

AN ANNOTATED LIST OF FISHES KNOWN TO OCCUR IN THE FRESH-WATERS OF COSTA RICA.

BY SETH EUGENE MEEK.

The following paper is based on a collection of fishes made by myself during April, 1912, and on a number of small collections made from time to time by Dr. Anastasio Alfaro, Director of the National Museum of Costa Rica. In the list of localities under each species Dr. Alfaro's name follows those localities where specimens were collected by him.

The following is a list of localities arranged according to river basins. The figures give in meters the approximate altitude of each locality.

Rio Reventazon Basin, Atlantic;— La Junta (65); Chitaria (340); El Guayabo (360); Turrialba (621); Tucurrique (941); Juan Viñas (1000); Rio Iroquois (?); Quebrada de los Negros (?).

Rio San Juan Basin, Atlantic;— Costa Rica River, one half day's ride from Guapilis (100).

Rio Colorado Basin, Atlantic;— Guapilis (250); Virginia (350).

Rio Parismina Basin, Atlantic;— Parismina (240).

Rio Matina Basin, Atlantic;— Zent (20); Cuba River near Zent (20); La Victoria (50).

Rio Tárcoles Basin, Pacific;— El Sardinal, Santa Clara (60); Rio Turrubales (200); Orotina = Santo Domingo (250); Turrúcares (300); Rio Siquiaries (500); Irazú (1100+); Tiribi (1160); San José (1165); Rio María Aguilar (1165); Patarrá (1180); Tobosí (1200); San Isidro (1260); Pacaca (1500).

Rio Diquis Basin, Pacific;— Rio Grande de Térraba (367); Buenos Aires de Térraba (389); Boruca (563).

Rio Ballena Basin, Pacific;— Ballena (100); Rio Ballena (100).

Rio Tempisque, Pacific;— Las Cañas (50); Higuerón (50); Las Lajas, Taboga (50); Vol. Tenorio (?).

Rio Jesus María Basin, Pacific;— Jesus María at mouth of Rio Machuca (50); Orotina, Rio Machuca (250).

Rio Guacimal Basin, Pacific;— El Sardinal, Santa Clara (60).

Pacific;— Sumbres (?); Paso Agres (?); Brazo Seco (?); Punta Arenas (3); Tivives (10).

While collecting fishes in Costa Rica I was much aided in way of transportation by the United Fruit Company. I also received many courtesies from its agents at Limón, Zent, Victoria, and San José, also from Mr. Zeledon at Parismina.

Prof. Tristan of San José accompanied me to Orotina and the Rio Turribales; Dr. Alfaro assisted me in collecting near San José. He also arranged for me transportation to Orotino and return, besides giving me the services of his assistant, Mr. Jesus María Moran, while I was on the western slope of Costa Rica. Dr. Alfaro permitted me to examine all of the fresh-water fishes from Costa Rica which he had collected from time to time in the past.

The following is a list of localities where collections were made by me in Costa Rica in April, 1912:

La Junta, small stream near station	April 7
Guapilis, Rio Guapilis	" 8
Virginia, Rio Virginia	" 9
Parismina, Rio Parismina	" 10
Zent, Rio Zent and Rio Cuba	" 12
La Victoria, Rio Zent and tributaries	" 13
Zent, Rio Zent	" 15
San José, Rio María Aguilar	" 18
San José, Rio Torres	" 19
Orotina, Rio Machuca	" 20
" Rio Turrubales	" 21
" Rio Grande	" 22
Jesus María, Rio Jesus María and Rio Machuca	" 23
San José, Rio Tiribi	" 26

Costa Rica is a well watered country. The sides of the tall volcanoes are furrowed by many small streams which unite, forming near their bases large rivers. The Reventazon from its source to beyond La Junta is a raging torrent; the same is true of the Rio Tárcoles opposite on the Pacific side. The smaller streams visited by me on the north slope of Volcano Turrialba flowed with considerable current over rocky or gravelly bottoms. There were only occasional stretches where the bottom was smooth enough to permit successful seining. The Rio Zent had much less current with a gravelly and sandy bottom. In the foot hills above La Victoria there were cascades and rapids. The Rio Cuba flowed, where visited, through a marshy region in a deep channel. In all of these streams the water was clear.

On the Pacific slope the streams are much the same as those on the

Atlantic. It was impossible to use a seine in the main channel of the Rio Tárcoles and so our collecting was confined to small bayous and cutoffs along the main stream. The Rio Machuca is a swift stream with many rocks and occasionally level stretches. Rio Turrubales has a moderately swift current and a sandy and gravelly bottom. Much the same conditions exist in the Rio Jesus María, only the current is less swift.

Family **Siluridæ.**

Rhamdia rogersi (Regan).

Pimelodus rogersi Regan, Ann. & Mag. Nat. Hist., 1907, 259 (Irazú, Costa Rica).

Rhamdia regani Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 144 (Turrialba and Rio Tiribi, San José, Costa Rica).

Rhamdia brachycephala Meek (not Günther?), Pub. Field Mus., Zoöl. Ser., VII, 1907, 144 (Turrialba, Costa Rica).

Rhamdia rogersi Regan, Biol. Cent. Amer., 1907, pl. 23, fig. 1, 136.

This species is very abundant in the streams about San José, and appears rather common in the upland streams tributary to the Reventazon. It remains hidden under stones, and in other hiding places during dry weather. After a few rains in the latter part of April and in May they come out in large numbers in grassy places, where they are easily caught, and sold in the San José market. In the San José valley this is the only fish which grows large enough to be regarded as a food fish.

The species varies somewhat. Some of the larger ones are more slender than the others, and the occipital process may be long and narrow to rather robust. It is very probable that the species of *Rhamdia* in Central America have been unduly multiplied. This is due to the fact that they are subject to more variation than has been suspected and to the difficulty in securing sufficient material to study these variations. I have spent many hours in attempting to get these fishes from their hiding places in streams where I had reason to believe they were plentiful, with little or no results. I have never collected in the tropics in the rainy season when they are said to be abundant in shallow water. This species is very much like *Rhamdia brachycephala* Günther, and may prove to be identical with it.

Turrialba (17), 75 to 175 mm. (Alfaro); El Guayabo (8), 78 to 180 mm. (Alfaro); Chitaria (1), 135 mm. (Alfaro); Rio Tiribi (3), 114

to 140 mm. (Alfaro); San José (2), 91 and 108 mm. (Alfaro); Rio María Aguilar (8), 93 to 135 mm. (Alfaro); Rio Tiribi, San José (79), 45 to 160 mm. (Alfaro); Tiribi (19), 70 to 150 mm. (Alfaro); Patarrá (2), 80 to 130 mm.; San José, April 26 (79), 50 to 150 mm.

Rhamdia heteracantha Regan.

Rhamdia heteracantha Regan, Biol. Cent. Amer., 1907, 134 (Juan Viñas, Costa Rica).

Parismina (5), 125 to 205 mm.

Rhamdia underwoodi Regan.

Rhamdia underwoodi Regan, Biol. Cent. Amer., 1907, 135, pl. 23, fig. 4 (Juan Viñas, Costa Rica).

Costa Rica River (1), 155 mm.; Chitaria (1), 83 mm. (Alfaro); Tobosí (9), 68 to 105 mm. (Alfaro).

Rhamdia nasuta Meek.

Rhamdia nasuta Meek, Pub. Field Mus., Zool. Ser., VII, 1909, 207 (Buenos Aires de Térraba, Costa Rica).

Buenos Aires de Térraba (1), 125 mm.; Las Lajas, Taboga (17), 50 to 125 mm. (Alfaro).

Rhamdia wagneri (Günther).

Pimelodus wagneri Günther, Fishes Cent. Amer., 1869, 474 (Pacific and Atlantic Rivers of Panama).

Rhamdia wagneri Regan, Ann. & Mag. Nat. Hist., 1908, 457 (Rio Ballena).

This species was not obtained by me.

Arius evermanni Gilbert and Starks.

Arius evermanni Gilbert and Starks, Mem. Cal. Ac. Sci., 1904, 32, pl. 5, fig. 10 (Panama Bay);—Regan, Ann. & Mag. Nat. Hist., 1908, 457 (Rio Ballena).

This species more properly belongs to the salt-water fauna. Individuals of this and related species, however, often ascend streams to some distance, but probably not beyond the limits of tide water.

Family **Cyprinidæ**.**Carassius auratus** (Linnæus).

Introduced species, which has escaped from aquaria.

Pacific side (1), 124 mm.; San José (in captivity) (1), 112 mm.

Family **Characidæ**.**Astyanax æneus costaricensis** var. nov.

Astyanax ærstedii Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 145 (Turrialba).

Tetragonopterus æneus Regan, Ann. & Mag. Nat. Hist., 1908, 455, part (Rio Iroquois, Costa Rica).

Astyanax æneus (Günther) is very variable and when studied in more detail will, no doubt, be found to comprise a number of fairly well marked varieties. Specimens examined by me from both sides of Guatemala appear to be the same, *Astyanax a. microphthalmus* (Günther). In these the inner premaxillary teeth are 5-5, though occasionally these are 4-5. The maxillary teeth are 2-2, but these are sometimes 1-2 or 2-3. The anal rays range from 26 to 30. In form those from any one locality vary greatly, some being slender, others comparatively deep. Specimens from Lake Managua, Nicaragua, resemble those from Guatemala, except that the snout averages a little shorter and slightly blunter, the inner row of premaxillary teeth is 5-5, except occasionally 4-5. There are also a few more teeth on the maxillary; these are usually 2-3, but are occasionally 3-3 or 3-4. The anal rays average a little less, ranging from 25 to 29. This form is the *Astyanax ærstedii* (Kroyer) and the *Astyanax nicaraguensis* Eigenmann and Ogle.

In Costa Rica there are two well-marked varieties or species. Those from the Atlantic slope resemble the preceding forms, in that the inner premaxillary teeth are 5-5 (occasionally 4-4 or 4-5). The maxillary teeth are 2-2; these occasionally vary from 0 to 3; the anal rays vary from 28 to 31 (*Astyanax a. costaricensis* Meek).

Specimens from the west side of Costa Rica have the inner maxillary teeth 4-4, occasionally 4-5; the anal rays vary from 26 to 31. The form from the west side of Costa Rica differs rather more from the other forms than they do from each other (*Astyanax albeolus* Eigenmann).

The following table gives the counts of anal rays of a number of specimens:

Number of anal rays	25	26	27	28	29	30	31
<i>Astyanax æneus microphthalmus</i> (Günther)							
El Rancho, Guatemala (Atlantic)		1*	5	9	7	4	
San José del Idolo, Guatemala (Pacific)		1	7	7	9	4	
Lake Amatitlan, Guatemala (Pacific)		3	10	9	3		
<i>Astyanax æneus ærstedii</i> (Kroyer)							
Lake Managua, Nicaragua (Atlantic)	3	7	8	6	2		
<i>Astyanax albeolus</i> Eigenmann							
Jesus María, Costa Rica (Pacific)		2	6	10	6	2	1
Orotina, April 20, Costa Rica (Pacific)			4	9	10	4	
Turribales, Costa Rica (Pacific)		3	4	14	12	9	2
<i>Astyanax æneus costaricensis</i> Meek							
Guapilis, Costa Rica (Atlantic)					3	1	2
Parismina, Costa Rica (Atlantic)				1	7	8	4
Zent, April 15				9	11	4	2

* The figures in the columns give the number of specimens counted.

La Junta (39), 45 to 80 mm.; Guapilis (5), 75 to 125 mm.; Parismina (22), 80 to 125 mm.; Costa Rica River (2), 65 to 112 mm.; Cuba River (5), 82 to 105 mm.; Zent, April 12 (48), 55 to 100 mm.; Zent, April 15 (62), 56 to 120 mm.; La Victoria (22), 70 to 120 mm.; Chitaria (2), 85 to 95 mm. (Alfaro).

Astyanax albeolus Eigenmann.

Astyanax ærstedii Meek (not Kroyer), Pub. Field Mus., Zoöl. Ser., VII, 1907, 145, part (Rio Siquiaries* & Rio Machuca, Costa Rica).

Astyanax albeolus Eigenmann, Bull. Mus. Comp. Zoöl., 1908, 97 (Rio Machuca and Rio Siquiaries,* Costa Rica).

Astyanax æneus Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 145 (Rio Siquiaries* and Pacific Side, Costa Rica).

Tetragonopterus æneus Regan (not Günther), Ann. & Mag. Nat. Hist., 1908, 456, part (Rio Grande de Térraba, Costa Rica).

Turribales (52), 45 to 115 mm.; Jesus María (48), 75 to 110 mm.; Orotina, April 20 (70), 50 to 145 mm.; Orotina, April 22 (160), 35 to 120 mm.; Rio Machuca (2), 115 and 118 mm. (Alfaro); Siquiaries (1), 86 mm. (Alfaro); Pacific Side (1), 83 mm. (Alfaro); Sumbres (10),

* Misspelled Siquiaries.

85 to 130 mm. (Alfaro); Paso Agres (1), 100 mm. (Alfaro); Turrubales (5), 75 to 115 mm. (Alfaro); Rio Higuieron (48), 45 to 103 mm. (Alfaro); Las Cañas, Taboga (50), 30 to 40 mm. (Alfaro).

Astyanax regani Meek.

Astyanax regani Meek, Pub. Field Mus., Zoöl. Ser., VII, 1908, 207
(Las Cañas, Costa Rica, Pacific Slope).

This species is nearest to *A. albeolus*. It differs in being more slender and more robust anteriorly. The snout is blunter and more decurved, the fins slightly shorter. In this species the anterior dorsal rays are shorter than the head, in *A. albeolus* they are as long as, or even longer than, the head. *A. regani* also has a shorter anal base.

Las Cañas, Costa Rica (type), 135 mm. (Alfaro); Pacific Side, Costa Rica (1), 100 mm. (Alfaro); Turrúcares (3), 95 to 110 mm. (Alfaro).

Bryconamericus scleroparius (Regan).

Tetragonopterus scleroparius Regan, Ann. & Mag. Nat. Hist., 1908, 455 (Rio Iroquois).

Bryconamericus peruanus ricæ Eigenmann, Bull. Mus. Comp. Zoöl., 1908, 106 (Chitaria, Costa Rica).

Astyanax robustus Meek, Pub. Field Mus., Zoöl. Ser., X, 1912, 69 (Virginia River, Costa Rica).

This species varies considerably. The young, usually the smaller specimens up to 70 mm., have a higher and more pointed dorsal, the free edge of the fin being straight or slightly convex. The caudal lobes are pointed, and the color silvery (*B. scleroparius* (Regan) and *B. p. ricæ* Eigenmann). The larger specimens (140 mm.) have a much more robust body, the caudal peduncle being very broad; the dorsal fin is shorter, and the free edge convex. The caudal lobes are very short and rounded. The color of the large specimens is very dark, with a reddish tinge in life (*Astyanax robustus* Meek). The faint humeral spot on the young apparently disappears with age. Caudal spot scarcely defined in the large specimens, but present in the smaller ones, extending on the rays to the end of the caudal fin. Inner premaxillary teeth 4-4, the outer 5-5.

La Junta (5), 76 to 100 mm.; Virginia (50), 75 to 143 mm.; Parismina (30), 80 to 130 mm.; Zent, April 12 (8), 85 to 115 mm.; La Victoria (6) 95 to 120 mm.; Guapilis (27), 85 to 122 mm.; Chitaria (3), 82 to 95 mm. (Alfaro).

Bryconamericus terrabensis sp. nov.

Tetragonopterus emperador Regan (not Eigenmann & Ogle), Ann. & Mag. Nat. Hist., 1908, 456 (Rio Grande de Térraba, Costa Rica).

I did not obtain any specimens of this species. It differs from the eastern form chiefly in the smaller scales.

Carlia gen. nov.

Type *Cheirodon eigenmanni* Meek.

Body elongate, compressed; top of head convex; fontanelle large; mouth rather large, the maxillary not reaching posterior margin of the eye; entire edge of maxillary toothed, 2-2 anterior ones denticulate the remaining 6-6 canine, about equally spaced; premaxillary teeth 5-5, denticulate, in one series; teeth of lower jaw denticulate, in one series of 6-6, the last one on each side slightly longer than the others, these followed by 2-2 canine teeth; dorsal fin pointed, high.

I placed the type of this genus provisionally in the genus *Cheirodon* because of the similarity of its anterior teeth to those of that genus. I am indebted to Dr. Eigenmann for suggesting to me that it should be the type of a new genus, being close to *Rhoadsia* Fowler, and to whom I dedicate the genus.

Carlia eigenmanni (Meek).

Cheirodon eigenmanni Meek, Pub. Field Mus., Zool. Ser., x, 1912, 70 (La Junta, Costa Rica).

La Junta, Costa Rica (6), 60 to 65 mm.

Six specimens only of this interesting species were taken at La Junta.

Brycon guatemalensis Regan.

Brycon guatemalensis Regan, Biol. Cent. Amer., 1908, 168 (Rio Chisoy, Rio Usumacinta, Rio Motagua, and Lake Izabal, in Guatemala).

The dark edges of some of the scales forming irregular dark vertical streaks are very prominent on all Costa Rica specimens obtained by me.

This species is quite abundant in the deeper portions of the large streams. The larger specimens are very difficult to capture without the use of dynamite.

Costa Rica River (15), 175 to 365 mm.; La Victoria (8), 105 to 225

mm.; Zent, April 12 (20), 85 to 140 mm.; Zent, April 15 (4), 75 to 135 mm.; Parismina (22), 40 to 235 mm.

Brycon striatulus Kner.

Chalcinopsis striatulus Kner, Sitzgsb. Bayer. Ak., 1863, 226 (Rio Chagres, Panama).

Brycon striatulus Regan, Biol. Cent. Amer., 1908, 169 (Juan Viñas and El Pozo del Rio Grande, Costa Rica).

I did not obtain any specimens of this species in Costa Rica. This species differs from the preceding in having 70 to 75 scales in the lateral series instead of 52 to 56, the number for the preceding species. In general appearance the two species are alike; neither of the two species of *Brycon* listed here have yet been taken on the Pacific side of Costa Rica.

Ræboides guatemalensis (Günther).

Anacyrtus (*Ræboides*) *guatemalensis* Günther, Cat., v, 1864, 347 (Huamuchal, Guatemala; Rio Chagres, Panama).

Ræboides guatemalensis Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 145 (Santo Domingo, Costa Rica);— Regan, Biol. Cent. Amer., 1908, 174 (Juan Viñas, El Pozo del Rio Grande, Costa Rica).

This species, though widely distributed in Central America, is not very abundant in Costa Rica.

Parismina (1), 94 mm.; La Junta (2), 75 and 90 mm.; Zent, April 12 (12), 73–87 mm.; Zent, April 15 (6), 58–92 mm.; Guapilis (1), 63 mm.; Santo Domingo (1), 90 mm. (Alfaro); Higuerón (18), 50 to 86 mm. (Alfaro); Machuca (1), 107 mm. (Alfaro).

Family **Pœciliidæ**.

Haplochilus dovii Günther. White Eye.

Haplochilus dovii Günther, Cat., vi, 1866, 316;— Günther, Trans. Zoöl. Soc., 1868, 481, pl. 82, fig. 5 (Punta Arenas, Costa Rica).

Fundulus dovii Regan, Biol. Cent. Amer., 1907, 80 (Punta Arenas, Costa Rica).

Dr. Alfaro informs me that this fish is known as White Eye, and is used for bait by fishermen in and near Punta Arenas.

Tivives (1) 155 mm. (Alfaro); Rio Higuerón (4), 140 to 180 mm. (Alfaro). Brazo Seco (8), 125 to 145 mm. (Alfaro).

Rivulus isthmensis Garman.

Rivulus isthmensis Garman, Mem. Mus. Comp. Zoöl., 1895, 140 (Rio San José, Costa Rica);—Regan, Biol. Cent. Amer., 1907, 82;—Regan, Ann. & Mag. Nat. Hist., 1912, 503.

Rivulus flabellicauda Regan, Ann. & Mag. Nat. Hist., 1907, 64 (Juan Viñas, Costa Rica);—Regan, Biol. Cent. Amer. 1907, 81, pl. 4, fig. 6 (Juan Viñas and San José, Costa Rica);—Regan, Ann. & Mag. Nat. Hist., 1912, 500 (Costa Rica).

The fact that I had collected so many specimens of this species near San José, and found none to agree with the description of *Rivulus isthmensis*, led me to suspect that but one species was found there. I sent a few specimens to Mr. Garman and asked him to compare them with his types of *R. isthmensis*. This he kindly did and informed me that they were the same. He states in his letter to me that "32 (the scale count for the lateral line) is in all likelihood an error for 42."

San José, April 26 (20), 50 to 70 mm.; San José, April 19 (3), 51 to 60 mm.; Tucurrique (1), 62 mm. (Alfaro); San José (2), 75 mm. (Alfaro); Tobosí (16), 48 to 60 mm. (Alfaro); El Guayabo (3), 54 to 63 mm. (Alfaro).

The following species of *Pæciliidæ* belong to the subfamily *Pæciliinæ*, which comprises those species in which the anterior rays of the anal fin are considerably elongated and modified into an intromittent organ. Mr. Regan of the British Museum has recently published (Ann. & Mag. Nat. Hist., 1913, 977-1118) a revision of this family, basing his classification chiefly on the modified anal fin of the male. Although my manuscript was practically ready for publication when I received Mr. Regan's paper, I have changed it so far as it relates to the species here listed of this subfamily to conform to his classification. The males of many of the species of *Pæciliinæ* are so small, and so few in collections, that the study of the group is even more difficult than with the old classification. It is generally considered that the males of *Gambusia* and related genera are less numerous than the females, because they are taken in comparatively few numbers by collectors. This is, however, practically accounted for because of their small size, which enables them to pass easily through the mesh of the average collecting net which would easily retain the female.

I give here a key to the genera of this subfamily treated of in this paper, which is taken from the one published by Mr. Regan:

a. Lower edge of caudal peduncle sharp, without a median series of

scales; bones of the lower jaw firmly united; teeth conical or villiform. *Alfaro.*

- aa. Lower edge of caudal peduncle rounded, or obtuse, with a median series of scales.
- b. Ventral fins similar in both sexes; first produced ray of anal fin of male without long processes or appendages.
- c. Anal fin of male short, ending in a small retrorse hook formed by second and third produced rays; teeth conical or villiform, not movable. *Brachyrhaphus.*
- cc. Anal fin of male ending in a more or less distinct antrorse hook; the anterior branch of the second produced ray curved forward.
- d. Mouth moderate, with distinct lateral cleft; teeth conical or villiform, not movable.
- e. Dorsal rays 7 to 12; origin of dorsal behind that of anal; extremity of anal fin of male supported equally by third and anterior branch of second produced rays. *Priapichthys.*
- ee. Dorsal rays 11 to 17; origin of dorsal in advance of that of anal; extremity of male anal fin a strong hook and formed by the unsegmented end of the anterior branch of the second ray. *Pseudoxiphophorus.*
- dd. Mouth small, transverse; teeth oar-shaped, movable; extremity of anal fin of male supported equally by first and anterior branch of second produced rays; first ray not serrated. *Paciliopsis.*
- bb. Ventral fins enlarged in the males, the second ray longest; first prolonged anal ray bearing a small antrorse spine at or near its end; last bearing a pair of processes directed outwards and towards the base of the fin. *Mollienisia.*

The following is a key to the species *Paciliinae* listed here and is based mostly on characters of the females:

- a. Dentary bones firmly united; teeth not movable; alimentary canal shorter than the body.
- b. Lower edge of caudal peduncle sharp, without a median series of scales. *Alfaro cultratum.*
- bb. Lower edge of caudal peduncle rounded or obtuse, with a median row of scales.
- c. Origin of dorsal well behind that of anal.
- d. No caudal spot; middle half of sides with 5 to 8 narrow vertical lines; D. 7. A. 9 or 10. *Priapichthys turrubarensis.*
- dd. A prominent caudal spot; no dark bars on sides; D. 7 or 8; A. 8 or 9. *Priapichthys parismina.*

- cc. Origin of dorsal slightly behind to well in advance of anal.
- e. Origin of anal under or slightly in advance of dorsal; origin of dorsal fin nearer tip of caudal than snout.
- f. Anal with a black blotch at base of anterior 5 rays to tip of third ray; dorsal rays 9 or 10. *Priapichthys olomina.*
- ff. Anal without dark blotch at base of anterior rays; dorsal rays 10 to 12. *Priapichthys annectens.*
- ee. Origin of anal below middle of dorsal; dorsal rays 11 or 12; an interrupted dark lateral stripe. *Pseudoxiphophorus terrabensis*
- eee. Origin of anal below anterior fourth of dorsal; origin of dorsal nearer tip of snout than end of caudal.
- g. A series of short, dark, vertical bars along the middle of the side; dorsal with 2 or 3 series of dark spots. *Brachyrhaphis rhabdophora.*
- gg. A few faint, narrow, dark bars on posterior half of body; basal third of dorsal black. *Brachyrhaphis umbratilis.*
- aa. Dentary bones not firmly united, teeth movable; alimentary canal longer than the body.
- h. Origin of the dorsal fin nearer tip of caudal than end of snout.
- i. Origin of dorsal behind that of anal, nearer tip of caudal than end of snout, midway between anterior margin of eye and tip of caudal fin; origin of anal in advance of dorsal; anal rays 10. *Pacilopsis retropinna.*
- ii. Origin of dorsal over or before that of anal.
- j. Origin of dorsal midway between base of caudal and anterior margin of the eye; modified anal of the male twice the length of head. *Pacilopsis pittieri.*
- jj. Origin of dorsal midway between base of caudal and middle of opercle; scales with darker centers; modified anal of male short, its length less than that of head.
- k. Base of dorsal rays without definite black spot; dorsal rays 9 to 11, the free edge convex. *Mollienisia sphenops.*
- kk. A black spot at base of dorsal rays; dorsal rays 8 or 9; free edge of dorsal straight or slightly convex. *Mollienisia s. tropica.*
- hh. Origin of dorsal midway between end of snout and posterior edge of caudal fin, behind that of anal; anal rays 8. *Mollienisia elongata.*

Alfaro Meek.

Petalosa Regan, Ann. & Mag. Nat. Hist., 1908, 458 (type *Petalosa cultratum* Regan).

Alfaro Meek, Pub. Field Mus., Zoöl. Ser., x, (September) 1912, 72
(type *Alfaro acutiventralis* Meek).

Petalurichthys Regan, Ann. & Mag. Nat. Hist., (November) 1912,
494 (substitute for *Petalosa* preoccupied in *Coleoptera*).

This paper by Regan, in which he first established the genus *Petalosa*, was overlooked by me in preparing an account of the new species collected by myself in Costa Rica in 1912, which resulted in my proposing the name *Alfaro* for this peculiar and interesting form. This name, however, preceded the substitute proposed by Mr. Regan after he discovered that *Petalosa* was preoccupied in *Coleoptera*.

Alfaro cultratum (Regan).

Petalosa cultratum Regan, Ann. & Mag. Nat. Hist., 1908, 458 (Rio Iroquois, Costa Rica).

Alfaro acutiventralis Meek, Pub. Field Mus., Zoöl. Ser., x, 1912, 72 (Guapilis, Costa Rica).

Petalurichthys cultratum Regan, Ann. & Mag. Nat. Hist., 1912, 494 (name only).

Alfaro cultratum Regan, Ann. & Mag. Nat. Hist., 1913, 981 (Costa Rica).

Taken only among the rocks in clear rocky streams. One other species of this genus is known from Brazil.

Guapilis (38), 30 to 80 mm.; Parismina (36), 45 to 80 mm.; La Junta (9), 35 to 70 mm.; Virginia (15), 45 to 80 mm.

Priapichthys turrubarensis (Meek).

Gambusia turrubarensis Meek, Pub. Field Mus., Zoöl. Ser., x, 1912, 71 (Turrubales, Costa Rica).

Priapichthys turrubarensis Regan, Ann. & Mag. Nat. Hist., 1913, 992.

Very abundant.

Orotina, April 22 (65), 25 to 65 mm.; Turrubales (89), 30 to 70 mm.; Jesus María (37), 30 to 70 mm.; Rio Higuerón (48), 45 to 60 mm. (Alfaro).

Priapichthys parismina (Meek).

Gambusia parismina Meek, Pub. Field Mus., Zoöl. Ser., x, 1912, 71 (Parismina).

Priapichthys parismina Regan, Ann. & Mag. Nat. Hist., 1913, 992.

This species is easily distinguished from the other Costa Rica

Priapichthys by the large black caudal spot.

Parismina (28), 37 to 55 mm.

***Priapichthys olomina* sp. nov.**

Gambusia terrabensis Meek (not Regan), Pub. Field Mus., Zoöl. Ser., VII, 1907, 146 (Las Cañas, Alajuela, Costa Rica).

Type No. 7827, F. M. N. H.; length 50 mm.; Orotina, Costa Rica. Head 3.7 to 4.0; depth 3.2 to 3.3; D. 9 or 10; A. 8 or 9; scales 28.

Body robust; top of head flat; snout equal to or shorter than eye, its length 3.3 to 3.7 in head; diameter of eye 3.0 to 3.6; interorbital 1.7 to 1.8; pectoral not reaching ventrals, 1.3 in head; depth of caudal peduncle 1.5 in head; anal fin of male reaching $\frac{2}{3}$ distance to caudal fin, its length 4 in body.

Greenish olive, edges of scales black; side with a row of small quadrate spots which disappear in some large examples; posterior $\frac{2}{3}$ of body with narrow vertical bars, interradiial membranes of dorsal black; anal with a black blotch at base of anterior 5 rays extending to tip of third ray; caudal sometimes with a black bar near its tip.

This species is very abundant in the valley of the Rio Grande de Tárcoles.

Orotina, April 20 (135), 25 to 50 mm.; Turrubales (3), 40 to 50 mm.; Pacaca (3), 26 to 48 mm. (Alfaro); Pacific Side (16), 20 to 60 mm. (Alfaro).

***Priapichthys annectens* (Regan).**

Gambusia annectens Regan, Ann. & Mag. Nat. Hist., 1907, 259 (Carillo, Juan Viñas and Irazú, Costa Rica);—Regan, Biol. Cent. Amer., 1907, 97, pl. xiv, figs. 5 and 6 (Carillo, Juan Viñas and Irazú, Costa Rica);—Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 145 (Turrialba; San José; Quebrada de los Negros; San Isidro; Pacific Side).

Priapichthys annectens Regan, Ann. & Mag. Nat. Hist., 1913, 992 (Costa Rica).

This species is more abundant in the streams about San José than any of the species of fishes found there.

Rio María Aguilar (16), 32 to 60 mm. (Alfaro); San José (27), 26 to 49 mm. (Alfaro); Quebrada de los Negros (24), 35 to 62 mm. (Alfaro); San Isidro (2), 43 mm. (Alfaro); Tucurrique (5), 38 to 60 mm. (Alfaro); Tobosí (2), 30 mm. (Alfaro); San José, April 26 (180), 30 to 70 mm.;

San José, April 19 (100), 28 to 70 mm.; San José, April 18 (150), 30 to 65 mm.; Parismina (24), 35 to 75 mm.; Guapilis (6), 35 to 45 mm.

Pseudoxiphophorus terrabensis (Regan).

Gambusia terrabensis Regan, Ann. & Mag. Nat. Hist., 1907, 260 (Rio Grande de Térraba);— Regan, Biol. Cent. Amer., 1907, 97, pl. XII, fig. 7 (Rio Grande de Térraba, Costa Rica).

Pseudoxiphophorus terrabensis Regan, Ann. & Mag. Nat. Hist., 1913, 993 (Rio Grande de Térraba, Costa Rica).

I did not obtain any specimens of this species.

Brachyrhaphis rhabdophora (Regan).

Gambusia rhabdophora Regan, Ann. & Mag. Nat. Hist., 1908, 457 (Volcano of Tenorio, and Rio Grande de Térraba, Costa Rica).

Brachyrhaphis rhabdophora Regan, Ann. & Mag. Nat. Hist., 1913, 997 (Costa Rica).

None of this species was taken by me.

Brachyrhaphis umbratilis (Meek).

Gambusia umbratilis Meek, Pub. Field Mus., Zoöl. Ser., 1912, 70 (Guapilis, Costa Rica).

Virginia (22), 30 to 52 mm.; Guapilis (60), 38 to 49 mm.

Pæciliopsis retropinna (Regan).

Pæcilia retropinna Regan, Ann. & Mag. Nat. Hist., 1908, 458 (Boruca, Costa Rica).

Pæciliopsis retropinna Regan, Ann. & Mag. Nat. Hist., 1913, 997 (Costa Rica).

No specimens were secured by me.

Pæciliopsis pittieri (Meek).

*Pæcilia pittieri** Meek, Pub. Field Mus., Zoöl. Ser., x, 1910, 71 (La Junta, Costa Rica).

Pæciliopsis pittieri Regan, Ann. & Mag. Nat. Hist., 1914, 997.

This species was taken in swift rocky streams on the Atlantic side. It is not so abundant as the preceding. The long, modified anal of the

*This species was named for Dr. Henry Pittier, who has done very much to advance our knowledge of the natural history of Costa Rica.

male easily distinguishes this species from the *Mollienisia s. tropica* found in the same region. The specimens collected by me are as follows:

La Junta (14), 38 to 70 mm.; Parismina (11), 58 to 70 mm.; Guapilis (18), 27 to 63 mm.; Virginia (4), 35 to 55 mm.

Mollienisia sphenops (Cuvier & Valenciennes).

Pacilia sphenops Cuvier & Valenciennes, Hist. Nat. Poiss., XVIII, 1846, 130, pl. 526 (Vera Cruz, Mexico);—Regan, Biol. Cent. Amer., 1907, 102, pl. XIII, figs. 3-7, part.

Mollienisia sphenops Regan, Ann. & Mag. Nat. Hist., 1913, 1012 (part).

This species is widely distributed and varies greatly. The original types were taken at Vera Cruz, Mexico, probably in the salt-water pools there where it is very abundant, and where it grows comparatively large. I did not do any collecting in salt water in Costa Rica, and so did not obtain any specimens, but presume those occurring there are the same as those taken at Vera Cruz, Mexico.

Mollienisia sphenops tropica (Meek).

Platypacilia tropicus Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 146 (Turrialba, Costa Rica).

Pacilia tenuis Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 147 (Rio María Aguilar, Costa Rica).

Pacilia tropica Regan, Biol. Cent. Amer., 1908, 191; Regan, Ann. & Mag. Nat. Hist., 1908, 459 (Rio Iroquois).

Pacilia sphenops Regan, Biol. Cent. Amer., 1907, 102, part (San José, Costa Rica);—Regan, Ann. & Mag. Nat. Hist., 1908, 458 (Volcano of Tenorio).

Pacilia spilonota Regan, Ann. & Mag. Nat. Hist., 1908, 460 (San José, Costa Rica).

Pacilia caucana Regan (not Steindachner), Biol. Cent. Amer., 1908, 190, pl. 13, fig. 2 (San José and Rio María Aguilar, Costa Rica).

Pacilia caudata Meek, Pub. Field Mus., Zoöl. Ser., VII, 1909, 209 (Turrubales, Costa Rica).

Mollienisia sphenops Regan, Ann. & Mag. Nat. Hist., 1913, 1012 (part).

The inland or fresh-water forms of this species or variety found in Costa Rica are very variable, and as a result several species have from time to time been described. The upland forms in general are smaller

than those found in the larger streams in or near the lowlands. Without the opportunity of examining material from the salt or brackish water of Costa Rica, and after comparing the material at my command with specimens from the salt water at Vera Cruz, Mexico, it seems best to recognize these inland forms as a variety or subspecies of the preceding.

The females and many of the males of these inland forms usually have a black spot at the base of the middle dorsal rays, the free margin of the dorsal is straight or slightly convex, and the caudal fin is subtruncate, and in these respects this subspecies presents a few trifling differences from the species. On many specimens from salt and brackish water some of the scales have a dark spot which forms lines along the rows of scales. These spots are not present on the specimens from the uplands and are scarcely present on some from the larger lowland streams. In both the species and subspecies some of the larger males have a very high dorsal fin. On many of the males, especially from the larger streams, the basal half of the caudal is black, or with black blotches; on some of these the basal half of the dorsal is also black. In general, the upland specimens are more uniform in coloration than those from the lowland streams.

Patarrá (17), 52 to 80 mm. (Alfaro); Rio María Aguilar, San José (8), 48 to 80 mm.; Rio Tiribi, San José (275), 30 to 70 mm.; Rio Grande, Orotina, April 22 (29), 28 to 80 mm.; Rio Machuca, Orotina (20), 30 to 60 mm.; Turrubales (75), 30 to 90 mm.; Jesus María (2), 43 mm.; Virginia (5), 45 to 72 mm.; Zent, April 12 (20), 37 to 92 mm.; La Victoria (24), 28 to 105 mm.; La Junta (24), 60 to 110 mm.; Parismina (11), 43 to 90 mm.; Guapilis (35), 44 to 95 mm.; Turrubales (3), 64 to 78 mm. (Alfaro); Rio María Aguilar, San José (20), 30 to 60 mm. (Alfaro); Chitaria (1), 53 mm. (Alfaro); Turrialba (1), 50 mm. (Alfaro); Tucurrique (4), 65 to 120 mm. (Alfaro); Tiribi (2), 64 to 70 mm. (Alfaro); Las Lajas, Taboga (12), 35 to 45 mm. (Alfaro); Rio Higuieron (30), 37 to 83 mm. (Alfaro).

Family Mugilidæ.

Joturus pichardi Poey. Bobo.

Joturus pichardi Poey, Mem., II, 263, 1861 (Cuba);— Jordan & Evermann, Bull. 47, U. S. Nat. Mus., 1896, 821 (Costa Rica);— Meek, Pub. Field Mus., Zool. Ser., VII, 1907, 148 (Reventazon River; El Sardinal, Santa Clara, Costa Rica).

Xenorhynchichthys stipes Regan, Ann. & Mag. Nat. Hist., 1908, 461
(Rio Iroquois).

The young of this species has two oblique black bands on each lobe of the caudal and two similar ones on the soft dorsal and anal fins. Large examples, 270 mm. and up, are darker in color, the fins being the color of the body except lighter on distal portion. These larger examples have a prominent tubercle on the upper edge of the snout, which is probably used to turn stones to obtain crustaceans and insects upon which they feed. These fishes are abundant in the rocky streams of Costa Rica, and especially so at the foot of rapids and waterfalls. They are difficult to capture except with the use of dynamite. The white employees of the United Fruit Company regard this species as the best food fish found in the Costa Rica rivers. It is reported to reach a length of 3 feet, but the largest obtained by us at La Victoria were about 2 feet in length. These largest specimens I did not preserve. The specimens, large and small, examined by me have teeth on the vomer, palatines and pterygoids. Mr. Hildebrand kindly examined the type of *Joturus stipes* Jordan and finds teeth also on the palatines. This species varies greatly especially with age. It is generally known throughout Central America as Bobo.

Victoria (5), 55 to 320 mm.; Virginia (1), 110 mm.; Zent, April 12 (14), 90 to 150 mm.; Zent, April (5), 78 to 120 mm.; Rio Reventazon (1), 300 mm. (Alfaro); El Sardinal, Santa Clara (1), 270 mm. (Alfaro).

Agonostomus monticola (Bancroft).

Mugil monticola Bancroft, in Griffith's Ed. Cuvier's Animal Kingdom, 1836, 367, pl. 36 (West Indies).

Agonostomus masutus Regan, Biol. Cent. Amer., 1906, 68, pl. x, fig. 4 (Juan Viñas, Costa Rica).

Agonostomus percoides Regan, Ann. & Mag. Nat. Hist., 1908, 461
(Rio Iroquois).

These fishes inhabit clear running water and are usually most abundant in swift currents where there are many rocks. They are very timid, retreating under rocks or overhanging banks when in the least disturbed. In general, the smaller specimens have thin lips and a terminal or subterminal mouth. Apparently with age the lips thicken and the lower jaw shortens and becomes subinferior. It is very probable that most, if not all, of the American species referred to this genus are the same, the variations being due to age and probably to sexual differences. The larger specimens are very difficult to collect except with

the use of dynamite. In Costa Rica this species and *Joturus pichardi* are regarded as excellent food fishes.

Virginia (4), 55 to 185 mm.; Parismina (8), 50 to 95 mm.; Zent, April 15 (9), 67 to 120 mm.; Zent, April 12 (26), 90 to 185 mm.; La Victoria (7), 58 to 225 mm.; Costa Rica River (5), 211 to 236 mm.; La Junta (2), 47 to 87 mm.; Orotina, April 20 (4), 75 to 165 mm.; Jesus María (7), 70 to 160 mm.; Turrubales (21), 60 to 128 mm.; Turrialba (1), 98 mm. (Alfaro); El Sardinal, Santa Clara (1), 235 mm. (Alfaro).

Family Syngnathidæ.

Siphostoma elcapitanense Meek and Hildebrand sp. nov.

Head 9.0; depth 3.0; D. 33; rings 14+38; dorsal on 0+9 rings; body slender, the angles not prominent; anal fin wanting; snout equal to postorbital part of head.

Color, grayish brown mottled with pearly spots.

This species occurs in the streams on the west slope of eastern Panama. It will be described in more detail in an account of the Fishes of Panama, by Meek and Hildebrand. Type locality, El Capitan, Panama.

Jesus María (1), 85 mm.; Turrubales (1), 110 mm.

Family Atherinidæ.

Menidia chagresi Meek and Hildebrand sp. nov.

Head 4.4 to 5.0; depth 6.1 to 6.9; D. III or IV-1, 7 to 9; A. 1, 20 to 23; scales 42 to 44.

Body elongate, the ventral region moderately compressed, but without an edge; mouth rather small, the lower jaw the shorter; teeth in jaws in villiform bands, the outer series in the upper jaw enlarged; scales with entire edges, except a few in front of dorsal and on median line of the back slightly crenate; soft dorsal and anal without scales.

Color, greenish above, paler below; sides with a conspicuous bluish black band. Type locality, Gorgona, Canal Zone.

A more complete description of this species will appear in an account of the Fishes of Panama, by Meek and Hildebrand.

Zent, April 12 (30), 60 to 80 mm.; Parismina (5), 65 to 70 mm.

Family **Centropomidæ**.**Centropomus pectinatus** Poey.

Centropomus pectinatus Poey, Mem., II, 12, 1860 (Havana and Cienfuegos);—Regan, Biol. Cent. Amer., 1906, 46.

Centropomus medius Regan, Biol. Cent. Amer., 1906, 47.

Mr. Regan regards *C. pectinatus* Poey and *C. medius* Günther as closely related but different species, the former occurring on the Atlantic side, the latter on the Pacific. The studies of Mr. Hildebrand and myself, of a considerable amount of material from both coasts of Panama, leads us to consider that but one species exists. In the streams in Costa Rica I obtained this species only on the Pacific side.

Jesus María (17), 93 to 285 mm.; Rio Grande, Orotina (1), 290 mm.

Centropomus undecimalis (Bloch).

Sciæna undecimalis Bloch, Ausl. Fisch., VI, 1792, 60, pl. 203 (Jamaica).

Centropomus undecimalis Regan, Biol. Cent. Amer., 1907, 49.

This species occurs only on the Atlantic side of tropical America.

Zent, April 12 (3), 183 to 193 mm.

Centropomus robalito Jordan and Gilbert.

Centropomus robalito Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 462 (Mazatlan; Acapulco);—Regan, Biol. Cent. Amer., 1907, 51.

This species occurs only on the Pacific side of tropical America.

Jesus María (2), 211 to 227 mm.

Family **Lutianidæ**.**Neomænsis argentiventris** (Peters).

Mesoprion argentiventris Peters, Berlin. Monatsbr., 1869, 704 (Mazatlan).

This species is more often taken in fresh and brackish water than in the sea.

Jesus María (1), 223 mm.

Family **Carangidæ.****Caranx latus** Agassiz.

Caranx latus Agassiz, Pisc. Bras., 1829, 105 (Brazil).

One specimen of this species was taken in swift clear water at the foot of rapids, with *Joturus*, *Agonostomus*, and *Brycon*.

Zent (1), 180 mm.

Family **Liognathidæ.****Gerres brevimanus** Günther.

Gerres brevimanus Günther, Proc. Zoöl. Soc. Lond., 1864, 152
(Chiapas, Guatemala).

The members of this family are marine, although some few species ascend rivers to some distance above tide water.

This species was very abundant in the Rio Jesus María.

Jesus María (21), 50 to 245 mm.

Encinostomus californiensis (Gill).

Diapterus californiensis Gill, Proc. Ac. Nat. Sci. Phila., 1862, 245
(Cape San Lucas).

Jesus María (6), 63 to 120 mm.

Family **Cichlidæ.**

The Cichlids; Mojarras.

In Costa Rica thirteen species of cichlids have been taken. It is probable that others known from Nicaragua also occur in the lower courses of the rivers of Costa Rica, which flow into Lake Nicaragua and its outlet, the Rio San Juan. The cichlids occupy a position in the fresh-waters of tropical America quite similar to that of the sun-fishes in the eastern half of temperate North America. In general form they are much alike, and so far as known have in general much the same habits. Some species, like many of the genus *Lepomis*, have

very small mouths; while others, like *Cichlasoma dovii*, much resemble our black basses. No one has tested the game qualities of the cichlids, but a few that I have caught in Lake Managua on a baited hook certainly put up a good fight. As food fishes they rank well with our sunfishes, and in the markets of the larger cities on the lakes in Nicaragua they are offered for sale.

These fishes are the most important food fishes of the fresh-waters of Central America. The Bobo (*Joturus*) and the Trucha (*Agonostomus*) are perhaps better flavored, but they are usually difficult to capture and more limited in their distribution, occurring usually* only in swift running water. The large characins are too full of bones, and the catfishes (*Rhamdia*) are too small and too few in number to be of any special commercial importance, although their flesh is of excellent flavor. It would seem that the larger cichlids are deserving of considerable attention. They are hardy and some of the larger species would, no doubt, do well to domesticate as pond fishes.

The significance of the thickened lips in some species, as well as the hump developed on the nape of others, is not well understood. The genus *Cichlasoma* has been broken up into a number of genera, most of which are scarcely of importance sufficient to be retained as subgenera.

The following is a key to the species of *Cichlasoma* known to occur in the fresh-waters of Costa Rica:

- a. Mouth large; a few of the anterior teeth enlarged and canine-like; lower jaw the longer.
- b. Anal spines 4 to 6; pectoral fin short, about $1\frac{2}{3}$ in head; fold of lower lip free; dorsal XVIII to XIX, 12 or 13. *dovii*.
- bb. Anal spines 7 to 9; pectoral fin $1\frac{1}{3}$ in head; fold of lip free; dorsal XVII to XVIII, 9 or 10. *friedrichsthalii*.
- aa. Mouth smaller, no enlarged canine-like teeth in either jaw; jaws equal or the lower one the shorter.
- c. Fold of lower lip free.
- d. Free fold of lower lip broad, the lips usually thick, sometimes developed as fleshy median lobes; dorsal XVI, 13 or 14; anal IV to V, 9; caudal fin emarginate; pectoral not reaching anal; sides with dark bars; vertical fins with dark spots. *tuba*.
- dd. Free fold of lower lip narrow, without fleshy median lobes; dorsal XVI to XVII, 11 to 13; anal VI to VIII, 7 to 9; caudal fin rounded; vertical fins without dark spots. *citrinellum*.
- cc. Fold of lower lip interrupted at the symphysis.
- c. Lower lip forming broad lateral folds; dorsal XVI, 11; anal V, 8 to 9; caudal fin slightly rounded; sides with 5 to 6 dark cross

- bars; light blue spots on body, soft dorsal, anal and caudal fins.
altifrons.
- ce. Lower lip not forming broad lateral folds.
- f. Caudal fin subtruncate or rounded; sides without well defined lateral blotch.
- g. Anal spines 8 to 10; pectoral reaching past first anal spines; dorsal XVII to XVIII, 8 to 10; anal VIII to X, 7 to 8; body with about 7 dark bars; vertical fins without spots. *spilurum.*
- gg. Anal spines 4 to 7.
- h. Anal spines 6 to 7; teeth conical, and pointed at all ages.
- i. Spinous dorsal low, the middle ones about 4 in head; pectoral not reaching front of anal; dorsal XVII to XVIII, 10 or 11; anal VI to VII, 8 to 9; sides with 7 cross bars and a broken lateral band; vertical fins with few pale spots. *alfari.*
- ii. Spinous dorsal higher, the middle spines about 3 in head; pectoral reaching front of anal.
- j. Caudal peduncle without a large dark blotch; dorsal XVII to XVIII, 10 to 11; anal VI to VII, 8 or 9; sides with 7 dark bars and a broken lateral band; vertical fins with pale spots.
lethrinus.
- jj. Caudal peduncle with a large dark blotch; dorsal XVI to XVII, 12 to 14; anal VI to VII, 9 to 10; depth 1.7 to 2.0.
maculicauda.
- hh. Anal spines 4 to 5; teeth more or less compressed at base, the tips pointed or truncate; pectorals not reaching anal.
- k. Dorsal rays 11 to 12; dorsal XVII to XVIII, 11 to 12; anal V, 8 to 9; sides with broad cross bars, none of the scales with black spots; vertical fins with dark spots. *underwoodi.*
- kk. Dorsal rays 9 to 10; dorsal XVII to XVIII, 9 to 10; anal IV to V, 6 to 7; sides with faint cross bars, some of the scales with black spots forming broken lines along the rows of scales; no spots on vertical fins. *punctatum.*
- ff. Caudal fin emarginate or slightly forked, sides with a well-defined lateral blotch.
- l. Snout pointed, mouth terminal, the profile nearly straight; pectoral reaching first anal spine; dorsal XVII, 10 or 11; anal VII, 8 or 9. *rostratum.*
- ll. Snout rounded, mouth subinferior, profile convex; dorsal XIX to XX, 10 to 11; anal VIII to IX, 7 to 8; pectorals not reaching front of anal; a black spot on middle of the side below lateral line; vertical fins with numerous white spots. *spilotum.*

Cichlasoma dovii (Günther).

Heros dovii Günther, Proc. Zoöl. Soc. Lond., 1864, 154 (Lake Nicaragua);—Günther, Fishes of Cent. Amer., 1866, 461, pl. 73, fig. 4 (Lake Nicaragua).

Color variable, sides with vertical bars irregular and not well defined in the larger specimens; usually a dark spot on each scale on lower part of the body, these forming broken stripes along the rows of scales; anal spines 6 or 7; vertebræ 15 + 19 = 34. This species grows larger than any other cichlid found in Costa Rica. It is the largest and most important food fish in the lakes of Nicaragua as well.

Parismina (1), 130 mm.; Costa Rica River (2), 215 to 240 mm.; Zent, April 12 (8), 115 to 290 mm.; Zent, April 15 (11), 50 to 160 mm.; La Victoria (13), 45 to 250 mm.; Rio Higuerón (11), 43 to 115 mm. (Alfaro).

Cichlasoma tuba Meek. Tuba.

Tomocichla underwoodi Regan, Ann. & Mag. Nat. Hist., 1908, 463 (Rio Iroquois) (preoccupied).

Cichlasoma tuba Meek, Pub. Field Mus., Zoöl. Ser., x, 1912, 73 (La Victoria).

By the people at La Victoria this species is known as Tuba. The dentition of this species varies considerably. In the smaller specimens examined by me the anterior teeth are conical or nearly so. In most of the larger specimens these teeth are more or less flattened at the base, their tips being truncate or slightly rounded. There is also considerable variation in the thickness of the lips; in some specimens, usually the smaller, the lips are normal; in others they vary from normal to lips similar (though smaller) to those of *Cichlasoma lobochilus* Günther. Two specimens (170 to 180 mm.) from La Victoria have very thick lips and compressed teeth, while a specimen from Guapilis (195 mm.) has the lips nearly normal and the teeth much less compressed. The teeth in general are more compressed in specimens with the thickest lips, and these are only in the most general way correlated with size. I am inclined to believe that the variation in the dentition is due to age; and the thickened lips are due to age and are also associated in some way with breeding.

The backward position of the ventral fins is not very marked in this species, especially when compared with other slender species of *Cichlasoma*. The species which form the types on which were based the genera *Herichthys*, *Paranetroplus* and *Tomocichla* have a variable and quite

similar dentition, and form a series from the strictly conical teeth of most of the *Cichlasoma* nearly to the strictly compressed incisor teeth of *Neetroplus*. The fact that the dentition of the species listed under these genera vary so greatly, apparently with age, renders this character of little generic or specific value. Vertebrae $16 + 16 = 32$.

***Cichlasoma friedrichsthalii* (Heckel).**

Heros friedrichsthalii Heckel, Flusfische Brazil, 1840, 381 (Rio San Juan, Nicaragua).

The specimens listed below have 6 with 7 anal spines, 2 with 8, and 6 with 9. The smaller specimens have from 7 to 9 dark lateral bars with a faint broken lateral band; the larger ones have a more prominent lateral band with the bars faint or wanting. Usually a black spot on suboperculum; soft dorsal, anal and caudal fins with dark dots.

La Victoria (1), 128 mm.; Zent, April 12 (5), 62 to 108 mm.; Parismina (3), 60 to 125 mm.; Zent, April 15 (5), 90 to 105 mm.; Parismina (4), 35 to 85 mm.; La Victoria (8), 40 to 220 mm.; Virginia (1), 145 mm.; Zent, April 12 (2), 33 to 170 mm.; Guapilis (6), 111 to 205 mm.; Cuba River (1), 205 mm.; Costa Rica River (2), 205 to 245 mm.

***Cichlasoma citrinellum* (Günther).**

Heros citrinellum Günther, Proc. Zool. Soc. Lond., 1864, 153 (Lake Nicaragua).

Cichlasoma citrinellum Regan, Biol. Cent. Amer., 1908, 187 (Juan Viñas, Costa Rica).

I did not obtain any specimens of this species in Costa Rica. It is very abundant in the lakes Nicaragua and Managua and in the smaller neighboring lakes. It is interesting, though rather unexpected, to find this species at an altitude of over 3,000 feet in Costa Rica and not in the streams of the lower lands. No doubt it occurs there but is probably very scarce.

***Cichlasoma altifrons* (Kner & Steindachner).**

Heros altifrons Kner & Steindachner, Sitzb. Ak. Bayern., 1863, 223; — Kner & Steindachner, Abhandl. Ak. Bayern., x, 1866, 11, fig. 1 (Chiriqui, Western Veragua).

Cichlasoma altifrons Regan, Ann. & Mag. Nat. Hist., 1908, 463 (Rio Grande de Térraba, Costa Rica).

I did not obtain any specimens of this species.

***Cichlasoma spilurum* Günther.**

Cichlasoma spilurum Günther, Cat., IV, 1862, 289 (Yzabal & Rio Motagua, Guatemala).

Cichlasoma septemfasciatus Regan, Ann. & Mag. Nat. Hist., 1908, 461 (Rio Iroquois).

The specimens from Turrubales are identical with those taken on the Atlantic Side. Those from the Rio Higuérón are more robust anteriorly, and only the three and anterior bars and the one at the base of caudal are distinct, the others are quite faint. On the middle of the side the three anterior bars form three black lateral blotches. This species is very abundant in the East Coast streams of Costa Rica, but rather scarce on the Pacific Side.

I have compared the specimens listed below with several specimens from the Rio Motagua, Guatemala, and find no specific differences.

Guapilis (48), 45 to 110 mm.; Zent, April 12 (85), 36 to 120 mm.; Parismina (36), 60 to 110 mm.; La Victoria (19), 55 to 120 mm.; Zent, April 15 (11), 45 to 100 mm.; Cuba River (4), 70 to 105 mm.; Turrubales (1), 97 mm.; Turrubales (1) 103 mm. (Alfaro); Rio Higuérón (24), 45 to 95 mm. (Alfaro); Chitaria (2), 50 to 76 mm. (Alfaro).

***Cichlasoma alfari* Meek.**

Cichlasoma alfari Meek, Pub. Field Mus., Zool. Ser., VII, 1907, 148 (Turrialba).

This species has been taken at Turrialba, apparently reaching a higher altitude than any other cichlid in Costa Rica. Vertebræ 12+16 = 28.

Parismina (5), 40 to 165 mm.; Costa Rica River (3), 133 to 178 mm.; Virginia (1), 165 mm.; Guapilis (19), 80 to 175 mm.; Turrialba (4), 60 to 93 mm. (Alfaro); Tucurrique (7), 65 to 135 mm. (Alfaro).

***Cichlasoma lethrinus* Regan.**

Cichlasoma lethrinus Regan, Ann. & Mag. Nat. Hist., 1908, 462 (Rio Iroquois).

This species is close to *Cichlasoma alfari*. It differs from that species in having a slightly deeper body, a larger eye, a straighter profile and higher dorsal spines. The dark bars on side are prominent and the lateral band less defined than *C. alfari*. Vertebræ 13+15 = 28.

Zent, April 12 (63), 40 to 160 mm.; Zent, April 15 (13), 70 to 140 mm.; Parismina (11), 50 to 100 mm.; La Victoria (15), 75 to 150 mm.;

Guapilis (13) 45 to 100 mm.; Chitaria (12), 47 to 92 mm. (Alfaro); Rio Higuerón (6), 32 to 136 mm. (Alfaro).

Cichlasoma maculicauda Regan.

Cichlasoma maculicauda Regan, Ann. & Mag. Nat. Hist., 1905, 227 (Lake Yzabal, Rio Motagua, Guatemala; Rio Chagres).

I did not obtain this species in Costa Rica. The fact that it has been found in Guatemala and Panama, and that it is a resident of lowland streams, being occasionally taken in brackish water, it may be expected to occur in some of the lowland streams of Costa Rica. It is one of the best marked of the cichlids, being easily distinguished by the large round black blotch on the caudal peduncle and base of caudal fin.

Cichlasoma underwoodi (Regan).

Herichthys underwoodi Regan, Biol. Cent. Amer., 1906, 30, pl. III, fig. 5 (Costa Rica).

Cichlasoma sieboldii Regan (not Steindachner), Biol. Cent. Amer., 1908, 186 (Costa Rica).

Paraneetroplus sieboldii Regan (not Steindachner), Ann. & Mag. Nat. Hist., 1908, 464 (Rio Grande de Térraba, Costa Rica).

Cichlasoma frontale Meek, Pub. Field Mus., Zoöl. Ser., VII, 1909, 210 (Turrubales, Costa Rica).

In the Turrubales River this species was found to be very abundant. Vertebræ 15+16=31.

Rio Grande, Orotina (16), 30 to 70 mm.; Turrubales (65), 45 to 225 mm.; Turrubales (5), 128 to 150 mm. (Alfaro).

Cichlasoma punctatum Meek.

Cichlasoma punctatum Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 210 (Buenos Aires, Costa Rica).

This species is near the preceding, but differs in color and markings and in fewer soft rays on dorsal and anal fins. The only specimens I have seen are those listed below which were collected by Mr. Carriker. Vertebræ 14+17=31.

Buenos Aires (12), 85 to 100 mm. (Carriker).

Cichlasoma rostratum (Gill & Bransford).

Heros rostratum Gill & Bransford, Proc. Ac. Nat. Sci. Phila., 1877, 181 (Lake Nicaragua).

Soft dorsal and caudal fins with white spots, these sometimes forming bars. In 1907* I suggested that this species was probably the male of *Cichlasoma longimanus* (Günther). Since I secured only the one form in Costa Rica and find both sexes represented, it is evident that the two species are not the same.

La Victoria (4), 140 to 205 mm.; Zent, April 12 (20), 77 to 200 mm.
Zent, April 15 (8), 68 to 98 mm.

Cichlasoma spilotum Meek.

Cichlasoma spilotum Meek, Pub. Field Mus., Zoöl. Ser., x, 1912, 73
(La Victoria, Costa Rica).

This species is known only from material listed below. It is easily distinguished from the other Costa Rica *Cichlasoma* by the decurved profile, small subinferior mouth, and by the prominent black spot on middle of the side below the lateral line. Vertebrae 15+17=32.

La Victoria (11), 95 to 190 mm.

Neetroplus fluviatilis Meek.

Neetroplus fluviatilis Meek, Pub. Field Mus., Zoöl. Ser., x, 1912, 74
(Costa Rica River near Guapilis).

This species resembles in form *Neetroplus nematopus* Günther, from Lake Nicaragua. It differs from that species in a more convex inter-orbital, a more decurved profile, a more slender body, and in having 6 or 7 faint though well defined dark bars on the sides. The specimens of *Neetroplus nematopus* in this museum from Nicaragua are uniform brownish with a faint dark bar downward and backward from the 9'' and 10'' dorsal spines; a nuchal crest is also developed on some of these specimens 85 mm. in length, and is very prominent on a specimen 135 mm. On the two specimens of *N. fluviatilis* there is no nuchal crest.

Costa Rica River (2), 110 to 123 mm.

Herotilapia multispinosa Günther.

Herotilapia multispinosa Günther, Fishes Cent. Amer., 1869, 453,
pl. LXXIV, fig. 2 (Lake Managua).

In general form and appearance this species resembles *Cichlasoma spilurum*, from which it is easily distinguished by its tricuspid incisor-like teeth. Vertebrae 13+15=28.

Zent, April 12 (2), 77 to 135 mm.; Zent, April 14 (1), 80 mm.

* Pub. Field Mus., Zoöl. Ser., VII, 1907, 126.

Family **Pomadasidæ**.**Pomadasis croco** (Cuvier & Valenciennes).

Pristopoma croco Cuvier & Valenciennes, Hist. Nat. Poiss., v, 1830,
264 (Martinique).

Pomadasis croco Regan, Biol. Cent. Amer., 1907, 44.

This species inhabits the eastern streams and coasts of tropical America.

La Victoria (15), 87 to 195 mm.; Zent, April 12 (17), 70 to 183 mm.;
Zent, April 15 (5), 90 to 200 mm.

Pomadasis bayanus Jordan & Evermann.

Pomadasis bayanus Jordan & Evermann, Bull. 47, U. S. Nat. Mus.,
1906, 33 (Bayano River, Panama);—Regan, Biol. Cent. Amer.,
1907, 43.

Pacific Coast streams of tropical America.

Jesus María (4), 87 to 345 mm.

Family **Gobiidæ**.

Nearly all of the members of this family are marine. Some species, however, run into brackish and fresh water, though seldom beyond the influence of the tides; others, as *Conophorus*, *Scycidium* and some species of *Eleotris*, are permanent residents of fresh water.

Philypnus dormitor (Lacépède).

Gobiomorus dormitor Lacépède, Hist. Nat. Poiss., II, 1798, 599
(Martinique).

Philypnus dormitor Regan, Biol. Cent. Amer., 1906, 5.

The dark lateral band is very well marked in specimens up to about 75 mm. In larger specimens (290 mm.) it becomes broken up and fades into the general color of the body. Caudal fin with spots arranged to form 5 or 6 vertical bars; these bars are broader and less numerous than those on the caudal fin of the following species.

Parismina (2), 258 to 400 mm.; La Victoria (7), 65 to 215 mm.;
La Junta (1), 285 mm.; Zent, April 12 (5), 125 to 300 mm.; Zent, April
15 (8), 95 to 230 mm.

Philypnus maculatus Günther.

Lembus maculatus Günther, Cat., 1, 1859, 505 (Ecuador).

Philypnus maculatus Regan, Biol. Cent. Amer., 1906, 5;—Regan, Ann. & Mag. Nat. Hist., 1908, 464 (Rio Ballena, Costa Rica).

In this species the lateral band is formed of dark blotches which are in most cases indistinct up to about 170 mm. These spots run together, forming a narrow dark stripe in specimens 200 mm. and larger. The caudal fin in smaller specimens with small spots arranged in about 10 narrow dark vertical bars.

Orotina, Rio Grande (38), 65 to 255 mm.; Turrubales (2), 140 and 160 mm.; Orotina, April 20 (2), 180 and 235 mm.; Jesus María (23), 40 to 130 mm.

Dormitator maculatus (Bloch).

Sciæna maculata Bloch, Ausl. Fische, 1790, 299, fig. 2 (West Indies).

Dormitator maculatus Regan, Biol. Cent. Amer., 1906, 8 (Southern Mexico; Haiti; St. Croix).

This species is very variable, and it seems quite impossible to separate the east and west forms, when a considerable amount of material from both sides is compared. The relation of the east and west forms will be treated of by Meek and Hildebrand in their report on the collections of fishes made by them in Panama.

Jesus Maria (5), 48 to 82 mm.; Rio Cañas, Taboga (4), 60 to 90 mm.

Guavina guavina (Cuvier & Valenciennes).

Eleotris guavina Cuvier & Valenciennes, Hist. Nat. Poiss., XII, 1837, 223 (Martinique).

This species inhabits Atlantic Coast streams from Mexico to Brazil. I did not secure any specimens in Costa Rica. My collecting was done in streams on the eastern side at a greater altitude than this species usually attains.

Eleotris macrolepis sp. nov.

Type No. 7775, F. M. N. H.; length 40 mm.; Jesus María, Costa Rica.

Head 3.15; depth 5.55; D V. 9; A 1-7; scales 33.

Body subterete to slightly compressed posteriorly; head depressed; lower jaw the longer; maxillary reaching to anterior third of eye;

diameter of eye 4.0 in head; snout 4.0; interorbital narrow, concave, its width 7.7 in head; nape naked nearly to spinous dorsal; pectoral fin broad, nearly reaching front of anal; breast and abdomen without scales; caudal fin rounded; gill membranes connected to the isthmus.

Color light olivaceous, the sides reticulated with darker and with 4 or 5 dark lateral blotches, caudal fin barred with darker. Known only from the type.

Eleotris latifasciatus Meek & Hildebrand.

Eleotris latifasciatus Meek & Hildebrand, Pub. Field Mus., Zoöl. Ser., x, 1912, 68 (Rio Cardenas, Panama).

This species had formerly been known only from Pacific streams of Panama.

Jesus María (1), 39 mm.

Eleotris picta Kner & Steindachner.

Eleotris picta Kner & Steindachner, Abhandl. Bayern Ak., 1864, 18, pl. 3, fig. 1 (Rio Bayano near Panama).

Pacific Coast rivers from California to Ecuador.

Rio Grande, Orotina, April 22 (1), 310 mm.; Jesus María (3), 68 to 117 mm.

Chonophorus taiasica (Lichtenstein).

Gobius taiasica Lichtenstein, Berl. Abhandl., 1822, 273 (Brazil).

Chonophorus banana Regan, Biol. Cent. Amer., 1906, 11.

This species inhabits the East Coast rivers from Mexico to Brazil and the fresh waters of the West Indies.

Guapilis (1), 195 mm.; La Victoria (5), 91 to 210 mm.; Parismina (2), 50 and 107 mm.; Zent, April 12 (11), 75 to 165 mm.; Zent, April 15 (13), 85 to 105 mm.; La Junta (1), 77 mm.

Chonophorus transandeanus (Günther).

Gobius transandeanus Günther, Cat., III, 1861, 62 (Western Ecuador).

Chonophorus transandeanus Regan, Biol. Cent. Amer., 1906, 12 (Western Ecuador);— Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 150 (Rio Machuca, Costa Rica).

Awaous nelsoni Evermann, Proc. Biol. Soc. Wash., 1898, 3 (Rosario, Sinaloa, Mexico).

This species inhabits fresh-water streams of the Pacific Slope from Sinaloa, Mexico, to Ecuador.

Turrubales (1), 115 mm.; Orotina (28), 73 to 220 mm.; Jesus María (7), 115 to 120 mm.; Rio Machuca (1), 200 mm. (Alfaro).

Sicydium pittieri Regan.

Sicydium pittieri Regan, Ann. & Mag. Nat. Hist., 1907, 260 (Rio Grande de Térraba, Costa Rica);—Regan, Biol. Cent. Amer., 1908, 185.

Turrubales (1), 62 mm.

Sicydium altum Meek.

Sicydium altum Meek, Pub. Field Mus., Zoöl. Ser., VII, 1907, 149 (Turrialba, Costa Rica);—Regan, Biol. Cent. Amer., 1908, 185.

Males with the high dorsal fins, the longest spines 3 in body. The head of this species is broader and interorbital wider than the preceding. Young individuals (40 mm.) have 7 broad vertical bars on the side, becoming faint on larger (80 mm.) specimens, and three narrow ones on caudal fin. This species is very abundant on the gravelly bottom and on the rocks in clear running water. They rest attached to rocks by the suctorial disk on the pectoral fins.

La Victoria (22), 36 to 84 mm.; Parismina (1), 50 mm.; Zent, April 15 (10), 37 to 80 mm.; Zent, April 12 (5), 53 to 65 mm.; El Guayabo (2), 85 to 98 mm. (Alfaro).

Family **Gobiesocidæ.**

Gobiesox costaricensis Meek.

Gobiesox costaricensis Meek, Pub. Field Mus., Zoöl. Ser., X, 1912, 74 (Zent, Costa Rica).

These small fishes can be seen clinging to rocks in clear water in considerable numbers, but their capture is very difficult. This species is probably a resident of fresh water only.

Zent, April 12 (3), 50 to 61 mm.; Parismina (1), 41 mm.; Turrubales (2), 42 mm.

Family **Pleuronectidæ.****Citharichthys spilopterus** Günther.

Citharichthys spilopterus Günther, Cat., IV, 1862, 421 (New Orleans).

This species is said to vary considerably. The specimen taken in the river at La Victoria has head 3.6; depth 2.0; dorsal rays 69; anal rays 53; scales 53; eye 5.9 in head; maxillary 2.5; pectoral 2.0.

La Victoria (1), 155 mm.

Family **Soleidæ.****Achirus fonsecensis** (Günther).

Solea fonsecensis Günther, Cat., IV, 1862, 475 (Gulf of Fonseca).

Achirus fonsecensis Regan, Biol. Cent. Amer., 1906, 3 (Gulf of Fonseca, and Rio Presidio).

Jesus María (24), 30 to 80 mm.

In the foregoing list there are recorded 71 species of fishes; all except two have been known to occur in the fresh waters of Costa Rica. The two, *Pacilia sphenops* and *Cichlasoma maculicauda*, occur in the brackish and fresh water near the coast from Mexico to Panama, and no doubt are to be found in Costa Rica.

The Characins and the Cichlids are the only families treated of in this paper which belong strictly to fresh water. Of the Characins there are nine species, six occurring on the Atlantic and four on the Pacific side. One species, *Raboides guatemalensis*, a lowland form, occurs on both sides. It ranges from southern Mexico south into South America. The Cichlids are represented by 15 species; 12 occur on the Atlantic and 6 on the Pacific side, three species being common to both sides. None of the species of these two families is found in the streams about San José; they exceed but little, if any, an altitude of 1000 meters.

The catfishes belonging to the genus *Rhamdia*, a fresh-water group, are represented by 5 species, four occurring on the Atlantic and 3 on the Pacific side, two species being common to both sides; one of these, *R. rogersi*, is quite abundant in the streams forming the head waters of the Rio Tárcoles and the Rio Reventazon, the other, *R. wagneri*, is known only from the lowlands. It no doubt occurs on the Atlantic side of Costa Rica although not yet taken there. The *Paciliidæ* are represented by 14 species, 8 on the Atlantic side and 10 on the Pacific,

4 species being common to both sides. Two of these occur on the divide in upland streams, one from the lowlands to the highest altitude attained in Costa Rica by any fish, while the remaining one is taken in the brackish and salt water near or on the coasts. All except two of the *Pæciliidæ* are viviparous. The one, *Haplocheilus dovii*, nearest to *Fundulus*, has been taken only in salt and brackish water on the Pacific side of Costa Rica, the other *Rivulus isthmensis* occurs in small upland streams. The remaining fishes taken in the fresh waters of Costa Rica belong to families, most of whose members live in salt water. Some of these have become established in fresh water and are properly fresh-water fishes; the others are really salt-water fishes which have been taken occasionally in fresh waters.

The fish fauna of Costa Rica is mostly like that of the Nicaragua Lake region. This relationship will be more marked when the lowland streams of both Nicaragua and Costa Rica will have been more thoroughly explored.

While the fish fauna of Costa Rica is essentially that of South America, it is not likely that its fishes migrated from South America along Panama within recent geological times. Whatever its ancestors may have been, or what may have been their relation with those of South America, we must regard Central America as a somewhat remote center of distribution. From recent studies by Mr. Hildebrand and myself in the region of the Canal Zone, it is quite evident that strictly South American migrants in comparatively recent times did not go far beyond the Canal Zone and that most of these are lowland forms which came from the streams on the Atlantic side of Colombia to the Pacific side after the last gap (Atrato-Tuyra) here between the two oceans was closed. We find *Curimatus*, *Ctenolucius* and *Gasteropelecus* and other Colombian Atlantic forms in streams opposite the Rio Chagres, but not in it. Some Loricarids occur in these streams and also in the Rio Chagres, but these appear to us to have probably crossed from the Pacific side streams to the Chagres and not to have migrated from the rivers of Colombia to the Chagres direct. The distribution of the fresh-water fishes of central Panama will be treated of in detail by Meek and Hildebrand in their report on the fishes of the Biological Survey of the Canal Zone.