

Revision of the eastern Pacific species of *Gobulus* (Perciformes: Gobiidae), with description of a new species

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Abstract: *Gobulus birdsongi* is described as a new species from the Pacific coast of Panama. The two other known species of *Gobulus* from the eastern Pacific, *Gobulus crescentalis* and *G. hancocki* are redescribed. *Gobulus birdsongi* differs from other species in the genus in having more numerous second dorsal and anal rays. *Gobulus hancocki* differs from *G. crescentalis* in having a much smaller eye. The genus is distinctive in having reversed countershading, with the ventral surface of the body darker than the dorsal surface.

Key words: New genus, new species, description, taxonomy, *Gobulus*

Ginsburg (1933) described *Gobulus*, separating it from *Gobiosoma* on the basis of the reduction in the connection of the two pelvic fins. However, the apparent reduction of the interradiation membrane between the two pelvic fins resulted from damage. The interspinal membrane is present or absent depending on the species. Subsequently, Ginsburg (1938) described a second species of *Gobulus* (*G. hancocki*), from the Pacific coast of Panama. Ginsburg (1939) also described *Gobulus myersi* from the Gulf of Mexico. More recently a third, undescribed species from the eastern Pacific was discovered. Böhlke and Robins (1968) discussed the relationships of New World seven-spined gobiid genera, but did not discuss *Gobulus* in detail. Similarly Hoese (1971) briefly treated the relationships of the genus. Because of the brief early

descriptions and incomplete diagnoses, the genus is redefined here and all the known eastern Pacific species treated.

MATERIALS AND METHODS

Counts and measurements follow those given by Hubbs and Lagler (1958), except that the last ray in the second dorsal and anal fins is branched to the base and counted as a single ray. All fish lengths are standard lengths. Measurements of eye length was based on the longest length of the eye, measured with an ocular micrometer to two decimal places. The interspinal membrane is the thin membrane connecting the two pelvic spines and is often referred to as the velum or pelvic frenum (Böhlke and Robins, 1968). The interradiation membrane is

the thin membrane connecting the fifth pelvic rays of the two pelvic fins. Vertebral counts include the urostyle. The pterygiophore formula follows Birdsong (1975). Institution abbreviations for material used in this study follows Leviton, et al., 1985. Information for the Atlantic species *Gobulus myersi* was based on examination of the holotype (USNM 107283) and data from Hastings (1983).

Gobulus Ginsburg

Gobulus Ginsburg, 1933: 12-15 (type species: *Gobiosoma crescentalis* Gilbert, by original designation).

Description: First dorsal fin with 7 spines; pterygiophore formula typically 3(221110). Branched caudal rays 15-17. Procurent caudal rays usually 4/4 or 5/4, varying from 4/3 to 6/5. Pseudobranchs 3-5. Gill rakers on outer face of first gill arch 9-11. Head pores absent. Pelvic fins connected, by a complete, or partly complete, interradial membrane; interspinal membrane reduced to a thin membrane or absent. Barbels absent. Head depressed, depth about 0.60 to 0.75 times width. Tongue tip rounded to truncate. Anterior nostril tubular; posterior nostril with a raised rim or tubular. Scales absent. Body slender, not tapering posteriorly. Posterior end of maxilla covered by a flap of skin. Gill opening extending ventrally to just below lower margin of pectoral base. Head and body with reversed countershading; ventral half to two thirds of body dusker than dorsum. Caudal fin with a crescent-shaped bar.

Osteology based on specimens of *G. crescentalis* and *G. hancocki* only. Frontal prolonged, without a flange forming posterior part of orbit. Supraoccipital short with tapering lateral wings just touching dorsal flange of sphenotic. Scapula not ossified. Pelvic girdle broad, width 0.64 to 0.77 times length. Anterior zygapophyses prominent on vertebrae 2 to 10-12. Epipleural ribs on vertebrae 1 to 11-12, unfused on vertebrae 3 to 11-12. Pleural ribs on vertebrae 3 to 10; ultimate pre-caudal vertebra without a pleural rib. Upper

and lower hypurals fused to each other and to urostyle.

The presence of two transverse papillae rows behind the eye and the prolonged frontal suggests a close relationship with *Nes. Gobulus* is most easily distinguished by the reversed countershading, although the countershading is obscure in large specimens. *Gobulus* is distinctive from other genera in the tribe Gobiosomini in having few pseudobranchs and procurent caudal rays, in having a depressed head, and in having the interspinal membrane of the pelvic disc reduced or lacking. The genus is also characterized by the reduction of the eye which does not completely fill the orbit.

The eastern Pacific species of *Gobulus* are readily distinguishable on coloration, meristics, and certain morphometrics. Although proportions often overlap, these change with size, and actual measurements provide complete separation of *G. hancocki* and *G. crescentalis* in eye size (Fig. 1). Hastings (1983) redescribed the Atlantic species *G. myersi* Ginsburg based on specimens from the Gulf of Mexico, the Bahamas, Greater and Lesser Antilles and Venezuela. That species is most similar in eye size to *G. crescentalis*, differing from that species in averaging fewer second dorsal (I,9-10) and anal rays (I,7-9) and pectoral rays (typically 15). Hastings also noted that several characters, including eye proportions decrease with increasing size. Minimal growth in eye size in eastern Pacific species studied, is apparent over a wide size range (0.9 to 2.6 mm over a size range of 14.0 to 68 mm SL in *Gobulus crescentalis* and a range of 0.63 to 0.89 mm over a size range of 14 to 28.3 mm SL in *Gobulus hancocki*.)

Gobulus birdsongi, new species

(Figs. 1-4)

Holotype: SIO 71-36, 57.8 mm female, Miraflores Lock, Panama, 6 m in rock crevice, J. McCosker and S. McCosker, 17 Feb., 1971.

Paratype AMS I.40231-001, 46.3 mm female, Miraflores Lock, Panama, R. Birdsong and T. Fraser, 11 May, 1967.

Key to eastern Pacific species of *Gobulus*

1. Second dorsal-fin rays I,13. Anal-fin rays I,13. Two dorsal fins partly connected. (Vertebrae 27).
..... *G. birdsongi* n. sp.
1. Second dorsal-fin rays I,10-11. Anal-fin rays I,9-10. Two dorsal fins completely separate 2
2. Pelvic interspinal membrane present, but reduced. Vertebrae 28. Eye small, less than 0.8 into snout. Body darker (dusky or brown) below, with upper edge of dark pigment well above midline in adults (greater than 15 mm SL), forming a smooth border. Pectoral-fin rays typically 16 *G. hancocki*
2. Pelvic interspinal membrane rudimentary or absent. Vertebrae 27. Eye larger 0.8 or greater in snout. Body darker below with upper edge of dark pigment along midline of side of body (countershading obscure in large specimens) 3
3. Pectoral-fin rays usually 15, rarely 16; second dorsal-fin rays usually I,9-10. Western Atlantic *G. myersi*
3. Pectoral-fin rays usually 17; second dorsal-fin rays usually I,10-I,11. Eastern Pacific..... *G. crescentalis*

Diagnosis: The species is distinguished by the following combination of characters: second dorsal rays I,13; anal rays I,13, pectoral rays 16-18; eye small, 1.4 mm in length in two specimens (46 and 58 mm SL); first dorsal fin connected to base of second dorsal fin; pelvic interspinal membrane very reduced; fifth pelvic ray subequal in length to fourth ray; upper edge of dark body stripe well above midside of body.

Description: First dorsal fin rays VII (in 2); pterygiophore pattern 3(221110) in holotype and 3(212110) in paratype. Second dorsal rays I,13(2). Anal rays I,13(2). Pectoral rays (both sides counted) 16(1), 17(1), 18(2). Vertebrae 11+16 = 27 (2); Segmented caudal rays 9/8 (2). Branched caudal rays 9/8 (2). Procurrent caudal 5/5(2). Gill rakers on outer face of first arch 9. Pseudobranchs 4(1).

Pelvic fin short, just reaching midbelly; interspinal membrane thin and reduced; interradial membrane complete, without a shallow notch between two pelvic fins; fifth pelvic ray subequal to fourth ray. Mouth short, extending posteriorly to a vertical between the anterior margin and middle of eye; mouth oblique, forming an angle of about 55° with body axis. Two dorsal fins connected, with seventh spine connected by membrane with lower quarter of spine of second dorsal fin. Eye very small 1.8-3.0%

of SL (proportion lowest in largest specimen). Body slender, body depth at anal origin 13-16 % of SL.

Dentition: Upper jaw - an outer row of 10 enlarged curved conical teeth on each side of jaw; anterior 3-5 teeth distinctly larger than posterior teeth. Anterior portion of jaws with 3 or 4 rows of small conical teeth, tapering laterally to 2 rows at bend of upper jaw, grading posteriorly into 1 row of inwardly directed teeth near end of jaw. Lower jaw - an outer row of 2 or 3 enlarged curved teeth on each side, near anterior tip of jaw. Second row composed of smaller conical teeth extending from anterior tip to near end of dentary. Innermost row with 3 or 4 small conical teeth near anterior tip, followed by 2-3 enlarged conical teeth, followed by 3 or 4 small conical teeth; row extends posteriorly to middle of dentary.

Coloration in alcohol: Head and body light brown (both specimens faded considerably). A darker brown stripe on midside of body in holotype, light brown above and below stripe; melanophores not present above stripe, but present below stripe to as far as ventral midline; dorsal surface of snout and jaws white, pale brown on ventral surface, rest of head a darker brown; pectoral base with scattered melanophores; fins pale brown, without obvious melanophores; crescent-shaped bar at base of caudal no longer

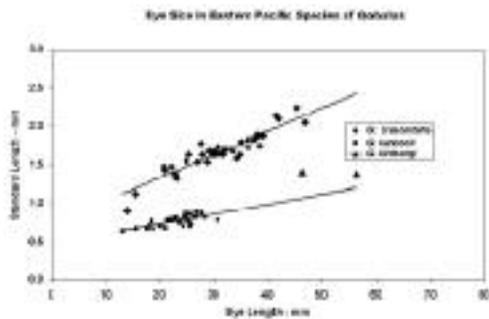


Fig. 1. Eye size in eastern Pacific species of *Gobulus*



Fig. 2. Holotype of *Gobulus birdsongi*, n.sp.

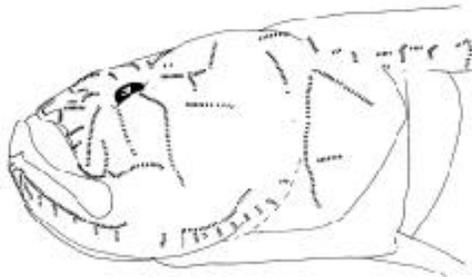


Fig. 3. Side view of head papillae of holotype of *Gobulus birdsongi*, n.sp.

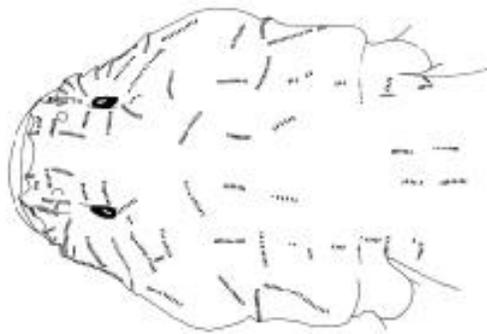


Fig. 4. Top view of head papillae of holotype of *Gobulus birdsongi*, n.sp.

visible. Paratype largely faded, with faint trace of stripe anteriorly only.

Gobulus birdsongi differs from all other species in having more numerous second dorsal and anal rays and in having transverse rows in the inner preopercular mandibular papillae series (Fig. 3). These transverse rows are unusual in gobiid fishes. They do occur in some species of *Cryptocentrus* and some species of *Callogobius*. The number of transverse rows varies with species in these genera and their occurrence is not considered sufficient to warrant generic separation. The eye is small, similar in size to *G. hancocki*.

Etymology: This species is named for Ray Birdsong, a long time friend and colleague of the senior author, who provided valuable assistance and inspiration to goby work.

Gobulus crescentalis (Gilbert)
(Figs. 5, 6)

Gobiosoma crescentalis Gilbert, 1892: 557 (off Isla Espiritu Santo, Gulf of California, holotype USNM 48258)

Diagnosis: The species is distinguished by the following combination of characters: second dorsal rays typically I,11; anal rays typically I,10, pectoral rays typically 17; eye moderate, greater than 1 mm in length in specimens larger than 15 mm SL to 2.6 mm in specimens over 60 mm SL; dorsal fins separate; pelvic interspinal membrane rudimentary; fifth pelvic ray subequal in length to fourth ray; upper edge of dark body stripe along midside of body.

Description: First dorsal fin spines VII(in 31). Second dorsal rays I,10(5); I,11(26). Anal rays I,9(9); I,10(22). Pectoral rays 16(3), 17(23), 18(4). Vertebrae 11+16=27(in 28). Pelvic fin rays I,5(19). Segmented caudal rays 9/8(25). Branched caudal rays 9/8(1); 8/8(7); 8/7(12); 7/8(1); 9/7(1). Procurrent caudal rays 6/5(1); 5/4(12); 5/5(4); 4/3(1); 4/4(1); 3/3(1). Gill rakers on outer face of first arch 9(9); 10(4);

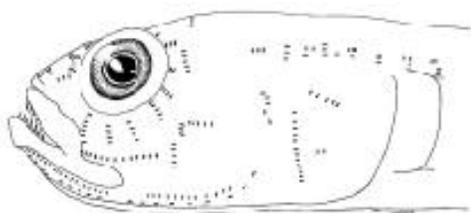


Fig. 5. Side view of head showing papillae of *Gobulus crescentalis*, composite.

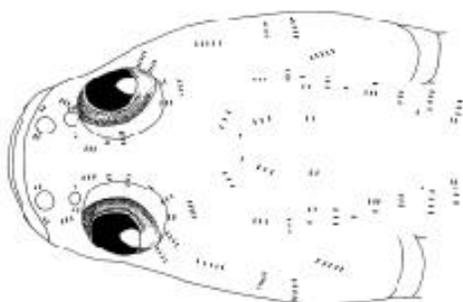


Fig. 6. Top view of head showing papillae of *Gobulus crescentalis*, composite.

11(2). Pseudobranchs 5(2); 4(16); 3(1).

Pelvic fin short, reaching to about middle of belly; interspinal membrane rudimentary or absent. Interradial membrane without a distinct notch along posterior margin of pelvic disc; fifth pelvic ray subequal to fourth ray. Two dorsal fins completely separate. Mouth short, extending posteriorly to a vertical between anterior margin and middle of eye; mouth oblique, forming an angle of about 45° with body axis. Eye moderate, 3-7% of SL (proportion decreases with increasing size). Body moderately slender, body depth at anal origin 12-15% of SL.

Dentition: Upper jaw - an outer row of 10-16 enlarged curved conical teeth on each side of jaw; teeth becoming progressively smaller posteriorly. Anterior portion of jaws with 2 or 3 rows of small conical teeth, tapering laterally to a single inwardly directed row near end of jaw. Lower jaw - an outer row of 2 or 3 slightly enlarged teeth on each side of jaw, near anterior tip of jaw. Two inner rows of smaller teeth extending to near

end of dentary. An innermost row of 6-8 enlarged teeth, extending to bend of dentary; teeth becoming progressively larger posteriorly.

Coloration in alcohol: Lower part of head and body dark brown; upper part light brown or tan, sometimes dark brown in large specimens obscuring countershading. Margin between upper light and lower dark coloration extending from snout to middle of eye then to upper attachment of gill membrane (sharply defined); margin extends onto pectoral base one quarter from top and connects to band on pectoral fin. On body, margin begins opposite middle of pectoral base and extends along midside, turning ventrally near caudal base, connecting to crescent-shaped dark brown bar on base of caudal fin; margin along body sharp in juveniles, but becoming irregular in adults. Dorsal surface of head with several small scattered dark brown spots. A series of approximately 8-10 dark brown irregular blotches ventral to dorsal fins, often connecting with ventral dark area in large specimens. Bases of dorsal fins with a series of small black blotches. Dark brown vertical bar near pectoral-fin base, typically connected ventrally to horizontal bar. Dorsal, anal and pelvic fins clear in juveniles, white in adults. First dorsal fin with 5 or 6 thin, grey, wavy longitudinal stripes. Second dorsal with 7-8 faint thin, grey, wavy longitudinal stripes.

Coloration of fresh material based on field notes of Ken Norris (UCLA W51-8) and C.L. Hubbs (SIO 61-185). Male - Ventral body dusky purplish anteriorly, brownish posteriorly. Upper part of body pale tan with dark markings. A crescent shaped mark at caudal base light cream; below and behind mark a blackish edge grading outwardly to brown. Caudal pale gold. Dorsal fins with considerable yellow. Anal and pelvic fins white. Pectoral fin with some orange. Female - Ventral body dark maroon. Dorsal surface of body whitish tan with fine brown spots. Crescent-shaped mark at caudal base. First

dorsal fin light orange. Second dorsal white.

Urogenital papilla of male with pointed tip, papilla of female with truncate tip. No other apparent sexual dimorphism in preserved material.

Distribution: *Gobulus crescentalis* is known only from the outer coast of Baja California at Magdalena Bay, throughout the Gulf of California, and from Panama. It occurs subtidally to depths of about 25 m.

Material Examined: Holotype - USNM 48258, a 26.7 mm male; Gulf of California, 24° 22' 15" N 110° 19' 15" W, 13 m. GULF OF CALIFORNIA; BAJA CALIFORNIA - Bahía Magdalena: SIO 64-54, 1(70), 5-7 m; SIO 64-55, 1(66), 3-7 m. Isla Angel de la Guardia: UCLA W56-20, 1(32). Bahía de Los Angeles: SIO 62-212, 2(31-49), 0-6 m; SIO 62-215, 1(13), 0-3 m; SIO 62-227, 3(16-32), 5-8 m. Punta Concepción: SIO 65-314, 1(43), 1-5 m. Isla Ildefonso: SIO 65-330, 1(38). Isla Carmen: SIO 65-321, 1(30), 12-21 m. SIO 65-325 1(31), 18-24 m. Isla Santa Catalina: SIO 65-337 1(7). Bahía Aquaverde: SIO 65-296, 1(32), 0-2 m; SIO 65-291, 2(25-27), 3-5 m. Isla Santa Cruz: SIO 65-342, 3(31-35), 0-11 m. San Telmo: SIO 65-287, 1(25), 6-9 m; SIO 65-283, 1(24), 0-11 m. Isla San Francisco: SIO 65-347, 1(30), 12-20 m; SIO 65-345, 8(28-43), 9-14 m. Isla Espíritu Santo: SIO 61-269, 4(21-30), 3-6 m. SIO 61-272, 2 (23-28), 0-15 m; SIO 61-280, 3(31-40), 0-2 m. Punta Pescadero: SIO 61-252, 1(40). GULF OF CALIFORNIA; SONORA - Guaymas: UCLA W51-8, 1(23). PANAMA- Isla Casabo: SIO 70-136, 1(36).

Gobulus hancocki Ginsburg
(Figs. 7, 8)

Gobulus hancocki Ginsburg, 1938: 118 (Secas Island, Panama, holotype USNM 107192).

Diagnosis: The species is distinguished by the following combination of characters: second dorsal rays typically I,11; anal rays typically I,10, pectoral rays typically 16; eye small, diameter less than 1 mm in length in specimens up to largest size known (56 mm); dorsal fins separate; pelvic interspinal membrane well developed; fifth pelvic ray shorter than fourth ray; upper edge of dark body stripe well above midside of body.

Description: First dorsal fin rays VII (in 34); VIII (1). Second dorsal rays I,10(3); I,11(29); I,12(3). Anal rays I,9(9), I,10(25), I,11(1). Pectoral rays 15(6), 16(28), 17(1). Vertebrae 11+16 = 27 (2); 11+17=28 (42, including holotype). Segmented caudal

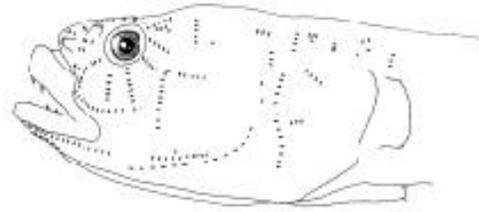


Fig. 7. Side view of head showing papillae of *Gobulus hancocki*.

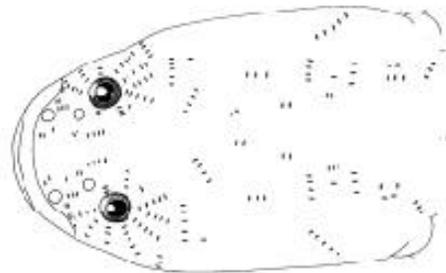


Fig. 8. Top view of head showing papillae of *Gobulus hancocki*.

rays 9/8 (15). Branched caudal rays 9/8 (6); 8/7 (6); 8/8 (3). Procurrent caudal rays 6/5 (1); 6/3 (1); 5/5(4); 5/4(8). Gill rakers on outer face of first arch 9(4); 10(3); 11(1). Pseudobranchs 4 (5).

Pelvic fin short, typically not reaching midbelly in adult; interspinal membrane thin and reduced; interradial membrane with a shallow notch between two pelvic fins; fifth pelvic ray shorter than fourth ray. Mouth short, reaching to under a point between the anterior margin to middle of eye; mouth oblique, forming an angle of about 45° with body axis. Two dorsal fins completely separate. Eye very small, 2.5-4.8% of SL (proportion decreases with increasing size). Body very slender, body depth at anal origin 10-13 % of SL.

Dentition: Upper jaw - an outer row of 8-12 enlarged curved conical teeth on each side of jaw; anterior 4-7 teeth distinctly larger than posterior teeth. Anterior portion of jaws with 3 or 4 rows of small conical teeth, tapering laterally to 2 rows at bend of upper jaw, grading posteriorly into 1 row of inwardly directed teeth near end of jaw. Lower jaw

TABLE 1.

Measurements of holotypes in millimetres of eastern Pacific species of Gobulus

	<i>G. crescentalis</i>	<i>G. hancocki</i>	<i>G. birdsongi</i>
Standard length	27.6	23.3	56.4
head length	7.5	5.7	12.5
head width (maximum)	4.9	3.7	10.3
head width at posterior preopercular margin	3.7	2.7	9.5
body depth at anal origin	3.9	2.3	9.2
caudal peduncle depth	3.1	1.9	7.2
second dorsal base length	8.2	7.5	24.8
anal fin base length	6.2	5.7	21.8
snout length	1.5	1.2	3.4
eye length	1.8	0.9	1.2
jaw length	3.0	2.1	5.2
pectoral length			12.4
pelvic fin length	4.8	3.5	9.2
caudal fin length			13.3

- an outer row of 2 or 3 enlarged curved teeth on each side of jaw, near anterior tip of jaw. Second row composed of smaller conical teeth extending from anterior tip to near terminus of dentary. Innermost row with 3 or 4 small conical teeth near anterior tip, followed by 2-5 enlarged conical teeth, followed by 3 or 4 small conical teeth; row extends posteriorly to middle of dentary.

Coloration in alcohol: Lower part of head and body brown, upper part light brown or tan. Margin between light and dark area typically sharp, extending from tip of snout to mid eye, then from mid-posterior margin of eye to upper attachment of opercular membrane, above pectoral base; then extending along body well above midline of sides to caudal peduncle; just anterior to base of caudal fin, dark area merges with crescent shaped, vertical band, which extends onto base of caudal fin. Top of head covered with numerous melanophores. Pectoral base with scattered melanophores, not forming a band; melanophores covering one-fifth of base of pectoral fin. Dorsal, anal, and pelvic fins without melanophores. Caudal fin only with a dark brown crescent shaped bar at base in some specimens. In others melanophores on top of head and along bases of dorsal and anal fins form diffuse grey spots. In heavily pigmented specimens spots may obscure coun-

tershading.

Live coloration from photo in Allen and Robertson (1994): Similar to coloration in alcohol, but with area above midline white, with a series of small dark brown spots.

Urogenital papilla of male with pointed tip, papilla of female with truncate tip. No other apparent sexual dimorphism.

Distribution: *Gobulus hancocki* is known from the Gulf of California, Costa Rica, Panama, and Isla del Coco. It occurs subtidally to depths of 12 m.

Material Examined: Holotype - USNM 107192, a 23.3 mm female; Secas Island, Panama, shore, coral tide flat, GULF OF CALIFORNIA; BAJA CALIFORNIA - Punta Concepción: SIO 65-314, 12(16-31), 0-5 m. Isla Carmen: SIO 65-300, 7(15-24), 0-2 m. Bahía Aquaverde: SIO 65-289, 12(20-27), 0-3 m. San Telmo: SIO 65-284, 9(22-27), 0-3 m, Espíritu Santo Is, - SIO 61-265, 4(19-26), 1-2 m; SIO 61-269, 5(13-19), 3-6 m. Cabo San Lucas SIO 65-186, 1(22). GULF OF CALIFORNIA; SONORA CAS - SU 18449 1(21); CAS-SU 18450, 1(20); CSCLB 680613-04, 2(18-23); UA 66-82, 4(23-26). COSTA RICA - Isla del Coco: LACM 8869-71., 3(26-29); SIO 59-331, 3(23-25). PANAMA - Isla San José: SIO 67-37 1(12).

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RESUMEN

Se describe una nueva especie *Gobulus birdsongi*, de la costa pacífica de Panamá. Además se redescubren las otras dos especies del género para el Pacífico Oriental. La nueva especie se diferencia por tener un mayor número de rayos dorsales y anales.

REFERENCES

- Allen, G.R. & D.R. Robertson. 1994. Fishes of the Tropical Eastern Pacific. Crawford House, Bathurst, 332 p.
- Birdsong, R. 1975. The osteology of *Microgobius signatus* Poey (Pisces: Gobiidae) with comments on other gobiid fishes. Bull. Fla. State Mus. Biol. Sci. 19(3): 135-187.
- Böhlke, J.E. & C.R. Robins. 1968. Western Atlantic seven-spined gobies, with descriptions of ten new species and a new genus, and comments on Pacific relatives. Proc. Acad. Nat. Sci. Philad. 120(3):45-174.
- Gilbert, C.H. 1892. Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally among the Santa Barbara islands and in the Gulf or California. Proc. U.S. Nat. Mus. 14:539-566.
- Ginsburg, I. 1933. Descriptions of new and imperfectly known species and genera of gobioid and pleuronectid fishes in the United States National Museum. Proc. U.S. Nat. Mus. 82:1-23.
- Ginsburg, I. 1938. Eight new species of gobioid fishes from the American Pacific coast. Allan Hancock Pac. Exped. 2: 109-121.
- Ginsburg, I. 1939. Twenty one new American gobies. Jour. Wash. Acad. Sci. 29:51-63.
- Hastings, P. 1983. Redescription of *Gobulus myersi* (Pisces: Gobiidae). Northeast Gulf Sci 6: 191-196.
- Hoese, D.F. 1971. A revision of the eastern Pacific species of the gobiid fish genus *Gobiosoma*, with a discussion of relationships of the genus. PhD. Thesis, University of California, San Diego: 213 p.
- Hubbs, C.L., & K.F. Lagler. 1958. Fishes of the Great Lakes region. Cranbrook Ins. of Sci., Michigan: 213 p.
- Leviton, A.E., R.H. Gibbs, E. Heal, & C.E. Dawson. 1985. Standards in herpetology and ichthyology: Part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia 1985: 802-832.