i>calendula</i>	<i>calendula</i>
KAUM-I. 167700	Great Barrier Reef	<i>C. chrysozonus</i>	<i>chrysozonus</i>	<i>chrysozonus</i>	<i>calendula</i>	<i>calendula</i>

*1 of 2 specimens (87.6 mm SL); n/a, not available; P2, pelvic fin; CPB, caudal peduncle band

Supplementary material and archive doi:

doi: <https://doi.org/10.5281/zenodo.7504805>:

DataSet_Coradion.xlsx: counts and measurements of examined specimens (page 1); list of distributional records of *C. calendula* and *C. chrysozonus* used for Figs. 10 and 11 (page 2).

doi: <https://doi.org/10.5281/zenodo.7504815>:

Supplemental FigureS1_Coradion.pdf: photographs of fresh specimens of *C. calendula* and *C. chrysozonus*.

Supplemental FigureS2_Coradion.pdf: photographs of para-lectotypes of *Ch. chrysozonus* and Kuhl & Hasselt's (Cuvier & Valenciennes, 1831) specimen of *Coradion* sp. (RMNH.PISC. S.27)

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