

Two new species of *Gobiodon* (Teleostei: Gobiidae) from the Indo-Pacific, with notes on South Pacific and Indian Ocean populations of *Gobiodon spadix*

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Abstract. The gobiid genus *Gobiodon* contains small, cryptic coral dwelling fishes that are particularly diverse but difficult to identify. Herein we name and provide formal descriptions for two new species of *Gobiodon*, *G. bicalvolineatus* and *G. cobenjaminsis*, previously known as *Gobiodon* sp. B and *Gobiodon* sp. C respectively. Additionally, we provide new information on the South Pacific Ocean population of the recently described *G. spadix*, and a revised description of the genus *Gobiodon*. Both *G. bicalvolineatus* and *G. cobenjaminsis* are small, highly specialised and cryptic members of the genus found in limited geographic ranges in Papua New Guinea (PNG). On the basis of colouration, *G. bicalvolineatus* is diagnosed in having a light blue-green base colouration with red vertical bars on the face, red spots and lighter diagonal bars on the dorsal surface of the head, and thin unbroken horizontal lines along the length of the body. It has only been recorded inhabiting *Acropora caroliniana* in the Bootless Bay area of PNG. *Gobiodon cobenjaminsis* is light orange-brown in colour with pale vertical bars on the face, black edges on all fins except pectoral fins, and a black spot on the upper opercular margin. It has been recorded inhabiting *Acropora elseyi* in the Kimbe Bay area of PNG. We also provide morphological confirmation that the individuals previously referred to as *Gobiodon* sp. D observed in PNG and the Great Barrier Reef (GBR) are conspecific with the recently described *G. spadix*, along with additional measurements, characters, and habitat ecology. The latter includes their host preference for *Acropora divaricata* in the GBR and slight variation in morphometrics. The study utilises an interdisciplinary approach combining morphological characters, meristic and morphometric measurements, molecular genetics, and multivariate-statistical analysis of morphometric data to provide these descriptions and aid in the identification of these species.

Key words. taxonomy, *Gobiodon*, coral goby, *Gobiodon bicalvolineatus*, *Gobiodon cobenjaminsis*, *Gobiodon spadix*

INTRODUCTION

Coral gobies are small, obligate coral dwelling reef fishes, belonging to the second most speciose family of vertebrates; family Gobiidae (Munday et al., 1997; Schiemer et al., 2009; Tornabene et al., 2013). One genus within this family, known for their specialisation in coral reef microhabitats, is *Gobiodon*

Bleeker, 1856, with 29 reported species (WoRMS Editorial Board, 2024). The 29 current species include: *G. acicularis* Harold & Winterbottom, 1995, *G. albofaciatus* Sawada & Arai, 1972, *G. aoyagii* Shibukawa, Suzuki & Arai, 2013, *G. ater* Herler, Bogorodsky & Suzuki, 2013, *G. atrangulatus* Garman, 1903, *G. axillaris* De Vis, 1884, *G. bilineatus* Herler, Bogorodsky & Suzuki, 2013, *G. brochus* Harold & Winterbottom, 1999, *G. ceramensis* (Bleeker, 1853), *G. citrinus* (Rüppell, 1838), *G. erythrospilus* Bleeker, 1875, *G. fulvus* Herre, 1927, *G. fuscoruber* Herler, Bogorodsky & Suzuki, 2013, *G. heterospilos* Bleeker, 1856, *G. histrio* (Valenciennes, 1837, in Cuvier & Valenciennes, 1837), *G. howsoni* Allen, 2021, *G. irregularis* Herler, Bogorodsky & Suzuki, 2013, *G. micropus* Günther, 1861, *G. multilineatus* Wu, 1979, *G. oculolineatus* Wu, 1979, *G. okinawae* Sawada, Arai & Abe, 1972, *G. proluxus* Winterbottom & Harold, 2005, *G. quinquestrigatus* (Valenciennes, 1837, in Cuvier & Valenciennes, 1837), *G. reticulatus* Playfair, 1867, *G. rivulatus* (Rüppell, 1830), *G. spadix* Sato & Motomura, 2024, *G. spilophthalmus* Fowler, 1944, *G. unicolor* (Castelnau, 1873a), and *G. winterbottomi* Suzuki, Yanao & Senou, 2012. However, it should be noted that the species *G. unicolor* is not widely accepted, as the holotype was found to be synonymous with *G. histrio*, and specimens previously

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identified as this species in the western Pacific were found to be members of the species *G. fuscoruber* Herler, Bogorodsky & Suzuki, 2013.

Many of the associated reef building scleractinian corals inhabited by *Gobiodon* belong to the genus *Acropora* Oken, 1815. Other coral genera such as *Stylophora* Schweigger, 1820, *Echinopora* Lamarck, 1816, *Hydnophora* Fischer von Waldheim, 1807, and *Pocillopora* Lamarck, 1816 are also inhabited at reduced frequencies (Munday et al., 1999). Some species of *Gobiodon* inhabit one or two species of corals at higher frequencies, whereas others inhabit up to 10 or more different coral species (Munday et al., 1997; Brandl et al., 2018; Froehlich et al., 2023). The degree of host specialisation is known to vary between species, throughout stages of development, and depending on disturbance levels (Munday et al., 1997; Dirnwöber & Herler, 2007; Froehlich et al., 2023).

Members of genus *Gobiodon* typically have a deep and well compressed head and body. The compression of the head in *Gobiodon* is greater than that seen in other genera with similar body shapes such as *Paragobiodon* Bleeker, 1873 and *Lubricogobius* Tanaka, 1915, and the more distantly related coral dwellers *Caracanthus*, Kröyer, 1845, in Scorpaenidae. *Gobiodon* species, however, are typically distinguished from other gobiid genera in having a more laterally compressed body and head, reduced facial papillae, absence of scales, small jaw teeth (with the exception of some species with well-developed canine teeth), and a narrow gill opening that is restricted to the pectoral fin base but not extending beyond the preopercular margin (Munday et al., 1999; Akihito et al., 2002; Harold et al., 2008). The genus is also known for the thick mucus layer containing crinotoxins that covers the body surface (Munday et al., 2003; Gratzer et al., 2015). Bi-directional sex change has been observed in the genus, with individuals of multiple species displaying the ability to switch back and forth between male and female sexes (Munday et al., 1998; Harold et al., 2008; Shibukawa et al., 2013). However, one of the most distinguishing features of this genus are the bright distinctive colour patterns in most species (Munday et al., 1999).

The taxonomic history of *Gobiodon* has been contentious, with nebulous diagnoses and inadequate descriptions of species resulting in confusion and difficulty in distinguishing species. Species were often separated using small but key differences, including body colour patterns, shape of the first dorsal fin, or morphometrics. These differences are somewhat difficult to identify when individuals are in their natural habitat due to the evasive and cryptic behaviour of the genus. However, collecting and preserving specimens does not solve this issue either, since the most distinguishing feature between species, live colouration and pattern, almost completely disappears upon ethanol preservation and are greatly reduced in formalin preserved specimens (Herler et al., 2013; Shibukawa et al., 2013). Confusion has also stemmed from the nebulous and often inadequate descriptions of species based on preserved specimens (Herler et al., 2013). These descriptions were often applied to several live

specimens, further adding to the confusion within the genus. The problematic taxonomic history of the genus *Gobiodon* provides impetus for an updated taxonomic description of the genus. The increasing use and advances in genetic sequencing has additionally helped clarify relationships within the genus and aid in alleviating some of the confusion present.

Presently, there are additional species found throughout the Pacific Ocean awaiting taxonomic descriptions. Of these, two species referred to as *Gobiodon* sp. B and sp. C, have been briefly detailed in field guides and speciation analysis, and should be scientifically described (Munday et al., 1999, 2004; Duchene et al., 2013; Herler et al., 2013). Previous studies employing genetic and morphological techniques have suggested that *Gobiodon* sp. B and sp. C represent putative new species that differ from congeners (Harold et al., 2008; Duchene et al., 2013; Herler et al., 2013). We herein provide formal taxonomic descriptions for these two species, *Gobiodon bicalvolineatus* and *Gobiodon cobenjaminsis*, respectively. Additionally, we provide new measurements and habitat and ecology information for the South Pacific and Indian Ocean populations of the recently described *Gobiodon spadix* Sato & Motomura, 2024, as well as an updated taxonomic summary for the genus *Gobiodon*, with genetic analyses and multivariate geometric morphometrics for select species. Our results provide a new benchmark in the facilitation of species identification within genus *Gobiodon*.

MATERIAL AND METHODS

Specimen collection. Field collection of *Gobiodon bicalvolineatus* (previously known as *Gobiodon* sp. B) (Munday et al., 1999; Munday et al., 2004; Harold et al., 2008; Duchene et al., 2013; Herler et al., 2013) and *Gobiodon cobenjaminsis* (previously known as *Gobiodon* sp. C) (Munday et al., 1999; Harold et al., 2008; Duchene et al., 2013; Herler et al., 2013) were conducted in the Bootless and Kimbe Bay areas of Papua New Guinea between 1998–2002 by Philip Munday and colleagues. Specimens of *Gobiodon spadix* were collected from One Tree Island, Australia during 2022 and 2023. Individuals were collected with hand nets and clove oil anaesthetic (Munday & Wilson 1997). Life colouration notation and photographs were taken while the fish were anaesthetised with dilute clove oil. Preserved colouration was recorded post exposure to 70–100% ethanol. One specimen (AMS I.51465-001) was fixed in 5% formalin prior to the ethanol preservation. The mucus layer was not removed from specimens. Collection details of these specimens are reported in Table 1.

Comparative specimens. Comparative *Gobiodon* specimens including the new species described herein, were examined from material housed in the ichthyology collections at the Australian Museum in Sydney, Australia (AMS). Specimens from Japan for comparison to the South Pacific Ocean population of *G. spadix* were loaned from Kagoshima University Museum and Osaka Museum of Natural History. Individuals identified as possible *Gobiodon* sp. D from the Maldives at the Natural History Museum of Denmark,

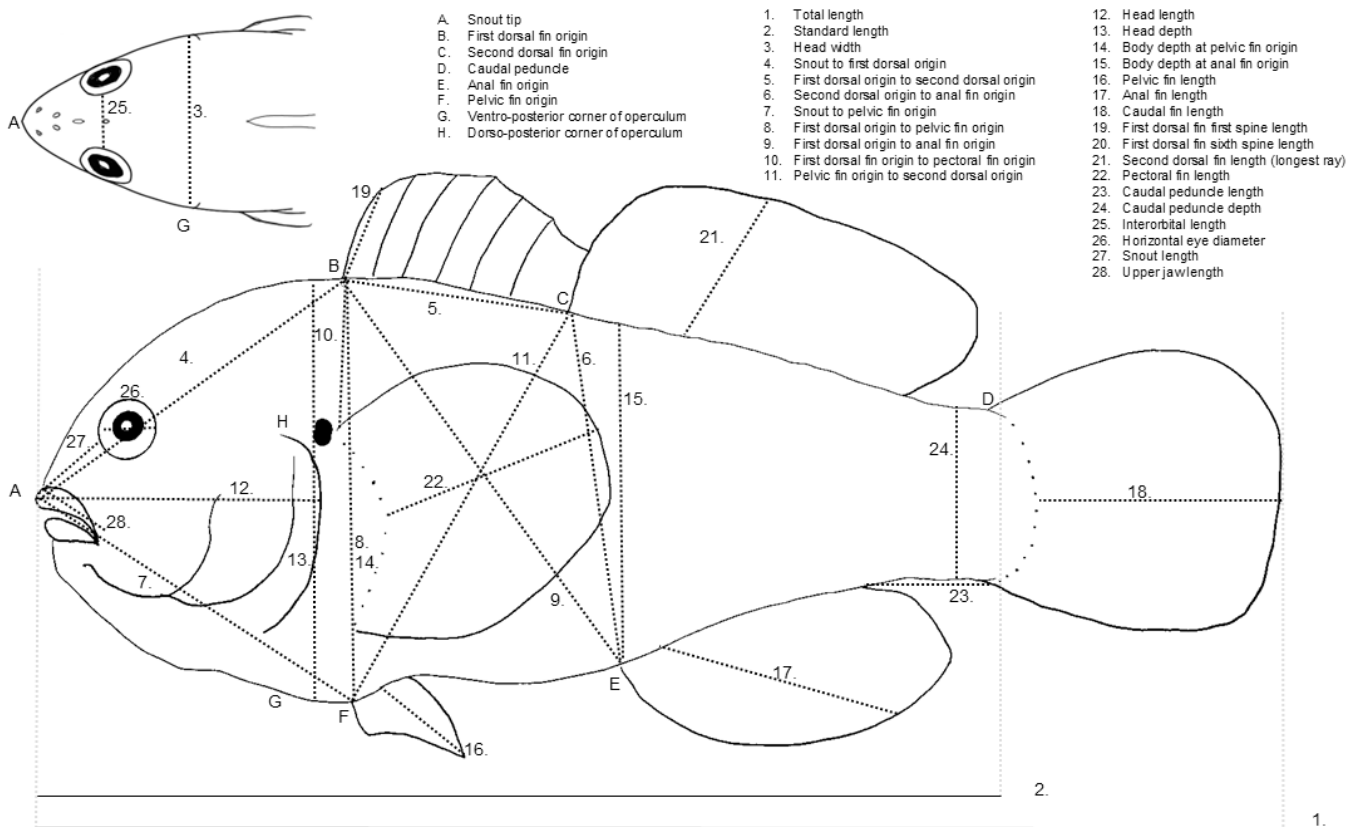


Fig. 1. Morphometric measurements recorded for species descriptions and comparisons displayed on a generalised illustration of a specimen from genus *Gobiodon*, measurements previously listed in Herler et al. (2013).

University of Copenhagen were loaned to determine if they belonged to *G. spadix*. Museum registration numbers are included in the comparative material section of the descriptions.

Collection abbreviations. In accordance with Sabaj (2020): AMS – Australia Museum, Sydney. QM – Queensland Museum. KAUM – Kagoshima University Museum. OMNH – Osaka Museum of Natural History. ZMUC – Natural History Museum of Denmark (formerly the Zoological Museum, University of Copenhagen).

Morphometrics. Body morphometric measurements followed those presented in Herler et al. (2013) and were taken from preserved specimens with the mucus layer still intact (Fig. 1). Fish body length was recorded in both standard length (SL) and total length (TL). An additional measurement, head width, is the least horizontal distance across the dorsal surface in line with the opercular margin (Fig. 1, Measurement 3). Measurements were taken under a binocular dissection microscope with a Mitutoyo Corp. electronic calliper to the nearest 0.01 mm. All specimens, including the loaned specimens, were measured at the Australian Museum, Sydney, by C. Hildebrandt, to remove any possible measuring bias. Unless otherwise specified, measurements are presented as a percentage of standard length (SL) or head length (HL).

Meristics. Fin-ray counts were taken for all individuals. Fin spines were numbered using Roman numerals and soft rays using Arabic numbers. Meristic values are given with the

full range observed and parentheses used to denote those of the holotype if range was present. Meristic counts followed Winterbottom & Harold (2005), with the exception of the caudal fin rays being separated into branched and unbranched rays only. Vertebrae were counted and fin-ray counts were confirmed on radiographed specimens. Radiography was conducted using a Thermo Scientific PXS 5-927EA-R model X-Ray. All radiographs used are the copyright of the Australian Museum, Sydney.

Morphometric analysis. A discriminant analysis of the body measurements of all specimens with a standard length larger than 15 mm (excluding juveniles) was conducted using the program PAST (Hammer et al., 2001) version 4.03, to investigate the relationship between species specific phenotypic characteristics of the new species compared with species with similar appearances or previously identified as adjacent species in the phylogenetic tree (Harold et al., 2008; Duchene et al., 2013; Herler et al., 2013; Hing et al., 2019). The measurements for all morphometric measurements, except total length, were used to generate a linear discriminant analysis (LDA) for the study species and comparative species, and principle coordinate analysis (PCoA) for the possible populations of *G. spadix*. Biplot analyses were used to identify the main morphometric characteristics between focus species and comparative species.

Updated genus description. The updated genus description provided here is based on morphometric data and characters of all previously described species descriptions and published morphological measurements (De Vis, 1884; Garman, 1903;

Table 1. Focus species specimen details of locality and collection. Locality code: PNG = Papua New Guinea, GBR = Great Barrier Reef.

Museum Registration Code	Species	Location	Collection	Type
I.51464-003	<i>Gobiodon bicalvolineatus</i>	PNG	AMS	Holotype
I.51464-001	<i>Gobiodon bicalvolineatus</i>	PNG	AMS	Paratype
I.51464-002	<i>Gobiodon bicalvolineatus</i>	PNG	AMS	Paratype
I.41386	<i>Gobiodon bicalvolineatus</i>	PNG	QM	Paratype
I.51464-005	<i>Gobiodon bicalvolineatus</i>	PNG	AMS	Paratype
I.51465-001	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Holotype
I.51466-001	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Paratype
I.51466-002	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Paratype
I.51467-001	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Paratype
I.51467-002	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Paratype
I.51466-003	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Paratype
I.51466-004	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Paratype
I.51466-005	<i>Gobiodon cobenjaminsis</i>	PNG	AMS	Paratype
I.41387	<i>Gobiodon cobenjaminsis</i>	PNG	QM	Paratype
I.51468-001	<i>Gobiodon spadix</i>	GBR	AMS	Non-type
I.51468-002	<i>Gobiodon spadix</i>	GBR	AMS	Non-type
I.51468-003	<i>Gobiodon spadix</i>	GBR	AMS	Non-type
I.51469-001	<i>Gobiodon spadix</i>	GBR	AMS	Non-type
I.51470-001	<i>Gobiodon spadix</i>	GBR	AMS	Non-type
I.41388	<i>Gobiodon spadix</i>	GBR	QM	Non-type

McCulloch & Ogilby, 1919; McCulloch, 1929; Fowler, 1944; Sawada et al., 1972; Emery & Winterbottom, 1986; Harold & Winterbottom, 1995, 1999; Herler & Hilgers, 2005; Winterbottom & Harold, 2005; Harold et al., 2008; Suzuki et al., 2012; Herler et al., 2013; Shibukawa et al., 2013; Allen, 2021; Sato & Motomura, 2024), as well as data newly collected in this present study.

Genetic analysis. Mitochondrial cytochrome c oxidase subunit I (COI) was used for the analysis. Three ethanol-preserved specimens from each of the putative new species were selected for molecular genetics. Gill tissue was removed from the right-hand side of the individuals. DNA was extracted at the Sydney Institute of Marine Science utilising a Promega SV Genomic DNA Purification Kit (Promega), utilising the kit's outlined protocol. The DNA was sequenced by Sanger Sequencing by Macrogen Biotechnology (Macrogen Inc., Republic of Korea). The mitochondrial COI DNA was sequenced using the primers DGLCO1490 for forward and DGHCO2198 for reverse (Folmer et al., 1994). The sequences were concatenated using Geneious Prime 2023.2 (Geneious by Dotmatics). Comparative *Gobiodon* sequences were taken from publicly accessible repositories, including GenBank and the Barcode of Life Database (BOLD) (Appendix). Sequences were

then aligned in MEGA 11 using the default settings for ClustalW. The specimen with the longest chain from each of the proposed species was then chosen to be aligned with the additional sequences for 16 other species of *Gobiodon* (see supplemental data for accession numbers). Two species of *Paragobiodon* were selected as outgroups. Tails at either end of sequence were removed to produce a set of sequences 600 bp long. The sequences from the specimens processed as part of this study have been uploaded to GenBank, with the code for *Gobiodon cobenjaminsis* accession number being PP882813, and the code for the Great Barrier Reef specimen of *Gobiodon spadix* accession number being PP874577.

Phylogenetic tree inference. Bayesian phylogenetic reconstruction was performed using BEAST (version 2.5) (Bouckaert et al., 2019). The program 'jmodeltest 2.1.10' (Guindon & Gascuel, 2003; Darriba et al., 2012) was used to determine the best nucleotide substitution model for the tree inference. Using the corrected Akaike Information Criterion (AICc) the GTR+I+G model (Tavaré, 1986) was chosen for analysis. A strict molecular clock was used as well as the tree prior for 'Speciation: Yule Process' (Gernhard et al., 2008) with a random starting tree. Bayesian analyses were conducted using Markov Chain Monte Carlo (MCMC) sampling with a chain length of 100 million, with the initial

10% of samples discarded as burn-in. The analysis was run in duplicate and checked in the program Tracer 1.7.1 (Rambaut et al., 2018) for convergence. TreeAnnotator v2.5 (Bouckaert et al., 2019) was used to generate the maximum-clade-credibility tree. The constructed Bayesian phylogenetic tree was then visualised and rearranged in Figtree 1.4.4 (<http://tree.bio.ed.ac.uk/software/figtree/>).

TAXONOMY

Infraclass Teleostei

Order Gobiiformes

Family Gobiidae

Genus *Gobiodon* Bleeker, 1856

Gobiodon (Bleeker, 1856) (separation from *Gobius* Linnaeus, 1758, as type species *Gobiodon heterospilus*)

Ellerya (Castelnaud, 1873b) (as a new genus, type species *Ellerya unicolor*, by monotypy)

Pseudogobiodon (Bleeker, 1874) (as a new genus, type species being *Gobius citrinus*)

Diagnosis. Laterally compressed deep body with thickened epidermal mucus layer. Head scaleless. Body generally naked with some squamation on caudal peduncle in some species. Dorsal-fin rays VI, I,9–13; pectoral-fin rays 16–21; anal-fin rays I,8–11; pelvic-fin rays I,5. Upper procurrent caudal-fin rays 4–6; lower procurrent caudal-fin rays 4–6; principal caudal-fin rays 7–8 + 9–10 (all segmented rays branched). Vertebra 25–27 including hypural plate. First dorsal fin varied in length. Second dorsal fin similar in length to first. Pelvic fins connected ventrally by membrane. Dentary bone triangular or elongate. Uniform or varying sized teeth. Post-symphysial canine teeth may be present.

Description. Dorsal-fin rays VI, I,9–11; pectoral-fin rays 16–21, typically 19–20. Anal-fin rays I,8–10. Pelvic-fin rays I,5. Upper unsegmented caudal fin rays 4–6. Lower unsegmented caudal fin rays 4–6. Upper segmented branched caudal fin rays 8–9. Lower segmented branched caudal fin rays 7–9. Vertebrae 25–27 including hypural plate.

Body laterally compressed, deeper than wide or somewhat fusiform. Ground colour during life variable, ranging from green/blue, yellow, brown, red, orange, black or grey. Ground colour once preserved often brown, beige, or yellow, with variation depending on preservation method. Live colouration markings when present usually as spots, lines, or ripples, occasionally restricted to the head as facial pigment bars. Small black spot on upper opercular margin in some species. Body of most species naked. When present, squamation is minimal and restricted to the caudal peduncle, e.g., *Gobiodon aoyagii*. Body covered in thick epidermal mucus layer.

Anterior head profile steep and blunt. Groove between isthmus and interopercle typically either deep or absent. Interopercle shallow and lance-like, deep sub-elliptical or anteriorly elongated and expanded. Metapterygoid deep or

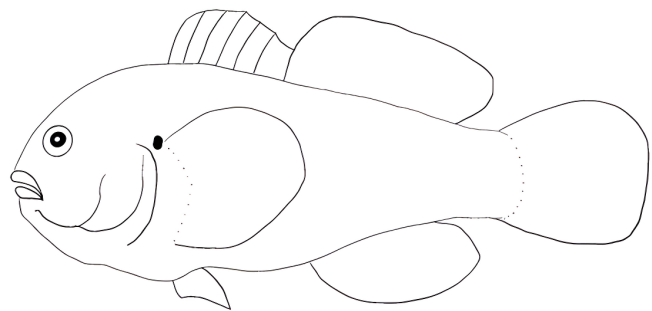


Fig. 2. Generalised sketch of representative *Gobiodon* species including the most common characteristics and example placement of upper opercular margin spot.

shallow in form. Lacrimal elongate and narrow, broadly spatulate or ventrally expanded, triangular or quadrilateral in shape. Interhyal basally expanded and triangular or dorsal/ventral extremities equal width.

Dentary bone triangular or elongate and recurved. Jaw teeth uniform in appearance or varying size with rows. Post symphysial canine teeth present in some species. Variation in protractor hyoidei muscle attachment process on ventral lower jaw.

Cephalic sensory system composed of anterior naris, posterior naris, six anterior oculoscapular canal pores, and three preopercular canal pores. Facial papillae equal width/length or longer than wide. Facial papillae reduced compared to related genera, e.g., *Paragobiodon*. Pit organs on head adjacent to lips, nostril, orbits and opercular margin.

Dorsal fin with varied configuration, some species having signature configurations, including varied length of rays to form a 'sail' or 'squared' shape. First and second dorsal fins attached by membrane. May appear with clear separation, with sixth spine of first dorsal shorter than first spine of second. In a small number of species first dorsal sixth spine length may be equal to second dorsal first spine, appearing more fused. Pelvic fin connected by a membrane, producing a fin capable of generating suction. All other fins share common shape throughout genus, with some variation of caudal and pectoral fins.

Species known to undergo bi-directional sex change (Nakashima et al., 1996; Munday et al., 1998; Munday et al., 2010). Difference between male and female *Gobiodon* present in the genitalia shape, with no known sexual dimorphism (Nakashima et al., 1996; Munday et al., 1998; Shibukawa et al., 2013).

Etymology. The commonly accepted source for *Gobiodon* comes from the Latin 'gobius' meaning gudgeon and the Greek 'odous' meaning teeth.

Habitat and biology. *Gobiodon* are small (20–70 mm SL) cryptobenthic coral-associated reef fish from family Gobiidae. Typically, they are observed deep within a coral colony, living between the branches. Basic body plan seen in Fig. 2. Their diet is debated, but is typically thought to include plankton,

small invertebrates, algae, and occasionally tissue from the coral host (Brooker et al., 2010). Members can be observed living solitarily, in pairs, or in groups, but most frequently as pairs (Hing et al., 2019). They are known to be highly specialised for life amongst the branches of their mutualist partner cnidarians, typically from the genus *Acropora*, but have also been seen living in *Echinopora*, *Hydnophora*, *Stylophora*, and *Pocillopora*, and are typically found at depths of 1–10 m. Their distribution is widespread, occurring where their host coral species can be found, throughout the Indo-Pacific from the Pacific Islands, GBR and Japan, through the Indian Ocean into the Red Sea.

***Gobiodon bicalvolineatus*, new species**

English name: Speckle-Lined Coral Goby

(Figs. 3, 4; Tables 2, 3)

Gobiodon sp. B (Munday et al., 1999; Munday et al., 2004; Harold et al., 2008; Duchene et al., 2013; Herler et al., 2013)
Gobiodon new species (Munday et al., 2004)

Holotype. AMS I.51465-001, 20.8 mm SL, Loloata Island, PNG, Indo-Pacific (9°32'30.7"S, 147°17'21.1"E), depth unknown, collected by P. Munday, 2002.

Paratypes. 4 specimens, all from PNG collected by P. Munday in 2002. AMS I.51464-001, 17.6 mm SL, Loloata Island, (9°32'30.7"S, 147°17'21.1"E), depth unknown; AMS I.51464-002, 15.6 mm SL, Loloata Island; QM I.41386, 19.2 mm SL, Loloata Island; AMS I.51464-005, 11.2 mm SL (juvenile), Loloata Island.

Comparative material. *Gobiodon aoyagii*: AMS I.27364-003 (2 specimens), 20.7–28.0 mm SL, Coast of Amitori, Ryukyu Islands, Japan, collected by H. Kishimoto, 1977. AMS I.46140-001 (1 specimen), Sakinome Beach, Oshima Straits, Amami Island, Amami Group of Ryukyu Islands, Japan (28°11.2'N, 129°16'E), 2–3 m depths, 12 September 1989, collected by M. Aizawa. AMS I.1944-076-1 (2 specimens), 18.3–30.2 mm SL, Eagle Island, GBR, Australia, collected by AMS Lizard Island Team, 1975. AMS I.22953-006 (2 specimens), 23.2–26.5 mm SL, Cebu Aquatics (Aquarium specimens), Philippines, collected by E. Murdy, 1982.

Gobiodon brochus: AMS I.22186-001 (1 specimen), 25.0 mm SL, Palfrey Island, GBR, Australia, collected by D. Hoese, 1975. AMS I.46739 (1 specimen), 21.0 mm SL, Ona Island, Tonga, collected by S. E. Reader, 2015. AMS I.35854-003 (2 specimens), 19.0–19.3 mm SL, Madang, PNG, collected by K. Cole, 1994. AMS I.22187-001 (1 specimen), 23.8 mm SL, Palfrey Island, GBR, Australia, collected by D. Hoese, 1975. AMS I.22579-072, 18.5 mm SL, Escape Reef, GBR, Australia, collected by D. Hoese, 1981.

Gobiodon histrio: AMS I.35859-006 (1 specimen), 23.9 mm SL, Massao Island PNG, collected by K. Cole, 1994. AMS IA.2026 (1 specimen), 22.5 mm SL, Hayman Island, GBR, Australia, collected by E. H. Rainford, 2018. AMS I.35906-001 (2 specimens), 30.6–31.4 mm SL, Riau Islands, Indonesia, collected by P. Ng, 1993. AMS I.21578-001 (2

specimens), 32.6–34.0 mm SL, Lizard Island, GBR, Australia, collected by D. Hoese and party, 1978. AMS I.20793-079 (1 specimen), 25.1 mm SL, Clack Island, Cape York, Australia, collected by Australian Institute of Marine Science Team, 1979. AMS I.22224-001 (1 specimen), Lizard Island, GBR, Australia, collected by D. Hoese, 1975. AMS I.11773-001 (1 specimen), 33.6 mm SL, Murray Island, Torres Strait, Australia, collected by Hedly and McCulloch, 1907.

Diagnosis. Dorsal-fin rays VI, I,10; anal-fin rays I,9–10; head and majority of body naked with some squamation on caudal peduncle; body slightly laterally compressed (body depth at pelvic-fin origin 40.6–45.3% SL), typically dorsal ventrally symmetrical, head rounded; mouth small with pronounced recurved lips; groove between isthmus and interopercle present; caudal peduncle relatively deep (15.5–18.6% SL); caudal fin long (22.1–29.3% of SL). Post symphyseal teeth absent, triangular dentary with various sizes of jaw dentition. Elongate cheek papillae length exceeding width. Adults with blue-green base colouration and red markings on the face and body. Facial markings as vertical bars on cheek, small spots on dorsal surface of head and unbroken horizontal lines along the length of the body beginning post pectoral fin (Fig. 2).

Description. Dorsal-fin rays VI, I,10; pectoral-fin rays 19; pelvic-fin rays I,5; anal-fin rays I,9–10 (I,9). Caudal-fin principal rays 9+8 or 9+9 (9+9), all branched and segmented; 6 procurrent caudal-fin rays above and below branched (all unbranched and unsegmented) (Fig. 3). Vertebral count 26.

Head and body deep, ovoid, highly laterally compressed. Body depth maximum at pelvic fin origin. Reduced body depth at opercular margin and anal fin origin. Dorsal profile of head steep, strongly convex. Curved profile upon approach of lips. Snout protrudes beyond upper lip, produced curved head appearance of dorsal profile. Eyes positioned dorso-laterally. Interorbital width narrow with high variation (14.0–33.2% of HL). Cheek papillae longer than wide. No visible dark pigmentation on upper opercular margin. Pigmentation of interorbital region uniform. Deep groove between isthmus and interopercle present. Anterior margin of interopercle prolonged. Interopercle attach to retroarticular by short ligament. Interopercle shallow spear-like appearance. Dentary elongate and recurved. Jaw dentition consists of two or three sizes. Post-symphyseal canine teeth absent. Multiple rows of teeth of varying sizes. Lacrimal shape elongate-narrow. Gill opening relatively narrow.

First dorsal fin origin located above or slightly anterior to the uppermost point of pectoral fin base. Posterior end of first dorsal fin base above anus. Second dorsal fin origin just behind posterior most point of first dorsal fin, connected via low membrane. Second dorsal fin not quite reaching caudal fin. Anal fin origin posterior to urogenital papilla. Pectoral fins elongate and obliquely pointed to dorsal surface. Pelvic fins cup shaped, fused medially with well-developed connecting membrane. Pelvic fin posterior to pectoral fin base. Posterior point of pelvic fin not reaching behind anus. Caudal fin rounded but more elongate than congeners. Head scaleless.

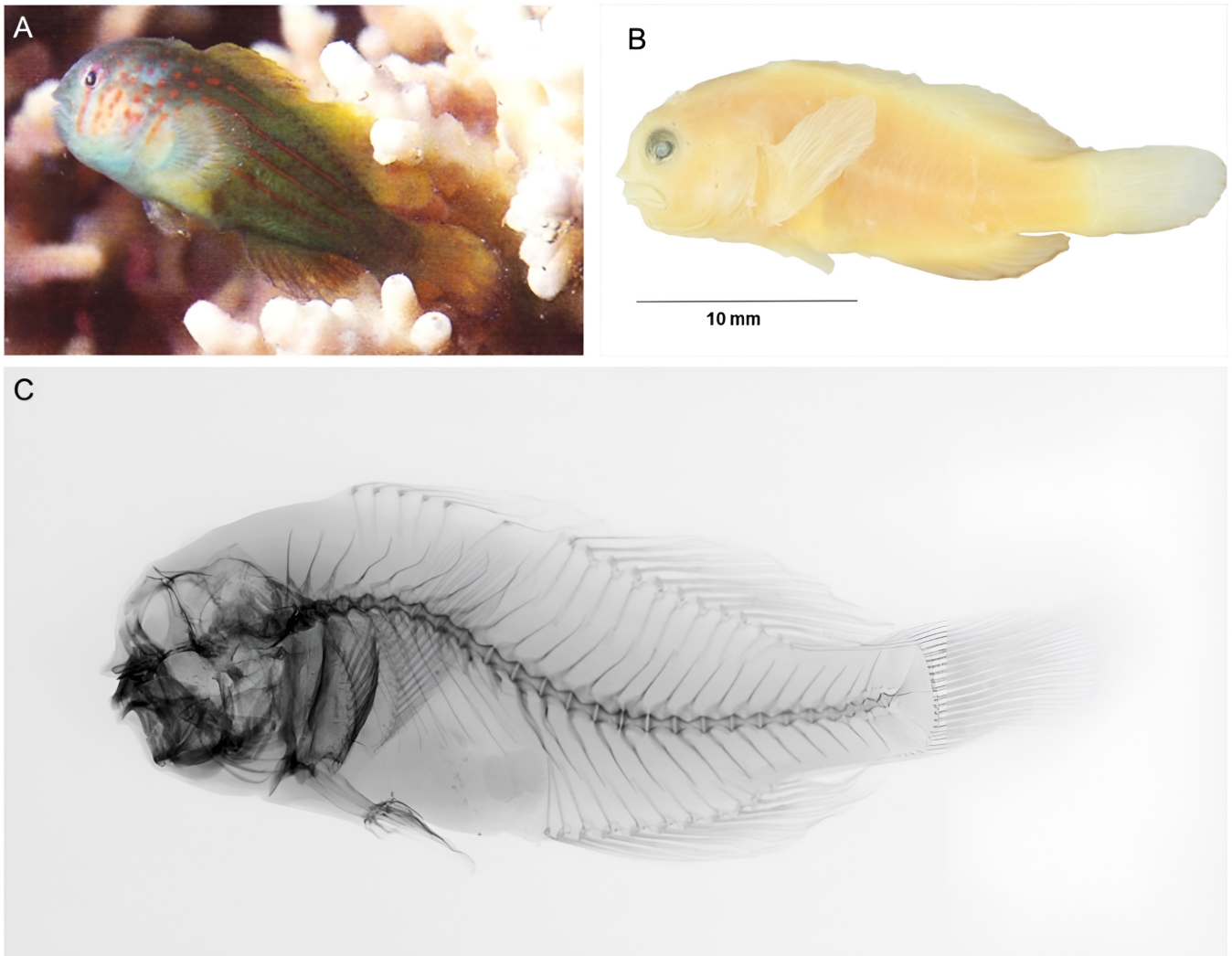


Fig. 3. Images and radiographs of the holotype specimen AMS I.51465-001 of *Gobiodon bicalvolineatus*. A, live specimen colouration photographed by P. Munday in Munday et al. (1999). B, photograph of preserved holotype of *G. bicalvolineatus* from Loloata Island Reef, PNG, holotype, 20.8 mm SL. C, radiograph of holotype of *G. bicalvolineatus* from Loloata Island Reef, PNG, holotype, 20.8 mm SL, X-rayed by Kerryn Parkinson.

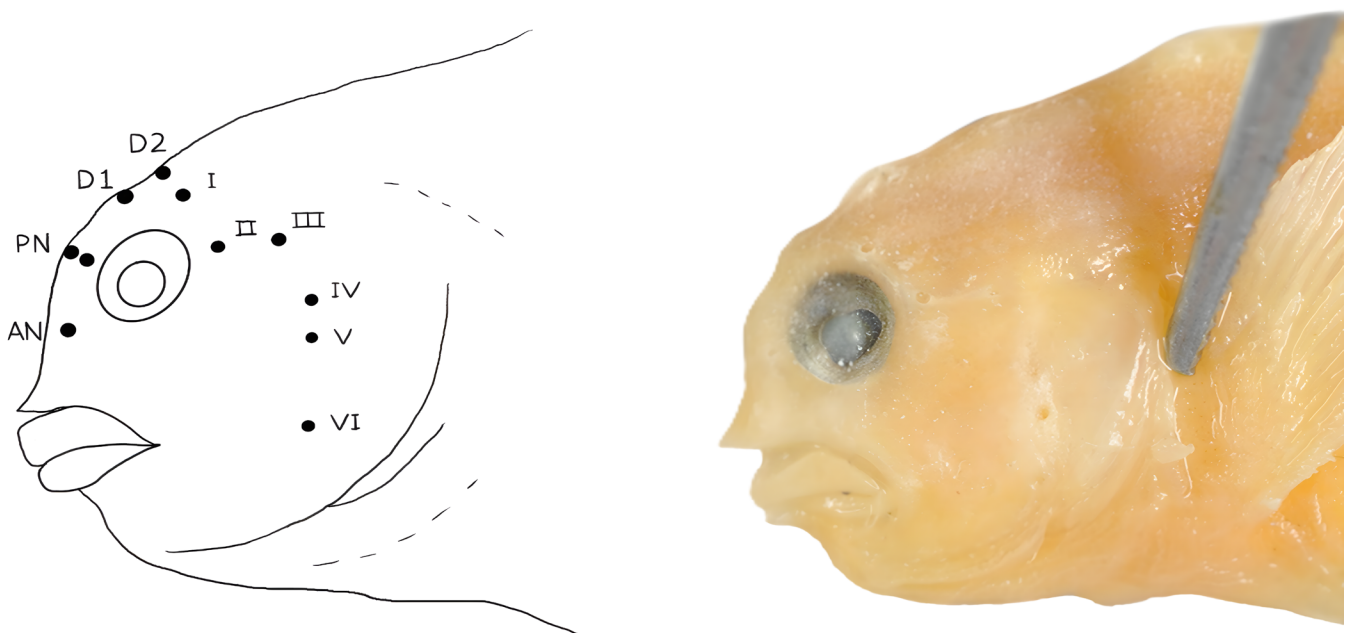


Fig. 4. Facial papillae and lateralis pores based on the holotype of *Gobiodon bicalvolineatus* AMS I.51465-003. Both sketch and photograph presented. AN – Anterior naris, PN – Posterior naris, D1 – first dorsal oculoscapular canal, D2 – second dorsal oculoscapular canal, I–III – three non-dorsal oculoscapular canal, and IV–VI – three preopercular canals.

Table 2. Body proportions of the holotype and three paratypes from *Gobiodon bicalvolineatus* from Papua New Guinea in the Indo-Pacific. Aside from those listed with millimetres (mm) as units, measurements are proportions (%) of standard length (SL) or proportions (%) of head length (the last four measurements denoted with an asterisks) respectively. Mean and standard deviation (SD) also supplied. No data resulting from damaged fins is recorded as a en dash.

Measurement	Holotype I.51464-003	Paratype I.51464-001	Paratype I.51464-002	Paratype I.41386	Mean \pm SD
Total length (mm)	26.7	22.4	–	25.1	22.1 \pm 5.5
Standard length (mm)	20.8	17.6	15.6	19.2	16.9 \pm 3.7
Head width (mm)	19.3	18.3	16.3	17.9	18.8 \pm 2.2
Snout to first dorsal origin	33.9	32.6	38.4	38.1	37.1 \pm 3.9
First dorsal fin origin to second dorsal origin	32.2	29.9	22.8	30.7	26.9 \pm 5.8
Second dorsal origin to anal fin origin	38.2	42.5	35.0	37.5	37.0 \pm 4.0
Snout to pelvic fin origin	38.3	43.2	41.3	37.2	38.9 \pm 3.4
First dorsal fin origin to pelvic fin origin	39.7	46.1	41.6	43.6	41.8 \pm 3.2
First dorsal fin origin to anal fin origin	49.1	61.6	45.9	50.9	49.8 \pm 7.5
First dorsal fin origin to pectoral fin origin	19.3	17.2	17.7	16.3	17.7 \pm 1.1
Pelvic fin origin to second dorsal fin origin	48.6	51.3	42.8	47.8	46.4 \pm 4.0
Head length	28.3	32.3	31.1	29.0	30.4 \pm 1.7
Head depth	36.7	43.8	35.7	38.4	38.6 \pm 3.1
Body depth - pelvic fin origin	40.6	45.3	40.6	45.3	41.5 \pm 4.0
Body depth - anal fin origin	36.7	40.8	30.3	32.3	33.2 \pm 5.6
Pelvic fin length	11.2	14.2	12.6	16.2	14.1 \pm 2.3
Anal fin length	22.3	25.7	17.6	22.1	22.3 \pm 3.0
Caudal fin length	29.1	22.1	–	30.3	26.0 \pm 4.3
First dorsal fin first spine length	10.5	7.9	13.5	10.0	10.6 \pm 2.0
First dorsal fin sixth spine length	6.4	11.2	9.9	6.2	8.6 \pm 2.2
Second dorsal fin length	23.9	27.0	16.3	21.6	21.4 \pm 4.3
Pectoral fin length	26.5	29.0	23.5	23.3	24.4 \pm 3.5
Caudal-peduncle length	16.1	19.8	14.2	15.8	17.1 \pm 2.5
Caudal-peduncle depth	14.5	16.3	15.6	11.9	15.1 \pm 2.1
Interorbital width*	23.2	33.2	14.0	17.7	21.0 \pm 7.6
Horizontal eye diameter*	23.2	23.6	27.2	23.1	26.0 \pm 4.2
Snout length*	27.9	27.5	20.0	36.2	27.8 \pm 5.7
Upper jaw length*	34.2	39.5	38.6	35.3	37.5 \pm 2.5

Table 3. Fin-ray counts of the holotype and three paratypes of *Gobiodon bicalvolineatus* from Papua New Guinea in the Indo-Pacific region. Roman numerals denote spines whilst Arabic numerals denote bone rays. Damaged fins were denoted with an en dash. N/A indicates specimens that were not X-rayed and hence the data is unavailable.

Meristic Value	Holotype I.51464-003	Paratype I.51464-001	Paratype I.51464-002	Paratype I.41386
First dorsal (D ₁)	VI	VI	VI	VI
Second dorsal (D ₂)	I-10	I-10	I-10	I-10
Pectoral (P)	19	19	–	19
Caudal segmented branched (C _b)	9+9	9+9	9+8	9+9
Pelvic (V)	I-5	I-5	I-5	I-5
Anal (A)	I-9	I-9	I-10	I-9
Vertebrae	26	26	N/A	N/A

Body mostly naked. Squamation present on caudal peduncle, large weakly ctenoid or cycloid shaped in rows (1–3 rows).

Cephalic sensory system standard for *Gobiodon* (Fig. 4). Consisting of anterior naris, posterior naris, first dorsal oculoscapular canal, second dorsal oculoscapular canal, three non-dorsal oculoscapular canals and three preopercular canals.

Colouration in life. *Gobiodon bicalvolineatus* is light blue-green with red vertical bars on the face, red spots and lighter diagonal bars on the dorsal surface of the head, oblique pale patch on cheek, and red thin unbroken horizontal lines along the length of the body. No black spot on opercular margin.

Colouration post preservation. All colouration lost upon preservation, with no remnants of the previously displayed colour. Uniformly light or dark brown. Lines on body and face are no longer visible (Fig. 4).

Genetic analysis. Previous genetic analyses have shown *G. bicalvolineatus* to be a distinct species, with its sister species being *G. aoyagii* (Munday et al., 2004; Duchene et al., 2013; Herler et al., 2013; Shibukawa et al., 2013). *Gobiodon bicalvolineatus* and *G. aoyagii* consistently form a clade, but neighbouring species on the phylogenetic tree can change depending on the genetic markers used. When only mitochondrial rRNA 12S and 16S markers are used, the pair fall out alongside *G. fulvus* and the clade containing *G. ater*, *G. axillaris*, and *G. fuscoruber* (Herler et al., 2013). With the addition of cytochrome b (mtDNA) and nDNA S711 to the original mitochondrial markers, the pair now fall in a clade with *G. brochus* and *G. cobenjaminsis* (Duchene et al., 2013). Unfortunately, the DNA sample used in our genetic analysis did not yield sufficient results for the COI gene for the species to be included in the current phylogenetic tree. However, the previous analyses do strongly confirm this species' position within a clade including *G. aoyagii*, *G. brochus*, and *G. cobenjaminsis* (Duchene et al., 2013).

Haplotype analyses have also been conducted comparing the networks seen in *G. bicalvolineatus*, *G. aoyagii*, *G. brochus*, *G. erythrospilus*, and *G. histrio* (Munday et al., 2004). Ten individuals from each species were genetically analysed to view the haplotype network present. *Gobiodon bicalvolineatus* was observed with only two present haplotypes, compared to the five seen in sister species *G. aoyagii* and even greater variation seen in the other species. The lack of genetic variation was hypothesised to be due to a strong genetic bottleneck that may have resulted from a founder event from a coral host shift in a small population (Munday et al., 2004). The low genetic diversity is not seen in the sister species *G. aoyagii* despite it also only occupying a single coral species, *Acropora tenuis* (Dana, 1846). However, the distribution of *G. aoyagii* and its host coral are considerably larger with better coverage density (Munday et al., 2004).

Habitat. *Gobiodon bicalvolineatus* has only been recorded inhabiting the branching coral *Acropora caroliniana* Nemenzo, 1976, making it highly specialised (Munday et al., 1999). Up to ten juveniles and adults have been observed living in the same coral colony at once (Munday et al., 2004).

Distribution. The species have been primarily recorded in waters surrounding Motupore and Loloata Islands in Bootless Bay in Papua New Guinea (Munday et al., 1999; Munday et al., 2004). There was previously quite a large population recorded within this area (Munday et al., 2004), but the current population numbers are unknown. An image of an individual observed in Kranket Lagoon in the Madang region of Papua New Guinea during an expedition in 1987 was also identified. However, the specimen could not be confirmed.

Etymology. The name is derived from the Latin for 'two,' 'bald' and 'lined', representing the two pale patches at the back of the head imitating baldness and the prominent lined pattern on the body.

Remarks. *Gobiodon bicalvolineatus* shares physical characteristics with several species within genus *Gobiodon*, sharing a relatively common appearance of a teal/green/blue base colour with red markings with *G. aoyagii*, *G. histrio*, and *G. erythrospilus*. Despite this commonality in appearance, only *G. aoyagii* is a close genetic relative within the genus phylogeny. There are both obvious and discrete differences between the two sister species. Whilst the markings of *G. bicalvolineatus* are relatively regular lines, *G. aoyagii* has a completely opposing set of markings, with the majority being cleanly broken circular patterns. More discrete differences can be seen with *G. bicalvolineatus* having a less pronounced and shallower interopercle than *G. aoyagii*. The cheek papillae are also significantly more elongated on *G. bicalvolineatus* specimens. The distinct differences between *G. bicalvolineatus* and *G. aoyagii* were also identified and highlighted by Shibukawa et al. (2013) in the formal description of the latter species.

The horizontal red lines seen on *G. bicalvolineatus* are thinner and unbroken compared to those seen in *G. histrio*. Additionally, the absence of spots or dots amongst broken lines separates them from *Gobiodon erythrospilus*. *Gobiodon bicalvolineatus* also lacks the black spot on the opercular margin seen in *G. histrio*. The oblique pale patch on the cheek, faint pale lines on dorsal surface of head, and recurved lower lip are shared with *G. brochus*. However, the lack of red markings on *G. brochus* makes them easily distinguishable. *Gobiodon bicalvolineatus* has only been observed occupying a single species of host coral, *Acropora caroliniana*, and only within a very limited geographic location. Individuals matching the description have not been identified in any other location, further suggesting a very limited range. Surveys of cryptobenthic fish species have not been recently conducted within the known geographic range of this species, and thus very little is known about the population condition.

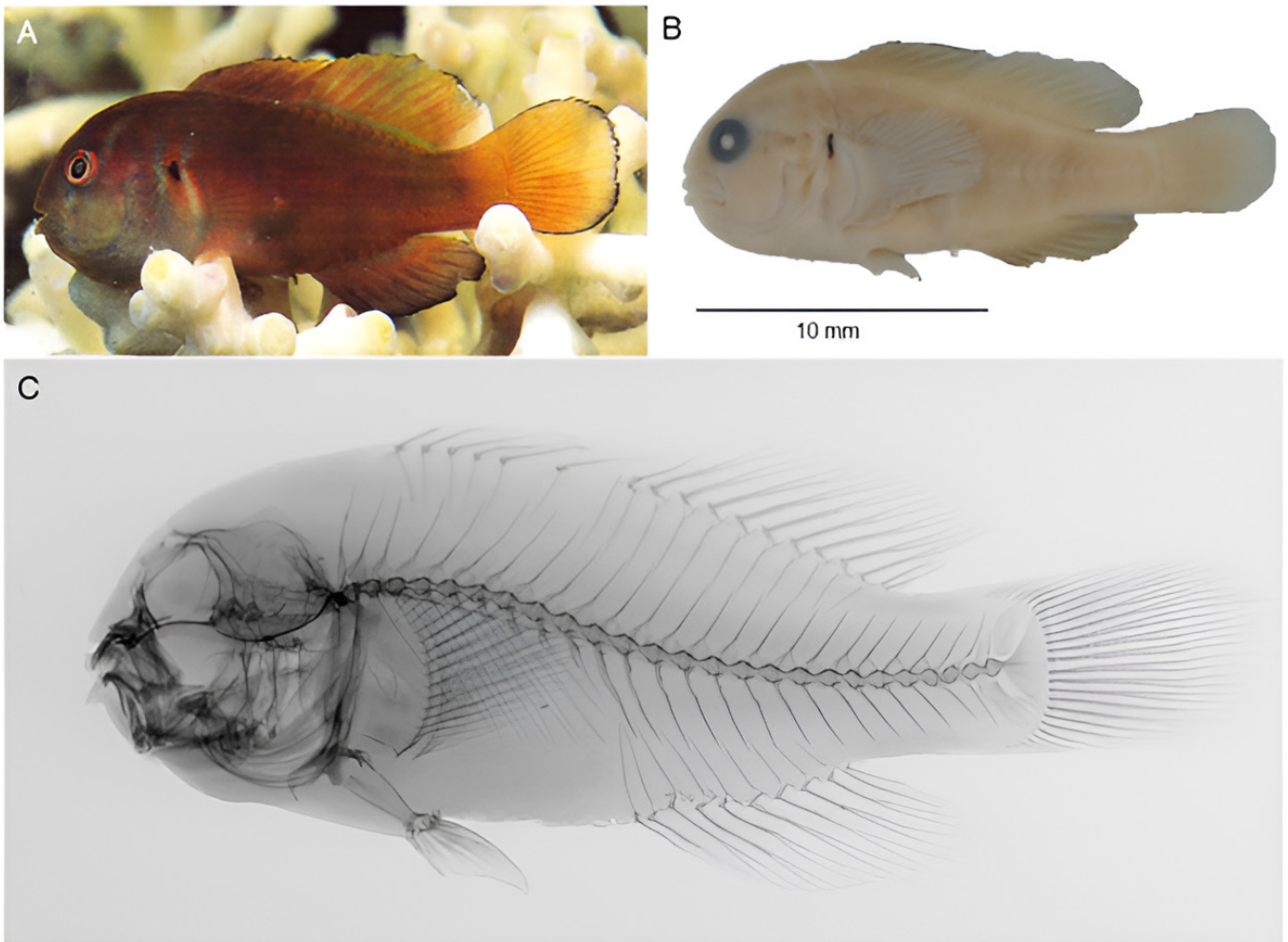


Fig. 5. Images and radiographs of select specimens of *Gobiodon cobenjaminsis*. A, live colouration of specimen of *G. cobenjaminsis* photographed by G. Barrall in Munday et al. (1999). B, photograph of preserved specimen AMS I.51465-001, 16.0 mm SL, Shuman Island, PNG, collected by P. Munday, 1998. C, radiograph of AMS I.51467-001 specimen, 19.2 mm SL, Kimbe Bay, PNG, collected by P. Munday, 1998, X-rayed by Kerryn Parkinson.

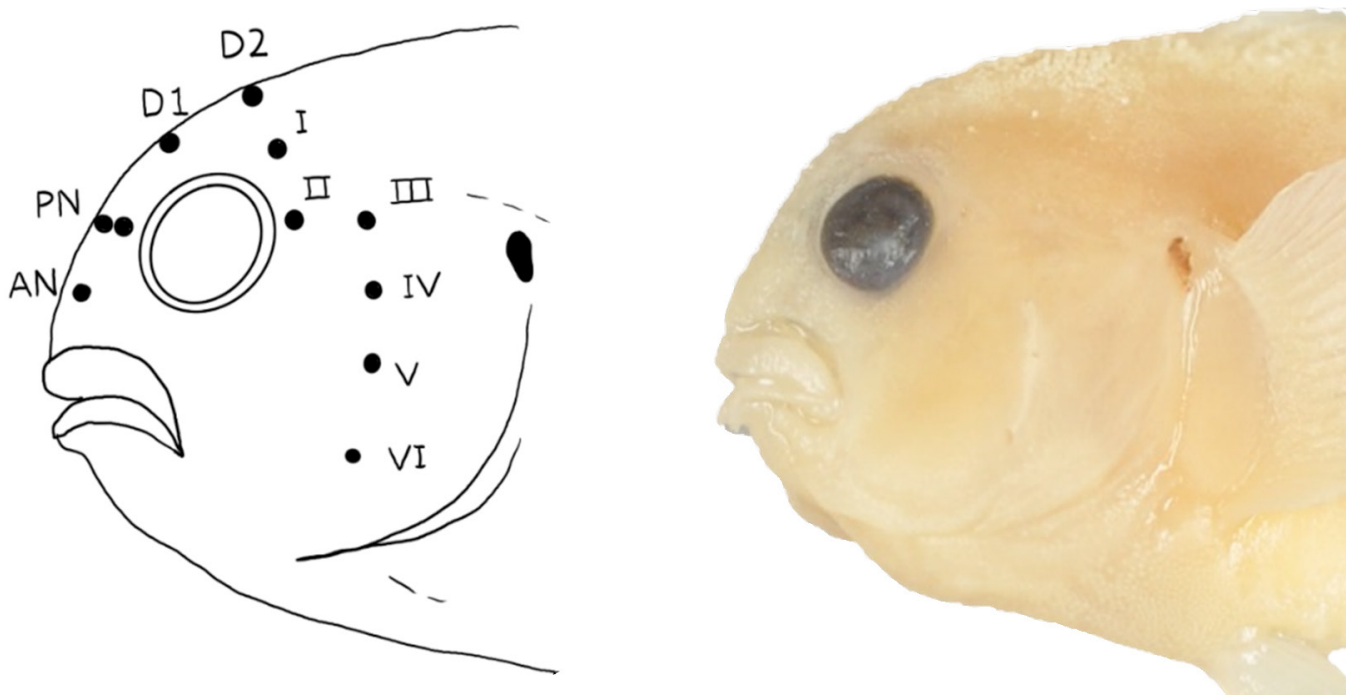


Fig. 6. Facial papillae and lateralis pores based on the paratype of *Gobiodon cobenjaminsis* (PM-KIM98-1). Both sketch and photograph presented. AN – Anterior naris, PN – Posterior naris, D1 – first dorsal oculoscapular canal, D2 – second dorsal oculoscapular canal, I–III – three non-dorsal oculoscapular canal, and IV–VI – three preopercular canals.

***Gobiodon cobenjaminsis*, new species**

English name: Russet Coral Goby

(Figs. 5, 6; Tables 4, 5)

Gobiodon sp. C (Munday et al., 1999; Harold et al., 2008; Duchene et al., 2013; Herler et al., 2013)

Holotype. AMS I.51465-001, 16.0 mm SL, Shuman Island, PNG (5°17'34.3" S, 150°05'23.3" E), depth unknown, collected by P. Munday, 1998.

Paratypes. 6 specimens from Wulai Island, PNG (5°21'02.4"S, 150°29'24.1"E) collected by P. Munday in 2002. AMS I.51466-001, 18.0 mm SL, depth unknown. AMS I.51466-002, 17.7 mm SL, depth unknown. AMS I.51466-003, 19.2 mm SL, depth unknown. AMS I.51466-004, 17.7 mm SL, depth unknown. AMS I.51466-005, 17.7 mm SL, depth unknown. QM I.41387, 15.3 mm SL, depth unknown. 2 specimens from Kimbe Bay, PNG (5°12'54.6" S, 150°29'27.8" E) collected by P. Munday in 1998. AMS I.51467-001, 19.2 mm SL, depth unknown. AMS I.51467-002, 19.2 mm SL, depth unknown.

Comparative material. *Gobiodon brochus*: AMS I.22186-001 (1 specimen), 25.0 mm SL, Palfrey Island, GBR, Australia, collected by D. Hoese, 1975. AMS I.46739 (1 specimen), 21.0 mm SL, Ona Island, Tonga, collected by S. E. Reader, 2015. AMS I.35854-003 (2 specimens), 19.0–19.3 mm SL, Madang, PNG, collected by K. Cole, 1994. AMS I.22187-001 (1 specimen), 23.8 mm SL, Palfrey Island, GBR, Australia, collected by D. Hoese, 1975. AMS I.22579-072, 18.5 mm SL, Escape Reef, GBR, Australia, collected by D. Hoese, 1981.

Gobiodon bicalvolineatus: AMS I.51465-001, 20.8 mm SL, Loloata Island, PNG, collected P. Munday, 2002. AMS I.51464-001, 17.6 mm SL, Loloata Island, PNG, collected P. Munday, 2002. AMS I.51464-002, 15.6 mm SL, Loloata Island, PNG, collected P. Munday, 2002. QM I.41386, 19.2 mm SL, Loloata Island, PNG, collected P. Munday, 2002. AMS I.51464-005, 11.2 mm SL (juvenile), Loloata Island, PNG, collected P. Munday, 2002.

Diagnosis. Dorsal-fin rays VI, I,10; anal-fin rays I,10; head and body naked; obvious groove between the isthmus and interopercle; body compressed and deep (depth at pelvic fin origin 39.4–45.0% of SL); head rounded in adults; dorsal fins fused with membrane. Caudal peduncle relatively deep (15.5–18.7% of SL); caudal fin long (22.2–29.3% of SL). Post symphyseal teeth absent, dentary elongate and recurved; teeth of two to three various sizes in several rows. Cheek papillae elongate. Adult orange-brown in colour with black margins on all fins except pectoral fins. Black spot on the upper opercular margin (Fig. 5). Fins lighter in colour than body, with lighter oblique patch on cheek and 3–4 lighter bands on facial area.

Description. Dorsal-fin rays VI, I,10; pectoral-fin rays 19; pelvic-fin rays I,5; anal-fin rays I, 10. Caudal-fin principal rays 9+9 or 8+8 (9+9), all branched and segmented; 5-6

procurent rays above and below branched (all unbranched and unsegmented). Vertebrae count 26.

Head and body deep, ovoid, highly laterally compressed. Body depth maximum at pelvic fin origin. Reduced body depth at opercular margin and anal fin margin. Dorsal profile of head rounded and moderately steep. Eyes positioned dorso-laterally. Cheek papillae longer than wide. Visible dark pigmentation spot on upper opercular margin. Pigmentation of interorbital region uniform. Deep groove between isthmus and interopercle. Anterior margin of interopercle prolonged. Interopercle attached to retroarticular by short ligament. Interopercle shallow spear-like appearance. Dentary elongate recurved. Jaw dentition consists of two or three sizes. Post symphyseal canine teeth absent. Multiple rows of teeth of varying sizes. Lacrimal shape elongate-narrow. Gill opening relatively narrow.

First dorsal fin origin located above or slightly anterior/posterior to uppermost point of pectoral fin base. Posterior end of first dorsal fin base above anus. Second dorsal fin origin just behind posterior point of first dorsal fin. Dorsal fins connected via a high membrane, fused appearance. Second dorsal fin not quite reaching caudal fin. Anal fin origin posterior to urogenital papilla. Pectoral fins rounded. Pelvic fins cup shaped, fused medially with well-developed membrane. Pelvic fin posterior to pectoral fin base. Posterior point of pelvic fin not reaching behind anus. Caudal fin rounded. Head and body scaleless.

Cephalic sensory system standard for *Gobiodon* (Fig. 6), consisting of anterior naris, posterior naris, first dorsal oculoscapular canal, second dorsal oculoscapular canal, three non-dorsal oculoscapular canals and three preopercular canals.

Colouration in life. *Gobiodon cobenjaminsis* is orange-brown in colouration during life. There are three to four lighter bands on the facial area. Pale oblique patch on cheek. Fins are slightly lighter in colour than the main body colour with a black margin and a pale line along the base of the dorsal fins. Black spot on the upper opercular margin.

Colouration post preservation. All colouration is lost upon preservation, with no remnants of the previously displayed colour. Uniformly light or dark brown. The only remaining colouration is seen in the preserved black spot on the upper opercular margin and the darker colouration on the edge of the fins (Fig. 5).

Genetic analysis. The genetic analysis for this species has been conducted twice prior to this study. Depending on the genetic markers that were used to produce the phylogenetic tree, *G. cobenjaminsis* was placed in different clades within the genus. When 12S and 16S rRNA mitochondrial genes were used, *G. cobenjaminsis* is sister to the clade including *G. okinawae*, *G. acicularis*, *G. ceramensis*, and *G. citrinus* (Herler et al., 2013). However, with the addition of cytochrome b (mtDNA) and nDNA s711, the placement of *G. cobenjaminsis* differed (Duchene et al., 2013). The closest

Table 4. Body proportions of the holotype and three paratypes from *Gobiodon cobenjaminsis* from Papua New Guinea in the Indo-Pacific. Aside from those listed with millimetres (mm) as units, measurements are proportions (%) of standard length (SL) or proportions (%) of head length (the last four measurements denoted with an asterisk) respectively. Mean and standard deviation (SD) also supplied.

Measurement	Holotype I.51465-001	Paratype I.51466-001	Paratype I.51466-004	Paratype I.51467-001	Mean ± SD
Total length (mm)	20.2	22.6	24.1	25.5	23.1 ± 2.3
Standard length (mm)	16.0	18.0	17.7	19.2	17.7 ± 1.3
Head width (mm)	14.8	17.0	19.9	20.8	18.1 ± 2.7
Snout to first dorsal origin	41.5	37.9	40.1	42.5	40.5 ± 2.0
First dorsal fin origin to second dorsal origin	22.7	28.1	26.3	30.0	26.8 ± 3.1
Second dorsal origin to anal fin origin	35.4	31.8	34.9	33.4	33.9 ± 1.6
Snout to pelvic fin origin	40.3	35.8	34.5	41.8	38.1 ± 3.5
First dorsal fin origin to pelvic fin origin	41.1	43.7	42.1	41.1	42.0 ± 1.3
First dorsal fin origin to anal fin origin	45.6	48.6	46.9	47.1	47.0 ± 1.2
First dorsal fin origin to pectoral fin origin	16.9	17.3	18.4	16.9	17.4 ± 0.7
Pelvic fin origin to second dorsal fin origin	41.7	46.6	41.8	51.5	45.4 ± 4.7
Head length	31.0	32.5	28.9	31.2	30.9 ± 1.5
Head depth	40.9	36.4	44.1	38.8	40.1 ± 3.3
Body depth - pelvic fin origin	39.4	42.5	44.3	42.3	42.1 ± 2.0
Body depth - anal fin origin	31.1	38.1	30.9	36.0	34.0 ± 3.6
Pelvic fin length	13.3	13.5	11.4	14.2	13.1 ± 1.2
Anal fin length	20.2	25.5	16.8	26.8	22.3 ± 4.6
Caudal fin length	27.2	22.2	29.0	22.9	25.3 ± 3.3
First dorsal fin first spine length	11.5	14.3	14.9	8.1	12.2 ± 3.1
First dorsal fin sixth spine length	15.0	11.5	12.4	9.6	12.1 ± 2.3
Second dorsal fin length	24.9	23.0	20.0	22.7	22.6 ± 2.0
Pectoral fin length	28.0	23.0	21.3	21.6	23.5 ± 3.1
Caudal-peduncle length	22.9	14.5	17.4	13.6	17.1 ± 4.2
Caudal-peduncle depth	15.6	15.5	16.7	16.1	16.0 ± 0.6
Interorbital width*	26.7	27.3	34.4	22.4	27.7 ± 5.0
Horizontal eye diameter*	28.7	20.8	27.3	23.4	25.0 ± 3.6
Snout length*	28.3	24.4	30.1	28.2	27.7 ± 5.0
Upper jaw length*	31.5	28.0	29.3	30.1	29.7 ± 1.5

Table 5. Fin counts of the holotype and three paratypes of *Gobiodon cobenjaminsis* from Papua New Guinea in the Indo-Pacific region. Roman numerals denote spines whilst Arabic numerals denote bone rays.

Meristic Value	Holotype I.51465-001	Paratype I.51466- 001	Paratype I.51466-004	Paratype I.51467-001
First dorsal (D ₁)	VI	VI	VI	VI
Second dorsal (D ₂)	I-10	I-10	I-10	I-10
Pectoral (P)	19	19	19	19
Caudal segmented branched (C _b)	9+8	9+8	8+8	9+8
Pelvic (V)	I-5	I-5	I-5	I-5
Anal (A)	I-10	I-10	I-10	I-10
Vertebrae	26	26	26	26

sister species to *G. cobenjaminsis* is now *G. brochus*, *G. aoyagii*, and *G. bicalvolineatus*, in the same clade, while a separate adjacent clade contains the above-mentioned species seen in the Herler et al. (2013) analysis.

In this study, unfortunately *G. bicalvolineatus* could not be included in our phylogenetic analysis, so further confirmation of the phylogenetic relationship between *G. cobenjaminsis* and *G. bicalvolineatus* was not possible. However, our analysis does confirm the relatedness between *G. cobenjaminsis* and *G. aoyagii*/*G. brochus*, confirming the strong genetic signal between these species across genetic markers.

Habitat. *Gobiodon cobenjaminsis* has only been recorded inhabiting the coral *Acropora elseyi* (Brook, 1892), making the species highly specialised (Munday et al., 1999).

Distribution. This species has only been recorded in the Kimbe Bay area of Papua New Guinea (Munday et al., 1999).

Etymology. The name was chosen with the Latin “co” for ‘with’ or ‘together’ and the “benjaminsis”, with the “-sis” component derived from the Greek for a process or action, to honour the actions of the Benjamin family under the request of the specimen collector Phil Munday, especially Max Benjamin. This is due to their contribution in research, field station set-up, and marine conservation in Kimbe Bay, Papua New Guinea, that resulted in the observation and collection of this species.

Remarks. Whilst this species is closely related to *G. brochus* genetically, they only share limited physical characteristics and vary largely in colouration. *Gobiodon cobenjaminsis* has a dark pigmentation spot on the upper opercular margin, a key method for differentiation of the two species. This can be utilised for preserved specimens as the black spot on the upper opercular margin remains after the preservation process. The other major distinguishing feature is the differences in lacrimal shape; where *G. cobenjaminsis* is elongate and narrow, *G. brochus* has a more ventrally expanded lacrimal that is often triangular to quadrilateral in shape. The only other species that is known to occupy *A. elseyi* is *G. brochus*, which can be easily distinguished from *G. cobenjaminsis*.

This species can be easily distinguished from other genus members *G. axillaris* and *G. atrangulatus*, which may appear similar in base colouration to *G. cobenjaminsis* on occasion, by the lack of red markings on the face and at the base of the dorsal fins, the presence of distinctive black fin margins, fused first and second dorsal fin, and distinctive recurved lower lip observed in *G. cobenjaminsis* (De Vis, 1884; Garman, 1903; Munday et al., 1999; Harold et al., 2008).

Gobiodon cobenjaminsis has a very limited range and restricted habitat niche, as it has only been observed in *Acropora elseyi* in Kimbe Bay, Papua New Guinea. The reasons for the limited distribution of *G. cobenjaminsis* are unknown, unlike its congener *G. bicalvolineatus* which has had genetic studies conducted focused on it (Munday et al., 2004). Individuals matching the description of this

species have not been identified elsewhere in the world. The combination of these factors makes estimating the species’ population status and relative rarity hard to determine.

***Gobiodon spadix* Sato & Motomura, 2024**

English Name: Akane Coral Goby

Japanese Name: Akane koban-haze

(Figs. 7–9; Tables 6, 7)

Materials examined. South Pacific: 3 specimens from One Tree Island, GBR (23°29.778’ S, 152°05.285’ E), collected at 1–2m depth by C. Froehlich and C. Hildebrandt in 2022. AMS I.51468-001, 32.5 mm SL. AMS I.51468-002, 36.1 mm SL. I.51468-003, 27.5 mm SL. 3 specimens from One Tree Island, GBR (23°29.778’ S, 152°05.285’ E), collected at 1–2m depth by C. Hildebrandt and S. O’Hea Miller in 2023. AMS I.51469-001, 30.2 mm SL. AMS I.51470-001, 38.3 mm SL. QM I.41388, 38.2 mm SL.

Japan: AMS I.51370-001 (Paratype), 33.0 mm SL, Ohto Beach, Kagoshima Prefecture, Japan, collected by M. Sato, 2022. KAUM I.156336, 37.0 mm SL, Take-shima [=Island], Kagoshima, collected by M. Matsuoka et al, 2021. KAUM I.168009, 25.7 mm SL, Take-shima, Kagoshima, collected by M. Matsuoka et al., 2022. KAUM I.163955, Mageshima [=Island], Kagoshima, collected by M. Yamada et al., 2021. KAUM I.99082, 29.7 mm SL, Akuseki-jima [=Island], Tokara Islands, Kagoshima, collected by Y. Fukui et al., on RV Nansei-maru, 2017. KAUM I.166757, 15.5 mm SL, Satsuma Peninsula, Bonotsu, Kagoshima, collected by M. Sato, 2022. KAUM I.184177, 35.1 mm SL, Yudomari, Yakushima [=Island], Kagoshima, collected by Y. Dewa, 2023. KAUM I.186861, 27.3 mm SL, Take-shima, Kagoshima, collected by A. Higuchi, 2023. OMNH-P 43085, Ryukyu Islands, Okinawa, Japan, T. Suzuki, 2015. OMNH-P 430086, Ryukyu Islands, Okinawa, Japan, T. Suzuki, 2015.

Maldives: 8 specimens from Kandahalagalaa, Maldives, collected by O. Brodnicke, P. R. Møller and K. Worsaae, 2021. ZMUC P2398073, 21.3 mm SL. ZMUC P2398100, 25.7 mm SL. ZMUC P2398511, 28.3 mm SL. ZMUC P2397923, 32.2 mm SL. ZMUC P2398072, 24.0 mm SL. ZMUC P2397997, 22.3 mm SL. ZMUC P2398558, 29.3 mm SL. ZMUC P2397939, 32.1 mm SL. 2 specimens from Tilla, Maldives, collected by O. Brodnicke, P. R. Møller and K. Worsaae, 2021. ZMUC P2398287, ZMUC P2398283, 22.7 mm SL.

The original description of *Gobiodon spadix* suggests that the individuals of similar appearance originally described in Munday et al. (1999) as *Gobiodon* sp. D from Papua New Guinea and the Great Barrier Reef are members of this species (Sato & Motomura, 2024). Our measurements and analysis of individuals from the southern Great Barrier Reef at One Tree Island (6 specimens) (Fig. 7, 8), compared with a paratype held at the Australian Museum (1 specimen) and loaned specimens from Kagoshima University Museum (7 specimens) and Osaka Natural History Museum (2 specimens), confirm this distribution pattern. We provide the following additional measurements as representations

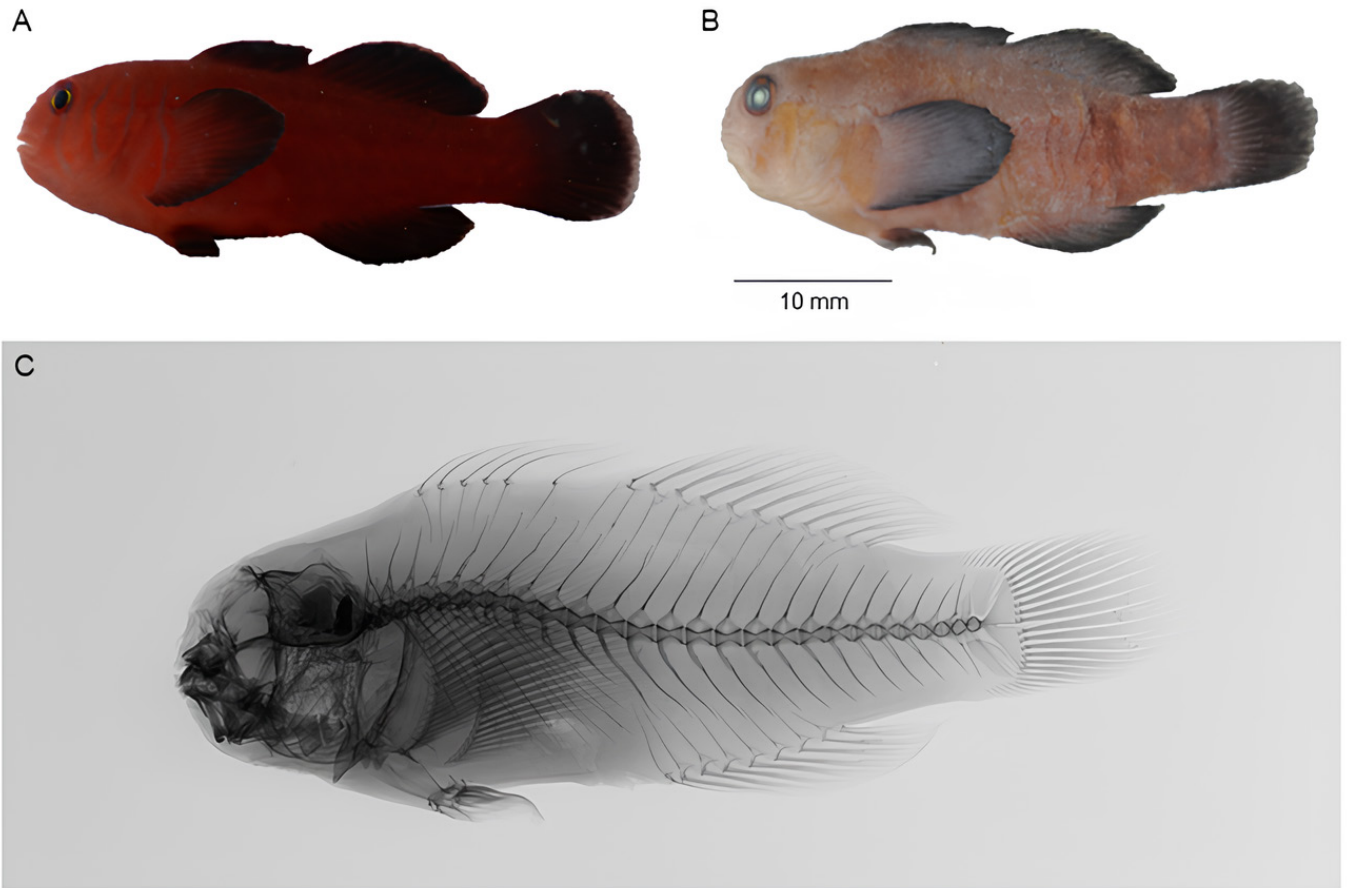


Fig. 7. Images and radiographs of AMS I.51468-001 from the South Pacific Ocean population of *Gobiodon spadix*. A, live colouration of specimen, photographed by C. Froehlich and C. Hildebrandt, One Tree Island, GBR, 34.9 mm SL prior to preservation, 2022. B, photograph of preserved specimen, One Tree Island, GBR, 32.5 mm SL preserved, collected by C. Froehlich and C. Hildebrandt, 2022. C, radiograph of specimen from One Tree Island, GBR, collected by C. Froehlich and C. Hildebrandt, 2022, X-rayed by Kerryn Parkinson.

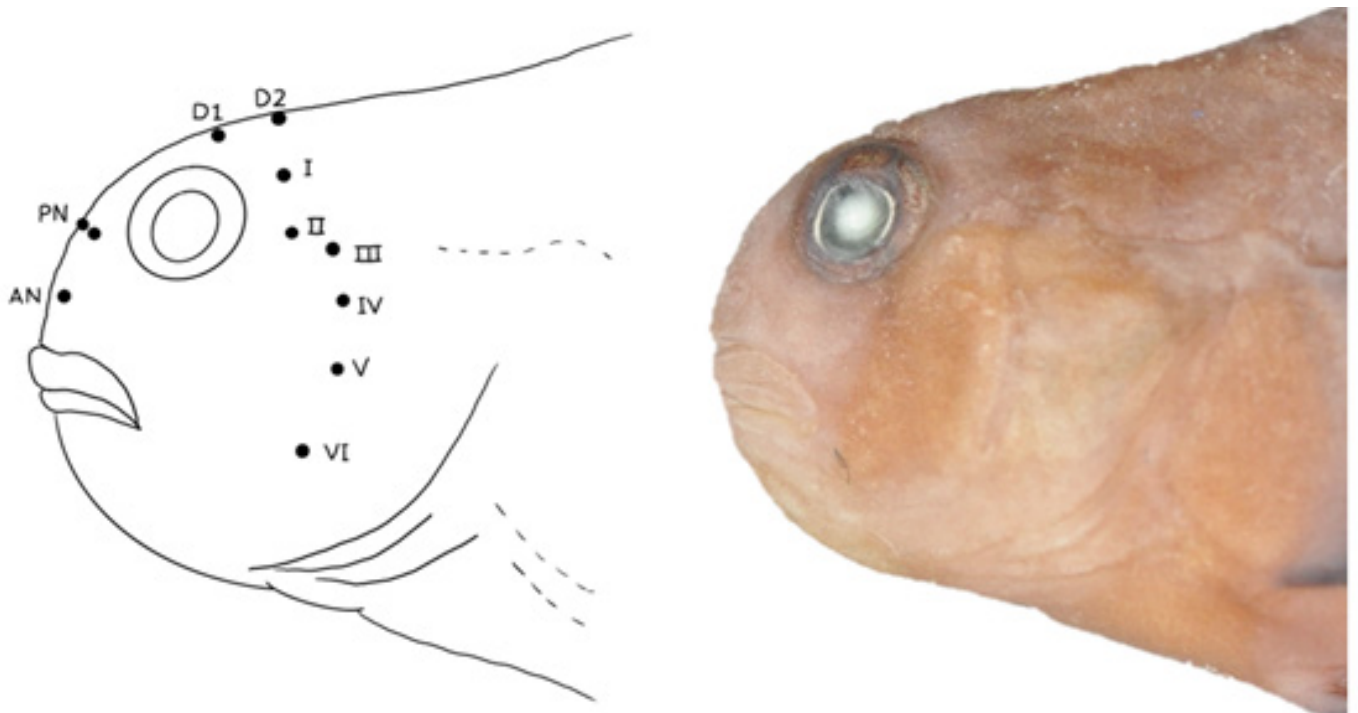


Fig. 8. Facial papillae and lateralis pores based on AMS I.51468-001. Both sketch and photograph presented. AN – Anterior naris, PN – Posterior naris, D1 – first dorsal oculoscapular canal, D2 – second dorsal oculoscapular canal, I–III – three non-dorsal oculoscapular canal, and IV–VI – three preopercular canals.

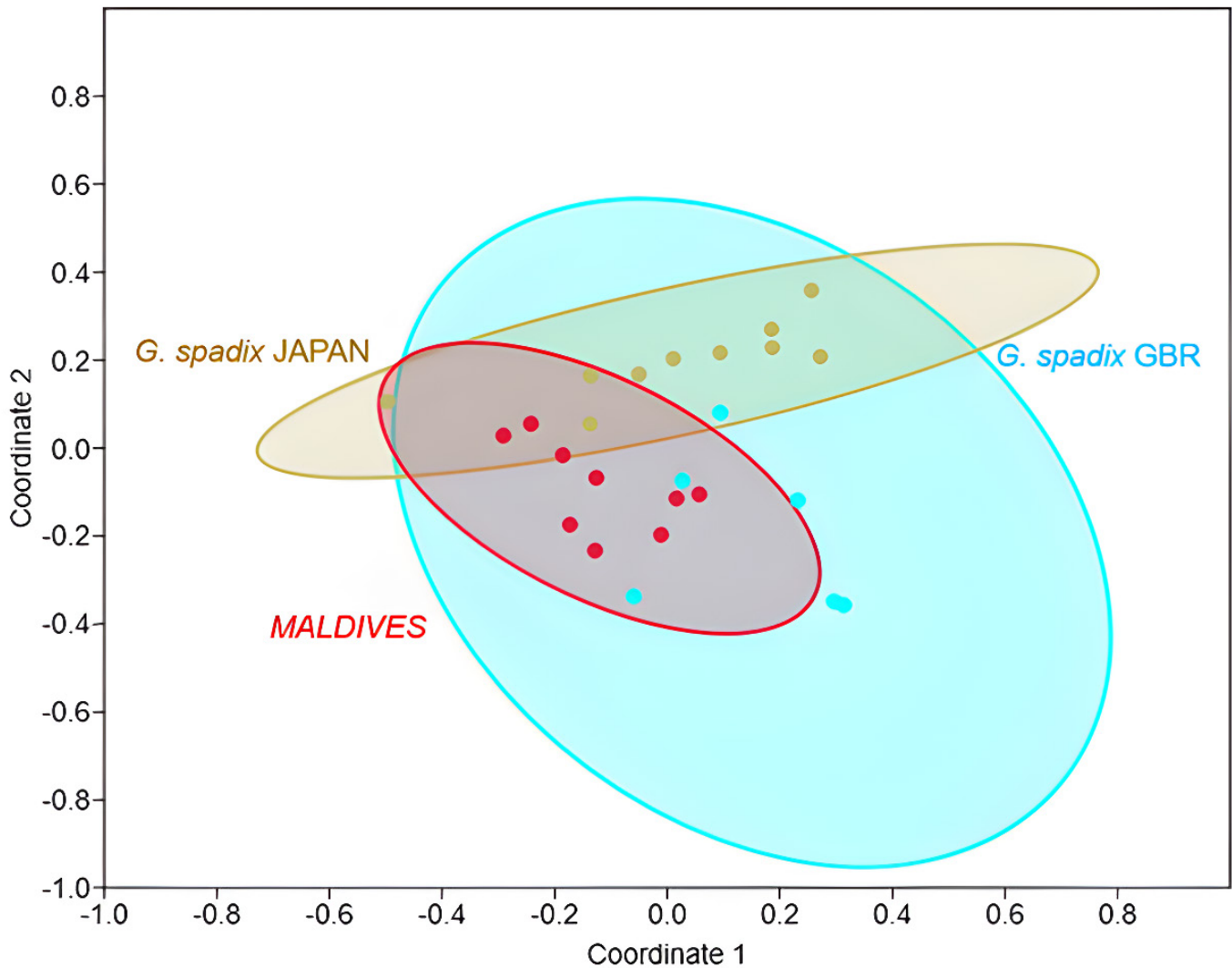


Fig. 9. PCoA of the morphological measurements of regional populations of *Gobiodon spadix* and the similar-appearing individuals observed in the Maldives, with 95% confidence interval displayed. The yellow colour denotes the Japanese population, blue denotes the Great Barrier Reef, and red denotes the similar-appearing individuals from the Maldives. Coordinate 1 on the x-axis explains 90.9% of the variation, whilst Coordinate 2 on the y-axis explains 1.9% of the variation observed.

of the South Pacific Ocean population for the summary diagnosis and additional remarks about differences seen in the southern population not included in the original description. Comparisons to similar-appearing individuals from the Maldives were also conducted but were inconclusive as they did not agree with previously conducted genetic analyses (Sato & Motomura, 2024).

Summary diagnosis. *Gobiodon spadix* was originally described with the following characteristics: “dorsal-fin rays VI–I, 9–11 (modally 9); anal-fin rays I, 8 or 9 (8); pectoral-fin rays 19–21 (20); body depth at pelvic-fin origin 32.4–38.3% (mean 36.0%) of SL; distance between first dorsal-fin origin to dorsal-most point of pectoral-fin base 50.4–64.8% (55.2%) of HL; pectoral fin relatively long, length 90.6–112.5% (100.8%) of HL; groove between isthmus and interopercle absent; when alive or freshly collected, body uniformly reddish-brown; coloration of all fins darker than that of body; 5 vertical narrow bluish stripes on lateral surface of head.” (Sato & Motomura, 2024).

The South Pacific Ocean population does display minor differences to their northern Pacific Ocean counterparts. Described from specimens collected from the southernmost extent of the Great Barrier Reef at One Tree Island, southern population measurement variations can be included in the diagnosis characteristics: dorsal fin rays VI–I, 9–10 (modally 10); pectoral fin rays 19–20 (modally 20); body depth at pelvic fin 34.9–40.8% of SL, pectoral fin relatively long, length 69.5%–93.9% of HL (average 85.2%). Additionally, some measurements have been provided in the common alternative format as percentages of standard length rather than head length: distance between first dorsal fin origin to dorsalmost point of pectoral fin base 13.2–17.5% of SL and pectoral fin length long at 19.5–30.1% of SL.

Supplementary details include absent post-symphysial canine teeth, triangular dentary shape of two to three sizes in several rows, short cheek papillae, and the presence of two additional pale blue lines behind the pectoral fin but not extending beyond this point as seen in other species such as

Table 6. Body proportions of specimens of *Gobiodon spadix* from the Great Barrier Reef in the Indo-Pacific. Aside from those listed with millimetres (mm) as units, measurements are proportions (%) of standard length (SL) or proportions (%) of head length (the last four measurements denoted with an asterisks) respectively. Mean and standard deviation (SD) also supplied.

Measurement	I.51468-001	I.51468-002	I.51469-001	Mean ± SD
Total length (mm)	38.8	43.6	36.7	40.8 ± 5.2
Standard length (mm)	32.5	36.1	30.2	33.8 ± 4.1
Head width (mm)	17.5	19.0	20.2	20.8 ± 2.5
Snout to first dorsal origin	37.1	37.5	37.1	36.6 ± 1.5
First dorsal fin origin to second dorsal origin	23.3	25.9	21.2	24.3 ± 1.6
Second dorsal origin to anal fin origin	22.7	34.5	32.4	32.6 ± 4.6
Snout to pelvic fin origin	34.2	33.1	32.4	33.5 ± 0.9
First dorsal fin origin to pelvic fin origin	36.8	37.0	37.0	36.4 ± 0.8
First dorsal fin origin to anal fin origin	44.1	41.8	45.9	44.8 ± 1.8
First dorsal fin origin to pectoral fin origin	14.4	15.3	16.1	15.0 ± 1.2
Pelvic fin origin to second dorsal fin origin	43.9	40.7	41.2	41.2 ± 2.2
Head length	26.8	29.6	30.1	27.3 ± 2.7
Head depth	31.6	27.9	32.5	29.2 ± 2.4
Body depth – pelvic fin origin	36.0	37.5	35.7	36.2 ± 1.0
Body depth – anal fin origin	31.4	32.7	31.6	32.7 ± 0.9
Pelvic fin length	10.6	10.0	8.5	10.3 ± 1.0
Anal fin length	17.0	18.7	17.3	16.9 ± 2.1
Caudal fin length	19.5	20.2	20.3	20.0 ± 1.0
First dorsal fin first spine length	10.9	12.8	12.0	11.7 ± 0.9
First dorsal fin sixth spine length	7.2	8.4	7.7	8.3 ± 0.9
Second dorsal fin length	17.9	18.2	15.1	16.6 ± 1.5
Pectoral fin length	24.1	22.4	20.9	22.8 ± 2.2
Caudal-peduncle length	19.1	17.5	18.9	20.1 ± 2.4
Caudal-peduncle depth	17.6	18.7	16.9	17.6 ± 0.8
Interorbital width*	25.7	28.6	28.7	30.6 ± 4.3
Horizontal eye diameter*	16.4	13.1	23.0	19.2 ± 3.8
Snout length*	24.2	27.6	28.2	28.3 ± 3.8
Upper jaw length*	27.9	29.1	24.5	30.5 ± 4.4

Table 7. Fin counts of specimens of *Gobiodon spadix* from the Great Barrier Reef in the Indo-Pacific region. Roman numerals denote spines whilst Arabic numerals denote bone rays. N/A indicates specimens that were not X-rayed and hence the data is unavailable.

Meristic Value	I.51468-001	I.51468-002	I.51469-001
First dorsal (D ₁)	VI	VI	VI
Second dorsal (D ₂)	I-10	I-10	I-10
Pectoral (P)	19	19	20
Caudal segmented branched (C _b)	9+8	9+8	9+8
Pelvic (V)	I-5	I-5	I-5
Anal (A)	9+8	I-8	I-9
Vertebrate	26	26	N/A

G. rivulatus. Photographs and radiographs of a representative specimen from the South Pacific Ocean population can be seen in Fig. 7. Papillae and pore maps can be seen in Fig. 8. Summaries of the morphological measurements and meristics can be found in Tables 6 and 7 respectively.

Remarks. There are slight differences in the host coral choices between the two populations. *Gobiodon spadix* was described in Sato & Motomura (2024) as being hosted by the corals *Acropora solitaryensis* Veron & Wallace, 1984 and *A. japonica* Veron, 2000 (in Veron & Stafford, 2000). However, members of the species have been seen being hosted by *Acropora divaricata* (Dana, 1846) and *Acropora solitaryensis* in the South Pacific Ocean (Munday et al., 1999, Hildebrandt, pers. obs.). Whilst the distribution of *A. divaricata* does include the areas of Japan where *G. spadix* can be observed, it is not a dominant coral seen in Japanese coral reefs (Veron et al., 1976). *Acropora japonica* is, however, a dominant component of coral reef communities within the Northern Pacific Ocean surrounding Japan, though it is not commonly found outside this region (Veron et al., 1976). Therefore, these differences in coral distribution could explain the differences seen in host coral between the populations of *G. spadix*. However, *A. japonica* does have a significantly different growth form when compared to the more bush-like structures of *A. solitaryensis* and *A. divaricata*. The table-like growth form seen in *A. japonica* has been known to host *Gobiodon* species, with corals such as *Acropora gemmifera* (Brook, 1892), *Acropora digitifera* (Dana, 1846), and *Acropora humilis* (Dana, 1846) frequently hosting *G. rivulatus*, *G. quinquestrigatus*, and *G. fuscoruber* (Munday et al., 1999; Untersteggaber et al., 2014; Wehrberger & Herler, 2014).

There are also several small morphometric differences between the two populations. However, these are not different enough to delineate them as separate species. Noticeable differences can be seen in the head length and depth measurements, with members from the South Pacific Ocean population typically displaying reduced head depth and increased head length compared to the Japanese population. Some minor meristic counts differ too, with the second dorsal fin ray count being slightly higher, modally 10 in the South Pacific Ocean population compared to 9 in the Japanese population. Whilst not major differences, they are points of interest that should be observed to monitor the differences between the two populations of this species.

Individuals of the South Pacific Ocean population have a smaller pectoral fin length (69.5%–93.9% of HL, average 85.2%) than the Japanese individuals (91.4–104.4% of HL, average 95.9%) measured in this analysis. *Gobiodon quinquestrigatus* measured in this study displayed highly similar ranges (78.4–99.8% of HL, average 84.2%) to members of *G. spadix* in the South Pacific Ocean. Therefore, pectoral fin length as a proportion of head length may not be a suitable distinguishing feature between *G. spadix* and *G. quinquestrigatus*. However, the two species differ in interorbital width, snout length, and snout to pelvic length. Additionally, when the overall set of morphological

measurements are combined in a PCA, there are sufficient differences between *G. spadix* and *G. quinquestrigatus* to confirm their status as separate species. This has been previously suggested by their physical appearance and genetics (Munday et al., 1999; Duchene et al., 2013; Herler et al., 2013; Hing et al., 2019).

Individuals with a similar description to *G. spadix* have also been observed in the central Indian Ocean on reefs surrounding the Maldives. Genetic testing conducted by Sato & Motomura (2024) suggest that these individuals are placed somewhere between *G. spadix* and *G. quinquestrigatus* when analysed using 16S rRNA. Sato & Motomura (2024) assigned these individuals the holding name *Gobiodon* sp. A. This separation between similar-appearing individuals from the Pacific Ocean and Maldives was also detected in an analysis of 12S and 16S rRNA conducted by Herler et al. (2013). The observed proportional morphometrics of the individuals originating from the Maldives displayed slightly larger variation than that seen between the Japanese and GBR specimens (Fig. 9). However, there was still considerable overlap of the 95% confidence intervals and individuals of all three groups intermixed in the central area of the principal coordinates analysis (PCoA). Both the morphometrics conducted here and the previously conducted genetic analyses suggest that further research will need to be conducted to determine the relationship between the individuals observed in the Maldives and the recently described *G. spadix*.

RESULTS

Morphometric Analysis

The groupings displayed in the morphometric analysis (Fig. 10) display similar patterns to those seen in previously conducted genetic analyses as well as that of this study. Only species measured in this study as type, additional information, or comparative species were included in the analysis, therefore members of the clade *G. acicularis*, *G. ceramensis*, *G. okinawae*, and *G. citrinus* were not included in the Least Discriminant Analysis (LDA) (Fig. 10). Previously defined clades can be seen sharing similar morphometric patterns and demonstrating proximity on the plot, with many members within a clade sharing some level of overlap (Duchene et al., 2013). One species described in this paper, *G. cobenjaminsis*, is seen to overlap with *G. brochus*, a common neighbour on phylogenetic trees (Duchene et al., 2013). The other species named in this paper, *G. bicalvolineatus*, can be seen as a distinct group adjacent to *G. brochus* and *G. cobenjaminsis*.

An exception to the correlation between morphometrics and genetics is *G. aoyagii*. *Gobiodon aoyagii* is morphologically closer to *G. histrio* than their genetically neighbouring species *G. cobenjaminsis* and *G. brochus* (Fig. 11) (Duchene et al., 2013; Herler et al., 2013; Hing et al., 2019). The recently described *G. spadix* displays a small level of overlap with *G. quinquestrigatus*, *G. oculolineatus*, and *G. rivulatus*, but is clearly distinguishable as its own species (Fig. 10) (Duchene et al., 2013; Herler et al., 2013; Hing

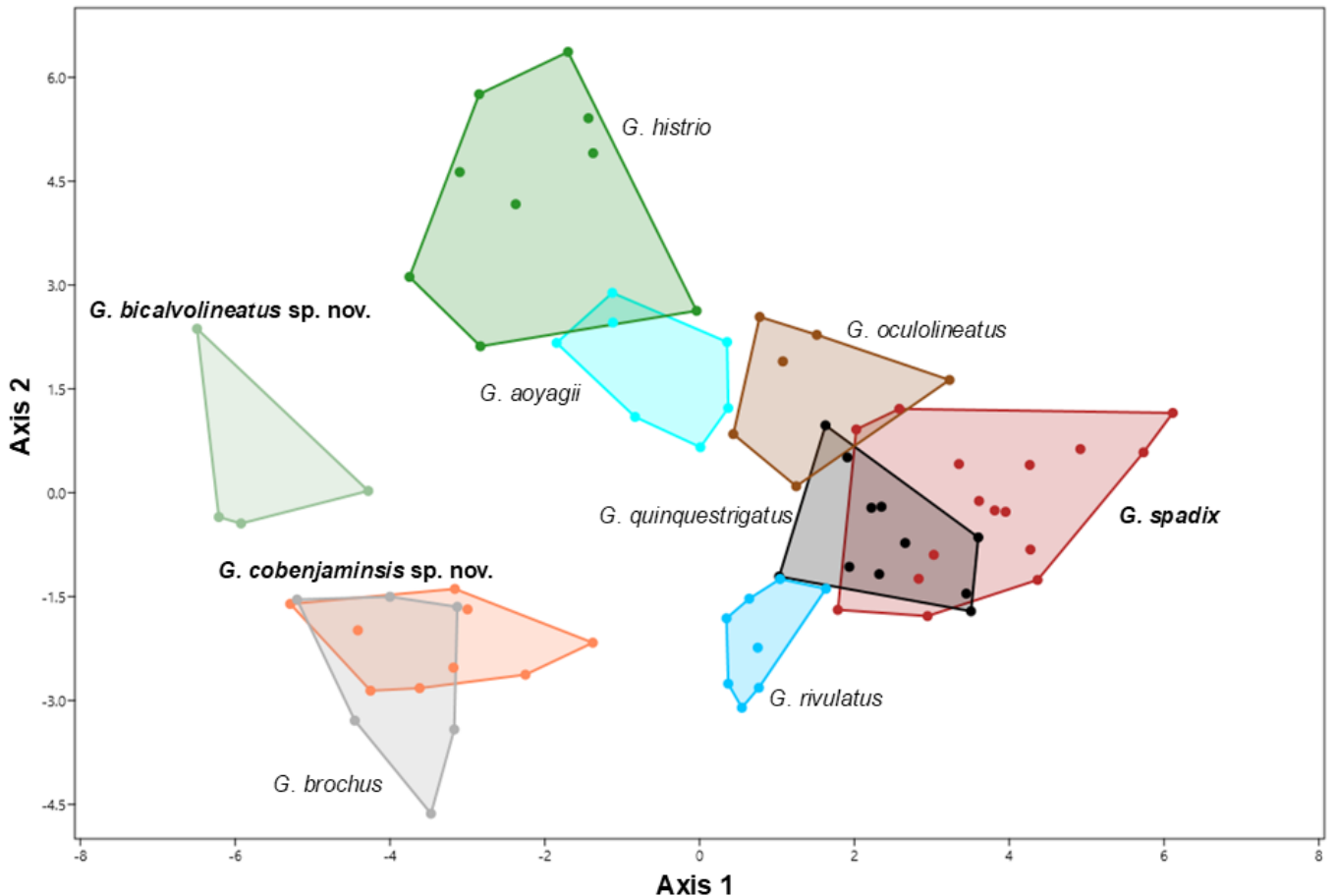


Fig. 10. Least-discriminant analysis (LDA) of morphometric measurements of all focus and comparative species measured in the study. Colours denote species and are there to aid in both the distinction between species and the identification of morphological overlap.

et al., 2019). *Gobiodon spadix* also displays a greater level of morphological variability akin to *G. histrio*, a possible correlation with the large regional distribution of the species.

Phylogenetic Tree Analysis

The genetic analyses conducted in this study paint a very similar picture to those that have previously been conducted (Fig. 11) (Harold et al., 2008; Duchene et al., 2013; Herler et al., 2013; Hing et al., 2019). There are some minor differences seen between this study and previously conducted studies on the 12S and 16S genetic markers (Harold et al., 2008; Herler et al., 2013). However, our results are consistent with those that have included the COI molecular marker (Duchene et al., 2013; Hing et al., 2019). Overall, these differences are to be expected as *Gobiodon* is a relatively young genus that has had a comparatively fast and more variable evolutionary history compared to other fish genera (Duchene et al., 2013; Carolin et al., 2023). The evolutionary history of *Gobiodon* is still in its early stages (Duchene et al., 2013; Hing et al., 2019), with it still being undetermined if extinction or variable speciation rates are better explanations for their pattern of evolution (Duchene et al., 2013). Combined with their short generation times for vertebrates, which has led to higher rates of molecular substitution and a high suitability for adaptive radiation, propensity for utilising ecological niches, and their location in some of the world's most biodiverse speciation hotspots, the genus structure (both genetically and morphologically) is highly complicated and will require

extensive analysis in order to successfully untangle (Munday et al., 2004; Duchene et al., 2013).

DISCUSSION

Using morphological characteristics, molecular data, and multivariate-statistical analyses, a mix of methods previously used by Herler et al. (2013), we have formally described two species of *Gobiodon* and supplied additional taxonomic information on the southern sub-population of the recently described *Gobiodon spadix*. With the addition of these two new species, *Gobiodon bicalvolineatus* and *Gobiodon cobenjaminsis*, our knowledge of *Gobiodon* within the South Pacific Ocean and particularly the reefs surrounding Papua New Guinea, is significantly increased. The two species have been known to exist and were thought to be distinct from other *Gobiodon* species for over 25 years (Munday et al., 1999; Munday et al., 2004), but this had not been confirmed nor had the species been described during this time. In addition, we add vital information about the South Pacific Ocean population of the newly described species *Gobiodon spadix*, originally described from northern Pacific Ocean Japanese specimens (Sato & Motomura, 2024). By providing additional characteristics and variations in morphology and ecology of the southern population of *G. spadix*, we hope to increase the ease of identification of this species and decrease the present confusion within the genus *Gobiodon*.

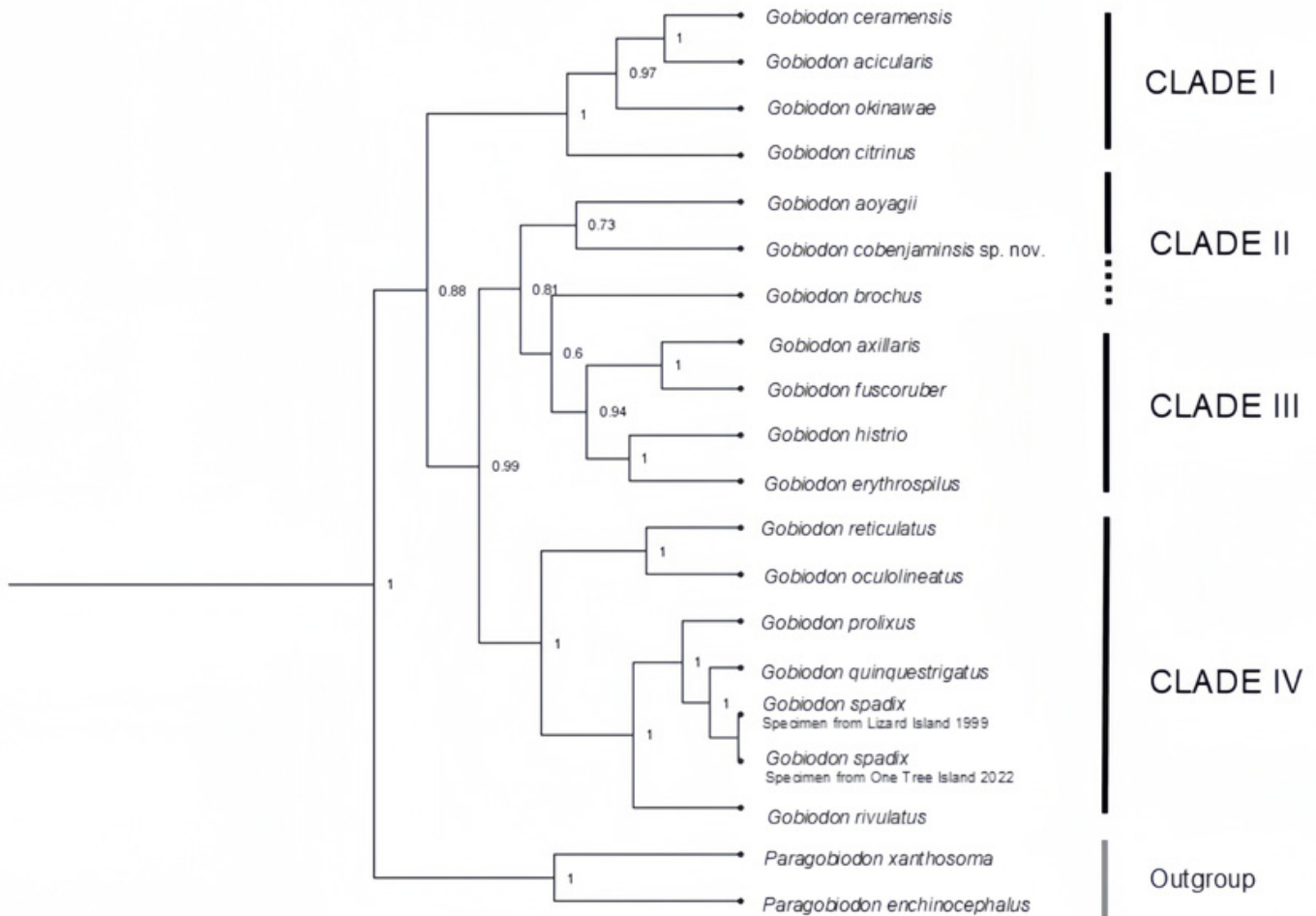


Fig. 11. Phylogenetic tree inference obtained by Bayesian analyses and based on mitochondrial cytochrome c oxidase subunit I (COI) for the genus *Gobiodon* with comprehensive taxon sampling and two known outgroup species, *Paragobiodon xanthosoma* and *Paragobiodon enchinocephalus*. Topology of best Bayesian tree (consensus of 1,000 post burn-in trees from each run) with posterior probabilities are indicated. Four main clades are indicated in alignment with Duchene et al. (2013), with solid bar denoting monophyletic members of the clade and dashed denoting paraphyletic species within the clade.

The status of the individuals that resemble *G. spadix* in the Indian Ocean was unable to be resolved within this study, as the individuals demonstrated similar morphology to *G. spadix* despite having differing genetics to known members of the species (Herler et al., 2013; Sato & Motomura, 2024).

Gobiodon bicalvolineatus has a distinctive appearance of two lighter lines on the dorsal head region, red dots on the head, and unbroken thin red horizontal lines on the body on a light green ground colour. The species' live colouration makes it easily distinguishable from congeners. This species is highly specialised, even amongst the notoriously specialised members of *Gobiodon*, only being recorded in *Acropora caroliniana* within Bootless Bay, PNG (Munday et al., 1999; 2004). The morphometric LDA performed confirms its distinctive appearance, separate from other species. However, those closest to it are *G. brochus*, *G. cobenjaminsis*, *G. aoyagii*, and *G. histrio*. Although we were unable to confirm the placement of the species with our own phylogenetic tree analysis, previous work has shown that they are in the same genetic clade as *G. cobenjaminsis*, *G. brochus*, and *G. aoyagii* (Harold et al., 2008; Duchene et al., 2013).

Gobiodon cobenjaminsis has a unique appearance within the genus, with an orange-brown base colouration, three to four lighter vertical bands on the facial area, a pale line at the base of the dorsal fin, and black margins on the fins. Additionally, the first and second dorsal fins are connected with a high membrane, giving a fused appearance not common within the genus. *Gobiodon cobenjaminsis* is highly specialised, only inhabiting *Acropora elseyi*, in addition to its small geographic distribution, as it has only been observed in Kimbe Bay, PNG (Munday et al., 1999). The morphometric analysis displays a similar morphology to *G. brochus*, but there is noticeable morphological variation between the two species in addition to their significantly different colouration and patterning. The phylogenetic tree inference was able to support the location of *G. cobenjaminsis* adjacent to *G. brochus*, *G. aoyagii*, and *G. bicalvolineatus*, previously seen in Harold et al. (2008) and Duchene et al. (2013). However, this does differ from the analysis conducted by Herler et al. (2013) which located the species within a different clade, neighbouring *G. okinawae*, *G. citrinus*, *G. ceramensis*, and *G. acicularis*.

The measurements taken of individuals known as *Gobiodon* sp. D in the GBR of the South Pacific Ocean confirm that they are members of the newly described species, *G. spadix*. Our phylogenetic tree supports the genetic analysis presented by Sato & Motomura (2024), with individuals of the South Pacific Ocean displaying a high level of genetic similarity to those from Japan in the Northern Pacific Ocean. However, there are some distinct differences in the morphology of the populations, with individuals from the South Pacific Ocean having deeper body depth at pelvic fin origin and shorter pectoral fins in comparison to head length than those observed in the North Pacific Ocean. The status of the individuals with a similar appearance to *G. spadix* from the Maldives, Indian Ocean, is still undetermined. The PCoA morphometric analysis suggests a high level of similarity to both the North and South Pacific Ocean populations. However, previous phylogenetic trees have suggested significant genetic differences between *G. spadix* and the individuals observed in the Indian Ocean (Herler et al., 2013; Sato & Motomura, 2024). Therefore, the incongruency between the results of the two different methods means the status of these individuals is still inconclusive.

The morphometric analysis conducted displays the correlation between morphometrics and phylogenetics within *Gobiodon*. Similarities in morphologic measurements can be observed between species within a clade, for example the grouping of *G. brochus* and *G. cobenjaminsis*. However, there are likely other strong influences on the morphological characteristics of these species, with some species having large morphometric differences from other members of their phylogenetic clade. Morphometric analyses provide strong evidence for genetic clades observed within the genus, although other aspects that can influence morphology should also be considered, such as host coral species (Untersteeggaber et al., 2014).

The phylogenetic tree inference conducted supports reconstructions utilising the COI marker. A stronger connection was observed between the clade containing *G. aoyagii*, *G. brochus*, and *G. cobenjaminsis* and the clade containing *G. axillaris*, *G. fuscuber*, *G. histrio*, and *G. erythrospilus* in the tree presented here compared to previous trees which utilised both the COI or 12S and 16S rRNA mitochondrial genes (Harold et al., 2008; Duchene et al., 2013; Hing et al., 2019). However, these differences are fairly common due to the young age of the genus *Gobiodon*, which has been noted to have a faster and more variable evolutionary history compared to other fish genera (Duchene et al., 2013; Carolin et al., 2023). The most notable difference is with Herler et al. (2013), where the location of *G. cobenjaminsis* differed considerably. Herler et al. (2013) suggests the species is an outgroup to the clade containing *G. okinawae*, *G. acicularis*, *G. ceramensis*, and *G. citrinus*. However, all other known phylogenetic trees place *G. cobenjaminsis* in a clade alongside *G. aoyagii*, *G. bicalvolineatus*, and *G. brochus*, regardless of the mitochondrial gene used, either 12S and 16S (Harold et al., 2008) or COI (Duchene et al., 2013; Hing et al., 2019).

The two new species—*G. bicalvolineatus* and *G. cobenjaminsis*—have been thoroughly demonstrated to be morphologically and genetically distinct species within the genus *Gobiodon*. Whilst body colour and patterning are a major distinguishing feature, there are also sufficient morphometric distinctions to support their positions as formal separate species. Lacking formal taxonomic descriptions and species names for nearly three decades, these species can now be formally recognised. The utmost care has been taken to ensure they are new species to avoid adding to the growing list of taxonomic ambiguities within this genus.

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APPENDIX

GenBank accession numbers for phylogenetic analysis. All codes sourced from <https://www.ncbi.nlm.nih.gov/genbank/>

Species	GenBank accession (COI)
<i>Gobiodon cobenjaminsis</i>	PP882813 (this study, sequence active from 1 December 2024)
<i>Gobiodon spadix</i> (GBR)	PP874577 (this study, sequence active from 1 December 2024)
<i>Gobiodon acicularis</i>	MK496336
<i>Gobiodon axillaris</i>	MK496339
<i>Gobiodon aoyagii</i>	MK496372
<i>Gobiodon brochus</i>	MK496343
<i>Gobiodon ceramensis</i>	MK496345
<i>Gobiodon citrinus</i>	MK496351
<i>Gobiodon erythrospilus</i>	MK496354
<i>Gobiodon fuscoruber</i>	MK496378
<i>Gobiodon histrio</i>	MK496357
<i>Gobiodon oculolineatus</i>	MK496361
<i>Gobiodon prolixus</i>	MK658254
<i>Gobiodon okinawae</i>	MK496364
<i>Gobiodon quinquestrigatus</i>	MK496367
<i>Gobiodon reticulatus</i>	MF123909
<i>Gobiodon rivulatus</i>	MK496369
<i>Gobiodon</i> sp. D (Lizard Island)	MK496376
<i>Paragobiodon xanthosoma</i>	MK496380
<i>Paragobiodon echinocephalus</i>	MF123968

For the raw measurements of the specimens of the species described in the study or the comparative species used, please email corresponding author (courtneyahildebrandt@gmail.com). Specimens are accessible at the institution listed in the specimens lists of the relevant section.