Bull. Natl. Mus. Nat. Sci., Ser. A, 39(3), pp. 143–165, August 22, 2013

Gobiodon aoyagii, a New Coral Goby (Actinopterygii, Gobiidae, Gobiinae) from the West Pacific, with Redescription of a Similarly-colored Congener *Gobiodon erythrospilus* Bleeker, 1875

Koichi Shibukawa[1], Toshiyuki Suzuki[2] and Masahiro Aizawa[3]

[1] Nagao Natural Environment Foundation, 3–10–10 Shitaya, Taito-ku, Tokyo, 110–0004 Japan
E-mail: kshibukawa@nagaofoundation.or.jp
[2] Kawanishi-midoridai Senior High School, 1–18 Koyodai, Kawanishi, Hyogo, 666–0125 Japan
[3] Imperial Household Agency, 1–1 Chiyoda, Chiyoda-ku, Tokyo, 100–8111 Japan

(Received 1 May 2013; accepted 26 June 2013)

Abstract A new species of coral goby, *Gobiodon aoyagii*, is described based on 57 specimens collected from the West Pacific. *Gobiodon aoyagii* is unique within the genus by having 3–4 rows of weakly ctenoid and/or cycloid scales on caudal peduncle. Furthermore, *G. aoyagii* differs from the congeners by the following combination of characters: a deep, inflected interopercular-isthmus groove; 5–6 upper or lower unsegmented caudal-fin rays; no distinct dusky spot at dorsoposterior corner of operculum; when alive or freshly-collected, 2 reddish circular spots on the pectoral-fin base; no reddish crescent-like bar along bases of pectoral-fin rays; reddish spots on the ventral surface of head. Our examination of 45 (of 86) syntypes of a similarly-colored congener *G. erythrospilus* reveals that these syntypes comprise 4 distinct species, viz., *G. erythrospilus*, *G. histrio*, *G. aoyagii* and an unidentifiable species. *Gobiodon erythrospilus* is re-described based on 25 syntypes and additional 49 specimens from Japan and Micronesia, and a lectotype is designated.
Key words: *Gobiodon aoyagii*, new species, Gobiidae, *Gobiodon erythrospilus*, redescription.

Introduction

The coral-commensal goby genus *Gobiodon* Bleeker, 1856, comprises small-sized gobies (up to ca. 40 mm in standard length) that are obligate inhabitants of the interstices in branching corals in the Indo-West Pacific. Species of *Gobiodon* have a characteristic deep and well-compressed head and body, and a general appearance resembling *Paragobiodon* Bleeker, 1873 and *Lubricogobius* Tanaka, 1915. *Gobiodon* is distinguished from the latter 2 genera by having a more compressed head and body (vs. less compressed in *Paragobiodon* and *Lubricogobius*), largely or entirely naked body (vs. large ctenoid scales covering entire body in *Paragobiodon*), and a narrow gill opening restricted to the pectoral-fin base (vs. large gill opening, extending anteriorly to, or slightly beyond, a vertical through posterior margin of preopercle in *Lubricogobius*) (Hoese, 1986; Winterbottom and Emery, 1986; Harold and Winterbottom, 1995, 1999; Randall and Senou, 2001; Akihito *et al.*, 2002; Senou *et al.*, 2004; Harold *et al.*, 2008; Suzuki and Randall, 2011). The body of *Gobiodon* is covered by a thick mucus layer, containing crinotoxins that may be an important predator deterrent (Hashimoto *et al.*, 1974; Randall and Senou, 2001; Munday *et al.*, 2003; Schubert *et al.*, 2003) and a corallivore repellent (Dirnwoeber and Herler, 2013). Bi-directional hermaphroditism (the ability to shift back and forth between male and female) has been confirmed in a number of species of *Gobiodon* (Nakanishi *et al.*, 1996; Munday *et al.*, 1998; Cole and Hoese, 2001; Cole, 2008, 2011).

Many *Gobiodon* species have distinctive, species-specific bright color patterns on the

head, body and/or fins. These color patterns are very useful in species identification of live or freshly-collected specimen. These patterns are, in many cases, largely or almost completely faded in the alcohol-preserved specimens (Bleeker, 1875; Aoyagi, 1943; Koumans, 1953) and may have led to an underestimate of the species diversity of *Gobiodon* by early researchers (*e.g*., Herre, 1927; Tomiyama, 1936).

The taxonomy of *Gobiodon* species is still open to debate. Although comprehensive revisions are hitherto not available, Harold *et al.* (2008) recognized 19 described species within the genus, as well as 6 additional undescribed species: *Gobiodon acicularis* Harold and Winterbottom, 1995; *Gobiodon albofasciatus* Sawada and Arai, 1972; *Gobiodon axillaris* De Vis, 1884; *Gobiodon brochus* Harold and Winterbottom, 1999; *Gobiodon ceramensis* (Bleeker, 1853); *Gobiodon citrinus* (Rüppell, 1838); *Gobiodon erythrospilus* Bleeker, 1875, *Gobiodon fulvus* Herre, 1927; *Gobiodon heterospilos* Bleeker, 1856; *Gobiodon histrio* (Valenciennes in Cuvier and Valenciennes, 1837); *Gobiodon micropus* Günther, 1861; *Gobiodon oculolineatus* Wu, 1979; *Gobiodon okinawae* Sawada, Arai and Abe, 1972; *Gobiodon prolixus* Winterbottom and Harold, 2005; *Gobiodon quinquestrigatus* (Valenciennes in Cuvier and Valenciennes, 1837); *Gobiodon reticulatus* Playfair *in* Playfair and Günther, 1867; *Gobiodon rivulatus* (Rüppell, 1830); *Gobiodon spilophthalmus* Fowler, 1944; and *Gobiodon unicolor* (Castelnau, 1873). Four of the 6 undescribed species of Harold *et al.* (2008) were illustrated in Munday *et al.* (1999). Subsequently a new species, *Gobiodon winterbottomi* Suzuki, Yano and Senou, 2012, was described from the Ryukyu Islands, Japan. Allen and Erdmann (2012) suggested that *G. spilophthalmus* and *G. albofasciatus* are probably junior synonyms of *G. heterospilos*, and we provisionally follow them here. Taxonomic status of the other nominal species *Gobiodon flavus* Sauvage, 1880 is unresolved (Bauchot *et al.*, 1991; D. F. Hoese, personal communication). Several additional, presumably-unnamed species have been reported from various regions of the Indo-West Pacific (*e.g.*, Munday *et al.*, 1999; Senou *et al.*, 2004; Herler and Hilgers, 2005; Allen and Erdmann, 2012).

The status of another *Gobiodon*-like nominal species, *Pseudogobiodon macrochir* Bleeker, 1875, is still unclear; the species is known only by a single type specimen from Ambon, and hitherto there are no records of additional specimens. In the original description, Bleeker (1875) separated *Pseudogobiodon*, currently comprising only a single species *P. macrochir*, from *Gobiodon* chiefly by the absence of post-symphysial canine teeth, and this action was concurred with Koumans (1931, 1953). Nevertheless, *Gobiodon*, as currently recognized, contains species with and without post-symphysial canine teeth; examples of the latter include *G. acicularis* and *G. winterbottomi* (Harold and Winterbottom, 1995; Harold *et al.*, 2008; Suzuki *et al.*, 2012). Recent phylogenetic analysis of *Gobiodon* species (Harold *et al.*, 2008) revealed that one of the species lacking post-symphysial canine teeth, *G. acicularis*, was deeply nested amongst congeners with post-symphysial canine teeth. This character is thus not useful for separating these genera, and, if *Pseudogobiodon* could be distinguished from *Gobiodon* by the absence of post-symphysial canine teeth, the former should be regarded as a junior synonym of the latter. These 3 species, viz. *P. macrochir*. *G. acicularis* and *G. winterbottomi*, are similar in one another in sharing a uniformly-pigmented body and fins, lengths of spines of first dorsal fin decreasing progressively from anterior to posterior, and modally 15 or 16 pectoral-fin rays, as well as the absence of post-symphysial canine teeth (Harold and Winterbottom, 1995; Suzuki *et al.*, 2012). Harold and Winterbottom (1995) showed that *G. acicularis* is distinct from *P. macrochir*, although they left the validity of *Pseudogobiodon* unresolved. Suzuki *et al.* (2012) did not provide any comments on *P. macrochir* in the original description of *G. winterbottomi*. Detailed comparison is needed between *P. macrochir* and *G. winterbottomi* in order to verify the validity of both

generic and specific names of the former, but that work is beyond the scope of this paper.

The primary purpose of this paper is to describe a reddish-spotted species of *Gobiodon* with a distinct groove inside of the interopercle (＝"interopercle-isthmus groove" of Harold and Winterbottom, 1995, 1999). This species, first recognized as an unnamed species by Suzuki *et al.* (1995), is found in shallow coral reefs of the West Pacific [*e.g.*, Suzuki *et al.*, 1995 (as *Gobiodon* sp.); Munday *et al.*, 1999 (as *Gobiodon* sp. A); Akihito *et al.*, 2002 (as *Gobiodon* sp. 2), 2013 (as *Gobiodon* sp. 1); Allen and Erdmann, 2012 (as *Gobiodon erythrospilus*)]. It resembles the other 2 reddish-spotted species with an interopercle-isthmus groove, viz. *G. erythrospilus* and *G. histrio*, but these 3 species, shown in Fig. 1, can be separated from one another by color details and the squamation on the body (Suzuki *et al.*, 1995). Nevertheless, the taxonomic treatment of these reddish-spotted species was unstable until recently; some researchers continued to regard *G. erythrospilus*-type fish as an intraspecific variation of *G. histrio* (*e.g.*, Munday *et al.*, 1999; Randall, 2005), and Allen and Erdmann (2012) identified their underwater photograph of *G.* sp. (sensu Suzuki *et al.*, 1995) as *G. erythrospilus*. Based on molecular analyses, Munday *et al.* (2004) and Harold *et al.* (2008) confirmed each of the 3 fishes of *Gobiodon* shown by Suzuki *et al.* (1995) as distinct species.

During the course of our research describing *Gobiodon* sp. of Suzuki *et al.* (1995), we examined 45 syntypes of *G. erythrospilus* (RMNH. PISC.6187). The syntypes, collected from various localities of the Dutch East Indies by Bleeker (1875), comprise four distinct species. Three of them have a distinct interopercle-isthmus groove, whereas the remaining one lacks it. We herein conclude that the former three are identical with the 3 reddish-spotted species of Suzuki *et al.* (1995) (see details in "Remarks" of *G. erythrospilus*, below). In this paper, we describe "*Gobiodon* sp." of Suzuki *et al.* (1995) as new, re-describe *G. erythrospilus*, and designate a lectotype for *G. erythrospilus*.

Materials and Methods

Specimens examined are deposited in the following institutions: Australian Museum, Sydney, New South Wales, Australia (AMS); Biological Laboratory, Imperial Palace, Tokyo, Japan (BLIP); National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture, Japan (NSMT); Osaka Museum of Natural History, Laboratory of Zoology, Osaka, Japan (OMNH); Naturalis Biodiversity Center, Leiden, Netherland (RMNH); Yokosuka City Museum, Yokosuka, Kanagawa Prefecture, Japan (YCM).

All fish lengths given are standard length (SL). The methods for measurements follow those of Hubbs and Lagler (1958), with exceptions given below (the snout tip refers to the mid-anteriormost point of the upper lip): head length is measured between the snout tip and dorso-posterior corner of operculum (including opercular membrane); interorbital width is the least width between bony rims of orbits; jaw length is measured between the snout tip and the posteriormost point of lips; body depth is measured in 2 ways, the first at the pelvic-fin origin, and the second at anal-fin origin; head width is measured at preopercular margin; preanal and prepelvic lengths are measured from the snout tip to the origin of each fin; length of first dorsal-fin base is measured from the origin of first dorsal fin to the anterior base of spine of second dorsal fin; length of second dorsal-fin base is measured from the anterior base of spine to the posterior base of ultimate segmented ray; lengths of fin spines and segmented rays are measured from the anterior base to the distal tip of each ray; pectoral-fin length is measured from the base to the tip of the longest ray; pelvic-fin length is measured between the base of pelvic-fin spine and the distal tip of the longest segmented ray; caudal-fin length is measured from the base to the tip of the middle caudal-fin ray. Measurements were made with calipers under a dissecting microscope to the nearest 0.01 mm. The methods for counts follow those of Akihito *in* Akihito *et al.* (1984). Pectoral-fin rays and branched caudal-fin

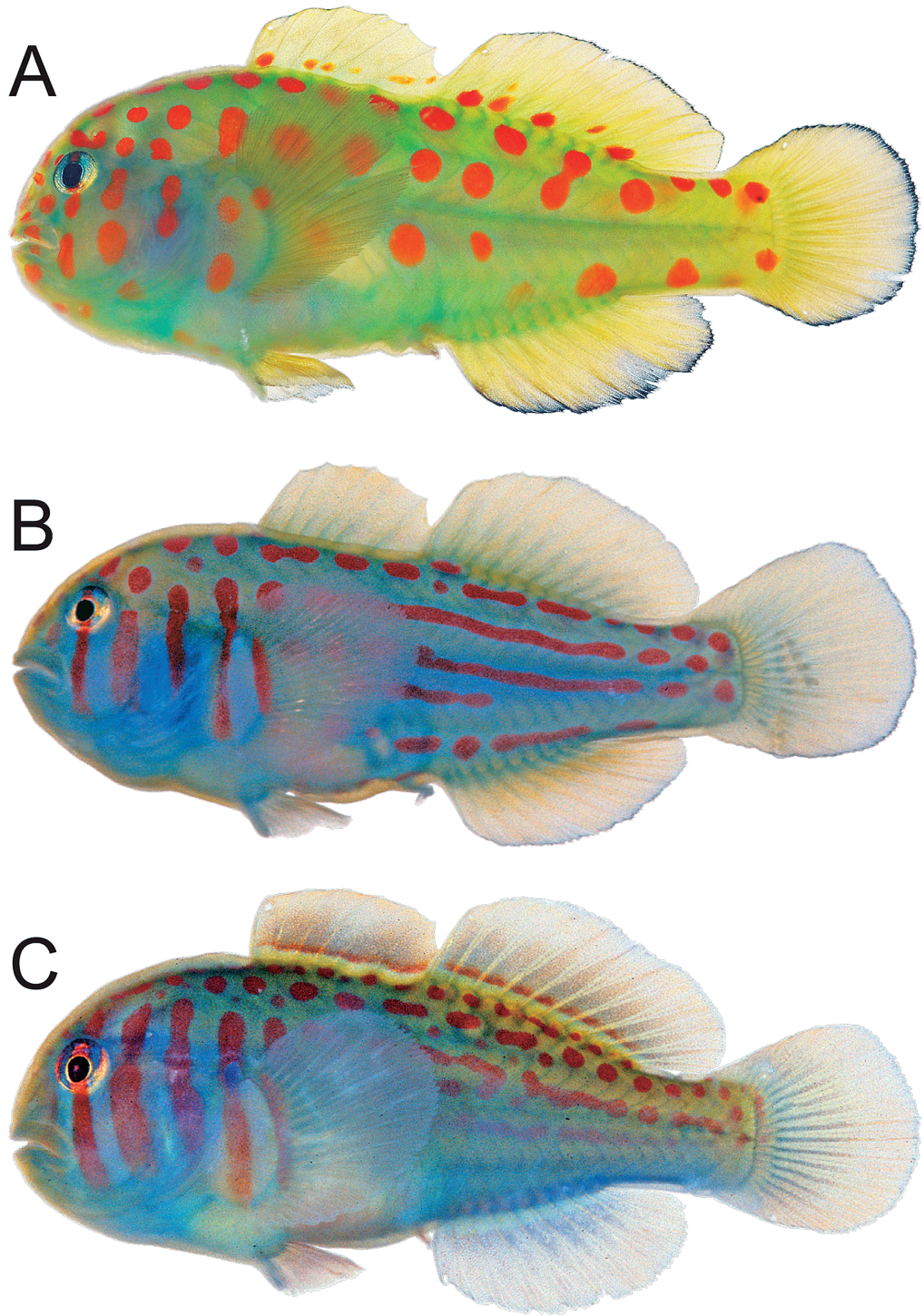


Fig. 1. Three similar-looking species of *Gobiodon* from Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan (photographed by T. Suzuki). — A) *Gobiodon aoyagii* sp. nov., paratype, NSMT-P 111423, female, 28.5 mm SL; B) *G. erythrospilus*, OMNH-P 4223, male, 25.9 mm SL; C) *G. histrio*, OMNH-P 5576, male, 22.2 mm SL.

rays are counted and numbered from dorsal to ventral. Paired-fin rays are counted bilaterally. Scales are embedded under a thick mucus layer, and easily detached when the mucus layer is removed; scales are confirmed largely based on scale pockets of specimens stained with a cyanine blue, or, in some specimens (including a single paratype of the new species), examined based on specimens stained with alizarin red. Osteological features and caudal-fin rays were observed and/or counted from radiographs. The methods of Akihito *in* Akihito *et al.* (1984) are used in describing the pattern of the interdigitation of the dorsal-fin pterygiophores between the neural spines ("P-V"). Cephalic sensory canals and papillae are observed on specimens stained with cyanine blue, and their notations follow Akihito *in* Akihito *et al.* (1984) and Sanzo (1911), respectively.

Gobiodon aoyagii sp. nov.
(Japanese name: Akaten-koban-haze)

(Figs. 1A, 2A–I, 3, 4C, 5C; Table 1)

Gobiodon erythrospilus Bleeker, 1875: 122 (part; East Indies; see "Remarks" of *Gobiodon erythrospilus*, below).

Gobiodon rivulatus (non Rüppell): Aoyagi, 1943: 221, pl. 35, fig. 1 (Itoman, Okinawa-Honto, Japan); Hayashi *et al.*, 1990: 138 (Amami-oshima Island, Amami Group of Ryukyu Islands, Japan); Masuda and Kobayashi, 1994: 342, figs. 6 and 7 (Nansei Islands, Japan).

Gobiodon rivulatus rivulatus (non Rüppell): Sawada and Arai, 1973: 595, figs. 20–24 (part; Ryukyu Islands, Japan); Hayashi and Itoh, 1978: 71, pl. 14, fig. 36 (part; Kabira Bay, Ishigaki-jima Island, Japan); Yoshino and Yamamoto *in* Akihito *et al.*, 1984: 256 (part; Ryukyu Islands, Japan).

Gobiodon sp: Suzuki *et al.*, 1995: 3, figs. 1–6 (Ryukyu Islands, Japan) ; Motomura *et al.*, 2010: 214 (Yakushima Island, Japan).

Gobiodon sp. 1: Suzuki and Senou *in* Okamura and Ama-

Table 1. Proportional measurements of 2 species of *Gobiodon.*

	G. aoyagii		*G. erythrospilus*		
	Holotype NSMT-P 111422	Paratypes $n = 28$	Lectotype RMNH.PISC.6187	Paralectotypes $n = 9$	Non-type specimens $n = 10$
SL (mm)	28.1	25.6–34.7	29.2	28.8–34.3	18.8–28.7
% of SL					
Head length	29.9	28.9–33.5	30.4	28.6–30.3	29.6–33.1
Head width	15.4	14.2–20.7	15.3	15.3–17.6	15.1–18.8
Snout length	10.9	9.1–11.2	9.2	7.9–9.5	9.1–11.5
Eye diameter	6.8	5.8–8.0	7.1	5.9–6.8	6.4–8.2
Interorbital width	2.5	2.1–3.1	2.8	2.3–3.4	2.2–3.0
Jaw length	9.8	9.4–12.1	11.1	9.9–11.5	10.9–13.2
Body depth at P_2 origin	42.5	38.1–45.0	40.6	36.5–41.2	37.2–41.5
Body depth at A origin	35.0	31.4–37.6	34.3	29.0–34.9	30.2–36.1
Body width	13.8	11.1–18.2	14.2	10.3–14.6	11.0–15.3
Predorsal length	38.6	37.0–41.8	38.9	36.8–39.2	36.5–40.7
Prepelvic length	36.1	35.5–39.7	36.6	34.9–42.3	34.6–41.0
Preanal length	61.8	57.8–66.6	59.2	57.7–64.9	58.6–62.3
Caudal-peduncle length	21.1	20.2–23.1	24.0	20.7–24.7	19.4–23.4
Caudal-peduncle depth	17.5	15.0–18.1	16.8	14.9–17.4	14.4–18.8
Length of D_1 base	23.9	21.9–27.6	22.1	20.5–23.7	21.5–26.4
Length of D_2 base	31.1	27.3–33.2	28.8	26.9–32.0	28.3–32.2
Length of anal-fin base	23.6	22.4–25.9	21.7	19.1–25.1	22.1–25.9
Length of D_1 1st spine	9.7	7.6–12.5	13.9	10.5–12.8	10.1–12.5
Length of D_1 6th spine	10.5	7.7–12.1	11.0	10.2–12.6	9.3–12.6
Length of D_1 longest spine	13.7	11.1–15.2	16.2	14.8–17.4	12.6–15.1
Length of D_2 spine	13.9	9.9–15.7	14.5	12.7–15.0	12.1–15.2
Length of D_2 1st segmented ray	17.8	14.5–19.9	broken	15.7–18.3	17.2–19.4
Length of D_2 longest segmented ray	20.6	17.9–21.1	broken	18.3–22.7	18.8–21.5
Length of A spine	10.5	7.9–12.8	11.6	8.4–11.9	8.7–11.6
Length of A 3rd segmented ray	17.8	14.8–18.8	16.9	15.4–19.8	14.7–19.5
Length of A longest segmented ray	18.6	15.6–20.7	20.7	16.8–21.2	16.8–20.5
P_1 length	24.6	21.1–26.3	23.3	21.6–24.8	22.1–28.2
P_2 length	16.0	13.2–18.3	15.6	12.3–15.4	13.3–17.4
C length	23.0	20.9–25.1	broken	broken	22.2–27.8

Abbreviations: A, anal fin; C, caudal fin; D_1, first dorsal fin; D_2, second dorsal fin; P_1, pectoral fin; P_2, pelvic fin.

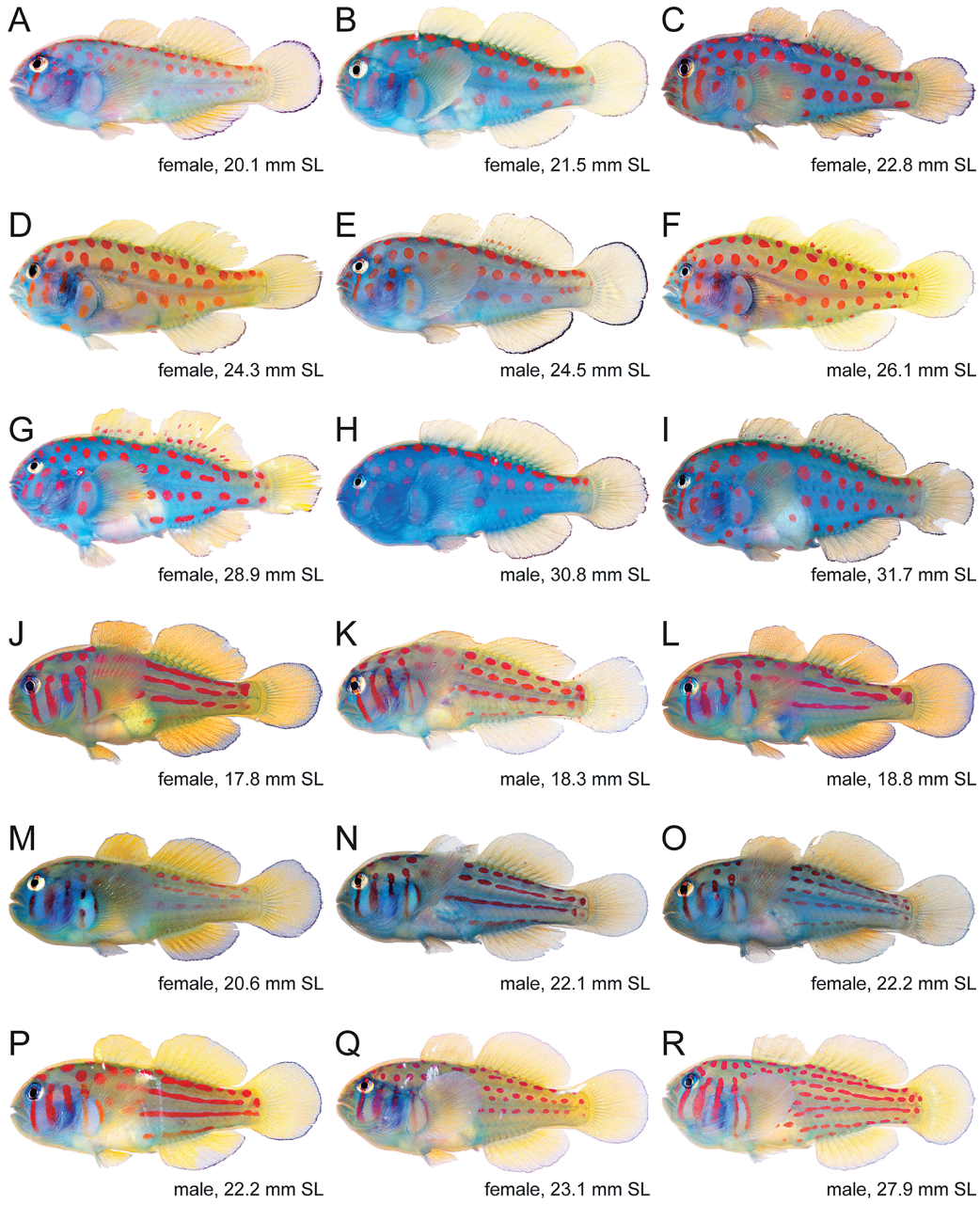


Fig. 2. Two species of *Gobiodon*, showing intraspecific variations in coloration. — *Gobiodon aoyagii* sp. nov.: A) NSMT-P 111434; B) NSMT-P 111433; C) OMNH-P 5572; D) NSMT-P 111430; E) OMNH-P 5567; F) NSMT-P 111428; G) NSMT-P 111426; H) OMNH-P 5568; I) OMNH-P 5569. *Gobiodon erythrospilus*: J) OMNH-P 5574; K) NSMT-P 11437; L) OMNH-P 5573; M) OMNH-P 5575; N) OMNH-P 4150; O) OMNH-P 4151; P) NSMT-P 111442; Q) NSMT-P 111441; R) NSMT-P 111440. All specimens were collected from the Ryukyu Islands, Japan, and photographed by T. Suzuki.

oka, 1997: 615 (with underwater photograph taken by K. Yano; Ryukyu Islands, Japan); Akihito *et al.*, 2013: 1419 (Yaku-shima Island and Amami, Okinawa and Yaeyama groups of Ryukyu Islands, Japan).

Gobiodon sp. 2: Akihito *et al.*, 2000: 1188 (Amami, Okinawa and Yaeyama groups of Ryukyu Islands, Japan) ; Akihito *et al.*, 2002: 1188 (Amami, Okinawa and Yaeyama groups of Ryukyu Islands, Japan).

Gobiodon sp. A: Munday *et al.*, 1999: 55 (Papua New Guinea and Great Barrier Reef); Harold *et al.*, 2008 (Lizard Islands of Great Barrier Reef, Queensland, Australia).

Gobiodon sp. B: Senou *et al.*, 2004: 172 (Yaeyama Group of Ryukyu Islands).

Gobiodon erythrospilus (non Bleeker): Allen and Erdmann, 2012: 897 (East Indies).

Holotype. NSMT-P 111422, 1 specimen (female), 28.1 mm SL, Barasu, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 8 Aug. 1996, collected by T. Suzuki and M. Hosokawa.

Paratypes. Total 56 specimens, 11.3–34.7 mm SL: AMS I.19444-076, 2 specimens, 18.3–29.0 mm SL, Lizard Island area, Great Barrier Reef, Queensland, Nov. 1975, collected by AMS party; AMS I. 22953-006, 2 specimens, 24.3–26.7 mm SL, Cebu Aquatics, Cebu, Philippines, 1980, collected by D. F. Hoese and party; AMS I. 27364-003, 2 specimens (males), 21.6–27.9 mm SL, Amitori Bay, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 14 Aug. 1977, collected by H. Kishimoto; AMS I.46140-001, 1 specimen (male), 25.6 mm SL, collected with holotype; NSMT-P 31255, 1 specimen (female), 31.6 mm SL, Sakinome Beach, Oshima Straits, Amami-oshima Island, Amami Group of Ryukyu Islands, Japan (28°11.2′N, 129°16′E), 2–3 m depths, 12 Sept. 1989, collected by M. Aizawa; NSMT-P 31256, 1 specimen (male), 24.6 mm SL, collected with NSMT-P 31255; NSMT-P 31751, 4 specimens (1 male and 3 females), 18.1–26.2 mm SL, collected with NSMT-P 31255; NSMT-P 34807, 1 specimen, 34.7 mm SL, Sokaru, Amami-oshima Island, Ryukyu Island, Japan, 3 m depth, 11 June 1991, collected by M. Aizawa; NSMT-P 61947, 1 specimen (male), 23.7 mm SL, off Itona, Nosoko, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan (23°28.8′N, 124°13′E), 5 m depth, 21 Aug. 1996, collected by K. Matsuura and K. Shibukawa; NSMT-P 61948, 1 specimen (male), 25.5 mm SL, collected with NSMT-P 61947; NSMT-P 64067, 3 specimens (1 male and 2 females), 22.1–24.5 mm SL, collected with NSMT-P 61947; NSMT-P 111423, 1 specimen (female), 28.5 mm SL, (stained with alizarin red), Busashi Beach, Sonai, Iriomote-jima Island, Yaeyema Group of Ryukyu Islands, Japan, 14 Aug. 2012, collected by T. Suzuki, M. Hosokawa, A. Kawai and K. Shibukawa; NSMT-P 111424, 7 specimens (2 males and 5 females), 14.7–27.8 mm SL, Kabira, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 18–23 Mar. 1972; NSMT-P 111425, 1 specimen (male, stained with alizarin red), 28.4 mm SL, collected with holotype; NSMT-P 111426, 1 specimen (female), 28.8 mm SL, Hinai Beach, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 27 July 1997, collected by T. Suzuki and M. Hosokawa; NSMT-P 111427, 1 specimen (male), 28.9 mm SL, collected with NSMT-P 111426; NSMT-P 111428, 1 specimen (male), 26.1 mm SL, Barasu, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 29 July 1997, collected by T. Suzuki and M. Hosokawa; NSMT-P 111429, 1 specimen (female), 22.3 mm SL, collected with NSMT-P 111428; NSMT-P 111430, 1 specimen (female), 24.3 mm SL, collected with NSMT-P 111428; NSMT-P 111431, 3 specimens (1 male and 2 juveniles), 11.3–24.6 mm SL, collected with NSMT-P 111428; NSMT-P 111432, 1 specimen (male), 28.1 mm SL, off west coast of Funauki, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 28 July 1998, collected by T. Suzuki and M. Hosokawa; NSMT-P 111433, 1 specimen (female), 21.5 mm SL, southern reef of Hatoma-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 19 Aug. 1999, collected by T. Suzuki and M. Hosokawa; NSMT-P 111434, 1 specimen (male), 20.1 mm SL, southern reef of Hatoma-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 17 Aug. 2000, collected by T. Suzuki and M. Hosokawa; OMNH-P 5565, 1 specimen

(female), 26.5 mm SL, Barasu, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 1 Aug. 1993, collected by T. Suzuki and M. Hosokawa; OMNH-P 5566, 1 specimen (female), 27.5 mm SL, collected with OMNH 5565; OMNH-P 5567, 1 specimen (male), 24.5 mm SL, Hinai Beach, Uehara, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 22 Aug. 1994, collected by T. Suzuki and M. Hosokawa; OMNH-P 5568, 1 specimen (male), 30.8 mm SL, north side of Barasu, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 22 Aug. 1994, collected by T. Suzuki and M. Hosokawa; OMNH-P 5569, 1 specimen (female), 31.7 mm SL, collected with OMNH-P 5568; OMNH-P 5570, 1 specimen (female?), 17.9 mm SL, collected with OMNH-P 5568; OMNH-P 5571, 1 specimen (female), 26.7 mm SL, Barasu, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 27 Aug. 1994, collected by T. Suzuki and M. Hosokawa; OMNH-P 5572, 1 specimen (female), 22.8 mm SL, collected with OMNH-P 5571; OMNH-P 5578, 1 specimen (female), 23.9 mm SL, Saneku, Kakeroma-jima Island, Amami Group of Ryukyu Islands, Japan, 7 Aug. 1987, collected by T. Suzuki; OMNH-P 5579, 1 specimen (male), 25.8 mm SL, collected with OMNH-P 5578; OMNH-P 40294, 1 specimen (male), 28.4 mm SL, collected with holotype; YCM-P 45136, 6 specimens (3 males and 3 females), 19.5–20.4 mm SL, Kabira Bay, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 28 Apr. to 7 May 1976.

Non-type specimen. RMNH.PISC.36258, 1 specimen (formerly registered as a part of RMNH 6187), 24.9 mm SL, the East Indies.

Diagnosis. *Gobiodon aoyagii* is the one of species of the genus with many reddish spots/stripes on a yellow-green or sky-blue body. When alive or freshly-collected, it is distinguished from similar reddish-spotted/lined congeners, viz. *G. erythrospilus* and *G. histrio*, by having the following unique coloration: 2 reddish circular spots (rather than linear spots) on pectoral-fin base (vs. reddish markings on pectoral-fin base usually forming vertical bars in *G. erythrospilus* and *G. histrio*, except for small specimens of *G. erythrospilus* with discontinuous bars); reddish spots on ventral surface of head (vs. absent); no reddish crescent-like bar along bases of pectoral-fin rays (vs. present). All reddish spots are largely or entirely faded in alcohol-preserved specimens (Fig. 3A, 3B, 5C, 6C), but *G. aoyagii* can be readily identified by having its unique squamation, i.e., 3–4 rows of weakly ctenoid and/or cycloid scales on caudal peduncle (vs. scales absent or a single row of minute cycloid scales on caudal peduncle in the congeners; see Fig. 3D). Furthermore, *G. aoyagii* also differs from its congeners by having the following combination of characters: a deep, inflected interopercular-isthmus groove (Figs. 3C, 5C); each 4–6 upper and lower unsegmented caudal-fin rays; no distinct dusky spot at dorsoposterior corner of operculum.

Description. The following descriptions of meristic values are based on the type series; data from the holotype have an asterisk, and the frequency of each count in given in the parentheses following the relevant count. Dorsal-fin rays VI-I, 9 (3), VI-I, 10* (33) or VI-I, 11 (2); anal-fin rays I, 8 (2) or I, 9* (38); pectoral-fin rays 19 (14), 20* (42) or 21 (20); pelvic-fin rays I, 5* (76); segmented caudal-fin rays 9 + 8 (38), all rays branched at least in adults; upper unsegmented caudal-fin rays 5 (24) or 6* (13); lower unsegmented caudal-fin rays 4 (6), 5* (26) or 6* (5); P-V 3/II II I I 0/9* (35) or 3/I III I I 0/0 (1); vertebrae 10 + 15 = 25 (1), 10 + 16 = 26* (35) or 10 + 17 = 27 (1); epurals 1* (37); anal-fin pterygiophores anterior to first haemal spine 2* (38).

Head and body deep, ovoid, highly compressed. Dorsal profile of head steep and strongly convex; snout short, its length 119.4–181.1% (161.1% in holotype) of eye diameter. Snout not protruding beyond upper lip. Eye dorsolateral, its diameter 19.4–25.4% (22.6%) of head length; interorbital space narrow, its bony width 27.7–45.2% (37.4%) of eye diameter. Anterior narial opening a short tube at a level of ventral edge of eye, closer to upper jaw than to eye; no fleshy

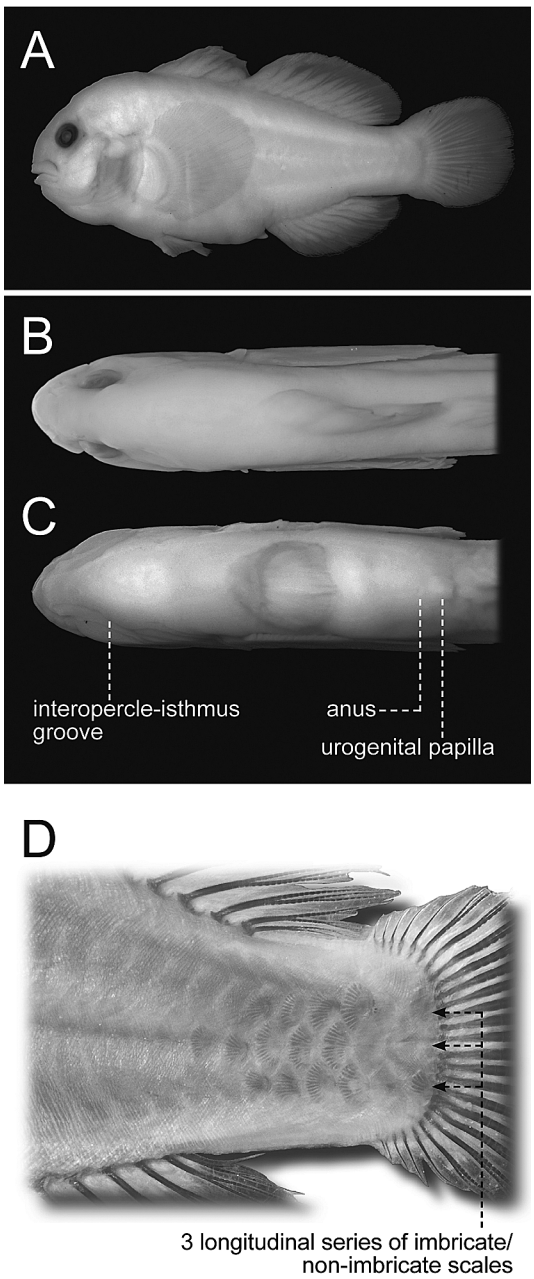


Fig. 3. Lateral (A), dorsal (B) and ventral (C) views of alcohol-preserved holotype of *Gobiodon aoyagii* sp. nov. (NSMT-P 111422), and close-up of the caudal-peduncle area (D) of paratype (OMNH-P 5579) stained with alizarin red.

flap at tip of anterior naris; posterior narial opening a very short tube (much shorter than anterior naris), located at a level of middle of eye or upper margin of pupil. No raised cutaneous ridges on head and nape. Tongue small, rectangular with rounded anterior margin, free from floor of mouth. Gape oblique, forming angle of about 15–30 (15) degrees with body axis. Upper jaw subequal or slightly projecting beyond lower jaw; posterior end of jaws reaching posteriorly to a vertical line between anterior margin and center of pupil. Posteroventral margin of lower lip interrupted at symphysis. No mental flap on chin. Gill opening relatively broad, ending ventrally opposite bases of ventralmost or next pectoral-fin ray; first gill slit well developed. No fleshy projections on lateral wing of shoulder girdle. A distinct, deep, inflected interopercle-isthmus groove on ventral side of head (Figs. 3B, 6C).

All dorsal- and anal-fin spines slender and flexible, but not elongate and filamentous; all segmented rays of dorsal, anal, pectoral, pelvic and caudal fins branched at least in adults; ultimate ray of anal and second dorsal fins split to base. First dorsal fin typically nearly rounded (occasionally rectangular) with convex distal margin; first dorsal fin originating directly over, or slightly before, upper end of pectoral-fin base; third (1 specimen), fourth (14 specimens) or fifth* (12 specimens) spine of first dorsal fin longest; first dorsal fin extending slightly beyond base of first segmented ray of second dorsal fin when adpressed; first dorsal fin slightly lower than second dorsal fin in height; dorsal fins connected via low connecting membrane; a distinct notch between first and second dorsal fin; in second dorsal fin, second (2 specimens), third* (11 specimens), fourth (9 specimens), fifth (4 specimens) or sixth (1 specimen) segmented ray longest; second dorsal fin extending to procurrent rays part of caudal fin when adpressed at least in adult; second dorsal fin subequal to anal fin in height. Anal-fin origin directly below base of first, second or third segmented ray of second dorsal fin; fourth (1 specimen), fifth (5 specimens), sixth* (13 specimens) or seventh (6 speci-

mens) segmented ray longest; anal fin not or barely reaching posteriorly to procurrent-rays part of caudal fin. Pectoral fin elliptical, with no free rays; pectoral fin extending posteriorly beyond a vertical through anus, and reaching to a vertical through base of first, second or third segmented ray of second dorsal fin. Pelvic fins cup-shaped, fused medially with well-developed connecting membrane (between innermost rays) and thick frenum (between spines); origin of pelvic fins at slightly before or behind a vertical through dorsal-fin origin; pelvic fins extending posteriorly to (as in holotype), or slightly beyond, midway between pelvic-fin origin and anus when adpressed. Caudal fin rounded, its length 62.4–82.8% (76.8% in holotype) of head length.

Head and body largely naked, except for imbricate/non-imbricate weak ctenoid or cycloid scales on midlateral body (Fig. 3D), i.e., 3–4 longitudinal, continuous rows of imbricate scales on caudal peduncle, narrowing to a single row and becoming non-imbricate anteriorly; scales extending anteriorly to above pectoral-fin base in some specimens.

Teeth on jaws small, unicuspid and slightly inwardly curved, except for 1–2 (1 in holotype) pairs of enlarged, stout post-symphysial canine-like teeth on lower jaw; teeth on outermost row on jaws conical, distinctly larger than teeth on inner rows, but much smaller than enlarged post-symphysial canine-like teeth; inner teeth on jaws villiform, forming tooth band anteriorly [ca. 2–3 (ca. 3) and 5–6 (ca. 5) irregular rows around upper and lower-jaw symphysises, respectively, except for post-symphysial canine-like teeth on lower jaw], narrowing to 1–2 (1) rows posteriorly; no teeth on vomer and palatine.

Configuration of cephalic sensory-canal pores and sensory papillae were shown by Akihito *et al.* (2000, 2002, as *G*. sp. 2), and not figured again here. Anterior oculoscapular canal with pores B′, C (s), D (s), E, F and H′ and preopercular canal with pores M′, N and O′; right and left sides of anterior oculoscapular canals fused medially in interorbital space; posterior oculoscapular canal not developed. Sensory-papillae rows on head relatively reduced; all cephalic sensory-papillae rows uniserial or comprising a single papilla, not forming multiple lines nor aggregations; row *a* comprising 4 papillae, continuous to row *c*; row *b* comprising 2 papillae at middle of cheek; sensory papillae of row *e* elongate, longer than wide (best confirmed in specimens after removing thick mucus layer); a pair of short longitudinal rows just behind chin (= row *f*).

Color when alive (based on underwater photograph taken by K. Yano in *Okamura and Amaoka, 1997: 615)*. Ground color of head and body greenish yellow, slightly darkened dorsally; numerous scarlet circular spots on head and body, including snout, ventral surface of head and pectoral-fin base; each scarlet spots subequal or smaller than eye, and some of them fused; short vertical scarlet bar below eye; iris bright yellow green, with 2 small scarlet spots dorsoventrally; fins pale greenish yellow, subtranslucent; a series of 3 small circular scarlet spots on anteroventral part of second dorsal fin.

Color when fresh (Figs. 1A, 2A–I). Ground color of head and body bright greenish yellow or sky blue; 3–4 longitudinal, irregular series of circular reddish (scarlet or carmine) spots on body; each reddish spot subequal or smaller than eye, but larger than pupil; minute, weak melanophores encircled the reddish spots; similar melanophores at interspaces of vertically-arranged reddish spots on cheek and pectoral-fin base; ca. 4 vertical rows of reddish spots on head including the ventral surface, some of them fused and forming short vertical bars; 2 reddish rounded spots on pectoral-fin base (indistinct in small specimens, *e.g.*, Fig. 2A, B); an additional smaller reddish spot at base of pectoral-fin rays in some specimens (including holotype); iris silvery or bluish, with a reddish or dusky vertical bar through pupil; fins pale yellow, pale greenish yellow or dull yellow; dorsal, anal and caudal fins narrowly edged by black; a series of small reddish spots on first and/or second dorsal fins in some specimens, and additional series of reddish dots at middle of second dorsal fin in one specimen (Fig. 2G); a narrow bright blue or pale green cres-

cent-like mark around bases of pectoral-fin rays.

Color in alcohol (Figs. 3A–C, 4C, 5C). Ground color of head and body pale yellow; iris dark gray; all reddish markings faded, but trace of the patterns confirmed based on weak melanophores encircling the patterns; these melanophores relatively vivid on head and pectoral-fin base, but not so on body (best seen after removing the thick mucus layer); fins pale, subtranslucent; second dorsal, anal and caudal fins narrowly edged by black distally. In an old specimen examined (i.e., the Bleeker's specimen, RMNH.PISC.36255, Figs. 5C, 6C), head and body beige, and melanophores entirely faded.

Sexual dimorphism. Urogenital papilla narrowed distally and nearly triangular in male, broader and nearly rectangular in female.

Distribution and habitats. Specimens of *Gobiodon aoyagii* examined here were collected from Japan (Ryukyu Islands), the Philippines (Cebu), Australia (Queensland), and one specimen (one of the syntypes of *Gobiodon erythrospilus*) from the East Indies (Cocos Islands or Indonesia). *Gobiodon aoyagii* has been recorded also from Papua New Guinea and the Great Barrier Reef [Munday *et al.*, 1999, 2004 (as *Gobiodon* sp. A); Allen and Erdmann, 2012 (as *G. erythrospilus*)]. E.O. Murdy (in litt.) showed us an underwater photograph of *G. aoyagii* from Cebu, Philippines. Senou *et al.* (2004) reported this species is found in the interstices among branches of corals of the genus *Acropora* in the protected bays and reef edges and slopes at depths of 3–10 m in Japan. Munday *et al.* (1999) noted that this species was "almost totally confined to *A. tenuis*" in Papua New Guinea and the Great Barrier Reef.

Etymology. The new species is named after the late Hyoji Aoyagi (1912–1971), a Japanese ichthyologist who first provided accounts of this species from Japan (as *Gobiodon rivulatus*) with an excellent illustration (see "Remarks" below).

Remarks. As far as we know, the first illustration of *Gobiodon aoyagii* was provided by Aoyagi (1943), as *G. rivulatus*, on the basis of a single specimen (23.7 mm SL) from the Itoman of Okinawa-Honto (= Okinawa-jima Island, Okinawa Group of Ryukyu Islands). Although the voucher specimen was not found in Aoyagi's fish collection (now housed in YCM; see Hayashi, 1995), the illustration, drawn by the Japanese artist Mitsuo Shirao, clearly shows that the specimen has 2 and 1 rounded reddish-orange spots on the pectoral-fin base and ventral surface of the head below the operclum, respectively, the characteristic color pattern of *G. aoyagii*.

Gobiodon aoyagii has been confused with *G. erythrospilus*, *G. histrio* or *G. rivulatus* as shown in the synonym list, but recognized as a distinct species by Suzuki *et al.* (1995) and subsequent researchers (Munday *et al.*, 1999, 2004; Harold *et al.*, 2008). *Gobiodon rivulatus* is readily distinguished from *G. aoyagii* by having numerous thin irregular blue lines on head and body and lacking an interopercle-isthmus groove and scales (Winterbottom and Emery, 1986; Herler and Hilgers, 2005).

Previous confusion in the taxonomy of sympatric reddish-spotted *Gobiodon* species has sometimes led to misidentification and a mixture of congeners in museum collections. For example, a single specimen of *G. aoyagii* (now registered as RMNH.PISC.36258) was mixed with the syntypes of *G. erythrospilus* (see "Remarks" of *G. erythrospilus*, below).

***Gobiodon erythrospilus* Bleeker, 1875**

(Japanese name: Shuobi-koban-haze)

(Figs. 1B, 2J–R 4, 4A, 5A; Table 1)

Gobiodon erythrospilus Bleeker, 1875: 122 (part; Batu, Cocos, Sumbawa, Solor, Timor, Celebes, Buro and Goram); Bleeker, 1983, pl. 431, fig. 5; Suzuki *et al.*, 1995: 4, figs. 7–10 (Ryukyu Islands, Japan); Akihito *et al.*, 2000: 1188 (Miyako and Yaeyama groups of Ryukyu Islands, Japan), 2002: 1188 (Miyako and Yaeyama groups of Ryukyu Islands, Japan), 2013: 1419 (Okinawa, Miyako and Yaeyama groups of Ryukyu Islands, Japan); Munday *et al.*, 2004: 1499, fig. 1E (Papua New Guinea).

Gobiodon verticalis (non Alleyne and Macleay): McCulloch and Ogilby, 1919, pl. 32, fig. 2 (part; see "Remarks").

Gobius douglasi Saville-Kent, 1893: 310, pl. 16, fig. 12

(Queensland, Australia).

Gobiodon rivulatus rivulatus (non Rüppell): Sawada and Arai, 1973: 595, figs. 20–24 (part; Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan); Hayashi and Itoh, 1978: 71, pl. 14, fig. 36 (part; Kabira Bay, Ishigaki-jima Island, Japan); Yoshino and Yamamoto *in* Akihito *et al.*, 1984: 255, pl. 246, figs. O and P (Ryukyu Islands, Japan).

Gobiodon rivulatus (non Rüppell): Akihito *et al.*, 1993: 1032 (Ryukyu Islands, Japan).

Gobiodon histrio (non Valenciennes): Munday *et al.*, 1999: 55, fig. 6 (part, as "*Gobiodon histrio* erythrospilus form"; Papua New Guinea and Great Barrier Reef); Hoese and Larson, 2006: 1656 (part; Northern Territory, Queensland, Western Australia and Shark Bay region, Australia).

Lectotype. RMNH.PISC.6187, 29.2 mm SL, the East Indies.

Paralectotypes. RMNH.PISC.36256, 24 specimens (formerly registered as a part of RMNH 6187), 19.9–34.3 mm SL, the East Indies.

Other materials. Total 49 specimens, 15.7–28.7 mm SL: NSMT-P 17663, 24 specimens (11 males, 12 females and 1 sex-indeterminable), 19.0–29.9 mm SL, Kabira, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 18–23 Mar. 1972; NSMT-P 22895, 1 specimen (male), 26.7 mm SL, off Sapuk, east coast of Moen, 0.5 m depth, 3 July 1982; NSMT-P 55332, 1 specimen (male), 25.7 mm SL, Kuro-shima Island, Yaeyama Group of Ryukyu Islands, Japan, 8 m depth, 28 June 1998, collected by M. Mitsuhashi; NSMT-P 111435, 3 specimens, 15.4–28.7 mm SL, off northwestern coast of Jokaj Island, Ponape, 0.5 m depth, 19 July 1982; NSMT-P 111436, 2 specimens, 20.0–20.8 mm SL, west side of Caroline Island, Majuro Atoll, 3 m depth, 14 Aug; 111437, 1 specimen (male), 18.3 mm SL, Hoshizuna-no-hama Beach, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 28 Aug. 1995, collected by T. Suzuki and M. Hosokawa; NSMT-P 111438, 1 specimen (female), 16.9 mm SL, collected with NSMT-P 111437; NSMT-P 111439, 1 specimen (male), 27.3 mm SL, Barasu, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, 8 Aug. 1996, collected by T. Suzuki and M. Hosokawa; NSMT-P 111440, 1 specimen (male), 27.9 mm SL, Hoshizuna-no-hama Beach, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 9 Aug. 2001, collected by T. Suzuki and M. Hosokawa; NSMT-P 111441, 1 specimen (female), 23.1 mm SL, collected with NSMT-P 111440; NSMT-P 111442, 1 specimen (male), 22.2 mm SL, Nakano, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 22 Aug. 2002, collected by T. Suzuki and M. Hosokawa; OMNH-P 4150, 1 specimen (male), 22.1 mm SL, Shimoji-shima Island, Miyako Group of Ryukyu Islands, Japan, 10 Feb. 1993, collected by T. Suzuki and M. Hosokawa; OMNH-P 4151, 1 specimen (female), 22.2 mm SL, collected with OMNH-P 4150; OMNH 4223, 1 specimen (male), 25.9 mm SL, Higashi-hennazaki Point, Miyako-jima Island, Miyako Group of Ryukyu Islands, Japan, 12 Feb. 1993, collected by T. Suzuki and M. Hosokawa; OMNH-P 4224, 2 specimens (male and female), 22.5–23.0 mm SL, collected with OMNH-P 4223; OMNH-P 5573, 1 specimen (male), 18.8 mm SL, Barasu, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 27 Aug. 1994, collected by T. Suzuki and M. Hosokawa; OMNH-P 5574, 1 specimen (female), 17.8 mm SL, collected with OMNH-P 5573; OMNH-P 5575, 1 specimen (female), 20.6 mm SL, Hoshizuna-no-hama Beach, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 25 Feb. 1994, collected by T. Suzuki and M. Hosokawa; YCM-P 2742, 1 specimen (male), 25.2 mm SL, Kabira Bay, Ishigaki-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 28 Apr. to 7 May 2976; YCM-P 45137, 3 specimens (females), 21.4–28.1 mm SL, collected with YCM-P 2742.

Diagnosis. *Gobiodon erythrospilus* is the one of species of the genus with many reddish spots/stripes on a yellow-green or sky-blue body. When alive or freshly-collected, this species can be distinguished from similar reddish-spotted/lined congeners, viz. *G. aoyagii* and *G. histrio*, by having the following unique combination of details in color: 5–6 (usually 5) vertical reddish bars on head and pectoral-fin base; the bars on cheek and operculum relatively short, usually not

or barely extending dorsally beyond a level of dorsal margin of eye; 3–8 longitudinal series of rounded or longitudinally elongate scarlet/reddish spots on body, sometimes continuous and forming longitudinal stripes; dorsal, anal and caudal fins pale yellow with very narrow black distal margins; no black spot at dorsoposterior corner of operculum. All reddish spots are largely or entirely faded in alcohol-preserved specimens (Figs. 5A and 6A), but *G. erythrospilus* can be distinguished from congeners by having the following combination of characters: a deep, inflected interopercle-isthmus groove (Fig. 6A); a series of minute non-imbricate cycloid scales on midlateral body; 6–7 upper or lower unsegmented caudal-fin rays; no distinct dusky spot at dorsoposterior corner of operculum.

Description. The following descriptions of meristic values are based on the lectotype and 24 paralectotypes (designated here); data from the lectotype followed an asterisk, and the frequency of each count in given in the parentheses following relevant count. Dorsal-fin rays VI-I, 10* (24) or VI-I, 11 (1); anal-fin rays I, 8 (4), I, 9* (20) or I, 10 (1); pectoral-fin rays 18 (3), 19 (18), 20* (23) or 21 (6); pelvic-fin rays I, 5* (50); segmented caudal-fin rays 9 + 8* (25), all rays branched except for uppermost and/or lower most ray occasionally unbranched; upper unsegmented caudal-fin rays 6 (9), 7* (16); lower unsegmented caudal-fin rays 6* (19) or 7 (6); P-V 3/II II I I 0/9* (22) or 3/II II I 0 I/9 (1); vertebrae 10 + 16 = 26* (25); epurals 1* (25); anal-fin pterygiophores anterior to first haemal spine 2* (25).

Head and body deep, ovoid, highly compressed. Dorsal profile of head steep and strongly convex; snout short, its length 115.9–159.4% (130.0% in lectotype) of eye diameter. Snout not protruding beyond upper lip. Eye dorsolateral, its diameter 20.3–25.8% (23.4%) of head length; interorbital space narrow, its bony width 32.6–53.2% (40.1%) of eye diameter. Anterior narial opening a short tube at a level of ventral edge of eye, closer to upper jaw than to eye; no fleshy flap at tip of anterior naris; posterior narial opening a very short tube (much shorter than anterior naris), located at a level of middle of eye or upper margin of pupil. No raised cutaneous ridges on head and nape. Tongue small, rectangular with rounded anterior margin, free from floor of mouth. Gape oblique, forming angle of about 20–40 (35) degrees with body axis. Upper jaw subequal or slightly projecting beyond lower jaw; posterior end of jaws reaching posteriorly to a vertical line between anterior margin and center of pupil. Posteroventral margin of lower lip interrupted at symphysis. No mental flap on chin. Gill opening relatively broad, ending ventrally opposite bases of ventralmost or next pectoral-fin ray; first gill slit well developed. No fleshy projections on lateral wing of shoulder girdle. A distinct, deep inflected interopercle-isthmus groove on ventral side of head (Fig. 5A).

All dorsal- and anal-fin spines slender and flexible, but not elongate and filamentous; all segmented rays of dorsal, anal, pectoral, pelvic and caudal fins branched at least in adult; ultimate ray of anal and second dorsal fins split to base. First dorsal fin nearly rounded or rectangular with slightly or deeply convex distal margin; first dorsal fin originating directly over upper end of pectoral-fin base; second* (1 specimen), third (1 specimen), fourth (5 specimens) or fifth (3 specimens) spine of first dorsal fin longest; first dorsal fin extending slightly beyond base of first segmented ray of second dorsal fin when adpressed; first dorsal fin subequal to or slightly lower than second dorsal fin in height; dorsal fins continuous via low connecting membrane, with a distinct notch between first and second dorsal fin; in second dorsal fin, fourth (3 specimens) or fifth (2 specimens) segmented ray longest; second dorsal fin extending to procurrent-rays part of caudal fin when adpressed at least in adult; second dorsal fin subequal or slightly lower than anal fin in height. Anal fin origin directly below base of first, second or third segmented ray of second dorsal fin; third (1 specimen), 4th (1 specimen), fifth (1 specimen), sixth* (3 specimens) or seventh (1 specimen) segmented ray longest; anal fin not or barely reaching posteri-

orly to procurrent-rays part of caudal fin. Pectoral fin elliptical, with no free rays; pectoral fin extending posteriorly beyond a vertical through anus, and reaching to a vertical through base of first, second or third segmented ray of second dorsal fin. Pelvic fins cup-shaped, fused medially with well-developed connecting membrane (between innermost rays) and thick frenum (between spines); origin of pelvic fins directly below base of first, second, third or fourth spine of first dorsal fin; pelvic fins extending posteriorly to, or slightly before or beyond, midway between pelvic-fin origin and anus (but not to anus) when adpressed. Caudal fin damaged in all type specimens; in the non-type specimens, caudal fin rounded, its length 75.0–89.7% (distal part of caudal fin damaged in lectotype) of head length.

Head and body largely naked, except for a longitudinal series of ca. 13–23 (most frequently 17 or 18; 23 in lectotype) minute non-imbricate scales on midlateral body (at least on the tail); in some specimens (including the lectotype), the scale row extending anteriorly to humeral area above pectoral-fin base.

Teeth on jaws small, unicuspid and slightly inwardly curved, except for 1–2 (1 in lectotype) pairs of enlarged, stout post-symphysial canine-like teeth on lower jaw; teeth on outermost row on jaws conical, distinctly larger than teeth on inner rows, but much smaller than enlarged post-symphysial canine-like teeth; inner teeth on jaws villiform, forming tooth band anteriorly [ca. 2–3 (ca. 3) and 5–6 (ca. 6) irregular rows around upper and lower-jaw symphysises, respectively, except for post-symphysial canine-like teeth on lower jaw], narrowing to 1–2 (1) rows posteriorly; no teeth on vomer and palatine.

Configuration of cephalic sensory-canal pores and sensory papillae were illustrated by Akihito *et al.* (2000, 2002), and are not figured again here. Anterior oculoscapular canal with pores B′, C (s), D (s), E, F and H′ and preopercular canal with pores M′, N and O′; right and left sides of anterior oculoscapular canals fused medially in interorbital space; posterior oculoscapular canal not developed. Sensory-papillae rows on head relatively reduced; all cephalic sensory-papillae rows uniserial or comprising a single papilla, not forming multiple lines nor aggregations; row *a* comprising 4 papillae, continuous to row *c*; row *b* comprising 2 papillae at middle of cheek; sensory papillae of row *e* elongate, longer than wide (best confirmed in specimens after removing thick mucus layer); a pair of short longitudinal rows just behind chin (= row *f*).

Color when alive (based on underwater photograph taken by P. Munday in *Munday et al., 1999: 55)*. Ground color of head and body dull grayish yellow green, slightly darkened dorsally; numerous scarlet circular spots on body and dorsum of head; each scarlet spots subequal or smaller than pupil; 5 vertical scarlet bars on head and pectoral-fin base, all of these bars extending dorsally to a level of middle of eye; interspaces of these bars sky blue; fins bright or dull yellow.

Color when fresh (Fig. 1B, 2J–R). Ground color of head and body bright greenish yellow or sky blue; 3–8 longitudinal, irregular series of longitudinally-elongate reddish (scarlet or carmine) spots on body; these reddish spots frequently continuous, and forming longitudinal stripes; 5–6 reddish vertical bars on head and pectoral-fin base, posteriormost of them along bases of pectoral-fin rays; reddish bar at middle of pectoral-fin base indistinct and/or discontinuous in small specimens (*e.g.*, Fig. 4B and 4D); minute, weak melanophores encircling the reddish spots/stripes on body; patches of dense weak melanophores overlapping vertical reddish bars on head and pectoral-fin base; iris silvery or bluish, with a reddish or dusky vertical bar through pupil; fins pale yellow, pale greenish yellow or dull yellow; dorsal, anal and caudal fins narrowly edged by black; no reddish spots on fins in some specimens.

Color in alcohol (e.g., Figs. 4A, 5A). Ground color of head and body pale yellow or pale brown; iris silvery gray or black; all reddish markings faded, but trace of the patterns confirmed based on weak melanophores encircling the patterns (on body) or patches of dense weak

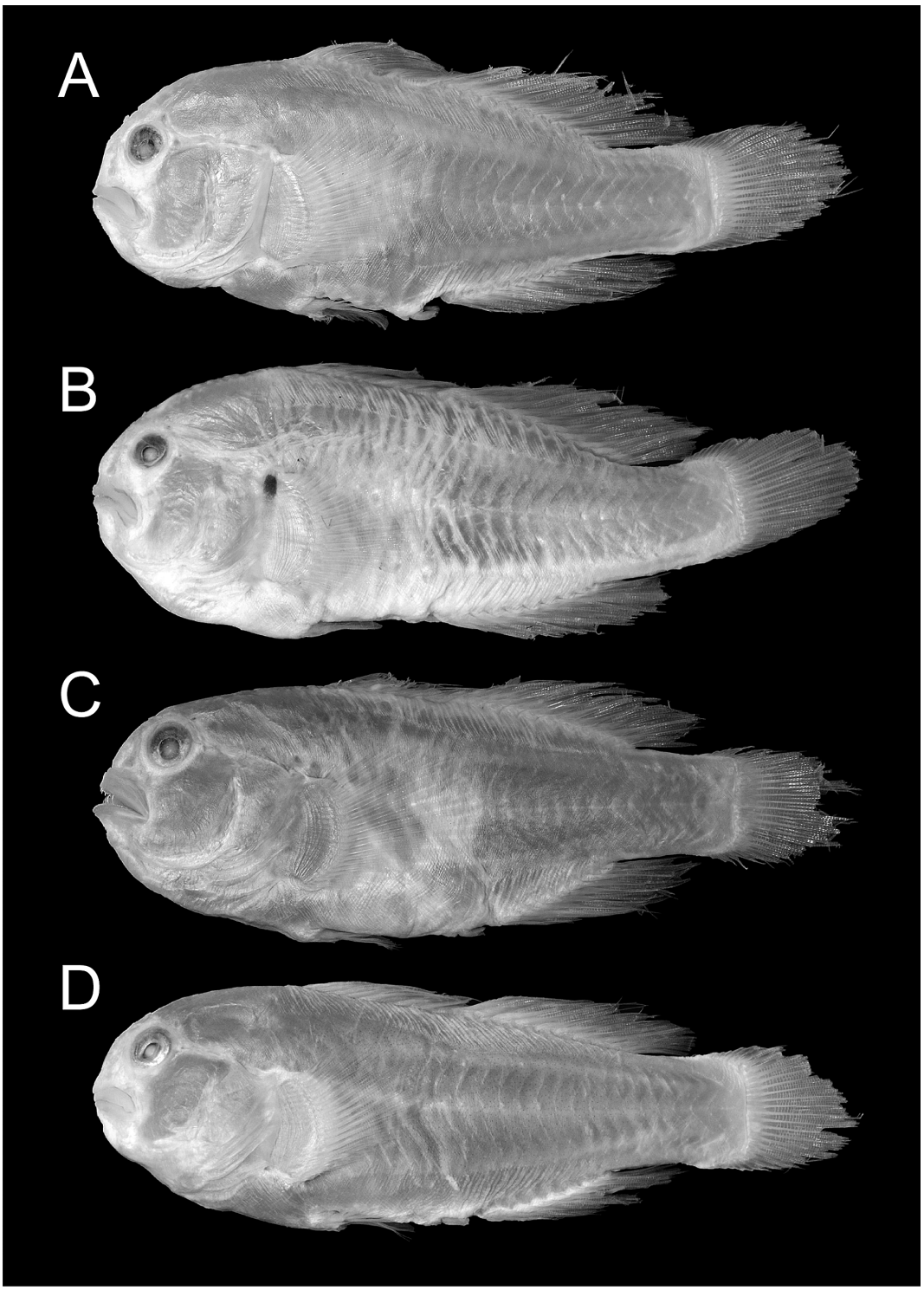


Fig. 4. Lateral views of 4 species found in the syntypic series of *Gobiodon erythrospilus*. — A) Species A (= *G. erythrospilus*), RMNH.PISC.6187 (lectotype of *G. erythrospilus*); B) species B (= *G. histrio*), one of RMNH. PISC.36257; C) species C (= *G. aoyagii*), RMNH.PISC.36258; D) species D (= *G.* sp.), one of RMNH. PISC.36259.

melanophores (on head and pectoral-fin base) in recently collected specimens (i.e., non-type specimens examined, collected since 1970's); in old specimens (i.e., the Bleeker specimens, RMNH. PISC.6187 and RMNH.PISC.36256, Figs. 5A, 6A), these melanophores barely visible on head and/or pectoral-fin base, or entirely faded; fins pale, subtranslucent, tinged narrowly dusky at distal edges. In the lectorype, melanophores remain only on pectoral-fin base, and form 2 quite faint vertical bars.

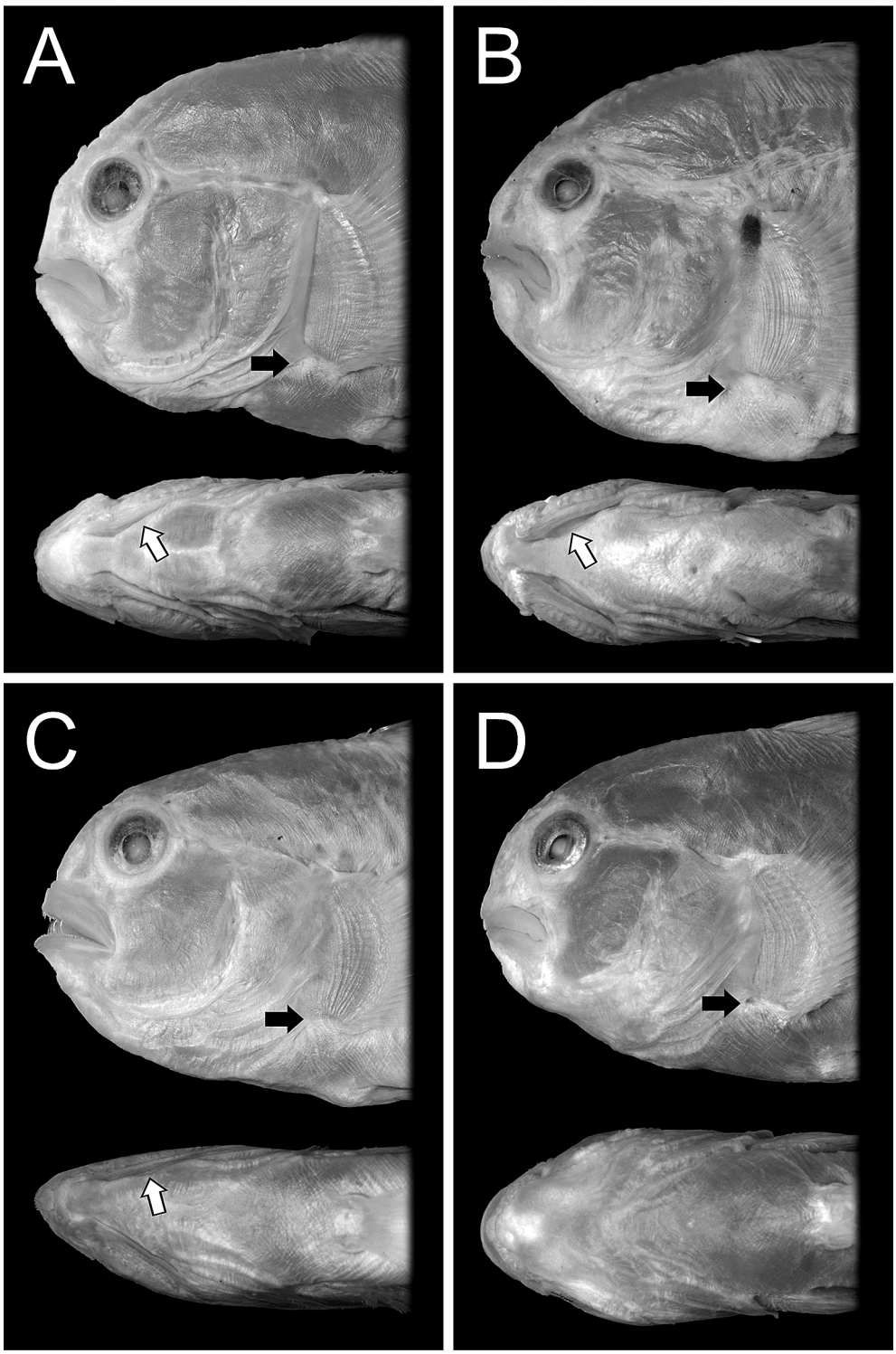
Sexual dimorphism. Urogenital papilla more narrowed distally and nearly triangular in male, broader and nearly rectangular in female.

Distribution and habitat. Bleeker's (1875) specimens of *Gobiodon erythrospilus* were collected from the Dutch East Indies, including Cocos Islands and Indonesia. The other specimens examined here were obtained from the Ryukyu Islands of Japan and Ponape. In addition, many specimens of *G. erythrospilus* from Queensland and Northern Territory of Australia were examined by the first author at the Australian Museum, Sydney, although not included these in the materials examined (above) since KS merely identified them; these specimens are as follows (number of specimens in each lot is in parenthesis): AMS IA. 3061 (2), IB. 487 (1), 488 (1), IB. 5115 (1), I. 19472-093 (1), I. 19473-159 (1), I. 20673-001 (2), I. 20762-060 (1), I. 20766-008 (5), I. 20770 (4), I. 20793-080 (4), I. 20937-006 (1), I. 21540-009 (2), I. 22221-001 (1), I. 22225-001 (1), I. 25119-001 (1). *Gobiodon erythrospilus* appears to be broadly distributed in the West Pacific, but, due to taxonomic confusion, the exact records are difficult to determine, except for the records from Papua New Guinea and the Great Barrier Reef by Munday *et al.* [1999 (as *G. histrio* erythrospilus form), 2004]. Akihito *et al.* (2000, 2002) noted that this species is found among "the branches of table-like corals of the Acroporidae" in Japan. Munday *et al.* (1999) reported this species "usually inhabit *Acropora nasuta* but also found in *A. valida*, *A. millepora* (coarse branched form) and sometimes *A. tenuis*" in Papua New Guinea and the Great Barrier Reef.

Remarks. As noted above, *Gobiodon erythrospilus* as herein re-defined is similar to *G. aoyagii* and *G. histrio* in having reddish spots/stripes on yellow-green or sky-blue head and body. Another congener *G. axillaris* also has a series of reddish spots on dorsum of body [see photos/illustrations in Akihito *et al.*, 1984, 1993, 2000, 2002 (all as *G. atrangulatus*); Masuda and Kobayashi, 1994 (as *G. atrangulatus*); Munday *et al.*, 1999; Senou *et al.*, 2004 (as *G. atrangulatus*); Randall, 2005], but lacks the interopercle-isthmus groove (vs. present in *G. aoyagii*, *G. erythrospilus* and *G. histrio*). Munday *et al.* (1999, 2004) reported an additional reddish-striped species from the Papua New Guinea as "*Gobiodon* sp. B", but, according to Munday *et al.* (1999, 2004), the species can be readily distinguished from the other 3 reddish-spotted/striped congeners, viz. *G. aoyagii*, *G. erythrospilus* and *G. histrio*, by having uninterrupted fine reddish longitudinal stripes and a recurved lower jaw with a dentigerous pad anterior to dentary symphysis (like *G. brochus*; see also and Harold and Winterbottom, 1999 and Harold *et al.*, 2008). The species, *G.* sp. B of Munday *et al.* (1999, 2004) remains undescribed, and is not considered below.

Due to their similar appearances, the taxonomy of *G. aoyagii*, *G. erythrospilus* and *G. histrio* was confused until recently. Suzuki *et al.* (1995), Munday *et al.* (2004) and Harold *et al.* (2008) hypothesized that these 3 species were non-conspecific, but studies on the nominal spe-

Fig. 5. Lateral (top) and ventral (bottom) views of heads of 4 species found in the syntypic series of *Gobiodon erythrospilus*. — A) Species A (= *G. erythrospilus*), RMNH.PISC.6187 (lectotype of *G. erythrospilus*); B) species B (= *G. histrio*), one of RMNH.PISC.36257; C) species C (= *G. aoyagii*), RMNH.PISC.36258; D) species D (= *G.* sp.), one of RMNH.PISC.36259. Solid and open arrows show the position of ventral end of gill opening and interopercle-isthmus groove, respectively.


A
B
C
D

cies and respective type series were not yet completed. In addition to *G. aoyagii*, *G. erythrospilus* and *G. histrio*, the taxonomic status of following 2 nominal species, regarded as junior synonyms of *G. histrio* by Hoese and Larson (2006), should be clarified: *Gobiodon verticalis* Alleyne and Macleay, 1877 and *Gobius douglasi* Saville-Kent, 1893. These 5 nominal species are investigated in detail below.

Gobiodon histrio is the oldest name amongst these 5 nominal species. According to Valenciennes *in* Cuvier and Valenciennes (1837), the species has a beautiful dawn-colored body, darker dorsally, with series of dark blue spots, stripes and irregular lines; these series are vertical on head, longitudinal on body, and 2 of these lines are on the pectoral-fin base. We presume that he regarded interspaces between reddish markings as dark-blue spots, stripes and lines. If so, regarding the illustration given by Valenciennes, the dawn-colored (reddish) bars on cheek and operculum extend dorsally to well beyond eye level, a character that agrees only with *G. histrio* of Suzuki *et al.* (1999) and Munday *et al.* (2004) (Fig. 1C). Unfortunately the characteristic black spot at the dorsoposterior corner of the operculum was not mentioned in the original description nor shown in the illustration, but the faint spot was examined on the syntypes (MNHN 3098) by D. F. Hoese (personal communication). *Gobiodon histrio* will be redescribed by D. F. Hoese and us.

Bleeker (1875) described *G. erythrospilus* based on 86 specimens from various localities of the Dutch East Indies, including "Batu; Cocos (Nova-selma); Sumbawa (Bima); Solor (Lawajong); Timor; Celebes (Kema); Buro (Kajeli); Goram." He stated that *G. erythrospilus* has: yellow or orange fins; 5 vertical reddish bars on head and pectoral-fin base; about 7 longitudinal series of reddish spots on body; and vertical fins lightly margined by violet. The color pattern was very evident in an illustration of *G. erythrospilus* in Bleeker (1983), and, regarding the illustration, the figured specimen has relatively short reddish bars (not or barely extending dorsally beyond a horizontal line with the dorsal margin of the eye) on the cheek and operculum. Amongst the known species of *Gobiodon*, a color pattern similar to that described by Bleeker (1875, 1983) is seen only in *G. erythrospilus* of Suzuki *et al.* (1995) and Munday *et al.* (2004). *Gobiodon histrio* has a similar color pattern to *G. erythrospilus*, but has darker fins, longer vertical reddish bars on cheek and operculum, and reddish spots that form longitudinal irregular stripes on the body. *Gobiodon histrio* also has a conspicuous black spot at the dorsal corner of the gill membrane that does not appear in Bleeker's illustration of *G. erythrospilus*. *Gobiodon aoyagii* has the reddish marking at pectoral-fin base divided into two rounded spots (rather than vertical bars as in Bleeker's original description and illustration of *G. erythrospilus*).

In his key to the Indo–Australian species of *Gobiodon*, Koumans (1953: 6) placed *G. erythrospilus* in a group with "No stripes longitudinally on body," and separated it from *G. histrio* having "Body with longitudinal blue bands and spots." The shape of the markings on the body varies in *G. erythrospilus* of Suzuki *et al.* (1995) and Munday *et al.* (2004) (see Fig. 4); some individuals have 3 or more rows of reddish spots [as in the Bleeker's (1983) illustration], some have 3 or more longitudinal stripes, and the others have an intermediate condition.

Of the original 86 Bleeker specimens (the original syntypes) of *G. erythrospilus*, 75 specimens are known to still exist in the Naturalis, Leiden. These syntypes comprise more than a single species. After identification by D. F. Hoese (AMS) in 1976, these specimens were divided into following 4 registration lots (R. de Ruiter, in litt.): RMNH.PISC.6187 (or RMNH 6187), 45 specimens, *G. erythrospilus*; RMNH.PISC.28676, 1 specimen, *Paragobiodon* cf. *xanthosoma* (Bleeker, 1853); RMNH.PISC.28677, 2 specimens, *Gobiodon* sp.; RMNH.PISC.28678, 27 specimens, *Gobiodon* sp.

All 45 specimens of RMNH.PISC.6187 were examined by us. These specimens share: dorsal-fin rays VI-I, 10–11 (most frequently VI-I, 10); anal-fin rays I, 8–10 (most frequently I, 8 or I, 9);

pectoral-fin rays 18–21; all dorsal-fin spines not elongate nor prolonged; relatively wide gill opening, extending ventrally to a horizontal point equivalent to the base of the lowermost or penultimate pectoral-fin ray; and 1–2 pairs of postsymphysial canine teeth. Our examination of these specimens, however, revealed that these contain 4 morphotypes (Figs. 5 and 6), each considered here as a distinct species. These 4 species are compared in Table 2.

Of these 4 species (viz., species A–D, see Table 2), species A is presumed to be identical with *G. erythrospilus* of Suzuki *et al.* (1995) and Munday *et al.* (2004), which agrees well with the Bleeker's *G. erythrospilus* (see above). We thus identify species A as *G. erythrospilus*. Species B and C can be identified as *G. histrio* and *G. aoyagii*, respectively. Although every trace of the reddish markings on head and body is almost entirely faded, species A–C can be separated from other congeners bearing the interopercle-isthmus groove, viz. *G. brochus*, *G. flavus*, *G. fulvus*, *G. micropus* and *G. unicolor*, by having inflected interopercle-isthmus groove (vs. nearly straight in the latter five species), 10–11 branched dorsal-fin rays (vs. 12–13 in *G. micropus*), broader gill opening, extending ventrally to a horizontal point equivalent to the base of the lowermost or penultimate pectoral-fin ray (vs. more restricted, extending ventrally to a horizontal point equivalent to the bases of the thirteenth to fifteenth pectoral-fin rays in *G. fulvus*), and scales present at least on midlateral caudal peduncle (vs. body naked in *G. brochus*, *G. fulvus*, *G. micropus* and *G. unicolor*) (Winterbottom and Emery, 1986; Harold and Winterbottom, 1999; D. F. Hoese, personal communication). Note that we tentatively follow Winterbottom and Emery (1986) for identification of *G. fulvus*, *G. microps* and *G. unicolor*. The remaining species, species D, could not be associated with a described species, as these 2 specimens lack sufficient informative characteristics. Species D does not have an interopercle-isthmus groove, and its barely-visible, dense minute melanophores on the trunk and tail suggest that it may be one of the species with a darkened body and paler head (*e.g.*, *G. quinquestrigatus* and *G. oculolineatus*).

In order to confirm the species identity, a lectotype of *G. erythrospilus* is designated here. Although the ICZN (1999: Article 74.7, Recommendation 74B) recommends that an illustrated specimen should be designated as lectotype, we could not identify the illustrated specimen of Bleeker (1983) from the syntypic series. We, therefore, selected as lectotype a specimen that was in good condition (Figs. 5A, 6A), and was

Table 2. Comparisons of 4 species found in the syntypes of *Gobiodon erythrispilus* [formerly registered as RMNH.PISC.6187 (or RMNH 6187)].

	Species A	Species B	Species C	Species D
	25 specimens 19.9–34.3 mm SL	17 specimens 22.8–37.9 mm SL	1 specimen 24.9 mm SL	2 specimens 24.3–29.6 mm SL
Interopercle-isthmus groove	well developed, deep	well developed, deep	well developed, deep	undeveloped
Scales on body	a longitudinal series of minute non-imbricate scales	a longitudinal series of minute non-imbricate scales	3 longitudinal series of relatively large imbricate/ non-imbricate scales	absent
dusky spot at dorsoposterior corner of operculum	absent or, if melanophores present at the position, fainter than the other patches of melanophores	present, usually conspicuous	absent	absent
Present identification	*Gobiodon erythrospilus*	*Gobiodon histrio*	*Gobiodon aoyagii*	*Gobiodon* sp. (unidentifiable)
Current registration number	RMNH.PISC.6187 (lectotype) and RMNH.PISC.36256 (paralectotypes)	RMNH.PISC.36257	RMNH.PISC.36258	RMNH.PISC.36259

similar to Bleeker's illustration. The remaining specimens of species A become paralectotypes.

The other 2 nominal species of *Gobiodon*, *G. douglasi* and *G. verticalis*, were considered as junior synonyms of *G. histrio* by Hoese and Larson (2006), who also regarded *G. erythrospilus* as a junior synonym of *G. histrio*. Of these, as done by Hoese and Larson (2006), *G. verticalis* is regarded here as a junior synonym of *G. histrio*, since six syntypes of *G. verticalis* have a dark spot at dorsoposterior corner of operculum and inflected interopercle-isthmus groove. McCulloch and Ogilby (1919) examined "six cotypes" of *G. verticalis*, and described, "five broad darker cross-bars on the head and pectoral base" and "opercular lobe with or without a dark spot". They also provided an illustration of a well-preserved specimen of *G. histrio* from Green Island off Cairns (McCulloch and Ogilby, 1919, pl. 32, fig. 2) but the illustrated specimen can be identified as *G. erythrospilus* (rather than *G. histrio*) by its relatively shorter dusky bars on cheek and operculum not reaching to, or slightly beyond, a level of upper margin of eye; vertical bars on pectoral-fin base, numerous traces of ovoid or rounded spots on body; and no distinct black spot at dorsoposterior corner of operculum. It suggests that at least two species (viz., *G. histrio* and *G. erythrospilus*) were contained in McCulloch and Ogilby's (1919) *G. verticalis*.

No type specimens are known for *G. douglasi*, but the original illustration in Saville-Kent (1893, pl. 16, fig. 12) shows a greenish body with numerous red spots, 6 vertical bars on the head and pectoral-fin base (those on the cheek and operculum not reaching dorsally to the mid-eye level) and yellowish fins. All of these characters agree well with those of *G. erythrospilus* redescribed here, and, thus, we consider *G. douglasi* to be a junior synonym of *G. erythrospilus*.

Comparative materials. Gobiodon histrio (31 specimens, 14.3–37.9 mm SL): AMS I. 16392-001, 6 specimens (syntypes of *Gobiodon verticalis*, 3 males and 3 females), 30.3–35.3 mm SL, Endeavour River, Darnley Island, Torres Straits, Queensland, 1875, collected by Chevert Expedition; NSMT-P 58764, 1 specimen, 33.1 mm SL, Samet Island, Thailand, 26 Nov. 1963; NSMT-P 68431, 2 specimens (male and female), 25.0–26.3 mm SL, south of Mot Island, Nha Trang, Vietnam (12°10′N, 109°14.5′E), 3–4 m depths, 4 Dec. 2003, collected by G. Shinohara; NSMT-P 105833, 2 specimens (males), 26.7–27.7 mm SL, Ao Phrao, Ko Samet, Rayong, Gulf of Thailand, Thailand, 3 m depth, 29 Nov. 1986, collected by Vipoosit; NSMT-P 106208, 1 specimen (male), 28.6 mm SL, collected with NSMT-P 105833; OMNH-P 5576, 1 specimen (male), 22.2 mm SL, Hoshizuna-no-hama Beach, Iriomote-jima Island, Yaeyama Group of Ryukyu Islands, Japan, 25 Aug. 1994; OMNH-P 5577, 1 specimen (female), 14.3 mm SL, collected with OMNH-P 5576; RMNH.PISC.36257, 17 specimens (formerly registered as a part of RMNH 6187), 22.8–37.9 mm SL, the Dutch East Indies. *Gobiodon rivulatus* (1 specimen, 23.8 mm SL): SMF 586, one of seven syntypes of *Gobius rivulatus* (female), 23.8 mm SL, Djubal, Red Sea, E. Rüppell, 1828. *Gobiodon* sp. (2 unidentifiable specimens, 24.3–29.6 mm SL): RMNH.PISC. 36259, 2 specimens (a part of syntypes of *Gobiodon erythrospilus*, previously registered as RMNH 6187), 24.3–29.6 mm SL, the East Indies.

Acknowledgments

We express our sincere thanks to the following persons and institutions for specimen loans and/or registrations and assistance during the visit to their institutions: M. McGrouther and D. F. Hoese (AMS); K. Matsuura, G. Shinohara and E. Katayama (NSMT); K. Hatooka (OMNH); M. J. P. van Oijen and R. de Ruiter (RMNH); K. Hagiwara (YCM). M. Hosokawa (Kawanishi, Hyogo, Japan) and A. Kawai (Iriomote-jima Island, Ryukyu Islands, Japan) helped in field collection. H. Senou (Kanagawa Prefectural Museum, Kanagawa, Japan), E. O. Murdy (National Science Foundation, U.S.A.), D. F. Hoese and R. de Ruiter kindly supplied useful information, photo-

graphs and/or literatures. D. F. Hoese and E. O. Murdy also read the draft manuscript, and gave helpful comments. H. Kohno and M. Moteki (Tokyo University of Marine Technology and Science, Tokyo) provided working space and facilities for examining specimens when the first author visited at their laboratory.

References

Akihito, Prince, M. Hayashi, T. Yoshino, K. Shimada, H. Senou and T. Yamamoto 1984. Suborder Gobioidei. In Masuda, H., K. Amaoka, C. Araga, T. Uyeno and T. Yoshino (eds.): The Fishes of the Japanese Archipelago. pp. 236–289 (English text) and pls. 235–258 and 353–355. Tokai University Press, Tokyo.

Akihito, A. Iwata, K. Sakamoto and Y. Ikeda 1993. Gobioidei. In Nakabo, T. (ed.): Fishes of Japan with Pictorial Keys to the Species, pp. 997–1087. Tokai University Press, Tokyo.

Akihito, K. Sakamoto, Y. Ikeda and M. Aizawa 2013. Gobioidei. In Nakabo, T. (ed.): Fishes of Japan with Pictorial Keys to the Species, Third Edition, pp. 1347–1608 and 2109–2211. Tokai University Press, Tokyo.

Akihito, K. Sakamoto, Y. Ikeda and K. Sugiyama 2000. Gobioidei. In Nakabo, T. (ed.): Fishes of Japan with Pictorial Keys to the Species, Second Edition, pp. 1139–1310. Tokai University Press, Tokyo.

Akihito, K. Sakamoto, Y. Ikeda and K. Sugiyama 2002. Gobioidei. In Nakabo, T. (ed.): Fishes of Japan with Pictorial Keys to the Species, English Edition, pp. 1139–1310. Tokai University Press, Tokyo.

Allen, G. R. and M. V. Erdmann 2012. Reef fishes of the East Indies. Volume III. Pages 857–1260. Tropical Reef Research, Perth.

Alleyne, H. G. and W. Macleay 1877. The ichthyology of the Chevert expedition. Proceedings of the Linnean Society of New South Wales, 1(3–4): 261–281, 321–359, pls. 3–17.

Aoyagi, H. 1943. Coral fishes. Part 1. Maruzen Co. Ltd, Tokyo. viii + xii + 224 pp., 37 pls.

Bleeker, P. 1853. Nieuwe bijdrage tot de kennis der ichthyologische fauna van Ceram. Natuurkundig Tijdschrift voor Nederlandsch Indië, 3(5): 689–714.

Bleeker, P. 1856. Bijdrage tot de kennis der ichthyologische fauna van het eiland Boeroe. Natuurkundig Tijdschrift voor Nederlandsch Indië, 11: 383–414.

Bleeker, P. 1872. Mémoire sur la faune ichthyologique de Chine. Nederlandsch Tijdschrift voor de Dierkunde, 4: 113–154.

Bleeker, P. 1875. Gobioideorum species insulindicae novae. Archives néerlandaises des sciences exactes et naturelles, 10: 113–134.

Bleeker, P. 1983. Atlas ichthyologique des Indes Orientales Néêrlandaises, publié sous les auspices du Gouvernement colonial néêrlandais, par M. P. Bleeker. (Plates originally planned for planned tomes XI–XIV published here for the first time). Smithsonian Institution Press, Washington.

Castelnau, F. L. 1873. Contribution to the ichthyology of Australia. Nos. III thru IX. Proceedings of the Zoological and Acclimatisation Society of Victoria, Melbourne, 2: 37–158.

Cole, K. S. 2008. Modifications of the reproductive complex and implications for the reproductive biology of *Gobiodon oculolineatus* (Teleostei: Gobiidae). Environmental Biology of Fishes, 84(3): 261–273.

Cole, K. S. 2011. Patterns of reproductive morphology in the genus *Gobiodon* (Teleostei: Gobiidae). Environmental Biology of Fishes, 92(3): 323–335.

Cole, K. S. and D. F. Hoese 2001. Gonad morphology, colony demography and evidence for hermaphroditism in *Gobiodon okinawae* (Teleostei, Gobiidae). Environmental Biology of Fishes, 61(2): 161–173.

Cuvier, G. and A. Valenciennes 1837. Histoire naturelle des poissons. Tome douzième. Suite du livre quatorzième. Gobioïdes. Livre quinzième. Acanthoptérygiens à pectorales pédiculées. i–xxiv + 1–507 + 1 pp., pls. 344–368.

De Vis, C. W. 1884. Fishes from South Sea islands. Proceedings of the Linnean Society of New South Wales, 8(4): 445–457.

Dirnwoeber, M. and J. Herler 2013. Toxic coral gobies reduce the feeding rate of a corallivorous butterflyfish on *Acropora* corals. Coral Reefs, 32: 91–100.

Fowler, H. W. 1944. Fishes obtained in the New Hebrides by Dr. Edward L. Jackson. Proceedings of the Academy of Natural Sciences of Philadelphia, 96: 155–199.

Günther, A. 1861. Catalogue of the fishes in the British Museum. Catalogue of the acanthopterygian fishes in the collection of the British Museum. Volume 3. Gobiidae, Discoboli, Pediculati, Blenniidae, Labyrinthici, Mugilidae, Notacanthi. London. i–xxv + 1–586 + i–x.

Harold, A. S. and R. Winterbottom 1995. *Gobiodon aciculari*s, a new species of gobioid fish (Teleostei: Gobiidae) from Belau, Micronesia. Proceedings of the Biological Society of Washington, 108(4): 687–694.

Harold, A. S. and R. Winterbottom 1999. *Gobiodon brochus*: a new species of gobiid fish (Teleostei: Gobioidei) from the western South Pacific, with a description of its unique jaw morphology. *Copeia*, 1999(1): 49–57.

Harold, A. S., R. Winterbottom, P. L. Munday and R. W. Chapman 2008. Phylogenetic relationships of Indo-Pacific coral gobies of the genus *Gobiodon* (Teleostei: Gobiidae), based on morphological and molecular data. Bulletin of Marine Science, 82(1): 119–136.

Hashimoto, Y., K. Shimoi and K. Aida 1974. Occurrence

of a skin toxin in coral gobies *Gobiodon* spp. Toxicon, 12(5): 523–524.

Hayashi, M. 1995. Catalogue of fishes of Yokosuka City Museum (III) — Dr. Aoyagi (Ikeda)'s fish collection. Miscellaneous Report of the Yokosuka City Museum, (20): 1–70

Hayashi, M., M. Aizawa, T. Ito and R. Arai 1990. The marine gobiid fish fauna of Amami-Oshima Island, the Ryukyus, Japan. Memoirs of the National Science Museum, (23): 123–150, pls. 1–2.

Hayashi, M. and T. Itoh 1978. Gobioid fishes of Ryukyu Islands, southern Japan. Science Report of the Yokosuka City Museum, (24): 55–82, pls. 10–21.

Herler, J. and H. Hilgers 2005. A synopsis of coral and coral-rock associated gobies (Pisces: Gobiidae) from the Gulf of Aqaba, northern Red Sea. aqua, Journal of Ichthyology and Aquatic Biology, 10(3): 103–132.

Herre, A. W. C. T. 1927. Gobies of the Philippines and the China Sea. Bureau of Science Manila Monographs, 23: 1–352, pls. 1–30.

Hoese, D. F. 1986. Family No. 240: Gobiidae. In Smith, M. M. and P. C. Heemstra (eds.): Smiths' Sea Fishes, pp. 774–807. Macmillan South Africa, Johannesburg.

Hoese, D. F. and H. K. Larson 2006. Gobiidae. In Beesley, P. L. and A. Wells (eds.): Zoological Catalogue of Australia, 35(3), Fishes, Actinopterygii: Acanthopterygii (in part): Perciformes (Notothenioidei to Stomateoidei) to Tetraodontiformes, pp. 1612–1697. ABRS & CSIRO Publishing, Victoria.

Hubbs, C. L. and K. F. Lagler 1958. Fishes of the Great Lakes Region. Cranbrook Institute of Science, Bloomfield Hills, Michigan. vii + 213 pp., 44 pls.

ICZN (The International Commission on Zoological Nomenclature) 1999. International Code of Zoological Nomenclature, Fourth Edition. xxix + 306 pp. The International Trust for Zoological Nomenclature, London.

Koumans, F. P. 1931. A preliminary revision of the genera of the gobioid fishes with united ventral fins. 174 pp. Proefschrift, Rijks-Universiteit Leiden, Leiden.

Koumans, F. P. 1953. Gobioidea. In M. Weber and L. F. de Beaufort (eds.): Fishes of the Indo-Australian Archipelago, 10, xiii + 423 pp. E. J. Brill, Leiden.

Masuda, H. and Y. Kobayashi 1994. Grand Atlas of Fish Life Modes. xxxxviii + 467 pp. Tokai University Press, Tokyo.

McCulloch, A. R. and J. D. Ogilby 1919. Some Australian fishes of the family Gobiidae. Records of the Australian Museum, 12(10): 193–291, pls. 31–37.

Motomura, H., K. Kuriiwa, E. Katayama, H. Senou, G. Ogihara, M. Meguro, M. Matsunuma, Y. Takata, T. Yoshida, M. Yamashita, S. Kimura, H. Endo, A. Murase, Y. Iwatsuki, Y. Sakurai, S. Harazaki, K. Hidaka, H. Izumi and K. Matsuura 2010. Annotated checklist of marine and estuarine fishes of Yaku-shima Island, Kagoshima, southern Japan. In Motomura, H. and K. Matsuura (eds.): Fishes of Yaku-shima Island, pp. 65–248. National Museum of Nature and Science, Tokyo.

Munday, P. L., M. J. Caley and G. P. Jones 1998. Bidirectional sex change in a coral-dwelling goby. Behavioral Ecology and Sociobiology, 43(6): 371–377.

Munday, P. L., A. S. Harold and R. Winterbottom 1999. Guide to coral-dwelling gobies, genus *Gobiodon* (Gobiidae), from Papua New Guinea and the Great Barrier Reef. Revue française d'Aquariologie Herpétologie, 26(1–2): 53–58.

Munday, P. L., L. van Herwerden and C. L. Dudgeon. 2004. Evidence for sympatric speciation by host shift in the sea. Current Biology, 14: 1498–1504.

Munday, P. L., M. Schubert, J. A. Baggio, G. P. Jones, M. J. Caley and A. S. Grutter 2003. Skin toxins and external parasitism of coral-dwelling gobies. Journal of Fish Biology, 62: 976–981.

Nakanishi, Y., T. Kuwamura and Y. Yogo 1996. Bothways sex change in monogamous coral gobies, *Gobidon* spp. Environmental Biology of Fishes, 46(3): 281–288.

Okamura, O. and K. Amaoka 1997. Sea Fishes of Japan. 784 pp. Yama-Kei Publishers, Tokyo.

Playfair, R. L. and A. Günther 1867. The fishes of Zanzibar, with a list of the fishes of the whole east coast of Africa. i–xix + 1–153, pls. 1–21. John van Voorst, London.

Randall, J. E. 2005. Reef and shore fishes of the South Pacific. New Caledonia to Tahiti and the Pitcairn Islands. xii + 707 pp. University of Hawai'i Press, Honolulu.

Randall, J. E. and H. Senou 2001. Review of the Indo-Pacific gobiid fish genus *Lubricogobius*, with description of a new species and a new genus for *L. pumilus*. Ichthyological Research, 48: 3–12.

Rüppell, W. P. E. S. 1830. Atlas zu der Reise im nördlichen Afrika. Fische des Rothen Meers. Frankfurt am Main (Heinrich Ludwig Brönner). Pages 95–141, pls. 25–35.

Rüppell, W. P. E. S. 1838. Neue Wirbelthiere zu der Fauna von Abyssinien gehörig. Fische des Rothen Meeres. Frankfurt-am-Main. Pages 81–148, pls. 22–33

Sanzo, L. 1911. Distribuzione delle papille cutanee (organi ciatiformi) e suo valore sistematico nei gobi. Mitteilungen aus der Zoologischen Station zu Neapel, 20: 249–328.

Saville-Kent, W. 1893. The Great Barrier Reef of Australia; its products and potentialites. W. H. Allen and Co., London. 387 pp., 48 pls., 16 chromo pls.

Sawada, Y. and R. Arai 1972. *Gobiodon albofasciatus*, a new coral-goby from the Ryukyu Islands, Japan. Bulle-

tin of the National Science Museum (Tokyo), 15(3): 415–420.

Sawada, Y. and R. Arai 1973. Three species of coral gobies (the genus *Gobiodon*) from the Ryukyu Islands. Bulletin of the National Science Museum (Tokyo), 16: 586–603.

Sawada, Y., R. Arai and T. Abe 1972. *Gobiodon okinawae*, a new coral-goby from the Ryukyu Islands, Japan. Japanese Journal of Ichthyology, 19: 57–62.

Schubert, M., P. L. Munday, M. J. Caley, G. P. Jones and L. E. Llewellyn 2003. The toxicity of skin secretions from coral-dwelling gobies and their potential role as a predator deterrent. Environmental Biology of Fishes, 67: 359–367.

Senou, H., T. Suzuki, K. Shibukawa and K. Yano 2004. A Photographic Guide to the Gobioid Fishes of Japan. Heibonsha, Tokyo. 536 pp. (In Japanese.)

Suzuki, T., M. Aizawa and H. Senou 1995. A preliminary review of three species of *Gobiodon rivulatus* complex from Japan. I.O.P. Diving News, 6(7): 2–7.

Suzuki, T. and J. E. Randall 2011. *Paragobiodon kasaii*, a new gobiid fish from Japan and Palau. Bulletin of the National Museum of Nature and Science, Series A, 37: 155–161.

Suzuki, T. K. Yano and H. Senou 2012. *Gobiodon winterbottomi*, a new goby (Actinopterygii: Perciformes: Gobiidae) from Iriomote-jima Island, the Ryukyu Islands, Japan. Bulletin of National Museum of Nature and Science, Series A, Supplement 6: 59–65.

Tanaka, S. 1915. Ten new species of Japanese fishes. Dobutsugaku Zasshi, 27(325): 565–568.

Tomiyama, I. 1936. Gobiidae of Japan. Japanese Journal of Zoology, 7(1): 37–112.

Winterbottom, R. and A. R. Emery 1986. Review of the Gobioid fishes of the Chagos Archipelago, Central Indian Ocean. Royal Ontario Museum Life Science Contributions, (142): i–v and 1–82.

Winterbottom, R. and A. S. Harold 2005. *Gobiodon prolixus*, a new species of gobiid fish (Teleostei: Perciformes: Gobiidae) from the Indo-West Pacific. Proceedings of the Biological Society of Washington, 118(3): 582–589.

Wu, H.-L. 1979. Description of two new species of *Gobiodon* Bleeker from China. Oceanologica et Limnologica Sinica, 10(2): 157–160.