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# New Species and New Records of Costa Rican Freshwater Fishes with a Tentative List of Species

by

William A. Bussing*

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The collections included in this report were made primarily by the author during the periods July 1961-December 1962, January 1964 and during the first half of 1966. Much of the latter half of 1961 was spent in making zoological collections for the University of Southern California with other students from the university. During 1962 frequent collections were made in the Río Puerto Viejo where I was carrying out an ecologic study of the fishes; several collections from other parts of the country were also made during this period. Several large collections were made in southern Costa Rica during January 1964. Additional specimens were taken in 1966 in conjunction with my duties as Professor of Biology at the Universidad de Costa Rica. The majority of the collections were made in connection with trips and other studies and thorough, intensive collections have consequently not been achieved in any areas except the Río Puerto Viejo. With few exceptions fish collections were made not far from the Interamerican Highway.

In examining the collections, I have encountered five undescribed species and 14 species that are new to the fauna of Costa Rica. Two of the above new records are not included in this report for their identifications are still uncertain; however, it is time that the other species are described and reported due to the zoogeographic significance of the area and in view of recent related studies (MILLER, 17; LOFTIN, 12).

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* Departamento de Biología, Universidad de Costa Rica.

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## MATERIAL AND METHODS

Counts and measurements were made according to the methods described by HUBBS and LAGLER (10) with the following exceptions and additions: in the fin ray counts of some groups the anterior unbranched rays are indicated by small Roman numerals; if the base of the last two dorsal and anal rays are closely approximated they are counted as one ray, unless otherwise stated; V is used to designate ventral (pelvic) fins. Body measurements are in mm SL (standard length). All body proportions are in per cent of SL. The bulk of the material has been deposited in the Los Angeles County Museum of Natural History (LACM). Additional material is in the Museo de Zoología, Universidad de Costa Rica (UCR), the University of Miami Ichthyological Museum (UMIM) and the University of Michigan Museum of Zoology (UMMZ). Comparative material was borrowed or data obtained from the following institutions: Allan Hancock Foundation (AHF), Academy of Natural Sciences of Philadelphia (ANSP), British Museum (Natural History) (BMNH), California Academy of Sciences

(CAS), Chicago Natural History Museum* (CNHM), University of Michigan Museum of Zoology (UMMZ), Stanford University (SU) and United States National Museum (USNM).

## COSTA RICAN COLLECTING STATIONS

For each collection the information is presented in the following order: field station number, province, locality, elevation in parentheses, collector, date of collection. The following abbreviations are employed: (IH) Interamerican Highway, (N, S, E, W) compass directions, (OTS) Organization of Tropical Studies, (JMS) Jay M. Savage, (NJS) Norman J. Scott Jr., (SJC) Salvador Jiménez C., (WAB) William A. Bussing. Altitudes are given in meters (± 10 m). Distances are expressed as kilometres (km) by road or train.

CR- 1 Puntarenas: Río Barranca (40 m) at IH; WAB; 8 July 1961.
CR- 4 Puntarenas: Río Barranca (20 m) near Barranca; WAB; 8 July 1961.
CR- 6 San José; Río Peje (560 m) 11 km S of San Isidro del General at IH; WAB, R. Casebeer; 16 July 1961.
CR- 7 San José: Río General (500 m) 15 km S of San Isidro del General at IH; WAB, R. Casebeer; 16 july 1961.
CR-10 San José: same as CR-6; WAB, R. Linsky; 18 July 1961.
CR-21 Limón: stream (50 m) 400 meters W of Río Madre de Dios at La Lola; WAB; 28 July 1961.
CR-24 Limón: Río Madre de Dios (50 m) at railroad bridge; WAB, R. Casebeer; 29 July 1961.
CR-25 Limón: same as CR-21; WAB; 29 July 1961.
CR-26 Limón: same as CR-21; WAB, R. Casebeer; 30 July 1961.
CR-32 San José: Río María Aguilar (1150 m) S of San José; WAB, SJC; 12 August 1961.
CR-33 San José: Quebrada Azul (870 m) 1.4 km W of Santa Ana; WAB, SJC; 13 August 1961.
CR-34 San José: Río de Oro (870 m) 2.4 km W of Santa Ana; WAB, SJC; 13 August 1961.
CR-35 San José: Río Ocloro (1150 m) S of San José; WAB, SJC; 15 August 1961.
CR-38 Alajuela: Caño Hidalgo (ca. 1000 m) between Venecia and Aguas Zarcas; WAB, SJC; 18 August 1961.
CR-39 Alajuela: Quebrada La Unión (ca. 1000 m) between Venecia and Aguas Zarcas; WAB, SJC; 18 August 1961.
CR-40 Alajuela: Quebrada Los Negritos (ca. 1000 m) between Venecia and Aguas Zarcas; WAB, SJC; 18 August 1961.
CR-41 Alajuela: Quebrada de Las Pericas (ca. 1000 m) near Aguas Zarcas; WAB, SJC; 18 August 1961.
CR-42 Alajuela: swamp (ca. 1000 m) between La Marina and Aguas Zarcas; WAB, SJC; 18 August 1961.
CR-43 Puntarenas: Río Naranjo (30 m) 10 km NW of Esparta on IH; WAB, SJC; 19 August 1961.
CR-46 Guanacaste: stream (ca. 700 m) at San Luis de Tilarán; WAB, SJC; 20 August 1961.
August 1961.

* Field Museum of Natural History.

CR-47 Guanacaste: swamp (ca. 700 m) between San Luis and Tilarán; WAB, SJC; 20 August 1961.
CR-48 Guanacaste: Río San Luis (ca. 700 m) on road to San Luis; WAB, SJC; 21
CR-49 Guanacaste: swamp (ca. 700 m) 80 meters W of Río San Luis; WAB, SJC; 21 August 1961.
CR-53, CR-68, CR-75, CR-80, CR-102, CR-107, CR-108, CR-115, CR-122, CR-135, CR-140, CR-159, CR-161, CR-164, CR-165, CR-169, CR-172 Heredia: Río Puerto Viejo (100 m) 2-9 km upstream from confluence with Río Sarapiquí; WAB, M. I. Bussing, R. Chavarría; December 1961 - December 1962.
CR-58 Puntarenas: Quebrada Chonta? (440 m) 2.3 km NW of Volcán, 0.8 km E of IH; WAB, SJC; 26 December 1961.
CR-59 Puntarenas: Río Sonador? (570 m) 6.5 km NW of Volcán on IH; WAB, SJC; 27 December 1961.
CR-60 San José: same as CR-6; WAB, SJC; 27 December 1961.
CR-61, CR-62 San José: Río Pacuar and tributary 4.5 km SW of San Isidro del General; WAB, SJC; 28 December 1961.
CR-63 San José: same as CR-6; WAB, SJC; 28 December 1961.
CR-131 Puntarenas: Río Barranca (40 m) at IH; WAB, J. R. Paxton; 26 May 1962.
CR64-2 Puntarenas: tributary (20 m) of Río Barú, ca. 1 km E of Barú; WAB, JMS; 2 January 1964.
CR64-3 Puntarenas: stream (30 m) ca. 1 km S of Palmar Sur; WAB; 4 January 1964.
CR64-4 Puntarenas: ditch (8 m) 13.5 km S of Palmar Sur near Sierpe; WAB, NJS; 4 January 1964.
CR64-6 Puntarenas: branch of Río Térraba (20 m) 2 km NW of Palmar Norte; WAB, JMS, NJS; 4 January 1964.
CR64-7 Puntarenas: stream (20 m) 7 km S of IH on road to Golfito; WAB, NJS; 5 January 1964.
CR64-8 Puntarenas: stream (20 m) 7.5 km S of IH on road to Golfito; WAB, JMS, NJS; 5 January 1964.
CR64-9 Puntarenas: stream (20 m) 12.6 km E of Golfito on Golfito road; WAB, JMS, NJS; 6 January 1964.
CR64-10 Puntarenas: stream (20 m) 14.6 km E of Golfito on Golfito road; WAB, JMS, NJS; 6 January 1964.
CR64-11 Puntarenas: Río Caracol (ca. 100 m) 8.8 km NW of Villa Neily on IH; WAB, JMS, NJS; 7 January 1964.
CR64-12 Puntarenas: Río Ceibo (260 m) at IH, 6 km W of Buenos Aires turnoff; WAB, JMS, NJS; 8 January 1964.
NJS63-182 Puntarenas: Río Nuevo (ca. 100 m) at IH, 4 km NW of Villa Neily; NJS, T. Clarke; 24 July 1963.
NJS63-193 Puntarenas: stream (300 m) 45.4 km SE of San Isidro del General; at IH; NJS, T. Clarke; 25 July 1963.
NJS63-194 Puntarenas: Río Convento (540 m) 32.8 km SE of San Isidro del General at IH; NJS, T. Clarke; 25 July 1963.
NJS63-334 Alajuela: stream (ca. 500 m) 9 km N of Villa Quesada; NJS; 31 August 1963.
NJS64-619 Cartago: Quebrada Molina (580 m) 1.5 SE of IICA, Turrialba; NJS; 8 May 1964.
CRE-F3 Guanacaste: Río Chiquito and Río Arenal (ca. 500 m) near Laguna de Arenal; R. Heyer, M. Heyer; 30 July to 2 August 1964.
MRBCR-8 San José: same as CR-6; M. R. Brittan, W. J. Houck; 11, 12 July 1962.
CRE-32 Cartago: stream near IICA, Turrialba; R. J. Lavenberg; 10 March 1959.
CRE-58 Cartago: pond and stream at IICA, Turrialba; R. J. Lavenberg; 22 March 1959.
Legler #1 Puntarenas: stream 10.3 km SE of Palmar Sur; J. Legler; 6 August 1961.
Legler #2 Puntarenas: same as Legler #1; J. Legler, 7 August 1961.

UCR-9 Guanacaste: Río Montenegro (60 m) 14 km NW of Cañas on IH; NJS; 12 July 1965.
UCR-13 Guanacaste: Río Villa Vieja (60 m) 17 km NW of Cañas on IH; WAB, OTS; 10 February 1966.
UCR-17 Limón: Quebrada Azul (300 m) 1 km W of Los Diamantes; WAB, OTS; 1 March 1966.
UCR-18 Limón: stream (300 m) 1.5 km W of Los Diamantes; WAB, OTS; 1 March 1966.
UCR-19 Limón: stream (ca. 5 m) near tip of Punta Cahuita; W. Pflieger; 16 March 1966.
UCR-28 Guanacaste: Quebrada Doña Celina (540 m) tributary of Río Santa Rosa; WAB, ichthyology class; 16 April 1966.
UCR-29 Guanacaste: Quebrada Bolívar (ca. 600 m) between Tilarán and Tronadora; WAB, ichthology class; 17 April 1966.
UCR-30 Guanacaste: spring (ca. 500 m) 100 meters E of Quebrada los Murciélagos between Tronadora and Arenal; WAB, ichthology class; 17 April 1966.
UCR-41 San José: same as CR-6; WAB, M. I. Bussing; 29 July 1966.

## ADDITIONS TO THE FAUNA

Under each species heading the Costa Rican material is listed by museum catalog number, number of specimens in parentheses and field station number if known. Data concerning comparative material of related species or specimens collected outside of Costa Rica are presented in a similar manner followed by brief locality data.

## PIMELODIDAE

### *Pimelodella chagresi* (Steindachner)

LACM 4735 (1) NJS63-182; LACM 4865 (4) CR64-8; LACM 4805 (1) CR64-9; LACM 4815 (46) CR64-10; LACM 4789 (1) CR64-11.

Body proportions of three specimens (49.7-65.2) are in close agreement with proportions presented by SCHULTZ (25) for specimens of *Pimelodella chagresi chagresi* from Panamá and the Río Chama system of Venezuela. Schultz also gave proportions for *P. c. odynea* (Río Motatán and Río Táchira, Venezuela) which is distinguished from *P. c. chagresi* by its longer barbels. The Costa Rican examples exhibit a wide variation in barbel lengths and are intermediate to those of the two subspecies of *P. chagresi.*

The following proportions based on 13 specimens (LACM 4789, 4815, 4865) include those proportions which were considered of greatest significance by EIGENMANN (5:230): SL 27.4-65.2; total adipose length 25.9-30.1; maxillary barbel length 64.6-76.6; inner mental barbel length 13.0-17.3; outer mental barbel length 22.2-31-2; pectoral spine length 15.9-18.1. The pectoral spine has 3 to 5 spinules on the basal half of the posterior edge; the anterior edge is irregular, but without spinules. The upper caudal lobe is slightly longer and more pointed in specimens over 35 mm SL.

The species was formerly known from Venezuela and Colombia to as far west as Río Chiriquí del Tiré, Panamá (BEHRE, 1). LOFTIN (12) also collected

the species as far as Río Chiriquí on the Pacific slope.

## PYGIDIIDAE

### *Pygidium striatum* Meek and Hildebrand

LACM 4732 (2) NJS63-182.

COMPARATIVE PANAMANIAN MATERIAL: ANSP 104019 (4) HL-88; Canal Zone; Río Agua Salud; H. G. Loftin, E. L. Tyson; 31 December 1961. ANSP 104111 (12) HL-106; Veraguas: creek near Santa Fe; H. G. Loftin, E. L. Tyson; 9 February 1962. ANSP 104157 (10) HL-184; Colón; stream near Buena Vista; H. G. Loftin, S. Olson, R. Stewart; 24 January 1963. ANSP 104215 (13) HL-174; Panamá: creek 8 miles N of Cerro Azul; H. G. Loftin, W. Kosan; 27 August 1962.

This is the first record of the genus in Costa Rica, although BEHRE (1) collected one specimen in the not distant Río Chiriquí del Tiré drainage of Panamá. The species extends along both slopes of Panamá (LOFTIN, 12) to Colombia.

BEHRE (1) also recorded 12 specimens of a new species, *Pygidium septentrionale*, from other tributaries of the Río Chiriquí. The species has a shorter and broader head, and a more anterior placement of the anal fin than *P. striatum*. The two Costa Rican specimens, although smaller than those previously recorded, resemble *P. striatum* more than *P. septentrionale* in diagnostic and other characteristics.

The Costa Rican material has larger eyes and shorter maxillary barbels than recorded for the types of *P. striatum*. The discrepancy in eye diameter is clearly ontogenetic. The eye diameter of larger western Panamanian specimens (ANSP 104111) is similar to that of the eastern Panamanian type specimens. There is a high degree of intraspecific variation in the barbel length of this species as is shown below. Thus, the characteristics of present material are very similar to those of the types of *P. striatum*.

Counts and body proportions follow for the 20.0 and 23.9 mm SL Costa Rican specimens respectively and in parentheses the range for four Panamanian specimens (ANSP 104019; 28.8-40.4 mm SL). D. iv,7; v,6 (iv,6-7); A. iv,4; iv,5 (iv,4-5); P. i,7; i,8; V. i,4; i,4. Head length 24.5, 22.6 (20.8-22.9); head width 19.0, 21.8 (16.7-19.8); snout length 10.5, 10.0 (8.7-9.7); eye diameter 4.0, 4.2, (3.2-3.9); fleshy interorbital distance 7.0, 6.3 (5.7-8.0); length of superior maxillary barbel 15.5, 17.1 (13.9-18.0); length of nasal barbel 11.5, 10.4 (11.6-16.0); body depth at ventral origin 14.5, 14.2 (12.6-17.4); caudal peduncle depth 11.0, 11.7 (12.1-14.4); predorsal distance 65.0, 64.8 (63.5-66.3); preanal distance 73.5, 72.0 (67.8-70.8); distance from tip of snout to anus 67.5, 67.3 (65.8-67.2); preventral distance 60.0, 56.5 (56.7-58.0). The median fins of the above specimens are composed of several prominent articulated rays, the first one or two unbranched at their tips; anterior to these and hidden in thick skin are several minute, unarticulated rays. The minute accesory rays were included

in counts by EIGENMANN (6:321) but not by MEEK and HILDEBRAND (15), they are represented by lower case Roman numerals in the present account.

The barbel length and especially the melanophore pattern varies considerably in this species. The specimens from Panamá Province (600 m elev.) have a black median lateral band from the operculum to the base of the caudal fin; some larger specimens have an indistinct spotted band above the median band. Specimens from Veraguas Province (300 m elev.) have an indistinct median band, and the sides above and below the lateral band are spotted. Often a very indistinct band is formed by the spots above the median band. The specimens from Colon Province (100 m elev.) were collected in caves and lack all markings. The four small specimens from the Canal Zone (60 m elev.) have faint median bands. The Costa Rican specimens (ca. 100 m elev.) have pronounced median bands. EIGENMANN (6:322, 323) noted that the very young specimens of *P. striatum* from Colombia all have black lateral bands, but that the adults varied in pattern from locality to locality exactly in the manner cited above. The pattern of Panamanian specimens seems correlated to altitude-a prominent median band is present in high altitude populations whereas the adults from lowland populations lack these dark markings. Eigenmann apparently found no such correlation to occur with the Colombian material.

The barbel length was measured in ten specimens of approximately the same size (51.7-99.4 mm SL) from each of three localities in Panamá. The specimens from Panamá Province had significantly longer barbels (maxillary barbel 15.5-20.5 % SL; nasal barbel 13.5-16.2 % SL) than specimens from Veraguas and Colon Provinces (maxillary barbel 10.3-16.5 % SL; nasal barbel 8.6-14.3 % SL). Considerable individual variation was evident although the smaller specimens usually had longer barbels.

Species of *Pygidium* are known to flourish in the high mountain streams of South America, but descend to the sea in favorable places. *P. striatum* occurs to 2500 m in Colombia and from 1300 m to near sea level in Panamá and Costa Rica.

## CHARACIDAE

### *Compsura gorgonae* (Evermann and Goldsborough)

(Figure 1)

LACM 4886 (42) CR64-7; LACM 4867 (28) CR64--8; LACM 4803 (1) CR64-9; LACM 4825 (82) CR64-10.

COMPARATIVE PANAMANIAN MATERIAL: Seventy-five collections made by H. G. Loftin *et al.* from both slopes of Panamá between September, 1961 and September, 1962. The material has been divided between USNM and ANSP.

This species is distinguished from members of the very similar genus *Pseudocheirodon* in the remarks under *Pseudocheirodon affinis*. Unlike the latter

species, specimens of *Compsura gorgonae* from the Pacific slope of Panamá show a more clinal than random variation in lateral line pore counts. From central Panamá to as far west as Herrera Province, only low pore counts are encountered. In Veraguas Province pore counts are higher and more variable with many high counts and an occasional specimen with a complete lateral line is found. In Chiriquí Province nearly all collections yield some to several individuals possessing a complete lateral line. The extreme condition is seen in two collections from Chiriquí Province (La Galera and along Boquete Road) in which nearly all specimens exhibit a complete lateral line. Specimens west of Boquete Road and from Costa Rica present high pore counts but no individuals with complete lateral lines. LOFTIN (12) collected *C. gorgonae* on three occasions on the Atlantic slope of central Panamá. These specimens all have a complete lateral line. The significance of this and other variations in *C. gorgonae* will be discussed in a future publication.

The species ranges throughout Pacific Panamá to the Río Coto drainage in southern Costa Rica. It also occurs on the Atlantic slope in Central Panamá. (LOFTIN, 12). Where its range overlaps that of *Pseudocheirodon affinis* in Panamá, they are frequently sympatric. In Costa Rica its range does not overlap that of *P. terrabae* which is restricted to the Río Grande de Térraba drainage just to the north.

## *Pseudocheirodon terrabae*, new species

(Figure 1)

HOLOTYPE: LACM 9238-1 (1) 49.5 mm SL, CR64-12. PARATYPES: LACM 4811 (47) CR64-12; LACM 2939 (7) CR-6; LACM 2859 (3) CR-58; LACM 2922 (44) CR-59; LACM 2893 (1) CR-61 and CR-62; LACM 2951 (11) CR-63; UMIM 5616 (12) CR-63; LACM 4880 (1) CR4-4; LACM 4837 (323) CR64-6; UCR-43-1 (20) CR64-12.

COMPARATIVE MATERIAL: *Pseudocheirodon affinis* (Meek and Hildebrand), twenty-five collections made by H. G. Loftin *et al.* from Pacific Panamá between October, 1961 and April, 1962. The material has been deposited in the USNM and ANSP.

DIAGNOSIS: *Pseudocheirodon terrabae* differs from its only congener *P. affinis* in the following characters: lateral line complete, rarely incomplete vs. lateral line incomplete, rarely complete; branched anal rays 21-22, usually 22 vs. 19-20, usually 20; maxillary teeth 3-6, usually 5 vs. 3-4, usually 3.

DESCRIPTION: Body deep, compressed. Dorsal profile straight or slightly concave at occiput, moderately arched posteriorly. Greatest depth at dorsal origin. Interorbital space convex. Mouth terminal, upper jaw slightly overhangs lower. Maxillary short, anterior portion following contour of premaxillary; posterior lobe curving downward and very reduced. Maxillary nearly reaching anterior border of eye in some specimens.

Teeth uniserial and usually multicuspid with 7 to 9 cusps, although final maxillary and mandibular teeth often reduced and sometimes conical. Borders of premaxillary and anterior maxillary teeth greatly arched. Cutting edges of mandibular and lateral maxillary teeth forming a nearly straight line. The following counts and those in succeeding paragraphs are given for *P. terrabae* followed by counts for *P. affinis* in parentheses. All counts are based on 10 specimens of each species. Maxillary teeth 3-6, usually 5 (3-4, usually 3); premaxillary teeth 5-6, usually 5 (4-5); mandibular teeth 7-10, usually 9 (5-8, usually 6-7). Gill rakers moderately long and slender, posterior edge finely serrated; 7-8 + 11-12, total 18-20, usually 19 (6-7 + 10-12, total 17-19).

Longitudinal scale rows 33-34, usually 34 (32-33, usually 33). Lateral line pores 33-34 (10-29). Scale rows above lateral line 6 (6); rows below lateral line 5-6 (5-6). Predorsal scales 10-12 (9-11).

D. ii,9 (ii,9); A. iv,21-22, usually 22 (iii-iv,19-20, usually 20); P. i,10-12, usually 11 (i,10-12, usually 10); V. i,7 (i,7); C. i,17,i (i,17,i). Dorsal fin origin slightly behind midpoint of SL, distinctly behind ventral origin and well in advance of anal origin. Pectoral fin just reaching ventral origin in some specimens. Ventral fin extending nearly to or slightly beyond anal origin in some large examples. Anal fin margin falcate. No hooks developed on any fins of either sex.

Body proportions as per cent of SL are presented for the holotype, the range for 10 paratypes (LACM 2951, LACM 4811 and LACM 4837) and in parentheses the range for 10 specimens of *P. affinis*. (HL-105, 135). SL 49.5 mm, 27.4-49.5 mm (23.5-35.4 mm); head length 25.7, 25.5-29.2 (26.3-28.9); eye diameter 9.1, 9.0-11.3 (9.0-11.5); snout length 6.3, 6.3-8.0 (6.8-8.5); maxillary length 4.9, 4.9-6.2 (5.7-6.8); interorbital distance 8.9, 8.9-9.9 (9.2-10.6); greatest depth 36.8, 36.8-42.6 (36.2-40.6); caudal peduncle length 15.2, 13.9-15.2 (14.3-15.5); caudal peduncle depth 12.3, 12.3-13.6 (12.8-14.5); predorsal distance 52.8, 51.3-55.3 (52.8-55.8); preanal distance 63.2, 62.6-66.6 (64.5-67.9); prepectoral distance 24.1, 24.1-27.7 (25.1-27.6); preventral distance 46.7, 46.1-49.3 (47.7-50.2); length of first branched dorsal ray 27.9, 25.5-29.2 (27.4-30.2); pectoral length 22.2, 21.2-23.8 (21.3-24.2); ventral length 18.8, 17.9-20.2 (18.3-20.7). On the basis of the new specimens measured, there seem to be only minor proportional differences between the species. Vertebral counts based on 20 specimens of each species: precaudal 15-17 (15-17), caudal 17-18 (16-18), total 32-35 (32-35).

Color in alcohol pale brown; dorsal half of body darker, with many small melanophores; few melanophores on ventral surface. A faint plumbous stripe over horizontal septum from behind shoulder to caudal base. Caudal spot intense, roughly rhomboid, not extending to tips of central caudal rays. No other markings on body or fins, although a triangular pseudotympanum present over anterior portion of air bladder giving impression of a dark spot. Interradial membranes of median fins with scattering of melanophores; paired fins dusky. Color in life silvery, dorsal edge of eye red. Yellow spot on base of each caudal lobe posterior to caudal spot. Median fins pale yellow.

REMARKS: *P. terrabae,* on the basis of its complete lateral line, keys to the genus *Odontostilbe* using EIGENMANN's key to the Cheirodontinae (4) Original descriptions of the 11 nominal species of *Odontostilbe* were examined and specimens of *O. fugitiva* (SU 36606), *O. pulchra* (IUM 15126, property of CAS; ANSP 70181); *O. paraguayensis* (IUM 17202, property of CAS) and *O. madeirae* (ASNP 39194-209) were kindly loaned to me by Dr. James E. Böhlke for the purpose of closer examination. On the basis of these specimens and literature descriptions of others, *P. terrabae* differs from all known species of *Odontostilbe* in having more maxillary teeth (3-6, usually 5 vs. 1-3, usually 2), more mandibular teeth (7-10, usually 9 vs. 4-8, usually 5-7) and a longer posterior lobe of the maxillary. With respect to characters other than the lateral line, the new species shows a stronger resemblance to the Panamanian *Pseudocheirodon affinis* than to members of the South American genus *Odontostilbe.* Dr. Horace G. Loftin (*in litt.*), indicated that some specimens of *P. affinis* from previously uncollected western Panamá also had a complete lateral line. Dr. Loftin kindly suggested that I borrow his specimens which had been donated to the U. S. National Museum. Two very similar species, *Compsura gorgonae* and *P. affinis,* both with variable pore counts, were found to make up this collection and will be the subject of a future publication. Specimens of *P. affinis* from single collections exhibit an extreme variation of from 9 to 33 lateral line pores. This wide variation is not characteristic of all populations but occurs in populations throughout the range of the species.

*P. affinis* occurs only in Panamá from the Río Tuyra to the Río San Pedro basin on the Pacific and in the Chagres basin on the Atlantic slope (LOFTIN, 12). Thus, although *P. affinis* occasionally exhibits a complete lateral line, it is rare for the species and it may be separated from *P. terrabae* on the basis of other meristic differences.

The genus *Pseudocheirodon* is distinguished from *Compsura* by: absence of peculiar scalation on the base of the caudal fin and lack of hooks on the anterior anal and lower caudal rays of mature males; shorter maxillary; dentary teeth with a nearly flat margin and cusps of equal size rather than a curved margin and enlarged central cusp.

Both species of *Pseudocheirodon* differ from most species of the genus *Cheirodon* in exhibiting the following characteristics: no hooks on any fins nor enlarged interhemal rays on mature males; very few interhemal rays (5-6 vs. 5-20); dentary teeth with flat margin and all cusps of equal size vs. curved margin and enlarged central cusp. BÖHLKE (2) stated that the weak development of the interhemal rays was not sufficient to merit the retention of *Pseudocheirodon,* especially since weak interhemal rays are also present in *Cheirodon stenodon* and *C. microdon.* Eigenmann pointed out however, that the latter two are quite distinct from the other species of *Cheirodon;* possibly they too merit generic recognition. In view of the uncertainty regarding the status of *Pseudocheirodon,* I prefer to make no taxonomic changes pending a detailed study of the problem.

Although it has been proposed that the present genera *Odontostilbe, Holoshesthes* and *Saccoderma* have retained the complete lateral line of an

*Odontostilbe*-like ancestor (BÖHLKE, 2) and that the general trend in minute species is toward reduction or suppression of the lateral line (MYERS, 19), such is not the case with *P. terrabae*. If it is assumed that *P. terrabae* is a descendant species of *P. affinis*, then the new species has attained a complete lateral line and certain populations of *P. affinis* are actively mutating in the same direction.

Presumably the number of pores in the lateral line is the expression of a response to some environmental factor or complex of factors which varies from eastern Panamá to Costa Rica. The results of a study to determine these factors will be the subject of the aforementioned report.

The species was collected only in the Río Grande de Térraba basin; sampling in other drainages both to the north and south did not reveal *P. terrabae*. The specific name refers to the only known distribution of the species.

## *Gephyrocharax intermedius* Meek and Hildebrand

LACM 4850 (7) CR64-3; LACM 4840 (1) CR64-6.

A few specimens of this species were collected in streams of the Río Grande de Térraba drainage. LOFTIN (12) collected the species on the Pacific side throughout most of western Panamá as far west as the Río Chiriquí basin. *G. intermedius* seems to prefer small streams or backwaters of larger rivers.

## *Bramocharax bransfordi* Gill

LACM 9120-8 (1) CR-68; LACM 9125-7 (1) CR-75; LACM 9155-1 (1) CR-107; LACM 9156-1 (2) CR-108; LACM 9162-1 (1) CR-115; LACM 9169-1 (1) CR-122; LACM 9181-1 (2) CR-140; LACM 9191-1 (6) CR-159; LACM 9193-1 (1) CR-161; LACM 9227-1 (1) CR-169; LACM 9230-1 (1) CR-172; LACM 9132-11 (2) CR-80.

The body depth of two large Costa Rican specimens (103 and 123 mm SL) goes 2.9 and 3.0 times in SL, respectively. This falls intermediate to ratios given for the nominal species *Bramocharax bransfordi* Gill (depth 2.7 in SL) and for *B. elongatus* Meek (depth 3.4-3.9 in SL). Six Costa Rican specimens measuring 22.9-123.4 mm SL yield SL/depth ratios of 2.9-3.4.

*B. elongatus* was originally distinguished from *B. bransfordi* on the basis of its narrow body depth, but it is likely that further collecting and comparison will reveal only one valid species of *Bramocharax*.

## *Hyphessobrycon savagei*, new species

(Figure 2)

HOLOTYPE: LACM 9237-1 (1) 36.7 mm SL., CR64-12. PARATYPES: LACM 4808 (14) CR64-12; LACM 2937 (2) CR-6; LACM 2856 (102) CR-58; LACM 2921 (339) CR-59; UMIM 5613 (12) CR-59; LACM 2715 (5) CR-60; LACM 2956 (4) CR-63; LACM 4760 (1) NJS63-193; LACM 4742 (12) NJS63-194; LACM 4851 (33) CR64-3; LACM 4881 (8) CR64-4; LACM 4836 (15) CR64-6; UCR 42-1 (43) UCR-42.

COMPARATIVE MATERIAL: *Hyphessobrycon panamensis* Durbin, Panamá: ANSP 99920 (2) HL-168; Bocas del Toro; Río San San; H. G. Loftin, M. Canipe; 2 September 1962. ANSP 99932 (2) HL-196; Bocas del Toro; Río Guarumo at Chiriquí; H. G. Loftin, R. W. Yerger, R. K. Godfrey; 19 April 1962. *Hyphessobrycon tortuguerae* Böhlke, Nicaragua: LACM 2470 (7); Comarca del Cabo, 15 km, SSW of Waspam; J. Zoeger; 6 February 1962.

DIAGNOSIS: *Hyphessobrycon savagei* differs from other members of the genus in the following combination of characters: branched anal rays 20-23; two humeral spots of equal intensity; no caudal, dorsal or anal spots; maxillary teeth 1-4; gill rakers 5-7 + 10-12, total 16-18; longitudinal scale rows 31-33.

DESCRIPTION: Body deep, compressed. Dorsal profile slightly concave at occiput; remaining distance to dorsal fin moderately arched. Greatest depth at dorsal origin. Interorbital space convex. Mouth terminal. Maxillary extends nearly to or reaches anterior margin of pupil and forms an obtuse angle with premaxillary.

The following counts and those in succeeding paragraphs are given for the holotype followed by the range in parentheses of 9 paratypes. Teeth principally tricuspid, the smallest lateral jaw teeth usually conical. Maxillary teeth 3 (1-4, usually 3); first 1 or 2 tricuspid, followed by 1 or 2 conical teeth. Outer premaxillary teeth 3 (3-5, usually 3); lateral cusps narrow and reduced, much smaller than central cusp. Inner premaxillary teeth 5 (5-6, usually 5); lateral cusps more prominent than those of outer teeth. Dentary teeth 4 (4 or 5 of equal occurence); front teeth tricuspid with prominent lateral cusps, followed by 9-12 abruptly smaller conical teeth at the sides. Tips of all teeth brown. Gill rakers long and slender; 5 + 11, total 16 (5-7 + 10-12, total 16-18). Vertebrae of two specimens (LACM 4851): precaudal 15, caudal 17 and 18, total 32 and 33.

Longitudinal scale rows 31 (31-33, usually 32); lateral line pores 12 (10-13). Scale rows above lateral line 6 (6-7); rows below lateral line 6 (5-6). Predorsal scales 10 (9-10, usually 10). One or two scale rows extend onto caudal base. A single row of scales borders bases of anterior anal rays.

D. ii,9 (ii,9); A. iv,21 (iii-iv,20-23); P. i,13 (i,12-13); V. i,7 (i,7); C. i,17,i (i,17,i). Dorsal fin origin slightly behind midpoint of SL, slightly behind ventral origin and distinctly in advance of anal origin. Tip of ventral fin reaches scarcely beyond anal origin. Tip of pectoral fin reaches ventral origin (females) or extends beyond ventral origin (large males). Fleshy areas on interradial membrane between first five branched anal rays and a single hook on final unbranched and first 2-3 branched rays. Caudal fin deeply forked and without hooks.

Body proportions as per cent of SL for 10 specimens of *H. savagei* and the ranges for specimens of *H. tortuguerae* and *H. panamensis* are presented in Table 1.

TABLE 1

*Counts and body proportions for* Hyphessobrycon savagei *and two other species of the genus*

| Character | *H. savagei* holotype | *H. savagei* paratypes [1] | *H. panamensis*[2] | *H. tortuguerae* BÖHLKE (3) |
|---|---|---|---|---|
| SL | 36.7 | 29.8-37.2 | 23.6-35.8 | 24.2-39.0 |
| Head length | 30.8 | 30.7-32.4 | 29.4-31.4 | 29.1-30.0 |
| Upper jaw length | 13.9 | 13.4-15.6 | 12.9-13.6 | 11.0-12.0 |
| Snout length | 7.6 | 7.5-8.9 | 7.0-7.2 | 6.9-7.5 |
| Eye diameter | 12.0 | 11.2-12.7 | 10.5-12.3 | 10.8-11.9 |
| Interorbital distance | 9.8 | 8.9-10.7 | 8.5-10.2 | 7.4-8.5 |
| Greatest depth | 43.1 | 37.3-44.3 | 35.2-39.7 | 28.4-37.2 |
| Peduncle length | 13.6 | 13.2-15.4 | 11.4-13.2 | 12.4-13.4 |
| Peduncle depth | 13.9 | 12.1-14.4 | 10.2-11.9 | 9.3-10.5 |
| Predorsal distance | 54.5 | 52.0-55.3 | 51.9-54.7 | 51.1-53.3 |
| Preanal distance | 64.0 | 61.3-65.5 | 58.5-61.2 | 58.0-59.9 |
| Prepectoral distance | 29.2 | 29.0-31.2 | 28.2-30.7 | 27.3-29.5 |
| Preventral distance | 48.0 | 46.7-50.6 | 45.5-47.5 | 43.1-45.5 |
| First branched ray of dorsal fin | 27.8 | 26.6-30.5 | 26.5-38.6 | ——— |
| Pectoral length | 25.3 | 21.2-25.4 | 22.7-23.4 | ——— |
| Ventral length | 19.9 | 17.9-21.6 | 20.8-21.8 | ——— |
| Dorsal rays | ii,9 | ii,9 | ii,9 | ii,9 |
| Anal rays | iv,21 | iii-iv,20-23 | iii-iv,23-26 | v,24-26 |
| Pectoral rays | i,13 | i,12-13 | i,11-12 | i,12-13 |
| Total gill rakers | 16 | 16-18 | 19-21 | 26-28 |
| Longitudinal scales | 31 | 31-33 | 33 | 35-36 |
| Lateral-line pores | 12 | 10-13 | 9-10 | 7-10 |
| Predorsal scales | 10 | 9-10 | 10-11 | ——— |
| Maxillary teeth | 3-3 | 1-4 (3) | 1-3 (2) | 9-10 |
| Outer premax. teeth | 3-3 | 3-5 (3) | 3-4 (3) | 2-4 (3) |
| Inner premax. teeth | 5-5 | 5-6 (5) | 4-5 (5) | 6-7 (6) |
| Mandibular teeth | 4-4 | 4-5 | 4-5 | 4-5 |

[1] Nine specimens from LACM 2715, 4808, 2856 and 4851.

[2] Four specimens from ANSP 99932 and 99920.

Color in alcohol light brown; dorsal median surface dark brown, sides abruptly paler. Two humeral spots of variable intensity separated by paler area. Both spots forming long narrow triangles with apices directed downward. Anterior spot widest but both of equal intensity. No other marks on body. Median fins dusky; anal fin border slightly darker than rest of fin. Color in life: body silvery, purple iridescense above anal fin of males; ventral and anal fins of male, especially near hooks, bright red; adipose fin yellow; dorsal and caudal fins pale dusky orange. Females with less intense coloration.

Mature males are distinguished by the fleshy swellings and hooks on the anterior anal rays and also by their slightly longer pectoral and ventral fins.

REMARKS: The species differs from *H. panamensis* in the fewer branched anal rays (20-23 vs. 23-26), total gill raker count (16-18 vs. 19-21) and greater magnitude of snout length, caudal peduncle length, caudal peduncle depth and preanal distance. *H. panamensis* also differs in lacking humeral spots, most specimens in having a reddish body coloration and intensely black-bordered anal fin in life (LOFTIN, 12) and in having longer anterior dorsal fin rays in the adults. Both *H. savagei* and *H. panamensis* differ from *H. compressus* (Meek), *H. milleri* Durbin and *H. tortuguerae* Böhlke in the fewer longitudinal scales (31-33 vs. 35-48) and fewer maxillary teeth (1-4, usually 2-3 vs. 3-13, usually 4-12). *H. savagei* seems closest to *H. panamensis* of the Middle American *Hyphessobrycon,* from which it may have been derived.

*H. savagei* has been collected only in tributaries of the Río Grande de Térraba, Costa Rica between 560 meters and near sea level. The species is named in honor of Jay M. Savage, Professor of Biology, University of Southern California, who first aroused my interest in the country of Costa Rica and who has continued to encourage and advise me in my studies of its ichthyofauna.

## ERYTHRINIDAE

### *Hoplias microlepis* (Günther)

LACM 4801 (1) CR64-9; LACM 4828 (3) CR64-10; LACM 4783 (4) CR64-11.

The Costa Rican specimens fit the descriptions of Panamanian material with the exception that the three specimens from LACM 4828 have 9 scale rows across the caudal peduncle as in *H. malabaricus.* In other characters however it agrees with *H. microlepis.* LOFTIN (12) reports *H. microlepis* from the Canal Zone all through western Panamá to the Río Chiriquí basin.

## LEBIASINIDAE

### *Piabucina boruca,* new species

(Figure 3)

HOLOTYPE: LACM 9239-1 (1) 118 mm SL, CR64-8. PARATYPES: LACM 4871 (1) CR64-8; LACM 2926 (1) CR-59; LACM 2714 (2) CR-60; LACM 2957 (2) CR-63; LACM 4743 (6) NJS63-194; UCR 42-2 (4) UCR-42.

COMPARATIVE PANAMANIAN MATERIAL: *Piabucina panamensis* Gill, ANSP 104114 (5) HL-170; Coclé; tributary of Río Indio near La Mesa; H. G. Loftin; 14 September 1962. ANSP 104137 (12) HL-174; Panamá; creek 8 miles N of Cerro Azul; H. G. Loftin, W. Kosan; 27 August 1962.

DIAGNOSIS: *Piabucina boruca* differs from its congeners in several respects: it lacks a dark lateral band or series of dark lateral spots along the body; a spot at the base of the dorsal fin and a humeral spot are obvious in small specimens but the dorsal spot is faint and the humeral spot absent in adults; markings are absent from the caudal base at all ages. Other distinguishing characteristics are included in the Remarks section.

DESCRIPTION: Body elongate, compressed and fusiform. Dorsal profile nearly straight or arching slightly. Greatest depth at ventral origin. Interorbital space convex. Lower jaw protruding beyond upper. Maxillary nearly vertical and forming a slight angle or nearly a straight line with premaxillary; dorsal edge of maxillary lying under first and second infraorbitals.

Premaxillary and outer dentary teeth tricuspid, lateral cusps much smaller than central cusp. Inner dentary teeth conical near symphysis, but tricuspid laterally. No teeth on vomer or palatines. Teeth of largest paratype: premaxillary 20; dentary outer row 17, inner row 38.

Gill rakers rather short and slender, tips pointed. Holotype: 13 + 16, total 29. Counts based on 12 paratypes: large specimens (118-138 mm SL) 13-14 + 15-16, total 28 or 29; smaller individuals (18.5-50.2 mm SL) 7-12 + 11-14, total 19-26. Counts for 17 specimens of *P. panamensis* (73.5-133 mm SL) 9-11 + 12-14, total 21-25.

The following counts and measurements in per cent of SL are presented for the holotype and the ranges for 9 paratypes (LACM 4871, LACM 2926, LACM 2714, LACM 2957 and LACM 4743) of *P. boruca* followed by the ranges in parentheses for 10 examples of *P. panamensis* (ANSP 104114 and ANSP 104137).

Longitudinal scale rows 28, 28-30 (28-30); circumference scale count 18, 18-19 (18); caudal peduncle scale count 13, 12-13 (12); predorsal scales 14, 14 (12-14). Body scales large, thick and cycloid. Two rows of smaller scales forming a sheath on both sides of anal fin base. Base of caudal fin covered by progressively smaller scales to a distance about halfway between caudal base and tips of longest caudal rays. First 2 to 3 scales of lateral line series crowded together, and without pores. Lateral line pores present only on the succeeding 2 or 3 scales.

D. ii,8; ii,8 (ii,8). A. iii,8; iii,8 (iii,8-9). P. i,13; i,13-14 (i,12-14). V. i,7; i,7 (i,7). C. i,17,i; i,16-17,i (i,17,i). Ventral fin origin slightly to well behind midpoint of SL. Dorsal fin origin slightly behind ventral fin base. Adipose fin origin slightly behind last anal rays. Anal fin origin about midway between ventral origin and mid-caudal base. Anal rays much wider and length of anal base greater (12.2 per cent of SL for 3 adult males) than in females (9.7 per cent of SL for 1 adult). Pectoral fin arising before posterior border of bony opercle. Caudal fin emarginate.

Body proportions: SL 118 mm, 20.1-138 mm (73.5-133 mm); head length 25.8, 25.6-33.0 (25.4-28.8); upper jaw length 7.9, 8.3-11.0 (8.6-11.0); snout length 6.1, 5.9-8.1 (5.5-7.1); eye diameter 4.4, 7.1-9.0 (4.5-6.1); interorbital distance 8.2, 8.1-10.9 (7.6-9.2); postorbital distance 15.4, 15.5-17.7 (15.3-17.7); greatest depth 22.8, 21.6-25.0 (20.9-24.0); caudal peduncle length 15.4, 12.9-16.2 (14.4-16.5); caudal peduncle depth 11.9, 11.7-15.1 (10.9-12.6); predorsal distance 55.9, 55.6-60.7 (51.2-56.0); preanal distance 78.3, 76.1-80.9 (70.2-78.8); preventral distance 53.3, 51.2-58.7 (47.7-55.5); length of anal base 12.2, 9.5-12.4 (10.2-17.2); length of first branched dorsal ray 14.2, 13.6-18.2 (9.9-16.0); length of first branched anal ray 14.7, 12.7-16.2 (10.5-13.6); pectoral length 18.4, 14.2-18.7 (13.7-17.7); ventral length 15.9, 13.9-16.0 (12.9-15.2).

Color in alcohol, dark brown above, below which a slightly paler longitudinal band about one and a half scale rows wide extending from opercle to caudal base. Below pale band another longitudinal band of equal width slightly darker like the dorsum. The latter band not extending across opercle to eye, nor interrupted, nor less distinct posteriorly. White spots (red in life) at inner basal region of many scales along middle 3 longitudinal scale rows. Base of dorsal rays and interradial membrane black in smaller specimens, only base of rays black in adults. Other fins clear. Coloration of juveniles like adults except: a black humeral spot and a dark area surrounding dorsal fin when viewed from above; a pair of narrow black stripes extending from dorsal spot anteriorly to above humeral spot.

Color in life gray dorsally, white below. Several lateral scales with circular red spots about half the scale diameter. A pale spot on dorsal midline immediately anterior to dorsal fin base. Dorsal and pectoral fins yellow-orange; caudal, ventral and anal fins dark orange. The large pale spot, also referred to in *P. panamensis* by HILDEBRAND (9), disappears when the fish is captured and is not visible on aquarium specimens.

REMARKS: *P. boruca* resembles *P. aureoguttata* Fowler in possessing two indistinct lateral bands although the latter has a much more curved dorsal profile, fewer scales (25) in the lateral series and a bar at the caudal base. *P. boruca* differs from its nearest geographic neighbor, *P. panamensis* Gill in lacking a dark lateral band and in several meristic and proportional differences. Large specimens of *P. boruca* have more gill rakers (28, 29) than large *P. panamensis* (21-25). It was noted also that the Pacific population of *P. panamensis* consistently had 9 upper limb rakers, whereas the Atlantic slope specimens had 10-11 rakers. *P. boruca* exhibits a greater predorsal distance, preanal distance, length of first branched dorsal ray, pectoral fin length and ventral fin length than *P. panamensis*. *P. festae* Boulenger, another Panamanian species, differs from *boruca* in having a dark lateral band below the median line of the side and a distinct humeral spot unconnected with the lateral band.

Males mature at least when reaching 90 mm SL and may be distinguished from females by their longer anal fin base and thicker anal rays. An enlarged

scale above the anal origin is present on some males.

*P. boruca* is restricted to southeastern Costa Rica in the Río Grande de Térraba and Río Coto drainages. The name *boruca* refers to the tribe of indians which formerly inhabited this region. The species is apparently widely separated from *P. panamensis* because LOFTIN (12) collected no *Piabucina* west of Colón and Panamá Provinces, Panamá.

## CURIMATIDAE

### *Curimata magdalenae* Steindachner

LACM 4822 (148) CR64-10; LACM 4869 (1) CR64-8; LACM 4884 (2) CR64-7; LACM 4777 (116) CR64-11.

COMPARATIVE PANAMANIAN MATERIAL: ANSP 104038 (12) HL-21; Coclé; creek 2 miles E of Nata; H. G. Loftin, E. L. Tyson; 15 October 1961. ANSP 104103 (4) HL-78; Chiriquí; Río Jacaque and tributary near San Lorenzo; H. G. Loftin, E. L. Tyson; 9 December 1961. ANSP 104104 (6) HL-37; Veraguas; Río Cuvibora 2 miles E of Santiago; H. G. Loftin, E. L. Tyson; 21 October 1961. ANSP 104419 (3) HL-158; Panamá, creek near Pacora; J. Legler; May 1962.

The present specimens were compared with 25 examples from Chiriquí, Veraguas, Coclé and Panamá Provinces, Panamá, as well as published descriptions of specimens collected in Colombia and Venezuela (SCHULTZ, 25). The only difference noted was an increase in the number of lateral-line scales (38 in Costa Rican and Panamanian populations vs. 39-43 in some Colombian and Venezuelan populations). This amount of variation is not great if one considers the extensive range of the species.

Formerly the northernmost record of the species was Río Chorrera, Panamá (MEEK and HILDEBRAND, 16).

## GYMNOTIDAE

### *Gymnotus cylindricus* LaMonte

LACM 9242-1 (2) CR-102; UCR 9-4 (2) UCR-9; UCR 13-2 (1) UCR-13; UCR 18-1 (1) UCR-18.

The body proportions of the present specimens are more closely in accord with the proportions of *Gymnotus cylindricus* than those of *G. carapo* as presented by LAMONTE (11). Dr. Robert M. Miller (*in litt.*) states that specimens of *Gymnotus* from the Atlantic slope of Costa Rica are definitely not *G. carapo*. No differences are apparent between the present Atlantic and Pacific slope material. Loftin did not collect *Gymnotus* in Panamá, although BEHRE (1) recorded *G. carapo* from extreme western Panamá.

Ratios are presented for the Costa Rican specimens followed by those in parentheses of the holotype of *G. cylindricus* taken from LAMONTE (11). Total

length 153-226 mm (187 mm); total length/head 9.2-9.6 (9.4); total length/depth 8.3-9.8 (9.4); head/snout 2.8-3.4 (3.8); head/interorbital 2.5-2.8 (2.8); snout/eye 3.7-4.5 (3.5); interorbital/eye 4.4-5.1 (6); head/eye 11.4-12.8 (ca. 13); head/pectoral fin 2.5-2.7 (2.5); body depth/head width 1.7-1.8 (1.6); body depth/head 1.5-1.8 (1.4).

## SYNGNATHIDAE

### *Pseudophallus starksi* (Jordan and Culver)

LACM 2794 (1) CR-1; LACM 2808 (1) CR-43.

The species was collected on two occasions in Pacific slope rivers well above tidal influence. Both specimens were seined from grassy river banks adjacent to swift water. The species is recorded for the first time from Costa Rica, although it has been reported from Pacific coastal streams from México southward to Ecuador.

## CYPRINODONTIDAE

### *Rivulus hildebrandi* Myers

LACM 4794 (1) CR64-7; LACM 4880 (30) CR64-9; LACM 4814 (2) CR64-10; LACM 4787 (1) CR64-11.

COMPARATIVE MATERIAL: *Rivulus isthmensis* Garman, LACM 4724 (17) NJS63-334; LACM 2767 (37) CR-35; LACM 2754 (8) CR-47; UCR 17-3 (9) UCR-17; UCR 28-1 (5) UCR-28.

This species can be readily distinguished from *Rivulus isthmensis* Garman by its pale-spotted caudal fin. Specimens of *R. isthmensis* from both Atlantic and Pacific drainages of Costa Rica usually have an unmarked caudal fin or one with a few indistinct dark spots near the base. An exception occurs in Guanacaste province near Tilarán where specimens collected from both drainages exhibit dark spots over the entire caudal fin. *R. hildebrandi* also has a narrower head and smaller orbit than *R. isthmensis*. The former was collected in cattle tracks and small pools along a sandy shore free of vegetation; *R. isthmensis* is always associated with dense vegetation such as grasses along the shore of rivers or streams or most often, in small grassy pools or swamps.

*R. hildebrandi* is apparently very similar to *R. volcanus* Hildebrand. Both were originally collected at high altitudes (1040 and 1370 meters respectively) in the headwaters of neighboring drainages. LOFTIN (12) collected *R. hildebrandi* from only 2 localities below Boquete. He assigned the remainder of his Chiriquí material to *R. volcanus*. The fact that he encountered difficulty in identifying his specimens of *Rivulus* indicates that specific differences between the two nominal species are less distinct when intermediate populations

are sampled. The Costa Rican lowland specimens were assigned to *R. hildebrandi* on the basis of their light-spotted dorsal, anal and caudal fins and the small ocellus which becomes somewhat obsolete with age (MYERS, 18). *R. volcanus* was described as having black-spotted vertical fins and a definite ocellus on the upper base of the caudal in females. No mention was made of the absence of an ocellus in large females of *R. volcanus* as is seen in the two large Costa Rican specimens of *R. hildebrandi.* I do not expect that the diagnostic proportional differeces between *R. hildebrandi* and *R volcanus* will hold up when intermediate lowland populations are analyzed. Nevertheless, the fin-spotting differences may be consistent and perhaps scale, head pore and internal differences will eventually be found to distinguish these two similar species.

*R. hildebrandi* was collected only from the Río Coto drainage in southern Costa Rica.

## POECILIIDAE

### *Brachyrhaphis holdridgei,* new species

(Figure 4)

HOLOTYPE: LACM 9240-1 (1) 27.7 mm SL, UCR-30. PARATYPES: LACM 2799 (1) CR-25; LACM 2911 (3) CR-48; LACM 9241-1 (6) CR-49; LACM 9243-1 (82) CR-165; UMMZ 187455 (4) CR-165; UCR 44-1 (10) CR-165; UCR 30-1 (18) UCR-30; UCR 29-1 (5) UCR-29.

COMPARATIVE COSTA RICAN MATERIAL: *Brachyrhaphis rhabdophora* (Regan), numerous collections from throughout Costa Rica were examined. Specimens were selected for critical analysis and clearing and staining from the following stations: LACM 2754 (60) CR-47; LACM 2693 (57) CR-34; LACM 2923 (30) CR-59; LACM 4846 (63) CR64-2; LACM 4835 (14) CR64-6; LACM 4852 (17) CR64-3; LACM 4868 (52) CR64-8. *Brachyrhaphis terrabensis* (Regan), LACM 4746 (34) NJS63-194. *Brachyrhaphis parismina* (Meek), numerous collections were examined, the following station in more detail: LACM 9132-4 (192) CR-80.

OTHER COMPARATIVE MATERIAL: *Brachyrhaphis episcopi* (Steindachner), Panamá: AHF 176-29 (2); Canal Zone; Barro Colorado Island; G. S. Myers; 27 February 1938. *Brachyrhaphis hartwegi* Rosen and Bailey, México: UMMZ 169071 (52 paratypes); Chiapas; tributary of Río Jalapa; Brodkorb, Staebler; 13 March 1939. UMMZ 169069 (9 paratypes); same data. *Brachyrhaphis cascajalensis* (Meek and Hildebrand), Panamá: ANSP 104348 (9) HL-166; Bocas del Toro; Río Sixaola and tributary; H. G. Loftin, M. Canipe; 2 September 1962. ANSP 104338 (30) HL-157; Bocas del Toro; creek on Bastimientos Island; H. G. Loftin, J. Legler; 12 May 1962.

DIAGNOSIS: *Brachyrhaphis holdridgei* differs from other species of the genus in the following characteristics: subdistal portion of ray 3 of gonopodium broadened, segments long, spine-like and produced antrorsely *(B. punctifer* has similar but retrose spines on ray 3); subdistal portion of ray 4a opposite serrae of ray 4b very broad, highest segments twice as high as long. The following combi-

nation of characters also serves to distinguish the new form from other species of *Brachyrhaphis*: body angulated at dorsal origin; snout pointed; anal fin of female very long (equals head length); dorsal fin rays of both sexes very long (last rays reaching from less than eye diameter to less than pupil diameter distance from procurrent caudal rays); colors in life pale orange or rose-colored body and caudal fin, dorsal fin red-orange; 5-6 short serrae on subdistal segments of ray 4p; primary gonactinost complex widely expanded; a pair of proximal and distal lateral wings on gonapophysis 4, a proximal pair on gonapophysis 9; gonapophyses well developed, first two with uncini which arise low on gonapophyseal shaft; gonopodium 3 times in SL; premaxillary symphysis of males without bony knob; no membranous processes at tip of gonopodium; no bean-shaped pad on tip of first ventral ray.

DESCRIPTION: A large and surface-frequenting species of the genus. Several characteristics can be correlated to this habitat preference: dorsal profile from snout tip to dorsal origin exceptionally straight in most individuals, body angulated sharply downward behind dorsal origin; dorsal fin short based (8-10 rays, usually 9) and arising far back on body; mouth opening superior, lower jaw protruding beyond upper. Body width between head and ventral fins about equal, posteriorly tapering to a very narrow but deep caudal peduncle.

The following counts, except where otherwise noted are based on 10 male and 10 female specimens. D. 8-10, usually 9; A. 8-9, usually 9; P. 13-14; V. 6, one specimen with 7 on both sides; C. 12-15, usually 14. All dorsal rays included in count because last two never divided to base; last two anal rays frequently divided to base and always counted as one ray. Dorsal fin arising over fourteenth to sixteenth vertebra and slightly posterior to anal fin origin in both sexes. Pectoral fin reaching to ventral origin or mid-ventral fin. Ventral fins not reaching or reaching slightly beyond anal origin of females; extending well beyond gonopodial origin. Gill rakers 11-14 on first gill arch, number increasing with length of specimen. Longitudinal scales 28; scales around caudal peduncle 14; predorsal scales 14-15. Vertebrae 30 in 5 examples, 31 in another.

The following body proportions are based on 10 adult males (3 individuals, 24.8-27.7 mm SL from UCR 30 and 7 specimens, 19.1-21.8 mm SL from LACM 9243-1) and 10 adult females (5 specimens, 30.7-48.2 mm SL from UCR 30 and 5 examples, 25.0-30.0 mm SL from LACM 9243-1). All proportions are expressed as per cent of SL; the range for the series is followed by the value in parentheses of the holotype.

Males: head length 28.9-31.4 (29.2); head width 18.8-20.9 (18.8); snout length 10.5-11.5 (10.5); orbit length 10.1-11.5 (10.5); interorbital bony width 13.0-14.7 (13.0); greatest body depth 25.6-29.8 (29.6); least depth caudal peduncle 17.8-19.8 (19.5); caudal peduncle length 39.0-41.5 (41.5); dorsal origin to caudal base 41.7-46.0 (45.1); anal origin to caudal base 48.4-52.3 (48.4); length dorsal fin base 15.2-17.0 (15.5); length penultimate dorsal ray 21.5-27.4 (25.6); predorsal length 56.3-61.2 (56.3) preanal length 51.8-56.6 (53.8); dorsal fin, depressed length 34.5-39.2 (38.3); gonopodium

length 32.8-35.0 (32.5); pectoral fin length 22.0-24.4 (23.8); ventral fin length 16.1-19.4 (16.6).

Females: head length 26.2-30.0; head width 19.7-21.3; snout length 9.7-11.4; orbit length 8.3-10.6; interorbital bony width 13.2-15.0; greatest body depth 25.6-29.9; least depth caudal peduncle 16.9-18.2; caudal peduncle length 30.4-34.0; dorsal origin to caudal base 39.2-41.7; anal origin to caudal base 40.5-45.6; length dorsal fin base 12.9-14.5; length penultimate dorsal ray 15.3-18.8; predorsal lengh 63.1-65.7; preanal length 59.0-65.3; dorsal fin, depressed length 28.0-30.0; and fin, depressed length 26.8-32.9; pectoral fin length 21.0-24.8; ventral fin length 14.3-15.8.

Gonopodium of mature males composed of anal rays 3, 4 and 5 all lying in same plane; gonopodium bilaterally symetrical without modified processes at tip (Figure 7). Ray 3 thick proximally, segments longer than high; subdistal segments highly compressed and 4 times higher than long with incipient spines produced antrorsely, last 4 or 5 segments progressively smaller at tip. Ray 3 terminating short of rays 4 and 5. Subdistal segments of ray 4a expanded medially and compressed laterally; distal segments progressively reduced. Five or 6 short serrae on subdistal portion of ray 4b opposite expanded portions of rays 4a and 3; serrae merging with 10 or 11 small unspecialized distal segments. Ray 5 diminishing in size toward tip. Ends of rays 4 and 5 forming tip of gonopodium which is bent slightly upward.

Gonapophysis I heavy and straight, inclined slightly forward, a pair of massive uncini arise near center of shaft and extend downward. Uncini of gonapophysis II arising closer to tip than base of shaft, projecting posteroventrally. Gonapophysis III curved sharply forward at tip; uncini absent. Gonactinost 1 slim, curving forward at tip or entire shaft curving forward. Gonactinosts 2, 3 and 4 fused into a large plate expanded well forward; a pair of lateral pointed wing-like processes arising near base, and another less pronounced pair near tip of gonactinost 4. Gonactinosts 9 and 10 fused distally, a pair of lateral pointed "wings" originating closer to tip than base of gonactinost 9 and tapering toward the base. Ligastyle absent.

One outer regular row and about 3 irregular inner rows of teeth in each jaw, those of premaxillary and dentary alike in structure. Teeth of outer row sharp-pointed, long and recurved; 13-15 in number. Inner series similar but more slender and extending farther toward edge of jaws than outer row.

Ground color of body and caudal fin in life, pale orange to rose-colored; dorsal fin red-orange. Remaining coloration similar to that of preserved material. Scale pockets edged in black on upper part of body; some, especially along lateral series, with margins variably intensified at apex to form a round or quadrate spot. A series of 11-15 long narrow vertical bars extend all along body but more intense posteriorly; last bar longest and more prominent in most individuals. Vertical barring most intense in males and more intense in Río Puerto Viejo females than in Tilarán females. An irregular black slash on each interradial membrane of proximal half of dorsal fin; distal half of rays dusky, especially in large males. Margin of dorsal and caudal fins outlined

in black. Caudal fin dusky, a diffuse vertical bar crossing most rays near base. Anal fin with a black blotch, most intense at base, on fourth to last rays; fourth and remaining rays of gonopodium intense black. Ventral and pectoral fins only slightly pigmented.

REMARKS: *B. holdridgei* has been directly compared to alcohol and alizarin-stained specimens of all known species of *Brachyrhaphis* except *B. punctifer* and *B. episcopi*. Only alcohol specimens of *B. episcopi* were examined but the osteology of the species is abundantly illustrated in ROSEN and BAILEY (24). Dr. Robert R. Miller has kindly compared examples of the new species with the types of *B. punctifer* (UMMZ 72573, 52572, 52574) and reports considerable differences between the two species in body form, color pattern, gonopodial structure, sensory canal and caudal peduncle scalation.

Several common characteristics point to a close relationship between *B. holdridgei* and *B. parismina*. Both species have a fairly wide distribution in Costa Rica and are restricted to the Atlantic slope; both are surface fishes with pointed snouts and dorsal fins of few rays placed far back on the body. Common to both species are a widely expanded primary gonactinostal complex with superior and inferior lateral "wings" on gonactinost 4; gonapophyses inclined well forward with well-developed uncini on first and second gonapophysis; subdistal segments of ray 4a much higher than wide; subdistal segments of ray 3 produced antrosely as incipient spines (more pronounced in *B. holdridgei*). The latter characteristic supports ROSEN and BAILEY's hypothesis (24) that *Brachyrhaphis* is closest to the ancestral gambusiins and that a *cascajalensis*-like coastal form gave rise to a prototype of *Gambusia* and *Belonesox* (genera which contain many euryhaline species). *B. cascajalensis* is very similar to *B. parismina* and *Gambusia* is the only genus of poeciliids in which well-developed antrorse spines are present on gonopodial ray 3. It is reasonable then, to suggest that the plain-colored coastal forms *(B. parismina* and *B. cascajalensis)* were derived from the inland, vertical-barred species through a form resembling *B. holdridgei*.

Several species of *Brachyrhaphis* are rather clearly defined although *B. rhabdophora* which occurs throughout Pacific Costa Rica and western Panamá *(Brachyrhaphis* sp. of LOFTIN, 12) and part of Atlantic Costa Rica has developed considerable intraspecific variation. This is not unusual for a form with a large distribution which lives between 20 and 1000 meters elevation. Populations of *B. rhabdophora* vary greatly in degree of pigmentation, color pattern, vertical barring, number of dorsal rays and body and caudal peduncle depth, although gonopodial and gonopodial suspensorial characters exhibit little variation. An exception is the population from Golfito, Costa Rica, which demonstrates more than ordinary gonopodial and suspensorial variation. Specimens from western Panamá resemble the southern Pacific Costa Rican specimens in their slim bodies and very pronounced vertical barring. I have not seen cleared and stained material from Panamá.

*B. holdridgei* was collected in the Río Madre de Dios, Río Sarapiquí and Río Arenal drainages on the Atlantic slope of Costa Rica between 50 and about 600 meters elevation. The species is named in honor of Leslie R. Hold-

ridge, President, Tropical Science Center, San José, Costa Rica. Dr. Holdridge made possible my study of the fishes of the Río Puerto Viejo, as well as the studies of many students of tropical biology, through his outstanding generosity and friendly advise.

## *Poeciliopsis paucimaculata,* new species

(Figure 5)

HOLOTYPE: LACM 9236-1 (1) 33.3 mm SL, CR-7. PARATYPES: LACM 2920 (3) CR-7; LACM 2897 (5) CR-61 and CR-62; UCR 45-1 (1) CR-7.

COMPARATIVE MATERIAL: *Poeciliopsis turrubarensis* (Meek), Costa Rica: LACM 2697 (28) CR-131; LACM 4727 (11) NJS63-182; LACM 2805 (18) CR-4; LACM 2796 (43) CR-1. *Poeciliopsis elongata* (*Günther*), Panamá: ANSP 104376 (14) HL-01; Río Pedasí; H. G. Loftin, E. I. Tyson; 29 September 1961. *Poeciliopsis retropinna* (Regan), Costa Rica: LACM 2914 (7) CR-7; LACM 2943 (8) CR-6; LACM 2950 (5) CR-10; LACM 2857 (7) CR-58; LACM 4834 (199) CR64-6; LACM 4781 (192) CR64-11. Panamá: ANSP 104453 (22) HL-84; creek 7 miles up Boquete Road; H. G. Loftin, E. L. Tyson; 16 December 1961. ANSP 104478 (9) HL-73; creek 10 miles W of David; H. G. Loftin, E. L. Tyson; 2 December 1961. ANSP 104454 (11) HL-74; creek 12 miles W of David; H. G. Loftin, E. L. Tyson; 2 December 1961. ANSP 104463 (9) HL-83; creek 6 miles from David on Boquete Road; H. G. Loftin, E. L. Tyson; 16 December 1961. *Poeciliopsis gracilis* (Heckel), Honduras: UMMZ 144657 (10); Río Yeguare; A. F. Carr; 17 February 1946. UMMZ 147186 (5); Río Yeguare; A. F. Carr; March 1946.

DIAGNOSIS: *Poeciliopsis (Aulophallus) paucimaculata* differs from other species of the subgenus in having 2 or 3 dark blotches on its sides vs. 8 thin bars or no markings on sides; 19 or 20 gillrakers vs. 27-34 gill rakers and asymmetrically paired distal serrae on ray 4p vs. symmetrically paired or unpaired serrae on ray 4p.

DESCRIPTION: A slender-bodied species of the genus. Dorsal profile from snout to origin of dorsal gently curved; dorsal profile from dorsal to caudal fin straight or slightly concave. Lips fleshy, lower one especially prominent. Mouth terminal; opening very wide and nearly equal to interorbital distance. Greatest depth at ventral origin.

The following fin ray counts are presented for the holotype followed by the range in parentheses for the 9 paratypes. D. 9 (8-10, usually 9); A. 9 (9); P. 16 (16); V. 6 (6); C. 18 (18). The last two rays of the dorsal and anal fins are always counted as one ray, because they are frequently divided to the base. Dorsal fin arising over anal fin origin (females); arising well behind gonopodial origin of holotype. Pectoral fins not quite reaching ventral fin origin (females); reaching nearly to tip of ventral fin of holotype. Ventral fins not reaching anal fin (females); reaching origin of gonopodium of holotype.

The following counts are given for the holotype followed by the range in parentheses for the 4 female paratypes. Gill rakers on first arch 19 (19-20).

Longitudinal scales 28 (28-30); scales around caudal peduncle 16 (16); predorsal scales 14 (14). Sensory canal pores of head following nomenclature of GOSLINE (8): mandibular pores absent on holotype, open groove on females; preopercular 7 (7); preorbital 4 (4): infraorbital 2 (2); supraorbital 2 (2 or 4), when 2, consisting of pores 1 and 2a or when 4, consisting of pores 1, 2a, 3, 4a.

The following body proportions as per cent of SL are given for the male holotype followed by the range in parentheses for the 4 female paratypes. Proportions for the immature specimens from LACM 2897 (14.2-15.2 mm SL) are not included. SL 33.3 mm (31.3-36.9 mm); head length 25.8 (26.6-27.4); snout length 10.2 (10.6-11.8); orbit length 8.7 (8.1-9.2); interorbital distance 12.0 (13.2-14.0); greatest body depth 25.5 25.3-27.7); least depth caudal peduncle 14.4 (15.4-16.2); caudal peduncle length 48.7 (34.2-37.1); dorsal origin to caudal base 42.3 (40.3-42.7); anal origin to caudal base 54.7 (41.5-43.0); predorsal distance 59.5 (59.5-62.8); preanal distance 49.2 (59.2-62.6); preventral distance 36.6 (45.5-47.7); dorsal fin, depressed length 22.2 (21.2-23.6); gonopodium length 38.2, anal fin, depressed length (19.0-20.4); pectoral fin length 21.3 (19.7-21.1); ventral fin length 12.0 (13.1-14.1).

Gonopodium of holotype asymmetrical, sinistral, composed of anal rays 3, 4 and 5; tip with a small membranous hook (Figure 8). Ray 3 thick proximally, all segments longer than high, but distal ones compressed, nearly square and progressively smaller at tip; subdistal segments not fused, those of right half broad and flat but not forming spines with pointed tips. Segments of ray 4a longer than high except distally where they are higher than long. Ray 4p with paired serrae on subdistal segments symmetrical distally, asymmetrical proximally; 13 large unicuspid retrorse serrae on right half of ray 4p; left half of ray 4p with 5 large unicuspid retrorse serrae distally, 5 bicuspid serrae proximally. Ray 5a diminishing in size toward tip and terminating well before tip of gonopodium; subdistal segments of right half of ray 5p higher than long, forming long rectangles; segments of left half of ray 5p very reduced, longer than high and diminishing in size toward tip. Rays 3 and 4a entering into extreme tip of gonopodium.

Gonopodial suspensorium with three slim, well-developed gonapophyses. Gonapophysis I curving abruptly forward at midpoint, distal portion straight; a pair of long, thin uncini arising at midpoint of shaft and extending nearly straight downward, but curving posteriorly at tip. Distal half of gonapophysis II arching anteroventrally; uncini arising at midpoint of shaft and curving posteroventrally. Gonapophysis III curved sharply forward as is gonapophysis I; uncini very short. Gonactinost I thin and straight, with no anterior subdistal swelling. Gonactinosts 2, 3 and 4 fused into a narrow plate. Gonactinosts 5 to 9 long, slim and free. X-rays of the holotype were kindly made by John R. Paxton, University or Southern California.

Teeth in both jaws uniserial, very long and thin, curved sharply inward. Teeth numerous and very weakly implanted in lips, each row consisting of sev-

eral groups of 6 teeth staggered vertically so not all are on same level. Tips of teeth truncate and brown-colored.

Ground color in alcohol pale brown, visceral region dark gray. Scale pockets with dark borders, the resulting reticulate pattern especially prominent dorsally. Two or 3 prominent dark blotches about twice as high as wide on sides of body; these quite distinct on immature specimens. Anterior blotch below a vertical midway between occiput and dorsal origin; middle blotch at any point below dorsal fin base; posterior blotch, if present, at any point below a vertical between end of dorsal fin base to midway between dorsal fin base and caudal fin base. Dorsal and caudal fins slightly dusky, other fins clear. No other markings present.

REMARKS: *P. (A.) paucimaculata,* although sharing much in common with both other species of *Aulophallus,* departs in the following characteristics of the subgenus as defined by ROSEN and BAILEY (24): subdistal segments of right half of gonopodial ray 3 *not* developed into broad flat spines with pointed tips; series of *asymmetrically* paired serrae distally on ray 4p; subdistal segments of right half of ray 5p forming long thin *rectangles* that are higher than long. A male specimen of *P. retropinna* collected near the type locality of *P. paucimaculata* also exhibits the first two of the three departures mentioned above, thus the species is more variable in these respects than was formerly indicated (ROSEN and BAILEY, 24). Table 2 compares four species of *Poeciliopsis* including all species of *Aulophallus* on the basis of external characteristics; only *P. elongata* does not occur in Costa Rica (see also Fig. 6).

The new species is very similar to the much commoner *P. retropinna* with which it has been collected on each occasion. Further knowledge of the distribution and ecologies of each of these species will prove interesting. *P. paucimaculata* has been collected only in tributaries to the Río General, a confluent of the Río Grande de Térraba. The specific name refers to the few dark blotches on the sides of the body.

## *Gambusia nicaraguensis* Günther

UCR 19-1 (15) UCR-19.

The present specimens closely resemble the original description and the description of specimens of *G. nicaraguensis* collected in the Canal Zone, Panamá by MEEK and HILDEBRAND (16). The species has been collected in the Río Escondido basin on the Atlantic slope of Nicaragua (RIVAS, 23), but was curiously not present in any of the collections made by LOFTIN (12) in the Almirante Bay region of Atlantic Panamá.

The Costa Rican specimens typically have dark-rimmed scale pockets, although no distinct dark dot is present on each scale. The dorsal and caudal fins have one or two irregular vertical rows of black dots. The middle of the anal fin is darkened. A black streak is present below the eye. No other markings are present.

TABLE 2

*Comparison between Costa Rican and Panamanian species of* Poeciliopsis

| Character | *P. (P.) turrubarensis* | *P. (A.) paucimaculata* | *P. (A.) retropinna* | *P. (A.) elongata* |
|---|---|---|---|---|
| Total gill rakers | 15-22 | 19-20 | 27-34 | 29-32 |
| Dorsal origin | Between anterior border of eye and tip of caudal fin; over 7-8th anal ray | Between snout tip and tip of caudal; over 2-3rd anal ray | Between anterior border of eye and tip of caudal; over 4-5th anal ray | Between snout tip and tip of caudal; over 2nd anal ray |
| Dorsal profile | Straight | Distinctly curved | Distinctly curved | Slightly curved |
| Mouth width | Always less than eye diameter | Always greater than eye diameter | Always greater than eye diameter | Always greater than eye diameter |
| Interorbital width | Equal to or slightly greater than postorbital distance | Equals opercular border to posterior border of pupil distance | Equals opercular border to center of eye distance | Equal to or slightly greater than postorbital distance |
| Color pattern | Cross-hatching diffuse not conspicuous; 6-8 thin bars | Cross-hatching prominent; 2-3 blotches | Cross-hatching prominent; plain | Cross-hatching not prominent; 8 thin, but diffuse bars |
| Pectoral fin, females | Reaches almost to mid-ventral fin | Reaches ventral base or slightly beyond | Reaches beyond ventral base, but not to middle of ventral fin | Reaches to middle of ventral fin |

## CICHLIDAE

### *Aequidens coeruleopunctatus* (Kner and Steindachner)

LACM 4883 (18) CR64-7; LACM 4861 (21) CR64-8; LACM 4797 (19) CR64-9; LACM 4820 (62) CR64-10; LACM 4775 (4) CR64-11.

The Costa Rican specimens of this species differ in no way from descriptions of Panamanian specimens (MEEK and HILDEBRAND, 16; HILDEBRAND 9). This is one of the most generally distributed species in Panamá and occurs as far west as the Río Coto drainage in southern Costa Rica.

## COMMENTS ON OTHER SPECIES

## CICHLIDAE

### *Cichlasoma alfari* Meek

(Figures 9 and 10)

*Cichlasoma alfari* Meek 1907, Field Mus. Nat. Hist. 7:148 (Type locality: Turrialba).

*Cichlasoma lethrinus* Regan 1908, Ann. Mag. Nat. Hist. (8) 2:462 (Type locality: Río Iroquois).

ATLANTIC COSTA RICAN MATERIAL: Arenal basin, Guanacaste: LACM 2932 (6) CR-46; LACM 2909 (5) CR-48; LACM 9232-1 (2) CRE-F3. Río San Carlos basin, Alajuela: LACM 2898 (4) CR-38; LACM 2815 (1) CR-39; LACM 2824 (1) CR-40; LACM 2836 (2) CR-41; LACM 2749 (17) CR-42. Río Sarapiquí basin, Heredia: LACM 9176-1 (3) CR-135; LACM 9196-1 (32) CR-164. Río Reventazón basin, Cartago: LACM 9233-1 (1) CRE-32; LACM 9234-1 (1) CRE-58; LACM 9235-1 (17) NJS64-619. Río Madre de Dios basin, Limón: LACM 2863 (12) CR-21; LACM 2825 (4) CR-24; LACM 2801 (2) CR-25; LACM 2840 (11) CR-26.

PACIFIC COSTA RICAN MATERIAL: Río Grande de Tárcoles basin, San José: LACM 2813 (10) CR-32; LACM 2727 (5) CR-33. Río General basin, San José: LACM 2942 (3) CR-6; LACM 2713 (11) CR-60; LACM 2954 (2) CR-63; LACM 2960 (35) MRBCR-8; LACM 4740 (6) NJS63-194. Río Grande de Térraba basin, Puntarenas; LACM 4838 (2) CR64-6; LACM 2759 (1) Legler # 1. Río Coto basin, Puntarenas: LACM 4864 (2) CR64-8; LACM 4819 (7) CR64-10; LACM 4770 (7) CR64-11.

COMPARATIVE NICARAGUAN MATERIAL: UCR 3-1 (1) JV-882; Río San Juan Depto.; river 1 km E of El Castillo; J. D. Villa; 25 January 1965.

The present study, based on specimens from several Atlantic and Pacific Costa Rican localities and one Nicaraguan locality, and on measurements and counts of the type specimens (Table 3), has revealed that the nominal species *C. lethrinus* Regan should be placed in the synonymy of *C. alfari* Meek.

MEEK (13) described *C. alfari* from 4 specimens (holotype 73 mm SL)

TABLE 3

*Body proportions and counts for Costa Rican specimens of* Cichlasoma alfari *including the holotype of* C. alfari *and syntypes of* C. lethrinus

| Character | Atlantic | Valle Central | Pacific | *C. lethrinus* syntypes[1] | *C. alfari* holotype[2] |
|---|---|---|---|---|---|
| SL (mm) | 59.2-141.5 | 57.3-128.1 | 43.3-110.0 | 58.6-111 | 73 |
| Head length | 36.4-41.1 | 34.8-41.6 | 37.3-41.3 | 36.3-40.7 | 36.3 |
| Snout length | 15.5-20.0 | 15.0-19.5 | 14.4-19.1 | 14.0-18.1 | 15.1 |
| Maxillary length | 11.1-13.1 | 11.1-13.2 | 11.0-13.4 | 11.3-12.8 | 11.9 |
| Orbit diameter | 7.4-11.6 | 6.6-11.3 | 8.2-13.8 | 8.9-12.3 | 10.5 |
| Interorbital length | 10.1-12.2 | 9.9-12.4 | 9.6-11.9 | 10.9-11.9 | 10.4 |
| Suborbital length | 9.2-12.2 | 8.3-12.6 | 8.3-11.3 | ——— | 10.3 |
| Greatest body depth | 39.1-46.7 | 40.1-43.9 | 37.3-47.6 | 41.6-46.3 | 39.0 |
| Peduncle depth | 13.4-15.9 | 13.4-14.2 | 13.6-15.7 | 14.0-15.0 | 13.0 |
| Predorsal distance | 40.8-45.8 | 40.6-45.5 | 42.1-46.5 | 41.8-46.3 | 42.0 |
| Preanal distance | 62.2-68.4 | 63.1-65.7 | 65.4-69.6 | 60.4-65.7 | 63.7 |
| Prepectoral distance | 36.0-40.9 | 34.7-41.1 | 37.7-40.8 | 38.7-42.3 | 35.6 |
| Preventral distance | 39.9-45.8 | 39.6-43.8 | 41.8-45.3 | 40.8-44.3 | 39.4 |
| Pectoral length | 23.7-30.5 | 23.8-30.7 | 26.4-33.8 | 27.6-32.9 | 28.4 |
| Ventral length | 25.4-31.6 | 21.3-37.8 | 26.4-33.3 | 27.1-32.8 | 26.6 |
| Dorsal fin base | 55.2-61.0 | 54.3-58.5 | 52.8-60.6 | 59.5-64.8 | 58.2 |
| Anal fin base | 25.1-29.9 | 25.9-28.6 | 21.9-26.4 | 29.4-30.4 | 26.2 |
| Mid-caudal rays | 24.7-31.6 | 24.5-32.1 | 27.9-35.1 | 31.0-36.0 | 29.4 |
| Sixth dorsal spine length | 7.7-12.3 | 8.4-12.2 | 7.9-14.1 | 10.0-14.5 | 10.1 |
| Last dorsal spine length | 10.3-13.3 | 10.7-14.7 | 11.4-15.2 | 12.9-17.8 | 12.0 |
| Anal rays | 7-9 | 8-9 | 8-9 | 9-10 | 8 |
| Pectoral rays | 15-16 | 14-16 | 14-15 | 15-16 | 16 |
| Ventral rays | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 |
| Caudal rays | 15-16 | 16 | 15-16 | 16 | 16 |
| Gill rakers | 10-12 | 11-13 | 10-13 | 10-13 | 11 |
| Longitudinal scales | 28-30 | 28-30 | 26-30 | 29-30 | 28 |
| Upper lateral line | 17-21 | 18-20 | 17-21 | 19-22 | 19 |
| Lower lateral line | 9-11 | 10-12 | 9-12 | 11-13 | 11 |

[1] Six syntypes, BMNH 1909.3.13.92-97. Data taken by Hugh H. DeWitt.
[2] Holotype, CNHM 6032. Data taken by Loren P. Woods.

collected at Turrialba, Costa Rica. REGAN (21) described *C. lethrinus* (based on 6 syntypes, 49.3-67.8 mm SL) from the Río Iroquois, Costa Rica without apparent knowledge of Meek's earlier description of *C. alfari.* The type localities drain into the Río Reventazón and Río Parismina respectively, and these rivers merge before emptying into the Atlantic.

REGAN (20) later included *C. alfari,* with no additional remarks, in the supplement to his *Pisces, Biologia Centrali-Americana.* MEEK (14) reported that *C. lethrinus* differed from *C. alfari* "in having a slightly deeper body, a larger eye, a straighter profile and higher dorsal spine. The dark bars on side are prominent and the lateral band less defined than *C. alfari*". In a key included in the same work, Meek distinguished *C. alfari* by its low spinous dorsal (mid-

dle ones about 4 in head) and pectoral fin not reaching the front of anal fin. The degree of difference referred to is very slight and the characters presented in the key are erroneous and not in agreement with the original description which states for *C. alfari* that the dorsal spines posterior to the fourth are of nearly equal length, the last 2.8 to 2.9 in head length; the pectorals reach the second or third anal spine. RIVAS (22) recorded both nominal species in the preliminary list of his Costa Rican fish collections. Rivas *(in litt.)* has since concurred with the merging of the two nominal species. Meek's key still serves to distinguish *C. alfari* from other Costa Rican cichlids if the above errors are taken into account. Dr. Robert R. Miller *(in litt.)* states that the species belongs in Regan's *Amphilophus* section of the genus *Cichlasoma.*

DESCRIPTION: Considerably more variation can be observed between Pacific slope populations of the species than between Atlantic forms. Even within the same river system, the Río Grande de Térraba, the San Isidro del General population varies remarkably from Golfito specimens (Fig. 9). This variation consists of differences in body depth, least depth of caudal peduncle, length of dorsal and anal fin bases and subtle color pattern differences. Other body proportions and meristic characters are constant between the two populations. If Regan had based *C. lethrinus* on specimens from San Isidro del General and no other specimens were available except Meek's Turrialba collection, one would not hesitate in recognizing the two distinct species. Table 4 sums up several characteristics which are shared by all Pacific populations and all Atlantic populations and reveals how the highland material from the Valle Central is intermediate to both of these. The Valle Central specimens, although inhabiting the headwaters of one of the large Pacific drainages, exhibit characteristics which are otherwise only observed on Atlantic examples (3 and 4, Table 4). Regardless of whether these similarities reflect genetic flow in the present or recent past between Atlantic and Pacific slope populations at this point or are the result of convergence of characters due to some environmental factors, I feel that this polytypic species has still not diverged sufficiently to prevent genetic interchange and to merit separation into more than one species. Likewise, I feel that the reference to the populations as Atlantic *C. alfari* and Pacific *C. alfari* serves as useful a purpose as subspecific designations.

A description of a live adult Atlantic specimen follows: body depth moderate, ground color olive-brown to olive-gray, becoming paler below. A black irregular band along side from behind eye to caudal base, one point just behind tip of pectoral fin forming a more pronounced eye-sized blotch. Dorsal head profile nearly straight, snout long. Dark blue spots or vermiculations on side of head; paler blue spots forming 5 fairly regular rows along side of body. Breast suffused with light pink. Dorsal fin golden, margin red. Anal fin golden, margin olive. Posterior lobes of dorsal and anal fins with white spots and produced into long filaments. Caudal fin rounded, golden with white spots. anterior ray of ventral fins dark and produced into a filament, posterior rays much paler or white. Pectoral fins not reaching anal origin, nearly transparent.

TABLE 4

*Comparison of Atlantic, Pacific and intermediate populations of* Cichlasoma alfari

| | Atlantic<br>Based on 121 specimens | Valle Central<br>Based on 15 specimens | Pacific<br>Based on 91 specimens |
|---|---|---|---|
| 1. | Numerous dark spots (blue in life) on cheeks and operculum. | A few spots on cheek and operculum. | Spots absent. |
| 2. | Vertical bars on body diffuse, only obvious on posterodorsal part of body. | Same as Atlantic. | Bars contrast more with ground color; most evident on dorsum. |
| 3. | Horizontal band usually present along most of body. | Same as Atlantic. | Band intermittent, often only visible anteriorly |
| 4. | Dark spot in posterodorsal part of pectoral fin base present or absent; not evident when fin appressed. | Spot absent. | Dark spot covering half to entire posterior pectoral base; visible through appressed fin. |
| 5. | Dorsal spines 17-19 | 17-18 | 15-17 |
| | Dorsal rays 9-12 | 10-12 | 11-12 |
| | Anal spines 6-8 | 6-8 | 5-6 |

Females and males much alike except females with a black blotch of varying intensity on seventh to twelfth dorsal spines. Juveniles similar, with less brilliant coloration; lateral spot and similar spot on upper caudal base very intense, lateral band indistinct.

The species has been collected on the Atlantic slope in the San Juan drainage of Nicaragua (new record), several drainages in Costa Rica and to the Río Guarumo, Bocas del Toro Province, Panamá (LOFTIN, 12). On the Pacific side it is only recorded from Costa Rica. It is common in southern Costa Rica, but has been recorded only once north of San Isidro del General. MEEK (14) recorded 6 specimens of *C. lethrinus* from Río Higuerón near Cañas, collected by Anastasio Alfaro.

It may be of value to point out the exact locality of the Río Iroquois, the type locality of *C. lethrinus* and other Costa Rican species described by REGAN (21) because it apparently does not exist on any current maps of Costa Rica. Sra. Marta E. de Barquero of the library of the Universidad de Costa Rica kindly obtained the following information from the United Fruit Company: "Río de la vertiente del Atlántico, corre de Norte a Sur, afluente del Parismina, y localización geográfica en relación al paso del puente del ferrocarril, es: latitud, 10°11'30" y longitud 83°36'30". Atraviesa una finca cuyo nombre es también Iroquois, su nombre es indígena, el cual no ha variado".

## LORICARIIDAE

### *Hypostomus plecostomus* (Linnaeus)

LACM 2935 (1) CR-6; LACM 2947 (1) CR-10; LACM 9247-1 (1) Legler # 2; UCR 41-1 (2) UCR-41.

This collection of 5 specimens from the Río Grande de Térraba drainage confirms the presence of the species in Costa Rica. Previously the only published record of *H. plecostomus* from Costa Rica was a reference by HILDEBRAND (9:236,238) to one specimen in the U. S. National Museum. The specimen was collected in Quebrada de India, a tributary of the Río Coto.

EIGENMANN (7) recognized the Panamanian specimens as a new subspecies based on their occipital plate being bordered by 3 or more small plates instead of 1 or 2 plates as in the typical South American specimens. The largest Costa Rican specimen has the occipital plate bordered by 2 plates, indicating that this characteristic may not be useful in separating all Central American *H. plecostomus* from South American specimens. The species is known from Costa Rica to Uruguay.

## CHECKLIST OF COSTA RICAN FRESHWATER FISHES

This list includes all fishes that have been reported in the literature as occurring in the fresh waters of Costa Rica. The list is far more complete for

those fishes restricted to fresh waters, than for marine fishes which frequently ascend rivers, sometimes for considerable distances. Many species of the latter group have been recorded from both north and south of Costa Rica, but have not yet been identified from Costa Rican waters. Some nominal species of doubtful validity have been included because their relationships are not yet clear. Species of the genera *Astyanax, Bryconamericus, Roeboides* and *Rhamdia* especially fall into this category. The letters A and P indicate Atlantic and Pacific slopes.

Carcharhinidae
**Carcharhinus leucas* A

Pristidae
**Pristis perotteti* A, P

Lepisosteidae
*Lepisosteus tropicus* A

Elopidae
*Megalops atlanticus* A

Pimelodidae
*Rhamdia alfaroi* A
*Rhamdia godmani* P
*Rhamdia heteracantha* A, P,
*Rhamdia nasuta* A, P
*Rhamdia rogersi* A, P
*Rhamdia underwoodi* A, P
*Rhamdia wagneri* A, P
*Pimelodella chagresi* P

Pygidiidae
*Pygidium septentrionale* P
*Pygidium striatum* P

Ariidae
*Arius fürthii*

Loricariidae
*Hypostomus plecostomus* P

Characidae
*Astyanax albeolus* P
*Astyanax fasciatus* A
*Astyanax regani* P
*Bramocharax bransfordi* A
*Brycon guatemalensis* A
*Brycon striatulus* P
*Bryconamericus emperador* P
*Bryconamericus ricae* A
*Bryconamericus scleroparius* A
*Compsura gorganae* P
*Gephyrocharax intermedius* P
*Hyphessobrycon savagei* P
*Hyphessobrycon tortuguerae* A
*Pseudocheirodon terrabae* P
*Rhoadsia eigenmanni* A
*Roeboides guatemalensis* A, P
*Roeboides salvadoris* A, P

Erythrinidae
*Hoplias microlepis* P

Lebiasinidae
*Piabucina boruca* P

Curimatidae
*Curimata magdalenae* P

Gymnotidae
*Gymnotus cylindricus* A, P

Anguillidae
**Anguilla rostrata* A

Syngnathidae
*Pseudophallus starksi* P
*Syngnathus elcapitanense* P

Poeciliidae
*Alfaro cultratus* A, P
*Belonesox belizanus* A
*Brachyrhaphis cascajalensis* A
*Brachyrhaphis holdridgei* A
*Brachyrhaphis parismina* A
*Brachyrhaphis rhabdophora* A, P

* Not reported in the literature. Based on personal communication with reliable observers.
** Introduced species.

*Brachyrhaphis terrabensis* P
*Gambusia nicaraguensis* A
*Neoheterandria umbratilis* A
*Phallichthys amates* A, P
*Phallichthys tico* A
****Poecilia reticulata*** A, P
*Poecilia sphenops* A, P
*Poeciliopsis paucimaculata* P
*Poeciliopsis retropinna* P
*Poeciliopsis turrubarensis* P
*Priapichthys annectens* A, P,
****Xiphophorus maculatus*** A
****Xiphophorus variatus*** A

Cyprinodontidae
*Oxyzygonectes dovii* P
*Rivulus hildebrandi* P
*Rivulus isthmensis* A, P

Atherinidae
*Melaniris chagresi* A

Synbranchidae
*Synbranchus marmoratus* A, P

Cichlidae
*Aequidens coeruleopunctatus* P
*Cichlasoma alfari* A, P
*Cichlasoma altifrons* P
*Cichlasoma centrarchus* A
*Cichlasoma citrinellum* A
*Cichlasoma dovii* A, P
*Cichlasoma friedrichsthalii* A
*Cichlasoma longimanus* P
*Cichlasoma maculicauda* A
*Cichlasoma motaguense* A
*Cichlasoma nigrofasciatum* A, P
*Cichlasoma rostratum* A, P
*Cichlasoma sieboldii* P
*Cichlasoma spilotum* A
*Cichlasoma spilurum* A, P
*Cichlasoma terrabae* P
*Cichlasoma tuba* A
*Herotilapia multispinosa* A
*Neetroplus nematopus* A

Mugilidae
*Joturus pichardi* A

*Agonostomus monticola* A, P

Centropomidae
*Centropomus pectinatus* A, P
*Centropomus robalito* P
*Centropomus undecimalis* A

Pomadasyidae
*Pomadasys bayanus* P
*Pomadasys crocro* A

Lutjanidae
*Lutjanus argentiventris* P

Carangidae
*Caranx latus* A

Gerridae
*Diapterus brevimanus* P
*Eucinostomus californiensis* P

Gobiidae
*Awaous taiasica* A
*Awaous transandeanus* P
*Evorthodus lyricus* A
*Gobionellus saggitula* P
*Sicydium altum* A
*Sicydium pittieri* P

Eleotridae
*Dormitator latifrons* P
*Dormitator maculatus* A
*Eleotris amblyopsis* A
*Eleotris picta* P
*Eleotris pisonis* A
*Gobiomorus dormitor* A
*Gobiomorus maculatus* P
*Guavina guavina* A
*Hemieleotris latifasciatus* P

Bothidae
*Citharichthys spilopterus* A

Soleidae
*Trinectes fonsecensis* P

Gobiesocidae
*Gobiesox nudus* A
*Gobiesox potamius* P

## DISCUSSION

The primary purpose of the present report is to survey the fish fauna of an area virtually unknown to ichthyologists, although located in an especially critical zoogeographical region. The southern part of Costa Rica and most of western Panamá were not readily accessible to collectors in 1911 and 1912 when Seth E. Meek of the Field Museum of Natural History and Samuel F. Hildebrand of the U. S. Bureau of Fisheries made their large collections in these countries. During the period 1961-1963 Horace G. Loftin made extensive collections in western Panamá especially on the Pacific slope, but since 1912 no large-scale collections have been made in any part of Costa Rica.

No detailed distributional analysis of the Costa Rican fish fauna has been undertaken but a few striking features of its zoogeography may be discussed. The unique alignement of the Cordilleras of Costa Rica forms a double barrier, one to the South American fauna on the Pacific slope and the beginnings of another, to the Central American fauna of the Atlantic slope. Most of the species discussed in the present report have found their way northward along the broad Pacific slope of Panamá and southern Costa Rica, only to be funneled into a dead-end, the Río Grande de Térraba drainage from which they apparently can not extend further northward. Likewise, their coastal route is blocked by the abruptly narrow and steep Pacific lowland north of the Térraba.

The Central American fish fauna, principally cichlids and poeciliids, seems to be moving southward along the broad lowlands of Atlantic Costa Rica. The group includes forms which probably had their origin in the Great Lakes of Nicaragua: the genera *Bramocharax, Herotilapia,* several species of *Cichlosoma (dovii, rostratum, spilotum, centrarchus, citrinellum)* and others. Their easy passage to the south is disrupted by a northward extension of the Cordillera de Talamanca along the Costa Rica-Panamá border, and further by the rapidly narrowing Atlantic coastal plain south of the Laguna de Chiriquí region in Panamá. Another assemblage of Central American fishes extends westward around the Cordillera at its northern terminus in southern Nicaragua but does not reach much farther south than the Río Tempisque drainage. *Alfaro culturatus,* a common Atlantic-slope poeciliid has been collected on the Pacific slope only in tributaries of the Río Tempisque. *Cichlasoma dovii* is common on most of the Atlantic slope but according to sports fishermen does not extend south of the Río Lagarto on the Pacific slope.

In addition to the southern Nicaragua route, there is evidence of a highland passageway for freshwater fishes through the Central Plateau of Costa Rica. The presence of intermediates between the Atlantic and Pacific populations of *Cichlasoma alfari* only at this point indicates a recent interchange between these populations. *Brachyrhaphis rhabdophora* has a broad Pacific slope distribution but is known on the Atlantic side only from tributaries of the Río Reventazón which drains the eastern portion of the Central Plateau. *Priapichthys annectens* and other eurythermal species have probably crossed the divide at this point as well. There is no present evidence of other routes, even in the

Laguna de Arenal region where Atlantic and Pacific headwaters are in very close proximity. Ubiquitous genera such as *Astyanax, Roeboides, Brycon, Poecilia* have clearly surmounted obstacles to movement which are barriers to many other species. Members of these genera most likely have considerable salinity tolerance and have on occasion overcome geological barriers by passing through the sea or estuaries.

Another aspect of the Costa Rican fish fauna is the rather high number of indigenous species. This phenomenon is typical of Middle American freshwater fishes and reflects the active geological history of the area. About 20 species, belonging principally to the families Pimelodidae, Characidae, Poeciliidae and Cichlidae are recorded only from Costa Rica. Further discussion must await more detailed analyses of distribution based on complete collections from numerous localities and habitats throughout Costa Rica.

## RESUMEN

Se describen cinco especies nuevas, *Hyphessobrycon savagei, Pseudocheirodon terrabae, Piabucina boruca, Brachyrhaphis holdridgei* and *Poeciliopsis paucimaculata,* y se anotan 12 especies de peces de agua dulce adicionales reportadas por primera vez en Costa Rica. Se presentan datos suficientes para indicar que la especie de cíclido descrita como *Cichlasoma lethrinus* Regan debe referirse a la especie *C. alfari* Meek, la cual fue descrita anteriormente. Se observa que las Cordilleras de Costa Rica forman una barrera doble: para la fauna centroamericana por el norte tanto como para la fauna sudamericana hacia el sur y que el país es un sitio de mucho endemismo con unas 20 especies indígenas. Asimismo se incluye una lista tentativa de los peces dulceacuícolas de Costa Rica.

## LITERATURE CITED

1. BEHRE, E. H.
1928. A list of the freshwater fishes of western Panama between long. 81°45' and 83°15' W. *Ann. Carnegie Mus.,* 18: 305-328.

2. BÖHLKE, J. E.
1954. *Studies on the phylogeny and systematics of fishes of the family Characidae.* Unpublished doctoral dissertation, Stanford University.

3. BÖHLKE, J. E.
1954. Studies on fishes of the family Characidae N° 16. A new *Hyphessobrycon* from Costa Rica. *Bull. Fla. State Mus., Biol. Sci.,* 3(4): 173-178.

4. EIGENMANN, C. H.
1915. The Cheirondontinae, a subfamily of minute characid fishes of South America. *Mem. Carnegie Mus.,* 7(1): 1-99.

5. EIGENMANN, C. H
1917. *Pimelodella* and *Typhlobagrus. Mem. Carnegie Mus.,* 7(4): 229-258.

6. EIGENMANN, C. H.
1918. The Pygidiidae, a family of South American catfishes. *Mem. Carnegie Mus.*, 7(5): 259-398.

7. EIGENMANN, C. H.
1922. The fishes of western South America. Part I. The fresh-water fishes of northwestern South America, including Colombia, Panamá... *Mem. Carnegie Mus.*, 9: 1-350.

8. GOSLINE, W. A.
1949. The sensory canals of the head in some cyprinodont fishes, with particular reference to the genus *Fundulus*. *Occas. Pap. Mus. Zool. Univ. Mich.*, Nº 519: 1-17.

9. HILDEBRAND, S. F.
1938. A new catalogue of fresh-water fishes of Panamá. *Field Mus. Nat. Hist. Zool. Ser.*, 22(4): 217-359.

10. HUBBS, C. L., & K. F. LAGLER
1958. *Fishes of the Great Lakes Region.* Cranbrook Inst. Sci. Bull. 26. xi + 213 pp., 44 pl.

11. LAMONTE, F. R.
1935. Two new species of *Gymnotus*. *Amer. Mus. Novitates*, Nº 781: 1-3.

12. LOFTIN, H. G.
1965. *The geographical distribution of freshwater fishes in Panama.* Unpublished doctoral dissertation, Florida State University.

13. MEEK, S. E.
1907. Notes on fresh-water fishes from Mexico and Central America. *Field Mus. Nat. Hist., Zool. Ser.*, 7(5): 133-157.

14. MEEK, S. E.
1914. An annotated list of fishes known to occur in the freshwaters of Costa Rica. *Field Mus. Nat. Hist., Zool. Ser.*, 10(10): 101-134.

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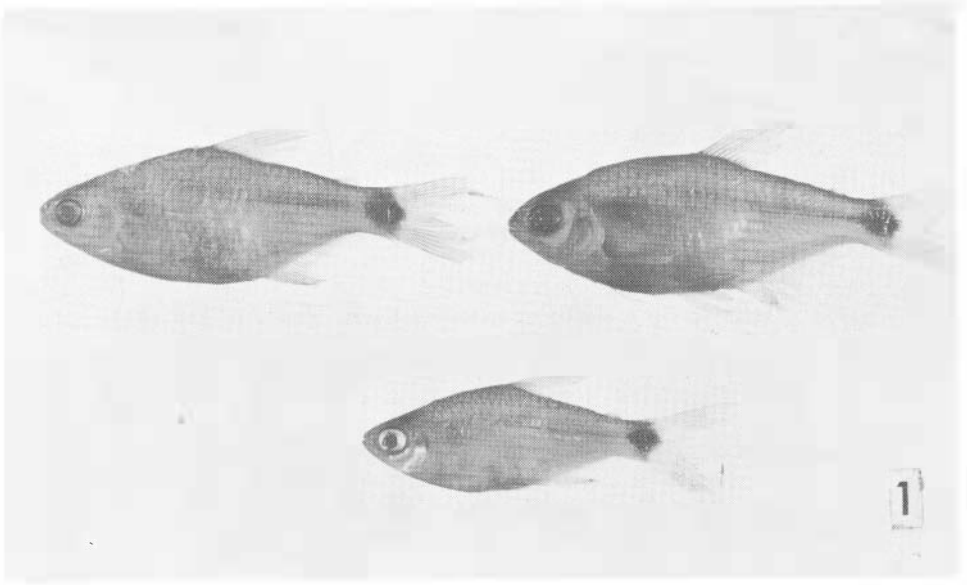
Fig. 1. Upper left: *Pseudocheirodon affinis*, 35.5 mm SL, HL-135 from Coclé Province, Panamá; upper right: *Pseudocheirodon terrabae*, paratype 38.5 mm SL, LACM 2951 from San Isidro del General, Costa Rica; below: *Compsura gorgonae*, 28.7 mm SL, LACM 4825 from Golfito, Costa Rica.

Fig. 2. Above: *Hyphessobrycon savagei*, paratype 33.5 mm SL, LACM 4851 from Palmar Sur, Costa Rica; below: *Hyphessobrycon panamensis*, 35.2 mm SL, ANSP 99932 from Bocas del Toro Province, Panamá.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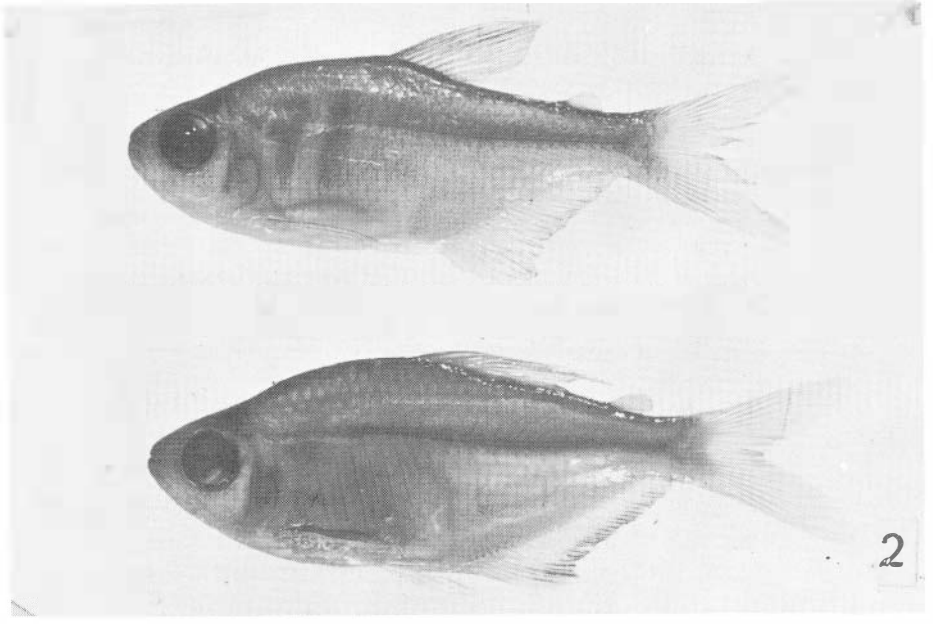
2

15. MEEK, S. E., & S. F. HILDEBRAND
1913. New species of fishes from Panama. *Field Mus. Nat. Hist., Zool. Ser.,* 10(8): 77-91.

16. MEEK, S. E., & S. F. HILDEBRAND
1916. The fishes of the freshwaters of Panama. *Field Mus. Nat. Hist., Zool. Ser.,* 10(15): 1-374.

17. MILLER, R. R.
1966. Geographical distribution of Central American freshwater fishes. *Copeia,* 1966(4). In press.

18. MYERS, G. S.
1927. An analysis of the genera of neotropical killifishes allied to *Rivulus. Ann. Mag. Nat. Hist.,* (9)19: 115-129.

19. MYERS, G. S.
1958. Trends in the evolution of teleostean fishes. *Stan. Ich. Bull.,* 7(3): 27-30.

20. REGAN, C. T.
1906-1908. Pisces. In: *Biología Centrali-Americana,* 8: 1-203.

21. REGAN, C. T.
1908. A collection of freshwater fishes made by Mr. C. F. Underwood in Costa Rica. *Ann. Mag. Nat. Hist.,* (8)2: 455-464.

22. RIVAS, L. R.
1959. Results of University of Miami Costa Rica Expedition (freshwater fishes), March 19-27, 1955. *Ich. Lab. and Mus., Univ. Miami Contrib.,* 33. 1-8. Mimeographed.

23. RIVAS, L. R.
1963. Subgenera and species groups in the poeciliid fish genus *Gambusia* Poey. *Copeia,* 1963(2): 331-347.

24. ROSEN, D. E., & R. M. BAILEY
1963. The poeciliid fishes (Cyprinodontiformes), their structure, zoogeography and systematics. *Bull. Amer. Mus. Nat. Hist.,* 126(1): 1-176.

25. SCHULTZ, L. P.
1944. Fishes of the family Characinidae from Venezuela, with descriptions of seventeen new forms. *Proc. U. S. Nat. Mus.,* 95: 235-367.

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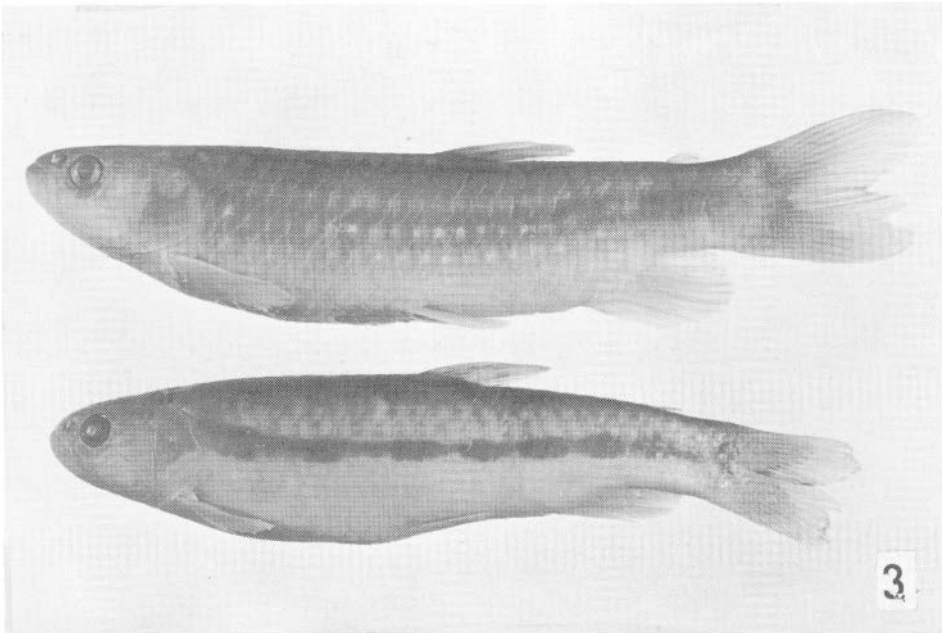
Fig. 3. Above: *Piabucina boruca,* holotype 118 mm SL, LACM 9239-1 from Golfito, Costa Rica; below: *Piabucina panamensis,* 112.5 mm SL, ANSP 104137 from Panamá Province, Panamá.

Fig. 4. *Brachyrhaphis holdridgei,* top left: female paratype 41.2 mm SL, UCR-30-1; top right: holotype 27.7 mm SL, LACM 9240-1; bottom left: female paratype 31.1 mm SL, UCR 44-1; bottom right: male paratype 22.3 mm SL, UCR 44-1. Upper pair from Arenal, lower pair from Puerto Viejo, Costa Rica.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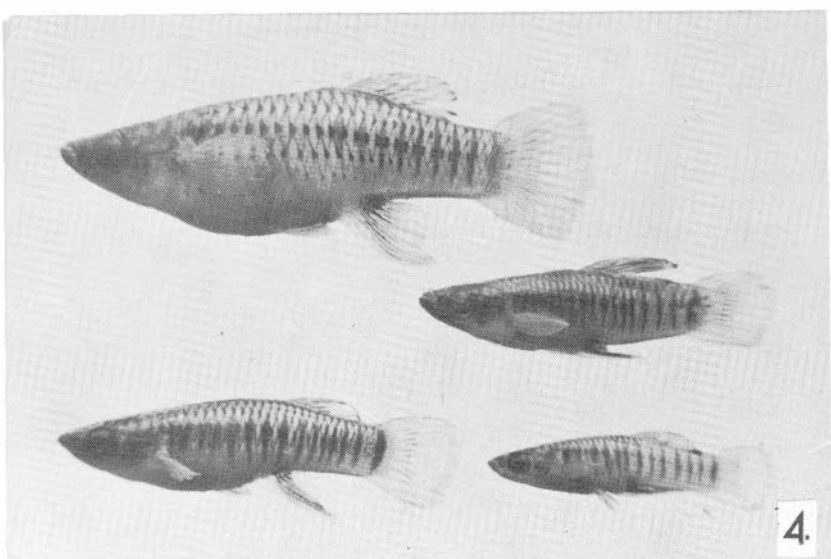
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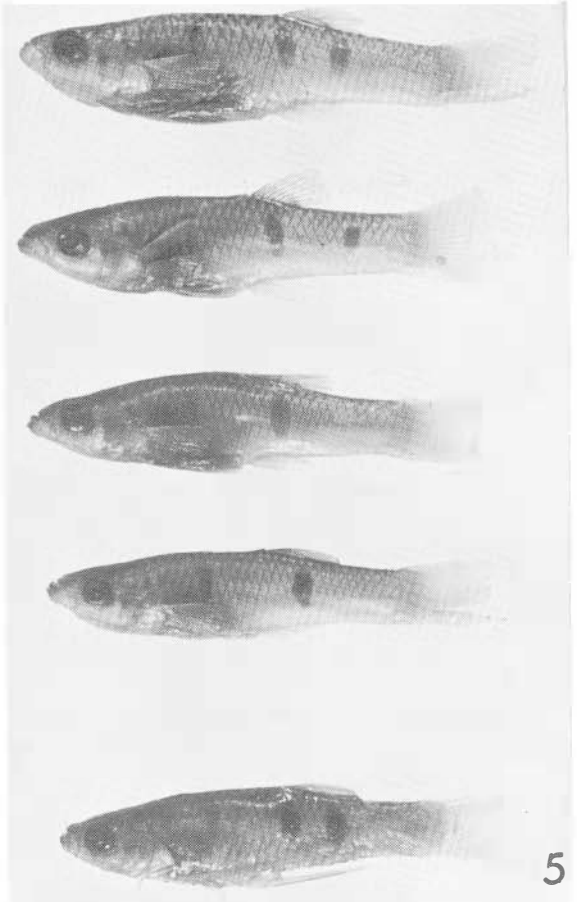
Fig. 5. *Poeciliopsis paucimaculata,* above: four female paratypes, top three 32.5-36.9 mm SL, LACM 2920; fourth paratype 31.3 mm SL, UCR 45-1; below: male holotype 33.3 mm SL, LACM 9236-1; all specimens from San Isidro del General, Costa Rica.

Fig. 6. Comparison of three species of *Poeciliopsis* from Costa Rica and Panamá. Females on left, males on right. Top: *Poeciliopsis retropinna,* 59.6 mm and 39.2 mm SL, LACM 4781 from Villa Neily, Costa Rica; middle: *Poeciliopsis elongata,* 49.2 mm and 40.1 mm SL, ANSP 104376 from Los Santos Province, Panamá; bottom: *Poeciliopsis turrubarensis,* 53.9 mm and 29.6 mm SL, LACM 2796 from Puntarenas, Costa Rica.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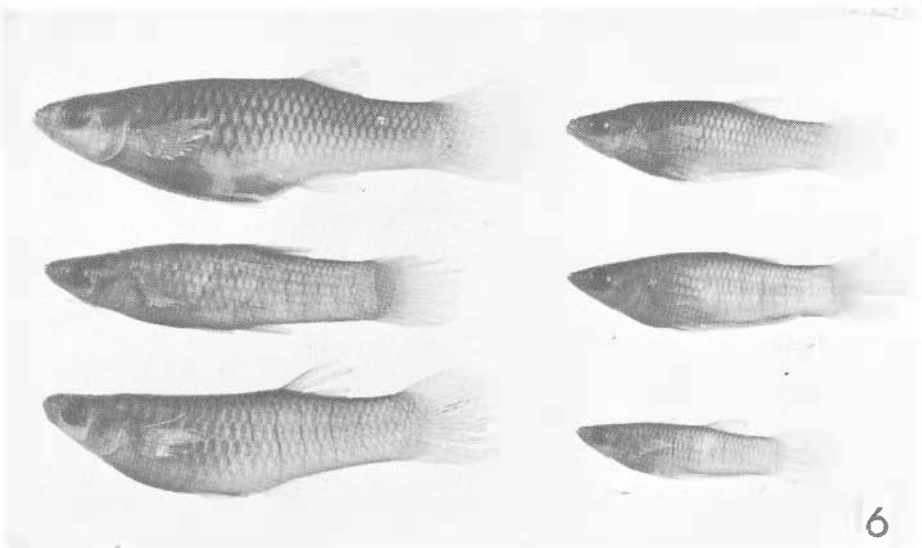
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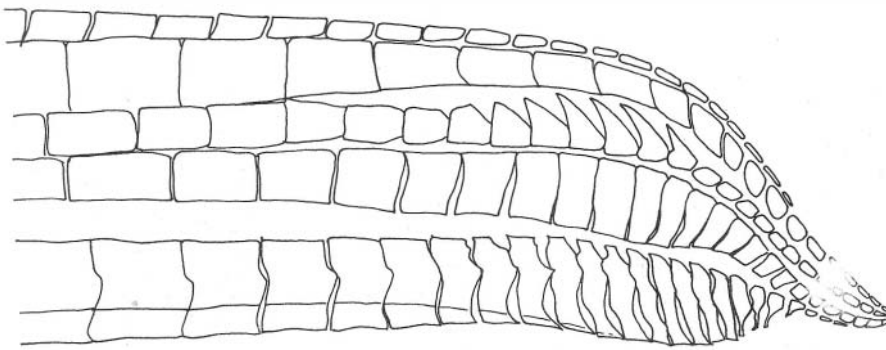
Fig. 7. Tip of gonopodium of a cleared and stained male *Brachyrhaphis holdridgei,* 22.2 mm SL, UCR 44-1 from Puerto Viejo, Costa Rica.

Fig. 8. Tip of gonopodium of the holotype of *Poeciliopsis paucimaculata,* 33.3 mm SL, LACM 9236-1 from San Isidro del General, Costa Rica.

Fig. 9. Specimens of *Cichlasoma alfari* from several localities of the Pacific slope of Costa Rica. Top: LACM 2727, Valle Central; middle left: LACM 4740, San Isidro del General; middle right: LACM 4838, Palmar Norte; bottom left: LACM 4864, Golfito; bottom right: LACM 4770, Villa Neily.

Fig. 10. Specimens of *Cichlasoma alfari* from several localities of the Atlantic slope of Costa Rica. Top: LACM 2909, Arenal; middle left: LACM 9234-1 Turrialba; middle right: LACM 2840, Madre de Dios; bottom left: LACM 9176-1 Puerto Viejo; bottom right LACM 2836, Aguas Zarcas.



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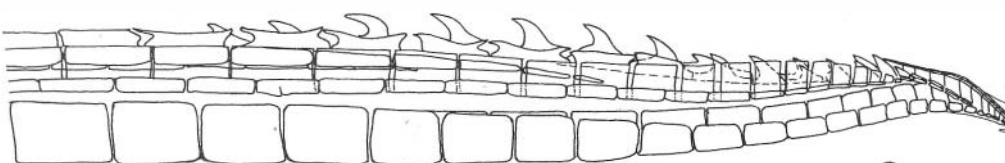

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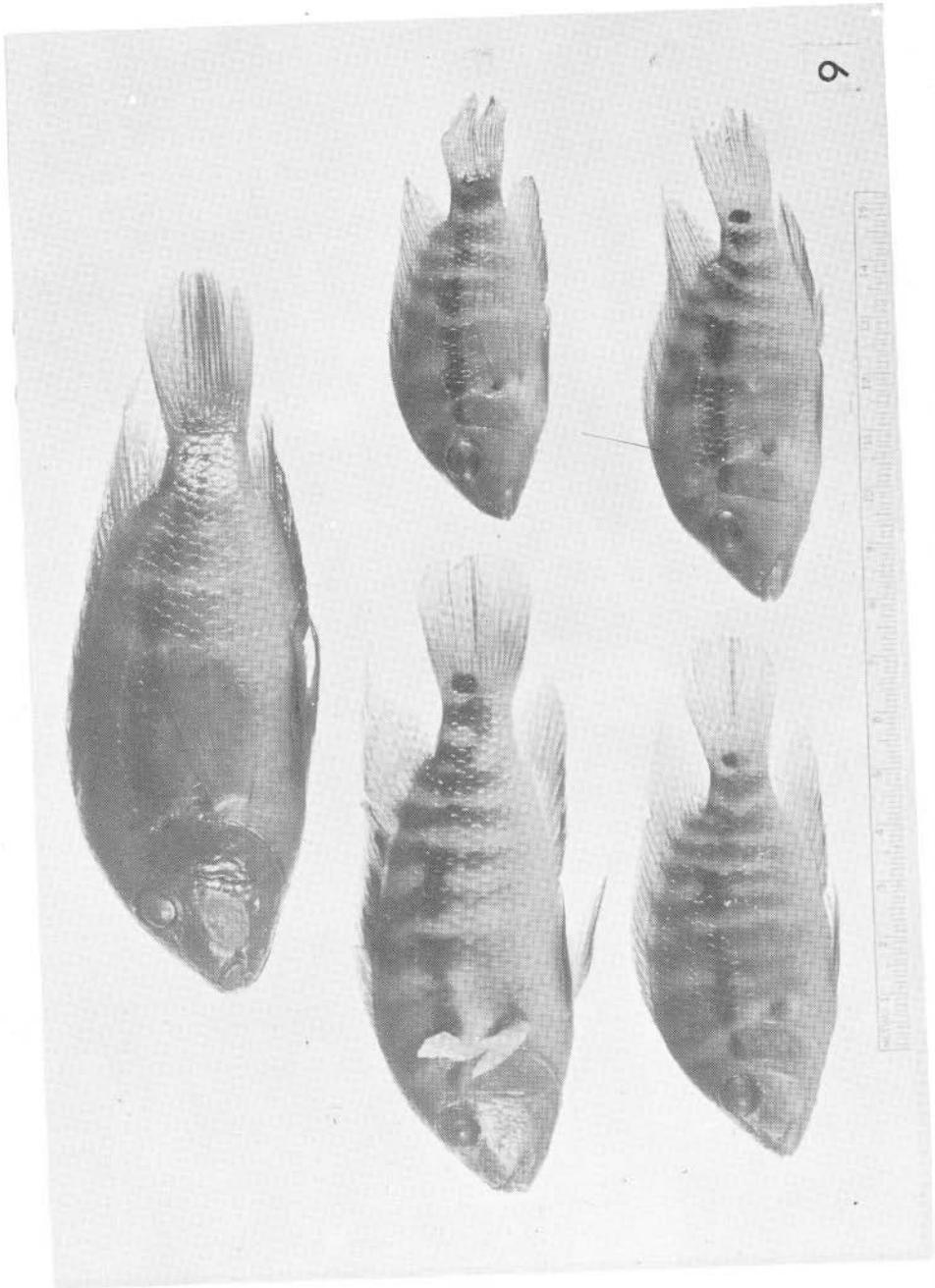
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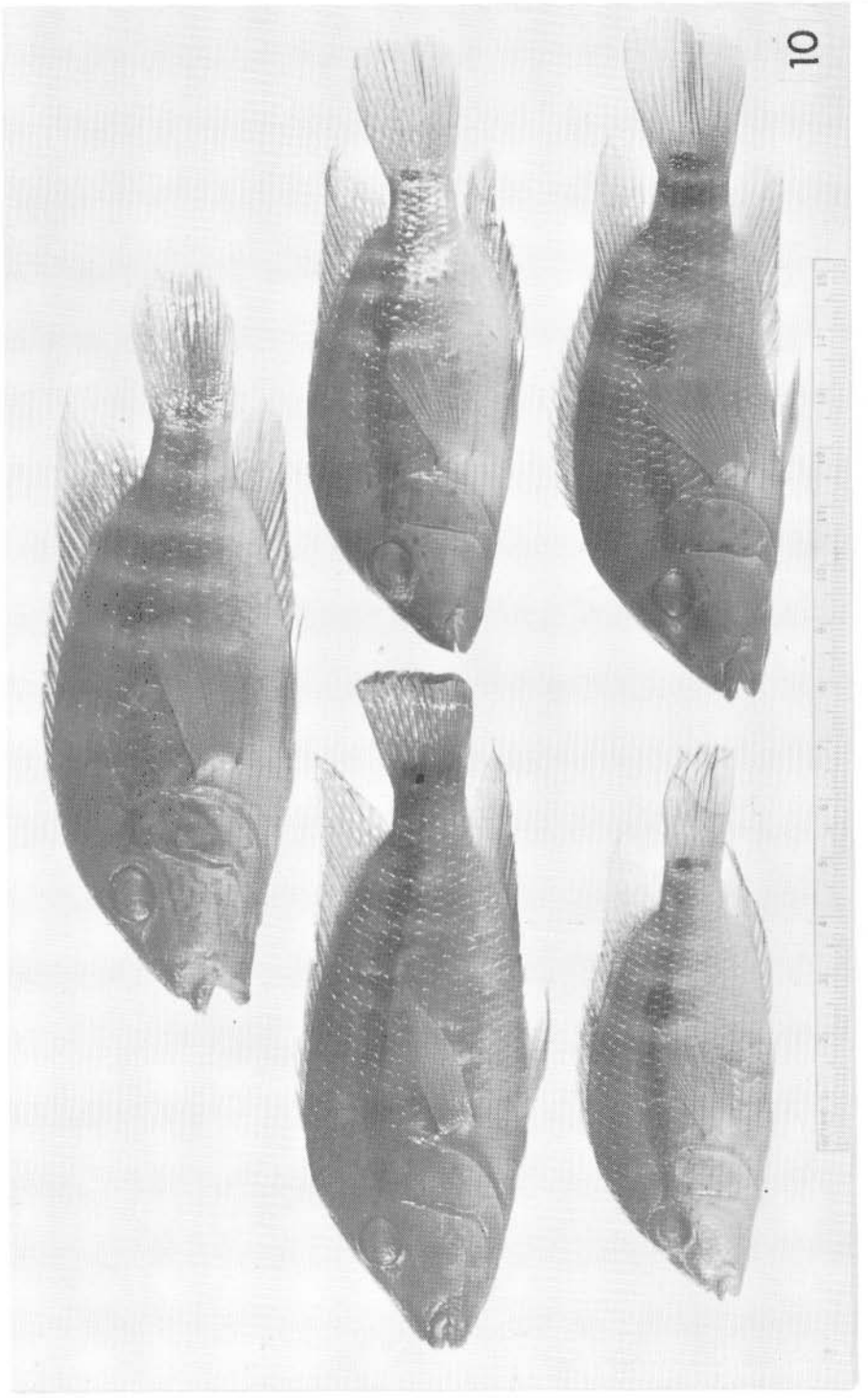
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