



# Article

## ***Microgobius urraca* (Teleostei: Gobiidae), a new species of goby from the tropical eastern Pacific**

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### Abstract

A new species of goby in the genus *Microgobius* (Teleostei: Gobiidae: Gobiosomatini) is described from the Pacific coast of Panama. It is morphologically similar to *M. erectus*, but differs from that species in possessing fewer lateral scale rows, lacking a patch of ctenoid scales under the pectoral fin, having unpigmented epaxial myosepta, having a distinct oval-shaped dark blotch on the first dorsal fin, and possessing three blue-white stripes on a dark caudal fin. Differences in both the number and type of scales, dorsal and anal fin ray counts, the poor development of a fleshy dorsal crest, and overall color patterns further distinguish this species from the remaining eastern Pacific congeners. Photographs of all Pacific species of *Microgobius* and a dichotomous key to the Pacific members of the genus are provided.

**Key words:** Gobiosomatini, *Microgobius* group, Gobiiformes, Panama, American seven-spined gobies

### Introduction

*Microgobius* Poey 1876 is a genus of American seven-spined gobies (tribe Gobiosomatini) that currently includes six species from tropical and warm temperate waters in the western Atlantic and eight species in the tropical eastern Pacific. Western Atlantic species include *Microgobius carri* Fowler 1945, *M. gulosus* (Girard 1858), *M. meeki* Evermann and Marsh 1899, *M. microlepis* Longley and Hildebrand 1940, *M. signatus* Poey 1876, and *M. thalassinus* (Jordan and Gilbert 1883), while *M. brevispinis* Ginsburg 1939, *M. crocatus* Birdsong 1968, *M. curtus* Ginsburg 1939, *M. cyclolepis* Gilbert 1890, *M. emblematicus* (Jordan and Gilbert 1882), *M. erectus* Ginsburg 1938, *M. miraflorensis* Gilbert and Starks 1904, and *M. tabogensis* Meek and Hildebrand 1928 are restricted to the eastern Pacific. Species of *Microgobius* often have bright color patterns in life that feature silvery bodies with iridescent blue, green, red and yellow marks on the head, body or median fins. Sexual dimorphism in color patterns, cranial osteology, dorsal fin spines, and the development of a fleshy dorsal crest occurs in several species. Most species of *Microgobius* are found associated with fine sediments in estuaries and shallow coastal waters while some are associated with burrows, roots and open sandy areas. Several species are common in depths less than 1 m whereas other species reach depths of at least 57 m (Birdsong 1981; Robertson and Allen 2008).

The genus was last treated in its entirety in a taxonomic review by Birdsong (1981). Several subsequent studies have addressed the relationship of *Microgobius* to other gobiid genera. Birdsong *et al.* (1988) placed the genus in the *Microgobius* group of the Gobiosomatini, together with *Bollmannia*, *Parrella* and *Palatogobius*. This was based on shared pterygiophore insertion patterns, vertebral counts, the presence of one epural and the absence of fusion of hypural 1–2 with 3–4 and the terminal caudal element. *Akko* and *Antilligobius* have since been added to the *Microgobius* group based on both molecular and morphological data (Rüber *et al.* 2003; Van Tassell and Baldwin 2004; Van Tassell *et al.* 2012). A clear sister genus to *Microgobius* has yet to be established. Monophyly of *Microgobius*, of the *Microgobius* group, and of the tribe Gobiosomatini is strongly supported by recent molecular phylogenetic analyses (Rüber *et al.* 2003; Thacker and Roje 2011).

In 2003, during a cruise of the Smithsonian Tropical Research Institute's research vessel R/V *Urraca*, three large gobies were collected while trawling on sand and leaf-litter bottoms at depths of 12–20 m off the Pacific coast of western Panama. The specimens were identified as a species of *Microgobius* based on the following suite of characters: first dorsal fin with seven spines; pterygiophore formula 3(221110) (following Birdsong *et al.* 1988); second dorsal and anal fin well separated from caudal fin; caudal fin lanceolate; head and body laterally compressed; pelvic fins fused into a disc, the frenum of which has a smooth posterior margin; trunk of body scaled; and head, nape, breast and pectoral fin base without scales. Based on several prominent differences between these three specimens of *Microgobius* and the eight previously described species of *Microgobius* from the eastern Pacific we describe them as a new species. We comment on the phylogenetic relationships of the genus and provide photographs and a dichotomous key for the Pacific species of *Microgobius*.

## Methods

Methods for counts and measurements follow Van Tassell *et al.* (2012). The dorsal pterygiophore formula is that of Birdsong *et al.* (1988), patterns of sensory papillae are described according to Miller (1986) and terminology of the head-canal pores follows Akihito *et al.* (1984). Institutional acronyms follow Sabaj Pérez (2010). Counts of branched and segmented caudal fin rays and vertebrae were made from radiographs.

### *Microgobius urraca* sp. nov.

Dark-finned sand goby

(Figures 1,2)

**Material examined:** Holotype: AMNH 255033, field number JVT-03-238, 69.4 mm SL, female, east of Isla Raya, Panama (Pacific), 7.3966°, -80.2991°, trawled specimen, collected by J.L. Van Tassell and D.R. Robertson, R/V *Urraca*, 20 June 2003, 12 m, sand substrate.

Paratypes: AMNH 255034, field number JVT-03-208, GenBank accession number JX139737 (partial cytochrome c oxidase I sequence), 62.2 mm SL, male, north of Isla Secas near main land, Panama (Pacific), 8.1435°, -81.8775°, trawled specimen, collected by J.L. Van Tassell and D.R. Robertson, R/V *Urraca*, 16 June 2003, 15–18 m, sand and leaf litter substrate; USNM 404510, field number JVT-03-210, 59.8 mm SL, male, north of Islas Secas, Panama (Pacific), 8.1135°, -81.8336°, trawled specimen, collected by J.L. Van Tassell and D.R. Robertson, R/V *Urraca*, 16 June 2003, 20 m, sand and leaf litter substrate.

**Diagnosis.** The new species is morphologically similar to *M. erectus*, but differs from that species in possessing fewer lateral scale rows, lacking a patch of ctenoid scales under the pectoral fin, having unpigmented epaxial myosepta, a distinct oval-shaped dark blotch on the first dorsal fin, and possessing three blue-white stripes on a dark caudal fin. Differences in both the number and type of scales, dorsal and anal fin ray counts, the poor development of a fleshy dorsal crest, and overall color pattern further distinguish this species from the remaining eastern Pacific congeners.

**Description.** Morphometric data and summary of meristics given in Table 1. Counts of the holotype indicated by an asterisk, followed by number of specimens with each count in parentheses.

Median and paired fins: first dorsal VII\*(3); first dorsal spines not highly filamentous, free tips of spines extending only a short distance beyond interspinal membrane; second dorsal I,14\*(3); anal I,14\*(3); second dorsal and anal fin rays extending slightly posterior to origin of caudal fin rays when laid flat; pectoral rays 21(1), 22\*(1), 23(1); pectoral fin length 17.3–20.2 % SL; caudal fin long and lanceolate, 35.3–40.0 % SL; segmented caudal rays 17\*(2); branched caudal rays 15\*(2); pelvic fin I,5\*(3); pelvic fins united to form oval-shaped disk with well-developed frenum; pelvic frenum with smooth posterior margin.

Scales: trunk covered with cycloid scales; predorsal region, cheek, operculum, pectoral fin base and pelvic fin base without scales; pre-anal region with small embedded cycloid scales; scales on anterior and ventral portions of trunk small, partially imbedded, and in irregular rows, becoming larger and arranged in distinct rows dorsally and posteriorly; no small patch of ctenoid scales beneath pectoral fin; lateral scale rows 67\*(1), 75(1), 76(1); transverse scale rows 15\*(1), 17(1), 18 (1).

**ABLE 1.** *Microgobius urraca* morphometrics and counts. Measurements are in % SL.

	Holotype	Paratype	Paratype
Catalog Number	AMNH 255033	AMNH 255034	USNM 404510
Field number	JVT-03-238	JVT-03-208	JVT-03-210
Sex	female	male	male
SL (mm)	69.4	62.2	59.8
Eye diameter	6.23	6.27	6.05
Upper jaw length	10.2	12.86	12.2
Head length	22.1	23.33	22.4
Post orbital length	10.95	10.93	11.2
Depth at DI origin	15.85	15.51	16.3
Least caudal peduncle depth	8.07	8.84	7.85
Pectoral fin length	18.7	17.25	20.2
Caudal fin length	35.3	38.7	40
Snout length	4.7	5.86	5.2
Interorbital width	3.2	3.4	3.7
Dorsal crest	present	present	present
Precaudal vertebrae	11	11	11
Caudal vertebrae	16	16	16
First dorsal fin	VII	VII	VII
Second dorsal fin	I,14	I,14	I,14
Anal fin	I,14	I,14	I,14
Caudal fin, segmented rays	17	17	x
Caudal fin, branched rays	15	15	x
Pectoral fin	22	21	23
Pelvic fin	I,5	I,5	I,5
Transverse scale rows	15	18	17
Lateral scale rows	67	75	76
Patch of ctenoid scales under pectoral fin	absent	absent	absent

Head: head length 22.1–23.3 % SL; mouth angled upwards at approximately 45–55 from horizontal; upper jaw length 10.2–12.9 % SL; teeth in upper jaw in two to three rows near symphysis, becoming two distinct rows near midpoint of premaxilla, terminating as single row near end of upper jaw; teeth in lower jaw two to three rows anteriorly near symphysis, becoming a single row near midway of dentary; teeth in outer row of both jaws enlarged, elongate and with slightly curved canines; tongue bilobed with deep medial notch; eye diameter 6.1–6.3 % SL; interorbital width 3.2–3.7 % SL; snout short, 4.7–5.9 % SL; low fleshy dorsal crest anterior to first dorsal fin in both sexes; anterior nare on short erect tube; posterior nare small, adjacent to head pore B'; gill rakers 5+16; epibranchials present.

Genitalia: female papillae unpigmented, short and bulbous; papilla in males unpigmented, slightly elongate and conical.

Sensory papillae and head pores (Figure 2): two interorbital canals anteriorly, joining posteriorly to become single interorbital canal at point in line with midpoint of eye; oculoscapular pores B', D(s), F, G, H' present; posterior canal (typically between pores K' and L') absent; preopercular pores M', O' present; sensory papillae on head in transverse pattern with three vertical rows below eye; transverse papillae row *b* beginning at vertical through midpoint of pupil, extending posteriorly, ending well short of posterior margin of preopercle; transverse papillae row *d* long, beginning anterior one third of eye, extending posteriorly, ending well short of posterior margin

of preopercle; papillae row  $n$  continuous across dorsal midline; papillae row  $x'$  continuous from above pore F to above base of pectoral fin.



**FIGURE 1.** *Microgobius urraca* holotype, AMNH 255033, 69.4 mm SL, female, at time of collection (A) and preserved (B). Photographs by JVT. Editing by DRR.

Vertebral skeleton: precaudal vertebrae 11; caudal vertebrae (including terminal element) 16; dorsal fin pterygiophore formula 3(221110); two anal fin pterygiophores preceding first haemal arch.

Pigmentation (based on freshly collected specimens unless otherwise noted): head brownish grey, with an indistinct silvery blotch at the lower corner of the operculum; iris creamy yellow; body uniformly light brownish-grey (pale grey to yellow in preservation); anterior half of trunk with four or five narrow, wavy, diffuse pale vertical “Y” shaped bars; epaxial myosepta unpigmented; first dorsal fin with a light grey-brown base, pale grey outer half, those two color areas separated by a conspicuous, horizontal oval blackish blotch across the center of the fifth to seventh spines; second dorsal fin darker posteriorly than anteriorly, with a dark grey base, grey-brown distal half, those two zones separated by a narrow blue-white stripe (stripe not apparent in preservation); anterior third of anal fin dark grey basal on basal quarter and paler grey on distal three-quarters; the posterior two-thirds of the fin is uniformly dark grey; caudal fin very dark, nearly black, with two blue-white stripes along its entire length above midline and one blue-white stripe below midline; pelvic and pectoral fins uniformly light grey; abdominal region pale; prepelvic region lightly pigmented with scattered melanophores; gular region pale.

**Habitat.** *Microgobius urraca* was collected in depths ranging from 12–20 m over sand or sand and leaf litter bottoms. In collections where leaf litter was present this species was collected with several specimens of *Ptereleotris carinata* and *M. erectus*. *Microgobius urraca* may be a burrowing species (see Discussion section below).

**Distribution.** Known only from the Pacific coast of western Panama (Figure 3)

**Etymology.** The specific epithet *urraca* is in reference to the Smithsonian Tropical Research Institute’s research vessel the *Urraca*, which served the institute between 1994–2007. *Microgobius urraca* was collected on one of the many expeditions throughout the tropical eastern Pacific and Caribbean by the R/V *Urraca*, which contributed a wealth of information on fish diversity in the tropical Americas. The species name is to be treated as a noun in apposition. The common name “dark-finned sand goby” is given in reference to the greyish-black second dorsal, anal and caudal fins and the sandy habitat over which it occurs.

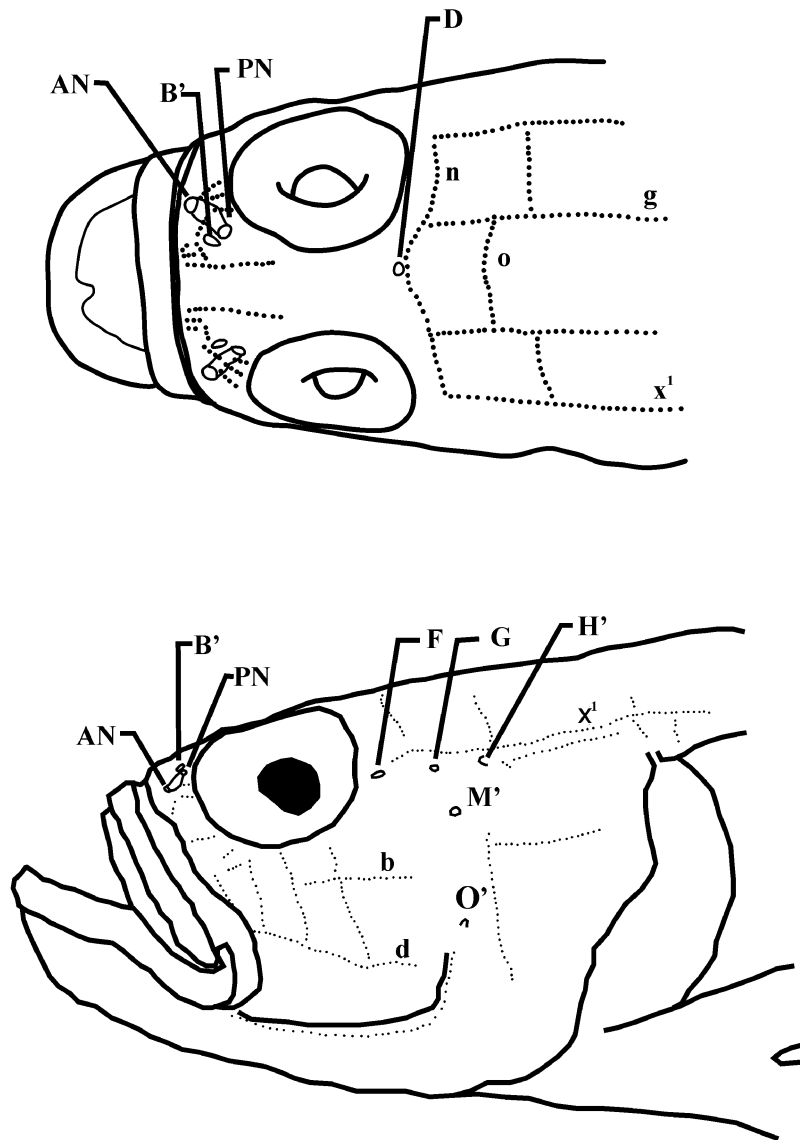
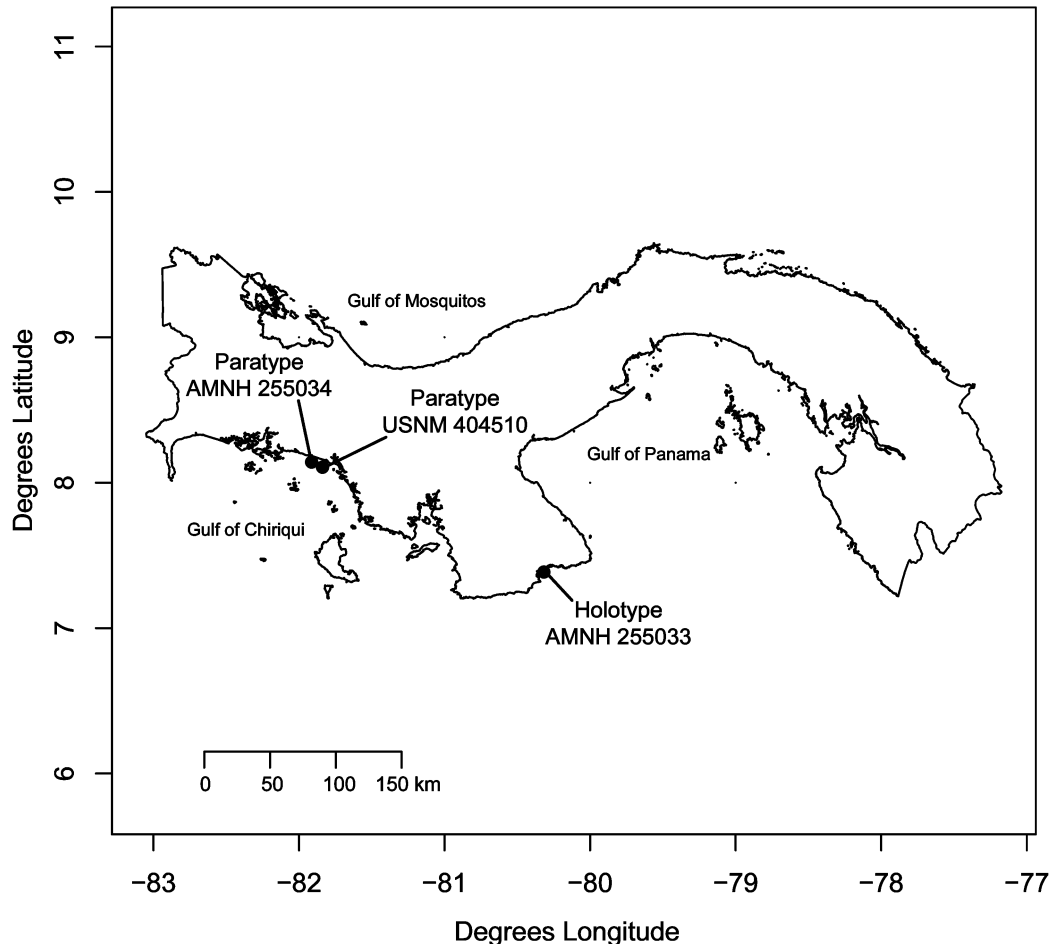


FIGURE 2. Sensory papillae and head pore pattern of *M. urraca* holotype AMNH 255033. Illustrations by JVT.

**Comparisons.** *Microgobius urraca* differs from all other eastern Pacific species of *Microgobius* except *M. erectus* in having counts of I,14 in both the second dorsal and anal fins (all other species typically have  $\geq 15$  rays in the second dorsal and anal fins). *Microgobius urraca* is most similar morphologically to *M. erectus*, but differs in possessing a higher lateral scale count (67–76 vs  $\leq 48$  in *M. erectus*), scales entirely cycloid and not easily lost, a dark blotch on the first dorsal fin (vs a pale/dusky fin with dark distal margin in female *M. erectus*), and in having unpigmented epaxial myosepta (darkly pigmented in preserved specimens of *M. erectus*). The absence of ctenoid scales under the pectoral fin further distinguishes *M. urraca* from *M. erectus*, *M. cyclolepis*, *M. curtus*, *M. crocatus*, *M. miraflorensis*, and *M. tabogensis*. Like most species of *Microgobius*, *M. urraca* can also be distinguished from its congeners by color patterns in life. No other species of *Microgobius* possesses a prominent sooty blotch on the first dorsal fin, dark grey anal and second dorsal fins, and a blackish caudal fin with three blue-white stripes. *Microgobius urraca* replaces *M. brevispinis* as the largest species in the genus (69.4 mm SL vs 64.6 mm SL, maximum size of *M. brevispinis*, SIO62-719)

**Discussion.** Birdsong (1981) reported *M. erectus* from mud and broken shell bottoms from 15–30 m. Many *M. erectus* were collected from the 2003 *Urraca* Panama expedition, several of which were collected with *M. urraca* in a trawl over sand and leaf litter (field number JVT-03-210, AMNH 255301 and field number JVT-03-209, AMNH 255297) and others were collected over sand and mud. Nearly all *M. erectus* specimens from these collections had lost most of their scales and fins were severely damaged. The ease at which scales were lost and the

delicate fin membranes of *M. erectus* led Birdsong (1981) to conclude that *M. erectus*, unlike many other *Microgobius* species, likely did not burrow. Although the specimens of *M. erectus* collected in 2003 were heavily damaged, the specimens of *M. urraca* from the same trawls had not lost scales and fins were more or less intact. Following Birdsong's rationale, it is possible that the partially imbedded nature of the scales and the integrity of the fins in *M. urraca* indicate a burrowing lifestyle. Burrowing behavior may also explain why, despite heavy sampling effort, so few specimens of *M. urraca* were collected in trawls in comparison to *M. erectus*, which were common in trawls in the same area.



**FIGURE 3.** Collection localities for *M. urraca* holotype and paratypes.

The phylogenetic relationship between *M. urraca*, the morphologically similar *M. erectus*, and other *Microgobius* species remain unclear. Birdsong (1981) struggled greatly to generate even a broad phylogenetic hypothesis for the genus, noting inconsistent patterns of shared characters across species, difficulty in determining ancestral/derived character states, and complex and contradicting patterns of sexual dimorphism (i.e. female conditions in one species are the male conditions in other species, while yet other species are sexually monomorphic). The only phylogenetic hypothesis to date was a molecular phylogeny of the Gobiosomatini based on mtDNA by Rüber *et al.* (2003) which contained 6 named (plus one unidentified) *Microgobius* species. Although more than half of the known named species of *Microgobius* were missing from this study the relationships shown were statistically robust and can provide a temporary framework for assessing the evolution and distribution of some morphological characters. When several morphological characters (i.e. predominant scale type, presence/absence of a patch of ctenoid scales under pectoral fin, second dorsal/anal fin counts, filamentous dorsal spines, presence/absence of a dorsal crest, head pores) are mapped onto the phylogeny of Rüber *et al.* (2003), many character states appear to have either arisen or been lost more than once, to which the overall confusion alluded to by Birdsong (1981) may be attributed. A comprehensive phylogenetic analysis that includes all 15 currently recognized species of *Microgobius* and incorporates morphological characters and additional molecular data (including nuclear loci) would help clarify the interspecific relationships of this diverse group.

**TABLE 2.** Morphological comparison of species of *Microgobius*. All measurements are means and are expressed in % SL. Fin ray counts are modes followed by ranges in parentheses.

	<i>erectus</i>	<i>urraca</i>	<i>cyclolepis</i>
Ocean	Pacific	Pacific	Pacific
Distribution	Southern Baja California, northern and eastern Gulf of California to Panama	Pacific coast of Panama	West coast of southern Baja California, northeast Gulf of California to Colombia
Habitat	coastal areas with sand, mud and broken shell bottom	sandy bottom generally with leaf litter (two collected with leaf litter one over sand)	sand, sand/mud or mud bottom
Depth	3–54 m	12–20 m	1–35 m
Elongate first dorsal fin spines	spine 5 sometimes slightly elongate in both sexes	not elongate in either sex	spines 2–6 moderately elongate in both sexes
Second dorsal (total elements)	15(14–15)	15	16(15–17)
Anal	15(14–15)	15	16(16–17)
Pectoral	23(20–23)	21–22	23(22–24)
Fleshy dorsal crest	males and females—low	males and females—low	males-very low; females -large
Preopercle pores	2 rarely 3	2	3
Oculoscapular pores	B',D,F,G,H'	B',D,F,G,H'	B',D,F,G,H'
Separation of supraorbital cephalic canals (see Birdsong 1981: Fig. 1)	canals join near interorbital pore	canals join between orbits	canals join between orbits
Dominant scale type on body	cycloid	cycloid	mostly cycloid
Ctenoid scale patch under pectoral fin	present	absent	present
Lateral scale rows and extent of scales	< 48 (easily lost), just short of pectoral fin axis	67–76, pectoral fin axis	46–55, pectoral fin axis
Epaxial myosepta	darkly pigmented	no pigment	no pigment
Gill rakers	3+13	5+16	5+16
Teeth outer row of dentary	6–8	6–7	6–8
Mouth angle	70 deg	45–50 deg	60 deg
Pectoral fin length	25.5	18.7	24.9
Head length—males	24.4	22.4	28.6
Head length—females	24.2	22.3	27.3
Interorbital width	2.6	3.4	2.6
Caudal fin length	45.0	38.0	32.9

continued.

	<i>curtus</i>	<i>emblematicus</i>	<i>brevispinnis</i>
Ocean	Pacific	Pacific	Pacific
Distribution	El Salvador to northern Peru	Southeast Gulf of California to northern Peru	West coast of southern Baja California, northeast Gulf of California to Panama
Habitat	muddy mangrove areas	beach areas with muddy shell bottoms	beaches and tidepools with muddy shell bottoms
Depth	0.2–16 m	0–17 m	0–6 m
Elongate first dorsal fin spines	spines 2–5 elongate in both sexes	males spines 4–7 elongate, to caudal fin; females only slightly elongate	males spines 2–5 elongate, to caudal fin; females only slightly elongate
Second dorsal (total elements)	16(15–17)	17(16–18)	18(16–19)
Anal	16(16–17)	17(16–18)	18(16–19)
Pectoral	21(20–22)	20(18–23)	21(19–22)
Fleshy dorsal crest	males and females—absent to poorly developed	males and females—low, poorly developed	males and females—moderate
Preopercle pores	2	2	2
Oculoscapular pores	B',D,F,G,H'	B',D,F,G,H'	B',D,F,G,H'
Separation of supraorbital cephalic canals (see Birdsong 1981: Fig. 1)	canals mostly separate	canals join through most of length	canals mostly separate
Dominant scale type on body	mostly cycloid	all cycloid	all cycloid
Ctenoid scale patch under pectoral fin	present	absent	absent
Lateral scale rows and extent of scales	62–78, pectoral fin axis	50–75, end before pectoral fin axis	63–81, end under third spine of D1
Epaxial myosepta	no pigment	no pigment	no pigment
Gill rakers	5+16	4+16	4+16
Teeth outer row of dentary	6–8	4–5	6–8
Mouth angle	45 deg	25 deg	45 deg
Pectoral fin length	20.3	19.2	21.6
Head length—males	27.8	27.8	25.5
Head length—females	27.9	27.8	25.8
Interorbital width	3.0	2.3	2.9
Caudal fin length	29.8	27.6	29.3



continued.

	<i>crocatus</i>	<i>miraflorensis</i>	<i>tabogensis</i>
Ocean	Pacific	Pacific	Pacific
Distribution	El Salvador to Ecuador	West coast southern Baja California (Bahia Magdalene), central eastern Gulf of California to northern Peru	West coast of Baja California(n. Bahia Magdalena), to Peru (Puerto Pizarro)
Habitat	mangrove slough with muddy detritus bottom	estuarine species, mud to silty sand bottom	mangrove ares with mud-sand bottoms
Depth	0–6 m	0–4 m	0–4 m
Elongate first dorsal fin spines	males spines 3–5 elongate to caudal fin; females elongate to end of D2;	males spines 2–6 extend to caudal fin; females to third ray of D2	spines 2–5 moderately elongate in both sexes
Second dorsal (total elements)	17(17–18)	17(16–18)	17(16–18)
Anal	18(17–18)	17(16–18)	17(16–18)
Pectoral	22(21–24)	21–22(20–23)	22(19–23)
Fleshy dorsal crest	males—absent; females—low	males and females—absent	males—absent; females—well developed
Preopercle pores	2	2	2
Oculoscapular pores	B',D,F,G,H'	B',D,F,H'	B',D,F,H', pore F frequently absent
Separation of supraorbital cephalic canals (see Birdsong 1981: Fig. 1)	canals widely divergent	canals join between orbits	canals join between orbits
Dominant scale type on body	mostly cycloid	mostly ctenoid	mixed
Ctenoid scale patch under pectoral fin	present, but small and weakly ctenoid	present	present
Lateral scale rows and extent of scales	46–56, pectoral fin axis	40–48, end under posterior 1/3 of pectoral fin	41–55, pectoral fin axis
Epaxial myosepta	no pigment	no pigment	no pigment
Gill rakers	5+18	4+15	4+13
Teeth outer row of dentary	5–6	20	7–9
Mouth angle	50 deg	35 deg	40 deg
Pectoral fin length	24.9	25.7	24.0
Head length—males	27.1	28.8	27.3
Head length—females	24.8	27.5	25.8
Interorbital width	3.7	2.4	2.0
Caudal fin length	35.3	36.9	37.4

continued.

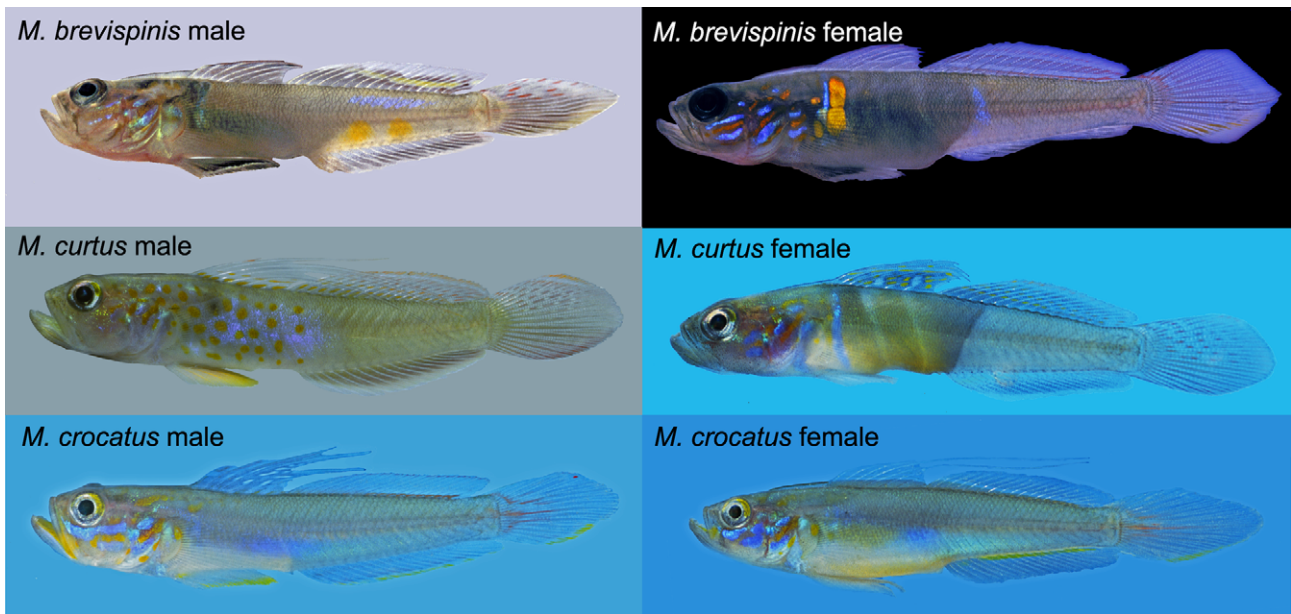
	<i>signatus</i>	<i>microlepis</i>	<i>meeki</i>
Ocean	Atlantic	Atlantic	Atlantic
Distribution	Atlantic—Greater & Lesser Antilles, coast of Venezuela	Southeast Florida (Jupiter Inlet south through Florida Bay) Dry Tortugas, Bahamas, Yucatan, Belize	Puerto Rico, Venezuela south to Santos, Brazil
Habitat	sandy bottom near islands	calcareous bottoms	shallow mud-bottom mangrove areas
Depth	1–14 m	1.5–5.0 m	0–27 m
Elongate first dorsal fin spines	males not elongate; females spine 1 elongate to first ray of D2	both sexes spines 2–6 slightly delongate to fourth ray of D2	males spines 2–6 extend to caudal fin and often beyond; females only slightly produced
Second dorsal (total elements)	20(19–21)	18–19(16–20)	17(16–18)
Anal	21(20–22)	19(18–20)	17(16–18)
Pectoral	20–21(19–22)	21–22(20–23)	21–22(19–23)
Fleshy dorsal crest	males and females—well developed	males—low, slightly developed; females—moderately developed	males—low; females—well developed
Preopercle pores	3	3, middle pore very small	2
Oculoscapular pores	B',D,F,G,H'	B',D,F,G,H'	B',D,F,G,H', pore G frequently absent
Separation of supraorbital cephalic canals (see Birdsong 1981: Fig. 1)	canals mostly separate	canals mostly separate	canals joined between orbits
Dominant scale type on body	mostly cycloid	mostly weakly ctenoid	mostly ctenoid
Ctenoid scale patch under pectoral fin	present, strongly ctenoid	body mostly ctenoid	body mostly ctenoid
Lateral scale rows and extent of scales	77–90, pectoral fin axis	68–78, pectoral fin axis	46–60, pectoral fin axis
Epaxial myosepta	no pigment	no pigment	no pigment
Gill rakers	5+16	4+12	4+13
Teeth outer row of dentary	4–5	5–6	7–8
Mouth angle	45 deg	50 deg	40 deg
Pectoral fin length	20.1	24.9 males, 21.4 females	26.1
Head length—males	25.9	27.1	28.0
Head length—females	26.9	28.2	27.5
Interorbital width	3.3	3.2	2.1
Caudal fin length	33.4	35.0	41.0

continued.

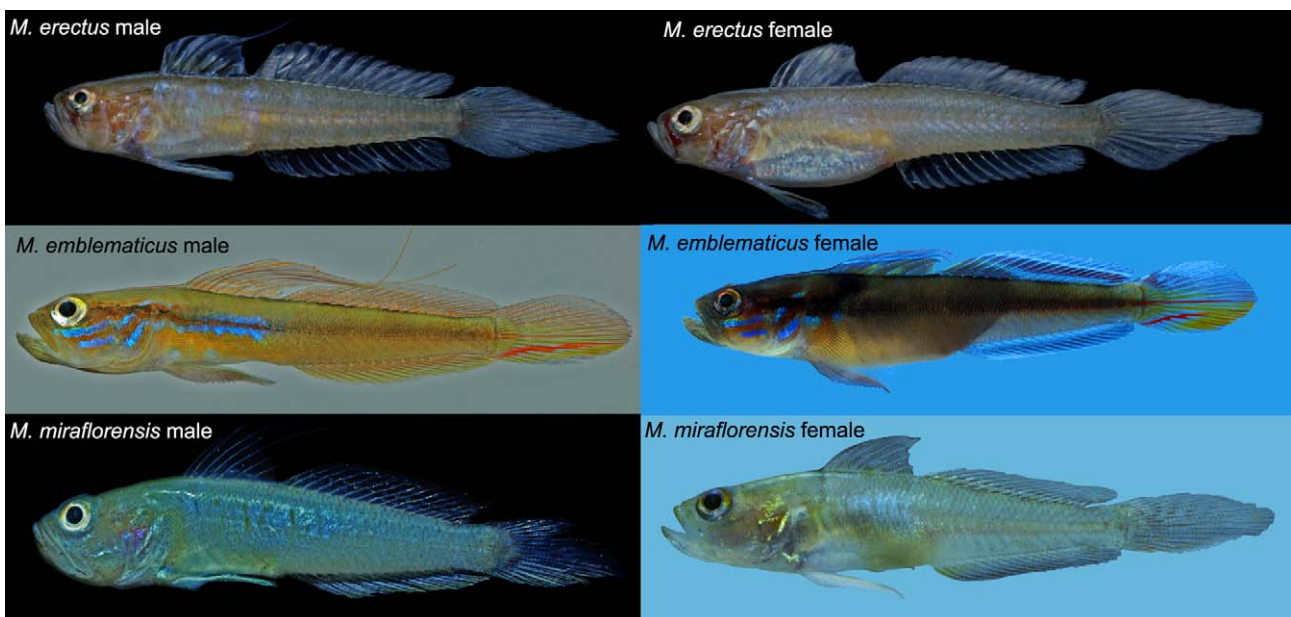
	<i>thalassinus</i>	<i>carri</i>	<i>gulosus</i>
Ocean	Atlantic	Atlantic	Atlantic
Distribution	Chesapeake Bay to Florida (Cape Canaveral), northern Gulf of Mexico to Texas (Galveston)	Florida, northeast Gulf of Mexico, Lesser Antilles to Tobago	Chesapeake Bay to Florida; Gulf of Mexico to Corpus Christi, TX
Habitat	muddy sand or mud bottoms	coarse sandy bottom	muddy-bottom, quiet waters
Depth	0–6 m	6–21 m	0–75 m
Elongate first dorsal fin spines	males slightly elongate; females not elongate	males spines 2–5 elongate, spine 5 longest to two-thirds length D2; females not elongate	males spines 2–6 elongate, reaching midpoint of D2; females not elongate
Second dorsal (total elements)	16(15–17)	16–17(15–18)	16–17(15–18)
Anal	17(15–17)	16–17(16–19)	16–17(16–18)
Pectoral	21–22(19–23)	21(20–24)	21–22(19–24)
Fleshy dorsal crest	males—absent; females low crest	males and females—absent	males and females—absent
Preopercle pores	2	2	2
Oculoscapular pores	B',D,F,H', pore D large	B',D,F,G,H'	B',D,F,G,H', pore D small, pores F,G,H variably present or absent
Separation of supraorbital cephalic canals (see Birdsong 1981: Fig. 1)	canals joined between orbits	canals mostly separate	canals join near posterior half of orbits
Dominant scale type on body	mostly cycloid	mostly ctenoid	mostly cycloid
Ctenoid scale patch under pectoral fin	present	body mostly ctenoid	present
Lateral scale rows and extent of scales	43–50, pectoral fin axis	50–62, pectoral fin axis	44–54, pectoral fin axis
Epaxial myosepta	no pigment	no pigment	no pigment
Gill rakers	5+16	5+15	3+10
Teeth outer row of dentary	7–9	4–5	7–9
Mouth angle	45 deg	30 deg	30 deg
Pectoral fin length	26.5	18.3	24.5
Head length – males	26.9	27.7	30.6
Head length – females	26.5	27.7	28.9
Interorbital width	2.5	4.1	2.4
Caudal fin length	34.0	29.7	31.7

## Key to the Pacific species of *Microgobius*

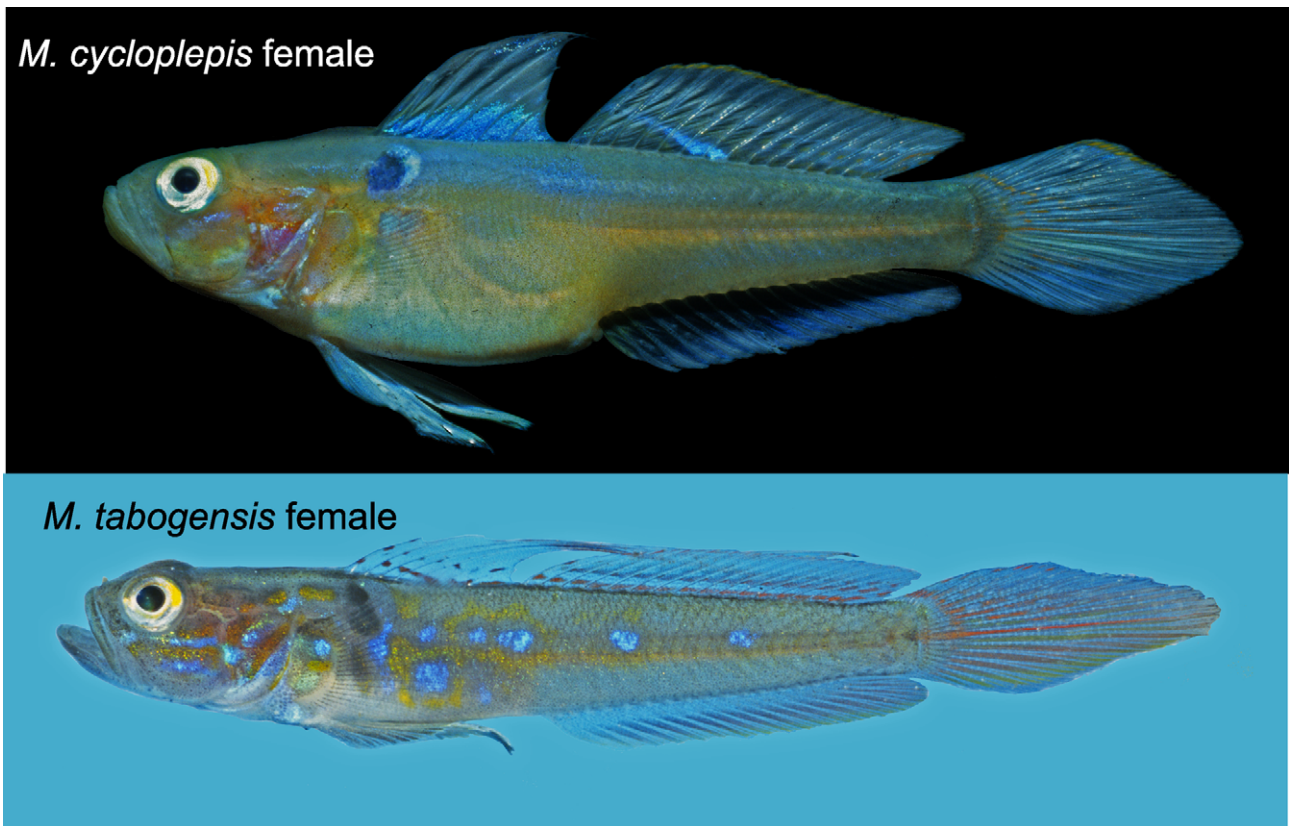
The following key to the Pacific species of *Microgobius* is largely based on diagnostic characters described by Birdsong (1981). Additional diagnostic pigmentation characters have been included in the key and photographs of freshly collected specimens of all Pacific *Microgobius* are included here to assist with identification of fresh material (Figures 4–6). A more comprehensive comparison of morphological features across the entire genus, summarizing data from Birdsong (1981) and data from additional material examined here (Appendix I), is given in Table 2.



**FIGURE 4.** Photographs of freshly collected *M. brevispinis*, *M. curtus*, and *M. crocatus*. Photos by JVT, editing by DRR.



**FIGURE 5.** Photographs of freshly collected *M. erectus*, *M. emblematicus*, and *M. miraflorensis*. Photos by JVT and Gerry Allen, editing by DRR.



**FIGURE 6.** Photographs of freshly collected *M. cycloplepis* and *M. tabogensis*. Photographs of males not available. Photos by Gerry Allen and JVT, editing by DRR.

- 1a. Second dorsal fin elements I,15 or fewer (rarely I,16); anal fin elements I,15 or fewer (rarely I,16); scales mostly cycloid . . . 2
- 1b. Second dorsal fin elements I,16 or more (rarely I,15); anal fin elements I,16 or more (rarely I,15); scales cycloid or ctenoid . . 5
- 2a. Second dorsal fin elements I,14 or fewer; anal fin elements I,14 or fewer. . . . . 3
- 2b. Second dorsal fin elements I,15 (rarely I,14 or I,16); anal fin elements I,15 (rarely I,16). . . . . 4
- 3a. No patch of ctenoid scales under pectoral fin base; all scales on body cycloid, lateral scales 67–76; epaxial myosepta not darkly pigmented; caudal fin blackish, with three blue-white stripes, an oval blackish blotch on rear of first dorsal fin. . . . .  
*M. urraca*
- 3b. Patch of ctenoid scales under pectoral fin base; patch of 10–22 weakly ctenoid scales sometimes present immediately below first and second dorsal fin, remaining scales cycloid, lateral scales less than 48; epaxial myosepta darkly pigmented in preserved specimens; body in life silvery brown in both sexes (pale in preservation), fins grey or silvery . . . . . *M. erectus*
- 4a. Preopercular sensory canal with three pores; lateral scale rows less than 60; pectoral rays 22–24; a prominent crescentic to ovoid dark blotch on shoulder below anterior of dorsal fin; anterior half of second dorsal fin of females often with a blue-white diagonal streak; no distinct rows of spots on first dorsal fin; no pale or blue vertical bars on body of females . . . *M. cycloplepis*
- 4b. Preopercular sensory canal with two pores; lateral scale rows more than 60; pectoral rays 20–21; dark spot on body below anterior dorsal spines indistinct; both sexes with two to four rows of prominent orange spots along both dorsal fins, spots dark in preservation; female often with pale or blue vertical bars both before and after pectoral fin base in life (bars less apparent in preservation); male with front half of body and head behind eye densely spotted with orange (not apparent in preservation). . .  
*M. curtus*
- 5a. Scales entirely cycloid, no ctenoid patch beneath pectoral fin; pectoral fin short, usually 18–24% of SL; both sexes with low, fleshy dorsal crest . . . . . 6
- 5b. Patch of ctenoid scales present beneath pectoral fin; remaining scales cycloid or ctenoid; pectoral fin long, usually 23–27% of SL; fleshy dorsal crest absent in males, present or absent in females. . . . . 7
- 6a. Dorsum with a row of four or five dashes (short, thin dark lines) along the dorsal fin base (sometimes with four or five dark saddles below them), sometimes a diffuse dark blotch on shoulder below front dorsal spines; caudal fin of both sexes with an oblique red stripe across lower half (not apparent in preservation); about four enlarged, caninoid teeth in outer row of each dentary; second dorsal fin elements usually I,16; anal fin elements usually I,16 . . . . . *M. emblematicus*
- 6b. Dorsum without dark dashes or saddles; males with a dark bar on shoulder bordered posteriorly with blue or yellow in life, and often with a short iridescent blue stripe below posterior half of second dorsal and two large round yellow spots above anal fin; an iridescent yellow bar with a blue anterior border on shoulder in living females; about six or seven enlarged, caninoid teeth in outer row of each dentary; second dorsal fin elements usually I,17; anal fin elements usually I,17 . . . . . *M. brevispinis*

- 7a. A dark spot (sometimes diffuse) or bar present on body below origin of first dorsal fin; second dorsal fin elements usually I,16; anal fin elements usually I,16; no elongate iridescent blue blotch on body above and before anus. . . . . 8
- 7b. No dark spot or bar on body below origin of first dorsal fin; second dorsal fin elements I,16–17; anal fin elements usually I,17; in life, both sexes with an elongate iridescent blue blotch on upper belly above and before anus, and the ventral edge of the caudal fin yellow (lost in preservation); male with anal and pelvic fins bordered in yellow in life, female with a yellow stripe along base of anal fin in life . . . . . *M. crocatus*
- 8a. Each dentary with about 15–20 teeth in outer row; fleshy dorsal crest absent in both sexes; often with a dark vertical bar on shoulder, and sometimes one to five faint vertical bars on trunk behind shoulder bar in preservation (due to the poor quality of our photos, life color patterns cannot be accurately defined) . . . . . *M. miraflorensis*
- 8b. Each dentary with about seven to nine teeth in outer row; fleshy dorsal crest well developed in females; both sexes with a diffuse dark spot on body below origin of first dorsal fin; in life, both sexes with a series of four or five large iridescent blue spots along mid flank, another series of two or three iridescent blue spots along side of belly beneath pectoral fin (spots lost in preservation) . . . . . *M. tabogensis*

## Acknowledgements

We thank J. Earle and the crew of the R/V *Urraca* for their assistance in the field. Funding for field work was provided by Smithsonian Tropical Research Institute to DRR. R. Arrindell, B. Brown and R. Schelly at AMNH; and J. Williams, C. Baldwin and D. Pitassy at USNM provided assistance with digital radiographs and museum material. Special thanks to S. Large for his assistance with the map and F. Pezold for his review of an earlier version of this paper.

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#### APPENDIX I. Additional *Microgobius* material examined.

- Microgobius curtus*: AMNH 255302, field number JVT-03-202, 1 specimen, Panama, Isla Brava north side, rotenone collection, 8.2609, -82.3267, mangrove area with fine mud, J.L. Van Tassell and D.R. Robertson, R/V *Urraca*, 15 June 2003.
- Microgobius emblematicus*: AMNH 255300, field number JVT-01-103, 15 specimens, Panama, Ancon Boat Club, south of boat ramp in mangrove creek, rotenone collection, 8.9392, -079.5547, mud and root substrate, J.L. Van Tassell and D.R. Robertson, 8 April 2001. AMNH 255303, field number JVT-EL-01-009, 3 specimens, El Salvador, Gulf de Fonseca, Isla Meanguera, rotenone collection, 13.1600, -87.7085, large gorgonian covered boulders with barnacle rubble substrate, J.L. Van Tassell and D.R. Robertson, R/V *Urraca*, 8 March 2001.
- Microgobius erectus*: AMNH 255296, 1 specimen, Gulf of Chiriqui, trawl 56, 7.9295, -81.6645 to 7.9091, -81.6528, 30.7-32.7 m, 27 April 2000, D.R. Robertson and J.L. Van Tassell, R/V *Urraca*. AMNH 255297, field number JVT-03-209, 55 specimens (4 examined), Gulf of Chiriqui, North of Isla Secas near main land, trawl 68, 8.12583, -81.8555 to 8.11483, -81.83083, 18.4-19.7 m, sand with leaf litter substrate, 16 June 2003, D.R. Robertson and J.L. Van Tassell, R/V *Urraca*. AMNH 255298, field number JVT-EL-01-082, 9 specimens, El Salvador, Pacific, trawl, 21 March 2001, D.R. Robertson and J.L. Van Tassell, R/V *Urraca*. AMNH 255301, field number JVT-03-210, 60 specimens, Gulf of Chiriqui, North of Isla Secas near main land, trawl 69, 08.1135, -081.8336 to 08.1128, -081.8573, 20.5-21.9 m, sand with leaf litter substrate, 16 June 2003, D.R. Robertson and J.L. Van Tassell, R/V *Urraca*. AMNH 255304, field number JVT-EL-01-058, 1 specimen, El Salvador, off Tamarindo, trawl, 13.202, -87.8798 to 13.172, -87.8756, 6.0-8.0 m, mud and tree litter, 18 March 2001, D.R. Robertson and J.L. Van Tassell, R/V *Urraca*.
- Microgobius gulosus*: AMNH 255305, field number JVT-07-789, 15 specimens, Texas, near town of Fulton, Copano Bay, Salt Lake, rotenone collection, 28.0777, -97.0860, 0-1 m, sand substrate with grass along edge of water, J.L. Van Tassell, D.R. Robertson, L. Tornabene, 16 October 2007.
- Microgobius tabogensis*: AMNH 255299, field number JVT-EL-01-014, 4 specimens, El Salvador, Golfo de Fonseca, Estero El Tamarindo, 13.2036, -87.9112, 0-1 m, rotenone collection, intertidal area silty sand, scattered rocks and logs, 10 March 2001, J.L. Van Tassell and D.R. Robertson, R/V *Urraca*. AMNH 255306, 4 specimens, Gulf of Chiriqui, Trawl 52, D.R. Robertson and J.L. Van Tassell, R/V *Urraca*, 26 April 2000. AMNH 255307, field number JVT-03-202, 1 specimen, Gulf of Chiriqui, Isla Brava north side, 8.2609, -82.3267, 0-1 m, rotenone collection, intertidal mangrove area with fine mud, 15 June 2003, D.R. Robertson and J.L. Van Tassell, R/V *Urraca*.