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Plectorhinchus caeruleonothus, a new species of sweetlips (Perciformes: Haemulidae) from northern Australia and the resurrection of *P. unicolor* (Macleay, 1883), species previously confused with *P. schotaf* (Forsskål, 1775)

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Abstract

Two distinct haemulid fishes from Australia and the Indo-Australian Archipelago respectively have long been confused with *Plectorhinchus schotaf* (Forsskål, 1775). *Plectorhinchus caeruleonothus* **sp. nov.** is described from 17 specimens collected off western and far northern Australia, between the Monte Bello Islands, Western Australia and Torres Strait, Queensland. It has also been confirmed outside this range by photographs taken at Ningaloo Reef and Exmouth Gulf, Western Australia, and at Claremont Isles and Lizard Island, Queensland. The new species is unique among the genus in having a combination of dorsal-fin rays XII, 18–20, lateral-line scales 56–61, gill rakers 7–9 on the upper limb and 18–20 on the lower limb of the first arch, nostrils minute, and fresh colouration in adults including body uniformly grey, cheek, opercles and posterior margin of the opercular membrane uniformly blue-grey, and rim of orbit and upper edge of maxilla dusky yellow. In contrast to its closest congeners, the juveniles have a distinctive pattern of narrow creamish-white to pale grey stripes on a dark grey to chocolate brown background on the head and body, and oblique dark stripes progressing with growth to spots on the caudal fin. *Plectorhinchus unicolor* (Macleay, 1883) from Japan to northern Australia is resurrected from the synonomy of *P. schotaf* and redescribed on the basis of the holotype and 24 non-type specimens. *Plectorhinchus unicolor* is most similar to *P. schotaf*, but can be distinguished by fresh colouration, modal dorsal and pectoral-fin ray counts and DNA barcoding. *Plectorhinchus schotaf* appears to be restricted to the region from southeast Africa to the Arabian Sea, including the Red Sea and Persian Gulf. *Plectorhinchus griseus* (Cuvier in Cuvier & Valenciennes, 1830) from Indian and Sri Lankan Seas has previously been treated as a junior synonym of *P. schotaf*, but in accordance with Smith (1962), is here confirmed as a valid species, readily distinguished from the latter by a concavity in the lateral profile of the snout in adults, deep body and high soft dorsal-fin ray count. Comparison of the CO1 genetic marker utilised in DNA barcoding also resulted in significant genetic divergences between the new species, *P. unicolor* and their closest sampled congeners. Some behavioural observations are also presented for the species treated, including aggressive interactions between individuals of the new species, the likes of which have not previously been recorded among species of *Plectorhinchus*.

Key words: *Plectorhinchus griseus*, aggressive behaviour, DNA barcoding

Introduction

Smith (1962) revised fishes of the family Gaterinidae, now regarded as the subfamily Plectorhinchinae (Johnson, 1980; Nelson, 2006), from the Western Indian Ocean and Red Sea. He noted the extensive taxonomic confusion that had occurred within the family, due in part to the 'almost incredible changes in colour and markings that occur in some species with growth' and the 'small variation in composition of the median fins' and in scale counts. Smith examined Forsskål's type of *P. schotaf*, ZMUC P.48214 from the Red Sea, providing diagnostic information on the specimen, including most meristic data. Unfortunately gill-raker counts were not obtainable, as the gill arches had been removed from the dried skin (see Smith, 1962, Fig. 4). He confirmed the validity of *P. griseus* (Cuvier in Cuvier & Valenciennes, 1830), which had previously been treated as a junior synonym of *P. schotaf*, designating a lectotype (MNHN 7807) and paralectotype (MNHN B.2952), from four original syntypes collected from the Malabar coast, India. The lectotype is well figured (Smith, 1962: fig. 71B) and *P. sivalingami* (Smith, 1956) was confirmed as a junior synonym of *P. griseus*. One of the four syntypes, MNNH 7808, was identified by Smith as a specimen of *P. schotaf* (see also Bauchot *et al*., 1983). The illustration of this specimen (Smith, 1962: fig. 71E) and Smith's counts of dorsal-fin rays and gill rakers (XII, 20 and 11+16) support this determination. Despite this, several authors (eg Roux, 1986, Eschmeyer, 2015) have incorrectly listed *P. griseus* as a junior synonym of *P. schotaf*. Smith also determined that *P. durbanense* (Gilchrist & Thompson, 1908) was a junior synonym of *P. schotaf*, noting that the holotype, SAM 10383, has been lost since at least 1962 (Smith, 1962, Eschmeyer, 2015).

Plectorhinchus umbrinus (Klunzinger, 1870) appears to have no unique features, but has many characters common to both *P. schotaf* and *P. sordidus* (Klunzinger, 1870). The syntypes are all small juveniles of about 30 mm SL and the original description and the key provided by Klunzinger (1884: 29) are of limited value in confirming the identity of the species. Smith (1962) examined one of the three syntypes and provided a series of counts. Those for gill rakers (9+16 = 25) and transverse lateral-line scales (10/16) fit *P. sordidus*, but not *P. schotaf*. Several authors have listed *P. umbrinus* as a valid species (Dor, 1984; Goren & Dor, 1994), but neither provided any additional information to support that status. More recently, Golani & Bogorodsky (2010) followed Smith (1962) and listed it as a junior synonym of *P. sordidus*. Given the available evidence, we concur with the findings of Smith.

Plectorhinchus unicolor (Macleay, 1883), type locality China Strait, New Guinea, has most often been ignored, or treated as a junior synonym of *P. schotaf* (eg Smith, 1962; Randall *et al*., 1990; Allen *et al*., 2006; Eschmeyer, 2015), however others (eg Randall *et al*., 1997; Johnson, 1999; Hutchins, 2001; Allen *et al*., 2003) have listed it as a distinct species, restricted to the Indo-Australian Archipelago. The first author's observations on SCUBA and examination of underwater photographs indicated that there were distinct differences in colouration between specimens of *P. schotaf* from the western Indian Ocean and a somewhat deeper-bodied '*P. unicolor*' from various locations throughout the Indo-Australian Archipelago. *Plectorhinchus unicolor* has a yellowish caudal fin in life, although this pigmentation fades on death and disappears in preservative. In contrast, live or fresh individuals of *P. schotaf* from the western Indian Ocean region have a dark grey to dusky caudal fin. In addition, the posterior margin of the opercular membrane and skin covering the underlying cleithrum in *P. schotaf* is distinctly crimson-red in live or fresh specimens, whereas in *P. unicolor* the opercular membrane is dusky, although orange-red pigmentation is often present on the concealed face of the cleithrum and can sometimes be observed externally when the opercular flaps are flared. As most meristic values and proportional measurements appeared to overlap strongly between the two, specimens of both morphotypes from a wide range of geographic locations were obtained to determine more conclusively whether consistent differences could be identified. Based on those results, *P. unicolor* is re-described below and resurrected from the synonymy of *P. schotaf*.

After extensive examination of specimens of *Plectorhinchus* throughout Australian ichthyological collections and the acquisition of fresh material, the presence of an undescribed species with uniformly coloured adults and striped juveniles gradually became apparent. Ben Bright, a fly-fishing enthusiast from Weipa, north Queensland, had suspicions that a fish commonly known to anglers as the 'Blue Bastard' was not merely a colour form of the Painted Sweetlips, *Diagramma picta* (Thunberg, 1792), but a distinct species. He caught, photographed and sent four frozen adult specimens to the Queensland Museum (QM) for identification. The specimens provided information on fresh and live colouration of the new species, and yielded tissue samples for genetic analysis. Subsequently, several lots of juvenile *Plectorhinchus* specimens with markings similar to stages of *P. polytaenia* (Bleeker, 1853) and *P. albovittatus* (Rüppell, 1838) were found to have meristic values consistent with the undescribed species. Randall & Johnson (2000) provided a detailed range of meristic data for the six species of *Plectorhinchus* that are marked with longitudinal stripes in juvenile life stages in a paper establishing *Plectorhinchus lineatus* (Linnaeus, 1758) and *P. vittatus* (Linnaeus, 1758) as valid species. Dorsal-fin ray counts from this data and differences in the configuration of markings on the head indicated that the unidentified juveniles were the new species, rather than aberrant specimens of *P. albovittatus, P. polytaenia*, or any other known species. The new species, including transformation in its colouration at progressive life stages, is described and illustrated herein and compared with its closest congeners.

DNA barcoding using the mitochondrial cytochrome c oxidase subunit 1 (CO1) genetic marker is now routinely used in conjunction with morphological techniques to distinguish similar or cryptic species complexes. Genetic samples of the new species were taken from four frozen adult specimens from Weipa and a striped juvenile collected in Darwin by Northern Territory Museum researchers. These, and samples from a specimen of *P. unicolor* collected at Gloucester Island, north Queensland were sequenced at QM. The results were compared with a wide variety of congeners, especially *P. schotaf*, *P. chubbi* (Regan, 1919), *P. sordidus* and *P. albovittatus*, sourced from GenBank and BOLD (Barcode of Life Database), as well as unpublished sequences of *P. polytaenia* and additional *P. unicolor*, sourced from Miyazaki University and CSIRO. In this study, *P. caeruleonothus* is described as a new species and *P. unicolor* is re-established as a valid species based on morphological features, which are strongly supported by molecular evidence. With the addition of the new species and resurrection of *P. unicolor* and *P. griseus*, *Plectorhinchus* now includes 27 valid species, 13 of which (*P. albovittatus*, *P. caeruleonothus* **sp. nov.**, *P. chaetodonoides*, *P. chrysotaenia*, *P. flavomaculatus*, *P. gibbosus*, *P. lessonii*, *P. lineata*, *P. multivittatus*, *P. picus*, *P. polytaenia*, *P. unicolor* and *P. vittatus*) are confirmed herein as occurring in Australian territorial waters.

Methods and material

Institutional codes for types and comparative material follow Fricke & Eschmeyer (2014). Type specimens of the new species are deposited in the Australian Museum (AMS), Bishop Museum (BPBM), Australian National Fish Collection, CSIRO (CSIRO), Museum & Art Gallery of the Northern Territory (NTM), Queensland Museum (QM), and Western Australian Museum (WAM).

Morphological analysis. Lengths of specimens are given as standard length (SL), being the horizontal distance from the front of the upper lip to the base of the caudal fin (posterior end of the hypural plate, at the caudal flexure). Head length (HL), is the horizontal distance between the front of the upper lip and the posterior tip of the opercular membrane. Body depth is greatest depth from the base of the dorsal-fin spines. Body width is the greatest width, just posterior to the head. Snout length is the horizontal distance between the tip of the upper lip and the fleshy margin of the orbit. Orbit diameter is the greatest fleshy diameter. Interorbital width is the least fleshy width. Preorbital depth is the least distance between the lower fleshy margin of the orbit and the ventral margin of the preorbital bone, near the tip of the maxilla. Upper jaw length is the distance from the posterior tip of the maxilla to the anterior extremity of the jaw, in a horizontal plane. Posterior nostril width is the greatest width, excluding the nasal flap. Posterior nostril to eye is the least distance from the fleshy margin of the orbit to the margin of the nostril. Caudal peduncle depth is the least depth. Caudal peduncle length is the horizontal distance between verticals from the rear base of the anal fin and the base of the caudal fin. Length of fin spines and rays are taken from their extreme bases in a straight (not vertical) line to the tips. The base of dorsal-fin rays and anal-fin spines and rays is obscured by a thick scaly sheath, especially in large specimens, so had to be estimated in many cases. Pectoral-fin length is from the upper fin base to the tip of the longest ray, in a straight line. Pelvic-fin length is from the base of the spine to the tip of the longest ray, in a straight line. Pectoral-fin ray counts include the uppermost simple rudimentary ray. The last dorsal and anal-fin rays are divided to the base, but counted as a single ray. Lateral-line scale counts are tubed scales to the base of the caudal fin, and do not include additional tubed scales on the fin. Transverse scale rows above the lateral line are taken from the base of the first dorsal-fin spine in a slightly oblique row to the lateral line. Transverse scale rows below the lateral line are taken vertically from the base of the first anal-fin spine to the lateral line. The lateral-line scale is not included in either of the above. Gill raker counts are taken on the first arch and include all rudiments at least as long as they are wide. The raker at the angle is included in the lower limb count. Vertebral counts were made from radiographs and skeleton preparations. Measurements were taken with digital calipers, to the nearest 1.0 mm, with the aid of a stereo microscope where necessary. Where different, values for paratypes follow those of the holotype in parentheses. Meristic and morphometric details for the new species are presented in Tables 3–5.

Molecular analysis. Tissues from six specimens of *Plectorhinchus*, including one *P. unicolor* and five *P. caeruleonothus* **sp. nov.** were sequenced for the DNA barcoding CO1 marker fragment, following the methods outlined in Ward *et al.* (2008). Existing CO1 sequences (n= 27) for eight other *Plectorhinchus* species, further *P. unicolor*, and two other species of the Haemulidae were obtained from GenBank, BOLD (Barcode of Life Database) and other sources, to use as outgroups in the phylogenetic analysis (Table 1). Where possible, the species identification of sequences accessed from BOLD or GenBank was validated via examination of the associated voucher specimen, or from photographs.

The new *Plectorhinchus* sequences and several other unpublished sequences were deposited in GenBank (accession numbers in Table 1). Chromatographs were checked and all sequences were aligned using Geneious v

7.1.7 (created by Biomatters, available http: www.geneious.com). Average pairwise sequence divergence (uncorrected p) was calculated among and between species using PAUP* v4.b.10 (Swofford, 2002). Bayesian phylogenetic analyses were carried out in MrBayes v3.2.1 (Ronquist *et al*., 2012) and posterior probabilities were calculated using a Markov chain, Monte Carlo (MCMC) sampling approach. Models of sequence evolution/ substitution patterns were calculated independently and determined by the Aikaike and Bayesian information criteria (AIC and BIC) in jModeltest v2.1.4 (Guindon & Gascuel, 2003; Posada, 2008). By default MrBayes v3.2.1 performs two independent runs. We ran the analysis twice, so that four independent runs were performed. For each run, starting trees were random and four simultaneous Markov chains were run for 3,000,000 generations with trees sampled every 1,000 generations, resulting in a total of 12,000 saved trees over the four runs. Burn-in values for each run were set at 500,000 generations (500 trees) after empirical values of stabilizing likelihoods indicated that convergence of the MCMC chains had been reached. A combined majority rule consensus tree from the four independent runs was generated in PAUP* v4.b.10 (Swofford, 2002) by sequentially importing the four MrBayes tree files (.t files); excluding the first 500 trees of each tree file and retaining the previous 2,500 trees in memory. The resulting consensus tree was therefore constructed from 10,000 trees. The posterior probabilities on the consensus tree are indicated only where branch support is greater than 0.6 (Posada & Crandall, 1998).

Results

Genetics. The phylogenetic analyses indicate that *P. caeruleonothus* **sp. nov.** is a distinct monophyletic group closely related (sister taxon) to *P. albovittatus*, with both species forming a well-supported clade (posterior probability of 1) within the phylogeny (Fig. 1). Among the other *Plectorhinchus* species analysed, there are two other well supported clades which are comprised of 1) *P. gibbosus* and *P. plagiodesmus* and 2) *P. schotaf* (putative forms A and B, see below), *P. chubbi*, *P. sordidus*, *P. playfairi* and *P. unicolor*. Finally, *P. polytaenia* falls out basally to all the other species. The close genetic relationship of *P. caeruleonothus* **sp. nov.** to *P. albovittatus* is further supported by an average sequence divergence of only 2.28% (Table 2). Our analyses also clearly confirm *P. unicolor* as a separate, monophyletic clade that is strongly divergent from *P. schotaf* (average across both forms = 14.68%) (Fig 1, Table 2). Sequence divergence estimates among the *Plectorhinchus* species in our study range from 2.28% (*P. caeruleonothus* **sp. nov.**/ *P. albovittatus*), up to 16.86% (*P. plagiodesmus / P. schotaf* form B), with an overall average of 11.41% (Table 2).

Asgharian *et al*. (2011) encountered CO1 sequence divergence of 5.12% between two specimens identified as *P. schotaf* from Nayband National Park, Iran, in the Persian Gulf. Photographs of both voucher specimens in fresh condition appear consistent with *P. schotaf*, however barcoding results suggest a cryptic species closely related to *P. schotaf* may have been sampled (these two molecular forms are distinguished in this study as *P. schotaf* A and B). In the current study, sequences from specimens identified as *P. schotaf* from Mozambique and Kuwait also split, forming matches with the A and B genetic forms of Asgharian *et al*. (2011) respectively (Fig. 1), with an average sequence divergence of 4.86% (Table 2). Unfortunately, voucher specimens of the two samples from Iran and one from Mozambique were not available for morphological examination. Museum specimens of *P. schotaf* available for this study were restricted to specimens up to a maximum of 245 mm SL, precluding a detailed morphological analysis of adult specimens. In the absence of more conclusive evidence, we continue to treat all specimens from the western Indian Ocean currently identifiable as *P. schotaf* as conspecific, pending a more thorough examination using morphological analysis of larger specimens, DNA barcoding, or other genetic techniques.

We also note here that during sequence acquisition and subsequent validation of voucher identifications that we discovered a number of identification errors in published sequences. Most relevant to this study, the COI sequences listed for *P. schotaf* (voucher ODU 3228, Genbank HQ676790) and *P. sordidus* (voucher ODU 3229, Genbank HQ676791) published in Sanciangco *et al.* (2011) in fact matched other COI sequences for *P. gibbosus* and *P. schotaf* (form B), respectively. Identification of the voucher specimen for the latter (ODU 3229) was confirmed as *P. schotaf* by photographs and meristic data kindly forwarded by Dr. K. Carpenter (ODU) and was therefore included in our analyses.

TABLE 1. Specimens used in molecular analyses.

Species	Locality	Voucher Specimen	Photo ID.	Sample ID.	Tissue No.	GenBank Accession No.	BOLD Sequence ID.
Plectorhinchus albovittatus	North Direction Is., Qld, Australia	AMS I.44733-002	Yes	N/A	CSIRO UG0636	KP194675	N/A
	Kedonganan market, Bali, Indonesia	CSIRO unreg.	Yes	N/A	CSIRO BW-A7476	GU673937	N/A
	Kedonganan market, Bali, Indonesia	CSIRO unreg.	Yes	N/A	CSIRO BW-A7477	GU673934	N/A
	Tanjung Luar market, Lombok, Indonesia	CSIRO unreg.	Yes	N/A	CSIRO BW-A10606	JN313097	N/A
Plectorhinchus caeruleonothus **sp. nov.**	Weipa, Qld, Australia	QM I.39242	Yes	N/A	QM A.013073 QM A.013074	KR232081	N/A
	Weipa, Qld, Australia	AMS I.46510–001	Yes	N/A	QM A.013075 QM A.013076	KR232082	N/A
	Weipa, Qld, Australia	QM I.39295	Yes	N/A	QM A.013077 QM A.013078	KR232083	N/A
	Weipa, Qld, Australia	QM I.39243	Yes	N/A	QM A.013079 QM A.013080	KR232084	N/A
	Darwin Harbour, NT, Australia	NTM S.16708–007	Yes	N/A	NTM S.16708–007	KR232085	N/A
Plectorhinchus chubbi	Park Rynie, KwaZulu Natal, South Africa	N/A	Yes	SAIAB ADC179.2-1	N/A	JF494166	TZMSA476-04
	Park Rynie, KwaZulu Natal, South Africa	N/A	Yes	SAIAB ADC12_179.2 #6	N/A	KF489701	DSFSG844-12
Plectorhinchus gibbosus	Pomene, Mozambique	N/A	No	SAIAB ADC10_179.5 #5	N/A	HQ561466	DSFSG120-10
	Mahe, Seychelles	SAIAB 77941	No	N/A	N/A	JX042272	ANGBF4042-12
Plectorhinchus plagiodesmus	Sodwana Bay, KwaZulu Natal, South Africa	N/A	Yes	SAIAB ADC12_179.6 #1	N/A	KF489702	DSLAG1730-12
	Inhambane, Mozambique	SAIAB 86802	No	N/A	N/A	JX042281	ANGBF4071-12
Plectorhinchus playfairi	Pomone, Mozambique	N/A	Yes	SAIAB ADC11_179.7 #4	N/A	KF489703	DSFSG607-11
	Cape Videl, KwaZulu Natal, South Africa	N/A	No	SAIAB ADC179.7-1	N/A	JF494173	TZMSC097-05

……*continued on the next page*

TABLE 1. (Continued)

Species	Locality	Voucher Specimen	Photo ID.	Sample ID.	Tissue No.	GenBank Accession No.	BOLD Sequence ID.
Plectorhinchus polytaenia	Tanjung Luar market, Lombok, Indonesia	CSIRO H.7694-01	Yes	N/A	CSIRO BW-A7317	GU674383	N/A
	Kedonganan market, Bali, Indonesia	CSIRO H.7695-02	Yes	N/A	CSIRO BW-A7470	GU673945	N/A
	Kedonganan market, Bali, Indonesia	CSIRO H.7695-01	No	N/A	CSIRO BW-A7469	GU673943	N/A
Plectorhinchus schotaf (A)	Maputo, Mozambique	SAIAB 86776	No	N/A	N/A	JX042283	ANGBF4070-12
	Nayband NP, Bushehr, Iran	N/A	Yes	NPPF1105	N/A	HQ149903	NNPF105-10
Plectorhinchus schotaf (B)	Nayband NP, Bushehr, Iran	N/A	Yes	NPPF 1024	N/A	HQ149904	NNPF024-10
	Fintas Beach, Kuwait	ODU 3229	Yes	N/A	N/A	HQ676791	GBGCA2272-13
Plectorhinchus sordidus	Diani Beach, Kenya	SAIAB 96209	No	N/A	N/A	JX042284	ANGBF4036-12
Plectorhinchus unicolor	Miyazaki, Japan	MUFS 41412	No	N/A	N/A	KR232087	N/A
	Gloucester Island, Qld, Australia	QM I.39292	Yes	N/A	QM A.013072	KR232086	N/A
	Lizard Island, Qld, Australia	AMS I.44723-035	Yes	N/A	CSIRO UG0410	KP194011	N/A
	Banyuwangi, East Java, Indonesia	CSIRO H.7681-01	Yes	N/A	CSIRO BW-A7151	GU674285	N/A
	Banyuwangi, East Java, Indonesia	CSIRO H.7681-02	Yes	N/A	CSIRO BW-A7152	GU674233	N/A
Diagramma centurio	Park Rynie, KwaZulu Natal, South Africa	N/A	Yes	SAIAB ADC 08 Smith 179.1 #1	N/A	JF493353	DSFSE506-08
Diagramma pictum labiosum	West of Lizard Island, Qld, Australia	CSIRO H.6894-01	No	N/A	CSIRO BW-A6540	GU673246	N/A
	Torres Strait, Qld, Australia	CSIRO unreg.	No	N/A	CSIRO BW-A6539	GU673245	N/A
	Torres Strait, Qld, Australia	CSIRO unreg.	No	N/A	CSIRO BW-A6538	GU673248	N/A

TABLE 2. Percentage sequence divergence among *Plectorhinchus* species sampled and outgroup specimens.

Plectorhinchus	*P. albovittatus*	*P. caeruleonothus* **sp. nov.**	*P. chubbi*	*P. gibbosus*	*P. plagiodesmus*	*P. playfairi*	*P. polytaenia*	*P. schotaf* A	*P. schotaf* B	*P. sordidus*	*P. unicolor*	*D. P. labiosum*	*D. centurio*
P. albovittatus	0.00%												
P.caeruleonothus	2.28%	0.20%											
sp. nov.	±0.02%												
P. chubbi	13.52%	13.80%	0.00%										
	±0.01%	±0.02%											
P. gibbosus	12.53%	12.45%	16.13%	1.10%									
	±0.04%	±0.04%	±0.32%										
P. plagiodesmus	14.45%	13.29%	16.27%	12.18%	0.31%								
	±0.01%	±0.08%	±0.16%	±0.25%									
P. playfairi	12.04%	12.68%	4.20%	15.36%	14.58%	0.00%							
	±0.03%	±0.01%	±0.03%	±0.32%	±0.13%								
P. polytaenia	10.02%	10.45%	12.65%	13.45%	13.92%	12.65%	0.10%						
	±0.02%	±0.02%	±0.03%	±0.15%	±0.04%	±0.09%							
P. schotaf A	14.70%	16.02%	15.41%	15.18%	16.86%	14.84%	15.16%	0.16%					
	±0.03%	±0.04%	±0.00%	±0.28%	±0.13%	±0.04%	±0.08%						
P. schotaf B	14.65%	15.89%	16.12%	16.17%	16.40%	15.92%	15.41%	4.86%	0.16%				
	±0.01%	±0.03%	±0.07%	±0.19%	±0.16%	±0.08%	±0.06%	±0.06%					
P. sordidus	14.29%	14.44%	3.28%	16.38%	16.50%	5.34%	13.59%	15.64%	16.46%	N/A			
	±0.00%	±0.00%	±0.00%	±0.44%	±0.17%	±0.03%	±0.05%	±0.06%	±0.06%				
P. unicolor	12.23%	12.46%	5.13%	15.75%	15.11%	5.38%	12.52%	14.45%	14.92%	5.49%	0.29%		
	±0.03%	±0.02%	±0.02%	±0.14%	±0.08%	±0.05%	±0.06%	±0.05%	±0.07%	±0.03%			
Diagramma pictum	11.35%	11.52%	13.06%	15.48%	17.08%	13.14%	10.17%	15.48%	15.81%	13.82%	12.68%	0.00%	
labiosum	±0.00%	±0.03%	±0.01%	±0.04%	±0.03%	±0.04%	±0.03%	±0.04%	±0.05%	±0.00%	±0.05%		
D. centurio	11.59%	10.86%	12.69%	15.11%	16.45%	13.41%	9.64%	16.71%	17.01%	14.27%	13.04%	4.48%	N/A
	±0.00%	±0.04%	±0.02%	±0.11%	±0.06%	±0.11%	±0.05%	±0.10%	±0.03%	±0.00%	±0.07%	±0.00%	

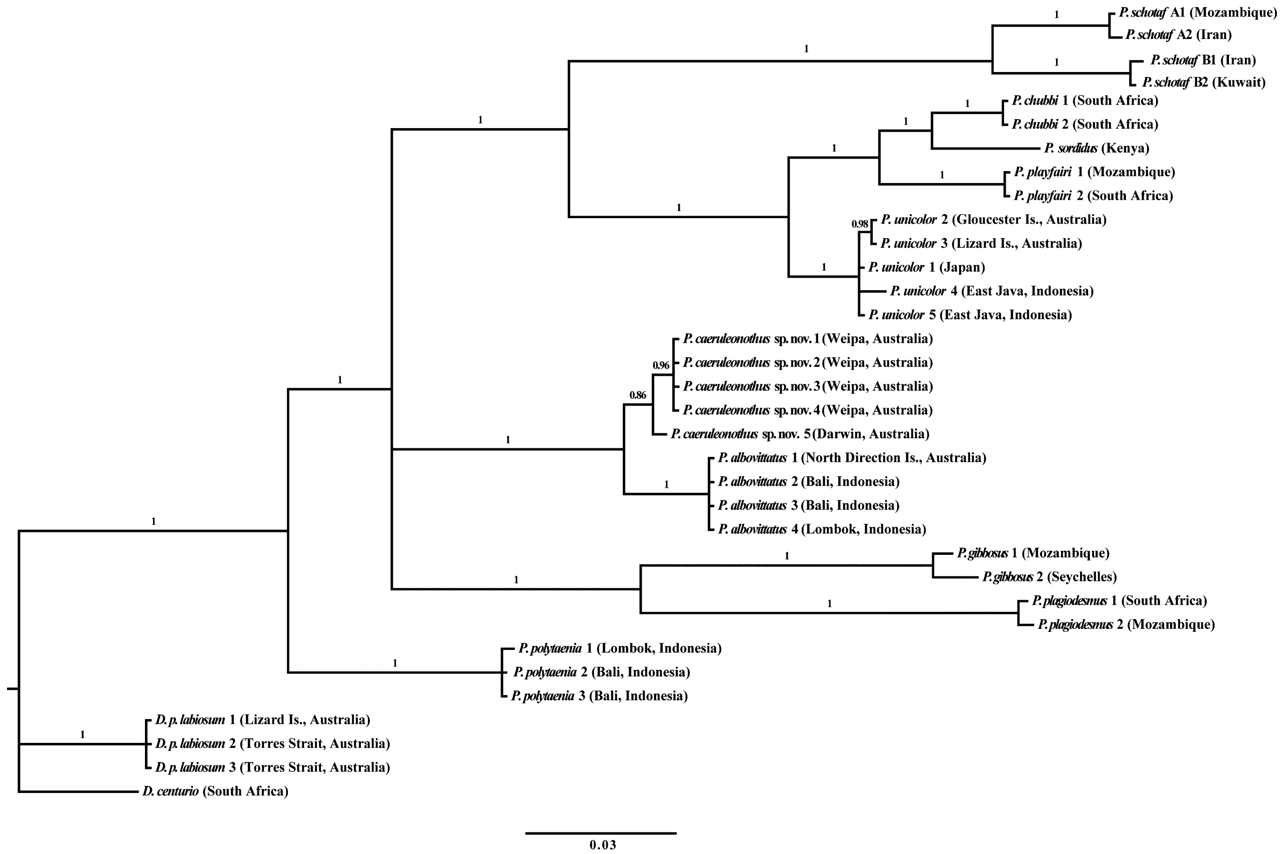

FIGURE 1. Majority-rule consensus tree of species of *Plectorhinchus* and outgroup taxa based on 4 independent runs of the DNA barcoding CO1 fragment. Posterior probabilities are detailed above the branches. Branches with < 60% support were collapsed. Scale bar represents 3% uncorrected sequence divergence. Details of specimen data and GenBank/BOLD accession numbers are provided in Table 1.

Plectorhinchus caeruleonothus **sp. nov.**
New English name: Blue Bastard
Figures 1–5, 14; Tables 1–5

Holotype. QM I.39243, 536 mm, Boyd Bay, SW of Weipa, Queensland, Australia, 12°54.9'S 141°38.6'E, 0.5–3 m, rod & line with artificial fly, B. Bright, 24 Jun 2014.

Paratypes. (n = 16) **Queensland, Australia**: AMS I.46510-001, 439 mm, same data as holotype, 3 Jul 2014; QM I.6496, 175 mm, Prince of Wales Island, 10°36'S 142°12'E, T.C. Marshall & E.G. Ogg, 9 Aug 1938; QM I.39242, 423 mm, same data as holotype, 26 Jul 2014; QM I.39295, 532 mm, same data as holotype, 8 Jul 2014 (skeleton, otoliths & tissue sample separate). **Northern Territory, Australia**: NTM S.11263-025, 182 mm, Coral Bay, Cobourg Peninsula, 11°12'S 132°03'E, 2–3 m, rotenone, B.C. Russell, 18 May 1983; NTM 16708-007, 5: 99–142 mm, Bullocky Point reef, Darwin Harbour, 12°26.14'S 130°49.74'E, rotenone, H. Larson & party, 14 Nov 2008; **Western Australia, Australia**: BPBM 17384, 245 mm, Kendrew Island, ca 20°29'S 116°32'E, 4 m, spear, J.E. Randall, 12 Oct 1973; BPBM 17385, 363 mm, W side of Kendrew Island, ca 20°29'S 116°32'E, 12 m, spear, J.E. Randall, 13 Oct 1973; CSIRO CA.1444, 291 mm, Monte Bello Islands, ca 20°30'S 115°30'E, spear, CSIRO, 11 Dec 1979; CSIRO H.1481-6, 525 mm, N of Cape Preston, 20°33.2'S 116°08.9'E to 20°33.7'S 116°07.1'E, demersal trawl, 30 m, CSIRO, 25 Sep 1988; WAM P.32170-020, 110 mm, Riddell Beach, tidal rock pool, Broome, 17°59'S 122°11'E, rotenone, A. Williams, 13 May 1982; WAM P.33288-006, 169 mm, Montgomery Reef, SW corner, intertidal mid-littoral fore-reef ramp tide pools, 16°00.865'S 124°10.389'E, 0–0.5 m, rotenone, S. Morrison & J. Johnson, 20 Oct 2009.

Non-types. (n = 5) **Queensland, Australia**: QM I.34724, 36 mm, Sweers Island, east side, rockpool north of Observation Hill, 17°07.9'S 139°36.9'E, rocky overhangs, crevices, brown macroalgae & fine sand, 0.1–1.0 m, rotenone, J. Johnson & A. Gill, 19 Nov 2002. **Western Australia, Australia**: WAM P.33274-024, 3: 68–101 mm, Adele Island, reef platform at head of Frazer Channel, 15°29.474'S 123°09.798'E, 0–1.0 m, rotenone, S. Morrison & J. Johnson, 15 Oct 2009; WAM P.33291-051, 99 mm, Montgomery Reef, small tide pools, 15°53.7'S 124°20.34'E, 0–0.5 m, rotenone, S. Morrison & J. Johnson, 24 Oct 2009.

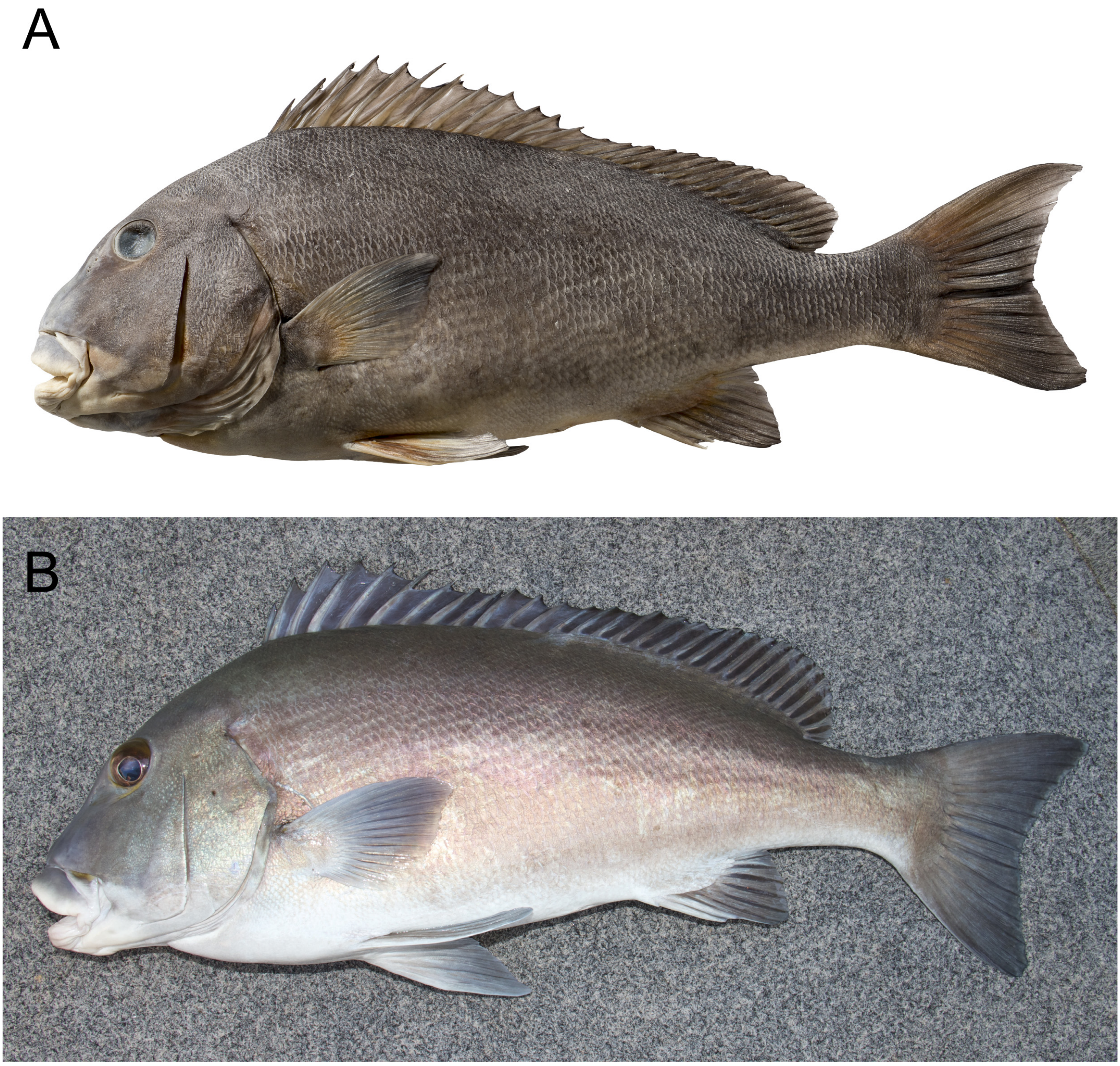

FIGURE 2. *Plectorhinchus caeruleonothus* **sp. nov.**, holotype, QM I.39242, 536 mm SL, Boyd Bay, Weipa, Queensland. **A.** Preserved. (Photo: P. Waddington); **B.** In life, immediately upon capture. (Photo: B. Bright).

Diagnosis. A species of *Plectorhinchus* with dorsal-fin rays XII, 18–20 (rarely 20); anal-fin rays III, 6–7 (rarely III, 6); pectoral-fin rays 16–17 (usually 17); lateral-line scales 56–61 (modally 59); transverse scale rows above lateral line 15; gill rakers 7–9 + 18–20 = 25–29 (modally 26); pelvic fins reaching anus in juveniles, slightly short of anus in adults; nostrils minute, 0.4–0.8 % SL, 2–3 times in distance from posterior nostril to eye; and fresh colouration in adults including body uniformly silver-grey, cheek and opercles blue-grey, rim of orbit and dorsal edge of maxilla dusky yellow, and posterior margin of opercular membrane silver-grey, non-contrasting with remainder of opercle and adjacent body.

Description. Dorsal-fin rays XII, 18 (18–20); anal-fin rays III, 7 (6–7, rarely 6); all dorsal- and anal-fin rays branched, last to base; pectoral-fin rays 17 (16–17, rarely 16), first ray rudimentary, second and lowermost rays unbranched, others branched; pelvic-fin rays I, 5, all branched; principal caudal-fin rays 9 + 8 = 17, uppermost and lowermost rays unbranched; lateral-line scales 60 (56–61, modally 59), plus about 16 smaller tubed scales on anterior third of caudal-fin base; scales above lateral line to base of first dorsal-fin spine 15; scales below lateral line to first anal-fin spine 19 (18–20); circumpeduncular scales 34 (33–35); gill rakers on first arch 7 + 19 = 26 (7–9 + 18–20 = 25–29, modally 26); branchiostegal rays 7; vertebrae 11 + 16 = 27.

Body oblong, moderately deep, depth 2.7 (2.5–2.9) in SL, and compressed, width 2.5 (2.4–2.8) in depth; head length 3.3 (3.0–3.4) in SL; dorsal profile of head moderately convex, a line from its apex forming an angle of about 38° (36–48°) from a horizontal at the snout tip, angle becoming more acute with growth, larger specimens developing small bump in snout profile followed above by slight concavity at about level of anterior nostrils (see holotype, Fig. 2A); snout long, length 2.8 (2.4–3.6) in HL, proportionally longer with growth; orbit diameter 5.4 (3.3–5.8) in HL, proportionally narrower with growth; interorbital width 3.1 (2.9–3.7) in HL; preorbital width 3.0 (3.0–4.6) in HL, proportionally wider with growth; caudal peduncle depth 2.8 (2.6–3.1) in HL; caudal peduncle length 1.3 (1.3–1.5) in HL.

Mouth moderately large, tip of maxilla reaching a vertical midway between anterior and posterior nostrils (reaching between posterior nostril and eye in subadults, to anterior margin of eye or slightly beyond in juveniles), upper jaw length 3.6 (3.4–3.7) in HL; lips thick and fleshy, upper lip protruding slightly beyond tip of lower jaw; teeth conical, outer series distinctly enlarged, but no canines, in band of up to 6 rows wide anteriorly in each jaw; band in upper jaw narrowing gradually to become one or two rows wide for about last 4 teeth in series; band in lower jaw narrowing abruptly at about midsection of jaw to become uniserial posteriorly; teeth in outer series of upper jaw about 20 on each side, those of lower jaw about 18 on each side; numerous small fleshy papillae interdigitating among teeth, fleshy flap behind bands of teeth in each jaw with shorter more flattened papillae that gradually decrease in size posteriorly; vomer and palatines edentate; tongue smooth, with broadly rounded tip; chin with 3 pairs of prominent pores, pair on lower lip closest together, others evenly spaced; gill rakers moderately long, raker below the angle longest, about 3 (2.5–4.0) in orbit diameter.

Nostrils minute, posterior nostril slightly smaller and dorsoposterior to anterior nostril, its width 10.6 in orbit diameter (10.1–14.0); posterior nostril in front of and just below a horizontal from centre of eye, anterior nostril just below horizontal from lower margin of eye (posterior nostril on horizontal from centre to lower third of eye, anterior nostril on horizontal from lower margin of pupil to just below lower margin of eye); internarial distance moderately wide, 2.5 (2.0–2.8) in distance from posterior nostril to eye; distance from posterior nostril to eye wide, 2.0 (1.8–4.7) in orbit diameter (1.8–2.6 in specimens > 250 mm SL); posterior nostril with raised membranous rim and broadly rounded flap anteriorly, flap about half nostril width (flap one-third to subequal to nostril width); anterior nostril with higher raised membranous rim and longer more spatulate flap posteriorly, slightly greater than nostril width.

Opercle lacking exposed spine; posterior edge of preopercle finely serrate (serrations more distinct in juveniles and subadults); margins of subopercle, including angle and interopercle, smooth.

Scales small and ctenoid on body and most of head, cycloid anteriorly on interorbital and suborbital; lateral line continuous, gently curved anteriorly, following dorsal contour of body and becoming straight on peduncle; head scaled except on snout just forward of anterior nostrils and band from anterior margin of eye to snout, bounded above by an oblique imaginary line from just above dorsal margin of eye through dorsal edge of anterior and posterior nostrils; small imbedded scales on preorbital reaching anteriorly to vertical just anterior to anterior nostril; horizontal scale rows from preorbital margin opposite tip of maxilla across cheek to edge of preopercle about 40, vertical rows below middle of eye obliquely to margin of preorbital about 30 (difficult to count accurately due to scales becoming imbedded with growth, numerous small supplementary scales, and irregular size and alignment of scales along rows); basal sheath of scales present on dorsal and anal fins; spinous and soft portions of dorsal fin with 1–2 and about 4–8 scale rows at bases respectively; spinous and soft portions of anal fin with 2–3 and about 4–7 scale rows at bases respectively; minute scales sparsely distributed on soft rays of all fins, except inner base of pelvic fins; axil of pectoral fin with scaly process, fleshy inner base naked.

Dorsal fin scarcely notched, its origin just anterior to vertical from posterior margin of opercle (midway between upper corner and posterior margin of opercle to just anterior to posterior margin of opercle); base of soft dorsal-fin usually subequal to that of spinous portion, 1.0 (0.9–1.3) in its length; interspinous membranes distinctly incised; dorsal-fin spines strong, first spine 5.6 (5.1–7.3) in HL; fourth spine longest, 2.6 (2.2–2.6) in HL; fifth spine next longest, followed by third; 12th (12th or 13th) soft dorsal-fin ray longest, 2.5 (1.7–2.7) in HL (2.2–2.7 in specimens > 250 mm SL); origin of anal fin below base of 4th (3rd to 5th) soft dorsal-fin ray; first anal-fin spine short, 3.9 (3.5–4.8) in second; second anal-fin spine more robust and slightly longer than third (slightly shorter than third in some paratypes), 2.9 (1.7–2.9) in HL; second anal-fin ray longest, 2.0 (1.5–2.1) in HL; anal-fin base short, 1.3 (1.3–1.8) in its height; caudal fin emarginate (truncate in small juveniles), 1.5 (1.3–1.5) in HL; fifth pectoral-fin ray longest, 1.6 (1.4–1.6) in HL, subequal to pelvic fins; origin of pelvic fins posterior to lower base of pectoral fins, on vertical from base of 4th to 5th dorsal-fin spine; pelvic-fins nearly reaching anus (reaching anus in juveniles and some subadults), first ray longest (second subequal to first), 1.6 (1.3–1.6) in HL.

Colour when fresh. Holotype (Fig. 2B) silver-grey above on head and body, gradually becoming lighter below from middle of sides. Suborbital region with pale bluish reflections (particularly so immediately after specimen taken from the water). Stark white below horizontal from corner of mouth, including lower part of head, exposed branchiostegal membranes, lower pectoral-fin base, chest, belly and lower part of caudal peduncle (in life some paratypes pale grey, rather than white on lower head and body, changing to white on death). Iris generally dusky orange-yellow dorsally and narrowly a more pale orange-yellow ventrally. Orbital margin orange-yellow, with narrow streak of same hue extending about half width of eye anteroventrally from posteroventral margin. Dorsal half of upper lip blue-grey, lower portion stark white. Maxillary groove and dorsal margin of maxilla dusky-yellow, remainder of maxilla stark white. Skin beneath edge of preopercles and upper branchiostegal membrane below posterior tip of opercle narrowly dusky-yellow, latter not visible externally unless opercles are flared (two of three paratypes from type locality lacking any yellowish pigmentation in these areas). Inside mouth white anteriorly, but throat and gill cavity to level of preopercular margin, including base of gill arches, bright orange-red. Spinous dorsal-fin medium grey, with spines lighter silver-grey, contrasting against the membrane. Soft dorsal-fin, anal fin and caudal fin grey, with intervening membrane darker than rays. Pectoral-fin base white with diffuse dusky blotch above on outer face. Pectoral-fin axil and dorsal part of inner face dusky orange-yellow, followed below by irregular dark brown blotch extending to about centre of inner face (paratypes from type locality differ variously in the size, shade and positioning of the irregular brown blotch; in two it extends dorsally to axil, in one blotch is vague and largely replaced by orange-yellow pigmentation, however in all it covers not more than half of inner fin base). Distal third of pectoral-fin pale grey, basal two-thirds whitish. Pelvic fin with distal half pale grey, basal half white.

Paratype, BPBM 17384, 245 mm SL (Fig. 3A), dull blue-grey on head, body and fins, with numerous very faint narrow pale stripes along sides. Caudal fin covered with vague dark spots. Similar sized individuals, estimated at 30–35 cm TL, photographed underwater off Cape Leveque (Fig. 3B) and Malus Island, Dampier Archipelago, Western Australia (not collected), silver-grey with 9 narrow whitish stripes along head and body. Upper stripes continuing forward through interorbital to tip of snout after traversing head. Stripe under eye with distinct crescentic ventral curve. Caudal fin with distinct black margin and profusely spotted with irregular dark markings about half pupil diameter.

Juveniles, approximately 20–25 cm TL, photographed underwater at Malus Island and West Lewis Island (Fig. 3C), Dampier Archipelago (not collected), dark chocolate-brown, with about 10 irregular narrow white stripes along head and body. Stripes on head, including curved one below eye, aligned similarly to those described above, but slightly broader and more well-defined. Numerous oblique white stripes on dark brown background on caudal fin, stripes converging toward centre of rear margin of the fin. Pectoral fins yellow, inner fin base with central dark brown blotch.

Colour in alcohol. Holotype (Fig. 2A) uniformly greyish brown on upper head and body; fading gradually to pale cream below horizontal from upper pectoral fin base, and on underside of head, branchiostegal membranes, chest and belly. Narrow pale streak about half width of orbit extending anteroventrally from lower margin of eye. Dorsal half of upper lip and dorsal margin of maxilla dark grey, lower portions pale cream. Lower lip uniformly pale cream. Spinous dorsal-fin pale grey with some faint irregular pale cream blotching to membrane and base of fin spines. Soft dorsal-fin, anal fin and caudal fin grey, with intervening membranes darker than rays. Pectoral-fin base with diffuse dusky blotch dorsally on outer face and darker more well-defined blotch extending from axil of fin to upper half on inner face. Distal third of pectoral-fin faintly dusky. Pelvic fin with distal half faintly dusky.

Juvenile, QM I.34724, 36 mm SL (Fig. 4C), with two broad pale cream stripes laterally on head and body, contrasting strongly against dark chocolate-brown ground colouration. Upper stripe on each side originating medially at snout tip above upper lip, traversing interorbital region, passing around upper margin of orbit, through upper corner of gill opening to soft dorsal-fin base, along upper margin of caudal peduncle, and through dorsal quarter of caudal fin. Lower stripe originating on margin of preorbital midway between snout tip and tip of maxilla,

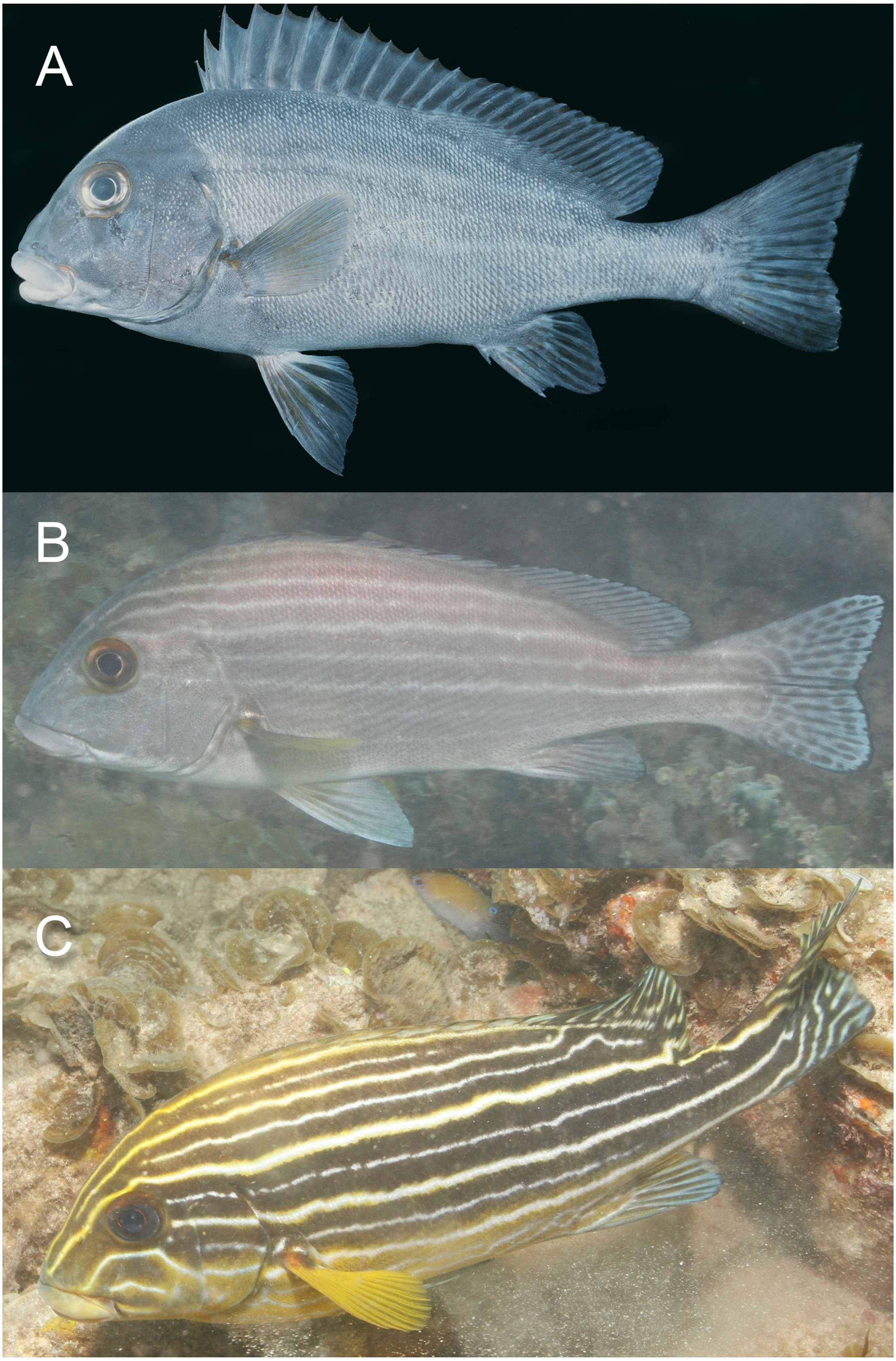

FIGURE 3. *Plectorhinchus caeruleonothus* **sp. nov. A.** Subadult, paratype, BPBM 17384, 245 mm SL, Kendrew Island, Western Australia, fresh condition. (Photo: J.E. Randall); **B.** Subadult, ca 30 cm TL, Cape Leveque, Western Australia, underwater. (Photo: G. Edgar); **C.** Juvenile, ca 25 cm TL, West Lewis Island, Dampier Archipelago, Western Australia, underwater. (Photo: G. Edgar)

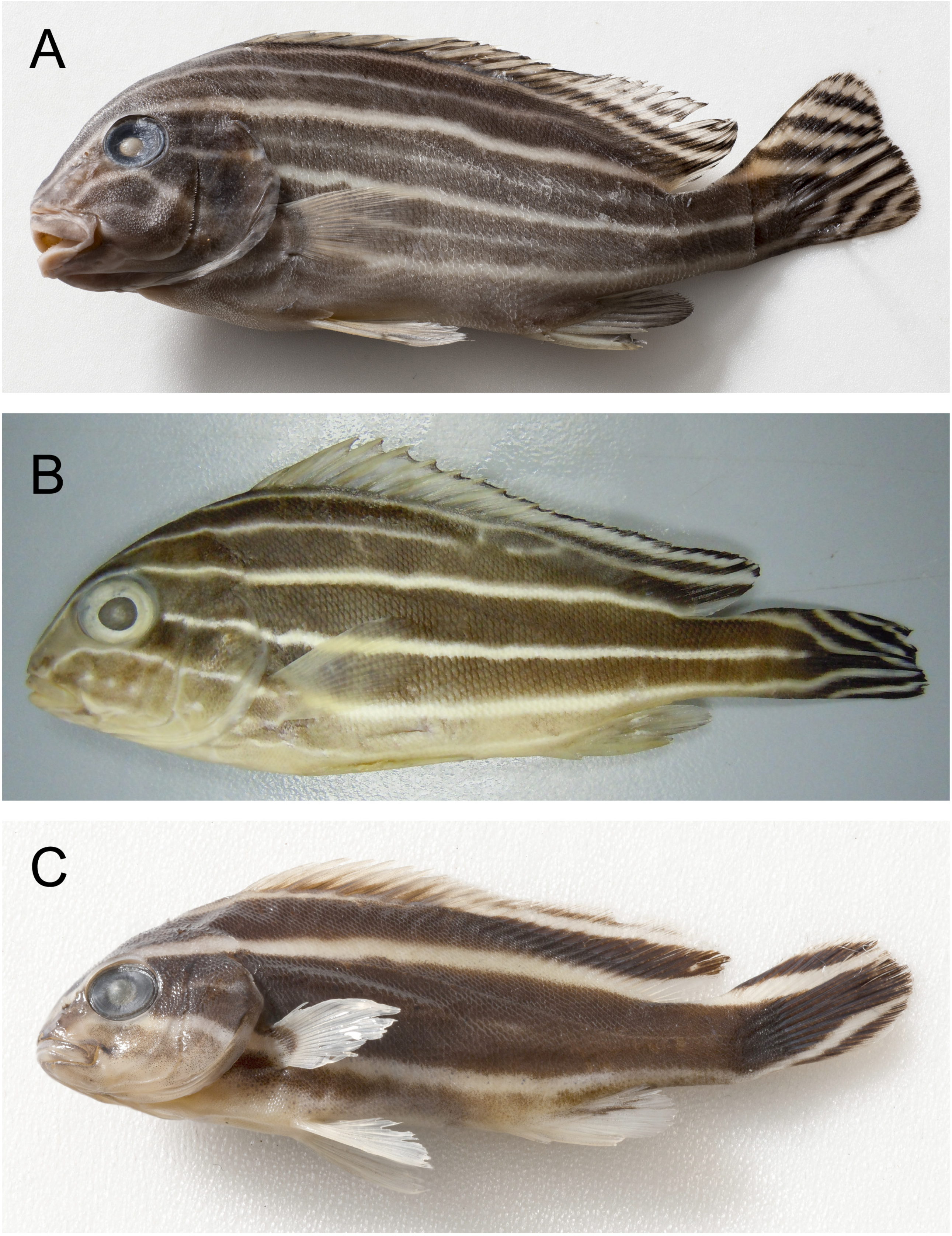

FIGURE 4. *Plectorhinchus caeruleonothus* **sp. nov.**, colour transition in preserved juveniles. **A.** Paratype, NTM S.16708-007, 129 mm SL, Darwin Harbour, Northern Territory. (Photo: P. Waddington); **B.** WAM P.33274-024, 101 mm SL, Adele Island, Western Australia. (Photo: J.W. Johnson); **C.** QM I.34724, 36 mm SL, Sweers Island, Queensland. (Photo: P. Waddington)

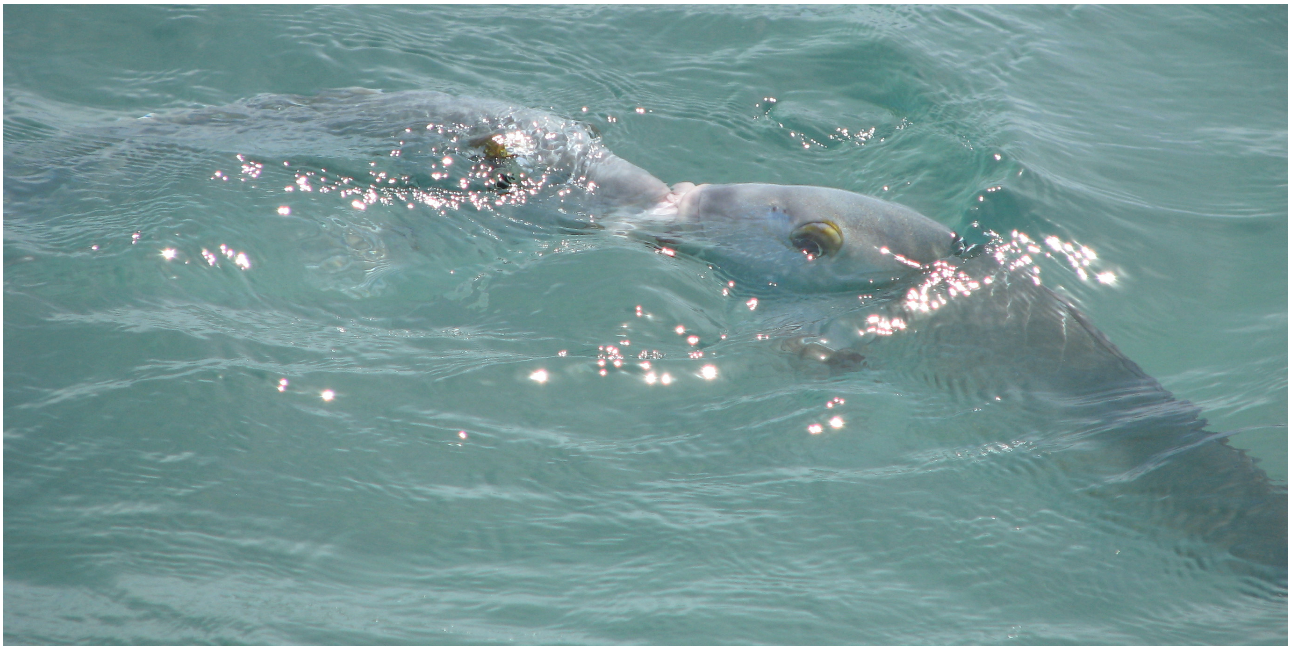

FIGURE 5. *Plectorhinchus caeruleonothus* **sp. nov.**, two individuals with jaws locked, engaging in aggressive behavior, off Weipa, Queensland. (Photo: B. Bright).

curving upward to lower margin of orbit at vertical from anterior third of eye, traversing opercle to midbase of pectoral fin, continuing along sides to lower edge of caudal peduncle and through lower quarter of caudal fin. Third narrower pale stripe originating on midline of forehead at vertical from anterior margin of orbit, bifurcating just anterior to dorsal-fin origin, continuing along spinous dorsal-fin base on each side and terminating at base of the penultimate spine. Soft dorsal-fin with submarginal pale stripe. Anal fin with diffuse dusky basal streak, extending onto last few rays of fin. Pectoral and pelvic fins semitranslucent.

Juveniles, 68–101 mm SL (WAM P.33274–024, Fig. 4B), 110 mm SL (WAM P.32170–020) and 99–142 mm SL (S.16708-007, Fig. 4A) with pale longitudinal stripes of variable width, strongly contrasting on dark brown background; stripes gradually splitting to form greater number of narrower stripes with growth; five in 68 mm SL specimen, six in 101 mm SL specimen, eight in 110 mm SL specimen and nine in 142 mm SL specimen. Caudal fin with converging pale diagonal stripes, increasing in number with growth.

Larger juvenile paratypes, 169 mm SL (WAM P.33288-006) and 182 mm SL (NTM S.11263-025), pale grey with numerous poorly-contrasting narrow pale stripes along sides of body and curved pale stripe on preorbital and suborbital, all vague and faded with preservation. Caudal fin in both specimens covered with numerous dusky spots of about one third diameter of pupil and with narrow dusky margin. Soft dorsal, anal and caudal fins with membranes contrasting slightly darker than rays. Subadult paratype, 291 mm SL (CSIRO CA.1444), lacking lateral stripes, but retaining obvious spots on caudal fin. All larger paratypes lacking stripes along body, spotting on caudal fin, or other juvenile markings.

Genetics. The phylogenetic analyses indicate that *P. caeruleonothus* differs genetically from its closest sampled congener *P. albovittatus* by only 2.28%, but from all other *Plectorhinchus* species in this study by an average of 13.19% (Table 2). Interestingly, *P. schotaf*, the species that is the most physically similar to *P. caeruleonothus* (see discussion below) is also the most genetically divergent (by 16.02% from form A and 15.89% from form B, Table 2, Fig. 1).

Etymology. From the Latin *caeruleo* for blue and *nothus* for bastard. 'Blue Bastard' has been the name commonly applied to this species by anglers for many years, so given for its blue sheen in life and difficulty to hook and land on artificial fly.

Distribution and abundance. Found on sand, rubble and reef bottom in western and far northern Australia, between Ningaloo Reef, Western Australia and Lizard Island, Queensland, mostly in the intertidal zone, or shallow reef, but one specimen also trawled in a depth of 30 m (Fig. 14).

The most southerly record on the east coast of Australia is a large individual estimated to be 1 m in total length, identified from an underwater photograph taken by J. Kerry in 2013 in Lizard Island lagoon (ca 14°41'S 145°27'E), at a depth of about 6 m. This individual and two others observed over a three month period were noted by the photographer to be solitary and actively foraging in the open sandy area of the lagoon diurnally. The species appears to be absent from the central and southern sections of the Great Barrier Reef.

TABLE 3. Selected meristic and morphometric values for specimens of *Plectorhinchus caeruleonothus* **sp. nov.** and *P. unicolor* examined (measurements as percentage of standard length).

	P. caeruleonothus		*P. unicolor*	
	Holotype QM I.29243	Paratypes n=16 (range)	Holotype AMS I.13415	Non-types n=24 (range)
Standard length (mm)	536	99–536	342	107–640
Dorsal-fin rays	XII,18	XII,18–20	XII,20	XII-XIII,17–20
Anal-fin rays	III,7	III,6–7	III,8	III,6–8
Pectoral-fin rays	17	16–17	17	16–18
Gill rakers	7+19=26	7–9+18–20=25–29	11+17=28	10–12+16–19=27–31
Lateral-line scales	60	56–61	55	54–57
Transverse scale rows	15/18	15/18–20	12/20	12–13/19–21
Vertebrae (abdominal + caudal)	11+16	11+16 (n=4)	11+16	11+16 (n=4)
Body depth	36.4	35.0–40.2	39.4	36.4–45.2
Body width	14.6	13.7–15.9	14.5	14.5–17.5
Head length	29.9	29.5–33.2	29.6	25.4–30.7
Snout length	10.8	8.9–12.6	8.0	5.5–10.2
Orbit diameter	5.6	5.2–9.8	8.3	5.2–10.0
Interorbital width	9.6	8.7–10.3	8.9	9.3–10.5
Preorbital depth	9.9	7.0–9.9	6.7	5.6–7.3
Upper jaw length	8.2	8.1–9.4	7.3	6.7–8.6
Posterior nostril width	0.5	0.4–0.8	1.4	0.9–1.5
Posterior nostril to eye	2.8	2.0–2.9	1.3	1.3–2.0
Caudal-peduncle depth	10.7	9.6–11.9	11.4	11.2–13.6
Caudal-peduncle length	22.8	21.5–24.8	19.4	18.7–21.5
Spinous dorsal-fin base	31.5	29.9–36.7	32.3	30.8–38.1
Soft dorsal-fin base	31.3	28.3–32.7	29.1	29.3–34.6
First dorsal-fin spine length	5.3	4.1–6.5	4.1	4.1–6.2
Second dorsal-fin spine length	8.5	7.5–11.6	7.5	6.9–9.8
Third dorsal-fin spine length	10.5	11.0–13.7	10.2	9.4–12.0
Fourth dorsal-fin spine length	11.6	11.3–14.6	12.3	9.7–13.2
Fifth dorsal-fin spine length	10.9	10.6–14.0	12.1	8.2–12.6
Longest dorsal-fin ray	11.8	11.2–18.8	13.4	10.6–16.2
Anal-fin base	11.6	10.3–12.2	12.1	11.1–14.2
Second anal-fin spine length	10.2	10.2–18.6	13.9	9.1–17.3
Third anal-fin spine length	10.1	11.0–16.4	13.3	9.4–15.3
Longest anal-fin ray	14.9	14.2–20.9	17.3	15.4–19.9
Caudal-fin length	20.5	19.6–25.1	21.9	19.2–25.1
Pectoral-fin length	18.1	18.2–22.3	23.8	19.8–25.9
Pelvic-fin length	19.0	19.5–24.6	21.7	17.8–25.4

TABLE 4. Frequency of dorsal and pectoral-fin rays, gill rakers and lateral-line scales in materal examined of *Plectorhinchus albovittatus*, *P. caeruleonothus* **sp. nov.**, *P. polytaenia*, *P. schotaf* and *P. unicolor* (* = holotype; data for *P. albovittatus* and *P. polytaenia* from Randall & Johnson, 2000).

	Dorsal-fin spines			Dorsal-fin rays						Pectoral-fin rays		
	XI	XII	XIII	17	18	19	20	21	22	16	17	18
P. albovittatus	-	1	15	-	14	2	-	-		-	14	2
P. caeruleonothus	-	22*	-	-	11*	10	1	-		2	20*	-
P. polytaenia	-	16	8	-	-	-	3	10	11	2	20	1
P. schotaf	1	24*	-	-	4	6	14*	1		17	6	1
P. unicolor	-	24*	1	3	6	12	4*	-		2	21*	2

	Upper gill rakers								Lower gill rakers					
	7	8	9	10	11	12	13	14	16	17	18	19	20	21
P. albovittatus	-	6	11	-	-	-	-	-	-	-	-	1	6	10
P. caeruleonothus	7*	9	5	-	-	-	-	-	-	-	3	11*	7	-
P. polytaenia	4	9	10	1	-	-	-	-	-	-	2	10	10	2
P. schotaf	-	-	-	2	8	11	3	1	7	17	1	-	-	-
P. unicolor	-	-	-	2	9*	11	-	-	1	10*	8	3	-	-

	Total gill rakers						
	25	26	27	28	29	30	31
P. albovittatus	-	-	-	4	4	8	-
P. caeruleonothus	1	8*	3	7	3	-	-
P. polytaenia	-	3	8	5	6	2	-
P. schotaf	-	1	4	6	11	2	1
P. unicolor	-	-	2	5*	8	5	2

	Lateral-line scales							
	54	55	56	57	58	59	60	61
P. caeruleonothus	-	-	1	2	7	5	5*	2
P. schotaf	9*	7	6	2	1	-	-	-
P. unicolor	3	11*	8	1	-	-	-	-

Behaviour. Agonistic behavioural interactions have been recorded between individuals of the new species. When approached by conspecifics on open sandy or rubbly flats, individuals have often been observed to interact highly aggressively, engaging in one-on-one conflicts (B. Bright pers. comm., 2014). On noticing a rival in close proximity, the two have been recorded (using video and still images) as coming together near the surface, locking jaws, and engaging in prolonged and violent struggles (Fig. 5). At the end of the struggle, one or both individuals make a hasty retreat, disappearing from view. Observations at Weipa (B. Bright pers. comm.) and Lizard Island (J. Kerry pers. comm.), indicate that large individuals are most often solitary, foraging diurnally over relatively open expanses of soft substrate. Reasons for the intraspecific agonism are uncertain, however it is surmised that individuals recognise other conspecifics as rivals for food, territory, or mating rights, and thereby mount an aggressive response to deter them. This behaviour appears to be unique among species of *Plectorhinchus*, most of which are relatively gregarious and peaceful among their own species. However, similar but less exaggerated behaviour has been reported in the family among at least three species of *Haemulon* in tropical western Atlantic region (eg. Böhlke & Chaplin, 1968; McFarland & Hillis, 1982; Mochek & Silva, 1975). Among *Haemulon* *flavolineatum*, *H. plumieri* and *H. sciurus*, aggressive responses were generally deemed by the above authors to be for defence of territory. The behaviours involved menacing rushes toward other fish, wide opening of the mouth to exhibit the bright red colour of the oral cavity, flaring of the fins, and sometimes a brief coming together of the jaws. Specimens involved in these disputes that were collected and dissected by Mochek & Silva were found to be females. In contrast to *Plectorhinchus caeruleonothus* **sp. nov.**, the *Haemulon* species tend to form small to large aggregations, at least during daylight hours.

TABLE 5. Meristic values for all material examined and proportional measurements as a percentage of standard length of similar sized specimens of *Plectorhinchus caeruleonothus* **sp. nov.**, *P. unicolor*, *P. schotaf* and *P. sordidus*.

	P. caeruleonothus	*P. unicolor*	*P. schotaf*	*P. sordidus*
Meristics	n = 22	n = 25	n = 25	n= 4
Dorsal-fin rays	XII,18–20	XII–XIII,17–20	XI–XII,18–21	XII,17–19
Anal-fin rays	III,6–7	III,6–8	III,7–8	III,8
Pectoral-fin rays	16–17	16–18	16–18	17
Gill rakers	7–9+18–20 = 25–29	10–12+16–19 = 27–31	10–14+16–18 = 26–31	10–11+15–16 = 25–26
Lateral-line scales	56–61	54–57	54–58	54–55
Transverse scale rows	15/18–20	12–13/19–21	11/18–19	10–11/16–17
Circumpeduncular scale rows	33–35	31–32	32–33	29–30
Morphometrics	n = 4	n = 8	n = 6	n = 3
Standard length (mm)	175–291	191–289	180–245	208–230
Body depth	37.6–40.2	39.9–45.2	35.3–38.4	38.6–39.1
Body width	14.6–15.9	15.4–17.5	13.8–17.0	15.8–16.4
Head length	30.9–33.2	26.4–30.7	28.3–32.5	28.3–31.3
Snout length	9.1–10.8	5.5–8.5	6.9–9.9	7.4–7.7
Orbit diameter	6.9–9.5	7.5–9.0	7.9–9.2	8.5–9.5
Interorbital width	9.2–9.6	9.3–10.5	9.1–9.7	9.5–9.6
Preorbital depth	7.9–9.3	6.0–6.7	6.0–6.6	5.7–6.1
Upper jaw length	8.9–9.3	6.7–8.6	7.7–8.6	7.7–8.4
Posterior nostril width	0.6–0.7	1.0–1.4	0.9–1.2	0.8–1.1
Posterior nostril to eye	2.3–2.6	1.5–1.9	1.5–2.0	2.1–2.3
Caudal-peduncle depth	11.0–11.8	12.9–13.6	10.7–12.7	11.6–12.3
Caudal-peduncle length	21.6–23.1	19.0–20.7	19.1–19.9	15.4–16.5
Spinous dorsal-fin base	31.6–35.4	33.3–36.8	30.1–33.6	33.0–36.1
Soft dorsal-fin base	28.8–32.7	30.4–34.5	29.8–35.3	30.2–31.3
First dorsal-fin spine length	5.2–6.5	4.6–5.3	4.0–5.0	4.6–5.6
Second dorsal-fin spine length	9.5–11.6	7.6–9.5	7.3–9.5	8.0–8.6
Third dorsal-fin spine length	11.1–13.7	10.3–11.6	9.2–12.0	10.1–10.9
Fourth dorsal-fin spine length	12.6–14.6	10.1–12.8	10.2–13.2	11.4–12.3
Fifth dorsal-fin spine length	11.8–13.9	10.4–12.6	10.5–12.7	11.3–12.2
Longest dorsal-fin ray	14.8–15.4	13.0–17.7	11.1–13.8	12.3–13.5
Anal-fin base	10.8–11.4	12.1–14.1	10.5–12.6	11.7–13.8
Second anal-fin spine length	13.7 –16.5	13.7–16.7	12.9–15.8	13.9–16.8
Third anal-fin spine length	13.1–14.8	11.7–15.2	11.9–14.2	12.3–13.6
Longest anal-fin ray	17.3–18.7	15.4–19.9	14.7–18.2	14.4–16.3
Caudal-fin length	22.0–24.5	21.1–25.1	18.5–21.5	17.9–21.1
Pectoral-fin length	20.2–21.8	21.6–25.9	19.1–20.9	21.8–22.9
Pelvic-fin length	22.5–23.4	21.4–26.1	18.6–21.0	20.4–21.9

Discussion. *Plectorhinchus caeruleonothus* (Fig. 2–4) is most physically similar to *P. schotaf* (Fig. 10–11), sharing similar morphology, meristic formulae, and colouration in adults, including a mostly uniform silver-grey head and body with yellowish highlights to the orbital margin and dorsal edge of the maxilla. It differs from that species most obviously in having the colouration of the margin of the opercular membrane and skin covering the underlying cleithrum consistent with that of the adjacent head and body (opercular margin and skin covering the underlying cleithrum crimson red when fresh, contrasting strongly against silver-grey colouration of adjacent head and body in *P. schotaf*). In addition, the rear base of the pectoral fin is dusky orange-yellow from the axil when fresh, usually with an irregular dark brown blotch in the upper half (red, with no brown blotch in *P. schotaf*). However, colouration of juveniles is strikingly different between the two species. Juveniles of *P. caeruleonothus* have strongly contrasting pale stripes on a dark background along the head and body (Fig. 3B–C, 4A–C). The pale stripes become narrower and more numerous with growth, until they fade completely by about 250 mm SL (Fig. 3A). The caudal fin has alternating pale and dark diagonal stripes, which gradually break up into dark spots and disappear by about 300 mm SL (Fig. 3–4). In contrast, small juveniles of *P. schotaf* have about six narrow pale blue lines along the head and body on a yellowish background (Fig. 11; see also Randall, 1995, Fig. 538; specimen BPBM 30410, 45 mm SL, labelled as *P. sordidus*). There are no distinctive markings on the caudal fin at any life stage in *P. schotaf* and the lines on the head and body fade and disappear much earlier, by about 120 mm SL. Although meristics for both species mostly overlap, there are numerous modal differences in counts: soft dorsal-fin rays (18–20, rarely 20, versus 18–21, modally 20 in *P. schotaf*), pectoral fin-rays (16–17, modally 17, versus 16–18, modally 16 in *P. schotaf*), gill rakers (7–9, modally 8 upper rakers, 18–20, modally 19 lower rakers, 25–29, modally 26 total rakers, versus 10–14, modally 12 upper rakers, 16–18, modally 17 lower rakers, 26–31, modally 29 total rakers in *P. schotaf*), lateral-line scales (56–61, modally 59, versus 54–58, modally 55 in *P. schotaf*) and transverse scale rows above the lateral line (15, versus 11 in *P. schotaf*) (Table 4–5). Differences also exist in various proportional measurements at a given length, with the *P. caeruleonothus* having a wider preorbital depth, longer upper jaw, smaller nostrils, wider distance from the posterior nostril to eye, longer caudal peduncle, longer first and second dorsal-fin spines, higher soft dorsal fin, and longer caudal and pelvic fins (Table 5).

Although *P. caeruleonothus* is most closely aligned and genetically similar to *P. albovittatus* based on barcoding results (Fig. 1, Table 2), the latter is readily distinguished morphologically, by colouration and meristic data. Adults of *P. albovittatus* are dark grey with numerous small pale spots and short irregular lines on the head and body; the soft dorsal-fin and lobes of the caudal fin have large black areas; and the anal, pectoral and pelvic fins are black (no pale spots or irregular lines over the head and body, and no prominent black areas on any fins in *P. caeruleonothus*). In common with *P. caeruleonothus*, small juveniles of *P. albovittatus* have three narrow pale stripes alternating with two much broader dark brown to black stripes along the body, however the lower pale stripe fades or terminates anteriorly at the posterior margin of the eye (narrow pale stripe continues across the suborbital and curves ventrally to the maxilla on the preorbital region in *P. caeruleonothus*, see Fig. 4C). In larger juveniles and subadults of *P. albovittatus* longitudinal stripes remain few and broad (versus stripes gradually splitting with growth to form multiple narrower stripes; up to 10 pale stripes forming in subadults of *P. caeruleonothus* before disappearing in the adult stage). The number of dorsal-fin spines and total gill rakers are also usually greater in *P. albovittatus* (XII–XIII, rarely XII and 28–30, median 29, versus XII and 25–29, median 27 respectively in *P. caeruleonothus*, Table 4).

Plectorhinchus caeruleonothus may be distinguished from the sympatric *P. unicolor* by fresh colouration (Fig. 2B, 3A–C, versus 6B, 7A–B, 8A–B, 9A–B), as well as various counts and proportional measurements. The head and body of adults is generally silver-grey to blue-grey in life and slate-grey on death, versus bronze, olive-brown, or tan in life and grey-brown on death in *P. unicolor*. Colouration of the posterior margin of the opercular membrane and underlying cleithrum is non-contrasting against the adjacent head and body, versus opercular margin dusky and the underlying cleithrum red in *P. unicolor*. In addition, the caudal fin of adults in life is uniformly grey (slightly darker than that of the upper body), versus dull yellowish, or greenish brown in adults and bright yellow in juveniles of *P. unicolor*. Juveniles have a distinctive pattern of pale longitudinal stripes on a dark background along the head and body, and alternating pale and dark oblique stripes on the caudal fin, gradually transforming into spots in subadults (Fig. 3A–C, 4A–C), versus juveniles with head, body and caudal fin uniformly coloured, without stripes, spots, or other distinctive markings in *P. unicolor* (Fig. 7A–C). *Plectorhinchus caeruleonothus* has a lower upper gill raker count (7–9, versus 10–12 in *P. unicolor*), a lower total gill raker count (25–29, modally 26, versus 27–31, modally 29 in *P. unicolor*), a higher lateral-line scale count (56–61, modally 59, versus 54–57, modally 55 in *P. unicolor*), a higher transverse scale count above the lateral line (15, versus 12–13 in *P. unicolor*) and a higher circumpeduncular scale count (33–35, versus 31–32 in *P. unicolor*) (Tables 3–5). It may also be separated by proportional measurements, including smaller nostrils, wider distance from the posterior nostril to eye and a longer caudal peduncle, as well as a longer snout and wider preorbital depth in specimens up to 500 mm SL (Table 3).

Among other species of *Plectorhinchus* with a uniform body colouration, *P. caeruleonothus* can readily be distinguished from *P. ceylonensis* and *P. gibbosus* by dorsal-fin spine and ray counts (XII, 18–20, versus XIV, 19 in *P. ceylonensis* and XIII–XIV (rarely XIII), 15–17 in *P. gibbosus*); from *P. chubbi* by dorsal-fin spine and ray and gill raker counts (XII, 18–20 and 7–9 + 18–20, versus XI–XII (rarely XII), 16–17 and 13–16 + 22–24 in *P. chubbi*); from *P. griseus* by dorsal-fin ray and upper gill raker counts, lateral profile of the forehead, and body depth (XII, 18–20 and 7–9 + 18–20, lateral profile of snout without distinct concavity, depth 2.5–2.9 in SL, versus XII, 21–23 and 11–12 + 17–18, lateral profile of snout with distinct concavity in adults (Fig. 12B), depth 2.2–2.4 in SL in *P. griseus*); and from *P. sordidus* (fig. 13a–b) by gill raker counts (7–9 + 18–20, versus 9–11 + 15–16 in *P. sordidus*).

Although adults of *P. caeruleonothus* can easily be distinguished from *P. polytaenia* by colouration, most meristic values overlap and juveniles of both species up to about 150 mm SL are marked with a similar pattern of pale longitudinal stripes. Hence juveniles have frequently been confused in museum collections. The juveniles are separated most readily by dorsal-fin ray counts (XII, 18–20 (rarely 20), versus XII–XIII, 20–22 in *P. polytaenia*) and by the alignment of the pale lines on the suborbital and interorbital regions of the head. In *P. caeruleonothus* lines on the suborbital are crescentic, strongly curving up from the preopercular margin toward the eye, then down on the preorbital to the maxilla (not meeting across the snout with those from the opposite side), and the lines from the nape pass forward straight through the interorbital region to terminate on or near the snout tip (Fig. 3C, 4A-C). In contrast, in *P. polytaenia* the longitudinal lines on the suborbital and preorbital regions are straight to slightly wavy, and meet across the snout with those from the opposite side (Fig. 12A). The lines extending forward from the nape all converge just posterior to or within the interorbital space, and all markings on dorsal part of snout are transverse across the snout.

***Plectorhinchus unicolor* (Macleay, 1883)**
English name: Sombre Sweetlips
Figures 1, 6–9, 14; Tables 1–5.

Diagramma unicolor Macleay, 1883: 261 (type locality: China Strait); Smith, 1962: 498 (as probable junior synonym of *P. schotaf* (Forsskål).
Plectorhinchus unicolor (Macleay): Randall *et al*., 1997: 195, upper fig.; Johnson, 1999: 736; Hutchins, 2001: 35; Allen & Adrim, 2003: 40; Allen *et al*., 2003: 172, centre left fig.; Myers & Donaldson, 2003: 627.
Plectorhinchus schotaf (non Forsskål, 1775): Akazaki in Masuda *et al*., 1984: 172, pl. 160F; Randall *et al*., 1990: 195, upper fig.; Shimida in Nakabo, 2002: 844; McKay, 2001: 2981 (in part); Allen *et al*., 2006: 1223; Chen *et al*., 2010: 232, fig. C; Johnson, 2010: 320, 340.
Plectorhinchus sp.: Francis, 1993: 161.
Plectorhinchus sp. A: Myers, 1999: 151, pl. 67C.

Holotype. AMS I.13415, 342 mm, China Strait, Papua New Guinea, Mr. Goldie.

Non-types. (25: 107–640 mm) **Western Australia, Australia**: WAM P.20127-001, 516 mm, Delambre Island, Dampier Archipelago, 20°26'S 117°04'E, R.J. McKay, 29 Oct 1971; WAM P.20287-001, 570 mm, Rottnest Island, west end, 32°00'S 115°30'E, spear, B. Paxman, 1972; WAM P.27178-001, 551 mm, Kalbarri, 27°44'S 114°06'E, handline, T. Jurjevic, May 1976; WAM P.29704-001, 640 mm, Exmouth area, 21°55'S 114°10'E, spear, Australian Underwater Federation, Jan 1988. **Queensland, Australia**: AMS I.7743, 131 mm, Moreton Bay, ca 27°25'S 153°20'E, 1906, Amateur Fishermen's Association of Queensland; AMS I.44723–035, 383 mm, Lizard Island, Mermaid Cove, N of mooring, 14°38'44"S 145°27'18"E, 3–10 m, spear, 8 Sep 2008, J. Johnson; QM I.6812, 338 mm, Horseshoe Bay, Magnetic Island, 19°07'S 146°51'E, 6 Sep 1939, G. Coates; QM I.10271, 302 mm, Off Bundaberg, ca 24°50'S 152°29'E, spear, Dec 1972, G. Lowe; QM I.11321, 199 mm, Off Cairns, ca 16°52'S 145°56'E, spear, 1973, H. Jesse; QM I.11456, 455 mm, Cairns, offshore reefs, ca 16°55'S 146°10'E, spear, Feb 1974, P. Pike; QM I.12664, 300 mm, Teewah Beach, Cooloola, 26°17'S 153°04'E, 17 Aug 1974, E.M. Grant; QM I.12711, 228 mm, Off Bundaberg, ca 24°50'S 152°29'E, spear, 20 Sep 1974, G. Lowe; QM I.12722, 282 mm, same data as previous; QM I.12907, 267 mm, Off Cairns, ca 16°52'S 145°56'E, spear, Dec 1974, H. Jesse; QM I.20130, 289 mm, Frankland Islands, Qld, 17°13'S 146°05'E, 7 m, spear, Nov 1982, J. Johnson; QM I.20131, 336 mm, same data as previous; QM I.21124, 357 mm, Cape Moreton, below lighthouse, 27°02'S 153°28'E, spear, 9 Aug 1984, J. Johnson; QM I.27499, 234 mm, Off Mooloolaba, 26°40'S 153°15'E, 1 Sep 1991, D. Tuma; QM I.29477, 142 mm, Cowan Cowan, Moreton Island, 27°08'S 153°22'E, 2 m, spear, 31 Oct 1994, J. Johnson; QM I.39292, 352 mm, NE end of Gloucester Island, 19°58'44"S 148°27'37"E, 3 m, spear, 30 Sep 2014, J. Johnson; QM I.12708, 285 mm, Off Bundaberg, ca 24°50'S 152°29'E, spear, 20 Sep 1974, G. Lowe (skeleton); QM I.12709, ca 230 mm, same data as previous (skeleton); QM I.12712, ca 240 mm, same data as previous (skeleton); QM I.20298, length not recorded, Frankland Islands, 17°13'S 146°05'E, 7 m, spear, Nov 1982, J. Johnson (skeleton). **New South Wales, Australia**: AMS I.15838–004, 107 mm, Tweed River mouth, 28°10'S 153°33'E, 1969, J. Lewis. **Indonesia**: CSIRO H.7681-01, 191 mm, Banyuwangi, East Java, 8°09'S 114°23'E, 27 Feb 2009, W. White; CSIRO H.7681-02, 191 mm, same data as previous. **Japan**: KPM-NI 28726, 247 mm, Kin Bay, E coast of Okinawa-jima Island, Ryukyu Islands, 26°25'12.151"N 127°49'49.182"E, spear, 2.0–2.5 m, H. Senou, 6 Jun 2011; MUFS 17430, 302 mm, Meitsu fishing port, Miyazaki Prefecture, H. Motomura, 12 Apr 1999.

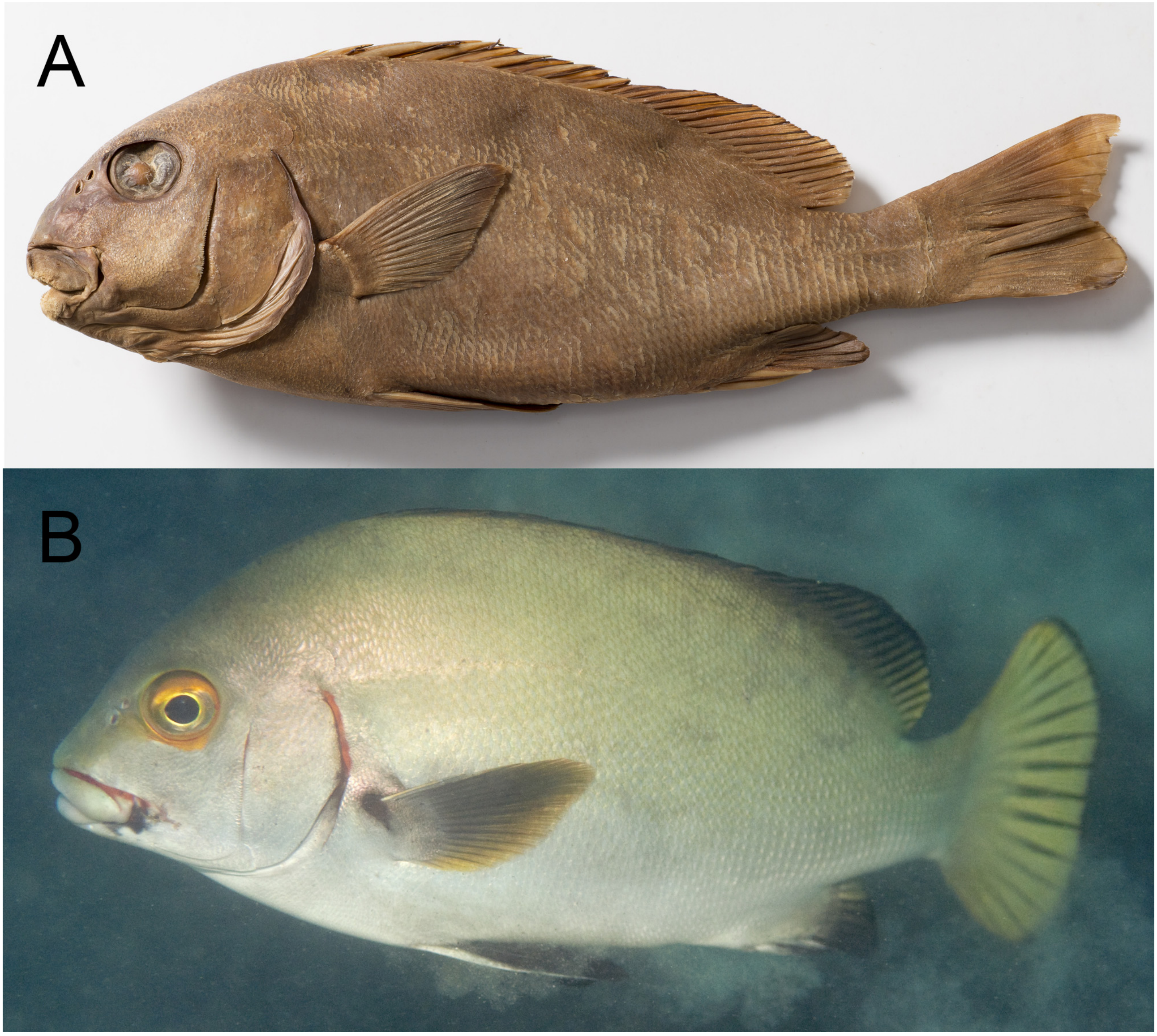

FIGURE 6. *Plectorhinchus unicolor.* **A.** Holotype, AMS I.13415, 342 mm SL, China Strait, Papua New Guinea, preserved. (Photo: P. Waddington); **B.** Adult, ca 40 cm TL, Southport Seaway, Queensland, underwater. (Photo: I. Banks).

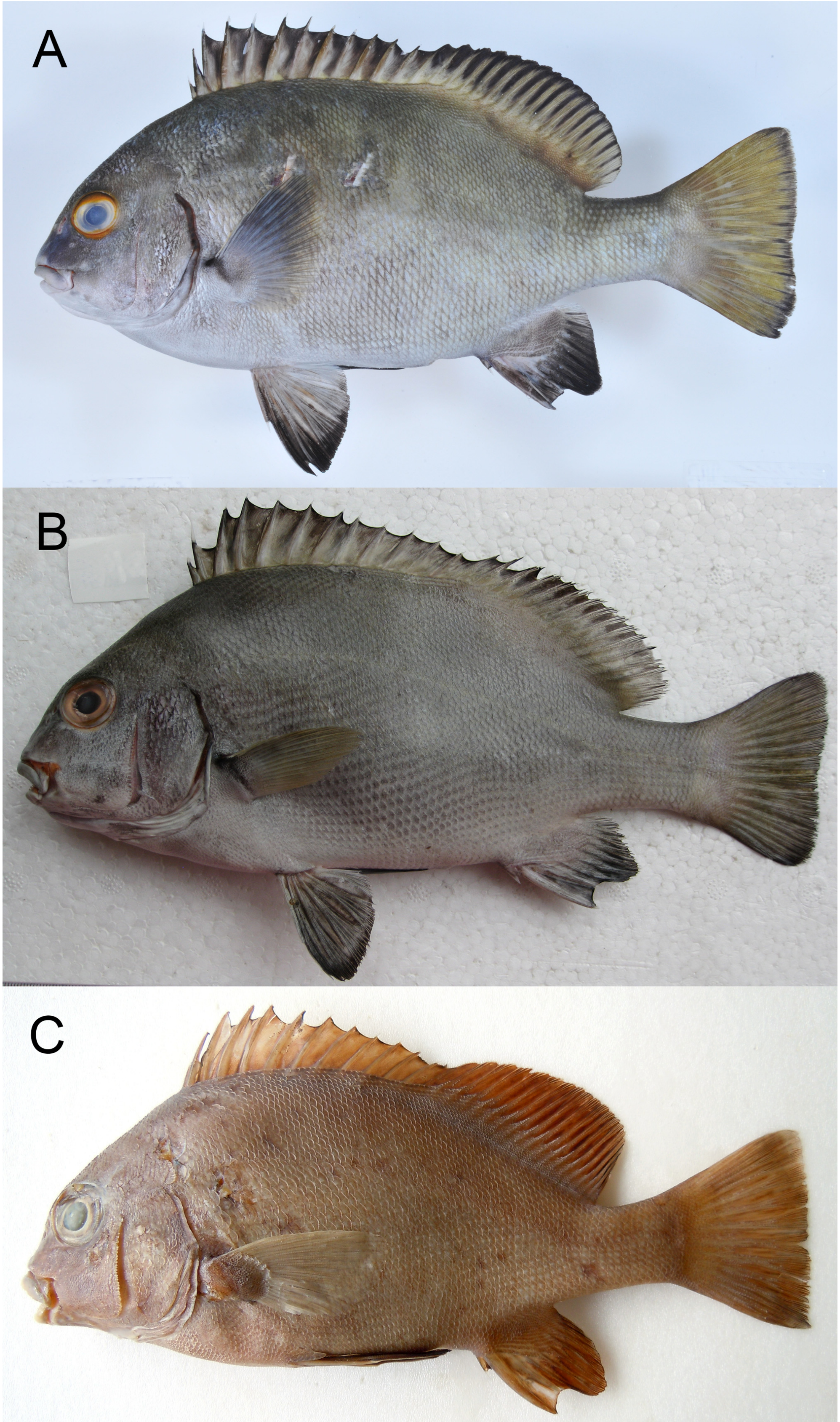

FIGURE 7. *Plectorhinchus unicolor.* **A.** Subadult, KPM-NI 28726, 247 mm SL, Okinawa-jima Isl., Ryukyu Isls., Japan, fresh condition. (Photo: H. Senou); **B.** Juvenile, CSIRO H.7681-02, 191 mm SL, Banyuwangi, East Java, Indonesia, fresh condition. (Photo: W. White); **C.** Juvenile, QM I.29477, 142 mm SL, Cowan Cowan, Moreton Bay, Queensland, preserved. (Photo: J.W. Johnson).

Diagnosis. A species of *Plectorhinchus* with dorsal-fin rays XII–XIII (rarely XIII), 17–20 (modally 19); anal-fin rays III, 6–8 (rarely 6); pectoral-fin rays 16–18 (usually 17); lateral-line scales 54–57 (modally 55); transverse scale rows above lateral line 12–13; gill rakers 10–12 + 16–19 = 27–31 (modally 29); pelvic fins usually reaching slightly short of anus; nostrils large, posterior nostril 0.9–1.5 % SL, 0.9–1.8 times in distance from posterior nostril to eye; fresh colouration of head and body generally olive-brown, tan, or grey-brown; posterior margin of opercular membrane dusky, with underlying cleithrum red; and caudal fin bright yellow in juveniles, to dull yellowish or greenish brown in adults.

Description. Dorsal-fin rays XII, 20 (XII–XIII, rarely XIII, 17–20, modally 19); anal-fin rays III, 8 (III, 6–8, rarely 6); all dorsal- and anal-fin rays branched, last to base; pectoral-fin rays 17 (16–18, rarely 16 or 18), first ray rudimentary, second and lowermost rays unbranched, others branched; pelvic-fin rays I, 5, all branched; principal caudal-fin rays 9 + 8 = 17, uppermost and lowermost rays unbranched; lateral-line scales 55 (54–57, modally 55), plus about 13 smaller tubed scales on anterior third of caudal-fin base; scales above lateral line to base of first dorsal-fin spine 12 (12–13); scales below lateral line to first anal-fin spine 20 (19–21); circumpeduncular scales 31 (31–32); gill rakers on first arch 11 + 17 = 28 (10–12 + 16–19 = 27–31, modally 29); branchiostegal rays 7; vertebrae 11 + 16 = 27.

Body oblong, moderately deep, depth 2.6 (2.2–2.7) in SL, and compressed, width 2.7 (2.3–2.8) in depth; head length 3.4 (3.3–3.9) in SL; dorsal profile of head distinctly convex, a line from its apex forming an angle of about 40° (40–53°) from a horizontal at the snout tip; snout short, length 3.7 (2.9–5.1) in HL; orbit diameter 3.6 (3.0–5.6) in HL, proportionally narrower with growth; interorbital width 3.3 (2.6–3.3) in HL; preorbital width 4.4 (3.6–5.4) in HL; caudal peduncle depth 2.6 (1.9–2.6) in HL; caudal peduncle length 1.5 (1.2–1.6) in HL.

Mouth small, tip of maxilla reaching a vertical just anterior to anterior margin of eye (between posterior nostril and just posterior to anterior margin eye), upper jaw length 4.1 (3.1–4.5) in HL; lips thick and fleshy, upper lip protruding beyond tip of lower jaw; teeth conical, outer series distinctly enlarged, but no canines; in band of up to 5 rows wide anteriorly in upper jaw and up to 6 rows wide anteriorly in lower jaw; band in upper jaw narrowing gradually to become one or two rows wide for about last 4 teeth in series; band in lower jaw narrowing abruptly at about midsection of jaw to become uniserial for about last 7 teeth in series; teeth in outer series of upper jaw about 24 (22–25) on each side, those of lower jaw about 22 (20–22) on each side; numerous small fleshy papillae interdigitating among teeth, fleshy flap behind bands of teeth in each jaw with shorter more flattened papillae that gradually decrease in size posteriorly; vomer and palatines edentate; tongue smooth, with broadly rounded tip; chin with 3 pairs of prominent pores, all fairly evenly spaced; gill rakers moderately short, raker below angle longest, about 3.9 (3.5–4.5) in orbit diameter.

Nostrils moderately large, posterior nostril subequal and dorsoposterior to anterior nostril, its width 5.9 in orbit diameter (5.2–7.9); posterior nostril in front of horizontal from centre of eye; anterior nostril in front of horizontal from lower margin of pupil (posterior nostril on horizontal from centre to lower third of eye; anterior nostril on horizontal from lower margin of pupil to lower margin of eye); internarial distance narrow, 3.3 (2.6–4.3) in distance from posterior nostril to eye; distance from posterior nostril to eye narrow, 6.4 (2.7–7.7) in orbit diameter (2.7–6.4 in specimens > 250 mm SL); posterior nostril with raised membranous rim, the rim widest anteriorly and forming broadly rounded flap about one-quarter nostril width (flap rounded to crenulate, one-quarter to one-third nostril width); anterior nostril with thicker, more fleshy raised rim and wider broadly rounded (rounded to crenulated) flap posteriorly, of almost half nostril width.

Opercle lacking exposed spine; posterior edge of preopercle finely serrate (serrations more distinct in juveniles and subadults); margins of subopercle, including angle and interopercle, smooth.

Scales small and ctenoid on body and most of head, cycloid anteriorly on interorbital and suborbital; lateral line continuous, gently curved anteriorly, following dorsal contour of body and becoming straight on peduncle; head scaled except on snout just forward of anterior nostrils and band from anterior margin of eye to snout, bounded above by an oblique imaginary line from dorsal margin of eye through dorsal edge of anterior and posterior nostrils; small imbedded scales on preorbital reaching anteriorly to vertical from anterior nostril; horizontal scale rows from preorbital margin opposite tip of maxilla across cheek to edge of preopercle about 26, vertical rows below middle of eye obliquely to margin of preorbital about 16 (not feasible to count accurately due to numerous small supplementary scales and irregular size and alignment of scales along rows); basal sheath of scales present on dorsal and anal fins; spinous and soft portions of dorsal fin with 1–2 and about 6–10 scale rows at bases respectively; spinous and soft portions of anal fin with 2–3 and about 7–12 scale rows at bases respectively;

minute scales sparsely distributed on soft rays of all fins, except inner base of pelvic fins; axil of pectoral fin with scaly process, fleshy inner base naked.

Dorsal fin with shallow notch, its origin just posterior to vertical from upper corner of opercle (between upper corner and just anterior to posterior margin of opercle); base of soft dorsal-fin subequal to that of spinous portion, 1.1 (1.0–1.2) in its length; interspinous membranes moderately incised; dorsal-fin spines strong, first spine 7.3 (4.6–6.7) in HL; fourth dorsal-fin spine longest, 2.4 (2.2–3.0) in HL; fifth spine next longest, followed by third; 12th (10th to 12th) soft dorsal-fin ray longest, 2.2 (1.7–2.8) in HL; origin of anal fin below base of 8th (6th to 8th) soft dorsal-fin ray; first anal-fin spine short, 3.2 (2.1–3.4) in second; second anal-fin spine more robust and slightly longer than third (slightly shorter than third in some larger specimens), 2.1 (1.6–3.2) in HL; second anal-fin ray longest, 1.7 (1.4–2.0) in HL; anal-fin base short, 1.4 (1.2–1.6) in its height; caudal fin emarginate (truncate in juveniles), 1.4 (1.1–1.5) in HL; fifth pectoral-fin ray longest, 1.2 (1.1–1.5) in HL, slightly longer than pelvic fins (slightly shorter to slightly longer); origin of pelvic fins posterior to lower base of pectoral fins, on vertical from base of 5th (5th to 7th) dorsal-fin spine; pelvic-fin tips slightly short of anus (reaching anus in juveniles and some subadults, more than eye diameter short of anus in specimens > 500 mm SL), first ray longest (second subequal to first), 1.4 (1.1–1.6) in HL.

FIGURE 8. *Plectorhinchus unicolor*, colour variation in life within an individual, QM I.39292, 352 mm SL, Gloucester Island, Queensland. **A.** Alive, immediately on capture. (Photo: J.W. Johnson); **B.** Alive, shortly after capture. (Photo: J.W. Johnson)

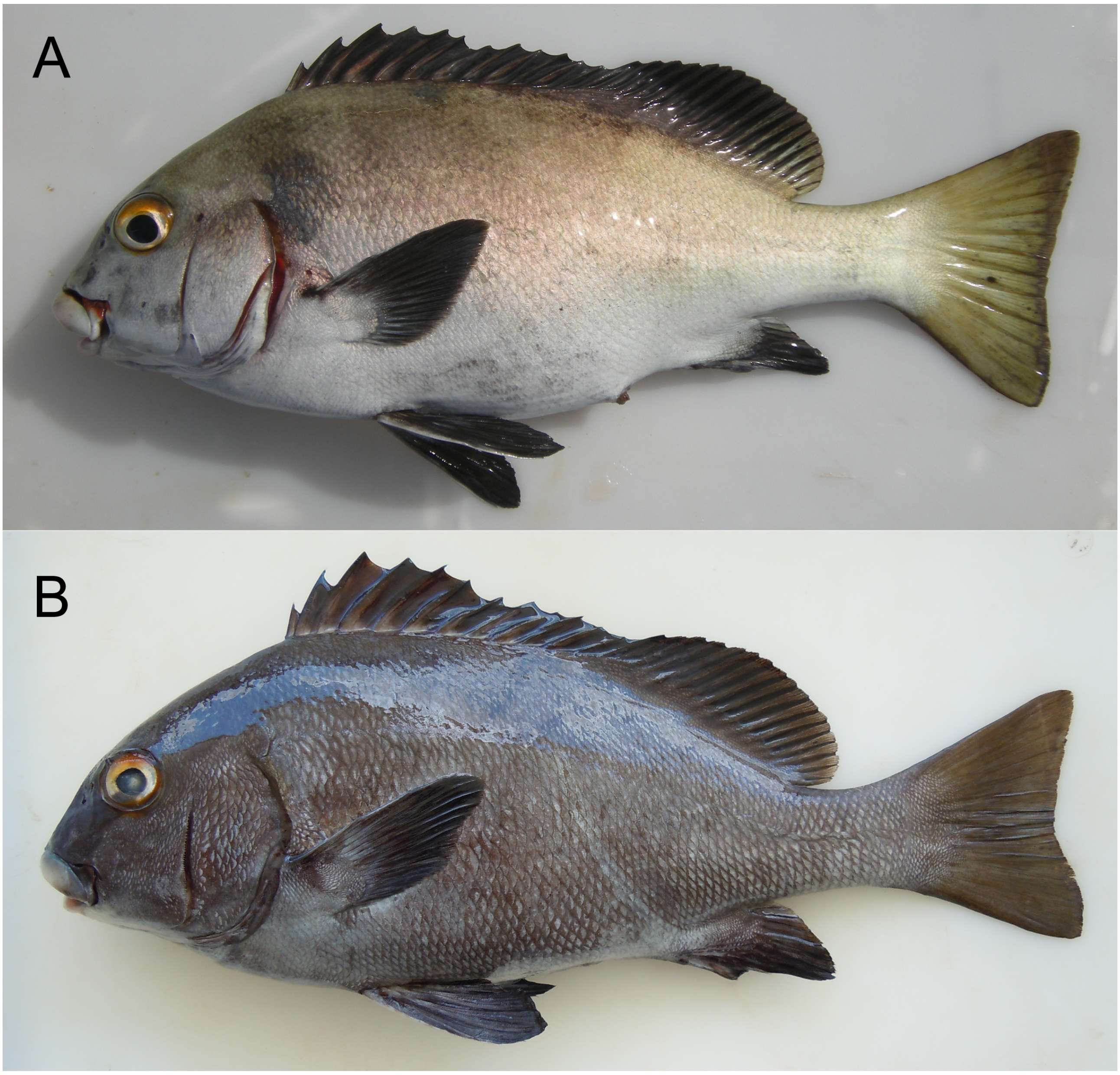

FIGURE 9. *Plectorhinchus unicolor*, colour variation post mortem within an individual, QM I.39292, 352 mm SL, Gloucester Island, Queensland. **A.** Fresh, upon death. (Photo: J.W. Johnson); **B.** Fresh, after freezing. (Photo: J.W. Johnson).

Colour when fresh. Fresh colouration of holotype, 342 mm SL, unknown.

Non-type QM I.39292, 352 mm SL, underwater in life: mostly uniform grey-brown on head and body, fins except caudal darker, caudal fin pale greenish yellow. The specimen underwent a series of significant colour changes after capture, until death (Fig. 8–9). Initial live phase on capture (Fig. 8A): upper half of head and body medium brown, lower head and body pearly white, with small irregular scattered brownish blotches. Groove above upper lip and behind maxilla, first branchiostegal membrane below lower edge of operculum and cleithrum, bright red. Opercular membrane dusky. Dorsal and anal fins mostly black, but membranes darker than spines and rays. Caudal fin olive-brown. Pectoral fins dusky, with pearly white base. Pelvic fins dusky, with leading edge white. Secondary phase in life after capture (Fig. 8B): Head and body tan overall, with paler scale edges, lower lip and dentary pale cream, otherwise similar to above. Immediately on death (Fig. 9A): Head and body mostly pale yellowish white, with faint dusky blotching on upper body above pectoral fins, caudal fin pale yellowish green, markings otherwise similar to the above. Fresh, after freezing (Fig. 9B): Head and body mostly dark brownish grey, with pale edges to most scales and light grey on chest, belly, pectoral-fin base and scaly sheath of anal fin. Upper lip creamy white, infused with grey; lower lip and dentary pale cream. Opercular membrane dusky. Dorsal fin mostly black, but membrane near base of most spines with a small pale grey blotch, and soft dorsal-fin rays contrasting as lighter than intervening membranes. Anal fin dusky to black. Caudal fin uniformly olive-brown. Pectoral fins with distal two-thirds dusky. Pelvic fins with leading edge of spine white and remainder black.

Juvenile QM I.29477, 142 mm SL, when fresh had violet reflections on the cheeks and snout and caudal fin uniformly pale yellow.

Colour in alcohol. Holotype, preserved prior to 1883 (Fig. 6A), mostly uniformly brown on head and body, fading slightly to a lighter brown on underside of head, branchiostegal membranes, chest and belly. Upper lip and maxilla dusky. Lower lip pale. Opercular membrane dusky. Spinous dorsal fin with pale spines and dusky membranes. Soft dorsal and anal fins with brown rays, contrasting strongly against dusky intervening membranes. Caudal fin brown. Pectoral fins brown, with distal third slightly dusky. Pelvic fins faintly dusky.

Non-type QM I.39292, preserved in 2014, dark grey-brown on head and body, lighter creamy brown on chest and belly. Lower portion of upper lip, lower lip and dentary to level of isthmus pale cream. Opercular membrane dusky. Spinous dorsal-fin spines and membrane mostly black, but membrane near base of first 10 spines with irregular pale blotch about one eighth height of membrane. Soft dorsal and anal fins with dark grey rays, contrasting against black intervening membranes. Caudal fin uniformly pale grey-brown. Pectoral fins grey-brown basally, with distal half faintly dusky. Pelvic fins with leading edge of spine pale, rays dark grey and membranes dusky. Colouration of juveniles similar to adults, except caudal fin contrasting paler against body.

Genetics. The phylogenetic analyses indicate that *P. unicolor* is most closely related to a well-supported clade comprised of *P. chubbi*, *P. playfairi* and *P. sordidus* and differs from those species by an average of 5.13%, 5.38% and 5.49% respectively (Figure 1, Table 2). This group is also clustered with the two molecular forms of *P. schotaf*, A and B, to which *P. unicolor* differs by an average of 14.45% and 14.92% sequence divergence respectively (Table 2).

Distribution and abundance. Known from southern Japan (Miyazaki Prefecture and Ryukyu Islands), Taiwan (Kenting National Park), Micronesia (Guam), West Malaysia (Pulau Redang), Indonesia (Bali and Banyuwangi, East Java), New Guinea (China Strait) and northern Australia, from Rottnest Island north to Dampier Archipelago, Western Australia on the west coast, and Lizard Island, Queensland south to Tweed River, New South Wales, and Lord Howe Island on the east coast (Fig. 14). Usually found in small groups, or solitary, around rocky headlands, coastal rocky reef, or continental islands, in depths of 1–10 m, with a rich growth of brown macroalgae and moderate wave action. Small juveniles are rarely seen or collected, possibly due to their preference for subtidal rocky reef with moderately high wave action. The species appears to be uncommon in Western Australia, with only four very large specimens (516–640 mm SL) held in collections of the Western Australian Museum. In contrast, *P. unicolor* is often encountered by divers on the east coast of Australia, but the largest specimen available for examination in museum collections was only 455 mm SL. The species appears to be rare in Japanese waters (Akazaki, 1984: 172; Iwatsuki pers. comm., 2015).

Discussion. *Plectorhinchus unicolor* (Fig. 6–9) is physically most similar to *P. schotaf* (Figs. 10–11), sharing similar morphology, meristic formulae, and colouration of adults, including head and body mostly uniform grey-brown and skin of cleithrum beneath the opercular margin crimson red. It differs most obviously in having fresh colouration of the margin of the opercular membrane dusky (crimson red, as in cleithrum, in *P. schotaf*) and colour in life of the caudal fin yellowish (dark grey or dusky, similar to body, in *P. schotaf*). Colouration of small juveniles is also strikingly different between the two species. Juveniles of *P. unicolor* are similar to the adults, except the caudal fin is consistently pale yellow. In contrast, small *P. schotaf* have about six narrow longitudinal pale blue lines along the head and body on a yellowish background (Fig. 11; see also Randall, 1995, Fig. 538; specimen BPBM 30410, 45 mm SL, labelled as *P. sordidus*). Although meristics for both species mostly overlap, there is a modal difference in soft dorsal-fin rays (17–20, modally 19, versus 18–21, modally 20 in *P. schotaf*) and a strong modal difference in pectoral-fin rays (16–18 (rarely 16 or 18), modally 17, versus 16–18 (rarely 18), modally 16 in *P. schotaf*) (Table 4). Differences also exist in various proportional measurements at a given length, with *P. unicolor* having a deeper body, wider caudal peduncle depth, longer spinous dorsal-fin base, higher soft dorsal fin, and longer pectoral and pelvic fins (Table 5). Data presented by Smith & McKay (1986) and McKay (2001) for *P. schotaf* were a compilation, as their material examined included both *P. schotaf* and *P. unicolor*, and the species were not differentiated.

Differences between *P. unicolor* and *P. caeruleonothus* are outlined above under the discussion for *P. caeruleonothus*. Among other species of *Plectorhinchus* with a uniform body colouration, *P. unicolor* can most

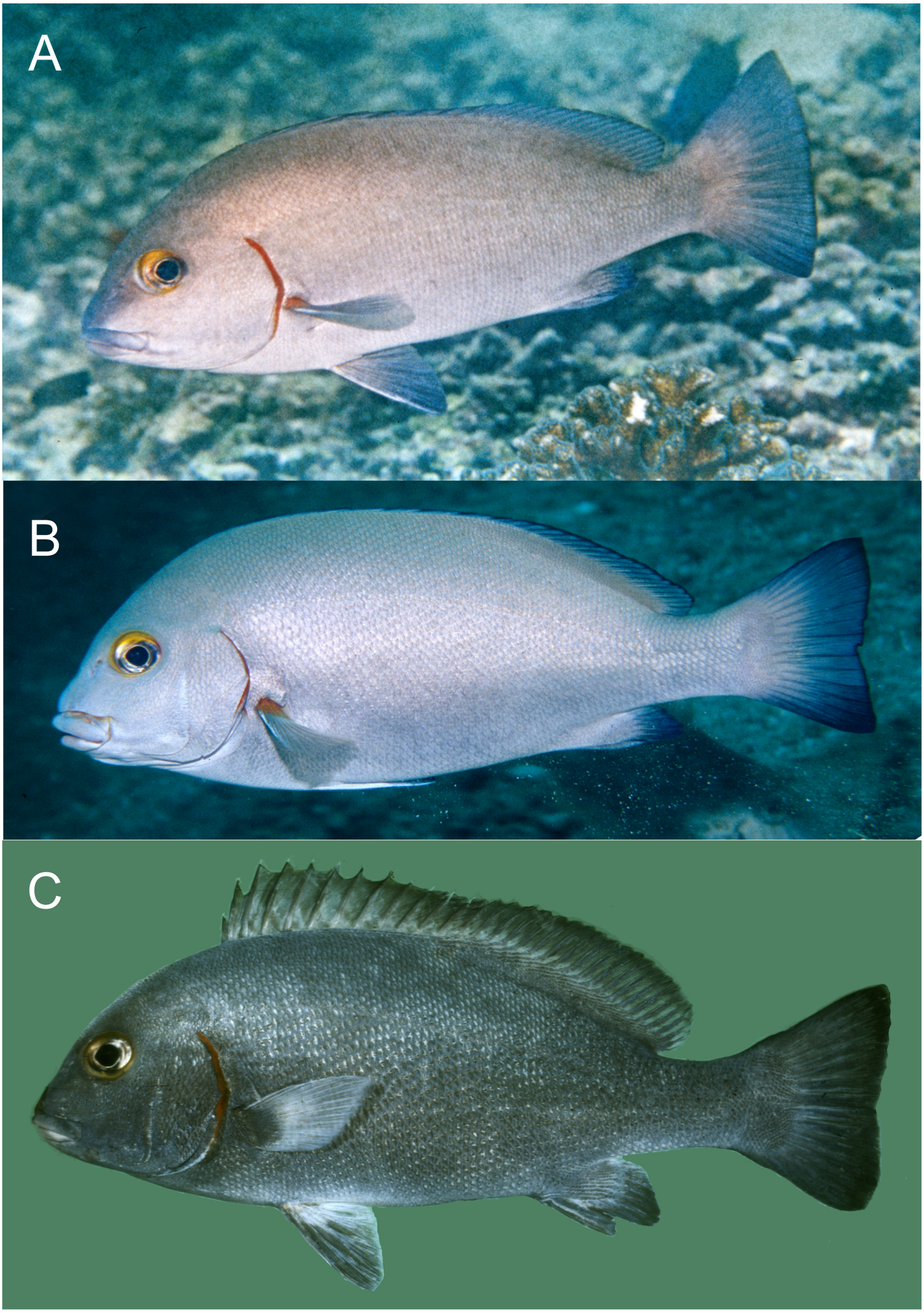

FIGURE 10. *Plectorhinchus schotaf* , adult and subadult colouration. **A.** Adult, ca 40 cm TL, Gulf of Oman, underwater. (Photo: R. Field); **B**. Adult, ca 40 cm TL, Gulf of Oman, underwater. (Photo: R. Field); **C.** Subadult, BPBM 20766, 243 mm SL, Port Sudan, Red Sea, fresh condition. (Photo: J.E. Randall)

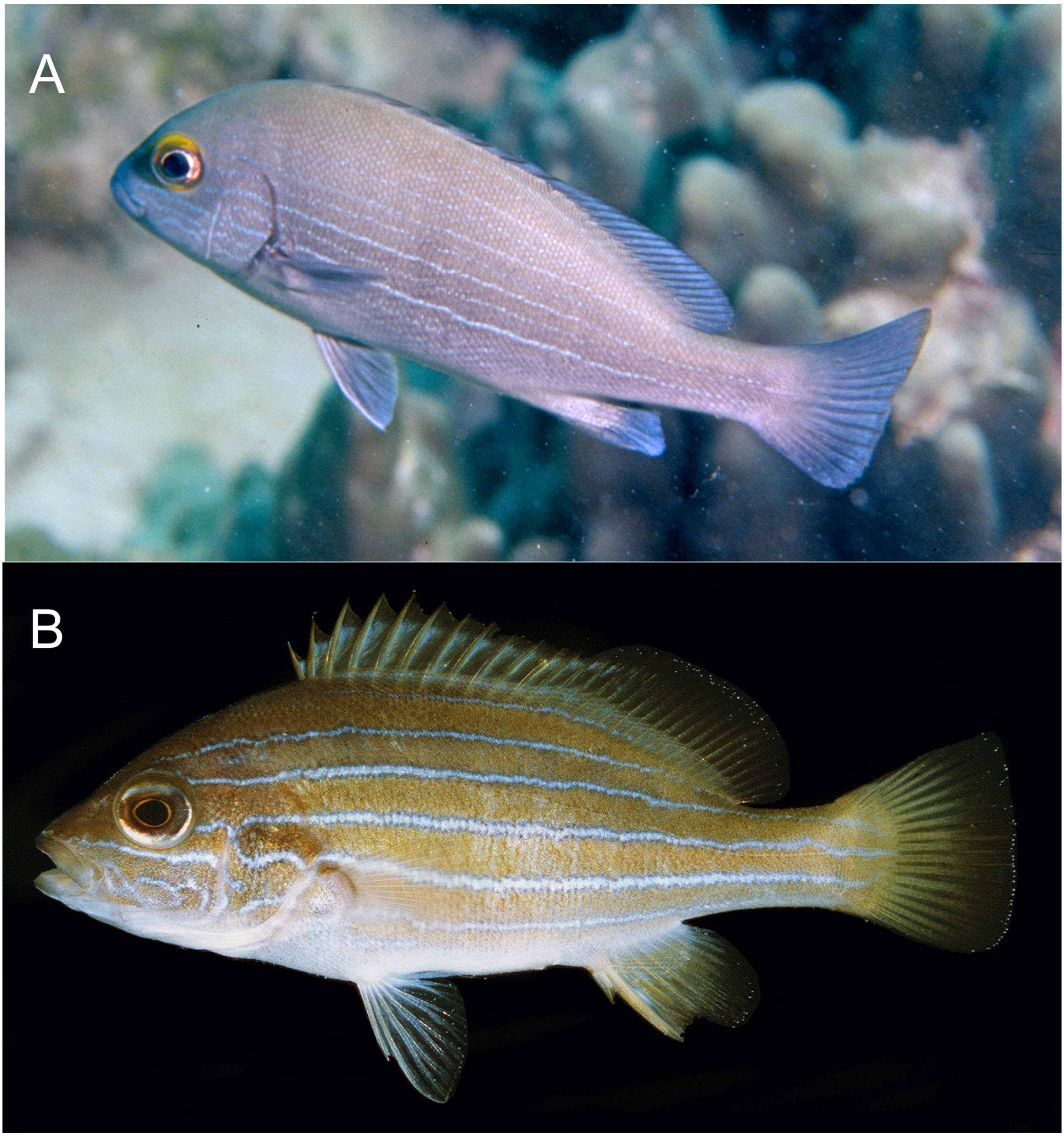

FIGURE 11. *Plectorhinchus schotaf* , juvenile colouration. **A.** Juvenile, ca 15 cm TL, Persian Gulf, underwater. (Photo: R. Field); **B.** Juvenile, BPBM 30410, 45 mm SL, Saudi Arabia, Persian Gulf, fresh condition. (Photo: J.E. Randall)

readily be distinguished from *P. ceylonensis* and *P. gibbosus* by dorsal-fin spine and ray counts (XII-XIII (rarely XIII), 17–20, versus XIV, 19 in *P. ceylonensis* and XIII–XIV (rarely XIII), 15–17 in *P. gibbosus*); from *P. chubbi* by dorsal-fin spine and ray and gill raker counts (XII-XIII, 17–20 and 10–12 + 16–19, versus XI–XII (rarely XII), 16–17 and 13–16 + 22–24 in *P. chubbi*); from *P. griseus* by dorsal-fin ray counts and lateral profile of the forehead (XII-XIII, 17–20, lateral profile of forehead at snout evenly convex, versus XII, 21–23, lateral profile of forehead at snout with distinct concavity in *P. griseus*); and from *P. sordidus* (fig. 13a–b) by gill raker counts (10–12 + 16–19 = 27–31, versus 9–11 + 15–16 = 25–26 in *P. sordidus*), a narrower distance from posterior nostril to the eye, and a longer caudal peduncle (Table 5).

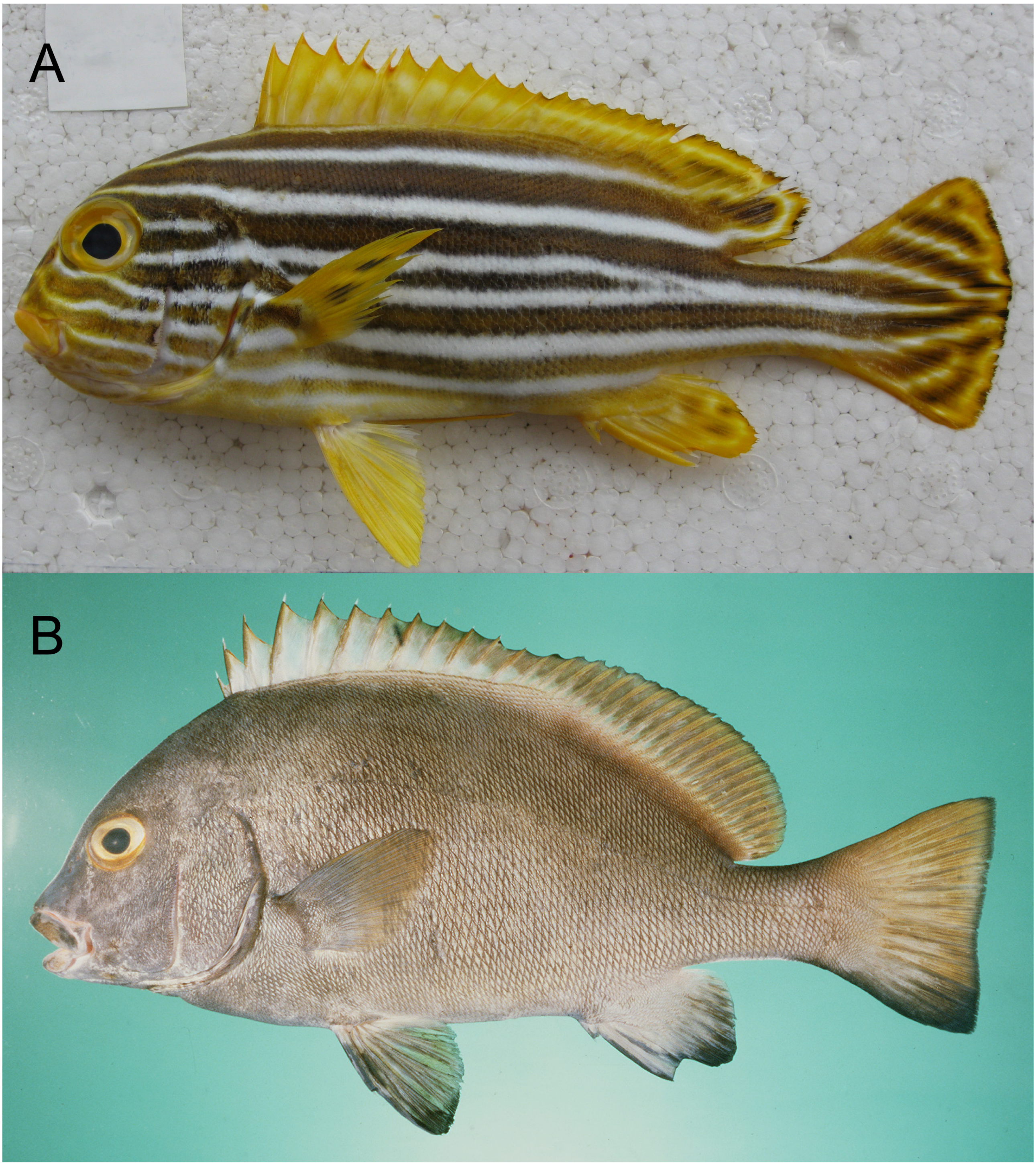

FIGURE 12. A. *Plectorhinchus polytaenia*, CSIRO H.7694-01, 158 mm SL, Tanjung Luar, Lombok, Indonesia, fresh condition. (Photo: W. White); **B.** *Plectorhinchus griseus*, BPBM 27726, 205 mm SL, Vizhinjam, India, fresh condition. (Photo: J.E. Randall)

Comparative materials

Plectorhinchus griseus **India**: USNM 395975, 226 mm, Wadge Banks, off southern tip of India, 4 Mar 1970, T. Roberts.

Plectorhinchus polytaenia **Philippines**: CAS SU26963, 2: 137–155 mm, Jolo Island, Sulu Archipelago, 21 Aug 1931, A.W. Herre. **Indonesia**: CSIRO H.7694-01, 158 mm, Tanjung Luar market, Lombok, 5 Mar 2009, W.

White; CSIRO H.7695-02, 250 mm, Kedonganan market, Bali, 2 Oct 2009, W. White; H.7695-01, 235 mm, Kedonganan market, Bali, 2 Oct 2009, W. White.

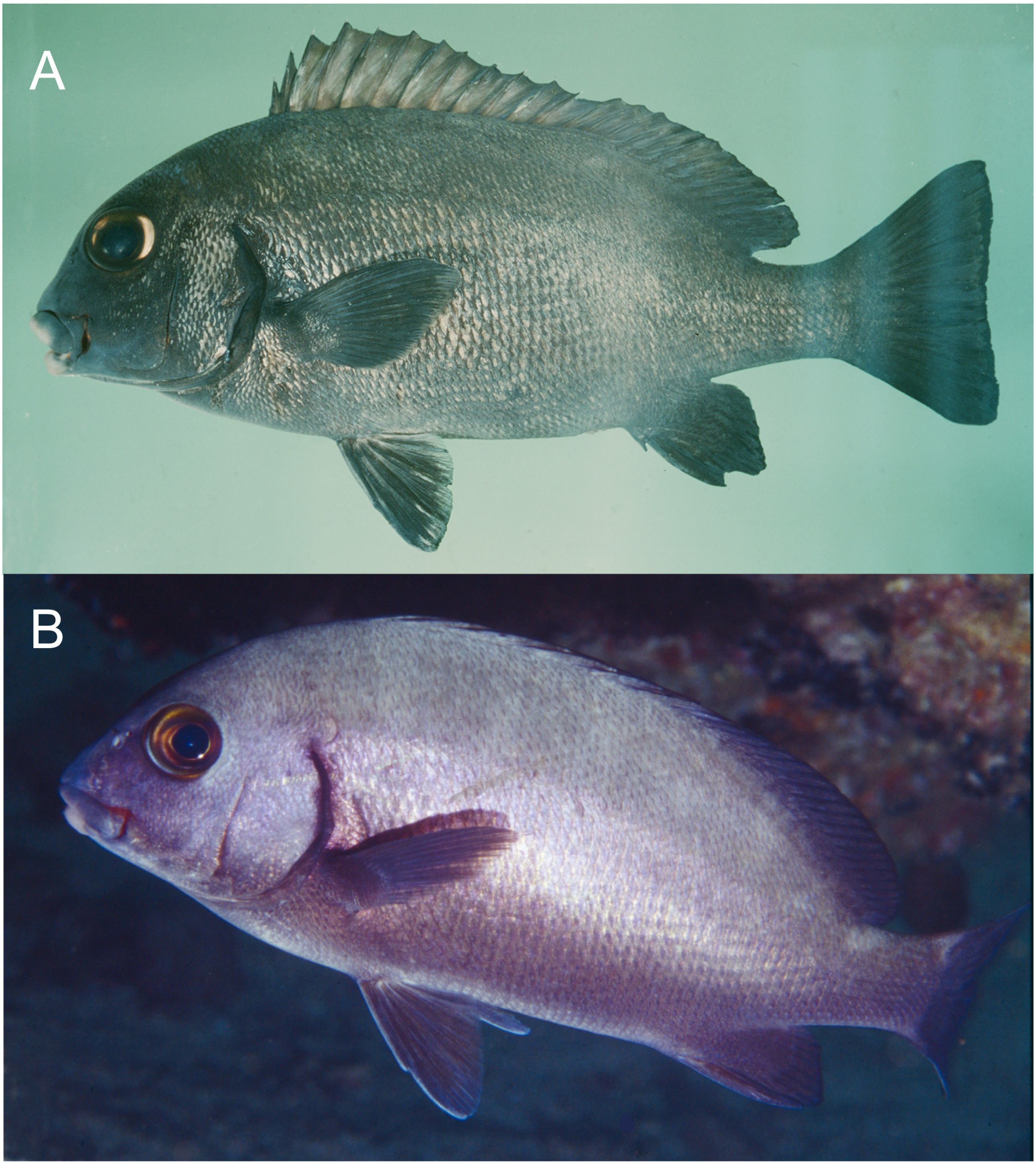

FIGURE 13. A. *Plectorhinchus sordidus*, BPBM 21379, 228 mm SL, Gulf of Oman, fresh condition. (Photo: J.E. Randall); **B.** *Plectorhinchus sordidus*, ca 30 cm TL, Gulf of Oman, underwater. (Photo: R. Field)

Plectorhinchus schotaf (25: 44–245 mm) **Persian Gulf**: BPBM 21288, 167 mm, off Manama, Bahrain, dead patch reef, 2 m, spear, 23 Feb 1977, J.E. Randall; BPBM 29512, 5: 88–180 mm, Bahrain, spear & trap, 9 Nov 1983, J.E. Randall; BPBM 30410, 45 mm, Saudi Arabia, patch reef 2–3 miles NE of Manifa, 1 m, spear, 4 Jun 1984, J.E. Randall; BPBM 33260, 2: 60–97 mm, Saudi Arabia, Ras Tanura, sand & small coral patches, 1–3 m, spear, 6 Sep 1985, B.E. Stanaland & A.B. Tarr; BPBM 36194, 3: 44–66 mm, Arabian Sea, Oman, W side Masirah Island, 1 km N of Marsis, tidal flat, seagrass & small rocks on hard substratum, 0.0–0.6 m, rotenone, 22 Nov 1993, J.E. Earle; ODU 3229, 196 mm, Hadra fish corral, Fintas Beach, Kuwait, 3 Oct 1999, K.E. Carpenter; QM I.30178, 2: 123–153 mm, Bahrain, spear & trap, 9 Nov 1983, J.E. Randall; USNM 148085, 201 mm, Najwa, east bank, 7 miles SE of Ras Tanura, Saudi Arabia, 5–7 m, D. S. Erdman & Native Fishermen, 26 Apr 1948; USNM 147885, 141 mm, Tarut Bay, Ras Tanura, Saudi Arabia, D.S. Erdman, Apr 1948. **Red Sea**: BPBM 20355, 245 mm, Port Sudan, edge of fringing reef 500 m N of harbour entrance, 2 m, spear, 9 Oct 1974, J.E. Randall; BPBM 20766, 2: 234–243 mm, Port Sudan, 1 mile S of port, coral head in lagoon, 2 m, rotenone, 14 Oct 1975, J.E. Randall. **Mozambique**: SAIAB 41668, 4: 100–121 mm, Inhaca, Sep 1948, J.L.B. & M.M. Smith; SAIAB 19796, 183 mm, Ibo, 8 Aug 1957, J.L.B. Smith.

Plectorhinchus sordidus (4: 81–230 mm) **Seychelles**: BPBM 21661, 230 mm, Caiman Rocks, 3-4 miles SW of La Digue, 17 m, spear, 7 Jun 1977, J.E. Randall. **Gulf of Oman**: BPBM 21379, 2: 208–228 mm, Bandar Sidab, just south of Muscat, Oman, rock & silty sand, 5–7 m, spear, 9 Mar 1977, J.E. Randall. **Mozambique**: SAIAB 41668 (part), 81 mm, Inhaca, Sep 1948, J.L.B. & M.M. Smith.

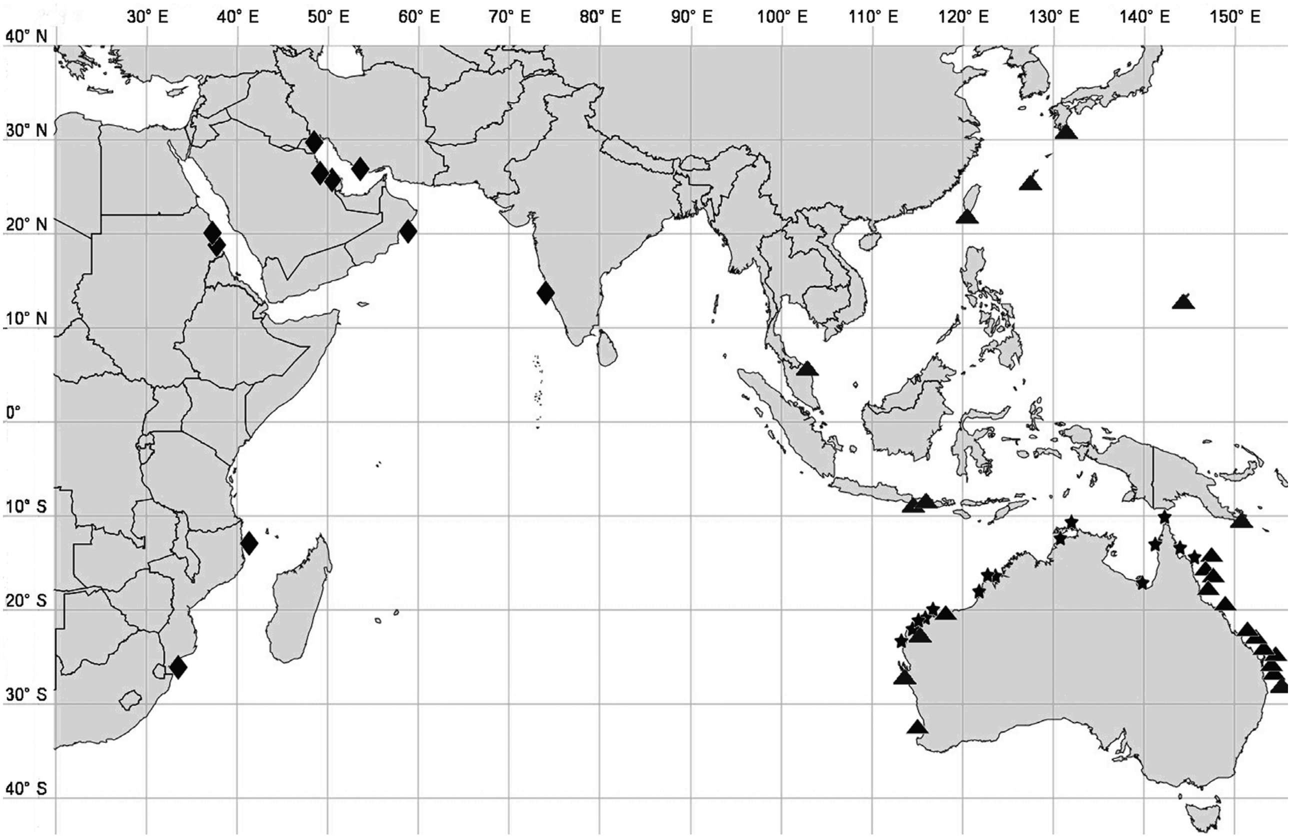

FIGURE 14. Distribution of *Plectorhinchus caeruleonothus* **sp. nov.** (stars), *P. schotaf* (diamonds) and *P. unicolor* (triangles), based on material examined and confirmed photographs taken underwater, or from fresh specimens.

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