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**VARIATION, DISTRIBUTION, AND RELATIONSHIPS OF THE
MEXICAN ELEOTRID FISH *Gobiomorus polylepis***

BY ROBERT RUSH MILLER

FOR nearly 150 years only two species of the distinctive American eleotrid genus *Gobiomorus* were known. Then Ginsburg (1953: 20-21) described *Gobiomorus polylepis* from Colima, México, based on two specimens, without specific locality, that had been exhibited with other fishes by the Mexican Government at the World's Fair in Chicago, 1893. In commenting on the surprising circumstance that such a large, well-marked species remained so long unknown, Ginsburg reasoned that this probably resulted from its very restricted geographic range. This proves to be only part of the explanation, since the species is now known to occur over more than 800 miles of the Pacific Coast in southern México (Fig. 1). Its scarcity in collections has resulted primarily from the inaccessibility, until recently, of the area it inhabits, and to the difficulty of collecting the species in its swift-water habitat.

Eighty-eight specimens of this interesting fish form the basis for this study of its variation, ecology, distribution, and relationships with the other two species of *Gobiomorus*. Over most of its range it is sympatric with *G. maculatus*, also a Pacific-slope species; the two are able to coexist because of marked differences in habitat selection. As a result of comparisons of the three species, several new characters were found that greatly facilitate taxonomic recognition (Table I) and clarify relationships.

Gobiomorus polylepis Ginsburg

Guavina Cristalina

(Pl. I and Fig. 1)

TYPE LOCALITY.—“Colima, México.”

MATERIAL.—In addition to the holotype (USNM 130917) and paratopotype (USNM 123233), which I have examined, the following account is based on 86 specimens in the University of Michigan Mu-

seum of Zoology (UMMZ), from 13 stations in Nayarit, Jalisco, Colima, Guerrero, and Oaxaca (Fig. 1).

DIAGNOSIS.—A fine-scaled species of *Gobiomorus* (70–80 scales in lateral series) with 18 (occasionally 19, rarely 17) pectoral rays, found in moderately fast to swift water. Scales cycloid on preopercle; those on top of head and on nape the same, except that specimens smaller than about 90 mm. in standard length have some or many ctenoid scales.

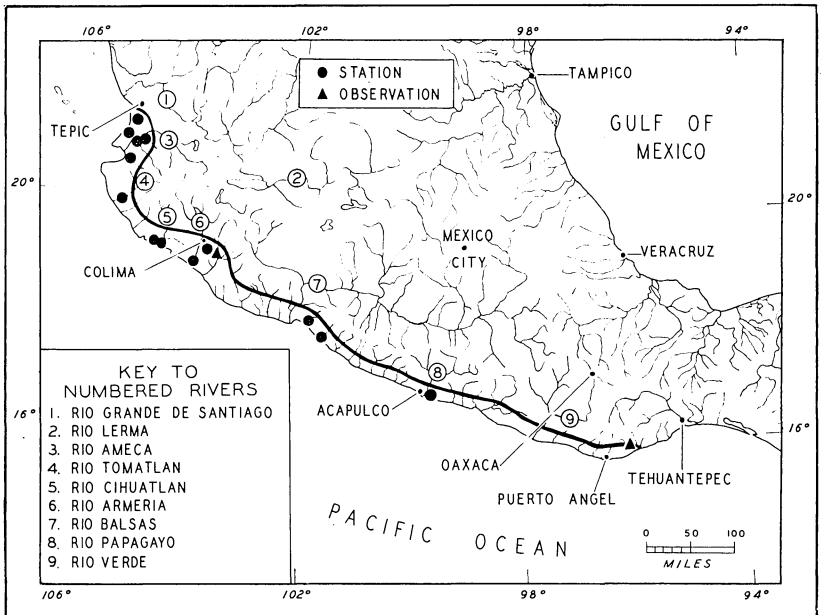


FIG. 1. Southern México, with record and observation stations for *Gobiomorus polylepis*. The precise type locality is unknown as the label with the type specimens registered only "Colima, Mexico."

VARIATION.—This species exhibits little variation in meristic characters (Tables II–IV). The number of elements in the two dorsal fins is invariably VI; I, 9; that in the anal fin is I, 9 except for one variant of I, 10. The pectoral fins have 18 rays (including all rudiments) on one or both sides, except in 4 of 86 fish that have 19 rays in each fin; only the left fin of one individual has 17 rays. The caudal rays (branched plus two unbranched) almost invariably number 14. The longitudinal scale rows, counted between upper pectoral base and base of hypural, number approximately 70 to 80, and the number

of scale rows between the origins of the two dorsal fins vary as follows: 26 (1), 27 (5), 28 (13), 29 (9), 30 (14), 31 (5), 32 (1), 33 (2), 34 (1).

Color pattern changes with age. The young and half-grown are generally prominently marked by an irregular lateral stripe, two broad, black saddles across the back, and a jet-black outer margin on the spinous dorsal (Pl. I)—features that fade, darken or disappear in the adult. In juveniles, a third, less obvious dark saddle crosses the back just before the origin of the procurrent caudal rays. The jet-black margin on the spinous dorsal is prominent on individuals up to 100 mm. long, and may still be readily seen on specimens 150 mm. long, but in an individual 170 mm. in standard length reduced pigmentation gives only a dusky effect. The rows of dark blotches along the rays of the dorsals, caudal and pectoral fins, and sometimes on the anal fin, may be even more conspicuous in adults than in immature fish.

The squamation on the nape, top of head, and cheeks (preopercles) varies individually, and the type of scale changes with age. The scales are cycloid on the nape and top of the head except on specimens between about 45 to 90 mm. standard length; these may have as many as 25 ctenoid scales on the interorbital region, and a few scattered over the nape. The scales on the preopercle, however, are cycloid in the young as well as in the adult.

The number of vertebrae, determined from radiographs, is $12 + 14 = 26$, including the urostyle.

DISTRIBUTION.—*Gobiomorus polylepis* occurs in suitable habitats of Pacific coastal rivers from a stream 8.5 road miles east of Las Varas, Nayarit (28 airline miles SW of Tepic; Fig. 1), southward and eastward to Río Copalita, 27.3 miles by road E of Pochutla, Oaxaca (Pochutla is about 8 miles N of Puerto Angel), at approximately 96° W. longitude, $15^{\circ} 45'$ N. latitude. The basis for the southernmost station is a sight record only as it was impossible to seine and neither rotenone nor hook and line fishing were successful. One adult, with prominent saddles on the back, was clearly seen among boulders in swift but not turbulent water on March 2, 1959. The lack of records between Río Papagayo and Río Verde (Fig. 1) results from the position of the road (which we traversed), too low on the coastal plain to transect habitat suitable for this species. I feel confident that when these streams are accessible at higher elevations *G. polylepis* will be found. The region from central Nayarit northwestward has now been so well studied that I am certain the species occurs only to the south of the Río Grande de Santiago; its northern limit is probably very

TABLE I
COMPARISON OF THREE SPECIES OF *Gobiomorus*
See Tables II to IV for details of meristic characters

Character	<i>G. polylepis</i>	<i>G. dormitor</i>	<i>G. maculatus</i>
Lateral scales	70 to 80	55 to 62 (58-64) ¹	51 to 57 (54-60) ¹
Gillrakers	13 to 16	14 to 17	17 to 24
Anal rays ²	10, rarely 11	10, rarely 9 or 11	11, rarely 10
Pectoral rays	Typically 18	Typically 17	Typically 15 or 16
Caudal rays	14	14	13
Lateral stripe	Disrupted into squarish, roundish, or hourglass-shaped blotches that tend to become more continuous and less prominent with increasing size, disappearing in adult	As in <i>polylepis</i>	More clearly defined as a continuous or only slightly interrupted stripe, fading with age
Saddles on back	Represented as two broad, prominent dark bands across rear of first and second dorsals, well developed on juveniles but fading at about 120 mm. s.l.	As in <i>polylepis</i>	Absent, or faintly suggested only, at all ages
Markings on fins	Rows of elongate, dark blotches confined mostly to the rays, usually weak or absent on pelvic and anal; tip of first dorsal jet black	As in <i>polylepis</i>	Numerous small spots in irregular rows along rays and interradial membranes (paired fins plain); tip of first dorsal dusky only; anal clear in females, spotted in males

Base of caudal fin	With three blotches forming a more or less conspicuous trident, the central and lowermost blotches often joined About 1/4 to 1/3 of base scaled	As in <i>polylepis</i>	No conspicuous blotch above and below terminal blotch
Squamation at pectoral base		As in <i>polylepis</i>	No more than 1/8 of base scaled
Habitat	On or near rocky riffles or deep, sandy and bouldery pools in strong to moderate current; not known from brackish water	In brackish to fresh swamps, canals, and quiet portions of streams, frequenting pools and weedy places; entering the sea	Open sandy to muddy streams of low gradient, in quiet pools and weedy places; brackish coastal lagoons
Range (Fig. 1)	Pacific coastal streams of Nayarit (south of Río Grande de Santiago) southward to Río Copalita, Oaxaca	Atlantic slope from southern Florida and Texas to Surinam and the West Indian islands	Pacific coastal streams from Río Yaqui (Sonora) and Cabo San Lucas (Baja California) to Perú

1 Scale counts in parentheses are those given by Ginsburg (1953: 21). Gilbert and Starks (1904: 168), evidently counting as I have, recorded 56 to 61 for *dormitor* and 51 to 56 for *maculatus* (their *lateralis*).

2 Includes the single spine.

3 Where the fish fauna is comparatively depauperate, as in parts of Tamaulipas and northern Veracruz, this species also lives in strong current over rocky riffles.

close to the demarcation of $21^{\circ} 30'$ N. latitude, west of Tepic. I do not believe that the species occurs as far south as the Isthmus of Tehuantepec, since the few streams in that region have been comparatively well collected. It conceivably might occur in the upper parts of the Río Tequisistlán or Río Tehuantepec, but we failed to secure it (with the aid of dynamite used by natives) at the Pan-American Highway crossing (elev. 740 ft.) of the Río Tequisistlán, Oaxaca, on March 31, 1957 (sta. M57-60). Considerable field work by myself and others on the Pacific slope of Guatemala has failed to uncover the species there.

HABITAT.—Unlike its two relatives, *Gobiomorus polylepis* shows a strong predilection for moderate to swift current, rocky riffles, and for rocks or boulders rather than just sandy situations. For example, on the Río Tomatlán (near Tomatlán, Jalisco; Fig. 1), where *G. polylepis* and *G. maculatus* are sympatric, *maculatus* was observed only in the quiet water of long, open shallow pools (young to half-grown) or in deep water (5-6 ft.) of rather quiet pools, whereas *polylepis* was caught and seen only on short, swift rocky riffles or at pool heads just below. Again at Cihuatlán (Río Cihuatlán, Jalisco-Colima border), where the two species coexist, young-of-the-year to juveniles of *maculatus* were common in sandy pools, well below riffles, venturing into water only about 8 inches deep, whereas *polylepis* was taken only near riffle mouths about rocks in deeper water. Hildebrand (1938: 339), commenting on his experience with *G. dormitor* and *G. maculatus* in Panamá, wrote: "They are rather sluggish carnivorous fishes, generally occupying shallow weedy areas where they lie quietly, hiding more or less among the plants, from which they make quick excursions, if hunger prompts them, to seize almost any animal of suitable size that comes near." Although both its relatives have been recorded from brackish water, and *G. dormitor* at least enters the sea, *G. polylepis* has been taken only from flowing streams. I do not know of its occurrence above an elevation of about 1300 feet (Río Salado, 4.5 mi. E of Colima), but suspect that it will be found at higher elevations.

ASSOCIATES.—Representatives of 17 families of fishes, comprising 23 species, have been taken from the waters inhabited by *Gobiomorus polylepis*. *Agonostomus monticola* (Bancroft), *Gobiomorus maculatus* (Günther), *Awaous transandeanus* (Günther), and *Sicydium puncticulatum* (Regan) are its most common associates; all except the mountain mullet are gobies, and each occurred at 11 to 13 of the 13 stations where *G. polylepis* was secured. *Mollienesia sphenops* (Valen-

ciennes), *Eleotris picta* Kner and Steindachner, *Pseudophallus starksi* (Jordan and Culver), and *Trinectes fonsecensis* (Günther) occurred at six to ten of the stations. Other associates included a characin, two species of *Poeciliopsis*, a goodeid, a snapper, a centropomid, an atherinid, a mullet, a gerrid, a pomadasyid, a cichlid, an eleotrid, a flatfish, a dactyloscopid, and a gobiesocid.

COMPARISONS AND RELATIONSHIPS.—*Gobiomorus polylepis* is easily distinguished from its sympatric relative, *G. maculatus*, by a number of meristic characters and by differences in color pattern and body form (Table I; Pl. I). In the field it is most easily separated by the contrasting life colors (as recorded for both species on March 10, 1959, at Río Papagayo—see Fig. 1): (1) there are no rusty to red

TABLE II
NUMBERS OF ANAL AND CAUDAL RAYS IN THREE SPECIES OF *Gobiomorus*

Species	Anal Rays (including spine)			Number	Average
	9	10	11		
<i>dormitor</i>	1	46	3	50	10.04
<i>polylepis</i>	...	87	1	88	10.01
<i>maculatus</i>	...	5	80	85	10.94
	Principal Caudal Rays				
	13	14	15		
<i>dormitor</i>	2	68	1	71	13.99
<i>polylepis</i>	2	79	7	88	14.06
<i>maculatus</i>	94	1	1	96	13.03

scattered flecks or spots on the sides, as in *maculatus*, and the comparatively obscure streaks about the eye are dark to black rather than rusty or red; (2) the anal and pectoral fins of males are white or colorless, not reddish-brown to red; (3) the caudal fin is yellowish-orange, especially intense around the median dark blotch at its base, whereas in *maculatus* there is but a single orange spot at the upper base of the caudal fin on each side of the body; (4) the light saddles on the back of juveniles and half-grown are pinkish-tan in *polylepis*, olivaceous in *maculatus*; and (5) the dark saddles crossing the back are black, very conspicuously set off from the light ones, whereas in *maculatus* the

TABLE III
NUMBERS OF GILL RAKERS AND PECTORAL RAYS IN THREE SPECIES OF *Gobiomorus*

Species	Gill Rakers												Number	Average
	13	14	15	16	17	18	19	20	21	22	23	24		
<i>dormitor</i>	..	1	16	32	11	..	..	..	..	..	..	..	60	15.88
<i>polylepis</i>	8	32	11	2	..	..	..	..	..	..	..	..	53	14.13
<i>maculatus</i>	..	..	..	..	1	2	14	23	22	18	3	2	85	20.63
	Pectoral Rays (both fins)													
	29	30	31	32	33	34	35	36	37	38				
<i>dormitor</i>	..	..	..	2	8	36	3	1	..	..			50	33.86
<i>polylepis</i>	..	..	..	..	..	..	1	76	6	4			87	36.15
<i>maculatus</i>	2	6	18	49	2	1	..	..	..	..			78	31.59

TABLE IV
NUMBER OF LATERAL SCALES IN THREE SPECIES OF *Gobiomorus*

Species	Lateral Scales										Range	No.	Ave.*
	50-52	53-55	56-58	59-61	62-64	70-72	73-75	76-78	79-80				
<i>dormitor</i>	..	1	25	13	1	..	..	..	..		55-62	40	57.97
<i>polylepis</i>	..	..	..	..	..	6	21	22	4		70-80	53	75.57
<i>maculatus</i>	5	47	8	..	..	..	..	..	..		51-57	60	54.05

* Computed from the original, unclassified data.

dark saddles are olivaceous—only slightly darker than the light ones. The reddish spots and streaks seen in life on *G. maculatus* were also noted in individuals from Panamá by Gilbert and Starks (1904: 67). The divergent habitat preferences of *polylepis* and *maculatus* make possible their sympatric occurrence, for *maculatus* occupies essentially the same niche as *dormitor*. This is dramatically shown by the behavior of these two species after man precipitated their mixing when the Panamá Canal was completed, for they have hybridized extensively in Gatún Lake (Miller, MS).

In its general appearance, life colors, color pattern, most meristic characters, squamation at base of caudal fin, and certain body pro-

portions, *Gobiomorus polylepis* is very similar to the Atlantic species, *G. dormitor* (Table I; Pl. I). These basic resemblances indicate that *polylepis* may have been derived from *dormitor*, from which it has diverged in developing smaller (and in certain areas less ctenoid) scales, 18 pectoral rays, and a deeper body; ecologically, it has become adapted to a niche different from that of its Atlantic counterpart. *G. polylepis* is somewhat intermediate between *dormitor* and *maculatus* in the squamation on the nape and head. The scales are cycloid on the preopercle in both *polylepis* and *maculatus*, but there are some ctenoid scales covering this bone in *dormitor*; except in juveniles, the scales are cycloid on the nape and top of head in *polylepis*, cycloid at all ages in *maculatus*, and ctenoid in these areas in *dormitor*, except in large individuals (about 200 mm. or more long, in which they are cycloid).

Material of *G. dormitor* and *G. maculatus* was examined from throughout the known ranges of those species.

The evolution of *maculatus* and *dormitor* from a common ancestral stock presumably took place after the closure of the Nicaraguan or Panamanian Tertiary water gaps in Miocene time. The differentiation of *polylepis*, on the other hand, appears to be associated with the more northerly, later water gap across the Isthmus of Tehuantepec, which was open from about late Miocene to middle Pliocene time (Mayr, 1946: Fig. 1). The comparatively restricted range of *polylepis* and its more intimate relationship with *dormitor* suggest such an origin, with subsequent dispersal westward and its establishment in moderate to swift portions of rivers along the Pacific slope of southern México. The development of smaller scales and a somewhat heavier build than *dormitor* may be adaptive responses of *polylepis* to its relatively fast-water habitat, the reduced scale size providing less resistance to the current and the heavier build enabling the species to maintain itself more effectively.

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Guadalajara, and our host at Tomatlán was Sr. Eduardo Fierro, Presidente Municipal, brother of the pilot, Capitán Raul Fierro. John T. Greenbank, Malcolm Miller, and R. Jack Schultz assisted ably with collecting. Leonard P. Schultz kindly allowed me to examine the types of *G. polylepis*. The photographs (Pl. I) were prepared by William L. Brudon, and the map (Fig. 1) was drafted by Mrs. Elizabeth M. Anthony. All of these people have my sincere gratitude.

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PLATE I

Juveniles of three species of *Gobiomorus* from México

UPPER: *G. dormitor*, UMMZ 167488, 66.5 mm. s.l., from a stream 2.3 mi. W of Ixtacocoa, Vera Cruz.

MIDDLE: *G. polylepis*, UMMZ 172143, 67.0 mm. s.l., from Río Armería at the Manzanillo-Colima highway crossing, Colima.

LOWER: *G. maculatus*, UMMZ 172038, 65.0 mm. s.l., from a stream 8.5 mi. E of Las Varas, Nayarit.

