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Gymnocranius obesus, a new large-eye seabream from the Coral Triangle

Gymnocranius obesus, *un nouveau bossu blanc du Triangle de Corail*

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ABSTRACT

Two previously recorded new species of the large-eye seabream genus *Gymnocranius* (*Gymnocranius* sp. D and *Gymnocranius* sp. E) remain undescribed. Here we describe *Gymnocranius* sp. E as *Gymnocranius obesus* sp. nov. This new species is morphologically distinct from all other known species under *Gymnocranius* by the following combination of characters: relatively deep body, with ratio of standard length to body depth 2.2–2.4; protruding large eye, with eye diameter about equal to or slightly larger than inter-orbital width; caudal fin moderately forked; no blue spots or wavy blue lines on cheek and snout in adults; fourth transversal dark bar on flank running from the sixth spine of the dorsal fin to the origin of the anal fin; anal, caudal and dorsal fins drab with yellowish to yellow margins. *Gymnocranius obesus* sp. nov. is distinct from *G. griseus*, with which it has been previously confused by a relatively larger head, scales above lateral line without dark basal patch, and a smaller number of front scales on the dorsal side of the head. *Gymnocranius obesus* sp. nov. is genetically distinct from its closest known relative, *Gymnocranius* sp. D by 104 diagnostic nucleotide characters, which translates into a 9.6% sequence divergence at the mitochondrial cytochrome *b* gene. *Gymnocranius obesus* sp. nov. reaches a length of at least 295 mm. Its distribution, from the Ryukyu Islands to Bali, including Taiwan and the Flores Sea, mostly coincides with the western half of the Coral Triangle.

Mots clés :
Nouvelle espèce
Indo-Pacifique ouest
Gymnocranius sp. D
Gymnocranius griseus

RÉSUMÉ

Deux nouveaux bossus blancs du genre *Gymnocranius*, précédemment signalés comme *Gymnocranius* sp. D et *Gymnocranius* sp. E, restent non décrits. Nous décrivons ici *Gymnocranius* sp. E comme *Gymnocranius obesus* sp. nov. Cette nouvelle espèce est morphologiquement distincte de toutes les autres espèces connues du genre *Gymnocranius* par la combinaison de caractères suivante : corps relativement haut, où le rapport de la longueur standard à la hauteur du corps est 2,2–2,4 ; œil saillant, large, dont le

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diamètre est approximativement égal ou légèrement supérieur à la distance interorbitaire ; nageoire caudale modérément fourchue ; pas de taches bleues ni de lignes bleues ondulées sur la joue et le museau chez les adultes ; quatrième barre transversale sombre sur le flanc allant de la base du sixième rayon de la nageoire dorsale à l'origine de la nageoire anale ; bord externe des nageoires anale, caudale et dorsale jaunâtre à jaune. *Gymnocranius obesus* sp. nov. se distingue de *G. griseus*, avec lequel il a été précédemment confondu, par une tête relativement plus grande, des écailles au-dessus de la ligne latérale sans patch basal sombre, et un plus petit nombre d'écailles frontales sur le dos de la tête. *Gymnocranius obesus* sp. nov. est génétiquement distinct de son plus proche parent connu, *Gymnocranius* sp. D, par 104 caractères nucléotidiques diagnostiques au gène mitochondrial du cytochrome *b*, ce qui se traduit par une divergence de séquence de 9,6 %. *Gymnocranius obesus* sp. nov. atteint au moins 295 mm de longueur. Sa distribution, des îles Ryukyu à Bali en passant par Taïwan et la mer de Flores, coïncide essentiellement avec la moitié ouest du Triangle de Corail.

1. Introduction

Large-eye seabreams of the genus *Gymnocranius* Klunzinger 1870 occur in the tropical and warm-temperate coastal waters of the Indo-West Pacific region. They dwell over sandy bottoms at or in the vicinity of coral reefs, at depths ranging from 1 m to about 80 m [1–3]. The genus *Gymnocranius*, together with the genera *Gnathodentex* Bleeker 1873, *Wattsia* Chan and Chilvers 1974, and *Monotaxis* [Bennett] 1830 form the Monotaxinae, which is one of the two subfamilies of the perciform family Lethrinidae [1]. The genus *Gymnocranius* currently comprises 10 valid species described between 1830 and as recently as 2013 [4]. These are: *G. audleyi* Ogilby 1916 [5], *G. elongatus* Senta 1973 [6], *G. euanus* (Günther 1879) [7], *G. frenatus* Bleeker 1873 [8], *G. grandoculis* (Valenciennes 1830) [9], *G. griseus* (Temminck and Schlegel 1843) [10], *G. microdon* (Bleeker 1851) [11], *G. oblongus* Borsa, Béarez and Chen 2010 [2], *G. satoi* Borsa, Béarez, Paijo and Chen 2013 [3], and *G. superciliosus* Borsa, Béarez, Paijo and Chen 2013 [3]. Twelve other species that have been described since 1830 have been recognized as junior synonyms of the foregoing [4]. In addition, *G. olivaceus* Fourmanoir 1961 [12], is recognized as a junior synonym of *Wattsia mossambica* (Smith 1957) [1,13]. *Sparus ornatus* Sevastianoff 1805 [14] has lost its precedence to its junior synonym *G. grandoculis* because the species name was not used after 1899 (Article 23.9 of the International Code of Zoological Nomenclature [15]).

Large-eye seabreams are sold at local fish markets throughout the tropical and warm-temperate Indo-West Pacific ([1]; authors' personal observations). Specimens suspected to possibly represent two unknown *Gymnocranius* species were first noticed at the Kedonganan fish market in Bali in February 2007 (Supplementary Figs. S1A, B and S3A). Provisional species names *Gymnocranius* sp. D and sp. E were given [3,16]. These two species were subsequently observed by WJC, along with other *Gymnocranius* species, at several local fish markets in eastern and southern Taiwan and on Penghu Islands in the Taiwan Strait during a biodiversity survey of lethrinid fishes in Taiwanese waters [16]. The two species differed by their patterns of dark bars on the flank and by the colouration of the margin of the caudal fin, which is reddish in *Gymnocranius* sp. D and yellowish in *Gymnocranius* sp. E [16]. Other specimens of these two species were simultaneously collected from the Ryukyu Islands by RM, who reached the same conclusions. Two of us (PB, WJC) initially intended to describe *Gymnocranius* sp. D together with *Gymnocranius* sp. E. However, as a paper by RM describing *Gymnocranius* sp. D was already in preparation, all three present co-authors agreed to separately describe the other species. The objective of the present paper is thus to describe *Gymnocranius* sp. E as a new species based on morphological and molecular diagnoses.

2. Materials and methods

2.1. Material examined

Specimens chosen as type material for the new species, *Gymnocranius obesus* sp. nov., were deposited at the Division of Fisheries Science, University of Miyazaki (MUFS) and at the National Taiwan University Museums, Taipei (NTUM) collections. Our specimen Let1006 collected from Fugang fishing port (22°47′30″N 121°11′31″E), Taiwan, 03 October 2013 (Fig. 1), catalogued No. NTUM 12079, was selected as the holotype. Seven other specimens were designated as paratypes: MUFS 25522 from Yaku-shima, Ryukyu islands, Japan, 11 August 2008; MUFS 41271 and MUFS 41272 from Okinawa Island, Japan, 27 October 2012; and NTUM 10766 including four individuals with sample Nos. Let998, Let999, Let1004, and Let1005 from Fugang fishing port, Taiwan, 03 October 2013 (Fig. 1). Additional voucher specimens are listed in Supplementary Table S1 and Supplementary Fig. S1.

The comparative material used for morphological examination included: NTUM 10722 (*G. griseus*; one individual: Let734), Chenggong fishing port, Taiwan; NTUM 10768 (*G. griseus*; six individuals: Let1000, Let1001, Let1007-Let1010) from Fugang fishing port; NTUM 10808 (*G. griseus*: one individual: Let1168) from Fugang fishing port; NTUM 10818 (*Gymnocranius* sp. D: one individual,

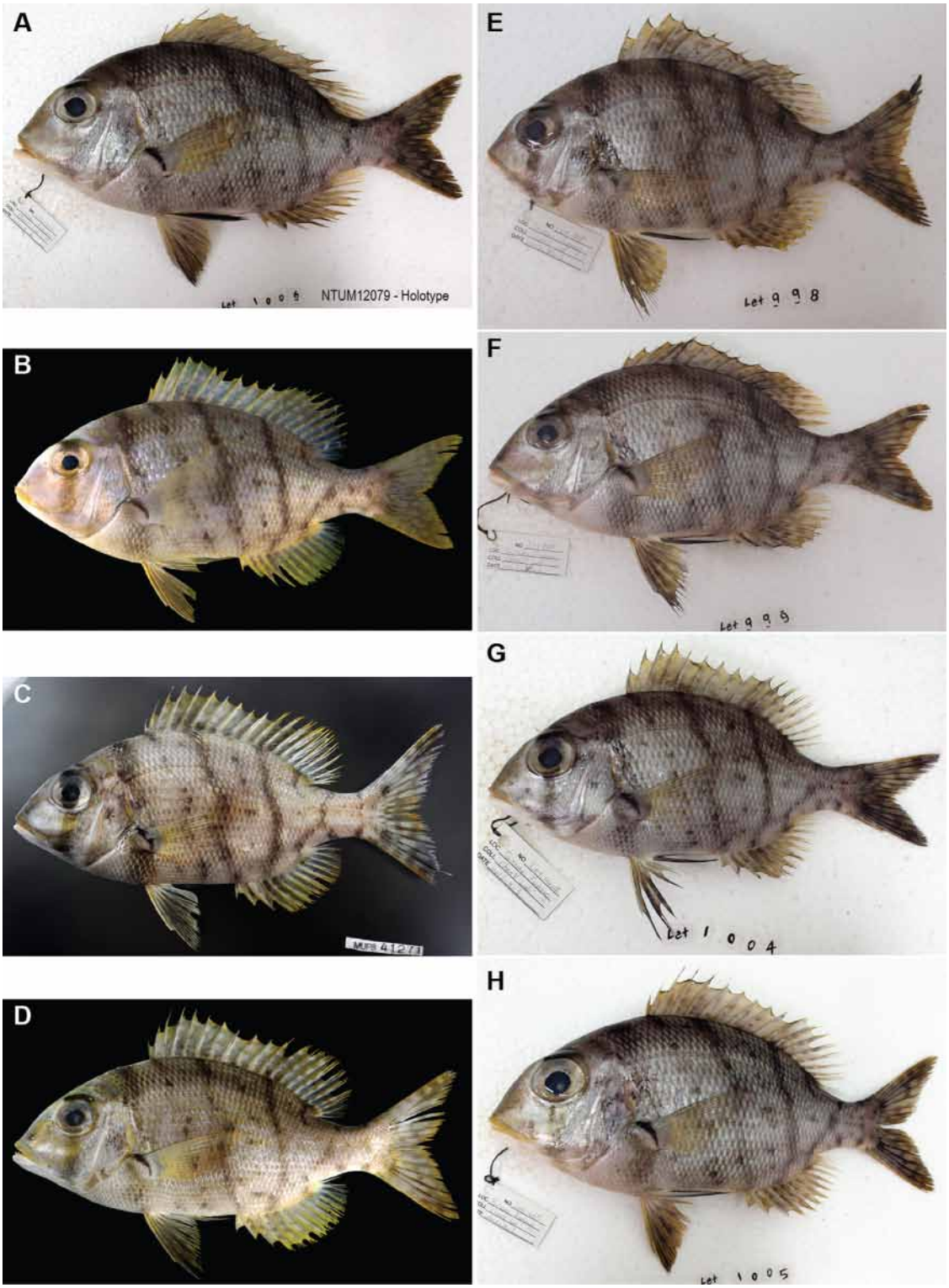

Fig. 1. Type series of *Gymnocranius obesus* sp. nov. **A.** Specimen NTUM 12079 (sample Let1006), holotype, standard length (SL) 270 mm, collected 3 October 2013 from off Fugang, Taitung, Taiwan (photographed by WJC). **B.** Specimen MUFS 25522, paratype, SL 295 mm, from off Anbo, Yaku-shima Island, Kagoshima prefecture, Japan (30°19′N, 130°39′E), 11 August 2008 (photographed by the MUFS fish team). **C.** Specimen MUFS 41271, paratype, SL 209 mm, purchased at Tomari-Fish Market (26°14′N, 127°41′E), Okinawa Island, Japan, 27 October 2012 (photographed by RM). **D.** Specimen MUFS 41272, paratype, SL 244 mm, purchased at the same place and same date (photographed by RM). **E.** Specimen NTUM 10766 (Let998), paratype, SL195 mm, from Fugang fishing port, Taiwan, 03 October 2013 (photographed by WJC). **F.** Specimen NTUM 10766 (Let999), paratype, SL220 mm, from Fugang fishing port, Taiwan, 03 October 2013 (photographed by WJC). **G.** Specimen NTUM 10766 (Let1004), paratype, SL192 mm, from Fugang fishing port, Taiwan, 03 October 2013 (photographed by WJC). **H.** Specimen NTUM 10766 (Let1005), paratype, SL239 mm, from Fugang fishing port, Taiwan, 03 October 2013 (photographed by WJC).

Let1211) from Penghu Islands; NTUM 10826 (*Gymnocranius* sp. D: one individual, Let1191) from Hengchun town; NTUM 10831 (*Gymnocranius* sp. D: one individual, Let1341) from Macclesfield Bank in the South China Sea (114°48′E 16°10′N); NTUM 10835 (*Gymnocranius* sp. D: two individuals, Let1362, Let1363) from Hengchun town; RMNHN.PISC.D.2248 (*G. griseus*, lectotype [17]) from the Nagasaki region [17]; RMNHN.PISC.1026 (*G. griseus*, paralectotype); and additional voucher specimens listed in Supplementary Figs. S2–S4.

Other type materials examined included ANSP 68291 (*G. orbis*, holotype), MNHN 0000-1317 (*Pentapus curtus*, holotype), MNHN 0000-8811 (*Cantharus grandoculis*, holotype), MNHN 2009-0009 (*G. oblongus*, holotype), MNHN 2009–0010 (*G. superciliosus*, holotype), MNHN 2011–0103 (*G. satoi*, holotype), RMNH 5680 (*Dentex lethrinoides*, holotype, and *Lobotes microprion*, syntypes), SAM 10037 (*D. robinsoni*, holotype), and SMF 3042 (*D. rivulatus*, holotype).

2.2. Measurements on specimens and identification to species

The specimens were photographed shortly after collection to record their fresh colour patterns. Standard length (SL), largest body depth (BD), body depth at origin of first dorsal fin, body depth at the origin of the first anal fin, and pre-dorsal, pre-pelvic and pre-anal lengths were measured to the nearest millimetre. Head length, snout length, eye diameter (ED), inter-orbital width (IOW) and median ray of the caudal fin length (MRC) were measured to the nearest tenth of millimetre using a vernier calliper. All the foregoing measurements followed [1]. Other measurements are listed in Table 1. Identification to species was done according to various complementary sources [1–3,18] or was assessed against the genetic library of Lethrinidae based in WJC's laboratory.

The relative proportions of eye diameter and body depth of the lectotype of *G. griseus* (RMNHN.PISC.D.2248) were obtained from the sharp photograph reproduced in Supplementary Fig. S2A.

2.3. Genetics

A small piece of muscle was excised from the flank, preserved in 95% ethanol, and stored at −20 °C before genomic DNA extraction. Nucleotide sequences of the mitochondrial cytochrome *b* (cytb) and/or cytochrome c oxidase I (COI) genes from five *G. obesus* sp. nov. specimens including MUFS 25522 from Yaku-shima Island, Japan, MUFS 41271 and MUFS 41272 from Okinawa Island, Japan. NTUM 10766 from eastern Taiwan, and NTUM 12079 (holotype) from eastern Taiwan were generated according to the laboratory protocols and procedures of, respectively, [16] and [19]. The chromatograms were edited and assembled using the CodonCode Aligner v. 6.0.2 software (CodonCode Corporation, Dedham, MA, USA). The sequences were deposited in DDBJ (http://http://www.ddbj.nig.ac.jp/; accession Nos. LC213035 to LC213038) and in GenBank (http://www.ncbi.nlm.nih.gov/; accession Nos. KY593332 to

Table 1
Measurements on the type material of *Gymnocranius obesus* sp. nov.

Measurement	Specimen no.							
	NTUM 12079 (Let1006)	MUFS 25522	MUFS 41271	MUFS 41272	NTUM 10766 (Let998)	NTUM 10766 (Let999)	NTUM 10766 (Let1004)	NTUM 10766 (Let1005)
	Holotype	Paratype	Paratype	Paratype	Paratype	Paratype	Paratype	Paratype
SL (mm)	270	295	209	244	195	220	182	239
Body depth (BD) (mm)	120	132	91	108	87	98	78	106
BD at origin of DF (mm)	119	132	89	105	86	97	77	105
BD at anal-fin origin (mm)	108	120	85	100	81	95	74	95
Head length (HL) (mm)	87.5	104.0	76.6	87.1	61.6	72.0	61.5	78.8
Snout length (mm)	37.7	43.3	32.3	36.3	20.0	25.0	21.7	30.0
Eye diameter (ED) (mm)	32.1	33.4	24.9	28.1	23.7	26.4	23.8	31.5
Inter-orbital width (IOW) (mm)	32.0	36.9	24.1	28.8	23.1	27.2	20.0	28.5
Predorsal length (mm)	101	131	93	109	72	83	67	92
Prepelvic length (mm)	93	122	88	100	66	75	57	86
Pre-anal length (mm)	168	193	137	159	117	133	107	144
Length of median ray of CF (MRC) (mm)	31.5	35.4	26.4	29.8	24.8	24.8	21.7	26.7
DF spines, rays	X, 10	X, 10	X, 10	X, 10	X, 10	X, 10	X, 10	X, 10
AF spines, rays	III, 10	III, 10	III, 10	III, 10	III, 10	III, 10	III, 10	III, 10
Pored scales on lateral line	48	47	48	48	49	47	48	48
Ratio of SL to BD	2.25	2.23	2.30	2.25	2.25	2.24	2.32	2.26
Ratio of SL to BD	2.27	2.23	2.34	2.33	2.28	2.27	2.36	2.29
Ratio of SL to HL	3.09	2.83	2.73	2.80	3.17	3.06	2.96	3.03
Ratio of ED to SL	0.12	0.14	0.15	0.14	0.12	0.12	0.13	0.13
Ratio of ED to HL	0.37	0.39	0.40	0.39	0.38	0.37	0.39	0.40
Ratio of ED to IOW	1.00	1.10	1.27	1.18	1.03	0.97	1.19	1.11
Ratio of ED to MRC	1.02	1.15	1.16	1.14	0.96	1.06	1.10	1.18

Sample number in brackets. Homologous measurements on additional voucher specimens are provided as Supplementary Table S1. MUFS: Miyazaki University Fisheries Science; NTUM: National Taiwan University Museums, Taipei; AF: anal fin; BD: largest body depth; CF: caudal fin; DF dorsal fin; SL: standard length.

KY593334) as a genetic reference for future DNA-identification and other research on large-eye seabreams. The cytochrome *b* gene sequences were aligned with homologous sequences from *G. elongatus*, *G. grandoculis*, *G. griseus*, *G. oblongus*, *G. satoi*, *Gymnocranius* sp. D, and *G. obesus* sp. nov. (GenBank accession Nos. AF381260, AF381275, AF381259, KU597061, KX357715, KX357714, and KX357713, respectively) published previously [16,20], and with those of *G. superciliosus* produced by [3]. The nucleotide sequences were compiled and aligned manually with Se–Al v. 2.0 [21] and MEGA6 [22]. The software PAUP* [23] was used to compute pairwise *p* distances, to visualize those nucleotides at the cytb locus that are diagnostic of different species, and to determine apomorphic nucleotide sites in *G. obesus* sp. nov. The COI-gene sequences assigned to the genus *Gymnocranius* that were available from the GenBank and BOLD (www.boldsystems.org) databases were compared against homologous sequences of reference *G. obesus* sp. nov. specimens. This screening was aimed at verifying whether any belonged to *G. obesus* sp. nov., for the purpose of documenting the species' distribution (see next subsection).

2.4. Distribution

The geographic distribution of *G. obesus* sp. nov. was deduced from four potential sources: (1) WJC and PB's database of large-eye seabream specimens, tissue samples, nucleotide sequences and photographs, comprising a total of 329 individuals from 12 locations in the Indian Ocean (in South Africa, Kenya, Îles Éparses, Mayotte, Reunion, Seychelles, Maldives, Aceh, western Sumatra, and northwestern Australia), 12 locations in the Coral Triangle (in Taiwan, the South China Sea, Malaysia, Vietnam, the Philippines, Indonesia, and West Papua), and nine locations in the western Pacific Ocean (in Japan, Papua New Guinea, New Caledonia, Fiji, the Marshall Islands, and French Polynesia); (2) additional information on its occurrence in the Japanese archipelago, which was presented (as "*Gymnocranius* sp. 1") at the 2016 annual Asian Society of Ichthyologists meeting by RM and Y. Iwatsuki [24]; (3) GenBank; (4) BOLD.

2.5. Notice

The present article in portable document (.pdf) format is a published work in the sense of the International Code of Zoological Nomenclature [25] or Code and hence the new names contained herein are effectively published under the Code. This published work and the nomenclatural acts it contains have been registered in ZooBank (http://zoobank.org/), the online registration system for the International Commission on Zoological Nomenclature. The ZooBank life science identifier (LSID) for this publication is urn:lsid:zoobank.org:pub:9CEB9BF1-E635-45F0-AC92-FA7A1A10CAA9. The online version of this work is archived and available from the *Comptes rendus Biologies* (www.sciencedirect.com/science/journal/aip/16310691) and haL-IRD repository (http://www.hal.ird.fr/) websites.

3. Results and Discussion

Species in the genus *Gymnocranius* are all moderately large and of high commercial value [1–3,10,26]. Despite this, *G. obesus* sp. nov. has remained unnoticed in the ichthyological literature until recently [3,16,24]. A possible explanation for this oversight is its previous confusion with *G. griseus* [27,28]. *Gymnocranius obesus* sp. nov. has also been confused with juvenile or pre-adult *G. grandoculis* [28].

3.1. Morphological comparison of G. obesus sp. nov. with congeneric species

Measurements on *Gymnocranius obesus* sp. nov. specimens are provided in Table 1 and in Supplementary Table S1. Homologous measurements on reference specimens of *G. griseus* and *Gymnocranius* sp. D are provided in Supplementary Tables S2 and S3, respectively. Morphological features including body shape, caudal fin shape, and pigmentation patterns are here compared across 12 *Gymnocranius* species, including all 10 species currently recognized as valid, *G. obesus* sp. nov., and *Gymnocranius* sp. D (Table 3).

Several species in the genus *Gymnocranius*, including *G. frenatus*, *G. grandoculis*, *G. microdon*, *G. oblongus*, *G. satoi* and *G. superciliosus* possess blue lines or dots on the snout and cheek. Scattered blue dots on snout and cheek are also present in some individuals of *G. euanus*, which also has a distinctive head shape (Table 3). The remaining five species, i.e. *G. audleyi*, *G. elongatus*, *G. griseus*, *Gymnocranius* sp. D and *G. obesus* sp. nov. do not possess blue ornamentation on snout and cheek. *Gymnocranius audleyi* has a distinctive parietal scale patch and *G. elongatus* has a distinctive swallow-like tail. The confusion of *G. obesus* sp. nov. with the juvenile or pre-adult *G. grandoculis* [28] was possibly due to the fact that the patterns of dark bars on the flank are similar between the two species, with the fourth dark bar running from the base of the sixth or seventh spine of dorsal fin to the origin of anal fin (Table 3). However, the body is more slender in *G. grandoculis* and the colour of the anal fin in the adult *G. grandoculis* is different (Table 3). Additional characters are needed for the morphological distinction of *G. obesus* sp. nov. from the remaining two species, namely *G. griseus* and *Gymnocranius* sp. D.

The lectotype of *Dentex* (= *Gymnocranius*) *griseus* (Supplementary Fig. S2A) had a ratio of SL to BD of 2.6; the eye diameter (ED) was 7.9% of SL. As pointed out previously by specialists of the family Lethrinidae [1,26], the exaggeratedly elongate shape of the lectotype may reflect distortion caused by the preparation of the dried specimen. Measurements on the drawing representing *G. griseus* in C.J. Temminck and H. Schlegel's original description (Plate 36 of [10]) were the following: ratio of SL to BD = 2.25; ratio of SL to HL = 3.4; ratio of ED to length of caudal fin's median ray (MRC) = 0.89. Neither the body shape of the presumably distorted lectotype of *G. griseus* nor that of the lithography accompanying the description can be considered as representative of the species. A particular morphological feature enabled us to distinguish *G. obesus* sp. nov. from *G. griseus*: the number of front scales

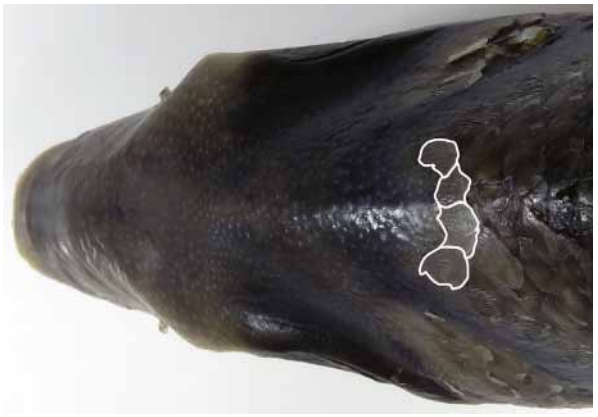

Fig. 2. *Gymnocranius obesus* sp. nov. Dorsal view of head of specimen No. MUFS 41272 (paratype) with front row of scales highlighted in white (photographed by RM).

on the top of head. We counted four to six front scales (Fig. 2) in *G. obesus* sp. nov., while nine to eleven were present in *G. griseus*, including the lectotype, which had nine (RM, pers. obs.; Supplementary Fig. S4). Last, *G. obesus* sp. nov. differed from *G. griseus* by the dark-bar patterns on flanks. While the fourth transversal dark bar in *G. obesus* sp. nov. ran from the basis of the sixth spine of the dorsal fin down to the origin of the anal fin, the one in *G. griseus*, when visible, ran down from the base of the sixth dorsal spine to the abdomen (Table 3).

Gymnocranius obesus sp. nov. was also characterized by its remarkably large eye. The eye diameter (ED) was about equal to or larger than the IOW (ratio of ED to IOW = 1.0–1.3) and generally found to be larger than the MRC, with a ratio of ED to MRC = 1.0–1.2 (Table 1, Supplementary Table S1), while the eye diameters of both *Gymnocranius* sp. D and *G. griseus* were generally smaller than both the IOW and MRC (Supplementary Tables S2 and S3). Other body proportions did not clearly differ between *G. obesus* sp. nov., *G. griseus*, and *Gymnocranius* sp. D (Table 1; Supplementary Tables S1–S3): the ratio of SL to BD was 2.2–2.4 in *G. obesus* sp. nov., vs. 2.1–2.4 and 2.2–2.6 in *G. griseus* and *Gymnocranius* sp. D, respectively; the ratio of SL to HL was 3.0–3.2 vs. 3.2–3.5 and 3.1–3.3 in *G. griseus* and *Gymnocranius* sp. D, respectively; and the ratio of ED to MRC was 1.0 to 1.2 vs. 0.9–1.1 and 0.8–1.2 in *G. griseus* and *Gymnocranius* sp. D, respectively. The upper lip of *G. obesus* sp. nov. was yellow (Fig. 1; Supplementary Fig. S1); the upper lip in *G. griseus* was generally drab, with sometimes a yellowish or a reddish hue (Supplementary Fig. S2); the lower edge of the upper lip in *Gymnocranius* sp. D was vermilion red (Supplementary Fig. S3). Three other morphological features distinguished *G. obesus* sp. nov. from *G. griseus*: (1) *G. griseus* had relatively shorter head, with ratio of SL to HL = 3.2–3.5, compared to 2.7–3.2 in *G. obesus* sp. Nov; (2) unlike *G. obesus* sp. nov., the scales on the flank above the lateral line in *G. griseus* had a darker spot giving the appearance of longitudinal rows. *G. obesus* sp. nov. and *Gymnocranius* sp. D roughly had the same deep body shape, but differed by their patterns of dark bars on the flank [16,24] and by the colouration of the caudal fin, whose margin was reddish in *Gymnocranius* sp. D and yellowish in *G. obesus* sp. nov. [16].

In summary, *G. obesus* sp. nov. is distinct from *G. griseus*, *Gymnocranius* sp. D, and any other known species in the genus *Gymnocranius* by its scale counts and by its body, fin and scale colour patterns.

3.2. Genetic comparison of G. obesus sp. nov. with congeneric species

Gymnocranius obesus sp. nov. was differentiated from the seven other congeneric species mentioned in Table 2 by 9.6 to 13.5% nucleotide sequence divergence at the mitochondrial cytochrome *b* gene. In particular, nucleotide sequences confirmed that *G. griseus*, *Gymnocranius* sp. D and *G. obesus* sp. nov. belong to three distinct genetic lineages. From the sample of eight *Gymnocranius* species for which cytochrome-*b* gene sequences were available, the closest relative of *G. obesus* sp. nov. was *Gymnocranius* sp. D (Table 2). The genetic distance (*p*-distance) between the two species was 0.096. One hundred and four diagnostic nucleotide sites were scored between *Gymnocranius* sp. D and *G. obesus* sp. nov. Four single-nucleotide polymorphisms were found within *G. obesus* sp. nov. based on five specimens from Taiwan and Japan. The *p*-distance between *G. obesus* sp. nov. and *G. griseus* was 0.109. The two foregoing values were substantially higher than the genetic distance between *G. satoi* and *G. superciliosus* (*p*-distance = 0.082) or that between *G. grandoculis* and

Table 2
Matrix of pairwise genetic distances (*p*-distance) at the cytochrome *b* locus, deduced from the nucleotide sequences sampled in 8 species of the genus *Gymnocranius*.

Sample				Sample									
No.	Species	GenBank	Reference	1	2	3	4	5	6	7	8	9	10
1	*G. elongatus*	AF381260	[20]	–									
2	*G. grandoculis*	AF381275	[20]	0.158	–								
3	*G. griseus*	AF381259	[20]	0.137	0.091	–							
4	*G. obesus* sp. nov.	KX357713	[16]	0.135	0.125	0.109	–						
5	*G. obesus* sp. nov.	KY593333	This study	0.134	0.126	0.109	0.001	–					
6	*G. obesus* sp. nov.	KY593334	This study	0.135	0.125	0.109	0.000	0.001	–				
7	*G. oblongus*	KU597058	[3]	0.141	0.087	0.101	0.121	0.122	0.121	–			
8	*G. satoi*	KX357715	[16]	0.143	0.082	0.087	0.119	0.119	0.119	0.100	–		
9	*G. superciliosus*	–	[3]	0.146	0.089	0.082	0.120	0.119	0.120	0.100	0.082	–	
10	*Gymnocranius* sp. D	KX357714	[16]	0.140	0.124	0.107	0.096	0.096	0.096	0.125	0.119	0.112	–

G. oblongus (p-distance = 0.087) (Table 2). The latter four species being reproductively isolated from one another [29], it is sensible to assume reproductive isolation between *G. griseus*, *Gymnocranius* sp. D, and *G. obesus* sp. nov.

Thus, we can now formally describe *G. obesus* sp. nov. A re-description of *G. griseus* and the formal description (or re-description) of *Gymnocranius* sp. D are pending taxonomic issues that will be addressed separately by RM.

3.3. Need for a comprehensive phylogeny of the Monotaxinae

It is common taxonomic practice to accompany new species descriptions with an identification key, in particular if former keys are obsolete. Existing identification keys in the Monotaxinae [1,26] are based on morphological characters with no reference to a phylogenetic hypothesis for the sub-family. The key proposed by [1] remains useful to identify most of the currently valid species in the Monotaxinae. The interested reader is able complete it using the information summarized in Table 3. The additional, specific information provided in this paper should further enable the interested reader to easily distinguish *G. obesus* sp. nov. from all other species, including, in particular, *G. griseus* and *Gymnocranius* sp. D.

Our position is that identification keys should be based on phylogenetically informative characters and that any revision of a taxon should be well grounded in a robust phylogenetic framework. An elaborate identification key of the sub-family Monotaxinae should be proposed at some stage, but not before the potential new species in *Gymnocranius* have been solved out and a comprehensive, robust phylogeny has been produced. A revision of the Monotaxinae currently is in preparation, which will be based on the phylogeny of all valid species including *G. griseus* once it has been re-described, *G. obesus* sp. nov., *Gymnocranius* sp. D, and four other cryptic lineages in the genera *Gymnocranius* and *Monotaxis* (WJC and PB, unpublished).

4. Taxonomy

Gymnocranius obesus sp. nov.http://zoobank.org/urn:lsid:zoobank.org:act:83F64FF2-41C9-47E8-B5B9-C284DC8F1AF5 (Table 1; Fig. 1A–H; Fig. 2; Supplementary Fig. S1). Previously referred to as *Gymnocranius* sp. *E* [3,16], *Gymnocranius* sp. 1 [24], *G. griseus* [27,28], and *G. grandoculis* [28].

4.1. Types

Holotype: NTUM 12079 (Fig. 1A). Paratypes: MUFS 25522 (Fig. 1B), MUFS 41271 (Fig. 1C), MUFS 41272 (Fig. 1D), and NTUM 10766 (four individuals; Fig. 1 E–H). See details in sub-section 2.1 and in legend to Fig. 1.

4.2. Description

The new species is described under *Gymnocranius* Klunzinger, 1870, because it has the following general characteristics of the species of this genus ([1]; Table 3): laterally compressed, ovate body; profile of the head in front of the eye convex, slope of the snout relatively steep; adult specimens often develop a bony ridge on the nape and a bony shelf above the anterior part of the eye; mouth small, posterior part of the jaw usually anterior to the level of the anterior edge of the eye; each jaw with two or three slender canines at the front, conical (molariform in *G. euanus*) teeth on the sides, and a range of numerous villiform teeth behind the front teeth; eye relatively large, a pair of close-set, round nasal openings on each side of the snout in front of the eyes, usually a thin flap of skin on the rear edge of the anterior opening; dorsal fin continuous with 10 spines and 10 (occasionally 11) soft rays; anal fin with 3 spines and 10 (occasionally 9) soft rays; pectoral fin rays 14; caudal fin strongly to moderately forked (moderately forked in *G. obesus* sp. nov.), usually with pointed or elongate tips (round in *G. euanus* and *G. satoi*); pored scales on lateral line 47 to 53 (48 in the holotype of *G. obesus* sp. nov.; 47 to 49 in paratypes and other voucher specimens); rear part of the cheek with three to five transverse scale rows (four in *Gymnocranius obesus* sp. nov.); remainder of the cheek, preorbital, snout, and inter-orbital region scaleless; inner surface of the pectoral fin base scaleless. Their body colour is generally silvery; the cheek region below the eye is often marked with either a dark bar (sometimes faint); the fins are clear to yellow or reddish (yellowish in *Gymnocranius obesus* sp. nov.). Freshly caught specimens, especially juveniles or small adults, often show a pattern of five to eight transversal dark bars [1].

Gymnocranius obesus sp. nov. specimens possess the following diagnostic combination of characters: body deep, 2.2–2.4 times in standard length (2.25 in holotype), apparently invariable across a range of sizes (Table 1), and plumpy (hence the species epithet); lower edge of the eye slightly above a line from tip of snout to middle of caudal fin; eyes protruding and large, eye diameter (ED) reaching 37–40% of head length (37% in holotype), usually close to or larger than inter-orbital width (IOW) with an ED/IOW ratio of 0.97–1.27 (1.00 in holotype) (Table 1); caudal fin moderately forked, the median rays nearly equal to or slightly shorter than ED; a row of four to six front scales on the dorsal side of the head (four in holotype) (Fig. 2); body sides with five to eight transversal dark bars often visible, even in adults (Fig. 1; Supplementary Fig. S1), the fourth one running from the base of the sixth or seventh spine of the dorsal fin to the origin of the anal fin (Fig. 1; Supplementary Fig. S1); anal, caudal and dorsal fins drab with yellowish to yellow margins, sometimes diffuse mottling or spotting on dorsal, pelvic, anal, and caudal fins (Fig. 1; Supplementary Fig. S1); no visible blue lines or spots on snout and cheek below eye in adults (SL > 270 mm) (Fig. 1; Supplementary Fig. S1); upper lip yellow (Fig. 1; Supplementary Fig. S1).

The nucleotide sequence of the COI gene of the holotype of *G. obesus* sp. nov. (GenBank KY593332) was: 5'- C T C T A T T T A G T A T T C G G T G C A T G A G C T G G G A T A G T A G G A A C C G C C C T A A G C C T T C T C A T C C G A G C G G A A C T T A G T C A A C C A G G C G C T C T C C T G G G G G A C G A C C A G A T T T A C A A T G T A A T C G T T A C A G C A C A C G C

Table 3
Summary of remarkable morphological features across species in the genus *Gymnocranius*.

Species	Body shape			Shape of CF	Pigmentation patterns		
	General	BD/SL	Head		Head	Flank	Fins
G. audleyi	High-bodied to oblong	2.2–2.4	Snout profile relatively steep	Moderately forked	Parietal scale patch blackish surrounded by brilliant white margin	With scattered brown flecks	Uniformly clear to slightly yellowish
G. elongatus	High-bodied to oblong	2.2–2.4	Snout somewhat pointed	Strongly forked	No blue ornamentation on snout or cheek	Fourth transversal dark bar running from 6th spine of DF to anterior portion of AF	Clear to yellow–orange; CF margin and tips often deep red
G. euanus	High-bodied to oblong	2.4–2.5	Sloping steeply	Moderately forked, inner edge of fork slightly convex, with blunt tips	Scattered blue dots on snout and cheek in some individuals	Scattered blackish scales mainly on anterior half of body	AF, CF, DF, PF clear to reddish
G. frenatus	High-bodied to oblong; dorsal side convex, ventral side horizontal	2.3–2.4	Dorsal profile sloping steeply	Moderately forked, inner edge of fork straight, with pointed tips	Obliquely ascending blue bands on snout and cheek	5–7 narrow, irregular dark bars	Uniformly clear
G. grandoculis	High-bodied to oblong	2.4–2.5	Forehead profile moderately steep	Moderately forked with subtle middle notch	Series of narrow undulating, longitudinal lines on cheek and side of snout	Overall silvery with thin brown scale margins. In juveniles, fourth transversal dark bar running from 6th spine of DF to origin of AF	AF, DF, PF clear to yellow–orange; CF frequently dusky grey-brown
G. griseus	High-bodied to oblong	1.9–2.3	Dorsal and ventral profile of head evenly convex	Moderately forked	No blue ornamentation on snout or cheek	Third transversal dark bar from 1st dorsal spine to lateral line; 4th transversal dark bar from 6th dorsal spine to abdomen	Fins mainly clear to yellowish
G. microdon	Oblong	2.5–3.0	Forehead prominent	Forked with pointed tips	Blue dots or dashes on cheek	Silvery in adults	AF, DF, PF clear to yellow or reddish. CF sometimes dusky brown
G. obesus sp. nov.	High-bodied to oblong	2.2–2.4	Protruding, large eye	Moderately forked	No blue ornamentation on snout or cheek	Fourth transversal dark bar running from 6th spine of DF to origin of AF	AF, CF, DF drab with yellowish to yellow margins
G. oblongus	Fusiform	2.6–2.8	Forehead prominent	Elongate, tips rounded in adults	Sub-horizontal wavy blue lines or dashes on snout and cheek	Fifth transversal dark bar forward-descending	DF, PF, AF and CF drab, brownish or yellowish with reddish to vermilion edges
G. satoi	High-bodied to oblong	2.4–2.5	Forehead bumpy	Shallowly forked, lobes convex inside and their extremities rounded	Blue speckles against bronze background on snout and cheeks	Silvery	AF, CF, DF, PF reddish to bright vermilion red
G. superciliosus	Oblong to elongate	2.7–3.1	Forehead prominent	Moderately forked with a subtle middle notch, its lobes slightly convex inside	Snout and cheek with blue speckles	Silvery	AF, CF, DF, PF reddish to red
Gymnocranius sp. D	High-bodied to oblong, symmetric dorso-ventrally	2.2–2.5	Eye large	Moderately forked with a subtle middle notch	No blue ornamentation on snout or cheek	Fourth transversal dark bar descending from 6th spine of DF to anterior to anus	AF, CF, DF drab with orange to vermilion red edge

Compiled from [1–3,16,26] and present work. AF: anal fin; BD: body depth at origin of first dorsal fin (DF); CF: caudal fin; PF: pectoral fin; SL: standard length.

CTTCGTAATGATTTTCTTTATAGTAATACCAAT
TATGATCGGAGGCTTTGGAAATTGACTTATCCC
CCTAATGATCGGGGCCCCTGACATGGCATTCCC
TCGAATGAACAACATGAGCTTTTGACTTCTCCC
CCCTTCCTTCCTACTGCTCCTAGCCTCCTCAGG
CATTGAAGCCGGAGCAGGTACCGGATGAACAG
TCTACCCCCCCACTAGCTGGTAACCTTGCTCACG
CTGGAGCATCTGTTGACTTAACCATTTTCTCCC
TCCACCTAGCTGGCATCTCCTCGATCCTGGGGG
CTATTAATTTTATTACAACCATCATCAATATAA
AACCCCCCGCCATCTCTCAATACCAGACCCCTC
TTTTCGTTTGAGCAGTCCTAATCACTGCTGTCC
TTCTCCTCCTTTCGCTGCCAGTCTTAGCCGCAG
GCATCACAATACTCCTTACGGACCGAAACTTAA
ACACAACTTTCTTTGACCCAGCAGGCGGGGGG
GACCCGATTCTT-3'.

4.3. Diagnosis

Gymnocranius obesus sp. nov. differs from its morphologically close congeners *G. griseus* and *Gymnocranius* sp. D by the number of front scales on the top of the head, and by the dark-bar patterns on flanks. While the fourth transversal dark bar in *G. obesus* sp. nov. runs from the basis of the sixth spine of the dorsal fin down to the origin of the anal fin, the one in *G. griseus*, when visible, runs down from the base of the sixth dorsal spine to the abdomen (Table 3). That in *Gymnocranius* sp. D descends from the sixth dorsal spine to the extremity of abdomen, before the anus (Table 3).

Along the cytochrome *b* gene, the following apomorphic sites have nucleotides shared by all five specimens of *G. obesus* sp. nov. examined so far, that are not present in *G. elongatus*, *G. euanus*, *G. grandoculis*, *G. griseus*, *G. oblongus*, *G. satoi*, *G. superciliosus* and *Gymnocranius* sp. D: Nos. 61, 108, 117, 135, 153, 165, 300, 303, 318, 375, 501, 564, 627, 630, 684, 756, 765, 816, 967, 972, and 1032. These nucleotide sites can be used for the diagnosis of *G. obesus* sp. nov. relative to *G. griseus* and *Gymnocranius* sp. D.

4.4. Habitat and distribution

The type locality is Fugang on the eastern coast of Taiwan. We recorded *G. obesus* sp. nov. from fish landing places in Bali, the Flores Sea, the Ryukyu Islands and Taiwan (Fig. 3). The species was not found in the Coral Sea despite substantial sampling effort targeting Lethrinidae [2,3,29]. All records south of the Ryukyu Islands were within the western half of the Coral Triangle as defined by [30]. The single specimen sampled from the Flores Sea was caught by handline together with other lethrinids including *Lethrinus erythropterus*, *L. rubrioperculatus* and *L. semicinctus* which typically inhabit the first tens of metres on the reef slope and adjacent flat areas [1]. We compared eighty-eight nucleotide sequences at the COI locus referring to the genus *Gymnocranius* available from the GenBank and BOLD public databases, to the COI-gene sequence of the holotype of *G. obesus* sp. nov. The most closely related sequence (GenBank No. JF493563, labelled *G. grandoculis*) diverged by 7.3% nucleotide difference from it. Thus, at the time of writing (January 2017), there was no evidence of the presence of *G. obesus* sp. nov. in these two COI-gene sequence databases.

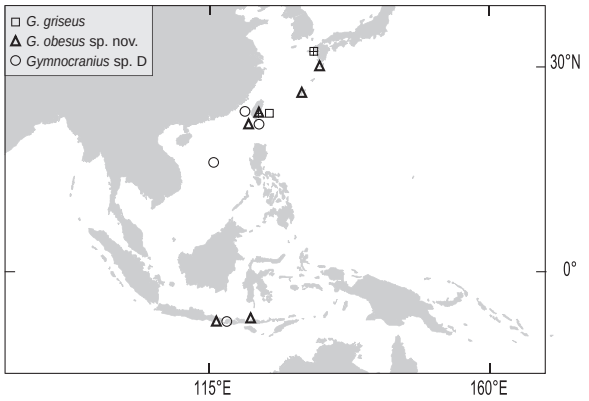

Fig. 3. Map of Southeast Asia and northern Melanesia showing the occurrence points of the material examined for the present study (see Table 1, Fig. 1, and Supplementary Material) or reported previously [16], including: *Gymnocranius griseus* (squares), *G. obesus* sp. nov. (triangles) and *Gymnocranius* sp. D (circles). Crosses (+) indicate the type localities of *G. griseus* (Nagasaki, Japan) and *G. obesus* sp. nov. (Fugang, Taiwan).

4.5. Etymology

Epithet *obesus* is the Latin translation of obese, a reference to the deep and relatively thick body shape of the specimens of this species. We propose the *obese large-eye seabream* as vernacular name for *G. obesus* sp. nov.

4.6. Remarks

The type specimens of *Lobotes microprion* Bleeker 1851 [31] and *Gymnocranius orbis* Fowler 1938 [32], both with deep body shape, exhibit patterns of dark bars on the flank that have been reported to fit those of *G. griseus* [1]. *Lobotes microprion* has also been listed by [26] as a possible synonym of *Dentex robinsoni* Gilchrist and Thompson 1909 [33], now synonymized with *G. grandoculis* [1]. Another species with oblong to deep body shape is *Pentapus curtus* Guichenot 1863 [34] also considered to be a junior synonym of *G. grandoculis* [1] (but see [2,26]). *Dentex lethrinoides* Bleeker 1850 [35] from Java and *D. rivulatus* Rüppell 1838 [36] are also considered to be junior synonyms of *G. grandoculis* [1].

We found that the dark-bar patterns of the syntypes of *L. microprion* (RMNH 5680), albeit faint, and those of *G. orbis* as represented in drawing [32] look more alike those of *G. frenatus* than *G. griseus* [24]. Further, the two syntypes of *L. microprion* have a row of at least eight front scales on the dorsal side of the head and the holotype of *G. orbis* has a row of 11 (Supplementary Fig. S5). *Gymnocranius obesus* sp. nov. thus can be easily distinguished from the foregoing two species. From pictures of the holotype of *Dentex robinsoni* Gilchrist and Thompson 1909 (SAM 10037), we were able to count at least eight scales in the row of front scales on the dorsal side of the head (Supplementary Fig. S5). Similarly, we counted more than seven front scales on the holotype of *P. curtus* (Supplementary Fig. S5). We also counted eight scales in

the row of front scales on the dorsal side of the head of the holotype of *D. lethrinoides* (Supplementary Fig. S5). Last, we confirm the synonymy of *D. rivulatus* Rüppell with *G. grandoculis.* Therefore, we can confidently exclude that G. obesus sp. nov. is synonymous with *D. lethrinoides, D. rivulatus, D. robinsoni*, *G. orbis*, *L. microprion*, or *P. curtus*.

Disclosure of interest

The authors declare that they have no competing interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.crvi.2017.08.004.

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