




Two new species of *Chromis* (Teleostei: Pomacentridae) from northwestern Australia and the southwestern Pacific Ocean, previously part of *C. fumea* (Tanaka, 1917)

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Abstract

The common coral-reef damselfish, *Chromis fumea* (Tanaka, 1917) was previously reported as widely distributed in the western Pacific Ocean and northwestern Australia, with disjunct populations in the northwestern Pacific, Western Australia, and the southwestern Pacific Ocean. The present investigation reveals the nominal species is composed of three distinct species, including two new species described herein, forming an anti-tropical species complex with *Chromis nitida*, from the Great Barrier Reef of Australia to southern New South Wales. The true *C. fumea* is mainly restricted to Japan and Taiwan, with vagrants ranging southward to Malaysia; it is characterized by a larger body size, a graded color pattern on the body, a small white spot at the base of the last dorsal-fin rays, and black upper and lower margins on the caudal fin. *Chromis nitida* is sharply bicolored with a black band from the eye to the tip of the soft dorsal fin and no posterior white spot. *Chromis norfolkensis*, n. sp. is described from 8 specimens, 47.5–83.3 mm SL, collected in the southwestern Pacific Ocean at Norfolk Island, northern New Zealand, and Chesterfield Bank, Coral Sea, with underwater photographic records from New South Wales and New Caledonia. It usually has more gill rakers than *C. fumea*, and the color pattern in life is diagnostic: adults are brownish above and whitish below, the transition relatively abrupt with a diagonal demarcation from the eye to a conspicuous small, rounded, white spot at the base of the last dorsal-fin rays; both the outer portion of the dorsal fin and the upper and lower margins of the caudal fin have prominent broad black bands with a bright blue-white edge. *Chromis sahulensis*, n. sp. is a smaller species, described from 86 specimens, 15.3–58.3 mm SL, from northwestern Australia. It has more gill rakers than *C. fumea*, and the color pattern is diagnostic: yellowish brown dorsally grading to paler grey-brown on the sides, with the white spot at the base of the last dorsal-fin rays more saddle-like and farther onto the upper caudal peduncle, and brownish bands along the upper and lower margins of the caudal fin. The mtDNA COI barcode sequence of *C. sahulensis* is 3.8% divergent from *C. fumea* from Taiwan and 5.15% from *C. nitida* from Queensland.

Key words: taxonomy, ichthyology, damselfish, coral-reef fishes, Indo-Pacific Ocean, phylogenetics, DNA barcoding

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Introduction

The pomacentrid genus *Chromis* Cuvier, 1814 is common on coral and rocky reefs throughout tropical and warm temperate seas. Previously, the genus was considered to include more than 100 species, the largest of nearly 30 genera in the family. However, a recent phylogenetic study (Tang et al. 2021), and the resultant provisional classification, provides a strong justification for splitting this group into at least three monophyletic genera, including *Azurina* Jordan & McGregor, 1898 (7 species; Atlantic, eastern Pacific, and Indo-West Pacific), *Pycnchromis* Fowler, 1941 (24 species; Indo-West Pacific), and *Chromis* (76 species; Atlantic, eastern Pacific, and Indo-West Pacific).

We review here the clade within the genus *Chromis* that includes *Chromis fumea* (Tanaka, 1917), hereafter “the *C. fumea* complex”. *Chromis fumea* was previously reported by Allen (1991) and Allen et al. (2015) from the western Pacific and eastern edge of the Indian Ocean including southern Japan, Taiwan, east coast of Malaysia, Indonesia (a misidentification), Australia (Western Australia and New South Wales), and northern New Zealand. However, the current study reveals a close complex of cryptic species inhabiting the region, with the nominal species mainly restricted to Japan and Taiwan, with apparent vagrants ranging southward to peninsular Malaysia. The species complex also includes *Chromis nitida* (Whitley, 1928) from eastern Australia and two undescribed species from northwestern Australia and the southwestern Pacific Ocean, respectively. The species in the complex exhibit very similar morphometric and meristic features, including 13 dorsal-fin spines; a pair of spiniform accessory caudal-fin rays; minute, but distinct, serrae on the margin of the preopercle; distinctive broad dark bands on the upper and lower margins of the caudal fin; and a black spot or blotch covering the fin portion of the pectoral-fin axil. Except for *C. nitida*, they are further characterized by a small but conspicuous white spot at the base of the last dorsal-fin rays. Modal gill-raker counts can be useful for identification, but the details of the color pattern in life are diagnostic. In addition, maximum size and geographic distributions (Fig. 1) assist in resolving the species, which exhibit mostly allopatric ranges.

The phylogenetic sister-relationship of *C. fumea* and *C. nitida* was revealed by Tang et al. (2021), whose detailed phylogenetic analysis of Pomacentridae was based on sequences of eight loci (three nuclear and five mitochondrial), spanning nine genes. The inclusion of these two species in the same clade is confirmed by unpublished BOLD sequence data involving the COI gene, which also shows that the new species from northwestern Australia is a member of this clade. Our present review includes expanded diagnoses for *C. fumea* and *C. nitida* and descriptions of the new taxa. We also include comparative data for *Chromis westaustralis* Allen, 1976, which does not belong to the mtDNA clade of the *C. fumea* complex, yet is similar in appearance and partially sympatric with the new species we describe from northwestern Australia.

Materials and Methods

Type specimens are deposited at the Australian National Fish Collection, Hobart, Tasmania (CSIRO), the Bernice P. Bishop Museum, Honolulu, HI, USA (BPBM), the Museum and Art Gallery of the Northern Territory, Darwin (NTM), and the Western Australian Museum, Perth, Australia (WAM). Comparative specimens examined came from the Australian Museum, Sydney (AMS).

Lengths of specimens are given as standard length (SL) measured from the anterior end of the upper lip to the base of the caudal fin (posterior edge of hypural plate); head length (HL) is measured from the same anterior point to the posterior edge of the opercle flap; body depth is the maximum depth taken vertically between the belly and base of the dorsal spines; body width is the maximum width just posterior to the gill opening; snout length is measured from the anterior end of the upper lip to the anterior edge of the eye; orbit diameter is the horizontal fleshy diameter, and interorbital width the least fleshy width; upper-jaw length is taken from the front of the upper lip to the posterior end of the maxilla; caudal-peduncle depth is the least depth, and caudal-peduncle length is the horizontal distance between verticals at the rear base of the anal fin and the caudal-fin base; lengths of fin spines and rays are measured to their extreme bases (i.e. not from the point where the ray or spine emerges from the basal scaly sheath); caudal-fin length is the horizontal length from the posterior edge of the hypural plate to a vertical at the tip of the longest ray; caudal concavity is the horizontal distance between verticals at the tips of the shortest to longest rays; pectoral-fin length is the length of the longest ray; pelvic-fin length is measured from the base of the pelvic-fin spine to the filamentous tip of the longest soft ray; pectoral-fin ray counts include the small

splint-like, uppermost rudimentary ray (the decimal figure “.5” appearing in the scale row count above and below the lateral line refers to a small truncated scale at the respective bases of the dorsal and anal fins); only the tube-bearing anterior lateral-line scales are counted, a separate count is given for the deeply pitted scales occurring in a continuous series midlaterally on the caudal peduncle; gill-raker counts include all rudiments and are presented as separate counts for the upper and lower limbs, as well as a combined count; the last fin-ray element of the dorsal and anal fins is usually branched near the base and is counted as a single ray. Counts and proportions in parentheses are the range for the paratypes, if different from the holotype. Proportional measurements are expressed as percentage of the standard length.

Genetic relatedness was assessed using sequences of the mtDNA COI marker available from the Barcode of Life Database BOLD (Ratnasingham & Hebert 2007, Ward et al. 2009) and all reported here are public on the database (<http://www.boldsystems.org>) and on GenBank. Sequence divergences between species are minimum interspecific p-distances (mean distances can disguise shared sequences and merged lineages). BOLD data include three *Chromis* sequences from Western Australia: we examined the specimens and identified two as one of our new species (CSIRO H8200-06 and H8344-05) and the other as *C. westaustralis* (CSIRO H6381-06).

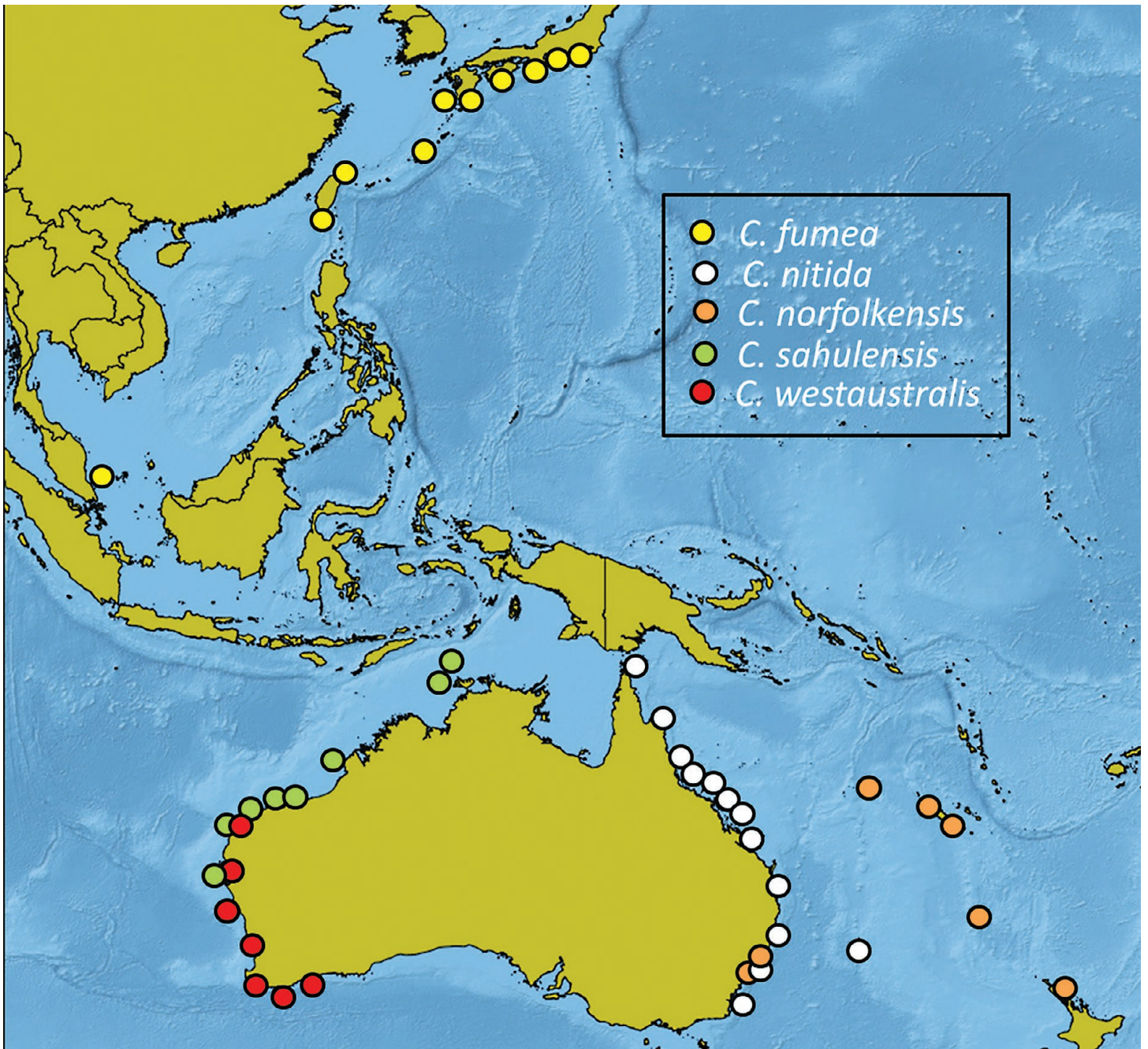


Figure 1. Map of the western Pacific Ocean with distributions indicated for the four species of the *Chromis fumea* complex, in addition to *C. westaustralis*.

Chromis fumea (Tanaka, 1917)

Smoky Chromis

mtDNA COI BIN BOLD:AAF3438 (<https://doi.org/10.5883/BOLD:AAF3438>)

Figures 2–4; Tables 1 & 3

Pomacentrus fumeus Tanaka, 1917: 9 (type locality: fish market in Nagasaki, Japan).

Chromis caudofasciata Shen & Chen, 1978: 33, fig. 12 (type locality: off Pa-dou-tzu, northern Taiwan).

Chromis fumea Allen 1991 (in part): 69 (southern Japan, Ryukyu Islands, Taiwan, and Malaysia).

Material examined. (32 specimens) Japan: BPBM 21113, 79.5 mm SL, Honshu, Shizuoka Prefecture, Izu Peninsula, Izu Marine Park; BPBM 22303, 56.5 mm SL, Ryukyu Islands, Okinawa, Sesoko Island; BPBM 22696, 12 specimens, 61.5–94.8 mm SL, southwestern Shikoku, Kochi Prefecture, Sukumo Bay. Taiwan: BPBM 18679, 3 specimens, 59.8–62.7 mm SL, Wanli District, Yehliu Cape.; BPBM 18695, 4 specimens, 54.0–60.2 mm SL, Wanli District, Yehliu Cape; BPBM 22700, 7 specimens, 56.7–67.4 mm SL, Wanli District, Yehliu Cape. Malaysia: BPBM 21962, 4 specimens, 32.9–40.9 mm SL, Pahang, northwest of Tioman Island, Pulau Chebeh.

Diagnosis. A species of *Chromis* with the following combination of characters: dorsal-fin elements XIII–XIV, 11–12 (usually 12); anal-fin elements II, 9–10 (usually 10); pectoral-fin rays 18–20 (usually 19); pelvic-fin rays 1, 5; principal caudal-fin rays 15; branched caudal-fin rays 13; procurrent spiniform caudal-fin rays 2; tubed lateral-line scales 16–19 (usually 18–19); gill rakers 7–11+18–23, total rakers 26–33 (usually 26–29).

Body depth 2.0–2.3, mean 2.2 in SL; body width 2.5–3.1, mean 2.7 in depth; head length 3.1–3.4, mean 3.3 in SL, snout length 3.7–4.7, mean 4.1 in HL; upper-jaw length 2.8–3.2, mean 3.0 in HL; orbit diameter 2.4–3.1, mean 2.7 in HL; width of bony interorbital 3.1–4.0, mean 3.5 in HL; caudal-peduncle depth 1.9–2.3, mean 2.2



Figure 2. *Chromis fumea*, freshly collected specimen, BPBM 22696, 91.6 mm SL, Shikoku, Japan (J.E. Randall).

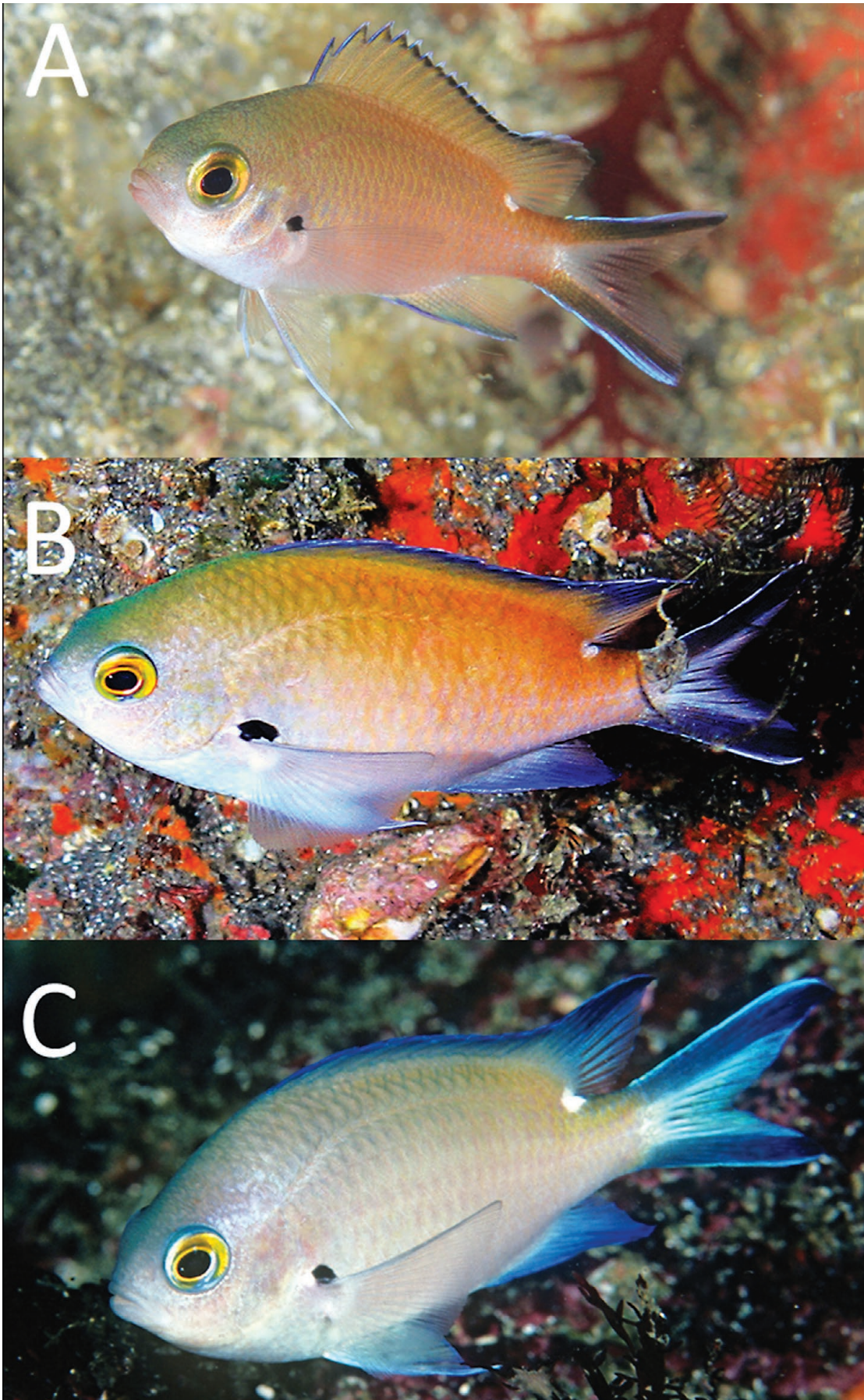


Figure 3. *Chromis fumea*, underwater photos: A) juvenile, approx. 35 mm SL, Suruga Bay, Honshu, Japan (K. Uchino); B) adult, approx. 80 mm SL, Suruga Bay, Honshu, Japan (K. Uchino); C) adult, approx. 90 mm SL, Izu Peninsula, Honshu, Japan (R.H. Kuiter).



Figure 4. *Chromis fumea*, preserved specimen, BPBM 22696, 91.6 mm SL, Shikoku, Japan (J.E. Randall).

in HL; caudal-peduncle length 1.7–2.2, mean 1.9 in HL; first dorsal-fin spine 2.8–3.9, mean 3.2 in HL; seventh dorsal-fin spine 1.6–2.1, mean 1.8 in HL; last dorsal-fin spine 2.0–2.5, mean 2.2 in HL; longest soft dorsal-fin ray 1.1–1.4, mean 1.3 in HL; first anal-fin spine 3.5–5.0, mean 4.2 in HL; second anal-fin spine 1.3–1.7, mean 1.5 in HL; longest soft anal-fin ray 1.2–1.6, mean 1.4 in HL; pectoral fin 3.0–3.5, mean 3.2 in SL; pelvic fin 2.7–3.3, mean 3.0 in SL; caudal fin deeply forked, length 2.3–3.5, mean 2.8 in SL.

Color in life. (Fig. 3) Adult light brown or brownish gray on back, gradually shading to whitish ventrally, scales on lower half with a broad yellowish brown margin, forming yellow stripes along each longitudinal scale row, often imparting an overall yellowish hue; head gray dorsally, silvery or silvery blue on cheek and opercle, sometimes with irregular yellowish markings, iris yellow; white spot (about a third of pupil size or less) at base of posteriormost dorsal-fin rays; dorsal fin brown, grading to dark brown or blue-black distally, darkest on outer two-thirds of anterior half of soft portion of fin, remainder of fin plain translucent and outer margin of entire dorsal fin narrowly pale blue; anal fin gray basally and broadly blue distally except membrane of last few rays clear and anterior edge of fin narrowly pale blue; caudal fin with a prominent black band and narrow blue-white outer margin along each lobe, central portion of fin whitish; pectoral fins translucent with a relatively large black patch covering both sides of axil, not invading dorsal edge of fin base, but extending slightly above fin base on body side of axil; pelvic fins whitish with a narrow, pale-blue anterior margin; Juvenile generally light brown with similar markings as adult; fins also similar, but lighter with translucent areas covering most of pelvic fins, posterior dorsal and anal fins, and central area of caudal fin.

Color when freshly collected. (Fig. 2) Brown on upper half, darkest on interorbital, nape, and anterior back, grading to yellowish-white ventrally; cheek and opercle silvery white; dorsal fin brown, darkest on distal portion of anterior soft rays; anal fin brown basally, grading to bluish gray on outer half; caudal fin with a whitish central portion and a broad dark-brown band on each margin, outer edge narrowly white; pelvic fins translucent whitish; pectoral fins slight dusky brownish dorsally, but mainly translucent with a black axil spot visible just above upper edge of fin base.

Color in alcohol. (Fig. 4) Generally medium to pale brown, including fins, with a broad dark band on each caudal-fin lobe; pectoral fin with a dark brown axil, mainly on fin side, but extending onto body side dorsally and extending slightly above upper edge of fin base.

Distribution and habitat. *Chromis fumea* ranges from Chiba Prefecture, central Honshu (east coast), Japan to the Ryukyu Islands, and southwards to Taiwan (Fig. 1). The only record south of Taiwan is from Tioman Island on the east coast (South China Sea) of peninsular Malaysia. Four small specimens (32.9–40.9 mm SL) were examined from this locality, which are possibly vagrants. Allen & Adrim (2003) reported it from Komodo Island, Indonesia, but this record was subsequently determined (Allen, unpublished) to be a misidentification of *Chromis pura* Allen & Randall, 2004. The preferred habitat consists of boulder substrates or mixed rock, rubble, and sand at depths between about 3 and 30 m.

Remarks. This species was previously reported (Allen 1991, Allen et al. 2015) from the western Pacific and eastern edge of the Indian Ocean including southern Japan, Taiwan, east coast of Malaysia, Indonesia (based on a misidentification), Australia (Western Australia and New South Wales), and northern New Zealand. However, the current study reveals a species complex inhabiting the region with the nominal species mainly restricted to Japan and Taiwan, with apparent vagrants ranging southward to peninsular Malaysia. In addition to *C. fumea*, the species complex contains two new species, one from northwestern Australia and the other from the southwestern Pacific (northern New Zealand, Norfolk Island, New Caledonia, Chesterfield Bank, and New South Wales), which are described below, and *C. nitida* (Whitley, 1928) from the Great Barrier Reef of Australia, ranging south to southern New South Wales. The members of the *C. fumea* species complex exhibit similar morphometric and meristic features (Table 1), including 13 dorsal-fin spines; a pair of spiniform accessory caudal-fin rays; minute, but distinct, serrae on the margin of the preopercle; distinctive broad dark bands on the upper and lower caudal fin margins; and a black spot or blotch in the pectoral-fin axil. Except for *C. nitida*, they are further characterized by a conspicuous small, bright white spot at the base of the last dorsal-fin rays. Modal gill-raker counts are of some utility for identification (Table 1), but color pattern details are diagnostic (Table 4). In addition, maximum size appears to differ and the species exhibit mostly allopatric ranges, except for *C. nitida* which overlaps at southern New South Wales, Australia with a new species (but both species are rare at that location) (Fig. 1).

Diagnostic features of *C. fumea* that are most useful for separating it from other members of the complex include a relatively low number of total gill rakers on the first branchial arch (26–33, usually 26–29, with a mean of 28.3) and several features of the color pattern: the color on the body is graded without a sharp transition and there is no lateral black band across the head and body, the bands along the caudal fin margins are black and strongly contrasted, the white spot at the base of the last dorsal-fin rays is relatively small and rounded, and the black pectoral-axil spot is particularly conspicuous in lateral view, especially the pronounced dorsal extension of the spot on the inner (body side) portion of the axil, which is clearly visible above the upper rim of the fin base. In addition, *C. fumea* has a relatively large body size (to about 95 mm SL). Although most specimens have fewer than 30 total gill rakers on the first arch there appears to be clinal variation with about one-third of Japanese specimens possessing 30–33 rakers. Likewise, 5 of 12 or about 42% of specimens from Japan have 14 dorsal spines compared to the usual count of 13.

TABLE 1

Meristic values for *Chromis fumea* species complex & *C. westaustralis*
[pectoral-fin rays and lateral-line scales counted on both sides when undamaged]

	Dorsal-fin soft rays				Anal-fin soft rays				Pectoral-fin rays					
	10	11	12	13	9	10	11	12	17	18	19	20		
<i>C. fumea</i>		7	25		1	31				11	45	7		
<i>C. nitida</i>		1	18	1	1	17	2			10	30			
<i>C. norfolkensis</i>			6	2		6	2			3	11	2		
<i>C. sahulensis</i>	1	4	49	2	2	53	1		3	19	83	7		
<i>C. westaustralis</i>		3	25			2	25	1		2	26	15		
	Lateral-line scales					Total gill-rakers								
	16	17	18	19	20	26	27	28	29	30	31	32	33	34
<i>C. fumea</i>	2	2	8	25		5	7	10	6	2	1		1	
<i>C. nitida</i>		15	22	3					3	10	4	3		
<i>C. norfolkensis</i>		3	7	4						1	7	3	4	1
<i>C. sahulensis</i>		1	51	32				6	11	19	17	1		
<i>C. westaustralis</i>		1	19	13	1		1	2	7	10	7	1		

Chromis nitida (Whitley, 1928)

Barrier Reef Chromis

mtDNA COI BIN BOLD:AAO0792 (<https://doi.org/10.5883/BOLD:AAO0792>)

Figures 5–7; Tables 1 & 3

Tetradrachmum nitidum Whitley, 1928: 219, plate 17, fig. 3 (type locality: Hayman Island, Queensland, Australia). *Chromis nitida* (Whitley, 1928) Allen 1975: 86 (Great Barrier Reef, Lord Howe Island, and Sydney, New South Wales); Randall et al. 1990: 260 (Great Barrier Reef); Allen 1991: 77 (Great Barrier Reef south to Lord Howe Island and Sydney, New South Wales); Kuitert 1993: 238 (eastern Australia from Cairns, Queensland to Montague Island, New South Wales); Hoese et al. 2006: 1450 (eastern Australia and Lord Howe Island); Allen et al. 2015: 87 (Great Barrier Reef south to Sydney, New South Wales and Lord Howe Island); Allen 2018: 192, plate 65, fig. 14 (Great Barrier Reef south to Sydney, New South Wales and Lord Howe Island).

Material examined. (21 specimens) Australia: CSIRO H692-02, 58.0 mm SL, Australia, Queensland, Torres Strait, northeast of Cape York Peninsula; WAM P.35246-001, 20 specimens, 44.7–65.3 mm SL, Australia, Queensland, Great Barrier Reef, Capricorn Group, One Tree Island.

Diagnosis. A species of *Chromis* with the following combination of characters: dorsal-fin elements XIII,11–13 (usually 12); anal-fin elements II,9–11 (usually 10); pectoral-fin rays 18–19; pelvic-fin rays I,5; principal caudal-fin rays 15; branched caudal-fin rays 13; procurent spiniform caudal-fin rays 2; tubed lateral-line scales 17–19 (usually 17–18); gill rakers 8–9 + 20–23, total rakers 29–32.



Figure 5. *Chromis nitida*, underwater photograph, adult, approx. 60 mm SL, Flynn Reef, northern Great Barrier Reef, off Cairns, Queensland, Australia (G.R. Allen).

Body depth 2.3–2.4, mean 2.3 in SL; body width 2.2–2.8, mean 2.5 in depth; head length 3.4–3.7, mean 3.5 in SL, snout length 3.7–4.4, mean 4.0 in HL; upper-jaw length 2.8–3.3, mean 3.0 in HL; orbit diameter 2.8–3.2, mean 3.0 in HL; width of bony interorbital 3.2–3.8, mean 3.5 in HL; caudal-peduncle depth 2.0–2.3, mean 2.2 in HL; caudal-peduncle length 1.5–1.9, mean 1.7 in HL; first dorsal-fin spine 3.2–3.8, mean 3.4 in HL; seventh dorsal-fin spine 1.7–2.2, mean 1.9 in HL; last dorsal-fin spine 2.1–2.6, mean 2.3 in HL; longest dorsal-fin ray 1.2–1.5, mean 1.4 in HL; first anal-fin spine 4.0–5.6, mean 4.9 in HL; second anal-fin spine 1.4–1.6, mean 1.5 in HL; longest anal-fin ray 1.2–1.5, mean 1.3 in HL; pectoral fin 3.1–3.5, mean 3.4 in SL; pelvic fin 3.2–3.8, mean 3.4 in SL; caudal fin deeply forked, length 2.6–3.0, mean 2.8 in SL.

Color in life. (Figs. 5 & 7) Adults prominently bicolored with an oblique dark-brown to blackish band extending from snout across upper body to posterior spinous dorsal fin and extending along upper margin of soft dorsal fin to tip of middle rays; portions of head, back, and spinous dorsal fin above black band yellowish brown and body below black band bright white; soft dorsal fin mainly translucent; anal fin mainly translucent with a dark brown band anteriorly and a narrow whitish anterior margin; caudal fin translucent whitish with a narrow blackish band (with a fine white margin) along edge of each lobe, upper band continuous along dorsal edge of caudal peduncle to base of last dorsal-fin ray; pectoral and pelvic fins translucent to whitish with a black spot in axil of pectoral fin.

Color in alcohol. (Fig. 6) Generally pale brown on forehead and anterior back and silvery white on sides with a diagonal, dusky brown zone from upper eye to base of posterior dorsal-fin spines, extending onto upper edge of soft portion of dorsal fin; anterior portion of dorsal fin pale brown and posteriormost portion of fin translucent; anal fin translucent to pale tan with a conspicuous, dark-brown, anterior margin; caudal fin pale tan with a narrow dark band along dorsal and ventral margin of each lobe; pectoral fin translucent whitish with a dark brown axil; pelvic fins translucent whitish.

Distribution and habitat. *Chromis nitida* is restricted to eastern Australia, including Lord Howe Island (Fig. 1). It mainly occurs on the Great Barrier Reef from its northernmost extent to the east of Torres Strait (approximately -10.36° , 143.68°) southward to the Capricorn/Bunker Group, off Gladstone, Queensland (approximately -23.9°) and is most abundant on the central and southern portions of the Reef south of about -18° . The distribution also extends southward along the coast of New South Wales to Montague Island (approximately -36.25°), but judging from museum specimens it is apparently uncommon in the southernmost section of its range.

The preferred habitat consists of extensive live coral areas and rocky reefs at depths ranging from 2–40 m, but is most abundant from about 8–25 m. It typically occurs in large midwater aggregations.



Figure 6. *Chromis nitida*, preserved specimen, WAM P.35246-001, 65.3 mm SL, One Tree Island, Capricorn Group, Great Barrier Reef, Queensland, Australia (G.R. Allen).

Remarks. This species is easily distinguished from the other members of the *C. fumea* complex on the basis of the live or preserved color pattern, particularly the conspicuous, dark, oblique band from the snout across the middle of the dorsal fin to the tip of the longest dorsal-fin rays; the dark band anteriorly on the anal fin; and the narrower dark bands along the upper and lower caudal-fin margins. It is most similar in general appearance to the new species from Norfolk Island (described below). Both species have extensive white coloration on the body with brown on the nape and anterior back. However, the demarcation between the brown and white areas is more diagonal in *C. nitida* and it forms the characteristic prominent dark band from the snout across the length of the dorsal fin not found on any other member of the *C. fumea* complex. *C. nitida* further differs from all other members of the complex in lacking the white spot at the base of the last dorsal-fin rays. The maximum size, based on 1,930 specimens deposited at the Australian Museum in Sydney, is 89 mm SL, but it usually attains about 65–70 mm SL.



Figure 7. *Chromis nitida*, Nambucca Heads, New South Wales, Australia, July 2014. Source: Observation © Ian Shaw / iNaturalist.org. License: CC by Attribution-Non-Commercial (image reversed).

***Chromis norfolkensis*, n. sp.**

Norfolk Chromis

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Figures 8–10; Tables 1–3

Chromis fumea (non-Tanaka) Allen, 1991 (in part): 69 with underwater image from Poor Knights Islands, New Zealand (Sydney area of New South Wales and northern New Zealand); Kuitert 1993: 237 with underwater image of true *C. fumea* taken in Japan (Sydney and Swansea, New South Wales); Francis 1993: 163 (Australia, Norfolk Island, and New Zealand); Francis 2001: 63, pl. 103 (Cape Reinga to Hen and Chicken Islands, North Island, New Zealand, photo from Norfolk Island); Hoese et al. 2006 (in part): 1449 (vicinity of Sydney, New South Wales); Allen et al. 2015 (in part): 87 with underwater image from New Caledonia (same as Fig. 9A herein).

Holotype. BPBM 34255, 73.1 mm SL, Australia, Norfolk Island, Duncombe Bay, -28.999°, 167.929°, 18 m, spear, J. E. Randall, 21 November 1989.

Paratypes. BPBM 17564, 47.5 mm SL, New Zealand, North Island, Poor Knights Islands, northwestern end of Aorangi Island, New Zealand, -35.474°, 174.736°, 12.5 m, W. Starck, 31 January 1974; BPBM 17565, 51.2 mm SL, New Zealand, North Island, Poor Knights Islands, northwestern end of Aorangi Island, New Zealand, -35.474°, 174.736°, 12.5 m, W. Starck, 28 January 1974; BPBM 33602, 3 specimens, 66.6–69.1 mm SL, Coral Sea, Chesterfield Bank, approximately -20.75°, 158.58°, 14–15 m, rotenone, M. Kulbicki, J. Randall, & P. Doherty, 21 August 1988; BPBM 41384, 83.3 mm SL, collected with holotype; WAM P.25560-001, 63.2 mm SL, New Zealand, North Island, Poor Knights Islands, approximately -35.5°, 174.67°, 40 m, B. Russell, 5 March 1975.



Figure 8. *Chromis norfolkensis*, freshly collected holotype, BPBM 34255, 73.1 mm SL, Norfolk Island (J.E. Randall).

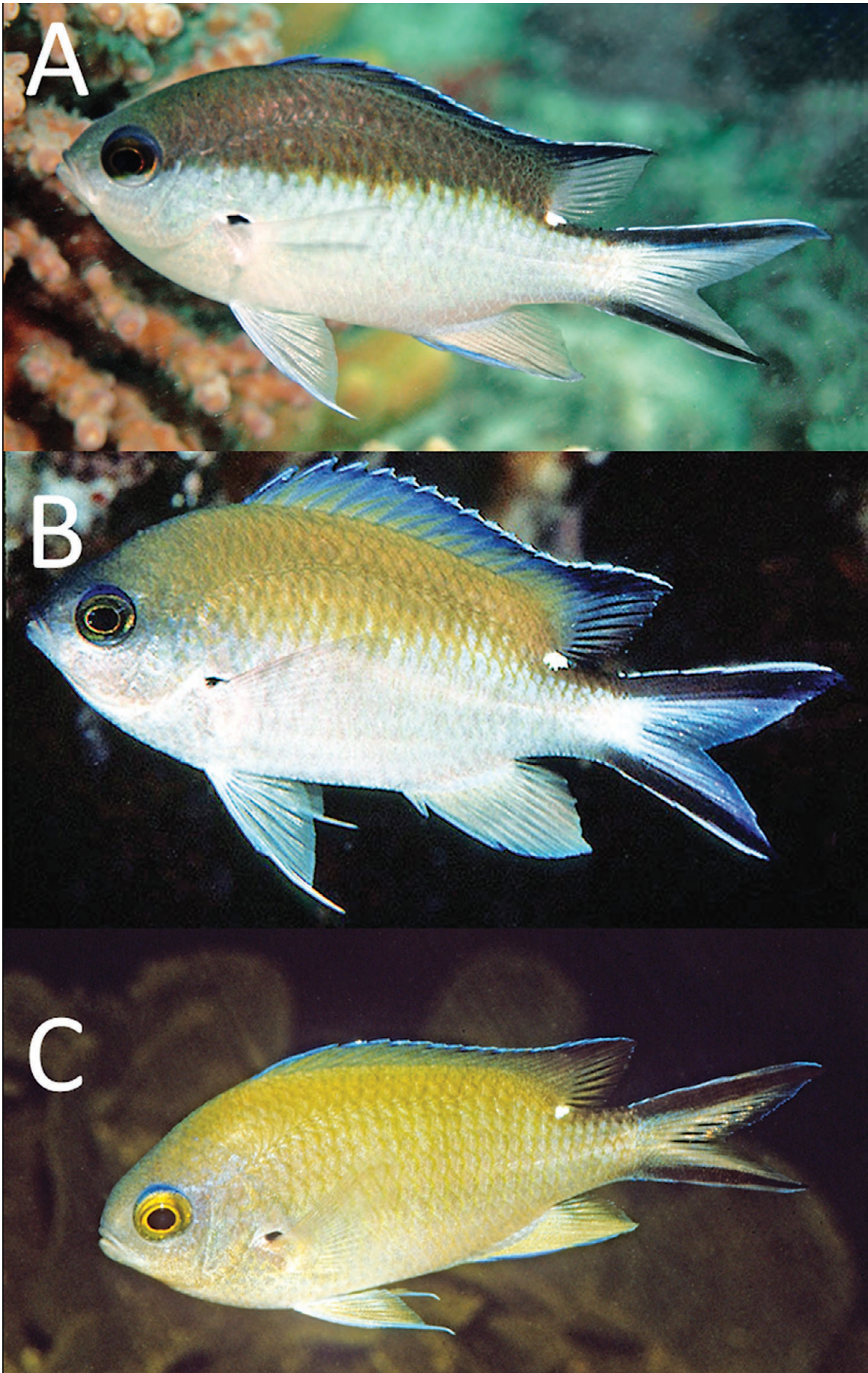


Figure 9. *Chromis norfolkensis*, underwater photographs: A) adult, approx. 75 mm SL, New Caledonia (G.R. Allen); B) adult, approx. 80 mm SL, Norfolk Island (J.E. Randall); C) subadult, approx. 55 mm SL, Swansea, New South Wales, Australia (R.H. Kuiter).

Diagnosis. A species of *Chromis* with the following combination of characters: dorsal-fin elements XIII–XIV,12–13 (usually XIII,12); anal-fin elements II,10–11 (usually II,10); pectoral-fin rays 18–20 (usually 19); spiniform caudal-fin rays 2; tubed lateral-line scales 17–19; total gill rakers on first branchial arch 30–34 (usually 31–33); body depth 2.0–2.4 (mean 2.2) in SL; adult color in life bicolored, light to dark brown to yellowish on upper half and white on lower half, transition between two halves more or less abrupt with slightly diagonal demarcation extending from lower rear corner of eye to conspicuous small, rounded, white spot, half pupil size or less, at base of last dorsal-fin rays; caudal fin translucent whitish to bluish with broad black bands along upper and lower margins with a narrow blue-white edge.

Description. Dorsal-fin elements XIV,12 (XIII,12–13); anal-fin elements II,10 (II,10–11); dorsal- and anal-fin soft rays branched, except first dorsal-fin ray usually unbranched and first anal-fin ray occasionally unbranched, last rays branched to base; pectoral-fin rays 18 (18–20), uppermost and lowermost pairs unbranched; pelvic-fin rays I,5; principal caudal-fin rays 15, uppermost and lowermost unbranched; spiniform caudal-fin rays 2, followed by two accessory segmented rays; scales in longitudinal series 27; tubed lateral-line scales 19/18 (17–19); posterior midlateral scales with a pore or deep pit (in continuous series) 7 (6–8); scales above lateral line to origin of dorsal fin 2.5; scales above lateral line to base of middle dorsal-fin spine 1.5; scales below lateral line to origin of anal fin 8.5; gill rakers 9+22/21 = 31/30 (8–10+21–25= 31–34); pseudobranchs 16; branchiostegal rays 6; supraneural (predorsal) bones 3; vertebrae 11+15.

Proportional data based on 8 specimens, 47.5–83.3 mm SL. Body moderately deep and ovate, depth 2.0 (2.0–2.4, mean 2.2) in SL, and compressed, body width 2.5 (2.6–2.9, mean 2.6) in body depth; head length 3.3 (2.9–3.4, mean 3.2) in SL; dorsal profile of head with a slight convexity above eye; snout shorter than orbit diameter, length 3.5 (3.7–4.2, mean 3.9) in HL; orbit diameter 2.7 (2.5–3.0, mean 2.8) in HL; interorbital space convex, width 3.2 (3.3–3.5, mean 3.4) in HL; caudal-peduncle depth 2.1 (2.0–2.3, mean 2.1) in HL; caudal-peduncle length 2.0 (1.8–2.3, mean 2.0) in HL.

Mouth terminal, small, and oblique, forming an angle of about 40° to horizontal axis of head and body; posterior edge of maxilla reaching a vertical about level with anterior edge of pupil, upper-jaw length 2.7 (2.7–3.5, mean 3.0) in head; teeth multiserial, an outer row of conical teeth in each jaw, largest anteriorly; 25 (19–27) upper and 21 (16–27) lower teeth on each side of jaw; a narrow band of villiform teeth posterior to outer row, in 2 or 3 irregular rows anteriorly, narrowing to a single row on side of jaws; tongue triangular with rounded tip; gill rakers long and slender, longest on lower limb near angle about 70% length of longest gill filaments; nostril with a low fleshy rim, more elevated on posterior edge and located at level of middle of pupil, about one-third distance from front of orbit to rear edge of upper lip.

Opercle ending posteriorly in a flat spine, tip relatively obtuse and obscured by a large scale; margin of preopercle with about 20 (20–41) tiny serrae, posterior margin extending dorsally to level of upper edge of pupil, ventral margin extending anteriorly to level of middle of pupil; lower margin of suborbital hidden by scales.

Scales finely ctenoid; tubed lateral-line scales ending beneath base of first two soft rays of dorsal fin; head scaled except lips, tip of snout, and a narrow zone from front of orbit to edge of snout containing nostril; a scaly sheath at base of dorsal and anal fins, up to about one-half pupil diameter in width at base of posterior dorsal-fin spines, progressively narrower on soft portion; a column of scales on each membrane of dorsal and anal fins, narrowing distally, those on spinous portion of dorsal progressively longer, reaching about two-thirds to three-fourths distance to spine tips on posterior membranes, then progressively shorter on soft portion; small scales broadly covering caudal-fin lobes; small scales on fleshy base of pectoral fins, extending onto basal part of rayed portion; a median scaly process extending posteriorly from between base of pelvic fins, length 35–60% that of pelvic spine; axillary scale above base of pelvic spine 48–55% length of spine.

Origin of dorsal fin over third lateral-line scale, predorsal distance 2.5 (2.4–2.7, mean 2.5) in SL; dorsal-fin base 1.6 (1.6–1.7, mean 1.6) in HL; first dorsal-fin spine 3.1 (2.6–3.3, mean 2.9) in HL; seventh dorsal-fin spine 1.8 (1.7–2.0, mean 1.8) in HL; last dorsal-fin spine 2.2 (1.9–2.3, mean 2.1) in HL; membranes of spinous portion of dorsal fin prominently incised, especially of anterior spines; fifth dorsal-fin soft ray longest, 1.3 (1.0–1.4, mean 1.2) in HL; preanal distance 1.4 (1.4–1.6, mean 1.4) in SL; anal-fin base 3.1 (2.9–3.3, mean 3.1) in dorsal-fin base; first anal-fin spine 5.2 (4.0–4.8, mean 4.5) in HL; second anal-fin spine 1.6 (1.4–1.7, mean 1.5) in HL; fifth anal-fin soft ray longest, 1.3 (1.0–1.5, mean 1.3) in HL; caudal fin forked, length 2.8 (2.1–2.7, mean 2.4) in SL, caudal

TABLE 2

Proportional measurements of type specimens of *Chromis norfolkensis*, n. sp.
as percentages of the standard length

	holotype			paratypes				
	BPBM 34255	BPBM 41384	BPBM 33602	BPBM 33602	BPBM 33602	WAM P.25560- 001	BPBM 17565	BPBM 17564
Standard length (mm)	73.1	83.3	69.1	66.8	66.6	63.2	51.2	47.5
Body depth	49.9	49.4	45.6	43.4	41.7	45.9	45.8	48.7
Body width	20.0	18.9	17.0	15.7	16.0	18.4	16.0	18.8
Head length	30.5	30.9	29.8	31.3	30.1	32.5	31.9	34.6
Snout length	8.6	8.3	8.1	8.2	7.2	7.9	7.7	8.3
Orbit diameter	11.4	10.6	9.7	10.3	10.7	11.3	12.1	13.6
Interorbital width	9.7	9.5	8.7	8.9	8.5	9.4	9.2	10.1
Caudal-peduncle depth	14.8	15.7	14.3	13.5	13.8	15.3	15.3	16.4
Caudal-peduncle length	14.9	15.1	15.6	16.0	16.8	18.0	16.3	15.3
Upper-jaw length	11.2	10.2	10.2	8.9	9.9	11.4	11.6	12.2
Predorsal length	39.8	37.2	38.6	38.8	38.0	41.5	41.6	41.5
Preanal length	70.9	68.8	70.9	67.7	64.1	70.3	72.1	69.7
Prepelvic length	40.4	41.7	40.2	41.7	39.6	39.7	42.5	43.9
Base of dorsal fin	62.9	61.5	61.0	60.6	59.2	60.6	58.6	62.0
Base of anal-fin	20.1	20.2	18.7	20.2	20.6	20.9	18.9	19.8
Pectoral-fin length	32.0	32.4	31.9	32.7	34.4	35.8	34.0	33.6
Pelvic-fin length	32.6	33.7	32.2	32.8	32.8	36.1	33.7	37.3
Pelvic-fin-spine length	17.1	18.3	9.9	18.9	17.6	20.4	18.8	19.5
First dorsal-fin spine	9.7	10.1	14.8	11.8	10.4	12.0	11.7	10.5
Seventh dorsal-fin spine	17.4	18.3	14.8	17.9	17.5	19.5	17.7	17.7
Last dorsal-fin spine	13.8	14.7	14.7	15.7	13.6	17.3	14.0	15.2
Longest dorsal-fin ray	24.0	26.3	22.4	25.3	25.0	31.0	22.3	27.4
First anal-fin spine	5.9	6.8	7.4	6.8	7.3	7.9	6.6	7.5
Second anal-fin spine	18.7	21.0	19.3	22.0	20.5	23.8	18.5	21.6
Longest anal-fin ray	22.9	23.9	24.3	23.9	20.5	32.3	23.8	26.5
Caudal-fin length	36.3	40.7	36.7	39.8	42.1	46.6	43.9	45.4
Caudal concavity	23.2	24.1	25.2	22.1	24.3	27.6	23.6	24.8

concavity 1.3 (1.2–1.4, mean 1.3) in HL; second to fourth (from uppermost) pectoral-fin ray longest, 3.1 (2.8–3.1, mean 3.0) in SL; first soft ray of pelvic fin filamentous (usually damaged in preserved specimens), 3.1 (2.7–3.1, mean 3.0) in SL; pelvic-fin spine 1.8 (1.6–1.8, mean 1.7) in HL.

Color in life. (Fig. 9) Adult dark to light brown or yellowish (hence the New Zealand common name of Yellow Demoiselle) on upper half and white on lower half, transition between two halves more or less abrupt with slightly diagonal demarcation extending from lower rear corner of eye to conspicuous small, rounded, white spot, half pupil size or less, at base of last dorsal-fin rays; dorsal fin brown grading to nearly black distally, darkest on outer two-thirds of anterior half of soft portion of fin, remainder of fin plain translucent and outer margin of entire dorsal fin narrowly pale blue to bluish white; anal and pelvic fins white with narrow, bluish, anterior margin; caudal fin translucent whitish to bluish with broad black bands along upper and lower margins with a narrow blue-white edge; pectoral fins translucent with a black patch covering outer portion (fin side) of axil, slightly encroaching on dorsal edge of fin base.

Color when freshly collected. (Fig. 8) Similar to live coloration with light yellowish brown on upper back and silvery white below; fin coloration similar, but white spot at base of last dorsal-fin rays relatively inconspicuous.

Color in alcohol. (Fig. 10) Generally pale yellowish brown, slightly darker dorsally on some specimens, and usually with a slight silvery hue on lower half; small, yellow-white spot at base of last dorsal-fin ray; fins generally yellowish brown to translucent with prominent brown bands along upper and lower margins of caudal fin; pectoral fins with brown patch covering outer portion (fin side) of axil, slightly encroaching on dorsal edge of fin base.

Etymology. This species is named for the type locality, Norfolk Island in the southwestern Pacific Ocean.

Distribution and habitat. *Chromis norfolkensis* is currently known on the basis of museum specimens from the northern Tasman Sea and southern Coral Sea region at northern New Zealand, Norfolk Island, New Caledonia, and the Chesterfield Islands (Fig. 1). It has also been photographed at New South Wales, Australia in the vicinity of Sydney and Swansea (Kuitert 1993). They are typically found on outer reef slopes around boulders or occasionally on coral patch reefs at depths of about 5–40 m.

Remarks. The new species was previously considered to be a southern population of *C. fumea*, which is now a species limited to the northwestern Pacific Ocean (primarily Japan and Taiwan). Both species share general



Figure 10. *Chromis norfolkensis*, preserved holotype, BPBM 34255, 73.1 mm SL, Norfolk Island (J.E. Randall).

features that characterize the *C. fumea* complex, including usual counts of XIII,12 dorsal-fin elements, II,10 anal-fin elements, 18–20 pectoral-fin rays, 18 or 19 tubed lateral-line scales, and a moderately deep body. The new species differs from *C. fumea* in having more gill rakers on the first branchial arch (30–33, mean 31.5 vs. 26–33, but usually less than 30, mean 28.3). The color pattern difference is diagnostic in adults: *C. fumea* exhibits a gradual rather than abrupt transition from the brown coloration of the back to paler ventral hue and it is not along a slight diagonal. Moreover, *C. fumea* often exhibits a yellow stripe along each longitudinal scale row on the lower half of the body, imparting an overall yellowish hue, along with yellow markings on the cheek and opercle. There is also a possible size difference with the largest *C. fumea* specimen reaching 95 mm SL, compared to 83.3 mm SL for the largest of our 7 specimens of *C. norfolkensis*. Finally, there is a considerable geographic separation of about 6,300 km between the Taiwan population of *C. fumea* and the Chesterfield Islands population of *C. norfolkensis*. Comparisons with the remaining members of the species complex, *C. sahulensis* and *C. nitida*, are discussed under those accounts.

Despite the aberrant count of 14 dorsal-fin spines, we designate the 73.1 mm SL specimen from Norfolk Island as the holotype because of its current excellent condition (Fig. 10) and corresponding freshly collected photograph by J.E. Randall (Fig. 8). It is otherwise typical of the species in other morphological and meristic features.

TABLE 3
Diagnostic color pattern features and maximum size of the *Chromis fumea* species complex

Feature	<i>C. fumea</i>	<i>C. norfolkensis</i>
Body color	pale brown to grayish	dark or pale brown/ abruptly white below
Anal fin (predominant color)	blue	white
Bands on caudal-fin lobes	dark brown or blackish	dark brown or blackish
Dorsal edge of caudal peduncle	contrasted dark brown	contrasted dark brown
Ventral edge of caudal peduncle	pale brown to grayish	white
Size of peduncular spot	about one-third pupil	about one-third pupil
Pectoral-axil spot (lateral view)	conspicuous above upper pectoral base	conspicuous above upper pectoral base
Maximum size	95 mm SL	83 mm SL
Feature	<i>C. sahulensis</i>	<i>C. nitida</i>
Body color	pale brown grading to gray	white/ brown on nape and anterior back
Anal fin (predominant color)	pale grayish	translucent whitish
Bands on caudal-fin lobes	yellowish brown	blackish
Dorsal edge of caudal peduncle	uncontrasted pale brown to grayish	contrasted dark brown or black
Ventral edge of caudal peduncle	gray	white
Size of peduncular spot	about one-half pupil	none
Pectoral-axil spot (lateral view)	barely visible as tiny spot	conspicuous above upper pectoral base
Maximum size	60 mm SL	89 mm SL, usually 60–70 mm SL

Chromis sahulensis, n. sp.

Sahul Chromis

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mtDNA COI BIN BOLD:ADO9919 (<https://doi.org/10.5883/BOLD:ADO9919>)

Figures 11–13; Tables 1, 3–4

Chromis fumea (non-Tanaka) Gloerfelt-Tarp & Kailola 1984: 227, fig. on p. 226 (northwestern Australia); Allen 1985: 2375, photo number 269 (Dampier Archipelago, Western Australia); Allen 1988: 104, Fig. 671 (Western Australia); Allen 1991 (in part): 69 (Western Australia); Hoese et al. 2006 (in part): 1449 (northwestern Australia); Allen 2018: 190, Plate 64, fig. 10 (Western Australia).

Holotype. WAM P.27599-010, 49.7 mm SL, Australia, Western Australia, North West Cape, Lighthouse Bay, -21.801°, 114.121°, 18 m, spear, G.R. Allen, 24 May 1976.

Paratypes. (all Western Australia unless stated otherwise) BPBM 19057, 2 specimens, 32.0 & 42.9 mm SL, Dampier Archipelago, Kendrew Island, -20.475°, 116.533°, 23 m, spear & quinaldine, G.R. Allen, 1 November 1974; CSIRO B2115, 33.5 mm SL, east of Barrow Island, approximately -20.88°, 115.67°, 15 m, trawl, R.V. *Soela*, 10 December 1979; CSIRO B2248, 6 specimens, 29.7–54.9 mm SL, north of Cape Cossigny, approximately -19.97°, 118.02°, 36 m, trawl, R.V. *Soela*, 24 October 1982; CSIRO H1467-4, 47.2 mm SL, northwest of Port Hedland, approximately -19.517°, 117.83°, 60 m, trawl, R.V. *Soela*, 22 September 1988; CSIRO H4657-02, 43.7 mm SL, northwest of Port Hedland, approximately -20.15°, 117.72°E, 30 m, trawl, W. Whitlaw on R.V. *Southern Surveyor*, 24 August 1997; CSIRO H8200-06, 44.1 mm SL, southwest of Lagrange Bay, approximately -18.72°, 121.0°, 51 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 11 October 2017 (**BOLD DNA sample FOAO1185-18, BW-A14396**); CSIRO H8200-09, 37.8 mm SL, southwest of Lagrange Bay, approximately



Figure 11. *Chromis sahulensis*, freshly collected paratype, CSIRO H.8200-06, 44.1 mm SL, southwest of Lagrange Bay, Western Australia (CSIRO).

-18.72°, 121.0°, 51 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 11 October 2017; CSIRO H8230-14, 2 specimens, 39.8 & 54.0 mm SL, north of Cape Lambert, approximately -19.98°, 117.07°, 58 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 19 October 2017; CSIRO H8231-05, 3 specimens, 24.8–37.7 mm SL, north of Cape Lambert, approximately -20.12°, 117.2°, 45 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 19 October 2017; CSIRO H8231-06, 14 specimens, 15.3–39.3 mm SL, north of Cape Lambert, approximately -20.12°, 117.2°, 45 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 19 October 2017; CSIRO H8251-12, 2 specimens, 31.9 & 32.2 mm SL, north of Dampier Archipelago, approximately -20.4°, 116.25°, 40 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 25 October 2017; CSIRO H8330-04, 41.0 mm SL, west northwest of Port Hedland, approximately -20.15°, 117.7°, 37 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 18 October 2017; CSIRO H8344-05, 45.0 mm SL, north of Dampier Archipelago, approximately -20.17°, 116.18°, 59 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 30 October 2017; CSIRO H8344-04, 27.0 mm SL, north of Dampier Archipelago, approximately -20.12°, 116.18°, 59 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 30 October 2017 (**BOLD DNA sample FOAO2187-20, BW-A1524**); CSIRO H8344-06, 10 specimens, 31.9–44.0 mm SL, north of Dampier Archipelago, approximately -20.12°, 116.18°, 59 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 30 October 2017; CSIRO H8447-03, 34.8 mm SL, Dampier Archipelago, north of Legendre Island, approximately -20.3°, 116.97°, 37 m, trawl, A. Graham & J. Pogonoski on R.V. *Investigator*, 24 October 2017; NTM S.10959-098, 2 specimens, 30.4 & 38.1 mm SL, north of Port Hedland, approximately -19.017°, 119.42°, 80 m, trawl, R. Williams on F.V. *Tung Mao I*, 18 April, 1983; NTM S.13331-004, 46.3 mm SL, Timor Sea, Northern Territory east of Margaret Harries Bank, approximately, -10.33°, 129.08°, 79 m, trawl, Northern Territory Fisheries, 11 December 1990; NTM S.17028-002, 42.5 mm SL, Arafura Sea, Northern Territory, south of Evans Shoals, 10.4298°, 129.667°, 75 m, trawl, B. Glasby on R.V. *Solander*, 8 August 2010; NTM S.17032-001, 48.4 mm SL, Arafura Sea, Northern Territory, northeast of Cootamundra Shoal, -10.520°, 129.524°, 55 m, trawl, B. Glasby on R.V. *Solander*, 18 August 2010; WAM P.25373-003, 54.5 mm SL, North West Cape, wreck of Mildura, approximately -21.78°, 114.12°, 14–16 m, spear, G.R. Allen, 1 July 1975; WAM P.26273-004, 50.0 mm SL, about 100 km northwest of Broome, approximately -17.25°, 121.63°, 58 m, trawl, P. Brown et al. on R.V. *Courageous*, 29 June 1978; WAM P.28680-004, 4 specimens, 32.1–42.6 mm SL, about 48 km north of North Turtle Island, approximately -19.5°, 118.87°, 40 m, trawl, S. Rainer on R.V. *Soela*, 11 February 1983; WAM P.28697-002, 10 specimens, 28.3–37.5 mm SL, Northwest Shelf, approximately -19.47°, 118.92°, 40 m, trawl, S. Rainer on R.V. *Soela*, 26 April 1983; WAM P.32564-001, 5 specimens, 50.6–58.3 mm SL, Shark Bay, off Red Cliff Point, -24.926°, 113.266°, 22 m, trawl, S. Morrison on R.V. *Naturaliste*, 25 September 2003; WAM P.32569-003, 54.4 mm SL, off Point Quobba, -24.523°, 113.364°, 48 m, trawl, S. Morrison on R.V. *Naturaliste*, 26 September 2003; WAM P.34141-003, 2 specimens, 38.2 & 47.0 mm SL, 4.7 km north of Monte Bello Islands, Trimouille Island, -20.337°, 115.568°, 45 m, sled trawl, G. Moore on R.V. *Naturaliste*, 19 June 2013; WAM P.34142-002, 2 specimens, 38.6 & 42.3 mm SL, Monte Bello Islands, 8.5 km northeast of Trimouille Island, -20.350°, 115.644°, 52 m, sled trawl, G. Moore on R.V. *Naturaliste*, 19 June 2013; WAM P.34144-005, 6 specimens, 44.4–53.5 mm SL, Monte Bello Islands, 2 km east of Trimouille Island, -20.401°, 115.601°, 38 m, sled trawl, G. Moore on R.V. *Naturaliste*, 19 June 2013.

Diagnosis. A species of *Chromis* with the following combination of characters: dorsal-fin elements XIII,10–13 (usually XIII,12); anal-fin elements II,9–11 (usually II,10); pectoral-fin rays 17–20 (usually 18–19); spiniform caudal-fin rays 2; tubed lateral-line scales 17–19 (rarely 17); total gill rakers on first branchial arch 29–34 (usually 31–32); body depth 2.1–2.4 (mean 2.2) in SL; color in life yellowish brown on dorsal head, nape, spinous dorsal fin, and back, grading to gray-brown on sides, with a prominent saddle-like white spot near base of last dorsal-fin rays extending onto upper caudal peduncle; brownish bands edged with white along upper and lower margins of caudal fin.

Description. Dorsal-fin elements XIII,12 (XIII,10–13); anal-fin elements II,10 (II,9–11); all dorsal-fin and anal-fin soft rays branched except first soft dorsal-fin ray usually unbranched, last rays branched to base; pectoral-fin rays 19 (17–20), uppermost and lowermost pairs unbranched; pelvic-fin rays I,5; principal caudal-fin rays 15, uppermost and lowermost unbranched; spiniform caudal-fin rays 2, followed by two accessory segmented rays; scales in longitudinal series 27; tubed lateral-line scales 18 (17–19); posterior midlateral scales with a pore or deep pit (in continuous series) 7 (7–8); scales above lateral line to origin of dorsal fin 2.5; scales above lateral

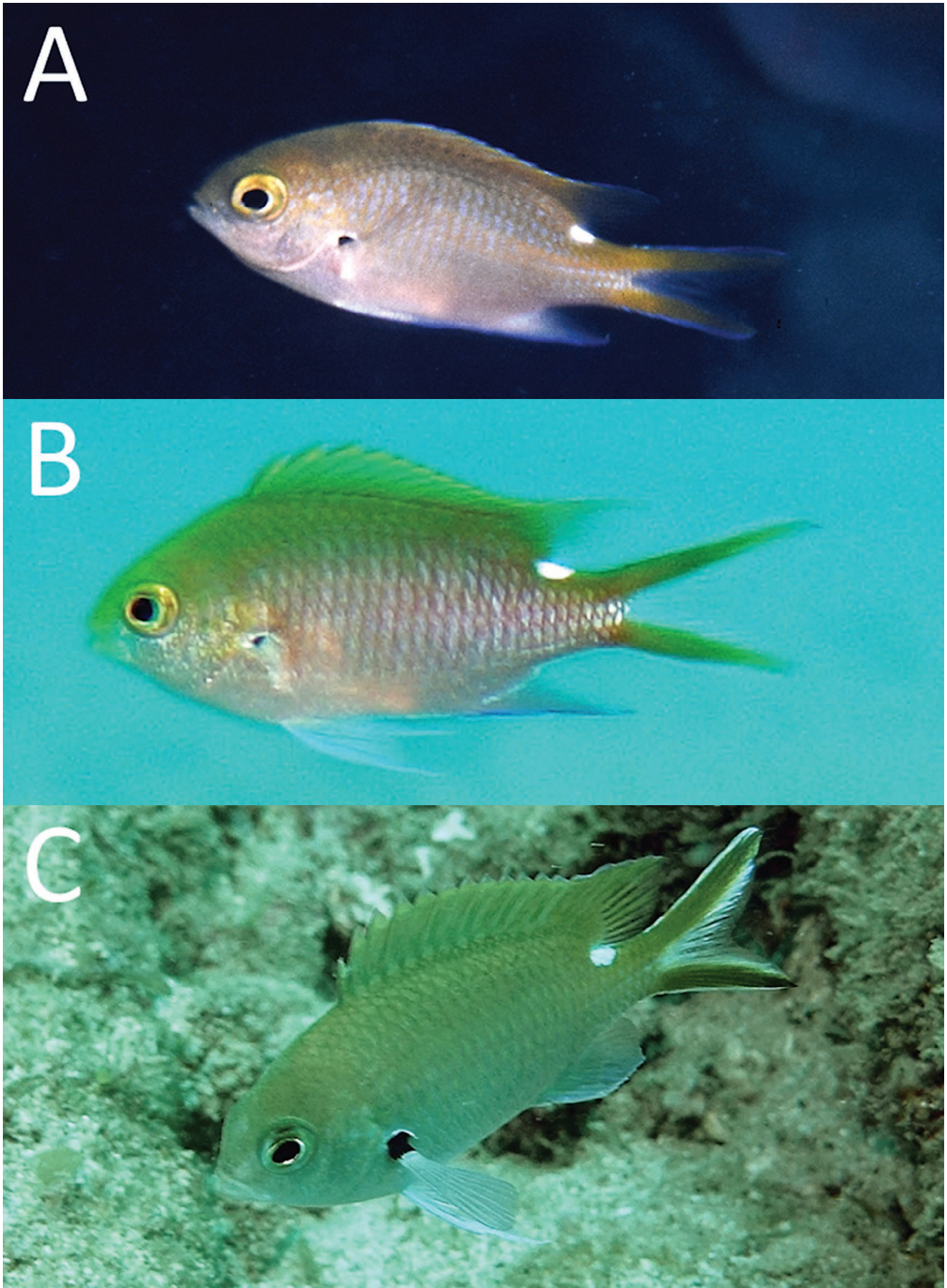


Figure 12. *Chromis sahulensis*, underwater photographs: A) juvenile, approx. 35 mm SL, Dampier Archipelago, Western Australia (G.R. Allen); B) adult, approx. 50 mm SL, Exmouth Gulf, Western Australia (A. Hoshcke); C) adult, approx. 50 mm SL, Exmouth Gulf, Western, Australia (A. Hoshcke).

line to base of middle dorsal spine 1.5; scales below lateral line to origin of anal fin 8.5; gill rakers 9+22 = 31 (9–11+20–23 = 29–34); pseudobranchs 16; branchiostegal rays 6; supraneural (predorsal) bones 3; vertebrae 11+15.

Proportional data based on 20 specimens, 41.0–58.3 mm SL. Body moderately deep and ovate, depth 2.3 (2.1–2.5, mean 2.3) in SL, and compressed, body width 2.4 (2.3–2.9, mean 2.6) in body depth; head length 3.2 (3.1–3.3, mean 3.2) in SL; dorsal profile of head with slight convexity above eye; snout shorter than orbit diameter, length 3.8 (3.2–4.7, mean 4.1) in HL; orbit diameter 2.7 (2.4–3.0, mean 2.7) in HL; interorbital space convex, width 3.7 (3.0–3.9, mean 3.5) in HL; caudal-peduncle depth 2.1 (2.0–2.5, mean 2.2) in HL; caudal-peduncle length 2.0 (1.8–2.6, mean 2.1) in HL.

Mouth terminal, small, and oblique, forming an angle of about 40° to horizontal axis of head and body; posterior edge of maxilla reaching a vertical about level with anterior edge of pupil, upper-jaw length 2.9 (2.8–3.2, mean 3.0) in head; teeth multiserial, an outer row of conical teeth in each jaw, largest anteriorly; 22 (20–27) upper and 21 (16–24) lower teeth on each side of jaw; a narrow band of villiform teeth posterior to outer row, in 2 or 3 irregular rows anteriorly, narrowing to a single row on side of jaws; tongue triangular with rounded tip; gill rakers long and slender, the longest on lower limb near angle about equal to length of longest gill filaments; nostril with a low, fleshy rim, more elevated on posterior edge and located at level of middle of pupil, about one-third distance from front of orbit to rear edge of upper lip.

Opercle ending posteriorly in a flat spine, tip relatively obtuse and obscured by a large scale; margin of preopercle with about 30 (34–50) tiny, but well-defined, serrae (although damaged in holotype), posterior margin extending dorsally to level of upper edge of pupil, ventral margin extending anteriorly to level of middle of pupil; lower margin of suborbital hidden by scales.

Scales finely ctenoid; tubed lateral-line scales ending beneath bases of second to fourth soft rays of dorsal fin; head scaled except lips, tip of snout, and a narrow zone from front of orbit to edge of snout containing nostril; a scaly sheath at base of dorsal and anal fins, up to about one-half pupil diameter in width at base of posterior dorsal-fin spines, progressively narrower on soft portion; a column of scales on each membrane of dorsal and anal fins, narrowing distally, those on spinous portion of dorsal progressively longer, reaching about two-thirds to three-fourths distance to spine tips on posterior membranes, then progressively shorter on soft portion; small scales broadly covering caudal-fin lobes; small scales on fleshy base of pectoral fins, extending onto basal part of rayed portion; a median scaly process extending posteriorly from between base of pelvic fins, length 56–67% of pelvic-fin spine; axillary scale above base of pelvic-fin spine 36–66% length of spine.

Origin of dorsal fin over second or third lateral-line scale, predorsal distance 2.6 (2.5–2.8, mean 2.6) in SL; dorsal-fin base 1.7 (1.6–1.8, mean 1.7) in HL; first dorsal-fin spine 3.0 (2.8–3.8, mean 3.2) in HL; seventh dorsal-fin spine 1.7 (1.6–1.9, mean 1.7) in HL; last dorsal-fin spine 1.8 (1.8–2.2, mean 2.0) in HL; membranes of spinous portion of dorsal fin prominently incised, especially of anterior spines; fifth dorsal-fin soft ray longest, 1.4 (1.1–1.5, mean 1.3) in SL; preanal distance 1.4 (1.4–1.6, mean 1.4) in HL; anal-fin base 2.9 (2.6–3.3, mean 3.0) in dorsal-fin base; first anal-fin spine 3.8 (3.5–4.5, mean 4.0) in HL; second anal-fin spine 1.4 (1.4–1.6, mean 1.5) in HL; fifth anal-fin soft ray longest, 1.1 (1.1–1.5, mean 1.3) in HL; caudal fin forked, length 2.4 (2.4–2.9, mean 2.6) in SL, caudal concavity 1.2 (1.4–1.9, mean 1.6) in HL; second to fourth (from uppermost) pectoral-fin ray longest, 3.2 (3.1–3.5, mean 3.3) in SL; first soft ray of pelvic fin filamentous (usually damaged in preserved specimens), 2.7 (2.7–3.2, mean 2.9) in SL; pelvic-fin spine 1.5 (1.5–1.8, mean 1.7) in HL.

Color in life. (Fig. 12) Adult generally yellowish brown on back, dorsal head, and nape, grading to gray, often with a silvery hue, ventrally; a conspicuous white spot (about one-half pupil size) near base of last dorsal-fin rays, saddle-like, extending onto upper caudal peduncle; iris of eye mainly golden yellow; dorsal fin pale brown, grading to translucent on posteriormost rays with yellowish submarginal band, and a narrow whitish to pale gray outer margin; anal fin dusky grayish, grading to translucent posteriorly with a narrow blue anterior edge; caudal fin translucent with prominent brown bands and narrow blue-white edges along upper and lower margins; pelvic fins translucent whitish with narrow white anterior margin; pectoral fins translucent with a black patch covering outer portion (fin side) of axil, slightly encroaching on dorsal edge of fin base. Juvenile similar to adult, but overall slightly paler.

Color when freshly collected. (Fig. 11) Similar to live coloration, but generally less vivid with yellowish dorsal fin and golden brown band on each caudal-fin lobe.

TABLE 4

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

	holotype				paratypes					
	WAM P.27599- 010	WAM P.32564- 001	WAM P.32564- 001	WAM P.32564- 001	CSIRO H8230	WAM P.34144- 005	WAM P.34144- 005	WAM P.34141- 003	CSIRO H8344	CSIRO H8344
Standard length (mm)	49.7	58.3	57.5	56.0	54.0	50.8	48.3	47.0	45.0	43.7
Body depth	43.8	45.3	46.9	47.0	43.2	45.7	45.7	41.5	44.2	41.2
Body width	18.2	18.4	19.7	18.5	15.0	16.9	16.7	15.6	16.8	16.7
Head length	31.1	31.3	31.3	31.6	30.8	31.4	32.0	31.1	32.7	32.1
Snout length	8.2	8.3	8.0	7.9	7.7	7.9	7.7	7.5	7.4	6.9
Orbit diameter	11.6	10.3	11.8	11.2	11.6	11.7	12.4	12.6	12.8	13.2
Interorbital width	8.4	8.1	9.6	9.8	8.1	9.8	9.1	8.3	8.7	8.6
Caudal-peduncle depth	15.1	15.0	15.1	15.9	13.9	15.1	14.5	14.2	14.1	13.0
Caudal-peduncle length	15.5	15.7	15.6	15.5	14.3	14.5	16.0	16.1	15.1	12.4
Upper-jaw length	10.8	10.3	10.1	10.8	10.1	11.1	10.0	10.4	11.0	10.5
Predorsal length	37.9	37.7	38.4	38.0	36.3	39.7	40.2	39.2	39.0	37.5
Preanal length	69.7	70.1	71.6	70.2	70.5	70.5	71.8	70.8	72.9	71.4
Prepelvic length	40.0	39.0	42.7	40.1	39.4	39.0	40.1	39.0	39.1	38.7
Base of dorsal fin	59.7	59.8	59.7	59.1	57.2	60.1	61.5	62.4	56.8	60.3
Base of anal-fin	20.4	19.8	19.5	21.7	19.0	19.5	19.9	21.2	20.2	18.1
Pectoral-fin length	30.9	28.2	31.8	31.7	29.5	32.2	28.7	30.7	32.0	31.8
Pelvic-fin length	36.8	32.5	33.8	33.2	33.0	35.6	35.1	36.6	35.5	34.6
Pelvic-fin-spine length	20.7	20.5	18.1	18.8	17.9	19.6	18.7	19.3	18.5	19.0
First dorsal-fin spine	10.3	8.8	8.1	10.2	9.9	10.7	9.1	10.7	9.7	10.7
Seventh dorsal-fin spine	18.7	18.0	17.3	18.4	17.3	20.2	17.0	17.2	20.6	19.1
Last dorsal-fin spine	17.2	15.8	14.3	17.3	15.0	16.2	15.0	14.2	16.8	16.0
Longest dorsal-fin ray	21.8	25.3	24.6	26.8	22.0	23.0	21.5	26.2	23.5	24.1
First anal-fin spine	8.2	8.0	7.8	7.5	7.6	8.4	8.4	7.5	7.2	7.2
Second anal-fin spine	22.9	21.6	20.5	22.0	21.3	22.2	21.7	22.7	20.7	20.6
Longest anal-fin ray	27.3	25.2	26.6	29.6	23.2	23.1	21.6	25.4	22.1	24.1
Caudal-fin length	42.1	39.9	40.8	38.8	39.1	36.8	34.7	39.1	38.5	34.4
Caudal concavity	26.5	18.5	22.0	20.6	22.0	20.4	14.7	22.3	17.8	16.7

Color of holotype in alcohol. (Fig. 13) Generally yellowish tan, except silvery white on breast; whitish spot on caudal peduncle evident; fins pale tan to translucent, pale yellowish basally on dorsal and anal fins; brown bands on caudal fin lobes as in live coloration, but barely visible if specimen viewed against white background; pectoral fins with a dark brown patch covering outer portion (fin side) of axil, slightly encroaching on dorsal edge of fin base. Paratypes similar, but brown to tannish and with dark bands on caudal fin more evident. Some specimens slightly darker dorsally and usually with slight silvery hue on lower half.

Etymology. This species is named for its geographic range, limited to the Sahul Shelf, the portion of the continental shelf lying off the northwestern coast of Australia.

Distribution and habitat. *Chromis sahulensis* is currently known only from northwestern Australia. The documented range extends from the vicinity of Evans Shoals, off Melville Island, Northern Territory southward to the Shark Bay region of Western Australia, a linear path of approximately 2,650 km (Fig. 1).

Preferred habitat is the outer slope of coral reefs and on gradually sloping or flat bottoms of trawling grounds, presumably around rock outcrops, sponges, and sea fans, at depths of about 15–80 m.

Remarks. Similar to the situation with *C. norfolkensis*, this species was previously identified as a population of *C. fumea*. However, it differs from *C. fumea* in having more gill rakers on the first branchial arch (29–34, mean 31.2 versus 26–33, but usually less than 30, mean 28.3). There are also notable color pattern differences: while both species possess prominent dark bands on the caudal fin, those of *C. sahulensis* are brownish vs. black on *C. fumea*. Unlike *C. fumea*, *C. sahulensis* is yellowish on the upper head and back. In contrast, *C. fumea* is often yellowish on the lower half of the body, compared to the uniform gray of *C. sahulensis*. Judging from underwater photographs, the white spot near the base of the last dorsal-fin rays is more saddle-shaped and extends farther onto the caudal peduncle in *C. sahulensis* vs. rounder and barely extending onto the peduncle in *C. fumea*. There is also a significant size difference between the two species with *C. sahulensis* reaching only about 60 mm SL, vs. at least 95 mm SL for *C. fumea*.

Chromis sahulensis and *C. norfolkensis* share meristic and morphometric features, but exhibit marked color pattern differences. Most notably, *C. sahulensis* lacks the pronounced bicolored pattern of *C. norfolkensis* formed by an extensive white or silvery-white coloration on the ventral two thirds of the head and body. Also the dark bands on the caudal fin of *C. norfolkensis* are darker and there is an extensive dark-brown zone on the outer portion of the anterior soft dorsal-fin rays not seen in *C. sahulensis*. There is also a considerable size discrepancy, with *C. norfolkensis* reaching at least 83 mm SL.



Figure 13. *Chromis sahulensis*, preserved holotype, WAM P.27599-010, 49.7 mm SL, North West Cape, Western Australia (G.R. Allen).



Figure 14. *Chromis westaustralis*, underwater photograph, adult, approx. 70 mm SL, Hall Bank, off Fremantle, Western Australia (D. Freemantle).

Another Western Australian species, *Chromis westaustralis* (Fig. 14), is similar in general appearance to *C. sahulensis*, although it is not a member of the *C. fumea* complex. Phylogenetic analyses reveal it belongs to another clade, designated as the *C. notata* species complex by Iwatsubo & Motomura (2018). The genetic relatedness of this group, which contains *Chromis katoi* Iwatsubo & Motomura, 2018; *Chromis kennensis* Whitley, 1964; *Chromis notata* (Temminck & Schlegel, 1843); *Chromis ovalis* (Steindachner, 1900); *C. pura*; *C. westaustralis*, and *Chromis yamakawai* Iwatsubo & Motomura, 2013, all from the Indo-Pacific region, was confirmed by Tang et al. (2021) and conforms with BOLD COI sequence data obtained by CSIRO (specimen H6381-06; COI sequence under BOLD process ID FOAG1020-08, sample ID BW-A4897, BIN BOLD:AAJ0270), which shows a 4.9% minimum interspecific p-distance from *C. notata* from Taiwan.

Chromis westaustralis is distinguished from *C. sahulensis* by its lack of serrae on the preopercular margin, a usual count of 11 anal-fin rays (vs. 10), and a black blotch that normally covers the upper half of the pectoral-fin base instead of being mainly restricted to the fin axil. In addition, it has a small, but conspicuous, white spot just anterior to the upper portion of the black blotch. These features are particularly useful for separating the two species, which share overlapping ranges along the Western Australian coast in the region between North West Cape and Shark Bay (approximately -21.78° and -25° respectively; see Fig. 1). The primary geographic range of *C. westaustralis* lies to the south of this zone, extending southward to Cape Leeuwin (approximately -34.37°) and eastward along the southern coast to the Albany region (approximately -35.03° , 118°). It appears to be most abundant in the central portion of the range (between about -28° and -32°), especially at the Houtman Abrolhos Islands and at Rottnest Island in the Perth region.

DNA comparisons

The neighbor-joining phenetic tree based on the COI mtDNA sequences of the *Chromis* species allied to the new species, following the Kimura two-parameter model (K2P) generated by BOLD (the Barcode of Life Database), shows relatively shallow divergences within the *C. fumea* complex (Fig. 15). The new species, *C. sahulensis* is 3.8% divergent from *Chromis fumea* from Taiwan (minimum interspecific p-distance to nearest neighbor lineage) and 5.15% from *Chromis nitida* from Queensland, Australia (p-distances). Although no DNA sequences are available for *Chromis norfolkensis*, it is certainly another member of the *C. fumea*-complex clade, based on morphology and color-pattern similarities. The mtDNA barcode sequence of *C. westaustralis* confirms that, despite its superficial similarity to *C. sahulensis*, it belongs to the relatively distant *C. notata* species complex.

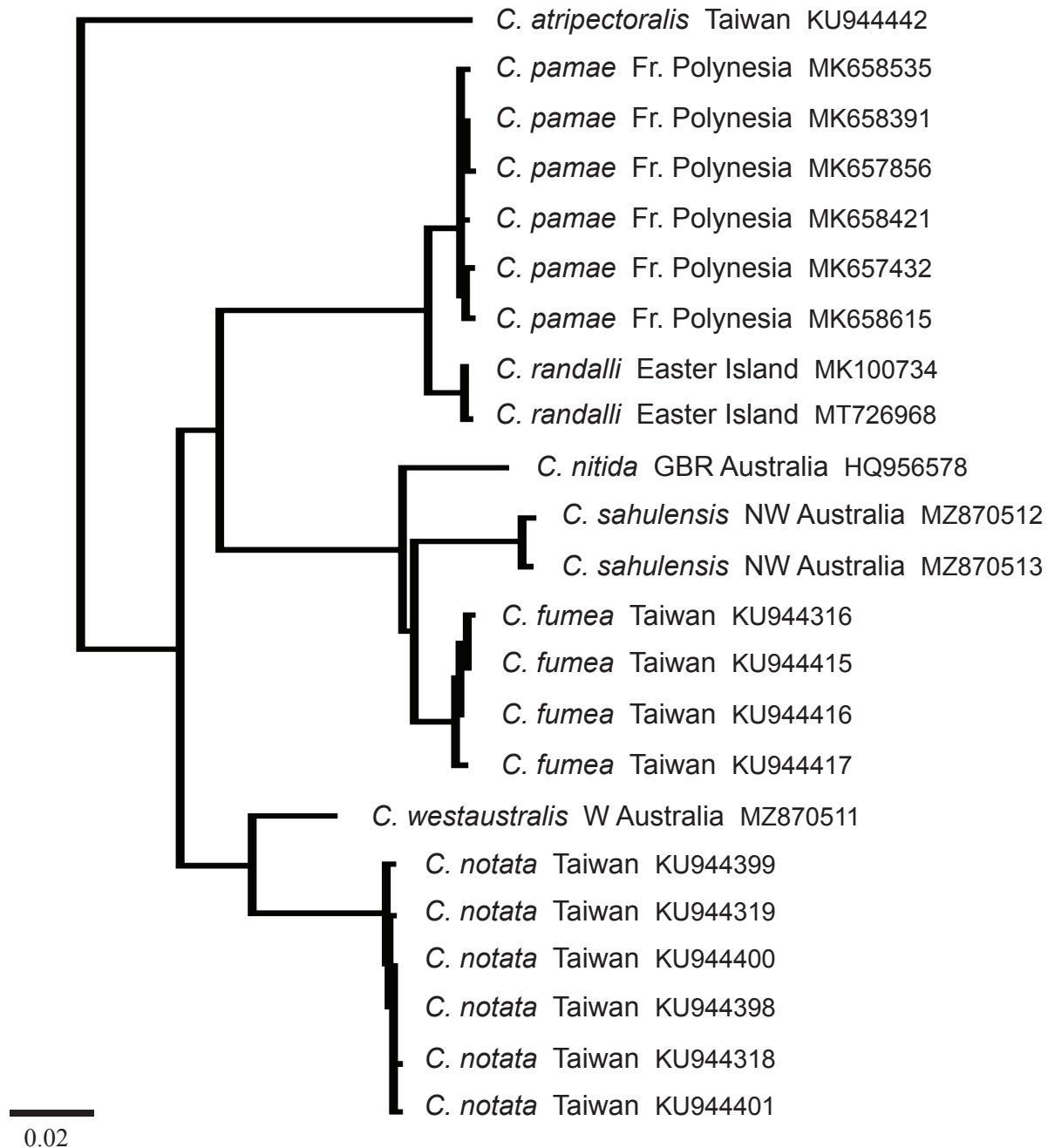


Figure 15. The neighbor-joining phenetic tree of COI mtDNA sequences of *Chromis* species following the Kimura two-parameter model (K2P) generated by BOLD (Barcode of Life Database, <http://www.boldsystems.org>). The scale bar at left represents a 2% sequence difference. Collection locations and GenBank accession numbers for specimens are indicated, and *Chromis tripterygius* is used as an outgroup.

Biogeography

The members of the *C. fumea* complex exhibit widely disjunct distributions, with the exception of *C. nitida* and *C. norfolkensis*, which sporadically co-occur at south-central New South Wales, Australia (Fig. 1). The overall anti-tropical distribution of this complex is suggestive of a former widespread western Pacific ancestor that eventually split into multiple lineages due to barriers created during past geologic episodes. Randall (1982) listed 56 Indo-Pacific species exhibiting similar anti-tropical distribution patterns and later gave several possible explanations to account for this phenomenon (Randall 1995). Foremost among these, which may be applicable in the case of the *C. fumea* complex, is that a subtropical ancestral species ranged widely across the equatorial zone during past epochs of lowered sea temperatures, but were separated into northern and southern populations as a result of increased sea temperatures following ice ages. An alternative theory, originally proposed by Théel (1885) and redefined by Briggs (1987), proposes that formerly widespread warm-water species became extinct in tropical regions, leaving relict populations to the north and south. Reasons proposed for tropical extinction include heightened competition for resources in the extremely biodiverse tropical marine environment.

The southern hemisphere population was likely split into western and eastern components by the formidable Arafura Plains land barrier (Hope 2007), which historically connected northern Australia and southern New Guinea, and persists to this day in the form of shallow turbid seas with significant freshwater discharge that prevents colonization of most reef fishes. At least 25 other reef-associated fishes are endemic to northwestern Australia (G.R. Allen, unpublished data). The eastern population likely underwent speciation resulting in a tropical, coral-reef associated fish (*C. nitida*) and a subtropical species (*C. norfolkensis*) primarily found in cooler rocky habitats. DNA sequence data are lacking for *C. norfolkensis*; nevertheless it is clearly more similar morphologically and in color-pattern phenotype to *C. fumea* than to the other members of the complex. Future phylogenetic studies of the species complex will resolve the relatedness of the various members of the complex.

Other material examined. *Chromis westaustralis* (all Western Australia): CSIRO H6381-06, 84.2 mm SL, southwest of Shark Bay, Western Australia (mtDNA COI sequence is BOLD process ID FOAG1020-08, sample ID BW-A4897, BIN BOLD:AAJ0270); WAM P.25317-008 (holotype), 83.6 mm SL, Houtman Abrolhos Islands; WAM P.24853-001 (paratype), 26.5 mm SL Albany; WAM P.25293-001, 70.5 mm SL, Rottneest Island; WAM P.25307-011 (paratype), 71.2 mm SL, Houtman Abrolhos Islands; WAM P.25308-006, 2 specimens (paratypes), 50.5 & 59.6 mm SL, Abrolhos Islands; WAM P.25317-009 (paratype), 81.3 mm SL, Houtman Abrolhos Islands; WAM P.25376-002 (paratype), 49.3 mm SL, North West Cape; WAM P.27590-010, 34 specimens, 14.8–42.9 mm SL, Houtman Abrolhos Islands; WAM P.2789-001 (paratype), 45.0 mm SL, Dirk Hartog Island; WAM P.33182-018, 4 specimens, 56.8–79.5 mm SL, Houtman Abrolhos Islands; WAM P.33193-004, 2 specimens, 77.3 & 88.7 mm SL, Rottneest Island.

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