

A REVIEW OF THE GOBIID FISH GENUS *MICROGOBIUS* POEY

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ABSTRACT

The genus *Microgobius* Poey 1876 comprises 14 species of gobies distributed from the Chesapeake Bay to southern Brazil in the western Atlantic and from Baja California to Peru in the eastern Pacific.

The species are redescribed and differentiated using meristic, morphometric and color pattern characteristics and keys to their identification are presented. Characters describing the genus are given.

Photographs of all species are presented and sexual dimorphism is described. The distribution and available ecological information for each species is included.

The distinctive genus *Microgobius* comprises 14 species of American seven-spined gobies (tribe Gobiosomini) distributed in the western Atlantic and eastern Pacific. The species display a range of habitat preferences from low salinity estuaries to coral reefs. Most species are strongly sexually dimorphic.

The genus has not been treated in its entirety since the work by Jordan and Evermann (1898). Since that time nine additional species have been described. Several species are known only from their brief original accounts and sexual dimorphism has been described for only a few.

This study reviews the systematics of the genus *Microgobius* and redescribes the species. The included synonymies are selective. Extended synonymies are given in Birdsong (1969). Where available, ecological data are given.

METHODS

Counts.—Counts given for the anal and second dorsal fins are of the total number of elements, the first element being spinous and the remaining soft, striated and bilaterally structured. The last two elements in the anal and second dorsal fins stem from a common pterygiophore and are treated as one.

Scale counts are of transverse rows along the lateral midline to the posterior edge of the hypural plate. The scale rows are very irregular, especially anteriorly, and exact scale row counts are difficult to obtain.

Gill-raker counts are the sum of the rakers on the upper and lower limbs of the first arch. The counts of teeth on the dentary are for one side and are given as an outer row and an inner row, though the inner (and smaller) teeth are occasionally in more than one row near the symphysis.

Measurements.—All measurements are straight-line distances taken with dial calipers to the nearest $\frac{1}{10}$ mm. These were made as described by Böhlke and Robins (1968: 49-50). Morphometric values are given in percent standard length. Laterosensory canal and pore terminology follows Lachner and McKinney (1974: 874).

Abbreviations.—The abbreviations used in the citations of material examined are: AMNH—American Museum of Natural History; ANSP—Academy of Natural Sciences of Philadelphia; CAS—California Academy of Sciences; FMNH—Field Museum of Natural History; FSU—Florida State University; GCRL—Gulf Coast Research Laboratory; IMARPE—Instituto del Mar del Peru; MCZ—Museum of Comparative Zoology; MHNLS—Museo Historia Natural La Salle de la Estación de Investigaciones Marinas de Margarita, Venezuela; SCMRRI—South Carolina Marine Resources Research Institute; SIO—Scripps Institution of Oceanography; SU—Stanford University; UCLA—University of California at Los Angeles; UCR—Universidad de Costa Rica; UF—University of Florida; UMML—Institute of Marine Sciences, University of Miami; UMMZ—University of Michigan Museum of Zoology; UNC—University of North Carolina; UPR—University of Puerto Rico; USNM—United States National Museum of Natural History.

The abbreviations used in the diagnoses and descriptions are: D_1 = first dorsal fin; D_2 = second dorsal fin; A = anal fin; P_1 = pectoral fins.

Microgobius Poey

Tables 1–4

Microgobius Poey, 1876: 168, pl. 8, fig. 3 (type species *Microgobius signatus* Poey by monotypy). Jordan and Eigenmann, 1866: 503–505 (key to species; good descriptions). Evermann and Marsh, 1902: 299 (key to Atlantic species). Meek and Hildebrand, 1928: 871 (synonymy, diagnosis and key to Pacific species).

Zalypnus Jordan and Evermann, 1896: 459 (type species *Gobius emblematicus* Jordan and Gilbert by original designation). Gilbert and Starks, 1904: 175 (synonymized with *Microgobius*).

Xenogobius Metzelaar, 1919: 140–141, fig. 40 (type species *Xenogobius weberi* Metzelaar by monotypy). Longley, 1932: 300 (*Xenogobius weberi* Metzelaar synonymized with *Microgobius signatus* Poey).

Characterization of *Microgobius*

Microgobius is characterized by the following combination of features, not listed according to taxonomic importance:

The first dorsal fin comprises seven spines with their pterygiophores arranged in relation to the underlying vertebrae (starting posterior to the third neural spine) in a ratio of 2:2:1:1:1. Following the notation of Birdsong (1975: 137), the pterygiophore formula is 3(221110). The dorsal spines are frequently elongated into filaments (usually only in the males), the longest occasionally reaching the base of the caudal fin.

The second dorsal fin comprises one spine and modally 14–19 soft rays (Table 1). The first pterygiophore of the second dorsal fin is posterior of the ninth neural spine; the elements are in approximately a 1:1 ratio with the underlying vertebrae.

The anal fin has one spine and modally 14–20 soft rays (Table 1). The first two anal pterygiophores lie anterior of the first haemal spine (12th vertebra), and the remaining elements are arranged in an approximate 1:1 ratio with the underlying vertebrae.

The caudal fin has 17 segmented rays of which 15 are branched; the medial rays are the longest resulting in a lanceolate caudal fin in most species.

The pectoral fin has modally 20–23 rays (Table 1).

The pelvic fin has one spine and five rays, the pair fully united to form a disc with a well-developed frenum; the medial rays are the longest.

There are 11 precaudal and 16 caudal vertebrae including the urostyle (total vertebrae 27), rarely 11 + 17 in variants.

The scales are cycloid or ctenoid, many species possessing both types. Most species have a patch of slightly enlarged ctenoid scales under the appressed pectoral fin. The head, nape, breast, belly and pectoral base are without scales; in most species the squamation stops short of the pectoral axil and the back below the anterior portion of the spinous dorsal fin is naked. Lateral scale rows range from about 35–90 (Table 2).

There are five branchiostegal rays, one on the epihyal, three on the expanded portion of the ceratohyal and one on the narrow portion of the ceratohyal.

The basihyal is bifurcated; the frontal bones form a single median crest posterior to the orbits (except *M. carri*) and a pair of troughs between the orbits; the metapterygoid does not reach the quadrate; and the symplectic process of the preopercle is reduced or absent.

The teeth are in two rows in both jaws (sometimes three to four rows near the symphysis), the outer row enlarged and caninoid.

Table 1. Frequency distribution of fin-ray counts for the species of *Microgobius*

Species	Second Dorsal Fin										Anal Fin										Pectoral fin									
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
<i>M. signatus</i>																														
<i>microlepis</i>																														
<i>meeki</i>																														
<i>thalassinus*</i>																														
<i>carri*</i>																														
<i>gulosus</i>																														
<i>emblemaicus</i>																														
<i>brevispinis</i>																														
<i>tabogensis</i>																														
<i>miraflorensis</i>																														
<i>curtus</i>																														
<i>crocatius</i>																														
<i>erectus</i>																														
<i>cyclolepis</i>																														

* See text table under species account.

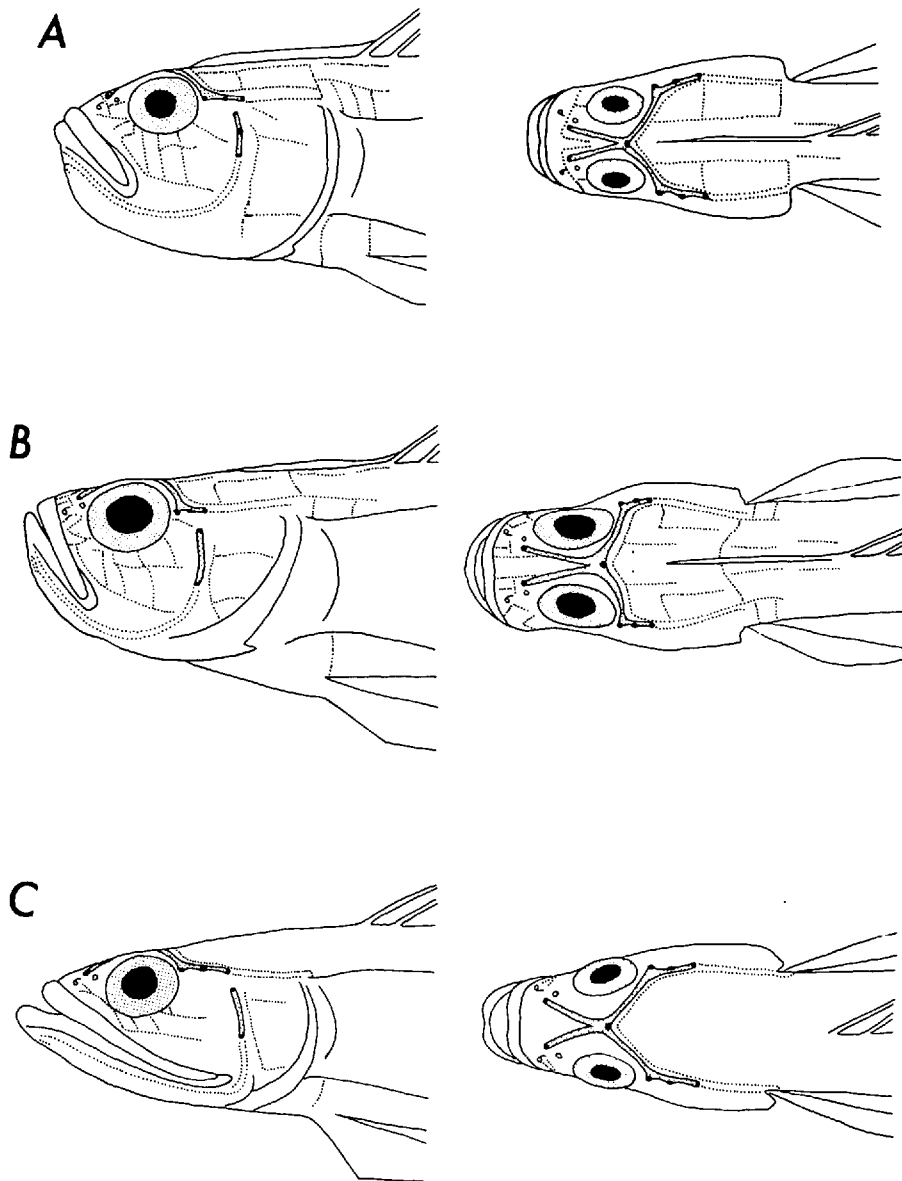


Figure 1. Lateral and dorsal views of the cephalic sensory canal and papillary system. A, *M. signatus*; B, *M. erectus*; C, *M. carri*.

The mouth is large (especially in males) and strongly inclined toward the vertical in most species.

The gill openings extend the length of the pectoral base.

The anterior nostrils open at the end of short tubes.

A fleshy, median crest is present on the nape in one or both sexes of most species.

The genital papilla is small in both sexes, that of the male conical in shape.

The laterosensory canal system (Fig. 1) is composed of two supraorbital canals (often contiguous or conjoined between the orbits), each terminating anteriorly

Table 2. Approximate ranges and means of lateral scale rows in the species of *Microgobius**

Species	Range	\bar{x}	N
<i>signatus</i>	77-90	85	31
<i>microlepis</i> †	68-78	72	21
<i>meeki</i>	46-60	51	24
<i>thalassinus</i> ‡	43-50	46	27
<i>carri</i>	50-62	56	18
<i>gulosus</i>	44-54	49	56
<i>emblematicus</i>	50-75	62	23
<i>brevispinis</i>	63-81	71	26
<i>tabogensis</i>	41-55	49	60
<i>miraflorensis</i>	40-48	44	16
<i>curtus</i>	62-78	69	18
<i>crocatus</i>	46-56	51	11
<i>erectus</i> §	35	35	3
<i>cyclolepis</i> §	46-55	50	5

* Irregularity of the scale rows precludes an exact count.

† One specimen from the Bahamas with 50 lateral scale rows.

‡ See text discussion.

§ Scales caducous.

in a nasal pore; posteriorly the supraorbital canals converge at the medially situated posterior interorbital pore and then diverge to join their respective lateral cephalic canals just behind the orbits. The lateral cephalic canal is short, with two or three pores (rarely four in variants). The preopercular canal has two or three pores. There is no temporal canal.

The sensory papillary system is extensively developed on the head (Fig. 1). In some species the papillary system extends well onto the body in short, vertical, disjunct rows and in a few species, horizontal rows of papillae can be seen along the medial caudal rays.

Most species are strongly sexually dimorphic in mouth size (Table 4) which is reflected in sexual differences in many bones of the mouth and suspensorium.

All species, where known, except *M. gulosus* and *M. miraflorensis*, possess bright colors on the fins and body. Many species display orange or reddish bands in the fins and iridescent blue markings on the cheek and opercle; a dark bar or spot is frequently present on the body below the anterior spinous dorsal elements. The sexes are usually dimorphic in color pattern and the females frequently possess a well-defined pale area on the body above the anal fin.

The body, and to a lesser degree the head, of most species is compressed.

All species have a well-developed gasbladder with a single rete mirabile.

Hypurals 1-2 are not fused to urostyle.

Misidentifications and Confusing Citations

Microgobius cinctus Nichols, 1952 = *Lythrypnus dalli* (Gilbert), 1891, see Birdsong (1967: 466).

Microgobius Bleeker, a museum name referable to *Stigmatogobius* Bleeker according to Koumans (1931: 102).

Microgobius sp. in Metzelaar 1919: 138 = *Risor ruber* (Rosen), 1911, according to Longley and Hildebrand (1941: 228) and Böhlke and Robins (1968: 133).

"*Microgobius lacustris*" in Breder and Rosen (1966: 533) *lapsus* for *Mirogobius lacustris* Herre.

KEY TO ATLANTIC SPECIES OF *MICROGOBIUS*

- 1a. Three pores in preopercular sensory canal; soft dorsal fin with more than 17 elements; anal fin with more than 18 elements; lateral scale rows greater than 65 2

- 1b. Two pores in preopercular sensory canal; soft dorsal fin usually with 17 or fewer elements; anal fin with 18 or fewer elements; lateral scale rows fewer than 65 3
- 2a. Soft dorsal-fin elements 20–21; anal-fin elements 21 (occasionally 20); lateral scale rows about 77–90; scales mostly cycloid; females with pale bar edged in black on body above pectoral fin *Microgobius signatus* Poey
- 2b. Soft dorsal-fin elements 18–19; anal-fin elements 19 (occasionally 20); lateral scale rows about 68–78; scales mostly ctenoid; no dark markings on body in either sex *Microgobius microlepis* Meek and Hildebrand
- 3a. A fleshy median crest present on nape; a prominent dark spot on body below spinous dorsal fin origin; caudal fin usually greater than 40% of SL *Microgobius meeki* Evermann and Marsh
- 3b. Fleshy median crest absent or poorly developed on nape; body with no dark spot below spinous dorsal origin or with many dark spots; caudal fin usually less than 40% of SL 4
- 4a. Scales mostly ctenoid; about 4 enlarged caninoid teeth in outer row of each dentary; inter-orbital width broad (about 4% of SL); a broad yellow stripe on side with 2 narrow yellow stripes above *Microgobius carri* Fowler
- 4b. Scales mostly cycloid; about 8 enlarged caninoid teeth in outer row of each dentary; inter-orbital width narrow (less than 3% of SL); no yellow stripes on body 5
- 5a. Three pores in lateral cephalic sensory canal; body with numerous dark blotches; mouth of males greatly enlarged (greater than 15% of SL in males larger than 25 mm) *Microgobius gulosus* (Girard)
- 5b. Two pores in lateral cephalic sensory canal; body without dark spots; mouth of males little enlarged (less than 15% of SL in males) *Microgobius thalassinus* (Jordan and Gilbert)

KEY TO PACIFIC SPECIES OF *MICROGOBIUS*

- 1a. Soft dorsal-fin elements 16 or fewer (rarely 17); anal-fin elements 16 or fewer (rarely 17); scales mostly cycloid, often caducous; a patch of ctenoid scales beneath pectoral fin 2
- 1b. Soft dorsal-fin elements 17 or more (rarely 16); anal-fin elements 17 or more (rarely 16); scales cycloid or ctenoid, not caducous; with or without patch of ctenoid scales beneath pectoral fin 4
- 2a. Soft dorsal-fin elements 15 or fewer; anal-fin elements 15 or fewer; lateral scale rows less than 40; epaxial myosepta darkly pigmented *Microgobius erectus* Ginsburg
- 2b. Soft dorsal-fin elements 16 (rarely 15 or 17); anal-fin elements 16 (rarely 17); lateral scale rows greater than 40; epaxial myosepta unpigmented 3
- 3a. Preopercular sensory canal with three pores; lateral scale rows less than 60; pectoral rays 22–24; a prominent crescent or ovoid-shaped spot on body below anterior dorsal spines *Microgobius cyclolepis* Gilbert
- 3b. Preopercular sensory canal with 2 pores; lateral scale rows more than 60; pectoral rays 20–21; spot on body below anterior dorsal spines faint, never crescent shaped *Microgobius curtus* Ginsburg
- 4a. Scales entirely cycloid, no ctenoid patch beneath pectoral fin; pectoral fin short, usually 18–24% of SL; both sexes with low, fleshy nuchal crest 5
- 4b. Patch of ctenoid scales present beneath pectoral fin; remaining scales cycloid or ctenoid; pectoral fin long, usually 23–27% of SL; fleshy nuchal crest absent in one or both sexes (always absent in males) 6
- 5a. Dorsum with about 5 dark dashes along dorsal fin base; diffuse dark spot on body beneath anterior dorsal spines; about 4 enlarged, caninoid teeth in outer row of each dentary; soft dorsal-fin elements usually 17; anal-fin elements usually 17 *Microgobius emblematicus* (Jordan and Gilbert)
- 5b. Dorsum without dark dashes; a dark bar bordered with yellow on body beneath anterior dorsal spines in males; an iridescent yellow bar present beneath pectoral fin of females; about 6–7 enlarged, caninoid teeth in outer row of each dentary; soft dorsal-fin elements usually 18; anal-fin elements usually 18 *Microgobius brevispinis* Ginsburg
- 6a. A prominent dark spot or bar present on body below origin of spinous dorsal fin; soft dorsal-fin elements usually 17; anal-fin elements usually 17 7
- 6b. No dark spot on body below origin of spinous dorsal fin; soft dorsal-fin elements 17–18; anal-fin elements usually 18 *Microgobius crocatus* Birdsong
- 7a. Each dentary with about 15–20 teeth in outer row; fleshy nuchal crest absent in both sexes; males with dark bar on body below spinous dorsal fin origin, females with dark spot *Microgobius miraflorensis* Gilbert and Starks
- 7b. Each dentary with about 7–9 teeth in outer row; fleshy nuchal crest well developed in females; both sexes with a diffuse dark spot on body below origin of spinous dorsal fin *Microgobius tabogensis* Meek and Hildebrand

Microgobius signatus Poey, 1876
(Figures 1A, 2A, B, Tables 1–4)

Microgobius signatus Poey, 1876: 168–169, pl. 8, fig. 3 (type locality Cuba; syntypes MCZ 13127).
Xenogobius weberi Metzelaar, 1919: 140–141 (type locality Curacao reef waters). Longley, 1932: 300 (junior synonym of *Microgobius signatus* Poey).

Diagnosis.—D₂ 19–21 (usually 20); A 20–22 (usually 21); lateral scale rows about 77–90; scales mostly cycloid; nuchal crest well developed in both sexes; preopercular sensory canal with 3 pores; females with pale vertical bar edged in black on shoulder; both sexes with a dark spot at upper hypural base.

Description.—P₁ 19–22 (usually 21–22); each dentary with about 4–5 teeth in outer row; mouth inclined about 45 degrees from the horizontal; upper jaw 12.0 in males, 11.7 in females; gill rakers on first arch about 5 + 16.

Eye diameter 6.8; interorbital width 3.3; head length 26.3; pectoral-fin length 20.1; pelvic-fin length 20.0 in males, 18.6 in females; caudal-fin length 33.4.

Scales on side extending forward almost to pectoral axil, absent on dorsum immediately below spinous dorsal; scales cycloid with patch of strongly ctenoid scales under appressed pectoral fin. First dorsal spine produced into filament in females, rarely extending past origin of second dorsal fin; first dorsal spine not elongate in males.

SENSORY CANAL SYSTEM (Fig. 1A). Supraorbital canals separate for most of their extent; lateral cephalic canal with three pores; preopercular canal with three pores; papillary chains extensive on head and body; body papillary chains consist of several discontinuous vertical rows extending to caudal peduncle.

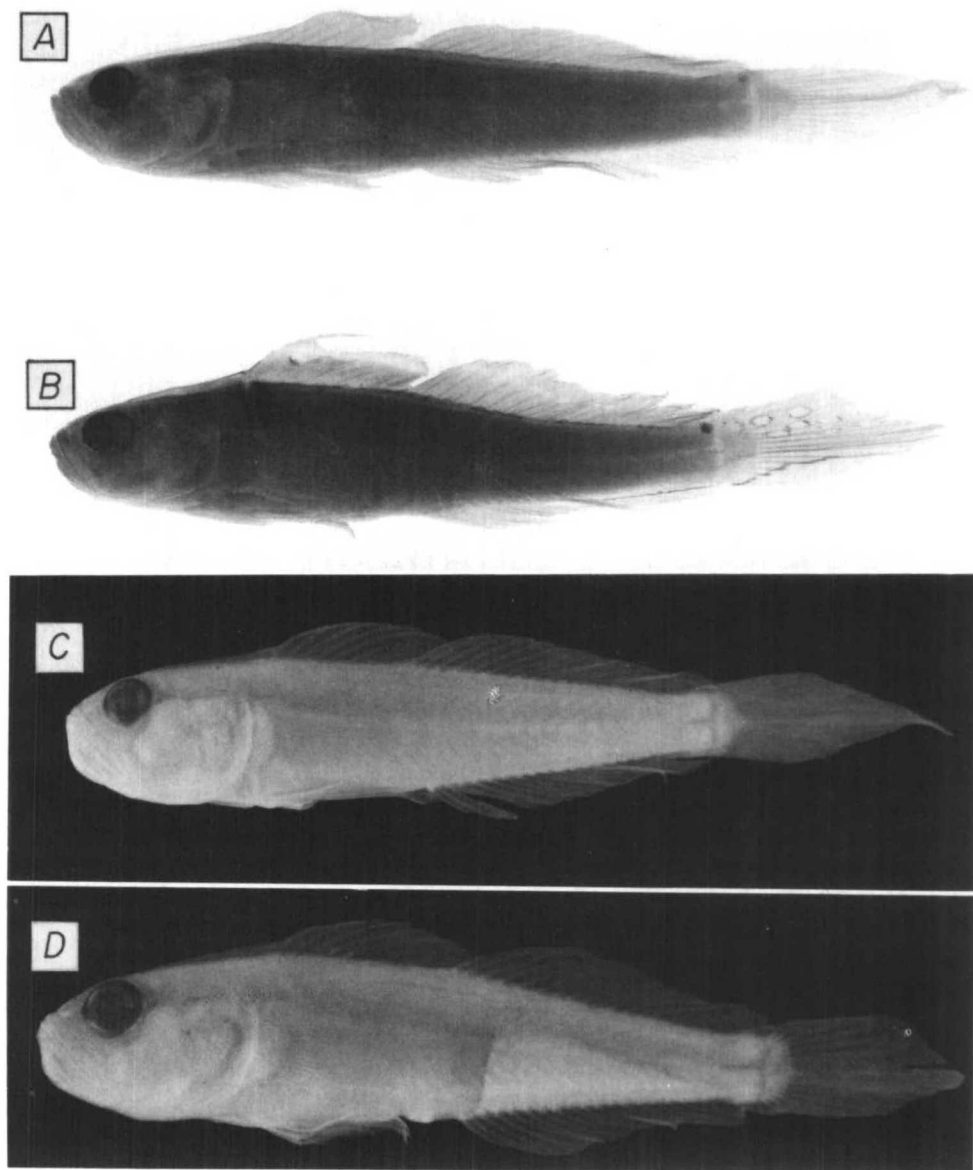
PIGMENTATION OF MALES. The following account is based on preserved specimens: body uniformly brownish in preservative with dark spot on upper hypural base; no markings on body over pectoral fin; head with two dark horizontal stripes on cheek below eye, separated by pale stripe (probably blue in life); spinous dorsal and pectoral fins uniformly dusky; soft dorsal fin dusky with narrow, pale submarginal stripe; anal fin dusky with narrow, pale stripe on posterior nine to ten rays continuous with similar stripe on caudal fin; caudal fin dusky with two pale stripes above midline and two pale stripes below midline; caudal stripes are horizontal and run obliquely across the caudal rays; pelvic fins dusky.

PIGMENTATION OF FEMALES. Body uniformly dusky with dark spot on upper hypural base; body dorsum along dorsal-fin base with 8 to 10 darkly pigmented dashes. Vertical, pale bar with darkened borders extending from the spinous dorsal origin to the axil of the pectoral fin; spinous dorsal dusky with broad, pale submarginal stripe; second dorsal fin dusky with narrow, pale submarginal stripe; anal fin dusky with narrow, dark stripe crossing last 8–12 rays and continuous with similar stripe on caudal fin; caudal fin dusky with dark, narrow median stripe and another dark, narrow stripe on ventral portion; dorsal rays of caudal fin with several indistinct, ocellated spots.

Ecology.—Little is known of the ecology of *Microgobius signatus*. Fernando Cervigón (personal communication) states that in Venezuela this species is most abundant in sandy bottom areas around islands.

Distribution.—Known from the Greater and Lesser Antilles and the coast of Venezuela.

Discussion.—Poey's type series of *Microgobius signatus* contained three specimens, all males. The largest of these (MCZ 13127, 34.8 mm SL) is hereby des-



ĀNSP 105182; C, *M. microlepis*, male, 32.5 mm SL, USNM uncat; D, *M. microlepis*, female, 26.4 mm SL, USNM uncat.

ignated as the lectotype. The remaining two specimens (MCZ 45904, 30.3, 34.5 mm SL) are thereby to be considered paralectotypes.

Following Longley (1932: 300), I consider *Xenogobius weberi* Metzelaar, 1919, to be a junior synonym of *Microgobius signatus* Poey, 1876. The type specimen of *Xenogobius weberi* was not examined, but the original description and illustration are sufficiently detailed to leave little doubt of the synonymy of *X. weberi* with *Microgobius signatus*.

Table 3. Ranges and means of measurements of head length, eye diameter, interorbital width and pectoral-fin length for the species of *Microgobius* expressed in percent of standard length (number of specimens given in parentheses)

Species	Head Length Males		Head Length Females		Eye Diameter		Interorbital Width		Pectoral-Fin Length	
	Range	\bar{x}	Range	\bar{x}	Range	\bar{x}	Range	\bar{x}	Range	\bar{x}
<i>signatus</i>	23–28	25.9 (15)	25–28	26.9 (12)	6–9	6.8 (23)	2–4	3.3 (22)	18–23	20.1 (26)
<i>microlepis</i>	25–30	27.1 (14)	26–31	28.2 (14)	7–10	8.3 (28)	3–4	3.2 (10)	20–27	24.4 (26)
<i>meeki</i>	26–31	28.0 (13)	25–32	27.5 (17)	6–11	7.7 (22)	2–3	2.1 (9)	23–28	26.1 (26)
<i>thalassinus</i>	25–28	26.9 (16)	24–28	26.5 (15)	6–8	6.8 (16)	2–3	2.5 (16)	22–31	26.5 (31)
<i>carr</i>	26–31	27.7 (13)	27–28	27.7 (10)	6–8	7.2 (23)	3–5	4.1 (18)	26–34	28.9 (23)
<i>gulosus</i>	29–33	30.6 (20)	26–31	28.9 (14)	6–8	7.0 (34)	2–3	2.4 (10)	21–28	24.5 (32)
<i>emblematicus</i>	26–30	27.8 (10)	26–30	27.8 (10)	6–9	7.4 (20)	1–3	2.3 (19)	18–21	19.2 (18)
<i>brevispinis</i>	24–27	25.5 (13)	25–27	25.8 (8)	6–8	7.0 (21)	2–4	2.9 (15)	19–24	21.6 (21)
<i>tabogensis</i>	26–30	27.3 (15)	24–27	25.8 (16)	6–9	7.4 (31)	1–3	2.0 (16)	21–29	24.0 (28)
<i>miraflorensis</i>	27–31	28.8 (16)	26–29	27.5 (15)	7–8	7.5 (31)	2–3	2.4 (8)	22–29	25.7 (28)
<i>curtus</i>	27–29	27.8 (10)	26–31	27.9 (11)	7–10	8.2 (22)	2–4	3.0 (16)	18–22	20.3 (18)
<i>crocatus</i>	25–30	27.1 (14)	23–27	24.8 (10)	7–11	9.0 (24)	3–5	3.7 (24)	23–28	24.9 (22)
<i>erectus</i>	23–26	24.4 (10)	23–26	24.2 (11)	7–8	7.6 (21)	2–3	2.6 (20)	23–27	25.5 (15)
<i>cyclolepis</i>	27–31	28.6 (11)	24–29	27.3 (12)	7–9	7.9 (23)	2–3	2.6 (23)	21–28	24.9 (19)

Material Examined.—Cuba: MCZ 13127 (male, 34.8), lectotype, original No. 513, F. Poey. MCZ 45904 (2, 30.3, 34.5), paralectotypes, original No. 513, formerly MCZ 13127, F. Poey. MCZ 30602 (7, 30.0–35.0). USNM 35164 (8). USNM 82521 (1, 32.0). Curaçao: UMML uncat. (1, 24.5). Antigua: UF 11303 (4, 25.8–31.7). Venezuela: ANSP 105182 (199, 31.5–52.0). ANSP 105341 (2, 34.8–37.8). MHNLS uncat. (2, 30.3–34.0), Cubagua, 1965, F. Cervigón. ANSP 105209 (2, 30.8–49.0). MHNLS uncat. (2, 32.0–32.2), Bahía El Fablazo, S. Isla Zapara, 1 Mar. 1961, F. Cervigón. MHNLS uncat. (4, 18.7–28.9), "Costas de Venezuela," F. Cervigón. MHNLS 1189 (1, 28.5). MHNLS uncat. (1, 26.2), Estado Sucre, Laguna Grande, 6 July, 1948, F. Cervigón. MHNLS 1914 (4, 25.0–26.2).

Microgobius microlepis Longley and Hildebrand, 1940
(Figure 2C, D, Tables 1–4)

Microgobius microlepis Longley and Hildebrand, 1940: 257 (type locality Tortugas, Fla.; holotype USNM 108868).

Diagnosis.—D₂ 16–20 (usually 18); A 18–20 (usually 19); lateral scale rows about 68–78 (see discussion); scales mostly ctenoid; nuchal crest present in both sexes; preopercular sensory canal with three pores; no dark spots on body or fins.

Description.—P₁ 20–23 (usually 21–22); gill rakers on first arch about 4 + 12; each dentary with about 5–6 teeth in outer row; mouth inclined about 50 degrees from the horizontal; upper jaw 13.7 in males, 12.7 in females.

Eye diameter 8.3; interorbital width 3.2; head length 27.7; pectoral-fin length of males 24.9, females 21.4; caudal-fin length 35.0.

Fleshy nuchal crest moderately developed in females, slightly developed in males. Scales on sides extending forward almost to pectoral axil, absent on dorsum below anterior portion of spinous dorsal fin; most scales weakly ctenoid, cycloid on venter. Dorsal spines two through six slightly produced as filaments in both sexes, the longest reaching the base of the fourth element of the soft dorsal fin.

SENSORY CANAL SYSTEM. Supraorbital canals separate between the orbits; lateral cephalic canal with three (rarely two) pores; preopercular canal with three pores (median pore very small).

COLORATION OF MALES. The following account is based on live and freshly preserved specimens: body pale with greenish cast to dorsum, whitish venter and dusky midlateral stripe; cheek below eye with three iridescent blue stripes with pale orange stripes between; pale orange stripe connecting anterior margin of orbit with upper lip; chin with rosy cast midventrally; opercle dusky orange with iridescent blue bar or spot; nuchal crest with rosy cast; branchiostegal membranes with bluish cast. Proximal half of spinous dorsal fin rosy orange (most intense distally), and in order from the base, a hyaline band, greenish-yellow band, hyaline band and pale, rosy-orange distal margin. Soft dorsal fin pigmented like spinous dorsal fin. Anal fin pale yellow proximally, becoming orange distally; pectoral fins pale; pelvics dusky rose. Caudal fin with orange cast to dorsal margin; greenish-yellow band across dorsal rays, continuous with similar band in dorsal fins; median, dusky stripe continuous with similar stripe on body; ventral caudal membranes with yellowish cast.

COLORATION OF FEMALES. Pigmented as male except the following: venter above anal fin white, this area bounded by a dusky line running posterodorsally from anal fin origin to above midline of body, then ventroposteriorly to caudal base, dipping well below midline along caudal peduncle. Belly with rosy cast; chin whitish. Soft dorsal pale with rosy-orange base which runs diagonally from mid-way first element to base of sixth to seventh element; a greenish-yellow stripe

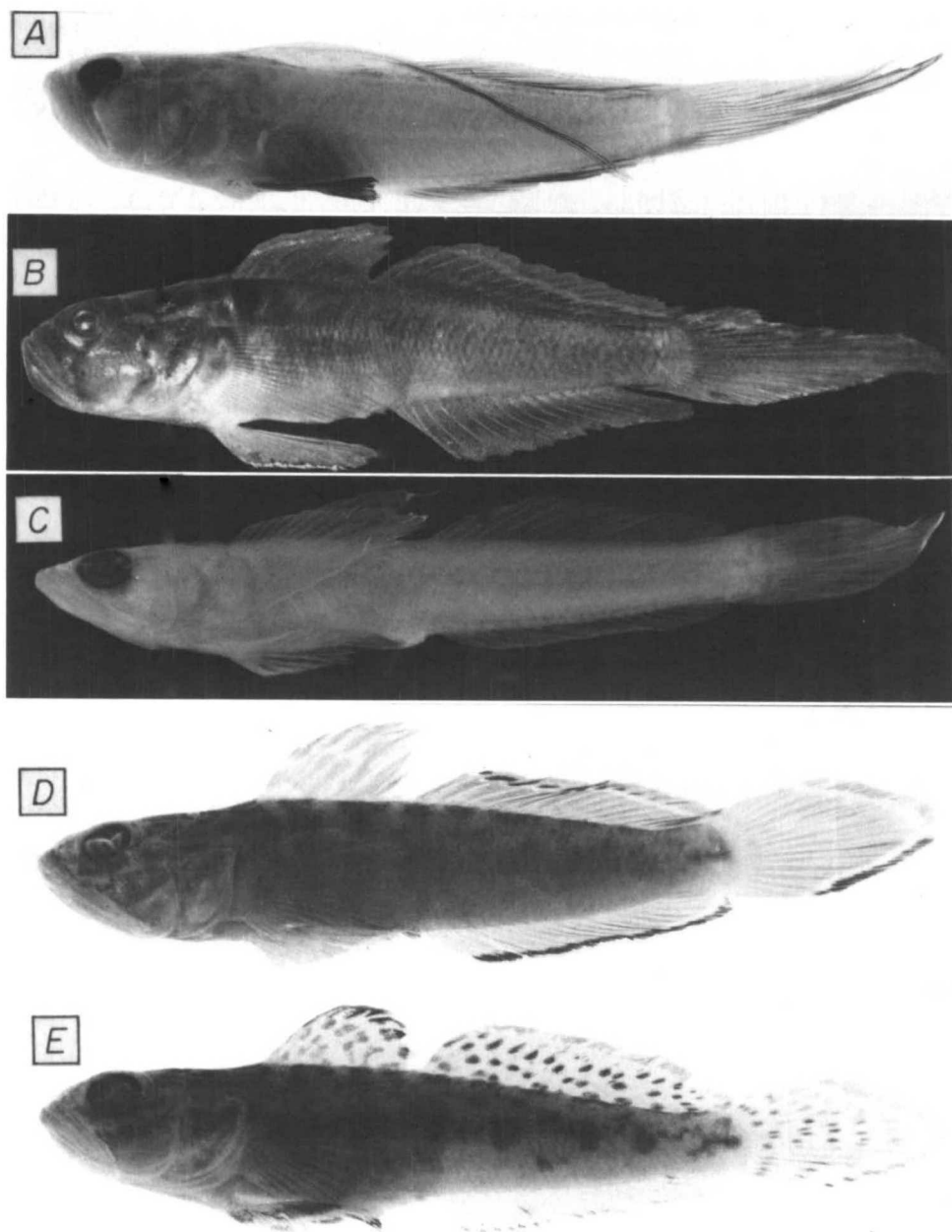


Figure 3. A, *M. meeki*, male, 31.8 mm SL, MHNLS uncat; B, *M. meeki*, female, 22.9 mm SL, UPR 2398 (photographed by John Randall); C, *M. carri*, female, 35.9 mm SL, FSU 18792; D, *M. gulosus*, male, 45.3 mm SL, USNM 176215; E, *M. gulosus*, female, 40.3 mm SL, USNM 176215.

running from leading fin edge to base of eighth or ninth elements, paralleling rosy-orange area; distal margin of fin with rosy cast. Anal fin pale with rosy cast to base. Caudal fin with median, dusky rose stripe and a similar stripe below that originates at ventral base and runs diagonally to fin margin just below tip; caudal fin yellowish above, rosy below.

Ecology.—During this study *M. microlepis* was observed in the field on numerous occasions in Biscayne Bay, Florida, and in the Florida Keys. It is a common species in the inshore waters of this area from 1.5 to 5.0 m of depth over fine, calcareous bottom sediments.

Longley and Hildebrand (1940: 258) noted that this species builds burrows in the bottom. The males are often seen actively transporting sand out of the burrows in their mouths. The burrows are usually 1.5–3.0 cm in diameter at their mouths and the walls are of tightly packed sediments (smooth to the touch). A single burrow may extend horizontally for 30–45 cm and often has more than one opening, as well as blind passages which terminate under small rocks or shells. The burrows are usually 5 to 7 cm beneath the sediment but some appear to go straight down for 10 to 15 cm before becoming horizontal.

This species typically hovers in the water 12 to 25 cm over the mouth of the burrow, in a head up-tail down attitude about 45 degrees from the horizontal. It occasionally can be seen to make short lunges, apparently picking plankters from the water. C. R. Robins (personal communication) reports having seen a group of this species schooling with a large school of anchovies.

Burrows are most frequently occupied by a mated pair; however, it is not uncommon to see three or four individuals enter a single burrow.

Females distended with eggs occur throughout the summer in the Florida Keys. Spawning may occur within the burrow (as in *M. carri*) but no eggs were found in any of the burrows examined.

The local distribution of this species seems to be dependent upon bottom composition and grain size (see ecology section under *M. gulosus*). Abundance varies considerably from year to year in any given locality.

Distribution.—*M. microlepis* is known from southeastern Florida (as far north as Jupiter Inlet, Martin County, and south through Florida Bay); and from Tortugas, Bahamas (see discussion), Yucatan and British Honduras.

Discussion.—This species is known from the Bahamas by a single specimen (UMML 5286, female, 24.7 mm SL). The Bahama specimen (figured in Böhlke and Chaplin, 1968) generally agrees with the Florida and eastern Caribbean material in all characters except number of lateral scale rows. In this character the Bahama specimen has only about 50 rows as compared to 68–78 in the other populations. Obviously more Bahama material is needed to clarify the status of this population.

Material Examined.—Florida: USNM 108868 (37.6), holotype, Tortugas, W. H. Longley. USNM 108880 (37, 14.2–39.7), paratypes, Tortugas, Longley. UMML 1376 (12, 18.3–24.2). UMML 2530 (2, 36.0–36.7). UMML 1340 (10, 15.5–30.5). UMML 3209 (9, 21.5–28.0). UMML 3319 (2, 29.9–39.0). UMML 24737 (3, 23.3–29.7). USNM uncat. (22, 20.2–31.9), RSB-G-16. FSU 12206 (2, 22.2–23.6). USNM 73144 (1, 20.8). Bahamas: UMML 5286 (1, 24.7). Eastern Caribbean: GCRL V68-3002 (2, 22.0, 24.8), Mexico. ANSP 97924 (1, 23.0), British Honduras.

Microgobius meeki Evermann and Marsh, 1900
(Figure 3A, B and Tables 1–4)

Microgobius meeki Evermann and Marsh, 1900: 356 (type locality between Culebra and Vieques Islands, Puerto Rico at FISH HAWK sta. 6087; holotype USNM 49367).

Microgobius omostigma Starks: 1913: 68–69 (type locality Natal, Brazil, in rock pools). Böhlke, 1953: 115 (types in Stanford Univ. collection; SU 22214 designated lectotype, SU 22383 designated paralectotypes).

Diagnosis.—D₂ 16–18 (usually 17); A 16–18 (usually 17); lateral scale rows about 46–60; fleshy nuchal crest well developed in females, smaller in males; scales

Table 4. Ranges and means of measurements of upper-jaw length, pelvic-fin length and caudal-fin length for the species of *Microgobius* expressed in percent of standard length (number of specimens given in parentheses)

	Upper-Jaw Length Males		Upper-Jaw Length Females		Pelvic-Fin Length Males		Pelvic-Fin Length Females		Caudal-Fin Length	
	Range	\bar{x}	Range	\bar{x}	Range	\bar{x}	Range	\bar{x}	Range	\bar{x}
<i>signatus</i>	11-13	12.9 (15)	11-12	11.7 (12)	18-26	20.0 (11)	17-21	18.6 (10)	25-39	33.4 (26)
<i>microlepis</i>	12-15	13.7 (14)	11-14	12.7 (13)	21-28	24.9 (13)	18-24	21.4 (13)	28-40	35.0 (21)
<i>meeki</i>	11-18	14.8 (13)	10-13	11.3 (16)	22-28	25.3 (9)	23-29	23.6 (12)	36-51	41.3 (29)
<i>thalassinus</i>	11-13	12.0 (16)	10-12	11.3 (14)	21-26	23.2 (11)	21-26	22.9 (10)	29-37	34.0 (27)
<i>carri</i>	16-24	20.1 (12)	10-14	13.1 (10)	15-20	18.3 (10)	16-21	18.3 (9)	24-36	29.7 (19)
<i>gulosus</i>	16-25	20.8 (20)	11-14	13.0 (14)	21-26	23.7 (20)	22-28	24.1 (14)	28-35	31.7 (33)
<i>emblematicus</i>	13-15	14.0 (10)	11-16	12.6 (10)	17-22	20.3 (10)	18-21	19.8 (10)	25-29	27.6 (20)
<i>brevispinis</i>	11-15	13.4 (13)	11-13	11.9 (8)	23-30	25.5 (13)	19-24	21.8 (8)	26-33	29.3 (21)
<i>tabogensis</i>	11-22	15.9 (15)	11-13	11.7 (16)	21-26	24.2 (14)	21-26	24.8 (13)	29-43	37.4 (29)
<i>miraflorensis</i>	14-22	17.2 (16)	11-14	12.5 (15)	23-27	24.9 (14)	23-27	24.2 (11)	32-41	36.9 (25)
<i>curtus</i>	12-19	14.9 (10)	12-14	13.0 (11)	16-28	23.3 (11)	15-25	20.3 (10)	25-34	29.8 (16)
<i>crocatus</i>	12-21	17.8 (11)	11-12	11.7 (10)	22-29	25.0 (13)	22-27	24.3 (9)	28-40	35.3 (20)
<i>erectus</i>	9-18	13.5 (10)	11-13	11.8 (11)	18-23	20.8 (8)	18-21	19.7 (6)	41-52	44.6 (14)
<i>cyclolepis</i>	13-22	16.5 (11)	11-14	12.8 (11)	20-26	23.2 (9)	22-27	24.6 (11)	29-37	32.9 (17)

mostly ctenoid; caudal fin lanceolate and about 41% of SL; a dark spot present on body below spinous dorsal-fin origin.

Description.—P₁ 19–23 (usually 21–22); gill rakers on first arch about 4 + 13; each dentary with about 7–9 teeth in outer row; mouth inclined about 40 degrees from the horizontal; upper jaw 14.8 in males, 11.3 in females.

Eye diameter 7.7; interorbital width 2.1; head length 27.7; pectoral-fin length 26.1; pelvic-fin length 25.3 in males, 23.6 in females; caudal-fin length 41.3.

Fleshy nuchal crest moderate to well developed in females, poorly developed in males. Scales on sides extending forward to about midway beneath the appressed pectoral fin, absent on dorsum immediately below anterior part of spinous dorsal fin. Scales ctenoid over most of body, cycloid on dorsum below posterior part of spinous dorsal fin and on belly and venter above anal fin. Second through sixth dorsal spines produced into filaments in males (longest reaching caudal base or beyond); dorsal spines only slightly produced in females.

Large specimens show sexual dimorphism in pelvic disc shape with posterior margin of pelvic disc truncate or slightly emarginate in males (i.e., medial rays equal to or slightly shorter than outer rays) and pointed in females (i.e., medial rays longer than outer rays).

SENSORY CANAL SYSTEM. Supraorbital canals contiguous between orbits; lateral cephalic canal with three pores (frequently median pore absent); preopercular canal with two pores.

PIGMENTATION OF MALES. The following account is based on preserved specimens: body dusky brown, slightly darker dorsally; a dark spot present on body below origin of spinous dorsal fin, spot bordered anteriorly and posteriorly by pale areas (spot variably developed in males); dorsum below dorsal-fin base marked with six dark dashes; pectoral base and head slightly darker than body, with larger melanophores; cheek, opercle, and area immediately posterior to eye somewhat mottled (probably brightly colored spots or stripes in life).

Spinous dorsal fin dusky with pale basal and pale medial stripes, fin becoming darker distally, occasionally with small dark spot on first interradi al membrane; soft dorsal fin dusky with submarginal pale stripe and narrow dark distal border; pectoral fins dusky; pelvic-fin membranes uniformly and densely pigmented with melanophores; anal fin dusky with pale distal margin; caudal fin dusky with narrow dark marginal stripe dorsally and pale marginal stripe ventrally.

PIGMENTATION OF FEMALES. Pigmented as the males except the following: venter above anal base devoid of melanophores (this pale area less well defined and less extensive than similar pattern of female *M. signatus*); spot on body above pectoral base very dark and well defined, bordered anteriorly and posteriorly by pale bars, these bounded by narrow dark bars (Fig. 3B).

Spinous dorsal fin dusky, often with small to large dark spot in the first, third or fourth interradi al membranes; soft dorsal fin dusky with median, pale stripe; pectoral fins dusky; pelvic fins dusky with pale border and a submarginal dark stripe; anal fin dusky, paling proximally; caudal fin with several large pale spots in dorsal half.

The following description (with minor editing) of life colors was recorded by Dr. John Randall from two females (23.7, 22.9 mm SL) from Puerto Rico (UPR 2398): "translucent, dusky olive, the belly greenish yellow; a blue-edged black spot on back above pectoral base; some iridescent blue green markings on cheek and opercle; 2 lengthwise rows of faint iridescent blue spots on anterior half of body; 2nd dorsal fin with a basal red-orange band; above this, bands of blue, red,

yellow and at the edge, orange-red; 1st dorsal with red outer margin and blue submarginal band; caudal dusky with 3 diagonal rows of red spots in upper part, a narrow median red band and some yellow ventrally."

Ecology.—*M. meeki* inhabits shallow, mud-bottom mangrove areas in Puerto Rico (J. Randall, field notes) and similar habitats in Venezuela (F. Cervigón, personal communication).

Distribution.—Known from Puerto Rico and Venezuela south to Santos, Brazil.

Discussion.—My examination of the type material of *M. omostigma* Starks in the Stanford collection and of another specimen (AMNH 3857) collected by Starks in Brazil, along with examination of abundant material of *M. meeki* leads me to concur with Miranda Ribeiro (1915: 13) in his placing *M. omostigma* in the synonymy of *M. meeki*.

A specimen (AMNH 3857) listed in the AMNH catalog as a "cotype" apparently has no type status as the three specimens listed by Starks in the original description (1913: 69) are deposited in the Stanford Collection.

Material Examined.—Puerto Rico: USNM 49367 (male, 29.1), holotype of *M. meeki*, between Culebra and Vieques Islands, in 15.5 fms., FISH HAWK sta. 6087. UPR 1764 (1, 21.1). UPR 683 (1, 21.1). UPR 2361 (3, 22.4–25.2). UPR 2398 (13, 14.8–23.7). Venezuela: MHNLS C: 863 (4, 17.4–25.5). MHNLS C: 1192 (3, 18.2–22.9). MHNLS uncat. (1, 27.0), Cubagua, 28 Feb. 1965, F. Cervigón. MHNLS uncat. (3, 28.9–30.3), Margarita Island, F. Cervigón. MHNLS uncat. (20, 20.5–32.5). Isla Margarita, L'atolladar, Feb. 1968. MHNLS uncat. (9, 18.0–28.2), Atoyada Pt., 24 Nov. 1964. MHNLS 1914 (2, 34.9–36.0). Brazil: SU 22214 (25.3), lectotype of *M. omostigma*, Natal, 1912, E. C. Starks. SU 22383 (2, 22.5, 27.7) paralectotypes of *M. omostigma* same data as lectotype. AMNH 3857 (1, 23.6). SU 52376 (5, 22.9–36.0). GCRL uncat. (4, 41.0–47.1) Pernambuco, Ihla de Itamaraca, 4 Sept. 1972.

Microgobius carri Fowler, 1945
(Figures 1C, 3C and Tables 1–4)

Microgobius carri Fowler, 1945: 322 (type locality Sanibel Island, Florida; holotype ANSP 71187).

Diagnosis.— D_2 15–18 (usually 16); A 16–18 (usually 16); lateral scale rows usually 50–62; interorbital width 4.1; nuchal crest absent in both sexes; scales mostly ctenoid; P_1 long, 28.9; no dark markings on body or fins; a bright orange-yellow stripe along mid-body continuing onto caudal fin.

Description.— P_1 20–24 (usually 21); gill rakers on first arch usually 5 + 15; each dentary with 4–5 teeth in outer row; mouth inclined about 30 degrees from the horizontal; upper jaw 20.1 in males, 13.1 in females.

Eye diameter 7.2; head length 27.7; pelvic-fin length 18.3; caudal-fin length 29.7.

Scales extending forward to pectoral axil; scales ctenoid except belly and dorsum below spinous dorsal fin where scales are cycloid. Dorsal spines two through five produced into filaments in males, the fifth spine much the longest, often reaching two-thirds length of soft dorsal fin.

SENSORY CANAL SYSTEM (Fig. 1C). Supraorbital canals separate most of their extent; lateral cephalic canal with three pores; preopercular canal with two pores; sensory papillae system of head somewhat reduced; caudal fin with three longitudinal rows of papillae on median interradiial membranes.

COLORATION OF MALES. The following account is based on life colors. Body pale with orange-yellow lateral stripe along midline and two narrow paler yellow stripes above; body along anal fin base yellowish with small dark spot of pigment at insertion of each anal ray. Head pale below, yellowish between orbits and on

snout; an elongate, iridescent blue line at posterodorsal corner of eye, another below eye extending to opercular margin; cheek and opercle each with a small spot of iridescent blue; pectoral fin base with bluish cast.

Pectoral fins pale; pelvic fins dusky with yellowish cast; spinous dorsal fin with suprabasal and medial orange-yellow stripe; soft dorsal fin with three orange-yellow stripes; anal fin pale; caudal fin yellow ventrally, pale yellow dorsally with median orange-yellow stripe which is continuous with similar stripe on body. The pigmentation of the females is similar to that of the males.

Ecology.—*Microgobius carri* inhabits moderately deep water (usually deeper than 5 m) in areas with a coarse, sandy bottom. Most collections have been made in depths from 6 to 21 m near coral reefs.

At Alligator Reef, Monroe Co., Florida, *M. carri* is one of the most abundant species in the open back-reef areas with coarse Halimeda sand. The poor representation of *M. carri* in collections is probably due to the sterile appearance of its habitat in relation to the adjacent reef areas; consequently, its habitat is rarely sampled.

Microgobius carri constructs burrows in the bottom, usually under a sandcovered shell or rock, into which it retreats when threatened. It typically maintains position in the water column one to two feet above its burrow. Several fish may occupy a single burrow; but often a burrow will be occupied by a pair, one male and one female.

Spawning apparently occurs within the burrow. W. A. Starck, II (personal communication) found a clutch of typically gobioid eggs attached to the under-surface of a bivalve mollusk shell roofing a burrow occupied by *M. carri*.

Distribution.—Known from the northeastern Gulf of Mexico, around Florida and Dry Tortugas north to Jacksonville and south through the Lesser Antilles.

Discussion.—The populations of *M. carri* from southern Florida and the Antilles show lower fin-ray counts than do the populations from the northern Gulf of Mexico. The four specimens examined from the Atlantic coast north of Cape Canaveral also displayed higher fin-ray counts.

	D ₂ elements				Anal elements				Pectoral elements				
	15	16	17	18	16	17	18	19	20	21	22	23	24
Atlantic N. of C. Canaveral		2	2			2	2					3	1
Northern Gulf of Mexico		1	7	2		2	7	1		1	2	4	1
South Florida and Antilles	6	16	4		14	12			5	16	2	—	1

In several features of pigmentation and morphology and in the lack of strong sexual dimorphism, *M. carri* is divergent from other members of the genus *Microgobius*. The sum total of these differences perhaps merits subgeneric recognition for *M. carri*; however, to subdivide the genus into parts containing 1 and 13 species respectively appears to me to be of no great value.

Material Examined.—Florida, Gulf of Mexico: ANSP 71187 (female, 45.0), holotype, Lee Co., Sanibel Island, received 23 March 1942, Mrs. J. S. Schwengel. USNM 142862 (1, 25.0). USNM 142864 (1, 27.5). ANSP 106131 (1, 52.8). ANSP 106134 (1, 34.7). UMML 7581 (5, 20.1–24.5). USNM 197740 (1, 29.4). USNM 201040 (1, 35.9). FSU 18790 (2, 31.7, 33.4). FSU 18792 (7, 34.4–54.8). Florida, Atlantic: UMML 11656 (2, 25.4, 29.6). UMML 19043 (2, 21.1–40.4). UMML 18957 (2, 18.3, 21.5). UMML 17840 (2, 25.8, 31.8). UMMZ uncat. (1, 44.5), Monroe Co., ledge ¼ mi. WSW of Alligator Reef light, B61-56, 21 July 1961, W. Starck, H. Feddern, R. Bailey. UMML 8675 (1, 33.0). UMML 24738 (1, 44.6). TABL uncat. (1, 54.4), NE of Jacksonville, approx. 31°53'N, 79°49'W in 19–22 fms., 14 March 1960, SILVER BAY sta. 1783. SCMRRI uncat. (2, 31.8–36.2), R/V DOLPHIN Cruise 5, Sta. 24, Coll.

0573370. SCMRRI uncat. (1, 27.2), R/V DOLPHIN Cruise 5, Sta. 36, Coll. 0573382. Lesser Antilles: UPR 1797 (1, 41.8), St. John V. I. UMML 6982 (3, 22.0–24.9), St. John, V. I. UMML 7399 (1, 44.5), St. John V. I. UPR 2291 (1, 40.4), Tobago. ANSP 105429 (1, 39.4), Anguilla.

Microgobius gulosus (Girard), 1858
(Figure 3D, E and Tables 1–4)

Gobius gulosus Girard, 1858: 169 (type locality Indianola, Texas). Not Smith, 1936.

Lepidogobius gulosus: Jordan and Gilbert, 1882b: 294 (new combination).

Microgobius gulosus: Jordan and Eigenmann, 1886: 503, 505, 514 (new combination).

Diagnosis.— D_2 15–18 (usually 16–17); A 16–18 (usually 16–17); lateral scale rows about 44–54; scales mostly cycloid; body with many dark spots or blotches; no bright colors in life; nuchal crest absent in both sexes; dorsal spines greatly produced as filaments in males.

Description.— P_1 19–24 (usually 21–22); gill rakers on first arch about 3 + 10; each dentary with about 7–9 teeth in outer row; mouth inclined about 30 degrees from the horizontal; upper jaw 20.8 in males, 13.0 in females.

Eye diameter 7.0; interorbital width 2.4; head length 30.6 in males, 28.9 in females; pectoral-fin length 24.5; pelvic-fin length 23.9; caudal-fin length 31.7.

Scales on sides extending forward almost to pectoral axil, absent on dorsum below anterior half of spinous dorsal fin; scales largely cycloid excepting some weakly ctenoid scales along lateral midline of body and caudal peduncle and large ctenoid patch under appressed pectoral fin. Dorsal spines two through six in males produced into filaments, spines three through five the longest, sometimes reaching midway soft dorsal; dorsal spines of females little elongated.

SENSORY CANAL SYSTEM. Supraorbital canals contiguous and posteriorly conjoined between the orbits; interorbital pore very small; lateral cephalic canal usually with three pores, occasionally with two or four pores; preopercular canal with two pores.

COLORATION OF MALES. The following account is based on live specimens. The pigmentation pattern is virtually unchanged by preservative except for a general darkening of the fish (the acquisition of a brownish hue) and the loss of pearly-escence in some areas. Except for a bluish cast to the soft dorsal fin distal margin and the caudal fin upper margin of some males, no bright colors are present in life.

Evermann and Bean (1898: 247) state that specimens taken from the freshwaters of Indian River, Florida, are darker than those from salt water. Reid (1954: 58) found specimens taken at Cedar Key, Florida, in the summer to be darker and more highly contrasted than those collected in the winter.

Body above midline marked with numerous, irregular dusky-brown blotches; body pale below midline; nape and dorsum along dorsal fin bases with 8–9 dark blotches; a pearlescent vertical bar on body beneath pectoral fin, followed posteriorly by a poorly defined dark bar; dorsal edge of pectoral base dark; head dusky with two pearlescent stripes below eye, one originating midway the maxilla, the other near the posterior tip and both running to near posterodorsal margin of opercle where they meet (lower stripe sometimes terminates at preopercular margin).

Spinous dorsal fin dusky with paler median band and dark blotches on base of membranes over corresponding blotches on body dorsum; spinous dorsal filament becoming pale distally. Soft dorsal fin with four to five dark basal blotches over corresponding blotches on body; basal blotches surrounded above and between

by opaque white area; then in order a median longitudinal row of more or less well defined dark blotches (one on each interradi al membrane), a hyaline band and a dark (black anteriorly) distal margin. Anal fin dusky with dark distal margin. Caudal fin dusky with darker margin and hyaline submarginal band. Pectoral fins pale, mottled along base. Pelvic fins dusky pale.

COLORATION OF FEMALES. The females are pigmented as the males with the following exceptions: body blotches better defined and highly contrasted; belly and lower sides more darkly pigmented anterior to third anal-fin element in large females. Spinous dorsal fin with two to three dark blotches along base over corresponding blotches on body dorsum and two rows of irregular dark blotches (one medial, one distal) on interradi al membranes. Soft dorsal fin with four to five dark blotches along base over corresponding blotches on body dorsum, three irregular rows of spots on interradi al membranes and a dusky distal margin. Anal fin with dusky base and faint submarginal dusky band in large individuals. Pectoral fins darkly pigmented with hyaline distal margin. Caudal fin with four to five irregular, diagonal rows of dark spots in upper half, dusky lower half and dusky posterior distal margin.

Ecology.—*M. gulosus* is locally abundant in protected estuarine habitats of the southern Atlantic and Gulf coasts. This species displays a wide salinity tolerance and has been found in abundance in salinities ranging from 0‰ (St. John R., Fla.; Tagatz, 1968: 44) to 36‰ (Big Pine Key, Fla.); however, most specimens have been collected in moderately reduced salinities.

Microgobius gulosus prefers muddy bottom, quiet water habitats where it forms a burrow in the bottom. Collections have been made over bottoms ranging from muck to fine calcareous sediment, suggesting that grain size is the factor of importance in the selection of bottom type by this species. At Big Pine Key, Florida, a population of *M. gulosus* shared a blind channel of about 3 m maximum depth with *M. microlepis*. Within the channel, *M. gulosus* was distributed along the edges in areas of lesser current and finer sediment while *M. microlepis* was distributed throughout midchannel in stronger current and coarser sediments.

The burrows of *M. gulosus* are not as well formed as those of *M. microlepis* (the softer bottom probably precludes this). At Big Pine Key the burrows were short tunnels, 25–50 cm long, 5–10 cm below the surface of the bottom and usually with an opening at each end. Most *M. gulosus* burrows were occupied by a single individual which (unlike *M. microlepis*) spent most of the time lying on the bottom in or near the mouth of the burrow.

Spawning, at least in southern Florida waters, probably occurs to some extent throughout the year. Kilby (1955: 229) found the smallest specimens at Cedar Key and Bay Port, Florida, in May and September respectively, but individuals smaller than 25 mm SL were present throughout the year. In the St. Johns River, Tagatz (1968: 44) collected specimens less than 15 mm SL in October through December. Ripe individuals have been taken in Tampa Bay in November and July (Springer and Woodburn, 1960: 73), May and June at Cedar Key, Florida (Reid, 1954: 58) and in February at Everglade, Florida.

Stomach contents of this species taken from three west Florida localities have been reported to consist of copepods, mysids and amphipods at Cedar Key (Reid, 1954: 58), essentially the same items plus polychaetes and small bivalves in Tampa Bay (Springer and Woodburn, 1960: 73), and amphipods, copepods and chironomid larvae in the North River (Odum, 1971: 86).

Distribution.—Known from Chesapeake Bay (?) to Corpus Christi, Texas.

Discussion.—*M. gulosus* is known north of the St. Johns River, Florida, by a single collection of 32 specimens (GCRL V66: 1528, 10 and UNC uncat., 22) made by Frank J. Schwartz near the mouth of the Patuxent River in Maryland. Taken with *M. gulosus* at this locality were 10 specimens of *Gobiosoma robustum*, a species also unrecorded north of Florida (Böhlke and Robins, 1968: 75). This unusual hiatus in the distribution of two well-known species over a relatively well collected length of the Atlantic coast merits further investigation.

The southern most populations of *M. gulosus* in the Florida Keys show slightly lower fin-ray counts than those to the north and also seem to mature at smaller sizes. I suspect that both of these phenomena are produced by the warmer waters and are not evidence of isolation.

Material Examined.—Chesapeake Bay: GCRL V66: 1528 (10, 28.4–41.7), Md., Calvert Co., Patuxent R. at Green Holly Oyster Bar, 10-m depth, 5 Feb. 1962, F. J. Schwartz. UNC uncat. (22, 26.8–43.0), same data as GCRL V66: 1528. Florida: USNM 68502 (9, 24.0–42.4). USNM 68459 (23, 23.8–46.7). USNM 25335 (35, 21.8–43.2). USNM uncat. (12, 33.7–43.7), Cocoa, 17 Jan. 1896. FSU 9806 (70, 15.3–32.5). UMML 315 (8). UMML 24739 (18, 23.0–35.1). USNM 89874 (1, 24.0). UMML 5095 (9). ANSP 86057 (61, 24.8–40.4). UMML 1301 (54, 18.5–50.2). UMML 8795 (429, 20.1–46.5). ANSP 75726 (12, 33.3–56.0). USNM 84025 (2, 41.1–42.5). USNM 176215 (18, 32.2–52.3). FSU 4501 (2, 55.2–58.7). FSU 13577 (40, 27.6–55.6). FSU 13796 (9, 30.5–57.5). Mississippi: ANSP 23706 (1, 34.2). USNM 63922 (1, 52.5). Louisiana: USNM 172102 (2, 40.4–51.7). USNM 172099 (1, 52.7). ANSP 55633 (1, 43.0). Texas: ANSP 95096 (15). USNM 155619 (7, 32.8–44.8). USNM 96309 (2, 24.2, 27.5).

Microgobius thalassinus (Jordan and Gilbert), 1883
(Figure 4A, B and Tables 1–4)

Gobius thalassinus Jordan and Gilbert, 1883a: 612 (type locality muddy tide pools in Charleston Harbor; holotype USNM 29674).

Lepidogobius thalassinus: Jordan and Gilbert, 1883b: 947–948 (new combination; after Jordan and Gilbert, 1883a).

Microgobius eulepis Eigenmann and Eigenmann, 1888: 69 (type locality Fortress Monroe, South Carolina; holotype MCZ 27123).

Microgobius holmesi Smith, 1907: 366–367, fig. 168 (type locality Uncle Israel Shoal, Beaufort Harbor, North Carolina).

Microgobius thalassinus: Jordan and Eigenmann, 1886: 503–505 (new combination). Ginsburg, 1934: 35 (*M. holmesi* and *M. eulepis* synonymized with *M. thalassinus*).

Diagnosis.— D_2 15–17 (usually 16); A 15–17 (usually 16); lateral scale rows about 43–50 (see text discussion); lateral cephalic sensory canal with two pores; fleshy nuchal crest absent in males, low in females, scales mostly cycloid; body with brilliant green luster.

Description.— P_1 19–23 (usually 21–22); gill rakers on first arch about 5 + 16; each dentary with about 7–9 teeth in outer row; mouth inclined about 45 degrees from horizontal; upper jaw 12.0 in males, 11.3 in females.

Eye diameter 6.8; interorbital width 2.5; head length 26.7; pectoral-fin length 26.5; pelvic-fin length 23.1; caudal-fin length 34.0.

Scales on sides extending forward almost to pectoral axil, absent on dorsum below anterior portion of spinous dorsal fin; scales cycloid with exception of patch of large ctenoid scales below appressed pectoral fin and an occasional weakly ctenoid scale on caudal peduncle. Dorsal spines slightly produced in males, not produced in females.

SENSORY CANAL SYSTEM. Supraorbital canals contiguous and posteriorly conjoined between the orbits; interorbital pore very large; lateral cephalic canal short with two pores (rarely lateral cephalic canal is absent); preopercular canal short, with two pores.

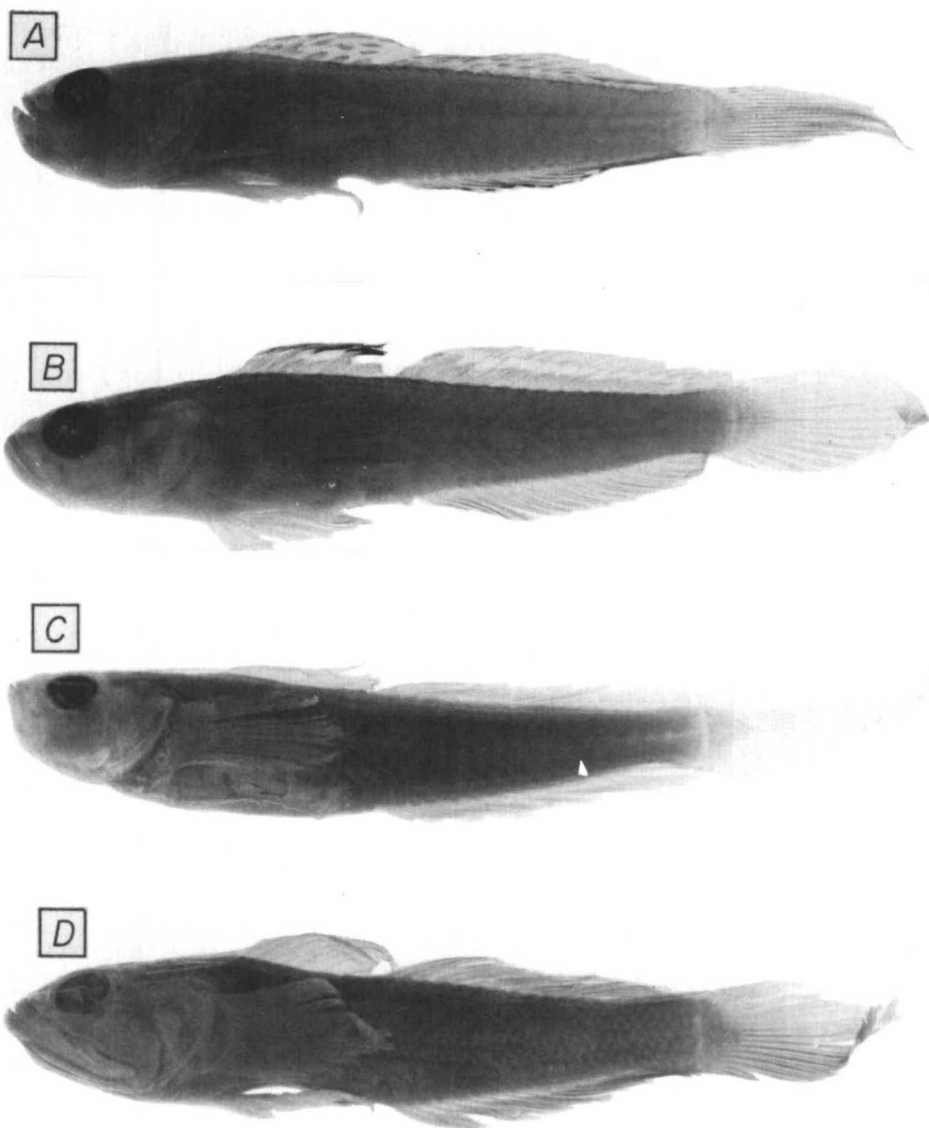


Figure 4. A, *M. thalassinus*, male, 27.8 mm SL, UMML 8808; B, *M. thalassinus*, female, 28.5 mm SL, USNM 187359; C, *M. erectus*, male, 47.3 mm SL, UCLA W50-43; D, *M. cyclolepis*, male, 52.4 mm SL, SIO 62-106.

PIGMENTATION OF MALES. The following account is based on preserved specimens: body and head pale brown with posterior scale margins darkened; two to three broad bars beneath appressed pectoral fin. Spinous dorsal fin with dusky base, a median, vertically elongated, dusky spot in each interradi al membrane (often extending to distal margin); spots separated from base by a hyaline stripe; soft dorsal fin dusky with one or two irregular, median, hyaline stripes; pectoral fins dusky; pelvic fins with dusky medial interradi al membranes; anal fin dusky, paler along base, with a supramarginal row of dark spots in the interradi al mem-

branes and a hyaline distal margin; caudal fin dusky with one or two irregular hyaline spots near upper caudal base and often with two to three dark spots along lower caudal margin.

PIGMENTATION OF FEMALES. Preserved specimens pigmented as the males with the following exceptions: body lacking pale bars beneath appressed pectoral fin; spinous dorsal fin dusky with median, hyaline stripe and one to three black spots in distal portion of interradiating membranes four through six; anal fin dusky with hyaline distal margin; caudal fin without dark spots along lower caudal margin.

LIFE COLORS. No live specimens of *M. thalassinus* were examined during this study; however, Jordan and Eigenmann (1886: 504) indicated that the head and body is "overlaid by a brilliant green luster . . . , three translucent bars . . . , crossing body close behind head; head with two brilliant narrow blue and green lines running obliquely across cheek below eye. Dorsal whitish with two or three lengthwise series of large reddish-brown spots Upper caudal rays marked with red." Though Jordan and Eigenmann did not specify sex, their description is almost certainly of a male.

Schwartz (1971: 160) described the life colors of Chesapeake Bay specimens as follows: "Females captured December 1959 had a red spot in the first dorsal in addition to the black spot posteriorly. A yellow band was most prominent across the length of the soft dorsal. The eye was golden, head golden and tan, and two gold-bluish bands extended horizontally below the eye. The first third of the lateral line was colored blue-silver, the rest of the body tan. Pectoral fins were clear, the pelvics dusky Females captured 22 January 1962 had four golden body bars while males had five, one over the cleithrum. Scales were dusky black edged with olive centers.

"Males caught 30 January 1961 had intense reddish hues on the dorsal fins. The anal fin was nearly black with a white posterior tip. The pelvic fin was a vivid orange-yellow. The lower part of the caudal fin tip was white. The body possessed four tan, not blue, vertical bars. Cheek bars were yellow-green. Males in aquaria at night had golden-hued cheeks and opercula, a golden spot over the pectoral base, with the sides of body a deep metallic blue. The pelvic fins were cream-yellow ventrally, clear dorsally. The dorsal fins were reddish with black margins. The anal fin was white and cream colored. Tan bars with golden flecks were evident on the body Males taken 22 June 1960 were an intense light blue over the entire body and caudal fin. An intense orange-tan prevailed over the pelvic fins. All specimens collected during July–October were usually lack-luster in color."

Ecology.—Though this species occurs from Chesapeake Bay to Texas, it does not appear to be common anywhere. *M. thalassinus* apparently exhibits a wide tolerance for salinity. Springer and Woodburn (1960: 73) reported this species from salinities of 13.7–33.0‰ in Tampa Bay; C. E. Dawson (1969: 41) indicated that *M. thalassinus* occurs from 1.0–33.0‰ salinity along the northern Gulf coast; and Schwartz (1971: 162–163) in salinities from 8.0–23.4‰ in Chesapeake Bay.

M. thalassinus apparently prefers muddy sand or mud bottom habitats in Florida and has been found in tidal pools or ponds in association with the more abundant *M. gulosus*. In Chesapeake Bay *M. thalassinus* is most frequently found in mud and oyster habitats often in association with the sponge, *Microciona* (Schwartz, 1971: 161). Though most collections of this species have been made in depths of less than 6 m, Schwartz (1971: 161) reports one specimen taken from between 20–37 m of depth in Chesapeake Bay.

Hildebrand and Cable (1938: 560) reported the larvae of *M. thalassinus* to be numerous during July through September in the area of Beaufort, North Carolina, and that they were taken in "Beaufort Harbor, the adjacent sounds and estuaries, and off Beaufort Inlet to Cape Lookout and as far as 12 to 13 miles offshore." They reasoned that since most goby eggs are attached to the substrate (including *Microgobius* where known), the young should be found in close proximity to the spawning adults and, therefore, spawning had occurred over much of the area where the larvae were taken. In view of the broad and somewhat spotty distribution and the relative scarcity of the adults, along with their common occurrence in plankton samples from some areas (Schauss, 1977; Richardson and Joseph, 1975) it appears more likely that the larvae are planktonic for some period.

Distribution.—Known from Chesapeake Bay to Galveston, Texas, but apparently absent from the lower east coast of Florida from Cape Canaveral to, and including, the Florida Keys.

Discussion.—Much of the early confusion of this species resulted from the failure of early investigators to recognize the sexually dimorphic characters. Ginsburg (1934: 35) pointed out that *M. eulepis* Eigenmann and Eigenmann, 1888, was based on a female specimen while *M. holmesi* Smith, 1907, was based on a male specimen.

Ginsburg (1934: 37) called attention to modal differences in the number of soft dorsal and anal-fin elements between the Atlantic and Gulf coast populations of *M. thalassinus*. My data support his in part; however, I did not find populational differences in soft dorsal elements (Table 1). The meristic data presented by Schwartz (1971: 160) on Chesapeake Bay specimens are generally consistent with my findings; however, his data show lateral scale rows to range from 40 to 58 with a mean of about 50 while my data show a range of 43–50 with a mean of about 46. This discrepancy may be due to the larger sample size in Schwartz's data or simply to the difficulty of making an accurate scale count in *Microgobius*.

The distribution of anal and pectoral-fin elements are:

	Anal elements			Pectoral elements				
	15	16	17	19	20	21	22	23
Atlantic Coast		4	32		1	6	21	5
Gulf Coast	2	12	8	2	5	11	5	

Material Examined.—Chesapeake Bay: USNM 134007 (2, 33.4, 33.7). USNM 93990 (1, 25.6). USNM uncat. (2, 21.0, 23.2), Md., Crisfield, 25 Oct. 1951, 3809, Littleford et al. USNM uncat. (2, 19.4, 20.7), Md., Crisfield, 4–5 Oct. 1951, 3810, Littleford et al. USNM uncat. (1, 26.7), Md., Crisfield, 29 Aug. 1951, 3808, Littleford et al. USNM uncat. (1, 30.9), Md., Galesville, 15 Nov. 1951, 3766, Clark and Sanderson. USNM 158252 (1, 33.9). USNM 92284 (6, 23.5–29.2). ANSP 76137 (1, 33.0). USNM 67933 (2, 29.1, 30.8). USNM 187359 (3, 27.2–29.3). USNM 187360 (1, 39.6). USNM 187361 (1, 36.3). North Carolina: USNM 72350 (1, 35.1). USNM 72351 (1, 33.0). South Carolina: USNM 29674 (26.5), holotype of *M. thalassinus*, Charleston, in muddy tide pool, C. H. Gilbert. MCZ 27123 (1, 37.0), holotype of *M. eulepis*, Fortress Monroe, 1897, Willard. Florida: UMML 8808 (46, 18.0–28.5). FSU 13578 (6, 24.8–28.3). USNM 116658 (1, 27.0). Louisiana: USNM 86125 (1, 27.9). Texas: ANSP 71186 (1, 33.1).

Microgobius erectus Ginsburg, 1938 (Figures 1B, 4C and Tables 1–4)

Microgobius erectus Ginsburg, 1938: 120–121 (type locality northern part of Gulf of California; holotype in Bingham Oceanographic Collection).

Diagnosis.— D_2 14–15 (usually 15); A 14–15 (usually 15); lateral scale rows about

35; caudal fin lanceolate, about 45% of SL; epaxial myosepta darkly pigmented; scales mostly cycloid, caducous.

Description.—P, 20–23 (usually 22–23); gill rakers on first arch usually 3 + 13; each dentary with about 6–8 teeth in outer row, 15–20 in inner row in males and 25–30 in inner row in females; mouth forming an angle of about 70 degrees with the horizontal; upper jaw 13.5 in males, 11.8 in females.

Eye diameter 7.6; interorbital width 2.6; head length 24.3; pectoral-fin length 25.5; pelvic-fin length 20.3; caudal-fin length 44.6.

A low, fleshy nuchal crest is present in both sexes; scales on side extending forward almost to pectoral axil; scales absent on dorsum below spinous dorsal fin; scales caducous; scales cycloid with patch of strongly ctenoid scales under appressed pectoral fin. Dorsal spines not produced into filaments in either sex. The fin membranes of this species are very delicate and few specimens were found with intact fins.

SENSORY CANAL SYSTEM (Fig. 1B). Supraorbital canals conjoined near interorbital pore; lateral cephalic canal with three pores; preopercular canal with two pores (rarely with three pores).

PIGMENTATION OF MALES. The following account is based on preserved specimens: body with few melanophores, appearing tan to brownish in preservative; darkly pigmented epaxial myosepta (especially pronounced myoseptal pigmentation over pectoral fin); no spot or blotch on body over pectoral fin; dorsum dusky; body along anal fin base pigmented with a dark line; dorsum of head and lips dusky; papillary chains on head darkly pigmented making them plainly visible; spinous dorsal fin pale with a median dusky stripe and a dusky distal border (becoming very dark along margin); soft dorsal fin dusky with pale, basal stripe and dark distal margin; anal dusky; paler along base; pectoral fins dusky; pelvic fins pale with few melanophores; caudal fin dusky, darkest along distal portion of medial rays and with indications of a pale longitudinal stripe in the distal portion.

PIGMENTATION OF FEMALES. Body and head pigmented as in the males. Spinous dorsal fin dusky basally, pale distally with dark distal margin; soft dorsal fin dusky with pale stripe in posterior half of fin which is continuous with pale stripe in the caudal fin; anal fin uniformly dusky; pectoral fins dusky proximally, pale distally; pelvic fins dark (many large melanophores) with pale distal border.

Ecology.—*M. erectus* is common in the Gulf of Panama in depths from 15 to 30 m over mud and broken shell bottom. The caducous scales and delicate fin membranes suggest that this species, like *M. cyclolepis*, does not burrow.

Distribution.—Known from the northern Gulf of California to the Gulf of Panama.

Material Examined.—Panama: UMML 23808 (11, 28.5–44.6). UMML 23809 (23, 28.4–37.3). UMML 24740 (7, 30.3–44.1). UMML 24741 (3). UMML 24742 (3, 43.2–44.1). UMML 24743 (1, 36.3). UMML 24744 (1, 27.3). SIO 64-762 (3, 30.8–32.4). SIO 64-772 (3, 29.8–42.5). SIO 64-354 (7). Mexico: SIO 63-522 (1, 29.3). SIO 63-523 (1, 38.3). SIO 63-521 (2, 38.7, 42.9). SIO 63-502 (1, 46.0). UCLA W50-43 (2, 37.4, 39.8). UCLA W59-14 (2, 45.5, 56.7). UCLA W62-60 (2, 48.3, 52.2). UCLA W59-10 (11, 21.8–39.5).

Microgobius cyclolepis Gilbert, 1891
(Figure 4D and Tables 1–4)

Microgobius cyclolepis Gilbert, 1891: 74 (type locality northern Gulf of California, ALBATROSS sta. 3020).

Zalypnus cyclolepis: Jordan and Evermann, 1896: 459 (assigned to *Zalypnus*).

Diagnosis.— D_2 15–17 (usually 16); A 16–17 (usually 16); lateral scale rows about 46–55; preopercular canal with three pores; scales mostly cycloid, caducous.

Description.— P_1 22–24 (usually 23); gill rakers on first arch usually 5 + 16. Each dentary with about 6–8 teeth in outer row; upper jaw 16.5 in males, 12.8 in females (Birdsong, 1975: 172); mouth inclined about 60 degrees from the horizontal.

Eye diameter 7.9; interorbital width 2.6; head length 27.9; pectoral-fin length 24.9; pelvic-fin length 24.0; caudal-fin length 32.9.

Fleshy nuchal crest well developed in females, poorly developed in males. Scales on side extending forward almost to pectoral axil, absent on dorsum immediately below spinous dorsal; scales cycloid with patch of strongly ctenoid scales under appressed pectoral fin. Second through sixth dorsal spines with moderately produced filaments in both sexes, the longest reaching base of eighth D_2 element.

SENSORY CANAL SYSTEM. Supraorbital canals contiguous between the orbits; lateral cephalic canal with three pores; preopercular canal with three pores.

PIGMENTATION OF MALES. The following account is based on preserved specimens: body brownish with six to seven faint, broad bars on dorsum; dark, ovoid to crescent-shaped spot on body just below D_1 origin; spot with concave to convex, diffuse anterior margin and a well-defined convex posterior margin bordered by a pale stripe; head uniformly brownish; pectoral base with pale spot; spinous dorsal, soft dorsal, pectoral and pelvic fins uniformly dusky; anal fin with dusky distal margin becoming pale along base; caudal fin dusky with pale bar crossing diagonally the dorsalmost 4–6 striated rays near their bases; caudal fin slightly darker ventrally than dorsally.

PIGMENTATION OF FEMALES. Body and head pigmented as in the males. Spinous dorsal fin dusky, paler along base; soft dorsal fin darkly pigmented with a pale stripe running diagonally from anterodistal tip of fin to the bases of the seventh through eighth elements; anal fin darkly pigmented distally, pale along base; pectoral fins dusky; pelvic fins dusky with darkly pigmented distal margin to fins and pelvic frenum. Caudal fin as in males; caudal fin in small specimens of both sexes dusky with two large, pale blotches.

Ecology.—This species apparently inhabits deeper waters (15–35 m) some distance from shore. The caducous nature of the scales suggests that *M. cyclolepis* may not possess the burrowing habits displayed by many species of this genus.

Distribution.—Known from the northern Gulf of California and Punta Pequeña, Baja California, to the Bay of Panama.

Discussion.—*Microgobius cyclolepis* has been in the synonymy of *M. emblematicus* since its placement there by Gilbert and Starks in 1904 (p. 175). *M. cyclolepis* has been known only from the poorly preserved type; but the recent accumulation of material (primarily by Scripps Institution of Oceanography) leaves no doubt about the validity of this species.

Material Examined.—Panama: UMML 24745 (1, 29.7). Mexico: USNM 44370 (44.8), holotype, northern Gulf of California, 30°37'30"N, 113°07'W in 7 fms., 24 Mar. 1889, ALBATROSS sta. 3020. SIO 62-106 (1, 53.3). SIO 64-42 (1, 37.4). SIO 64-888 (4, 33.1–51.9). SIO 62-710 (2, 29.2, 31.5). SIO 65-175 (1, 34.3). SIO 62-737 (1, 30.5). SIO 62-179 (1, 39.1). SIO 64-875 (109, 19.5–45.1). SIO 64-80 (3, 16.6–29.7). SIO 64-83 (23, 10.0–29.8). SIO 62-127 (2, 28.5, 34.0). SIO 65-158 (3). UCLA W51-36 (1, 37.7). UCLA W55-96 (11, 28.6–47.2).

Microgobius curtus Ginsburg, 1939
(Figure 5A, B and Tables 1–4)

Microgobius curtus Ginsburg, 1939: 56 (type locality Salada, Guayaquil, Ecuador, in mangrove swamp; holotype USNM 107292).

Microgobius emblematicus: Chirichigno Fonseca, 1968: 452, fig. 24 (Puerto Pizarro, Peru; illustration in error).

Diagnosis.—D₂ 15–17 (usually 16); A 16–17 (usually 16); lateral scale rows about 62–78; scales mostly cycloid; fleshy nuchal crest absent to poorly developed in both sexes; dorsal spines produced into filaments in both sexes.

Description.—P₁ 20–22 (usually 21); gill rakers on first arch usually 5 + 16; each dentary with about 6–8 teeth in outer row; upper jaw 14.9 in males, 13.0 in females; mouth inclined about 45 degrees from the horizontal.

Eye diameter 8.2 (see discussion); interorbital width 3.0; head length 27.9; pectoral-fin length 20.3; pelvic-fin length 23.3 in males, 20.3 in females; caudal-fin length 29.8.

Scales on side extending forward almost to axil of pectoral fin; naked on dorsum below spinous dorsal fin; scales cycloid with exception of small patch of ctenoid scales under appressed pectoral fin. Both sexes with dorsal spines two through five produced into filaments, the longest reaching half of soft dorsal fin.

SENSORY CANAL SYSTEM. Supraorbital canals separate most of their extent; lateral cephalic canal with three pores; preopercular canal with two pores.

COLORATION OF MALES. This account is based on freshly preserved specimens: body yellowish-green with bluish cast to belly; sides marked anteriorly with 10–15 small yellowish spots; a faint dusky blotch on side below spinous dorsal fin and five dusky dashes on body along dorsal fin base; cheeks with four longitudinal stripes alternately yellow and iridescent blue; opercle with several iridescent blue spots and several yellow spots; nape with several yellow spots. Spinous dorsal fin dusky with two basal longitudinal rows of yellow spots and three dark dashes along distal margin (sometimes obscure); soft dorsal fin with four rows of orange spots on interspinous membranes and four dark dashes along distal margin; anal fin dusky yellow proximally, pale at margin; caudal fin dusky with yellowish cast dorsally and orange cast ventrally; caudal fin with three dark dashes along dorsal margin and pale dorsal and ventral submarginal stripes; pectoral fins pale; pectoral base with large yellow spot medially and dusky blotch dorsally; pelvic fins dusky yellow.

COLORATION OF FEMALES. Body yellowish-green above, white ventrally above anal fin, the two areas being sharply defined by a narrow line originating at anal-fin origin and running dorsoposteriad to lateral midline, there continuing above the midline to caudal base and becoming faint posteriorly; belly bluish; anteriorly sides of body crossed by three narrow, pale bars originating under spinous dorsal fin; sides of body with five to six yellow spots under appressed pectoral fin and five dusky dashes on body along base of dorsal fins; cheeks with four longitudinal stripes alternately yellow and iridescent blue; opercle iridescent blue with several yellow spots; spinous dorsal fin dusky with numerous orange spots and three dark dashes along distal margin; soft dorsal fin with four longitudinal orange stripes; anal fin dusky; caudal fin dusky with numerous orange spots dorsally and yellowish cast ventrally; pectoral fins pale; pectoral base with yellow spot medially and dusky blotch dorsally; pelvic fins yellowish.

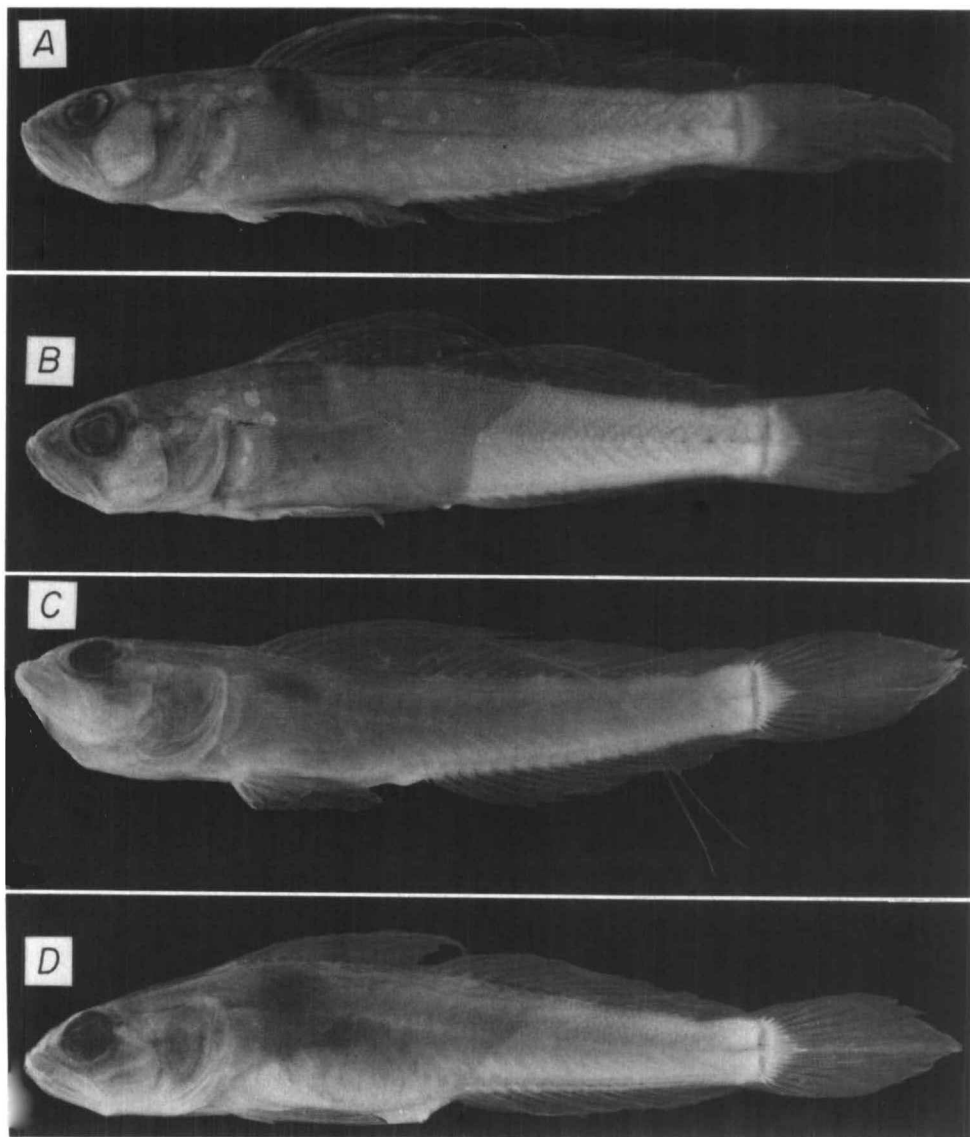


Figure 5. A, *M. curtus*, male 41.0 mm SL, GCRL uncat. (Field No. 1412); B, *M. curtus*, female, 38.2 mm SL, GCRL uncat. (Field No. 1412); C, *M. emblematicus*, male, 48.2 mm SL, UMML 23806; D, *M. emblematicus*, female, 38.0 mm SL, UMML 23806.

Ecology.—In Panama and Costa Rica, *M. curtus* was taken in muddy, mangrove areas. This is consistent with Ginsburg's description of the type locality in Ecuador.

Distribution.—*Microgobius curtus* is known from Pacific Costa Rica to Peru.

Discussion.—This species is known only from the material listed in this study. Specimens from the southern portion of the range (Ecuador and Peru) appear to have a larger eye (mean = 9.0) than those from Panama and Costa Rica (mean = 7.1).

Material Examined.—Ecuador: USNM 107292 (male, 29.9), holotype, Salada, Guayaquil, in mangrove swamp, 1–2 Oct. 1926, W. L. Schmitt. USNM 88788 (5, 18.7–33.9), paratypes, same data as USNM 107292. Peru: IMARPE uncat. (1, 31.0), Puerto Pizarro. Panama: UMML 23812 (1, 36.1). UMML 23811 (1, 39.3). UMML 23813 (1, 39.4). GCRL uncat. (48, 20.3–41.1), Field No. 1412. GCRL uncat. (9, 20.6–41.1), Field No. 1413. Costa Rica: GCRL 4032 (1, 17.8).

Microgobius emblematicus (Jordan and Gilbert), 1882
(Figure 5C, D and Tables 1–4)

Gobius emblematicus Jordan and Gilbert, 1882a: 330–331 (type locality Bay of Panama; type series apparently mixed, see discussion).

Lepidogobius emblematicus: Jordan and Gilbert, 1882c: 111 (new combination).

Microgobius emblematicus: Jordan and Eigenmann, 1886: 503–505 (new combination).

Zalypnus emblematicus: Jordan and Evermann, 1896: 459 (type of new genus *Zalypnus*).

Diagnosis.— D_2 16–18 (usually 17); A 16–18 (usually 17); lateral scale rows about 50–75; scales entirely cycloid, no ctenoid scales beneath pectoral fin; dorsum with about five dark dashes along dorsal fin bases.

Description.— P_1 18–23 (usually 20); gill rakers on first arch about 4 + 16; each dentary with about 4–5 teeth in outer row; upper jaw about 14.0 in males, 12.6 in females; mouth inclined about 25 degrees from the horizontal.

Eye diameter 6.8; interorbital width 2.3; head length 27.8; pectoral-fin length 19.2; pelvic-fin length 20.1, slightly sexually dimorphic in mature specimens, reaching anus in large males, falling somewhat short of anus in females; caudal-fin length 27.6.

Fleshy nuchal crest low and poorly developed in both sexes; scales on side stopping a considerable distance short of pectoral axil, absent on dorsum immediately below spinous dorsal; dorsal spines produced into filaments in males; fourth, fifth, sixth and seventh spine filaments often extending beyond hypural plate; dorsal spines of females not elongate.

SENSORY CANAL SYSTEM. Supraorbital canals conjoined most of their extent; lateral cephalic canal with three pores; preopercular canal with two pores.

COLORATION OF MALES. The following account is based on freshly preserved material: body yellowish green above; yellowish white below; belly with bluish cast; five dark dashes on dorsum along bases of dorsal fins; a dark diffuse spot on body just below D_1 fin; head and operculum with three longitudinal orange-yellow lines with iridescent blue lines between; horizontal orange stripe along midline under appressed pectoral fin; pectoral base and branchiostegal membranes yellowish; pectoral fins pale; pelvic fins dusky; spinous dorsal fin with yellow base; spine filaments orange-yellow distally; soft dorsal dusky with four yellow stripes which merge posteriorly; anal dusky with orange base, fading to yellow distally; caudal fin yellowish with bright orange stripe originating at base of ventral rays and running diagonally across them becoming horizontal just below midline of caudal fin, and extending to margin.

COLORATION OF FEMALES. Body yellowish green above; pale below, the two areas being well-delineated by an orangish yellow stripe originating at the origin of the anal fin and running dorsoposteriad to the lateral midline, there following the midline to the caudal fin base. Belly with bluish cast; dark diffuse spot on body below D_1 fin; head and operculum with three longitudinal yellow stripes separated by iridescent blue stripes; nuchal crest yellow; branchiostegal membranes and pectoral base yellowish; pectoral fins pale; pelvic fins dusky with yellowish cast; spinous dorsal fin with broad yellow basal stripe and broad yellow

stripe along distal margin; soft dorsal fin yellowish orange with a median pale stripe originating midway first element and becoming basal posteriorly and with a submarginal pale stripe; anal fin dusky, becoming darker distally; caudal fin yellowish with several orange spots in dorsal half and with median and ventral bright orange stripes originating at base of the rays, converging about midway the caudal fin and extending to margin.

Ecology.—In Panama *Microgobius emblematicus* was taken in beach areas with a muddy, shell bottom.

Distribution.—Known from the Gulf of California to the Pacific coast of Panama.

Discussion.—Jordan and Gilbert's type material of *M. emblematicus* has apparently been lost. Ginsburg (1939: 54–56) discussed the possibility that Jordan and Gilbert's description was based on a mixture of three species now recognized as *M. emblematicus*, *M. brevispinis* and *M. tabogensis*. He compared the meristic features of the three species and restricted the name *M. emblematicus* by designating a neotype, a male, SU 33208. Ginsburg (1939: 55) also states that Gilbert and Starks (1904: 174) based their account of *M. emblematicus* on a mixture of *M. emblematicus* and *M. brevispinis* and that Meek and Hildebrand (1928: 871–874) based their account of *M. emblematicus* wholly on specimens of *M. brevispinis*. My examination of a portion of Meek and Hildebrand's material from FMNH and USNM showed the specimens to be a mixture of *M. brevispinis* and *M. emblematicus*. Ginsburg (1939) did not have material available to compare life colors of the three species in question with the colors described for *M. emblematicus* by Jordan and Gilbert (1882a: 330–331). My examination shows the description of the color pattern of *M. emblematicus* given by Jordan and Gilbert apparently to be a mixture of the patterns of the three species but more applicable to *M. emblematicus* (as restricted by Ginsburg) than to the other two species. This substantiates Ginsburg's restriction of the name *emblematicus*.

Material Examined.—Panama: SU 33208 (male, 39.0), neotype, Jan. 1896, C. H. Gilbert. FMNH 8488 (1, 39.7). FMNH 8487 (1, 30.0). FMNH uncat., out of FMNH 8486 (1, 31.6), Panama City, tide pools, 24 Mar. 1912, Meek and Hildebrand. USNM uncat. (1, 33.6), Miraflores Locks, lower chamber, 26–29 Mar. 1937, Hildebrand. USNM uncat. (30, 18.1–37.7), Venado Beach, 26 Feb. 1937, Hildebrand, MCZ uncat. (1, 28.7), Pacific, Punta Vique, IR-150, I. Rubinoff. MCZ uncat. (2, 30.2, 39.1), Pacific, Golfo Montijo, IR-137, Rubinoff. UMML 23806 (59, 24.1–48.7). UMML 23807 (1, 28.7). UMML 24746 (13, 16.3–26.3). UMML 24747 (1, 18.1). GCRL uncat., Field No. V67: 1979 (11, 13.8–29.0). GCRL uncat., Field No. V67: 2112 (5, 31.0–34.1). Costa Rica: UCLA W54-97 (1, 29.3). UCLA W54-41 (4, 28.0–30.0). Mexico: UCLA W52-119 (1, 17.0). UCLA W51-36 (2, 30.0, 33.0).

Microgobius brevispinis Ginsburg, 1939 (Figure 6A, B and Tables 1–4)

Gobius emblematicus Jordan and Gilbert, 1882a: 330–331 (in part; see remarks under account of *M. emblematicus*).

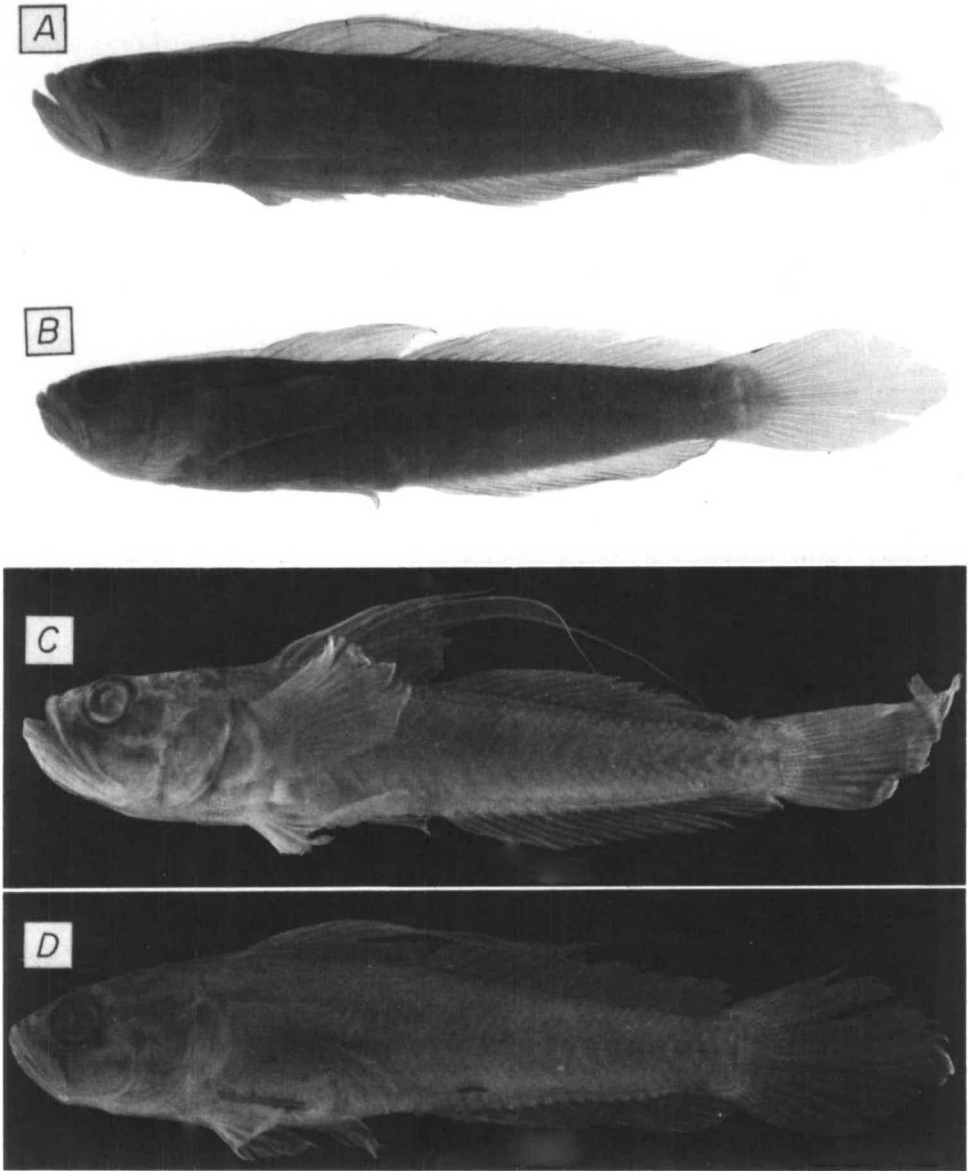
Microgobius emblematicus: Jordan and Eigenmann, 1886: 503–504 (in part).

Microgobius brevispinis Ginsburg, 1939: 56 (type locality Balboa, Panama; holotype USNM 81842).

Diagnosis.—D₂ 16–19 (usually 18); A 16–19 (usually 18); lateral scale rows about 63–81; scales entirely cycloid, no ctenoid scales beneath pectoral fin; dorsal margin of caudal fin with a single dusky orange spot (black in preservative).

Description.—P₁ 19–22 (usually 21); gill rakers on first arch usually 4 + 16; each dentary with about 6–7 teeth in outer row; upper jaw 13.4 in males, 11.9 in females; mouth inclined about 45 degrees from the horizontal.

Eye diameter 7.0; interorbital width 2.9; head length 25.6; pectoral-fin length 21.6; pelvic-fin length 25.5 in males, 21.8 in females; caudal-fin length 29.3.



SL, SIO 72-719; C, *M. crocatus*, male, 36.5 mm SL, GCRL uncat. (Field No. 1478); D, *M. crocatus*, female, 27.2 mm SL, GCRL uncat. (Field No. 1478).

Fleshy nuchal crest moderately developed in both sexes. Scales on side extending forward to a point about even with third dorsal spine. Scales absent on dorsum immediately below anterior half of the spinous dorsal fin. Second through fifth dorsal spines produced into filaments in males, extending past caudal base in large specimens. Dorsal spine filaments little produced in females.

SENSORY CANAL SYSTEM. Supraorbital canals separate most of their extent; lateral cephalic canal with three pores; preopercular canal with two pores.

COLORATION OF MALES. The following account of color pattern is from freshly preserved material: body yellowish green above, pale yellow below; sides under appressed pectoral mottled with iridescent blue and yellow spots; an intense dark bar bordered in orange-yellow on body just above the pectoral fin; head and operculum with four horizontal orange-yellow lines with iridescent blue lines between; branchiostegal membranes yellowish; pectoral base with three yellow-orange horizontal lines with iridescent blue lines between; spinous dorsal fin with two yellow-orange stripes and yellowish distal margin; soft dorsal fin with yellowish base, a median orange-yellow stripe and orange-yellow distal margin; pectoral fins uniformly pale; pelvic fins dusky; anal fin dusky with medial orange-yellow stripe which is continuous with similar stripe on caudal fin; caudal fin yellowish with yellow-orange longitudinal stripe on lower half and an intense orange spot at the base of dorsalmost rays (appearing dark in preservative).

COLORATION OF FEMALES. Body greenish yellow above, pale below; the two areas being sharply defined by a narrow stripe originating at the origin of the anal fin and running posterodorsad to the median line and continuing to the caudal base but becoming faint posteriorly; an intense iridescent yellow bar above and under appressed pectoral fin; head and pectoral base marked as in males; spinous dorsal fin pale with orange-yellow distal margin; soft dorsal fin with three dusky yellow stripes, one basal, one medial and one distal; pectoral fins pale; pelvic fins dusky with dusky-yellow border; anal fin dusky with pale distal margin; caudal fin yellowish with orange spot on base of dorsalmost rays.

Ecology.—*Microgobius brevispinis* has been taken in beach areas and tide pools with a muddy shell bottom, frequently with *M. emblematicus*.

Distribution.—Known from Baja California and the northern Gulf of California to the Pacific coast of Panama.

Discussion.—This species, the largest in the genus *Microgobius*, was long confused with *Microgobius emblematicus* (see discussion under *M. emblematicus*).

Ginsburg's name *brevispinis* is unfortunate as the males of this species have very filamentous dorsal spines; however, the large specimens from Panama do not have dorsal filaments as long as those from the northern end of the range at Baja California. Meristically and morphometrically the two populations are very similar.

Material Examined.—Panama: USNM 81842 (male, 42.0), holotype, Balboa, in tide pools, 7 Feb. 1912, S. E. Meek and S. F. Hildebrand. USNM 81841 (4, 42.4–48.7), paratypes, Panama City, in tide pools, 19 Feb. 1912, Meek and Hildebrand. USNM 81843 (2, 45.3, 50.1), paratypes, Panama City in tide pools, 21 Mar. 1912, Meek and Hildebrand. SU 33209 (32.4), paratype, Jan. 1896, C. H. Gilbert. USNM uncat. (2, 34.3, 40.0), Venado Beach, 26 Feb. 1937, Hildebrand. FMNH 8486 (6, 38.8–48.9) GCRL uncat., Field No. V67: 2113 (1, 36.2). UMML 23810 (4, 14.8–47.6). MCZ uncat. (1, 39.8), Pacific, Point Paitilla, 4 July 1961. GCRL uncat. (1), Perlas Islands, Bahia Santelmo, Isla del Rey, 1 Aug. 1968. Mexico: UCLA W51-20 (1, 34.1). UCLA W51-58 (4, 21.0–41.8). UCLA W52-12 (1, 31.8). SIO uncat. (1, 36.2), Sonora, Golfo de Calif., Puerto Peñasco, Norse Beach in tide pools, 24 Feb. 1967. SIO 62-106 (44, 34.6–63.0). SIO 62-719 (64, 22.5–63.7). SIO 62-713 (1, 52.2). SIO 62-721 (3, 19.5–48.7). SIO 62-737 (1, 18.7). SIO 64-42 (4, 16.0–28.5). SIO-H50-67 (1, 34.4). SIO 64-62 (3, 36.6–43.4). SIO 62-25-59B (2, 33.2, 36.4).

Microgobius crocatus Birdsong, 1968 (Figure 6C, D and Tables 1–4)

Microgobius crocatus Birdsong, 1968, figs. 1, 2 (type locality Pacific coast of Panama near Miraflores Locks; holotype USNM 202587).

Microgobius miraflorensis Chirichigno Fonseca, 1968: 454, fig. 25 (Puerto Pizarro, Peru; based on male specimens; illustration in error).

Microgobius tabogensis: Chirichigno Fonseca, 1968: 457, fig. 26 (Puerto Pizarro, Peru; based on female specimens; illustration in error).

Diagnosis.— D_2 17–18 (usually 17); A 17–18 (usually 18); lateral scale rows about 51; fleshy nuchal crest very low in females, absent in males; scales mostly cycloid; no dark spot or bar on body below origin of D_1 ; interorbital width broad, about 3.7.

Description.— P_1 21–24; gill rakers on first arch about 5 + 18; each dentary with about 5–6 teeth in outer row; mouth inclined about 50 degrees from the horizontal; upper jaw 17.8 in males, 11.7 in females.

Eye diameter 9.0; head length 27.1 in males, 24.8 in females; pectoral-fin length 24.9; pelvic-fin length 24.7; caudal-fin length 35.3.

Scales on side extending forward almost to pectoral axil, absent on dorsum immediately below spinous dorsal fin; scales mostly cycloid with small patch of weakly ctenoid scales under appressed pectoral fin. Third through fifth dorsal spines produced into filaments in both sexes, longest reaching end of soft dorsal fin in females, slightly longer in males.

SENSORY CANAL SYSTEM. Supraorbital canals widely divergent between orbits; lateral cephalic canal with three pores; preopercular canal with two pores.

COLORATION OF MALES. The following account is based on life colors: body dusky, greenish yellow dorsally, becoming white ventrally; belly bluish; two small yellow spots on body under dorsal edge of appressed pectoral fin; yellow spot on mid-pectoral base, another on midline of nape; two iridescent blue, longitudinal stripes on cheek; two iridescent blue spots on anterior edge of opercle, and two orange-yellow spots on posterior edge; lips dusky yellow; chin dusky.

Spinous dorsal fin dusky with yellowish cast to basal portion; a hyaline slash originating at base of each and running at slight diagonal to each spine; distal portion of fin dark with orange-red cast to filaments; soft dorsal fin dusky with narrow, dark distal margin and orange cast; pelvic fins dusky with yellow distal margin; anal fin dusky with yellow distal margin and a submarginal dark stripe; caudal fin with yellow ventral stripe and several orange spots dorsally; median caudal rays dusky orange.

COLORATION OF FEMALES. In preservative the females differ from the males as follows: body pale above the anal fin; corner of mouth beneath the tip of maxilla darkly pigmented; spinous dorsal fin with broad, dusky basal stripe with narrow dusky stripe above; second dorsal fin dusky with basal hyaline stripe.

Ecology.—The type locality in Panama is a mangrove slough with a mud and detritus bottom. The collections from Costa Rica and El Salvador apparently are from similar habitats.

Distribution.—Known from Peru, Panama, Costa Rica and El Salvador.

Material Examined.—Peru: IMARPE uncat. (3, 28.5–32.4), Puerto Pizarro, 10 Mar. 1966. IMARPE uncat. (4, 30.1–32.5), Tumbes, Jan. 1967. Panama: USNM 202587 (male, 30.6), holotype, Pacific, slough draining "Third Lock," approx. 1.3 mi. SSE of Miraflores Locks near town of Cocoli, 14 May 1967, RSB-PAN-11, Birdsong, T. Fraser, T. Murray. Costa Rica: GCRL 4028 (1, 19.7). GCRL 4117 (4, 20.2–34.0). GCRL uncat. (6, 23.0–34.6), Field No. 1409. UCR 33-11 (2, 22.4, 31.7). El Salvador: GCRL 4029 (10, 16.5–35.7). GCRL uncat. (2, 27.1–27.6), Field No. 1292.

Microgobius miraflorensis Gilbert and Starks, 1904
(Figure 7A, B and Tables 1–4)

Microgobius miraflorensis Gilbert and Starks, 1904: 176, fig. 54 (no type locality given). Böhlke, 1953: 115 (SU 6511, Rio Grande, Miraflores, Colombia, given as holotype).

Diagnosis.— D_2 16–18 (usually 17); A 16–18 (usually 18); lateral scale rows about 40–48; fleshy nuchal crest absent in both sexes; scales mostly ctenoid; about 5–20 teeth in outer row of each dentary; caudal fin lanceolate, about 36.9.

Description.— P_1 20–23 (usually 21–22); gill rakers on first arch about 4 + 15; mouth inclined about 35 degrees from the horizontal; upper jaw 17.2 in males, 12.5 in females.

Eye diameter 7.5; interorbital width 2.4; head length 28.2; pectoral-fin length 25.7; pelvic-fin length 24.6; caudal-fin length 36.9.

Scales on side extending forward to a point under one third the length of the appressed pectoral fin, absent on dorsum below spinous dorsal fin; all scales ctenoid. In males dorsal spines two through six produced into filaments, the longest reaching the caudal base; dorsal spines of females only slightly produced, the longest reaching the base of the third soft dorsal element.

SENSORY CANAL SYSTEM. Supraorbital canals contiguous between the orbits; lateral cephalic canal with two pores; preopercular canal with two pores.

PIGMENTATION OF MALES. The following account is based on preserved specimens. Gilbert and Starks (1904: 177) state that there are no bright colors in life. Body pale brown, paler ventrally, with five dark dashes on dorsum along the bases of the dorsal fins; a dark, well-defined vertical bar originates just below the base of the second dorsal spine and continues ventrad to a point below the median rays of the pectoral fin, occasionally an additional one to five faint vertical bars may occur on body parallel and posterior to the dark bar; pectoral base freckled with large melanophores; head light brown, slightly darker dorsally.

Spinous dorsal fin pale with dusky suprabasal stripe and one to five discrete dark spots in dorsal half of membranes one and two; dorsal fin becoming dusky distally, especially the filaments; soft dorsal fin with dusky base and two to three narrow, median, dusky stripes; anal fin dusky, paler along base and distal margin; pectoral fins pale; pelvic fin interradi al membranes dusky, the medial membranes darker; median rays of caudal fin dusky, two to three diagonal rows of small, faint spots in dorsal half.

PIGMENTATION OF FEMALES. Pigmented as the males with the following exceptions: dark vertical bar on body originating below base of second dorsal spine broader than in males and extending ventrad only to a point under dorsalmost pectoral rays; spinous dorsal fin without discrete dark spots in dorsal half of first two interradi al membranes; anal fin without pale distal margin; pelvic-fin membranes dusky with pale distal border.

Ecology.—*M. miraflorensis* is apparently an estuarine species with a considerable tolerance for reduced salinities. Meek and Hildebrand (1928: 873) reported this species from muddy and slightly brackish tidal streams in eastern Panama. Breder (1927: 143) found it to occur in similar habitats in the Rio Chucunaque drainage and described its occurrence to be “only in tide water, over very soft flocculent mud, in which they lay half buried.” Miller (1958: 236) described the habitat of *M. miraflorensis* at Laguna Papagayo (about 15 mi. SE of Acapulco, Mexico) as being “fresh turbid water to two feet deep over mud bottom,” and at Laguna Coyuca (about 10 mi. NW of Acapulco, Mexico) as being “fresh, greenish-brown water over a sand, silt and mud bottom.”

Distribution.—Known from Miraflores, Colombia to Sonora, Mexico.

Material Examined.—Colombia: SU 6511 (male, 39.0), holotype, Rio Grande, Miraflores. Panama: FMNH 8489 (2, 29.7, 33.2). USNM 81845 (2, 32.8, 33.8). Mexico: SIO uncat. (1, 28.6), Nayarit, Playa

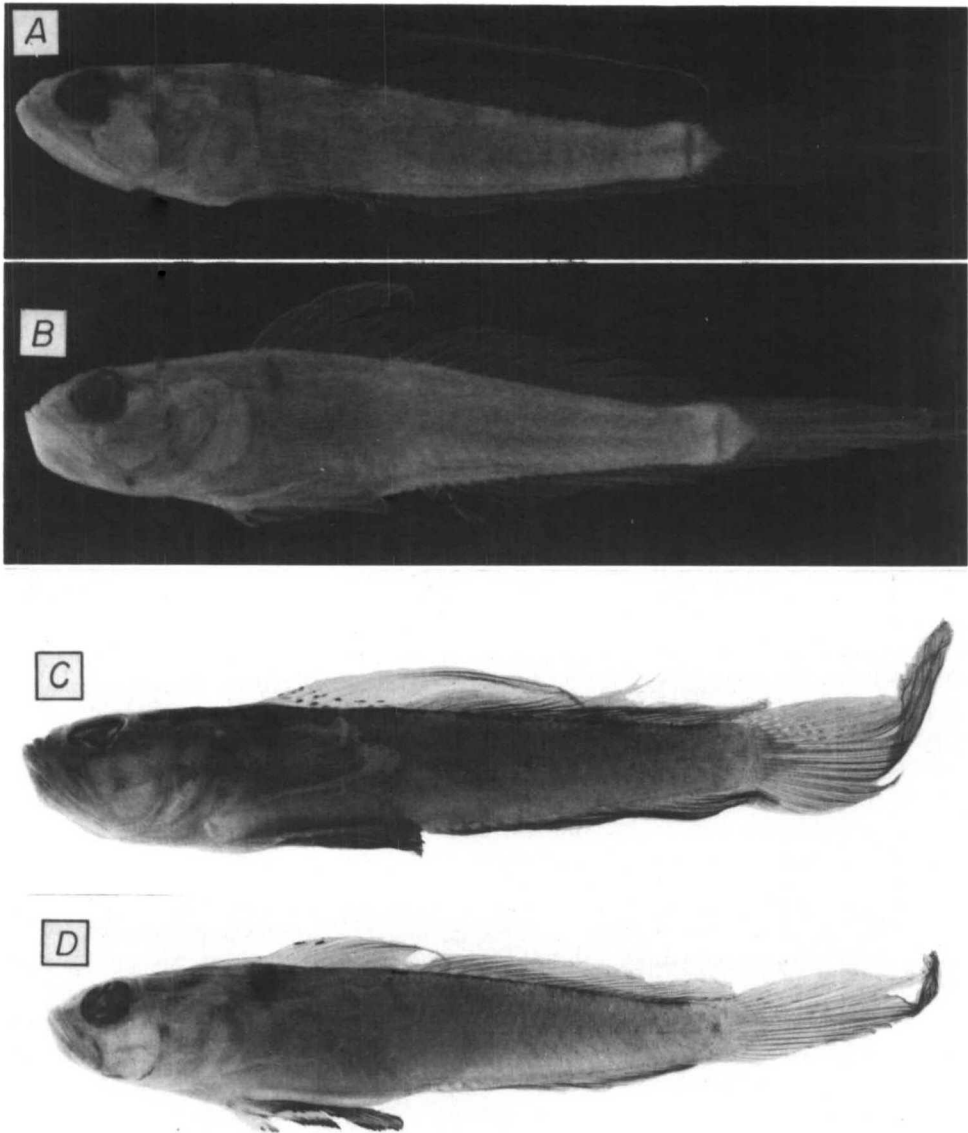


Figure 7. A, *M. miraflorensis*, male, 26.8 mm SL, UMMZ 184866; B, *M. miraflorensis*, female, 29.4 mm SL, UMMZ 173398; C, *M. tabogensis*, male, 42.2 mm SL, GCRL uncat. (Field No. 1428); D, *M. tabogensis*, female, 31.6 mm SL, GCRL uncat. (Field No. 1428).

Nuavos, 28 June 1968. UMMZ 173398 (9, 24.5–31.0). UMMZ 167568 (3, 19.8–27.6). UMMZ 184818 (1, 30.6). UMMZ 184866 (13, 19.9–29.4). UCLA W52-44 (17, 20.9–36.3). UCLA W52-47 (2, 28.2, 35.7).

Microgobius tabogensis Meek and Hildebrand, 1928
(Figure 7C, D and Tables 1–4)

Microgobius tabogensis Meek and Hildebrand, 1928: 873–874, pl. 85 (type locality Taboga Island, Panama; holotype USNM 81844).

Diagnosis.—D₂ 16–18 (usually 17); A 16–18 (usually 17); lateral scale rows about 41–55; fleshy nuchal crest absent in males, well developed in females; scales cycloid to ctenoid; spinous dorsal fin of females often with one to three small black spots; caudal fin lanceolate, about 37.4.

Description.—P₁ 19–23 (usually 22); gill rakers on first arch 4 + 13; each dentary with about 7–9 teeth in outer row; mouth inclined about 40 degrees from the horizontal; upper jaw 15.9 in males, 11.7 in females.

Eye diameter 7.4; interorbital width 2.0; head length 27.3 in males, 25.8 in females; pectoral-fin length 24.0; pelvic-fin length 24.5; extending well past origin of anal fin.

Scales on sides extending forward almost to pectoral axil; absent on dorsum immediately below spinous dorsal fin; scales cycloid to ctenoid (see discussion) with ctenoid scale patch under appressed pectoral fin; dorsal spines two through five produced into elongate filaments in both sexes, somewhat longer in males.

SENSORY CANAL SYSTEM. Supraorbital canals conjoined most of their extent; lateral cephalic canal with two pores (anteriormost lateral cephalic canal pore often absent); preopercular canal with two pores.

PIGMENTATION OF MALES. The following account is based on preserved specimens; body uniformly brownish in preservative; five poorly defined, dark dashes on the dorsum along the bases of the dorsal fins; a diffuse, dark blotch on side running from the origin of the spinous dorsal ventrad to the anterodorsal edge of the appressed pectoral fin; head with two horizontal pale stripes below eye, probably colored in life; nape and opercle with several pale spots; spinous dorsal fin with a suprabasal row of dusky spots; dorsal spine filaments dusky posteriorly; soft dorsal fin dusky with a basal and a suprabasal hyaline stripe; anal fin dusky, paling proximally; caudal fin dusky with several hyaline spots dorsally and dark margin to anterior dorsal membranes; pectoral fins pale; pelvic fins darkly pigmented becoming darker posteromedially.

PIGMENTATION OF FEMALES. Pigmentation as in males with the following exceptions: body paler below midline above anal fin, but pale margins of area poorly defined; head with dark pigmentation at corner of mouth and a thin line of dark pigment along the posteroventral margin of the preopercle; spinous dorsal fin uniformly dusky, often with one to three intensely dark spots on the first, fourth or fifth interradial membranes; anal fin dusky with broad, pale median stripe; soft dorsal fin dusky with broad, median hyaline stripe; caudal fin dusky with several pale spots dorsally, often with several small intense dark spots along the dorsal margin; pelvic fins dusky with hyaline margin.

Ecology.—This species appears to prefer mangrove areas with muddy sand bottom.

Distribution.—Known from the lower west coast of Baja California and the Gulf of California to Colombia.

Discussion.—Meek and Hildebrand (1928: 874) described *Microgobius tabogensis* as being “wholly without spots or bars; fins all plain translucent.” Their description was based on an alcohol preserved specimen that had, no doubt, faded. More recently collected specimens, some collected by Hildebrand, have a well marked pattern on the body and fins.

There is considerable variation in the development of scale ctenii among the populations of *M. tabogensis*. Ctenii are poorly developed in Panamanian spec-

imens, being restricted to a small patch of scales under the pectoral fin and a few scales on the caudal peduncle. Specimens from the northern end of the range, at Baja California, are almost entirely invested with ctenoid scales except for a few cycloid scales along the dorsum and on the belly. Specimens from the southern portion of the range in Colombia and those from Costa Rica and El Salvador display an intermediate condition in having more weakly developed ctenii and more extensive areas of cycloid scale development than specimens from Baja California.

Microgobius tabogensis is poorly collected over most of its range, a distance in excess of 2,500 miles. Life colors are undescribed for any of the populations, and there is little meristic or morphometric variation. For these reasons it seems advisable to let considerations of subspecific differentiation await further material and more data.

Material Examined.—Colombia: GCRL uncat. (27, 20.0–41.5), Field No. 1428. GCRL uncat. (3, 20.0–29.5), Field No. 1429. GCRL uncat. (3, 25.2–36.2), Field No. 1427. Panama: USNM 81844 (female, 36.2), holotype, Taboga Island, S. E. Meek and S. F. Hildebrand. USNM uncat. (2, 16.0, 22.3), San Francisco Beach near Panama City, 13 Feb. 1937, Hildebrand. USNM uncat. (3, 30.0–31.5), Venado Beach, 26 Feb. 1937, Hildebrand. USNM uncat. (26, 17.0–33.1), Miraflores Locks, lower chamber, 26–29 Mar. 1937, Hildebrand. GCRL uncat. (20, 24.7–42.5), Field No. 1412. Costa Rica: UCLA W54-45 (58, 14.2–34.3). UCLA W54-41 (9, 25.0–29.0). UCLA W54-35 (5, 25.0–32.0). UCLA W54-109 (4, 18.8–30.5). El Salvador: GCRL uncat. (19, 13.9–27.6), Field No. 1294. GCRL 4030 (2, 40.2, 40.3). Guatemala: GCRL uncat. (7, 16.4–47.5), Field No. 1403. Mexico: UCLA W53-192 (2, 25.4, 25.5). UCLA W54-20 (2, 23.4, 26.6). UCLA W51-36 (3, 17.2–39.0). UCLA W58-18 (42, 8.5–36.1). UCLA W52-254 (81, 29.7–47.6). SIO 64-81 (1, 33.0). SIO 64-84 (11, 21.9–41.0). SIO 62-721 (2, 31.0, 38.3).

GENERAL DISCUSSION

Relationships

Although the genus *Microgobius* has been placed in the tribe Gobiosomini (Birdsong, 1975), its relationship to other members of the tribe is obscure. While *Microgobius* shares the tribal characteristics of 11 precaudal and 16–17 caudal vertebrae in conjunction with a spinous dorsal fin formula of 3(221110), it lacks the unusual, and apparently apomorphic, condition of having the lower hypurals fused to the urostyle and the upper hypurals. Among the Gobiosomini it shares this deficiency only with *Bollmannia*, *Parrella*, *Palatogobius* and the apparent most primitive member of *Gobiosoma*, *G. etheostoma*. This characteristic appears to exclude all other Gobiosomini from the possible ancestry of *Microgobius*. *Microgobius* appears most closely related to *Parrella* and *Bollmannia*, but none seems to be a suitable candidate for the ancestry of another (Birdsong, 1975: 177).

The interspecific relationships of the *Microgobius* are equally complex. Ginsburg (MS) divided the genus into seven subgenera primarily on the basis of scale type, cephalic lateralis system, dentition and size of mouth. Since Ginsburg's unpublished work, three new species have been described and much additional material has been collected. In light of this new information, most of Ginsburg's groups now seem arbitrary.

The useful taxonomic character states of *Microgobius* are distributed among the species in a mosaic pattern and the direction of character state transformation is obscure for all but a few characters. Adding further confusion where no more is needed, is the fact that the male condition for several sexually dimorphic characters in some species can be the female condition in others or not dimorphic at all. Over the 15 years that I have intermittently contemplated the relationships of the 14 species of this genus I have come to many tentative conclusions, but

only one seems worthy of mention: I don't know how they are related to each other!

Zoogeography

The absence of phylogenetic information prevents any serious explanatory attempt at a zoogeographic analysis. The following is, accordingly, only descriptive.

Many of the apparent gaps in distribution are, no doubt, artifacts of collecting techniques and accessibility. Vast stretches of the shallow waters of both the Caribbean and Pacific coasts of Central and South America are virtually unsampled. Even in well sampled areas the habitat of many species of *Microgobius* is such that it is often the last and least collected.

Atlantic Zoogeography.—The Atlantic species of *Microgobius* can be roughly categorized into a northern and a southern group with some overlap in the Antilles. The northern group consists of *M. gulosus*, *M. thalassinus*, *M. microlepis* and *M. carri*; and the southern group of *M. signatus* and *M. meeki*. Both groups show basically continental distributions though there are insular populations of several species.

Microgobius gulosus and *M. thalassinus* are both restricted to the North American continent and are sympatrically distributed from the Chesapeake Bay to the northwestern Gulf of Mexico. Their known western limit roughly coincides with the U.S. border, and is more apparent than real. Both of these species seem to prefer estuarine conditions. Though *M. thalassinus* occurs near the southwestern tip of Florida, it is unreported from the lower east coast of Florida south of Cape Canaveral and from Georgia. If this gap is real, it is at best providing only partial isolation as the Atlantic and Gulf populations are little differentiated. Likewise, the apparent disjunct distribution of *M. gulosus* along the Atlantic coast has not resulted in differentiation.

Microgobius microlepis and *M. carri* also display northern distributions, but are apparently less tolerant of turbid waters and reduced salinities. *M. microlepis* is known from the southeastern coast of Florida, the eastern coast of the Yucatan Peninsula and from one specimen from the Bahamas. *M. carri* is found around Florida in deeper offshore waters and in the lesser Antilles with those from the Florida Keys and the Antilles all taken in close proximity to coral reefs. I suspect that both of these species have broader Caribbean distributions than present collections indicate.

The southern species, *M. meeki* and *M. signatus*, are both distributed along the South American coast and north through the Antilles. *M. signatus* is apparently a somewhat insular fish of sandy bottom habitats which have clear waters of full salinity. It appears ecologically similar to *M. microlepis*. *M. meeki* appears to prefer muddy mangrove areas and is unknown from the Lesser Antilles where this habitat is scarce. *M. meeki* is abundant in Puerto Rico which is the first large island in the Antillean chain on which the mangrove habitat is abundant.

Pacific Zoogeography.—The zoogeography of the Pacific Central American coast has been more thoroughly studied than that of the Caribbean. Springer (1959) has reviewed the most important literature dealing with the zoogeography of Pacific Central American shore fishes. The zoogeography of the Gulf of California and Baja California has been further discussed by Walker (1960) and Hubbs (1960), respectively.

All of the Pacific species of *Microgobius* are restricted to the Tropical Eastern Pacific faunal region. This region has been subdivided into several faunal prov-

inces by recent investigators (Hubbs, 1952; Briggs, 1955; Springer, 1959). As pointed out by Walker (1960: 123), all of these workers were concerned with fishes from rocky shores and their faunal provinces primarily reflect the distribution of such habitats. *Microgobius* inhabits sand and mud bottom habitats, in the main, and it is not surprising that its distribution poorly fits the faunal boundaries set forth by these previous workers.

All eight Pacific species occur in the general vicinity of the Gulf of Panama with six species (*M. tabogensis*, *M. erectus*, *M. cyclolepis*, *M. miraflorensis*, *M. emblematicus* and *M. brevispinis*) having their primary distribution northward to or through the Gulf of California and two species (*M. curtus* and *M. crocatus*) with their primary range southward to northern Peru.

The two southerly distributed species are known from limited material. Both *M. curtus* and *M. crocatus* occur as far south as Puerto Pizarro at the northern tip of Peru and range north to Costa Rica and El Salvador, respectively.

The six northerly distributed species all have their southern limits in or just south of the Gulf of Panama with *M. tabogensis* reaching as far south as Bahia de Buenaventura, Colombia.

Three species (*M. brevispinis*, *M. cyclolepis* and *M. erectus*) apparently extend northward through the northern Gulf of California. Both *M. erectus* and *M. cyclolepis* are deeper dwelling species which may occupy habitats atypical of the genus. *M. brevispinis*, also unlike many species of the genus, apparently shows no preference for estuarine, mangrove areas, but has been most often taken along rocky beaches.

The remaining three northern species (*M. emblematicus*, *M. miraflorensis* and *M. tabogensis*) reach their northern limit in the Gulf of California between Mazatlan and Guaymas. Springer (1959) emphasized the importance of this area as a faunal gap for many of the rocky shore fishes. It is unlikely that the species of *Microgobius* are limited by the absence of rocks, but Walker (1960) showed many other ecological differences between the northern and southern Gulf of California which may be limiting (e.g., surface temperatures in the northern Gulf show twice the annual range as those in the southern Gulf; and tides in the northern Gulf have a spring amplitude of 30 feet in some places as opposed to a spring amplitude of 4 feet in the southern Gulf). Walker (1960) further pointed out that numerous sandy shore species also reach their northern limit between Mazatlan and Guaymas.

The Gulf coast of Baja California is characterized by rocky shores and rocky cliffs (Walker, 1960: 124) and is quite different from the mainland shore of the Gulf. *M. erectus* is the only species recorded on this coast of Baja California.

Three species of *Microgobius* occur on the Pacific coast of Baja California. Walker (1960: 127) stated that 37 species of fishes are found in the area of Cabo San Lucas (southern tip of Baja California) but not in the northern or eastern Gulf. *M. tabogensis* has a similar distribution. *M. cyclolepis* and *M. brevispinis* also reach the outer coast of Baja California, but these species also occur in the northern Gulf. The Baja California population of *M. tabogensis* shows little differentiation from the mainland populations and probably crosses the water barrier at the mouth of the Gulf at least occasionally. Walker (1960: 127) postulated that most of the other species having this distribution have also crossed this water barrier.

Judging by the collections, all three species, *M. brevispinis*, *M. tabogensis* and *M. cyclolepis*, that reach the outer coast of Baja California are relatively abundant within the Magdalena Bay complex. Hubbs (1960: 135) states that "within the Bahia Magdalena complex, where the waters are less affected by upwelling and

are more subject to insolation, and are hence warmer, a more tropical fauna persist." The fish fauna along the outer coast of Baja California changes irregularly from almost strictly tropical near the southern tip to warm-temperate near the California border, and faunal boundaries are difficult to place (Hubbs, 1960: 134). All three species of *Microgobius* range up the outer coast northward from Magdalena Bay, the northern most record being *M. brevispinis* from Laguna San Ignacio. *M. cyclolepis* is known from as far north as Punta Pequeña and *M. tabogensis* from slightly farther south near Boca Santa Domingo.

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