

Signigobius biocellatus, a New Genus and Species of Sand-dwelling Coral Reef Gobiid Fish from the Western Tropical Pacific

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Abstract *Signigobius biocellatus* is described as a new genus and species of coral reef gobiid fish from Palau, the Philippines, Solomon Islands, New Guinea, and the Great Barrier Reef. The genus is compared with other sand-dwelling coral reef genera in morphological and ecological aspects. The genus is most similar in these aspects to the genus *Valenciennea*.

Introduction

Until the last 10 years little was known of the taxonomy and ecology of Indo-Pacific coral reef gobiid fishes. Even today little published information is available. It is estimated that approximately 400 to 600 of the 2000 gobiid fishes in the world live on Indo-Pacific coral reefs.

Specimens of *Signigobius* were first discovered in Palau by the junior author in 1971. Subsequently they have been collected in several localities in the western Pacific Ocean. We examined various museum collections and found that a specimen was collected in 1909 by the "Albatross" and three were collected in 1944. Of the 78 specimens known, all but four have been collected since 1968.

Field observations indicated that the genus was ecologically similar to *Valenciennea*, and detailed examination indicated that the two genera are very closely related. We have observed *Signigobius* and *Valenciennea* digging their own burrows and *Amblygobius* also constructs its own burrow (Klausewitz, 1960; H.K. Larson, pers. comm.).

Methods

Counts and measurements follow Hubbs and Lagler (1958). The transverse scale count was made in two ways; from the anal origin upward and backward to the base of the second dorsal fin (TRB) and from the anal origin upward and forward to the base of the first dorsal fin (TRF). The TRB count is

generally more consistent in gobiids since the scales below the first dorsal fin are often crowded and irregularly placed.

The osteology was studied from trypsin cleared and stained material. Vertebral counts were taken from cleared and stained material and radiographs.

Signigobius, gen. nov.

Type species: *Signigobius biocellatus*, sp. nov.

For diagnostic characters of the genus see Table 2.

First dorsal fin with six spines. Pelvic fins connected to form a cup shaped disc. Head compressed. Tongue tip broadly rounded. Gill opening narrow, extending from upper margin of pectoral base to a point just below lower margin of pectoral base. First gill arch not connected by membrane to inner face of operculum. Gill rakers on outer part of first gill arch developed only on posterior part of lower limb of arch. Upper limb of first arch with prominent fleshy lobes at uppermost part of limb. Minute close-set comb-like gill rakers on inner face of fourth gill arch. Anterior nostril a short slender tube positioned half way between anterior margin of eye and anterior margin of snout; posterior nostril, a pore positioned about midway between anterior margin of eye and anterior nostril. No flaps on shoulder girdle. Body covered largely with moderate sized ctenoid scales; cycloid on ventral surface of belly and anteriorly just behind pectoral base and below first dorsal

fin. Midline of nape and head naked. Seventeen segmented caudal rays.

A single row of conical curved wideset teeth covering most of premaxilla; a large gap anteriorly between left and right sides of jaw with no teeth. In specimens larger than 35mm SL, a single small tooth on each side of jaw anteriorly behind anterior row. Lower jaw with two rows of teeth; an outer row composed of curved conical teeth about equal in size to upper jaw teeth, covering anterior part of dentary; an inner row of slightly larger teeth anteriorly with one or two enlarged teeth at bend of dentary and two or three smaller teeth behind bend of dentary.

Head pores (Fig. 5a): a pore between anterior and posterior nostrils; a median anterior interorbital pore between anterior margin of eyes; a median posterior interorbital pore between posterior margin of eyes; a postorbital pore behind each eye; an infraorbital pore below each postorbital; a lateral canal pore over preoperculum; a terminal lateral canal pore above posterior margin of preoperculum; a short tube with pores at each end above operculum; and three preopercular pores.

Osteology. Branchiostegal rays 5. No postcleithrum. No mesopterygoid. Metapterygoid slender, without process extending over quadrate. Sphenotic short, flange supporting hyomandibular fused with flange forming posterior part of orbit. Preoperculum without a process extending to posterior flange of hyomandibular. No hyomandibular process from posterior flange to preoperculum. Frontal not prolonged, frontal ridge large, forming

posterior and dorsal part of orbit. Supraoccipital diamond shaped, with prominent anterior flange covering part of frontal; lateral wings prominent and wedge shaped. Sphenotic with a low rounded dorsal flange widely separate from supraoccipital. Glossohyal triangular, broader than long. Scapula absent. First dorsal fin with six pterygiophores articulating after third neural arch and spaced with respect to interneural spaces 2-2-1-1, the number indicates the number of pterygiophores between successive neural spines. An interneural gap without a pterygiophore between two dorsal fins. Anterior zygapophyses weakly developed on second to fifth vertebrae. Dorsal ribs associated with vertebrae one to twelve, last four free from vertebrae. Ventral ribs associated with vertebrae three to eleven. Caudal skeleton with a single epural. Vertebrae 10+16=26.

Etymology. Latin, *signus*=mark and *gobius*=a genus of fish, alluding to distinctive coloration.

Signigobius biocellatus, sp. nov.

(Figs. 1, 2, 3, 4A, 5A)

Description. Based on specimens 13 to 56mm SL, morphometrics based on specimens 20 to 56 mm SL. Counts of holotype indicated by an asterisk.

First dorsal VI (in 39 specimens)*. Second dorsal I, 10 (in 1); I, 11 (in 38)*. Anal I, 11 (in 38)*; I, 10 (in 1). Pectoral 20 (in 7); 21 (in 19)*; 22 (in 2). Segmented caudal rays 15 (in 1); 16 (in 1); 17 (in 28)*. Branched caudal rays 0 (in 1); 11 (in 3); 12 (in 3); 3 (in 18)*. Procurrent caudal rays 8/8 (in 1);

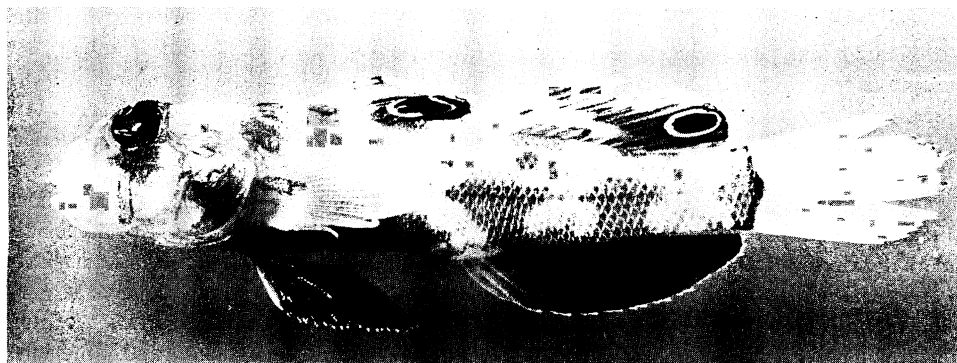


Fig. 1. Holotype of *Signigobius biocellatus*, AMS I 18767-001. Photo by G. Millen.

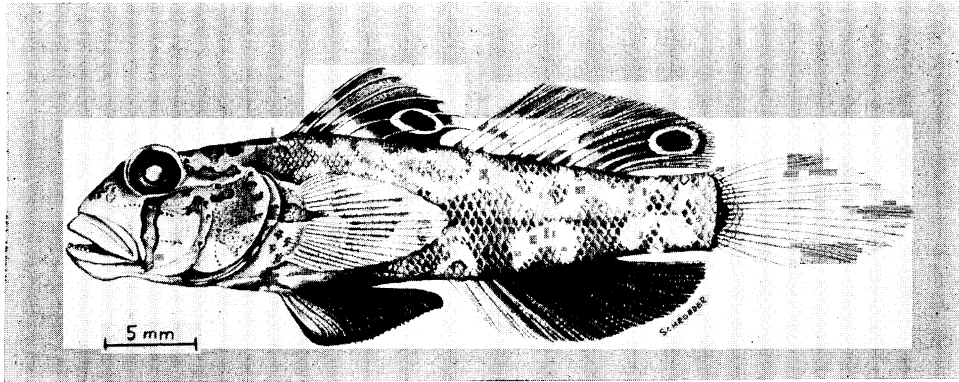


Fig. 2. Paratype of *Signigobius biocellatus*, UNSM 215044.

8/7 (in 2); 7/7 (in 1); 7/6 (in 2); 6/6 (in 2); 6/5 (in 1). Gillrakers on outer face of first arch 4 (in 1); 5 (in 4); 6 (in 1). Gillrakers on outer face of second arch 12 (in 2); 13 (in 1); 14 (in 1). Longitudinal scale count 48 (in 3); 49 (in 2); 50 (in 3); 51 (in 2); 52 (in 6); 53 (in 3); 54 (in 2)*; 55 (in 2). Transverse scale count forwards (TRF) 18 (in 2); 19 (in 5); 20 (in 6); 21 (in 5)*; 22 (in 2). Transverse scale count backwards (TRB) 16 (in 1); 17 (in 10)*; 18 (in 7); 20 (in 2); 21 (in 1). Branchiostegals 5 (in 5). Teeth on left side of upper jaw 13 (in 2); 14 (in 2)*; 15 (in 4); 16 (in 2); 17 (in 2). Vertebrae 10+16 (in 10).

Measurements of the holotype and five paratypes are shown in Table 1.

Head slightly compressed, width at preopercular margin 0.84 to 0.92 of depth at preopercular

margin. Snout longer than eye length, varying from 12.8 to 14.8% of SL in specimens less than 28 mm SL to 10.5 to 12.6% of SL in larger specimens; snout convex and gently sloping in lateral view. Eye small, 8.7 to 10.5% of SL in juveniles smaller than 28 mm and 6.2 to 8.2% of SL in larger specimens. Mouth moderate, slightly oblique, forming an angle of about 15 to 20° with body axis; jaws end under a point below anterior margin of eye in young, less than 20 mm, to under middle of pupil in adults; upper jaw 11.7 to 14.5% of SL. Interorbital narrow, about equal to pupil diameter. Gillrakers on outer face of first arch elongate, developed only on posterior half of lower part of arch. Inner rakers of first arch well developed. Gillrakers developed only along middle of second to fourth arches. No fila-

Table 1. Measurements of holotype and paratypes of *Signigobius biocellatus*, in millimetres.

Character	Holotype			Paratypes		
	AMS I 18767-001	AMS I 18755-001	AMS I 18479-001	AMS I 18480-001	AMS I 17676-013	BM (NH) 1976.4.9.2
Sex	♂	♀	♂	♀	♀	♀
Standard length	32.2	56.2	38.5	25.3	42.5	42.9
Head length	10.4	15.7	13.0	9.2	14.7	13.7
Head width at preopercular margin	6.4	9.0	6.6	4.8	8.0	8.8
Body depth at anal origin	6.0	11.7	7.6	4.5	9.7	10.0
Caudal peduncle length	4.0	7.1	4.2	3.0	5.7	5.4
Upper jaw length	4.1	6.6	5.0	3.6	6.6	5.6
Eye length	2.2	3.5	3.1	2.3	3.6	3.3
Snout length	3.3	6.4	4.9	3.5	5.2	5.5
Pectoral length	9.8	16.6	11.9	6.4	13.5	13.8
Pelvic length	8.3	13.7	10.1	6.2	12.0	11.9
Caudal length	8.7	16.6	12.9	7.1	12.7	12.0

mentous dorsal spines. Body completely scaled; nape with scales at sides, in adults only, extending forward to just above posterior margin of preoperculum. Gut elongate and coiled. Urogenital papilla of male pointed, recessed in groove in body cavity; in females a rounded lobe with two large lateral fleshy flaps.

Colouration of live and fresh material from Palau and Lizard Islands. Head and body grey to white. A vertical pinkish bar with brown edges, width about equal to pupil length, extending from ventral margin of eye to below posterior end of jaw. Sides of head with brown lines forming reticulated pattern around white spots. An irregular brown blotch with scattered white spots on operculum. Top of head, nape and upper half of body with irregularly shaped small brown blotches or small round brown spots. Three brownish to black diamond shaped blotches on mid side with narrower vertical bars of same colour extending ventrally from blotches; first blotch on side of belly; second near anterior end of anal fin; third just behind or over posterior end of anal fin. Middle of pectoral base with an irregular brown stripe; about equal to pupil length. Dorsal fins whitish with irregular pinkish brown mottling forming two or three ir-

regular longitudinal stripes; two ocellated spots, each about equal to eye length; the first a black spot on first dorsal between fifth and sixth dorsal spines, surrounded by a yellow ring, in turn surrounded by a dusky greyish ring; second spot similarly coloured near end of second dorsal fin between ninth and twelfth rays. Caudal transparent. Pelvic jet black with small scattered iridescent blue spots, and a narrow white distal margin. Anterior fifth of anal usually white; remaining part of fin jet black with three or four longitudinal or oblique rows of small iridescent blue spots; a narrow white distal margin. Pectoral fins clear.

Colouration in alcohol. Same as live colouration, except all traces of pink, yellow and blue absent. Rings of two dorsal spots clear. Pelvic and anal black, sometimes with traces of darker small spots.

Insufficient material is available to determine any geographical variation. The branching of the caudal rays increases with growth. Specimens smaller than 15 mm have few, if any, branched caudal rays.

Ecology. This species lives over sand, generally only one or two metres from coral or rubble (Fig. 3). The juveniles occur singly, but adults occur as male and female pairs. Individuals feed by taking large mouthfuls



Fig. 3. A male and female pair of *Signigobius biocellatus* from Lizard Island. Photo by D. F. Hoese.

of sand, sifting it through the gill openings. Stomach analyses of three specimens indicates that the species feeds primarily on interstitial copepods, but also takes in large numbers of nematodes, foraminifera, ostracods, unidentifiable detritus, and small amounts of sand. When approached by predators *Synodus* spp. juveniles were noticed to erect both dorsal fins revealing the eye spots and to hop in a forward direction, keeping the head down. Adults were observed feeding on the bottom, digging burrows with their mouths, or hovering above the substratum in pairs. When hovering the individuals move rapidly forward, backward, upward, or downward. The above observations are based on about 6 hours of underwater observation by the senior author at Lizard Island and the junior author at Palau. More details of their behaviour are discussed by Huson (1977).

Etymology. Latin, *bi*=two and *ocellatus*=small eye spots, referring to the two prominent ocellated spots on the dorsal fins.

Material examined. Type material has been deposited in the following institutions: Academy of Natural Sciences, Philadelphia, ANSP; Australian Museum, Sydney, AMS; British Museum (Natural History), London, BM (NH); Bernice P. Bishop Museum, Honolulu, BPBM; California Academy of Science, San Francisco, CAS; Museum National d'Histoire Naturelle, Paris, MNHN; National Science Museum, Tokyo, NSMT; Queensland Museum, Brisbane, QM; United States National Natural History Museum, Washington, USNM; Western Australian Museum, Perth, WAM.

In the material examined list, for each collection, the number of specimens is given followed by the size range in standard length enclosed in parentheses.

Holotype. AMS I 18767-001, a 32.2 mm male; Linnet Reef, Great Barrier Reef, collected 22 November 1975 in 6 to 15 m, on sand, coral and rubble bottom by D. F. Hoese, H. K. Larson, B. C. Russell, and N. Coleman.

Paratypes. Philippines: USNM 99290, 1 (41), Tipu, Boero Is., Albatross Sta. 2130, 11 Dec. 1909. Palau Island: ANSP 134365, 3 (15~26), Malakal Passage, 5 m, 23 Jan. 1973, G. Allen; AMS I 18479-001, 1 (39), off Ngargol

Is., 30 m, 9 March 1972, G. Allen; AMS I 18480-001, 2 (25~28). Koror Is., 1 m, 16 Dec. 1971, G. Allen; AMS I 18738-001, 4 (21~32), Auluptagel Is., 2 m, 8 Mar. 1972, G. Allen; WAM P 25539-001, 1 (24), taken with AMS I 18480; USNM 216210, 1 (15), taken with ANSP 134365. New Guinea: USNM 215043, 1 (32), Madang Harbour, 2 to 8 m, 30 May 1970, B. B. Collette and party; USNM 215044, 1 (36), Madang Harbour, 23 May 1970, B. B. Collette and party. Solomon Islands: BPBM 17990, 1 (33), Guadalcanal, 10 m, 21 July 1973, J. E. Randall; USNM 215045, 2 (34~38), Munda Lagoon, New Georgia Is., 16 July 1944; USNM 215046, 1 (29) Munda Lagoon, New Georgia Is., 16 July 1944. New Hebrides: AMS I 18434-002, 2 (25~30), Efate, Jan. 1974, P. Fourmanoir, MNHN 1975-1, 1 (30), taken with AMS I 18434. Great Barrier Reef; Yonge Reef: AMS I 18740-001, 1 (13), backreef, 9 to 12 m, 8 Nov. 1975, D. Hoese, H. Larson, N. Coleman, R. Cummins, and R. Kuronuma. Great Barrier Reef; Lizard Island: AMS I 17682-003, 1 (37), June 1973, B. Goldman; AMS I 17686-013, 1 (45), North Point, 9 m, 26 June 1973, D. Hoese; AMS I 18754-001, 1 (55), lagoon, 3 to 8 m, 7 Feb. 1975, D. Hoese; AMS I 18755-001, 4 (15~56), AMS I 18739-001, 3 (13~24), lagoon, 3 to 8 m, 21 Nov. 1975, J. Paxton and party; BM (NH) 1976.4.9.1, 1 (43), north end of island, 10 m, 18 May 1975, R. Lubbock; CAS 35953, 5 (17-23), lagoon, 1 to 15 m, 17 Nov. 1975, J. Paxton and party; LACM 35670-1, 1 (42), taken with AMS I 18754-001; NSMT-P. 18251, 1 (22), North Point, 8 to 15 m, 29 Jan. 1975, D. Hoese and H. Larson; QM I 13538, 1 (45), taken with AMS I 18755-001; WAM P 24765, 1 (48), North Point, 5 m, 4 May 1974, G. Allen; USNM 216211, 1 (24), taken with AMS I 18739-001. Great Barrier Reef; Linnet Reef: AMS I 18767-002, 1 (14), taken with holotype. Great Barrier Reef; Northern Escape Reef: USNM 215035, 1 (14), 26 to 29 m, 23 Jan. 1969, J. Tyler and party; ANSP 134804, 2 (27~28), 24 to 27 m, 24 Jan. 1969, J. Tyler and party. Great Barrier Reef; Big Hope Is.; ANSP 134803, 2 (26~30), 8 to 11 m, 19 Jan. 1969, J. Tyler and C. L. Smith; USNM 215039, 5 (29~35), 8 to 11 m, 19 Jan. 1969, J. Tyler and G. Bettles. Great Barrier Reef; Endeavour

Table 2. Comparison of characters in *Signigobius* and similar genera. Upper eight are structures used in feeding.

Character	<i>Signigobius</i>	<i>Valenciennea</i>	<i>Amblygobius</i>	<i>Cryptocentrus</i>
Upper jaw tooth rows	1	1	1-3	3-6
Lower jaw tooth rows	2	2	2-3	3-6
Outer row of lower jaw teeth	Enlarged, posterior most tooth largest and curved backward	As in <i>Signigobius</i>	Enlarged, posterior most tooth largest and curved posteriorly and laterally	Enlarged, all teeth equal in size
Inner row of lower jaw teeth	Small teeth	Small teeth	Small teeth	Enlarged, posterior teeth largest
Pharyngeal teeth	Numerous and elongate	Numerous and elongate	Numerous and elongate	Few and short
Outer gill rakers of lower part of first arch	Developed posteriorly only	As in <i>Signigobius</i>	Developed fully	Developed fully
Upper part of first gill arch	With prominent fleshy lobes and 2 or 3 elongate lobes pointing forward	With prominent fleshy lobes, but no slender projections	With prominent fleshy lobes and 4 to 6 very elongate projections pointing forward	With minute fleshy lobes only
Rakers on inner face of fourth gill arch	Numerous, slender, and close-set	As in <i>Signigobius</i>	As in <i>Signigobius</i>	Few, short normal rakers or none
Gill opening	Restricted to pectoral base	Restricted to pectoral base	Restricted to pectoral base	Extends forward below to under preoperculum
Scales	Mostly ctenoid 48 and 55 longitudinal rows	Mostly ctenoid 65 and 120 rows	Ctenoid or cycloid in 50 to 80 rows	Ctenoid or cycloid in 60 to 120 rows
Anterior nostril	Midway between eye and tip of snout	Midway between eye and tip of snout	Midway between eye and tip of snout	Near tip of snout
Nasal pore	Adjacent to posterior nostril	Adjacent to posterior nostril	Midway between nostrils	Adjacent or near posterior nostril
Pelvic fins	Connected to form disc	Separate	Connected to form disc	Connected to form disc or separate
Cheek papillae	In longitudinal rows	In longitudinal rows	Several short transverse rows under eye	Long transverse rows and 2 longitudinal rows

Reef: ANSP 134801, 1 (22), 17 to 21 m, 15 Jan. 1969, J. Tyler and C.L. Smith; ANSP 134800, 7 (14~28), 11 to 15 m, J. Tyler and C.L. Smith; ANSP 134802, 1 (13), 14 to 15 m, J. Tyler and C.L. Smith; USNM 21042, 13 (16~32), 14 to 18 m, J. Tyler and C.L. Smith.

Relationships of *Signigobius*

Superficially *Signigobius* resembles the nominal *Batman insignitus* Whitley (1956), which has an ocellated spot on the first dorsal fin. *Batman* differs in having cycloid scales, transverse head papillae rows, a broader gill opening, and several rows of teeth in upper jaw. All of these features are characteristic of *Cryptocentrus* and we regard *Batman* as a synonym of *Cryptocentrus*. The general head shape and single row of teeth in the upper jaw of *Signigobius* are similar to features found in *Oxyurichthys*. However, *Oxyurichthys* has paired anterior interorbital pores and is probably not closely related to *Signigobius*.

Signigobius is most similar to the genera *Valenciennea* and *Amblygobius* (Table 2). *Cryptocentrus* and the distantly related genera *Vanderhorstia* and *Ctenogobiops* differ from *Signigobius*, *Valenciennea*, and *Amblygobius* in occupying burrows constructed by alphaeid shrimps. *Cryptocentrus*, *Vanderhorstia*, and

Ctenogobiops differ further from the other three genera in feeding more selectively by taking small mouthfuls of sand and picking individual prey organisms from sand. *Signigobius*, *Valenciennea*, and *Amblygobius* all feed by taking large mouthfuls of sand, sifting out minute organisms and species of all three genera dig their own burrows with their mouths. All three have an elongate and coiled gut, while *Cryptocentrus*, *Vanderhorstia* and *Ctenogobiops* have a short S-shaped gut. From Table 2, it is apparent that *Cryptocentrus* differs considerably from these three genera in the structures associated with feeding. The teeth are better developed for grasping, and the pharyngeal teeth and gill rakers are typical for predatory gobiids in *Cryptocentrus*.

Cryptocentrus also differs from *Amblygobius*, *Signigobius*, and *Valenciennea* in having a broader gill opening (Table 1) and in the arrangement of the head sensory papillae (Fig. 5). *Amblygobius* differs from *Valenciennea* and *Signigobius* in the arrangement of the head papillae and other minor features (Table 1).

Stomach contents of *Valenciennea longipinnis*, *V. puellaris*, and *V. sexguttatus* indicate that the species feed largely on interstitial fauna, such as copepods, foraminifera,

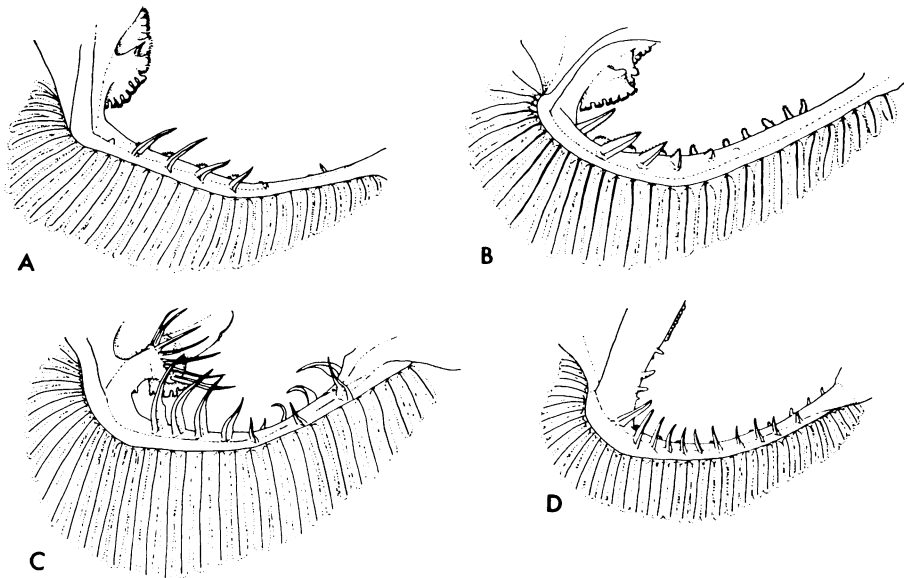


Fig. 4. Outer face of first gill arch in four gobiid genera.
A. *Signigobius*. B. *Valenciennea*. C. *Amblygobius*. D. *Cryptocentrus*.

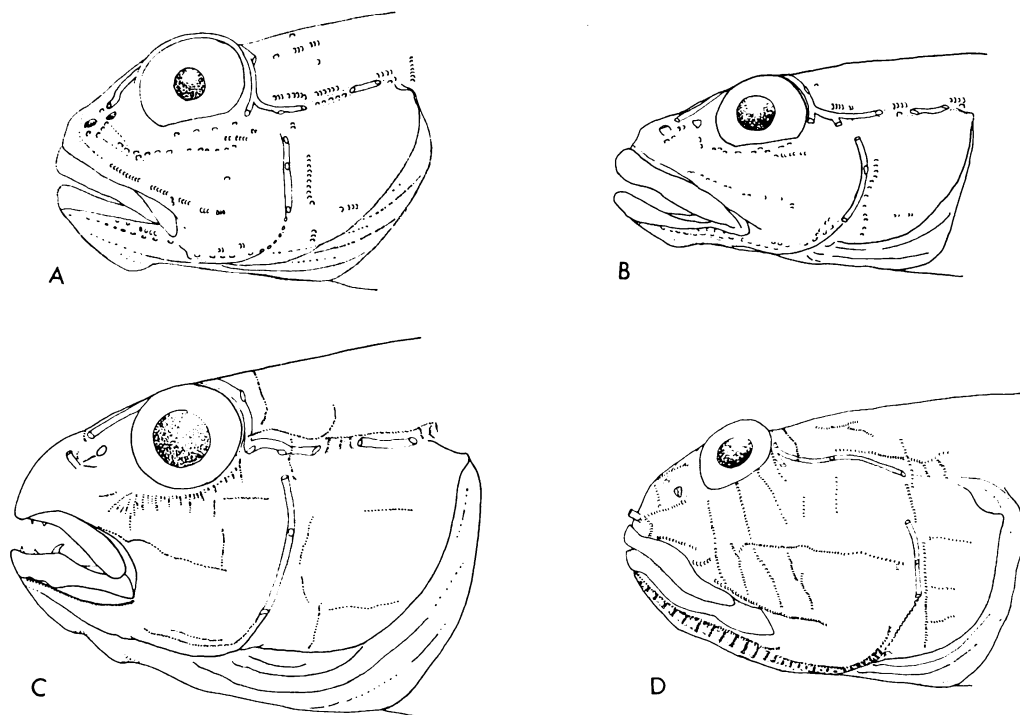


Fig. 5. Arrangement of sensory papillae in four burrow inhabiting coral reef gobiid genera. A. *Signigobius*. B. *Valencienea*. C. *Amblygobius*. D. *Cryptocentrus*.

nematodes, amphipods, and ostracods; basically the same groups of organisms eaten by *Signigobius*. *Amblygobius phalaena*, however, apparently feeds largely on algae (H. K. Larson, pers. comm.). *Amblygobius* differs from *Signigobius* and *Valencienea* in the structure of the first gill arch (Fig. 4), and some species of *Amblygobius* have more than one row of teeth in the upper jaw. *Valencienea* and *Signigobius* differ only slightly in the development of the fleshy pads at the upper end of the first gill arch.

Signigobius is most similar to *Valencienea*, and differs from that genus in having lower scale counts, a pelvic disc, and the nasal pore adjacent to the posterior nostril.

Acknowledgments

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Lachner for allowing us to use the fine drawing by J. R. Schroeder (Fig. 2).

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Hoese and Allen : A New Genus and Species of Coral Reef Goby

(Hoese: The Australian Museum, Sydney, Australia; Allen: The Western Australian Museum, Perth, Australia)

太平洋西部の熱帯海域で採集されたサンゴ礁の砂地に生息性のハゼ科の新属、新種 *Signigobius biocellatus*

Douglass F. Hoese and Gerald R. Allen

パラオ, フィリピン, ソロモン諸島, ニューギニ

アおよびオーストラリアのグレートバリアーリーフで採集されたサンゴ礁に生息するハゼ科魚類の新属、新種を記載した。本属を形態および生態の面からサンゴ礁の砂地に生息する他の属と比較した。本属はこれらの点でクロイトハゼ属 *Valenciennea* に類似する。