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STUDIES OF THE FISHES OF THE ORDER CYPRINODONTES. XVI. A REVISION OF THE GOODEIDAE

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STUDIES OF THE FISHES OF THE ORDER CYPRINODONTES. XVI. A REVISION OF THE GOODEIDAE*

INTRODUCTION

ALTHOUGH knowledge of the fishes of this entirely Mexican family of viviparous fresh-water cyprinodonts dates from the eighteenth century, the classification of the group, despite recent noteworthy advances, has remained incomplete and unsatisfactory to the present day. The viviparity, sexual dimorphism, and sexual behavior of *Girardinichthys innominatus* were noted by Don José António de Alzate y Ramyrez in 1769, and his observations were printed in 1772 (see Gill, 1882: 8; and Meek, 1904: 116–18). The same form was described as an unnamed species of *Lucania* by Girard (1859: 118), as *Girardinichthys innominatus* by Bleeker (1860: 484), and as *Limnurgus variegatus* by Günther (1866: 309), who also described (p. 308) a second genus and species now referred to the group, namely *Characodon lateralis*. *Goodea atripinnis* was named by Jordan (1880: 299).

Seven other genera referable to the Goodeidae have since been described: *Xenendum* Jordan and Snyder (1900: 127), a synonym of *Goodea; Zoogoneticus, Chapalichthys,* and *Skiffia* Meek (1902: 91, 97, and 102); *Ilyodon* Eigenmann (1907: 427); and *Lermichthys* and *Balsadichthys* Hubbs (1926: 18–19). Valid and nominal species have been added by David S. Jordan and Charles H. Gilbert (1882*a* and *b*), Tarleton H. Bean (1887 and 1892), Charles Girard (in George B. Goode, 1891), Therese von Bayern and Franz Steindachner (1895), Cloudsley Rutter (1896), Barton A. Bean (1898), David S. Jordan and Barton W. Evermann (1898, 1927), David S. Jordan and John O. Snyder (1900), Jacques Pellegrin (1901), Seth E. Meek (1902, 1904), C. Tate Regan (1904), Carl H. Eigenmann (1907), and Carl L. Hubbs (1924*b*, 1932*a*).

We now add the following new subfamilies (2), genera (9), and species (4):

Ataeniobiinae, new subfamily
Ataeniobius Hubbs and Turner (*Goodea toweri* Meek)
Alloophorus Hubbs and Turner (*Fundulus robustus* Bean)
Xenotoca Hubbs and Turner (*Characodon variatus* Bean)
Goodea gracilis, new species
Allodontichthys, new genus (*Zoogoneticus zonistius* Hubbs)
Neoophorus Hubbs and Turner (*Zoogoneticus diazi* Meek)
Xenoophorus Hubbs and Turner (*Goodea captiva* Hubbs)

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Xenoophorus erro Hubbs and Turner
Xenoophorus exsul, new species
Allotoca Hubbs and Turner (*Fundulus dugèsii* Bean)
Girardinichthyinae, new subfamily
Balsadichthys xantusi Hubbs and Turner
Ollentodon Hubbs and Turner (*Xenendum multipunctatum* Pellegrin)
Neotoca Hubbs and Turner (*Characodon bilineatus* Bean)

The new generic names, except *Allodontichthys,* and the new specific names, except *Xenoophorus exsul,* have been used by Turner (1937*b*), with the indication that their characterization was taken from the present joint paper, which was delayed in publication.

It is probable that a number of additional species and even genera remain unknown, and there are indications that several of the species as now recognized will each be found to be a complex of local forms when these species are subjected to an analysis of variation throughout their range.

Materials and Acknowledgments

The materials used in preparing this revision of the Goodeidae are included in the fish collections of the Field Museum of Natural History (F.M.N.H.), the United States National Museum (U.S.N.M.), and the University of Michigan Museum of Zoology (U.M.M.Z.). The Field Museum contains the wealth of material used by Meek in his classical studies (1902–8) of the fishes of Mexico. The National Museum contains much of the material described prior to Meek's Mexican investigations, as well as a series of Meek's specimens. The Museum of Zoology has the original material recorded in the present paper. These three collections together contain most of the available material on the family, including specimens of all previously known species as well as the types of those described by us as new. Either in these collections or in those of the Natural History Museum of Stanford University we have studied the types of all known species, valid and synonymic, with 7 exceptions: *Zoogoneticus maculatus* Regan, a synonym of *Alloophorus robustus; Characodon Luitpoldii* Therese von Bayern and Steindachner, represented by topotypes; *Characodon lateralis* Günther; *Characodon Geddesi* Regan, a synonym of *Girardinichthys innominatus* (of which the types were not examined but are represented by topotypes); and *Xenendum multipunctatum* Pellegrin. The characters of the female have been studied more or less in detail in all species with the exception of *Allodontichthys zonistius,* which is known only from 2 males, and the reproductive structures of the males have been determined for all species except *Allotoca dugèsii.*

Most of the detailed studies of ovarian and trophotaenial anatomy, basic to our new classification, were made by Turner on newly collected specimens. The winter of 1932 was devoted to field work in Mexico on this and related problems. In addition to material specially fixed for histological study, large series of ordinary formalin specimens of Goodeidae were preserved, and a stock of several species was obtained for rearing in aquaria. Other critical material of the family was collected for us by Myron Gordon, during the same season, particularly in the hitherto unexplored Río Santa María in San Luis Potosí, one of the headwaters of the Río Panuco system. In 1930 Gordon, with E. P. Creaser, collected many specimens of Goodeidae. Three series were collected for us in 1932 and 1936, in Laguna de Lerma and the Valle de México, by E. H. Taylor and Hobart M. Smith. In 1934 C. L. Lundell and companions collected the abundant type material of *Xenoophorus exsul* in isolated streams of San Luis Potosí. In 1935 James Oliver obtained fine series of 2 species from the state of Colima. C. Basil Jordan, Albert Greenberg, and F. H. Stoye have donated some of the types of *Goodea gracilis*.

To all who have given aid and encouragement in our researches on this family we owe a great debt of thanks. The directors of the several museums mentioned above have allowed us free use of their rich collections. Alfred C. Weed, Curator of Fishes in the Field Museum, and George S. Myers, formerly Curator of Fishes in the National Museum, have been particularly helpful to us in our museum work. The expeditions mentioned above were made possible by grants of research funds from the National Research Council, the University of Michigan, and Northwestern University. The success of the field work was largely due to the fine co-operation and assistance received from numerous officials and private citizens of Mexico, among whom we may particularly mention Isaac Ochoterena and his staff of the Instituto de Biologia, and Juan Zinser, Chief of the Game Service in the Forestry, Game, and Fisheries Department, F. C. Lona of the National Railways of Mexico, F. M. Riveroll of the Department of Express, Richardo Ostos of Monterrey, and Claudio Martinez. Myron Gordon has been particularly helpful in collecting new material, which he has kindly donated to the Museum of Zoology of the University of Michigan. He has allowed us to report on his material, in advance of 2 faunal papers which have been prepared by Hubbs and Gordon. These reports will give an account of the several recent collecting trips indicated above, a description of each collecting station, and a list of the species obtained. Acknowledgment is also made to the Horace H. Rackham School of Graduate Studies for the grant which made this publication possible.

Previous Classifications of the Goodeidae

Early workers on this group failed to recognize the characters which clearly indicate its phyletic unity. Species of the Goodeidae were even referred to genera now classed in separate families, the Cyprinodontidae and the Poeciliidae. The genera of Goodeidae, when distinguished, were classified here and there throughout the whole group of cyprinodonts, in accordance with their dentition and the length of their intestines.

Meek (1902, 1904) was the first to grasp the taxonomic significance of characters which define the Goodeidae as a group, namely viviparity coupled with a shortening rather than an elongation of the anterior anal rays in the male. He proved, on the basis of previously published and original information, that all of the genera then known (1) are viviparous, (2) have the anterior 5 or 6 [6–8] anal rays shortened and partially separated from the rest of the fin,[1] and (3) are restricted to the Río Lerma faunal area and contiguous territory.

Meek (1902, 1903, 1904), Regan (1908, 1915), and Eigenmann (1909) correctly indicated the range of the genera now comprising the Goodeidae as covering the very distinctive Río Lerma faunal area on the Mexican plateau, the Valle de México, the headwaters of the Río Panuco system which have cut back into the plateau, the headwaters of the Río Balsas in the mountains just south of the plateau, the interior drainage and the Río Mezquital drainage on the plateau to the north of the Río Grande de Santiago system, and certain coastal streams from the Río Mezquital to Colima—an unusually compact group range. Recent evidence indicates that all species reported from other localities were erroneously so recorded. *Characodon lateralis* presumably came originally from Mexico rather than "Central America" or "Southern Central America," as stated by Günther (1866: 308; and 1869: 480, respectively). *Characodon* (=*Ilyodon*) *furcidens* certainly did not come from "Cape San Lucas," as originally stated by Jordan and Gilbert (1882*a*: 354–55), and almost certainly not from the lagoons about La Paz or any other locality in Lower California as suggested by Jordan and Evermann (1896: 670) and subsequent authors, particularly Evermann (1908: 29), but presumably came only from Colima as indicated by Hubbs (1931: 2; and 1932*a*: 68) and by us (see p. 59). *Ilyodon paraguayense* Eigenmann (1907: 428), a synonym of *Characodon furcidens*, certainly did not come from Paraguay; it was based on specimens very likely collected by Xantus in Colima, Mexico (see p. 58).

Meek (1902, 1904) removed from *Fundulus, Adinia,* and *Platypoecilus,* the species of Goodeidae with conical teeth, erecting for them a new genus, *Zoogoneticus,* characterized by the triple evidence of relationship listed above. But so impressed was Meek with the primary separation of the

[1] Using only *Characodon lateralis,* and ignorant of Meek's work and of other pertinent data, Philippi (1906) made claim to the discovery of viviparity in this group, and held that the anal fin is unmodified. He then stressed this "*deszendenztheoretisch interessanter Fall*" of the necessity for the stimulation or use of an organ as an antecedent to its evolutionary modification!

Cyprinodontes into (1) carnivorous fishes with firm jaws and teeth and short intestine, having the teeth either conic or bifid, and (2) herbivors with loose jaws and teeth and long intestine, that he widely separated *Zoogoneticus* and *Girardinichthys* (as Fundulinae) from *Characodon* and *Chapalichthys* (as Orestiinae) and from *Goodea* and *Skiffia* (as Goodeinae). As late as 1910 Eigenmann followed Meek's classification.

It remained for Regan (1907: 76; and 1911: 323, 325) to carry Meek's discoveries to their logical conclusion, namely the association of all these genera into one systematic group, which Regan termed the subfamily Characodontinae. He continued, however, the primary division of this group into genera with firm jaws and teeth, and those with weakly connected jaws and loosely attached teeth ("*Goodea*"). Jordan (1923: 159) divided the group into two families, Characodontidae and Goodeidae, on much the same basis but with a somewhat different alignment of the genera. Hubbs (1924*a*: 4) then concluded that "the Characodontidae and Goodeidae should not be separated, for to do so would destroy the extreme naturalness of the combined group. The name Characodontinae is synonymous with Goodeinae, which is the older; the family should therefore be named Goodeidae." This family, however, was divided into the Zoogoneticinae (*Zoogoneticus* and *Girardinichthys*) and the Goodeinae (*Characodon, Chapalichthys, Goodea,* and *Skiffia*)—another alignment of the genera on the basis of tooth and intestine characters. Later, though admitting that the group of Zoogoneticinae is not sharply defined, Hubbs (1926: 17–19) retained the same erroneous scheme.

PROPOSAL OF A NEW CLASSIFICATION OF THE GOODEIDAE (TABLE I), BASED CHIEFLY ON THE ANATOMY OF THE OVARY AND OF THE TROPHOTAENIAE

The primary separation of the Goodeidae into two groups on the basis of differences in the structures correlated with food is untenable, not only because of extensive intergradation and various character combinations in the differential firmness of the connection between the rami of the lower jaw, tightness of the attachment of the teeth to the jaws, form of the teeth, and length of the intestine, but also, more significantly, because the data now available indicate that the classification so derived does not conform with the evident lines of phyletic relationship.

The newly discovered characters which appear to demand a reclassification of the Goodeidae, much as the use of gonopodial characters forced a revolution in the taxonomy of the Poeciliidae (Regan, 1913; and Hubbs, 1924*a*, 1926), involve structures associated with the viviparous reproduction of this group. The characters, primarily based on the structure of the ovary in adult and half-grown females, and of the rectal processes (trophotaeniae) in the embryos, have only recently been discovered (Turner, 1932–37*b*; Mendoza, 1937). In the present paper we apply these discoveries to the taxonomy of the family.

Comparative Anatomy of the Ovary

The goodeid ovary (Pl. I, Figs. 1–8) is an essentially hollow, median structure, approximately round in cross section, formed by the almost complete fusion of the right and left organs. It displays two principal types. In the first type (Pl. I, Figs. 1–6), the ovigerous tissue occurs through the outer wall, with a tendency toward concentration in the anterior wall and in the anterior two-thirds of the dorsal and ventral walls, and also in the thick, originally sagittal but now much-folded septum. This septum, apparently representing the fused walls of the united ovaries, divides the cavity of the compound ovary into two roughly equal compartments. In the second type (Pl. I, Fig. 7), the ovigerous tissue occurs neither in the outer wall of the ovary nor in the thin, delicate, strictly sagittal, unfolded septum, but is confined to a pair of elongated and convoluted folds, each suspended in its ovarian cavity by a sheet of tissue attached dorsolaterally to the outer wall of the ovary.

Since in both types of ovary the ovigerous portions become thickened, extremely vascular, spongy, and otherwise definitely modified during gestation, this condition applies in the first type to both the walls and the septum, whereas in the second type it applies principally to the ovigerous folds, leaving the outer wall and the septum relatively thin and unmodified. The septum of the first type, chiefly supplied with longitudinal blood vessels, becomes modified during pregnancy for the nutrition of the embryos. The septum of the second type, chiefly supplied by vertical blood vessels, remains less modified at that time.

The ovary (Pl. I, Fig. 8) of one genus, *Characodon* (*lateralis*), cannot be referred to either of the two main types, for it combines some of the features of each. The ovigerous tissue occurs in the median septum only in its dorsal portion, where the otherwise straight septum is folded and becomes thickened, highly vascular with longitudinal blood vessels, and modified during pregnancy for the nutrition of the embryos. Elsewhere the ovigerous tissue is confined to a pair of dorsolateral bands adhering flatly to the outer wall of the ovary, not occurring in the wall proper. These ovigerous bands occupy the same positions as the more extensive ovigerous lobes characteristic of the second type of ovary.

The ovaries of the first type show marked differences, particularly in the septum. In *Alloophorus robustus* (Pl. I, Fig. 1), in many ways the most primitive goodeid, the septum is entire, is attached to the middorsal and mid-ventral lines, and forms a few wide, flat folds; and the lateral

TABLE I

CONCORDANCE OF THE PROPOSED CLASSIFICATION OF THE GOODEIDAE WITH OLDER CLASSIFICATIONS

PROPOSED CLASSIFICATION	CLASSIFICATION BY JORDAN AND EVERMANN (1896–1900)	CLASSIFICATION BY MEEK (1904)	CLASSIFICATION BY REGAN (1907)
ATAENIOBIINAE	(Unknown)	GOODINAE (part)	CHARACODONTINAE (part)
Ataeniobius Hubbs and Turner	(Unknown)	*Goodea* (part)	*Goodea* (part)
1. *A. toweri* (Meek)	(Unknown)	*G. toweri*	*G. toweri*
GOODEINAE	FUNDULINAE (part) CYPRINODONTINAE (part) GOODEINAE	FUNDULINAE (part) ORESTIINAE (part) GOODINAE (part)	CHARACODONTINAE (part)
Alloophorus Hubbs and Turner	*Fundulus* (part)	*Zoogoneticus* (part)	*Zoogoneticus* (part)
2. *A. robustus* (Bean)	*F. robustus*	*Z. robustus* *Z. maculatus*	*Z. robustus*
Xenotoca Hubbs and Turner	*Characodon* (part)	*Characodon* (part)	*Characodon* (part)
3. *X. variata* (Bean)	*C. variatus* *C. eiseni*	*C. eiseni* *C. variatus*	*C. variatus*
Chapalichthys Meek	*Characodon* (part)	*Chapalichthys*	*Characodon* (part)
4. *C. encaustus* (Jordan and Snyder)	*C. encaustus*	*C. encaustus*	*C. encaustus*
Goodea Jordan	*Goodea* *Characodon* (part) *Xenendum*	*Goodea* (part)	*Goodea* (part)
5. *G. gracilis*, new species	(Unknown)	*G. atripinnis* (part)	*G. calientis* (part)
6. *G. atripinnis* Jordan	*G. atripinnis* *X. caliente*	*G. atripinnis* (part)	*G. atripinnis* (part) *G. calientis* (part)
7. *G. luitpoldii* (Therese von Bayern and Steindachner)	*C. luitpoldii* *X. luitpoldii* *X. xaliscone*	*G. luitpoldi*	*G. atripinnis* (part) *G. calientis* (part)
Zoogoneticus Meek	*Platypoecilus* (part)	*Zoogoneticus* (part)	*Zoogoneticus* (part)
8. *Z. quitzeoensis* (Bean)	*P. quitzeoensis*	*Z. cuitzeoensis*	*Z. cuitzeoensis*
Allodontichthys, new genus	(Unknown)	(Unknown)	(Unknown)
9. *A. zonistius* (Hubbs)	(Unknown)	(Unknown)	(Unknown)
Neoophorus Hubbs and Turner	(Unknown)	*Zoogoneticus* (part)	*Zoogoneticus* (part)
10. *N. diazi* (Meek)	(Unknown)	*Z. diazi* *Z. miniatus*	*Z. diazi*
Xenoophorus Hubbs and Turner	(Unknown)	(Unknown)	(Unknown)
11. *X. captivus* (Hubbs)	(Unknown)	(Unknown)	(Unknown)
12. *X. erro* Hubbs and Turner	(Unknown)	(Unknown)	(Unknown)
13. *X. exsul*, new species	(Unknown)	(Unknown)	(Unknown)
Allotoca Hubbs and Turner	*Adinia* (part)	*Zoogoneticus* (part)	*Zoogoneticus* (part)
14. *A. dugèsii* (Bean)	*A. dugesii*	*Z. dugesi*	*Z. dugesii*
CHARACODONTINAE	CHARACODONTINAE (part)	CHARACODONTINAE (part)	CHARACODONTINAE (part)
Characodon Günther	*Characodon* (part)	*Characodon* (part)	*Characodon* (part)
15. *C. lateralis* Günther	*C. lateralis* *C. garmani*	*C. lateralis* *C. garmani*	*C. lateralis*
GIRARDINICHTHYINAE	FUNDULINAE (part) CHARACODONTINAE (part)	FUNDULINAE (part) ORESTIINAE (part) GOODINAE (part)	CHARACODONTINAE (part)
Ilyodon Eigenmann	*Characodon* (part)	*Characodon* (part)	*Characodon* (part)
16. *I. furcidens* (Jordan and Gilbert)	*C. furcidens*	*C. furcidens*	*C. furcidens*
Balsadichthys Hubbs	(Unknown)	*Goodea* (part)	*Goodea* (part)
17. *B. whitei* (Meek)	(Unknown)	*G. whitei*	*G. whitii*
18. *B. xantusi*, new species	(Unknown)	(Unknown)	(Unknown)
Girardinichthys Bleeker	*Girardinichthys*	*Girardinichthys*	*Limnurgus*
19. *G. innominatus* Bleeker	*G. innominatus*	*G. innominatus*	*L. innominatus*
Lermichthys Hubbs	(Unknown)	*Characodon* (part)	*Characodon* (part)
20. *L. multiradiatus* (Meek)	(Unknown)	*C. multiradiatus*	*C. multiradiatus*
Skiffia Meek	(Unknown)	*Skiffia* (part)	*Goodea* (part)
21. *S. variegata* Meek	(Unknown)	*S. variegata*	*G. lermae* (part)
22. *S. lermae* Meek	(Unknown)	*S. lermae*	*G. lermae* (part)
Ollentodon Hubbs and Turner	(Unknown)	*Skiffia* (part)	*Goodea* (part)
23. *O. multipunctatus* (Pellegrin)	(Unknown)	*S. multipunctata*	*G. multipunctata*
Neotoca Hubbs and Turner	*Characodon* (part)	*Skiffia* (part)	*Goodea* (part)
24. *N. bilineata* (Bean)	*C. bilineatus*	*S. bilineata*	*G. bilineata*

walls of the ovary are almost entirely devoid of ovigerous tissue. *Xenotoca variata* is essentially similar in ovarian structure. In *Goodea atripinnis* and *G. gracilis* the structure is also similar, except that the folds, as in *G. luitpoldii* (Pl. I, Fig. 2), are narrower and more numerous. *G. luitpoldii* differs in that the septum ventrally is attached to the right of the mid-line. The ovary of *Chapalichthys encaustus* is like that of *Goodea luitpoldii*, except that the tissues are extremely delicate. The septum in *Xenoophorus captivus* (Pl. I, Fig. 3), *X. erro*, and *X. exsul* is interrupted slightly below the middle, to form 2 flaps which are rolled in opposite directions; the lateral walls of the ovary in this genus are likewise almost entirely devoid of ovigerous tissue. In *Neoophorus diazi* (Pl. I, Fig. 4), the ovarian structure is similar to that of *Xenoophorus*, except that the ventral flap of the interrupted septum is short, little rolled, partly divided, and attached to the left of the mid-line. In *Allotoca dugèsii*, the long, undivided ventral flap is attached to the mid-line, and is rolled or folded together with the dorsal flap. In *Zoogoneticus quitzeoensis* (Pl. I, Fig. 5), unlike the other genera and species of the family, the lateral as well as the dorsal and ventral walls of the ovary are ovigerous; the entire rolled septum hangs loose from its single attachment along the middorsal line, as though the connection had been broken where the septum originally joined the ventral wall. *Ataeniobius toweri* (Pl. I, Fig. 6) resembles *Zoogoneticus quitzeoensis* in the last-mentioned respect, but differs in having the lateral ovarian walls nonovigerous, and the septum relatively thick and branched near its base (the short, scarcely rolled left branch is more or less united with the ovarian wall).

The ovaries of the second type, distinguished above, show no noteworthy differences, although characteristic of 7 genera: *Ilyodon, Balsadichthys, Girardinichthys, Lermichthys, Skiffia, Ollentodon,* and *Neotoca* (Pl. I, Fig. 7).

Comparative Anatomy of the Trophotaeniae[2]

The trophotaeniae, by which term we designate the complex nutritive and respiratory rectal processes developed on the embryos of all Goodeidae with the exception of *Ataeniobius toweri,* likewise show marked differences that we utilize as generic distinctions. These differences in the trophotaeniae involve not only their number, varying from 2 to about 12, and their length, shape, regularity, symmetry, and manner of branching, but also their general anatomy and histology. The very marked differences in the finer structure of these nutritive processes apparently offer excellent characters, of great phyletic significance. On this basis we recognize 3 types of trophotaeniae:

[2] For further details on the comparative structure of the trophotaeniae see the papers of Turner (1933*c*, 1937*b*) and Mendoza (1937).

(1) UNSHEATHED TYPE (Pl. III, Figs. 3–6).—In this probably most primitive type, the trophotaeniae are completely filled with a spongy stroma, which lacks a differentiated solid basal layer and which is not separated by a primary tissue space from the surrounding or external epithelium. This epithelium is everywhere simple and very irregular in height. Trophotaeniae of this type, occurring in 4 monotypic genera, are always flat, rather pointed, and much elongated, and when fully developed extend to or beyond the end of the caudal fin of the embryo. In *Alloophorus robustus* (Pl. III, Fig. 4), apparently the most primitive goodeid bearing trophotaeniae, and in the seemingly very closely related *Xenotoca variata* (Pl. III, Fig. 3) and *Chapalichthys encaustus* (Pl. III, Fig. 5), the nutritive processes, numbering about 6 to 8, arise by dichotomous branching from 3 backwardly projecting trunks, 1 median and 2 lateral. In the fourth genus and species, *Zoogoneticus quitzeoensis* (Pl. III, Fig. 6), the approximately 10 to 12 trophotaeniae comprise several small anterior ones surrounding the anus and a group of others derived from the irregular branching of a backwardly directed trunk.

(2) ROSETTE TYPE (Pl. II, Figs. 1–6).—In the rosette type, so named from the external appearance of the trophotaeniae in most of the species of this group, the stroma is differentiated into a spongy upper layer and a dense basal layer. The upper layer is separated from the external epithelium by a shallow, transverse primary tissue space, of variable development, whereas the lower layer is in contact with the epithelium. The epithelium is compound, with regular high cuboidal cells over the tissue space, but with flat, irregular cells where in contact with the stroma. Typical rosette-shaped trophotaeniae (perhaps not the most primitive), characteristic of all species of *Goodea* (Pl. II, Figs. 1–2), form a cluster of relatively very short, blunt, flat processes, very irregular in size, shape, and secondary lobation, radiating in one plane about equally in all directions from the anus. A posterior pair of processes may be indefinitely evident in *Goodea,* but not elongated. In *Neoophorus diazi* (Pl. II, Fig. 3), the trophotaeniae forming a rather definite posterior pair are about twice as long as the lateral and anterior processes; the whole cluster shows a somewhat greater regularity and symmetry, though also forming a definite rosette of very irregular, more or less lobate branches. The trophotaeniae of *Allotoca dugèsii* (Pl. II, Fig. 4), scarcely showing a rosette pattern, are slightly elongated anteroposteriorly; but even when developed to their maximum length, the posterior ones though about twice as long as the anterior ones do not nearly reach to the end of the caudal fin; the processes are only slightly lobate and the minor branches are scarcely developed, so that the main processes are reduced to 4, comprising an anterior and a posterior pair. In *Xenoophorus* (Pl. II, Figs. 5–6), the trophotaenial

arrangement differs from a rosette pattern in another way: in addition to several rather small anterior processes, there is a very considerably elongated posterior pair of which the left member is much the broadest, often somewhat branched, very long (when fully developed about reaching end of caudal fin), and more or less rotated into a mid-line position. Whether the elongated or the rosette type is the more primitive cannot be stated with assurance from the available data.

(3) SHEATHED TYPE (Pl. II, Figs. 7–9, and Pl. III, Figs. 1–2).—Still more modified is the sheathed type of trophotaeniae, characteristic of the genera having the most highly specialized type of ovary, that is, of the group here called Girardinichthyinae. In this type the spongy stroma, well vascularized by internal blood vessels or a superficial capillary plexus, is almost completely surrounded by a wide primary tissue space for it is connected only by a narrow strip of attachment, on one side, with the external epithelium, which is simple and cuboidal or columnar. The histological features of this trophotaenial type are described in detail by Turner (1933*c*). Sheathed trophotaeniae are all greatly elongate, when fully developed extending about to the end of the caudal fin (not so far in *Lermichthys*), but show marked differences in arrangement and number. In *Ilyodon furcidens, Balsadichthys whitei* (Pl. III, Fig. 2), and *B. xantusi,* the blunt and numerous trophotaeniae (about 8 to 13) are irregularly united into a pair of lateral trunks and a pair of very long posterior processes, between which a shorter one may be developed. The number of trophotaenial tips appears to differ in these species: 8 to 10 in *I. furcidens,* 10 to 14 in *B. whitei,* 10 to 13 in *B. xantusi.* In *B. xantusi* the long posterior processes are very much more flattened than in *B. whitei;* they are also considerably flattened in *I. furcidens.* Two genera, *Girardinichthys* (Pl. II, Fig. 7) and *Lermichthys* (Pl. II, Fig. 8), have consistently 4 trophotaeniae, an anterior hornlike pair of rather short ones, and a pair of long posterior ones, reaching when most developed about to the end of the caudal fin in *Girardinichthys,* but not so far in *Lermichthys,* in which the processes are blunter than in the other genus. In *Skiffia* (Pl. III, Fig. 1), *Ollentodon,* and *Neotoca* the trophotaeniae form a very regular trident, with some differences in the relative length of the median and lateral processes: these are all of about equal length in *Ollentodon multipunctatus;* the median process is about three-fourths as long as the outer ones in *Skiffia variegata* and *S. lermae,* but distinctly the longer in *Neotoca bilineata.* The median 1 of the 3 trophotaeniae is often forked in *S. lermae,* but seems to be consistently undivided or at most incipiently divided in the other species of *Skiffia,* and in *Ollentodon* and *Neotoca.*

The lowest number of trophotaeniae, 2, occurs in *Characoden lateralis* (Pl. II, Fig. 9), which has a very regular pair of processes extending when fully developed about to the end of the caudal fin of the embryo. These processes of *Characodon* seem to have a large primary tissue space, and to be of the sheathed type, histologically.

Bearing of These New Characters on the Classification of the Goodeidae

The new ovarian and trophotaenial characters outlined above provide: (1) conclusive confirmation of the integrity of the group Goodeidae; (2) evidence on the phylogeny of the group; (3) the basis for an analytical classification of the family.

The ovaries and trophotaeniae of the Goodeidae, although exhibiting the remarkable series of differences indicated above, are so distinctive and so uniform as to confirm beyond any reasonable doubt the previous evidence indicating the phyletic integrity of the family, as Turner (1933*c*) has pointed out.

Differences in ovarian and trophotaenial characters, however, are so diverse and so definite as to indicate groups of almost certain phyletic significance. The combination of certain kinds of ovary with certain types of trophotaeniae (see Table II) confirms this view. For instance, those genera having a simple, nonovigerous, sheetlike, ovarian septum and the ovigerous tissue confined to a pair of dorsolaterally pendant, convoluted folds (p. 12, and Pl. I, Fig. 7) are also the ones which possess the sheathed type of trophotaeniae (p. 15): indicating a natural group which we define as the Girardinichthyinae (see the key, p. 32). The genera retaining an ovary with ovigerous walls and septum (p. 12, and Pl. I, Figs. 1–6), and having either the unsheathed or the rosette type of trophotaeniae (p. 14), are classed in the reorganized group Goodeinae. *Characodon,* with a distinctively different, perhaps intermediate type of ovary, and apparently with the sheathed type of trophotaeniae, is alone left in the Characodontinae. The single genus lacking trophotaeniae, *Ataeniobius,* is on this account thought so distinct phyletically as to call for its separation in a distinct subfamily, Ataeniobiinae.

These internal, sex-related characters appear to provide unusually trustworthy indications of phyletic relationship. This circumstance may result from the relative isolation and protection of the ovaries and trophotaeniae from the action of the external environment. It is quite in line with recent advances in the taxonomy of fishes, and of animals in general, to find again that characters associated with reproduction provide the most reliable indications of relationship.

A comparison of the new classification proposed in this paper with any of the previous classifications referred to above (as in Table I) will show that the new arrangement, based on characters related to reproduction,

TABLE II

CHARACTERS OF THE GENERA OF GOODEIDAE RELATED TO NUTRITION AND TO REPRODUCTION, INDICATING: 11 PROBABLY INDEPENDENT PHYLETIC LINES; THE BASIC SIGNIFICANCE OF THE CHARACTERS ASSOCIATED WITH REPRODUCTION; PARALLEL EVOLUTION IN THE STRUCTURES RELATED TO NUTRITION; THE APPARENTLY INDEPENDENT DEVELOPMENT OF BIFID TEETH 8 TIMES IN THIS GROUP OF 18 GENERA

	Teeth of outer row		CONIC	VARIABLE	BIFID						
	Tooth attachments Jaw structure Cleft of gape Intestine		Tight Strong Lateral Short	Tight Rather strong Intermediate Rather short	Tight Strong Lateral Short or rather short	Tight Rather strong Intermediate Moderate or long	Loose Weak Transverse Long				
Structure of ovary (see p. 12)									Trophotaeniae (see p. 13)		
Location of ovigerous tissue	Character of septum	Phyletic line	Type A	Type B	Type C	Type D	Type E	Phyletic line	Number	Length	Histological type
In outer wall and septum	Entire; attached dorsally; rolled; branched	(1)	…	…	…	…	*Ataeniobius**	(1)	0	0	Lacking
	Entire; attached dorsally and ventrally; much folded	(2)	*Alloophorus*	…	*Xenotoca*	*Chapalichthys*	…	(2)	About 6–8	Very long	Unsheathed
		(3)	…	…	…	…	*Goodea*	(3)	(Too irregular to count)	Very short	Rosette
	Entire; attached dorsally; rolled; unbranched	(4)	*Zoogoneticus*	…	…	…	…	(4)	About 10–12	Very long	Unsheathed
	Divided; dorsal flap rolled; ventral flap little rolled, partly divided	(5)	*Neoophorus*	…	…	…	…	(5)	(Too irregular to count)	Posterior pair slightly elongated	Rosette
	Divided; the 2 flaps rolled in opposite directions	(6)	…	…	…	…	*Xenoophorus*	(6)	About 8	Very long	
	Divided; the 2 flaps rolled together	(7)	*Allotoca*	…	…	…	…	(7)	4 main ones (paired)	Moderate	
In dorsolateral bands and in dorsal part of septum	Entire; attached dorsally and ventrally; folded only dorsally; unbranched	(8)	…	…	*Characodon*	…	…	(8)	2 (paired)	Long to very long	Sheathed
In pair of dorsolateral convoluted ovigerous folds	Entire; attached dorsally and ventrally; everywhere vertical, nowhere folded nor branched	(9)	…	…	…	*Ilyodon**	*Balsadichthys**	(9)	About 8–12		
		(10)	…	*Girardinichthys*	*Lermichthys*	…	…	(10)	4 (paired)		
		(11)	…	…	…	…	*Skiffia* *Ollentodon,** *Neotoca**	(11)	3 (one median) †		

* Teeth of inner row bifid in these 5 genera, conic in all others; characters distinguishing *Skiffia, Ollentodon,* and *Neotoca* are given in items 7o, 7p, and 7q of the analytical key.
† Median trophotaenia branched at tip in some specimens of *Skiffia lermae.*

often cuts directly across the old schemes, which were based on features related to nutrition. Genera or supposed generic groups, defined on dentitional and intestinal characters, are now distributed through the system. For example, the goodeids characterized by having bifid teeth loosely attached to the soft, weakly-joined jaws of a transverse mouth—obviously feeders on algae and ooze—instead of being interpreted as comprising a single phyletic unit (the genus *Goodea,* or a closely related group of genera clustering about *Goodea*), are now regarded as representing the terminal elements of several independent, parallel lines of evolution, scattered through 3 subfamilies. The data summarized in Table II suggest that forked teeth were probably evolved from conical teeth no fewer than 8 times in this small family, now divided into 18 genera: a remarkable indication of parallel evolution. The discovery of *Crenichthys,* a genus of the oviparous family Cyprinodontidae having bifid teeth almost exactly like those of *Goodea,* but obviously derived from *Empetrichthys,* which has conic teeth, provides another and indubitable example of the independent origin of bifid teeth (see Hubbs, 1932*b*: 2). Various dismembered elements of the old genera which were defined on characters of nutritional significance are now realigned on a horizontal basis into apparently very closely related groups: for example the *Alloophorus–Xenotoca–Chapalichthys* series, the *Girardinichthys–Lermichthys* pair, and the *Ilyodon–Balsadichthys* combination (see Table II).

This subordination, in the taxonomy of the Goodeidae, of divisions based on highly adaptive characters related to nutrition, repeats the relatively recent revolutions in the classification of two other groups of fresh-water fishes, Cyprinidae and Poeciliidae. In those families the primary divisions were formerly made in accordance with contrasts between the carnivorous type of dentition associated with a short intestine and an herbivorous type of dentition correlated with a long intestine. These features are now used merely to separate terminal elements comprising one to several genera, for the evidence indicates that the characters associated with an herbivorous diet were repeatedly evolved, along parallel lines, within each family. This is particularly true of the Poeciliidae, as reclassified by Regan (1913) and Hubbs (1924*a* and 1926).

Since the former classifications of the Goodeidae as well as of the Poeciliidae have been shown to be extensively false, one is led to wonder how true or significant are the classifications based on external, adaptative features in families not possessing such remarkable clues to ancestry as the ovaries and trophotaeniae of the Goodeidae, or the gonopodia of the Poeciliidae.

External Genital Characters of the Males

The external genital characters of the males, although showing marked differences in various genera of Goodeidae, exhibit an underlying common structure strongly confirming, as indicated above, the common origin and integrity of the group. The terminal portion of the genital duct has a thick muscular wall, easily evident on external examination because the surface of the body is swollen and more or less devoid of scales between the anus and the genital opening. The external genital opening is a relatively large transverse slit near, at, or around the origin of the anal fin. The anterior 6[3] developed anal rays consistently form a more or less strongly differentiated portion of the fin: they are moderately to much shortened, less extensively branched than the following rays, variably reduced in thickness, more or less closely approximated, and as a group slightly to deeply set off by a notch from the rest of the fin. A slight to very marked dermal thickening is usually evident about the base of the lobe or over its entire surface, and the thickening of each side tends to form a pocket about part or all of the lobe.

The male characters associated with reproduction are of much less importance than the female reproductive features in the classification of the Goodeidae. This provides a sharp contrast with the situation in the taxonomy of the Poeciliidae. Some male characters of real value, however, do exist. Marked differences are apparent in the form of the wholly or largely scaleless area, between anus and genital opening, overlying the muscular end of the genital opening; in the curvature, length, strength, and degree of approximation of the 6 anterior developed anal rays; in the deepness of the notch between the anterior lobe (formed from these rays) and the rest of the anal fin; in the differential dermal thickening along the base of the lobe or opposite the entire lobe; and in the depth of the pouch formed between this dermal thickening and the anterior lobe.

The swollen, typically scaleless area between anus and genital opening is very short and much wider than long in *Ataeniobius,* and less massive than in other genera; it is wider than long in *Alloophorus, Zoogoneticus,* and *Xenoophorus;* about as wide as long in *Goodea;* longer than wide in *Xenotoca, Chapalichthys, Allodontichthys, Neoophorus, Ilyodon, Balsadichthys, Characodon, Girardinichthys, Lermichthys, Skiffia, Ollentodon,* and *Neotoca;* very much swollen basally, narrow distally, almost flasklike in *Girardinichthys.* The median portion of the posterior edge of this swollen lobe (the transverse slit of the genital opening) is moderately concave and crenate in *Alloophorus;* rather evenly concave in *Xenotoca, Chapalichthys, Goodea, Zoogoneticus, Neoophorus, Xenoophorus, Characodon, Lermichthys, Skiffia,* and *Ollentodon;* nearly straight and broad in *Allodontichthys;*

[3] In *Xenotoca, Goodea, Zoogoneticus, Neoophorus,* and *Balsadichthys,* a minute seventh ray was found at the front of this 6-rayed anterior lobe of the male anal fin; in *Chapalichthys,* at least, this rudimentary anterior ray seems to be consistently lacking; in *Xenoophorus* it is absent or represented by a very minute stump. The number of *developed* rays in the anterior lobe is consistently 6 in all genera examined, other than *Ataeniobius,* in which 7 developed rays are preceded by 1 minute ray.

nearly straight and narrow in *Girardinichthys;* convex (with a median lobe) in *Ataeniobius, Ilyodon, Balsadichthys,* and *Neotoca.* The character of the covering of the genital tube, between the anus and the genital opening, is especially distinctive in *Ilyodon* and *Balsadichthys.* In these genera the anterior half of this area is little swollen and is scaled over, except for a narrow median strip. This is further evidence of the intimate relationship between *Ilyodon* and *Balsadichthys.* In *Neoophorus* the anterior sides of the area are scaled, leaving a scaleless V, with the apex just behind the anus. The next nearest approach to this condition is evident in *Allodontichthys,* in which the anterior sides of the swollen area are partly scaled over.

The 6 anterior developed rays are relatively little crowded in *Goodea;* moderately crowded in *Alloophorus, Xenotoca, Chapalichthys, Zoogoneticus, Allodontichthys, Neoophorus, Characodon, Ilyodon,* and *Balsadichthys;* much crowded in *Xenoophorus, Skiffia, Ollentodon,* and *Neotoca.* The dermal thickening over the basal part of the anterior lobe is scarcely evident in *Goodea, Girardinichthys,* and *Lermichthys;* slightly to moderately developed, but showing only a slight pocketing over the rays in *Xenotoca, Chapalichthys* (tissues thin and delicate), *Zoogoneticus, Characodon,* and *Neotoca;* conspicuously developed but still not forming a deep pocket on each side in *Xenoophorus;* well developed and forming a moderate pocket in *Allodontichthys;* well developed and extended on several rays of fin behind the anterior lobe, but still without deep pockets, in *Alloophorus;* conspicuously developed about basal portion of lobe, but separated from the lobe to form a deep pocket on each side, in *Ilyodon* and *Balsadichthys;* most extensively developed, though not very thick, forming a pouch into which the entire lobe is retractable, in *Skiffia* and *Ollentodon.*

The relative height of the anterior lobe and the rest of the fin differ widely among the genera. In *Goodea* the anterior lobe is about three-fourths as high as the highest anal ray; in *Xenotoca, Zoogoneticus, Allodontichthys, Characodon, Ilyodon,* and *Balsadichthys,* about two-thirds; in *Chapalichthys* and *Girardinichthys,* one-half to two-thirds; in *Ataeniobius, Neoophorus, Xenoophorus,* and *Neotoca,* one-half or a little more than one-half; in *Alloophorus,* about one-half; in *Lermichthys,* about two-fifths; in *Skiffia* and *Ollentodon,* less than one-third.

The curvature of the rays also shows differences. In *Ataeniobius, Alloophorus, Characodon, Ilyodon, Balsadichthys, Girardinichthys, Lermichthys, Skiffia,* and *Ollentodon,* the rays differ little in size and are all gently curved backward. In *Xenotoca, Chapalichthys, Goodea, Zoogoneticus, Allodontichthys, Neoophorus, Xenoophorus,* and *Neotoca,* the anterior 4 developed rays of the lobe are more or less abruptly curved forward, whereas the fifth and sixth rays, strengthened to a variable degree, diverge to fill the gap between the fourth and seventh developed fin rays.

The male reproductive characters have not been determined for *Allotoca.*

CHARACTERS OTHER THAN THOSE RELATED TO REPRODUCTION: METHODS OF STUDYING, MEASURING, AND COUNTING

Although the ovarian and trophotaenial structures of the females and the external genital characters of the males, both discussed above, have proved of primary significance in the classification of the Goodeidae, numerous other structures display marked differences of value in distinguishing between related genera and between species. A few remarks on these characters may prove suggestive to other workers and will indicate how the determinations given in this paper were made.

INTESTINE.—The coiling of the intestine is studied through an incision on the right side, on which the gut is chiefly coiled. The shortest intestines are described as S-shaped for there is always a forwardly-directed, reversed fold in the median section. The S-shaped intestines show the first stage of lengthening by becoming kinked around the second bend, where the forwardly directed segment is bent backward toward the anus. The amount of kinking differs in the various species, in some producing as many as 3 or 4 short transverse segments. The longer intestines are more or less evenly coiled on the right side; the longest ones are very regularly coiled. Every gradation occurs, from a very short simple S-shaped intestine to a very long one regularly wound in a close spiral. The length of the gut is given numerical expression by counting the number of transverse (=vertical) segments.

GILL-RAKERS.—The number of gill-rakers differs in certain goodeids and has been used to help separate the superficially similar genera with loose, bifid teeth. *Xenoophorus, Skiffia,* and *Neotoca* have about 20 to 25 gill-rakers on the first arch, *Ollentodon* about 29, *Goodea* and *Balsadichthys* about 39 to 45. It is desirable to count the rakers under a binocular dissecting microscope, after the arch has been excised carefully so as to leave no rakers at either end. All rakers are counted, even the 1 or 2 rudimentary ones sometimes developed at either end of the arch, and no distinction is made between those on the upper and lower limb.

TEETH.—Using any reasonable magnification, no difficulty is encountered in determining whether the teeth of the main row are conic or bifid, or variably intermediate (in *Girardinichthys*), or whether they form an even series, or an irregular row of alternating elements. Greater difficulty is met with in deciding how compressed and how curved, keeled, or concave these teeth are, and whether they are to be classed as firmly or loosely attached to the jaws. Even the "fixed" teeth are more or less freely movable from side to side, but present considerable resistance to backward or forward movement. "Loose" teeth are more or less freely, and generally very freely, movable forward and backward. The degree of development of the teeth of the inner row, their shape when developed (whether conic or bifid, strong or hairlike), their size (whether small or minute), the width and shape of the inner band, and the degree of obsolescence of the band, all provide valuable characters, which, however, are very difficult to appreciate by ordinary means of examination. A satisfactory method of determining the characteristics of the inner teeth, and of the band which they form, is to hold either jaw, open and strongly lighted, under a high power (about 64×) of a binocular dissecting microscope, examining the teeth closely while playing a fine jet of compressed air on them. A glass pipette on the end of a length of rubber tubing serves for this purpose.

JAWS.—The strength of the jaws and the firmness of their mutual attachment at the symphysis differ greatly in various Goodeidae and provide good characters, even though a graded series in respect to these characters exists. These points may be determined by vertically manipulating the jaws with a dissecting needle, observing whether each jaw is thin, flexible, and rather independent in movement, or thick, stiff, and not independently movable.

MOUTH.—The width of the mouth is numerically expressed as the number of times the width over all, including the lips, enters the length of the head. Whether the mouth is strictly or almost wholly transverse, or possesses a moderate or a wide lateral gape, is determined by inspection. Despite the intermediate mouth characters exhibited by some species, the contrasts are usually sharp.

MEASUREMENTS.—All measurements are expressed as proportions, that is, as the number of times a given part enters some base length, usually the *standard length* from the tip of the snout (= anterior tip of upper lip) to the base of the caudal rays, where the caudal base bends most readily, or the *length of the head,* from the tip of the snout to the extreme margin of the opercular membrane. The measurement of the part, taken carefully with good dividers, is stepped along the curve of the base length, a measured number of times plus estimated tenths. The depth of the body is the greatest depth, not including fins or their bases. The depth of the caudal peduncle is the least depth. The length of the caudal peduncle extends from the end of the anal fin base to the base of the middle caudal rays. The length of the snout is measured from the tip of the upper lip to the front rim of the orbit, excluding the thin soft membrane about the orbit. The length of the orbit is the longest diameter, between the free fleshy rims. The interorbital is measured between the bony rims where these are closest.

PELVIC FIN.—The degree of separation or union of the innermost or sixth pelvic ray of one fin from or with its mate of the other fin, and from or with the body, offers a hitherto unused character of considerable value. In one extreme condition, exhibited by *Girardinichthys,* the inner rays are separated from the body, and from one another by an interspace about equal to the width of either pelvic base. In *Lermichthys* the inner rays are almost as well separated from one another, but are joined to the body and are more or less conjoined by a wide, thin membrane. In *Ataeniobius, Neoophorus,* and *Allotoca* the two fins are more or less separated. In other genera the sixth rays of the two fins are variously approximated or in contact, and, except in *Allodontichthys,* are slightly to widely joined to the body and to one another by membrane. In an extreme condition, developed only in *Zoogoneticus quitzeoensis,* the fifth pelvic rays of each side are in contact, forcing the sixth ray to lie between the fifth ray and the body, in the membrane connecting that ray with the mid-line of the belly.

COUNTS.—All dorsal and anal fin rays are counted, including the short anterior 1 or 2; the last is always counted as a double ray, that is, as split to the very base, even though the 2 elements are widely separated. The pectoral rays are all counted, none as doubled. The transverse scale rows are counted from the bound-down edge of the opercle to the end of the hypural. The longitudinal rows are counted between the origins of the dorsal and anal fins.

The statements regarding external characters in the following analysis are drawn not only from the literature, but also from an examination of specimens of all the species.

ANALYSIS OF THE GENERA AND SPECIES OF GOODEIDAE[4]

The following analysis of the genera and species of Goodeidae, simplified and made more graphical in Table II, aims to compare all known forms in respect to all main characters used in their classification, as well as to provide a key for their identification. That the analysis is primarily based on internal characters which may prove difficult to detect and which are evident only in adult females and embryos may raise objections.

On the first point we maintain that convenience, ease, and simplicity should be left only a very minor role in taxonomy, that the trenchancy of the ovarian and trophotaenial characters and their value in phyletic analysis repay any effort expended in their study, that the essential features of ovarian anatomy can be determined without undue difficulty in adult and even half-grown females by simple dissection under an ordinary binocular microscope, that at least the superficial features of the trophotaeniae are evident in half-grown to large embryos taken from females ordinarily preserved for museum specimens, and that such embryos are very often present.

In answering the objection that the analysis is based on characters derived only from adult (or in part from half-grown) females, it must be admitted that this circumstance does complicate and hinder the identification of specimens and even renders uncertain or impossible the final classifi-

[4] Excluding *Allodontichthys zonistius* (Hubbs), the generic position of which is indeterminable in the absence of females.

cation of species known only from males (*Allodontichthys zonistius* is the one species now known only from males). The important point is that these characters are the ones indicating the natural groups, and that classifications surely should be made natural rather than convenient. To discard a classification because it is based primarily on one sex would seem absurd to us. To do so consistently would virtually require abandoning the whole accepted family classification of the American Cyprinodontes, since the family characters, at least the superficial ones, are based on adult males, and would also require the abandoning of the modern, now as a whole well-authenticated taxonomy of the Poeciliidae, because the identification and classification of poeciliids now depends chiefly on the gonopodial characters of breeding males and remains a guess when such males are not at hand, except in genera and higher groups which may be recognized definitely on the basis of very superficial, at times almost subjective, characters.

The following analytical key has been constructed not only to indicate relationships but also to lead to precise identifications, whether either the ovarian or the trophotaenial characters are available, or even if neither of these anatomical features of prime value in classification are usable. The isolated *Ataeniobius toweri* is first set off by significant internal as well as by relatively trivial superficial characters. The primary separations are then made on the basis of ovarian anatomy, so that if the ovarian characters are determinable, the items numbered *2*, *3*, and *4* may be employed. The next divisions are made on the basis of the trophotaenial characters, which are itemized for all groups, so that by using items *5*, *6*, *12*, and *13* alone, identifications can be made solely on the basis of the differential features of the trophotaeniae. Superficial characters, such as those of tooth, mouth, and fin structure, are then employed to confirm the differentiation made on the basis of the deeper anatomical characters, and to lead on to definite genus and species placement and identification. These more superficial characters are co-ordinated and given for every genus and species, under the items numbered *7*, supplemented by alternatives in items *1* and *6* and elaborated as necessary in items *8* to *15*. In at least some minor details all of these co-ordinate items are alternative. Therefore it is possible to locate specimens of any known species by the use of the analytical synopsis, without recourse to the ovarian and trophotaenial characters. For real convenience in "running down" males and young females, and to obviate the need for dissecting specimens, however, we append, on pages 73 to 76 an artificial key for the genera and species of the family.

Analytical Key

1a.—*Embryo* apparently without trace of trophotaeniae (nutritive rectal processes), but with enlarged fin folds, both before and behind anus. *Yolk-sac* less reduced. *Dorsal fin* smaller (with 10 or 11 rays), and placed farther back, beginning distinctly behind origin of anal fin, more than twice as far from tip of snout as from base of caudal fin.

2a.—Ovigerous tissue developed in the outer wall of the ovary (except laterally), and in the septum. *Outer wall and especially septum of ovary* much thickened and highly vascular during pregnancy. (Pl. I, Fig. 6.)

3a.—Ovarian septum entire, relatively thick; attached only to middorsal line of ovary; rolled; with a short, scarcely rolled left branch more or less in contact with the ovarian wall (Pl. I, Fig. 6).

ATAENIOBIINAE[5]

7a.—Teeth of outer row uniformly bifid, long, slender; about 48 in each jaw; rather loosely attached to soft, weakly conjoined jaws; inner teeth bifid, weak, in a broad band (about 8 rows) with sharp posterolateral extensions. *Mouth* narrow (width over all about 2.9 to 3.9 in head); with slight lateral cleft. *Intestine* long, coiled. *Scales* in 45 to 47 rows. *Dorsal rays* 10 or 11. *Origin of dorsal* much nearer end of caudal than tip of snout. *Innermost (sixth) rays of the two pelvic fins* separated by an interspace about half as wide as base of fin, joined to body by a scaly membrane for about one-fourth or one-third their length. *Coloration:* weakly speckled along mid-sides. *Swollen area between anus and genital opening of males* much wider than long, very short (less massive than in other goodeids), with a median lobe on convex posterior margin; scales at side of lobe forming a deep pocket. *Anterior anal lobe of males* with 1 minute and 7 developed rays (6 developed rays in all other goodeids); lobe little more than half as high as highest anal ray.
Río Verde of the Río Panuco system:
1. *Ataeniobius toweri*

1b.—Embryo with well-developed trophotaeniae (nutritive rectal processes) but with poorly developed fin folds. *Dorsal fin* typically larger (very rarely with as few as 11 rays), and placed farther forward, beginning over or before origin of anal fin, less than twice as far from tip of snout as from base of caudal fin (dorsal fin beginning approximately over origin of anal fin, about twice as far from tip of snout as from base of caudal fin, in *Goodea gracilis* and *G. atripinnis;* slightly in advance of anal fin, but more than twice as far from tip of snout as from base of caudal fin, in *Allotoca dugèsii*).

2b.—Ovigerous tissue developed in the outer wall of the ovary (dorsally and ventrally in all species; laterally also, only in *Zoogoneticus quitzeoensis*), and in the septum. *Outer wall and septum of ovary* thickened, extremely vascular, spongy, and modified during pregnancy; the septum supplied chiefly with longitudinal blood vessels, and modified during pregnancy for the nutrition of the embryos. (Pl. I, Figs. 1–5). GOODEINAE

3b.—Ovarian septum entire; attached along both the middorsal and the mid-ventral line of the ovary (or just to the right of the mid-ventral line, in *Chapalichthys encaustus* and *Goodea luitpoldii*); more or less tightly folded back and forth, like a fan (Pl. I, Figs. 1–2).

[5] New subfamily.

5a.—Trophotaeniae not rosette-shaped, always greatly elongated, when fully developed extending to or beyond end of caudal fin, moderately pointed, rather regular, about 6 to 8 in number, arising by dichotomous branching from 3 backward-directed trunks (Pl. III, Figs. 3–5); histologically of the *unsheathed type:* completely filled by a spongy stroma, lacking a solid basal layer, and not separated by a primary tissue space from the surrounding or external epithelium, which is everywhere simple and of irregular height.

7b.—Teeth of even outer row sharply conic, without compression, moderately curved along front edge; about 25 in each jaw, not alternating; firmly attached to very strong, tightly joined jaws; inner teeth conic, small, in a narrow, curved band. *Mouth* rather broad (width over all about 2.6 to 2.8 in head); with well-developed lateral cleft. *Intestine* short, very little coiled (S-shaped, more or less kinked about second bend). *Scales* in 36 to 39 rows. *Dorsal rays* 12 to 14. *Origin of dorsal fin* at middle of total length including caudal fin. *Innermost* (*sixth*) *rays of the two pelvic fins* in contact, and slightly joined together and to body. *Coloration:* body much speckled, but without really definite markings on either body or fins. *Scales* somewhat larger, in 36 to 39 rows. *Swollen area between anus and genital opening of males* wider than long, with slightly concave, fimbriate posterior border; scales scarcely extended on anterior sides of this area. *Anterior anal lobe of males* with basal dermal thickening extended onto several succeeding rays, not forming a pocket; lobe slightly more than half as high as highest anal ray; rays of lobe moderately crowded, all weakly curved backward, all except first developed ray deeply branched; lobe separated by moderate notch from rest of fin.

Río Grande de Santiago system, on the plateau:
2. *Alloophorus robustus*

7c.—Teeth of even outer row uniformly and rather sharply bifid, scarcely compressed anteroposteriorly, little curved backward; about 15 to 20, scarcely alternating; firmly attached to the very strong jaws; inner teeth conic, small, forming a narrow, curved band. *Mouth* very narrow (width over all only 3.6 in head); with well-developed lateral gape. *Intestine* short, little coiled (S-shaped, with an extra coil about second bend). *Scales* in 33 to 38 rows. *Dorsal rays* 13 or 14. *Origin of dorsal fin* near middle of total length, including caudal fin. *Innermost* (*sixth*) *rays of the two pelvic fins* in contact and joined together and to body for about half their length. *Coloration:* spotted with dark in females; with an irregular longitudinal dark stripe or nearly plain in males. *Swollen area between anus and genital opening of males* longer than wide, somewhat turgid basally and constricted distally, with concave posterior border; anterior sides of this area scarcely scaled over. *Anterior anal lobe of males* with slight dermal thickening near base, not forming a pocket; lobe two-thirds as high as highest anal ray; developed rays of lobe moderately crowded, the first 4 curved forward, the last 2 slightly strengthened and divergent, the last 2 to 4 branched near tip; lobe separated by a shallow notch from rest of fin.

8a.—*Ovarian septum* attached ventrally to mid-line. *Tissues* not delicate, rather leathery.

Río Grande de Santiago and Río Panuco systems, on and below the plateau:

3. *Xenotoca variata*

7d.—*Teeth* of even outer row uniformly and rather sharply bifid, rather short, slightly compressed anteroposteriorly; each lobe with a low keel near outer edge of posterior face and with an expanded, sharp, and sometimes irregular inner edge; weakly curved backward; about 15 or 16, scarcely alternating; rather firmly attached to the moderately strong and rather securely connected jaws; inner teeth small, conic, forming a narrow, curved band. *Mouth* narrow (width over all about 4.0 in length of head); with much reduced lateral gape. *Intestine* considerably elongate, coiled (with about 5 transverse elements on right side). *Scales* in 34 to 37 rows. *Dorsal rays* 15 or 16. *Origin of dorsal fin* far in advance of middle of total length, including caudal fin. *Innermost (sixth) rays of the two pelvic fins* in contact, and joined together and to body for about half their length. *Coloration:* strongly barred along middle of sides in both sexes. *Swollen area between anus and genital opening of males* slightly longer than wide, with broad, evenly concave posterior border. *Anterior anal lobe of males* with delicate dermal thickening near base, forming a slight pocket; lobe one-half to two-thirds as high as highest anal ray; developed rays of lobe moderately crowded, the first 4 curved forward, the last 2 distinctly strengthened and rather well spaced; all but the first branched near tip; lobe separated by a small notch from rest of fin.

8b.—*Ovarian septum* attached ventrally to right of midline. *Tissues* all very delicate, not leathery.

Lago de Chapala and Río Grande de Santiago, on the plateau:

4. *Chapalichthys encaustus*

5b.—*Trophotaeniae* forming a rosette about the anus, always short, very blunt, and very irregular in shape and size (Pl. II, Figs. 1–2);

histologically of the *rosette type:* stroma composed of a spongy upper and a dense basal layer, both lying below a shallow, transverse tissue space; external epithelium compound, with regular high cuboidal cells over the tissue space, but with flat, irregular cells where in contact with the stroma.

7e.—*Teeth* of even outer row uniformly bifid, with truncated lobes; long and slender, much compressed anteroposteriorly, rather strongly curved backward; about 40 in each jaw, more or less regularly alternating; very loosely attached to the extremely narrow, weak, and poorly joined jaws; inner teeth minute, almost hair-like when exposed from investing gum, obsolescent toward anterior edge of the broad and nearly transverse band, which has slight backward extensions at sides. *Mouth* moderately wide; with almost strictly transverse gape. *Intestine* elongate, much coiled (with about 12 transverse segments). *Gill-rakers* on first arch about 39 to 45, relatively long. *Scales* in 34 to 44 rows. *Dorsal rays* 12 to 15. *Origin of dorsal fin* considerably behind middle of total length, including caudal fin. *Innermost (sixth) rays of the two pelvic fins* in contact and joined together and to body for 0.3 to 0.7 their length. *Coloration:* body speckled in young, plain in adult. *Swollen area betweeen anus and genital opening of males* about as wide as long, with broad, gently concave posterior border. *Anterior anal lobe of males* with scarcely any dermal thickening; lobe about three-fourths as high as highest anal ray; developed rays of lobe relatively little crowded, the first 4 strongly curved forward, the last 2 strengthened and divergent; most or all rays branched near tip; lobe separated by a small notch from rest of fin.

GOODEA

9a.—*Ovarian septum* attached ventrally to mid-line (Pl. II, Fig. 1). *Scales* in 34 to 39 rows. *Dorsal fin* with 12 to 14, usually 12 or 13 rays; more posterior: distance from its origin to base of caudal usually about half distance forward to tip of snout. *Head* larger, about one-fourth standard length, or larger. *Size* small, usually much less than 4 inches.

10a.—*Body* rather slender: greatest depth 3.3 to 3.7 in standard length; least depth about half length of head in adult. *Width of mouth* usually about 2.5 in length of head.

Río Santa María (Río Panuco system), on the plateau:

5\. *G. gracilis*

10b.—*Body* moderately robust: greatest depth about 2.6 to 3.2 in standard length; least depth about two-thirds length of head in adult. *Width of mouth* about 3.0 in length of head.

Streams and smaller lakes, Río Grande de Santiago system, on the plateau:
6. *G. atripinnis*

9b.—*Ovarian septum* attached ventrally to right of mid-line (Pl. II, Fig. 2). *Scales* in 38 to 44 rows. *Dorsal fin* with 12 to 15, usually 13 or 14 rays; less posterior: distance from its origin to base of caudal usually distinctly more than half distance forward to tip of snout. *Head* smaller, usually less than one-fourth standard length. *Size* relatively large, often more than 4 inches (extreme length about 9 inches).

10c.—*Body* depth moderate, 3.0 to 3.3 in standard length; least depth about two-thirds length of head in adult. *Width of mouth* 2.6 to 2.9 in length of head.

Larger lakes (Chapala, Pátzcuaro, Zacoalcos, and perhaps others) in the Río Grande de Santiago system, on the plateau:
7. *G. luitpoldii*

3c.—*Ovarian septum* entire; attached only to middorsal line of ovary; rolled; unbranched (Pl. I, Fig. 5).

5c.—*Trophotaeniae* not rosette-shaped, greatly elongated, when fully developed extending to or beyond end of caudal fin, moderately pointed, somewhat irregular, about 10 to 12 in number, comprising several small anterior ones and others arising by the irregular branching of a main posterior trunk (Pl. III, Fig. 6); histologically of the *unsheathed* type, as in *5a*.

7f.—*Teeth* of even outer row conic, firmly attached to the very strong, tightly joined jaws; inner teeth conic, relatively large and strong, in a rather narrow, arched band. *Mouth* narrow (width over all 3.4 to 3.8 in length of head); with rather wide lateral cleft. *Intestine* short (S-shaped, slightly kinked about second bend). *Scales* in 29 to 34 rows. *Dorsal rays* 12 to 14. *Origin of dorsal fin* near middle of total length, including caudal fin. *Next to innermost (fifth) rays of the two pelvic fins* in contact, and joined to mid-line of body by a membrane containing the hidden sixth ray. *Coloration:* nearly plain (sometimes speckled), except for several black spots or bars in one row (rarely irregular or doubled) along lower sides; a pair of such spots (rarely fused) at base of caudal; dorsal and anal fins plain in females, but with conspicuous red borders in males. *Swollen area between anus and genital opening of males* wider than long, with very broad, evenly concave posterior border. *Anterior anal lobe of males* with moderate dermal thickening near base, forming a slight pocket; lobe about two-thirds as high as highest anal ray; developed rays of lobe moderately crowded, all gently curved forward, the last 2 somewhat strengthened and more spaced than the others; last 2 or 3 slightly branched; lobe separated by a moderate notch from rest of fin.

Río Grande de Santiago system, about lagos de Chapala and Quitzeo, on the plateau:
8. *Zoogoneticus quitzeoensis*

3d.—Ovarian septum divided near or below middle, to form 2 rolled flaps, one attached dorsally, the other ventrally (Pl. I, Figs. 3–4).

4a.—Ovarian flaps thick; the ventral flap short, little rolled, partly divided, and attached to left of mid-line (Pl. I, Fig. 4).

5d.—Trophotaeniae almost typically rosette-shaped, only the posterior pair of processes showing a slight tendency to become elongated, the several anterior processes irregularly lobate (Pl. II, Fig. 3); histologically of the *rosette type* as in *5b*, but with the primary tissue space much reduced.

7g.—Teeth of outer row conic, large; about 20 in each jaw; firmly attached to the strong, tightly joined jaws; inner teeth conic, in 2 strongly curved rows. *Mouth* rather narrow (width over all about 3.4 to 3.5 in head); with well-developed lateral cleft. *Intestine* short. *Scales* in about 32 to 39 rows. *Dorsal rays* 15 to 19. *Origin of dorsal fin* near middle of total length, including caudal fin. *Innermost (sixth) rays of the two pelvic fins* separated from each other by an interspace about as wide as base of fin, and joined together and to body for about one-third their length. *Coloration:* body crossed by irregular, submedian, narrow dusky bars, with some to much speckling. *Swollen area between anus and genital opening of males* nearly twice as long as wide, somewhat flask-shaped, with noncrenate, slightly concave posterior margin; anterior half with scales extending to the edge of a V having its apex just behind anus. *Anterior anal lobe of males* with 1 minute and 6 developed rays; lobe a little more than half as high as highest anal ray; the rays crowded.

Basin of the Río Lerma, and Valle de México, on the plateau:
10. *Neoophorus diazi*

4b.—Ovarian flaps thick; the ventral flap almost as long as the upper, strongly rolled in the opposite direction, undivided and attached to mid-line (Pl. I, Fig. 3).

5e.—Trophotaeniae very considerably elongated, when fully developed about reaching end of caudal fin, not lobate, asymmetrical (the long trunk arising from the left side, but twisted to a submedian position), often slightly branched, about 8 in number

(Pl. II, Figs. 5–6); histologically of the *rosette type,* as in *5b,* but with the primary tissue space greatly reduced, often to a cleft.

7h.—Teeth of even outer row uniformly and rather deeply bifid, with rounded or truncated lobes; rather long and slender, much compressed anteroposteriorly, moderately curved; 15 to 30 in each jaw, weakly to moderately alternating; rather loosely attached to the thin and rather weakly joined jaws (more strongly attached than in *Goodea,* however); inner teeth conic, very small (but less minute and hairlike than in *Goodea*), in a moderately wide band with definite backward extensions at sides. *Mouth* rather narrow (width over all, 2.6 to 3.4 in length of head); with markedly restricted lateral gape. *Intestine* elongate, considerably coiled (with about 4 to 7 transverse segments). *Gill-rakers* on first arch 21 to 25. *Scales* in 33 to 39, usually about 35 or 36 rows. *Dorsal rays* 12 to 14. *Origin of dorsal fin* considerably nearer end of caudal fin than tip of snout in females, about equidistant between these points in males. *Innermost (sixth) rays of the two pelvic fins* slightly separated, and not at all or only slightly joined together and to body by membrane. *Coloration:* speckled with dark in young, plain in adult, never barred. *Swollen area between anus and genital opening of males* wider than long, with broad, evenly concave posterior border. *Anterior anal lobe of males* with well-developed dermal thickening near base, forming only a slight pocket; lobe half or somewhat more than half as high as highest anal ray; the rays much crowded, and rather strongly and evenly curved forward; last 2 to 4 rays branched; lobe separated by a deep notch from rest of fin.

XENOOPHORUS

11a.—Length of head 3.3 to 3.6 in standard length in males; 3.5 to 3.9 in females. *Least depth of caudal peduncle* in adult females 1.7 to 2.3, usually about 2.0 in head. *Distance from origin of anal fin to base of caudal fin* 2.4 to 2.8 in standard length. *Anterior profile* little concave, even in adult males.

Basin of Río Panuco, about Jesús María:
11. *X. captivus*

11b.—Length of head 2.9 to 3.3 in standard length in males; 3.2 to 3.6 in females. *Least depth of caudal peduncle* in adult females 1.8 to 2.3, usually about 2.0 or 2.1 in head. *Distance from origin of anal fin to base of caudal fin* 2.4 to 2.8

in standard length. *Anterior profile* more concave, becoming deeply concave in adult males.

Río Santa María, tributary to Río Panuco:
12. *X. erro*

11c.—Length of head 3.2 to 3.5 in standard length in males; 3.4 to 3.8 in females. *Least depth of caudal peduncle* in adult females 2.1 to 2.5, usually about 2.3 in head. *Distance from origin of anal fin to base of caudal fin* 2.6 to 3.2 in standard length. *Anterior profile* little concave, even in adult males.

Isolated streams in San Luis Potosí, among the hills on the plateau north of Río Santa María:
13. *X. exsul*

4c.—Ovarian flaps relatively thin; the ventral flap long, rolled together with and inside the dorsal flap, undivided and attached to mid-line.

5f.—Trophotaeniae slightly elongated anteroposteriorly, when developed to maximum not nearly reaching end of caudal fin, slightly lobate; the minor branches scarcely developed, the main branches tending to be restricted to an anterior and a posterior pair (Pl. II, Fig. 4); histologically of the *rosette type,* as in *5b.*

7i.—Teeth of outer row long-conic, firmly attached to the strong, well-joined jaws; inner teeth conic, of moderate size, irregularly arranged in 2 moderately curved rows. *Mouth* rather narrow (width over all about 3.2 in head); with well-developed lateral cleft. *Intestine* short. *Scales* in 29 to 35 rows. *Dorsal rays* 15 to 17. *Origin of dorsal fin* very far behind middle of total length, including caudal fin. *Innermost (sixth) rays of the 2 pelvic fins* separated from each other at base by an interspace as wide as base of fin, but in contact on distal half; joined together and to body for one-third their length. *Coloration:* body crossed by regular, high, wide blackish bars. [Male characters unknown.]

Basin of the Río Lerma, on the plateau:
14. *Allotoca dugèsii*

2c.—Ovigerous tissue confined to a pair of short and narrow bands adhering flatly to the dorsolateral walls of the ovary, and to the upper part only of the septum. *Outer wall and septum of ovary,* except where ovigerous dorsally, remaining relatively thin and unmodified during pregnancy; dorsal part of septum becoming highly vascular with large longitudinal blood vessels, and modified for the nutrition of the embryos. (Pl. I, Fig. 8.)

3e.—Ovarian septum entire, attached to both middorsal and mid-ventral line, somewhat folded, fan-fashion, where ovigerous dorsally, but otherwise nearly straight (Pl. I, Fig. 8).

5g.—Trophotaeniae much elongated, when developed to maximum extending about to end of caudal fin, reduced to a single posterior pair of slender ribbons (Pl. II, Fig. 9); stroma apparently surrounded by a primary tissue space; histological structure probably of the *sheathed type,* as in *5h.*

CHARACODONTINAE

7j.—*Teeth* of even outer row uniformly bifid, except at sides of jaw; with sharp and conic lobes, scarcely compressed anteroposteriorly; strong and not greatly elongate, gently curved backward; 16 to 21 (in 2 specimens), scarcely alternating; firmly attached to the strong, tightly joined jaws; inner teeth conic, small, in a narrow, curved band. *Mouth* rather narrow (width over all 2.9 to 3.1 in length of head); with well-developed lateral gape. *Intestine* short and little coiled (with about 4 short transverse segments). *Scales* in 31 to 33 rows. *Dorsal rays* 11 to 13. *Origin of dorsal fin* far behind middle of total length, including caudal fin. *Innermost (sixth) rays of the 2 pelvic fins* rather well separated, but more or less joined together and to body. *Coloration:* body with short black bars in females, with a longitudinal stripe or plain in males. *Swollen area between anus and genital opening of males* longer than wide, contracted toward the rather narrow, concave, posterior border. *Anterior anal lobe of males* with moderate dermal thickening near base, forming a slight pocket; lobe about two-thirds as high as highest anal ray; the rays moderately crowded, and gently curved backward; the rays all unbranched; lobe separated by a shallow notch from rest of fin.

Interior drainage and headwaters of Río Mezquital, on the Sonoran plateau:

15. *Characodon lateralis*

2d.—*Ovigerous tissue* restricted to a pair of much convoluted folds, each suspended in its ovarian compartment from the dorsolateral ovarian wall. *Outer walls and septum of ovary* entirely nonovigerous, remaining relatively thin and unmodified even during pregnancy; the septum chiefly supplied with vertical blood vessels; the convoluted folds becoming thickened, extremely vascular, spongy, and otherwise modified during pregnancy. (Pl. I, Fig. 7.)

3f.—*Ovarian septum* entire, attached to middorsal and mid-ventral line, straight and vertical, not folded (Pl. I, Fig. 7).

5h.—*Trophotaeniae* much elongated, when developed to maximum extending about to end of caudal fin (not so far in *Lermichthys*), 3 to many in number (Pl. II, Figs. 7–8 and Pl. III, Figs. 1–2); histologically of the *sheathed type:* with a spongy stroma, and well vascularized by internal blood vessels or a superficial capillary plexus; except for a narrow strip of attachment on one side, separated by a wide primary tissue space from the external epithelium, which is simple and cuboidal or columnar.

GIRARDINICHTHYINAE[6]

6a.—*Trophotaeniae* numerous, about 8 to 14 (Pl. III, Fig. 2). *Fins:* dorsal usually with several more rays than anal, but

[6] New subfamily.

with fewer than 18 rays; caudal with upper angle somewhat produced, the margin slightly lunate, and the lower angle shortened and rounded off. *Coloration:* one or more of the unpaired fins with a blackish bar near or at margin; body variably speckled with dark and light in male, and with more or less definite parrlike bars along a diffuse dark lateral stripe in female.

7k.—*Teeth* of main row uniformly bifid, with a low keel on the posterior face of each pointed lobe; strong and not greatly elongate, little compressed anteroposteriorly, strongly curved backward; about 25 in each jaw, in an even row; firmly implanted in moderately strong and rather tightly joined jaws; teeth of inner row bifid and in an arched single series or very narrow band in upper jaw, obsolete in lower jaw. *Mouth* rather narrow (width over all 2.6 to 3.5 in length of head); with a moderate lateral gape. *Intestine* long and much coiled (with 8 to 12 transverse segments). *Scales* in 46 to 50 rows. *Dorsal rays* 14 to 17. *Origin of dorsal fin* near middle of total length, including caudal fin. *Innermost (sixth) rays of the two pelvic fins* closely approximated and joined together and to body for 0.1 to 0.4 their length. *Swollen area between anus and genital opening of males* longer than wide (measuring length from anus), with a produced median lobe on posterior border; anterior half of area scaled over except for a narrow median strip. *Anterior anal lobe of males* with well-developed dermal thickening near base, forming a deep pocket on each side; lobe about two-thirds as high as highest anal ray; the rays moderately crowded, weakly curved backward; 5 or 6 of the rays branched; lobe separated from rest of fin by a moderate notch.

ILYODON

12a.—*Scales* in 46 to 53 rows. *Head* thick, but narrowed forward. *Mouth* rather narrow (width over all 2.6 to 3.5 in length of head); with a moderate lateral gape. *Caudal peduncle* in adults half or a little more than half as deep as head is long. *Coloration:* the dark and light speckling of body, and the barring, usually less conspicuous than in *B. xantusi;* fin markings usually less prominent; dashes on basal two-thirds of dorsal and caudal fins of males usually much less prominent, often weak, not followed by a very conspicuous light area or band, which when evident is not bright yellow in life. *Trophotaeniae* 8 to 10; the larger posterior ones much flattened.

Streams of Jalisco and Colima, below the plateau:
16. *Ilyodon furcidens*

7l.—Teeth of main row uniformly bifid, with posterior face of each rounded lobe hollowed out; rather weak and long, considerably compressed anteroposteriorly, strongly curved backward; about 45 in each jaw, more or less regularly alternating to form an imperfect double row; loosely set in soft, poorly joined jaws; teeth of inner row usually obsolete or obsolescent in both jaws (a very narrow, little arched band of bifid teeth occasionally developed in upper jaw in *B. whitei*). *Mouth* wider (width over all 2.0 to 2.8 in length of head); with more or less strictly transverse gape. *Intestine* long and much coiled (with 8 to 12 transverse segments). *Gill-rakers* about 40 on the first arch. *Scales* in 43 to 55 rows. *Dorsal rays* 14 to 17. *Origin of dorsal fin* near middle of total length, including caudal fin. [*Pelvic fin and male reproductive characters* as in *7k*.]

BALSADICHTHYS

12b.—Scales usually smaller, in 46 to 55 rows. *Head* less bulky. *Mouth* narrower (width over all 2.4 to 2.8 in length of head); with a slight arch. *Caudal peduncle* slenderer (in adults less than half as deep as head is long). *Coloration:* the dark and light speckling of body, and the barring, less conspicuous; fin markings dusky; dashes on basal two-thirds of dorsal and caudal fins merely dusky, in fine pattern, usually obsolescent in females. *Trophotaeniae* 10 to 14, little flattened (Pl. III, Fig. 2).

Upper tributaries of Río Balsas, in mountains south of the plateau:

17. *B. whitei*

12c.—Scales usually larger, in 43 to 50 rows. *Head* bulkier. *Mouth* wider (width over all 2.0 to 2.6 in length of head); almost strictly transverse. *Caudal peduncle* deeper (in adult females half or a little more than half as deep as head is long). *Coloration:* the dark and light speckling of body, and the barring, more conspicuous; fin markings usually black; dashes on basal two-thirds of dorsal and caudal fins usually conspicuous in males and often so in females, followed in male by a conspicuous light area or band which is bright yellow in life. *Trophotaeniae* 10 to 13; the larger posterior ones much flattened.

Streams about Colima, below the plateau:

18. *B. xantusi*

6b.—Trophotaeniae consistently 4: a short anterior pair, and a long posterior pair (Pl. II, Figs. 7–8). *Fins:* dorsal and anal with rays in about equal number (18 to 30), often more in anal than dorsal; caudal with upper angle scarcely or not at all produced, the margin rounded or only very slightly concave, and the lower angle not distinctly cut off; unpaired fins without a blackish bar near or at margin.

7m.—*Teeth* of outer series conic to truncate; some arrow-shaped or slightly bifid or trifid; sometimes almost uniformly bifid; moderately long and strong, somewhat compressed anteroposteriorly, with posterior face of tip concave and anterior face of stem slightly keeled; only moderately curved backward; 19 to 27 in each jaw, scarcely alternating; firmly implanted in the strong, well-connected jaws; teeth of the curved inner row conical, in about 2 series. *Mouth* narrow (width over all about 3.0 in head); with some lateral gape. *Intestine* rather short, S-shaped, with some coiling (about 3 transverse segments) at second bend. *Scales* in 40 to 45 rows. *Dorsal and anal fins* elongate, with 18 to 26 rays; dorsal base in females about two-thirds as long, in males about as long as head. *Origin of dorsal fin* slightly before middle of total length including caudal fin in females, decidedly before that point in adult males. *Innermost (sixth) rays of the two pelvic fins* widely separated by an interspace about as wide as pelvic base, and disconnected from one another and from body. *Coloration:* breeding males jet black; dark blotch above anus smaller and less conspicuous than in *Lermichthys*, or lacking; sides speckled, barred, or streaked (but these different phases less distinct than in *Lermichthys*). *Swollen area between anus and genital opening of males* longer than wide, very conspicuously swollen and expanded, but constricted terminally into an almost flasklike shape, with narrow and nearly straight posterior border. *Anterior anal lobe of males* with scarcely any definite dermal thickening toward base; lobe one-half to two-thirds as high as highest anal ray; the rays very much crowded, gently curved backward; lobe separated by a well-developed notch from rest of fin.

13a.—*Posterior pair of trophotaeniae* very long, when developed to maximum reaching to or beyond caudal fin (Pl. II, Fig. 7). *Body* rather slender (the adults usually less than one-third as deep as long), chubby forward, attenuate posteriorly.

Valle de México (on the plateau):
19. *Girardinichthys innominatus*

7n.—*Teeth* of outer series uniformly bifid, with pointed lobes; rather long, moderately compressed, weakly curved backward; about 20 in each jaw, scarcely alternating; firmly implanted in moderately strong and well-joined jaws; those of inner series conic, in a narrow, curved band. *Mouth* narrow (width over all about 3.0 in head); with some lateral gape. *Intestine* short, S-shaped, with little coiling (only 1 to 3 transverse segments) at second bend. *Scales* in 42 to 47 rows. *Dorsal and anal fins* much elongated, with more than 25 rays; dorsal base in females about as long as head, in males about half longer. *Origin of dorsal fin* slightly before middle of total length including caudal fin in females, far before that point in adult males. *Innermost (sixth) rays of the two pelvic fins* well separated by an interspace nearly as wide as pelvic base, but joined to body and often together by a wide, thin, flat membrane. *Coloration:* breeding males darkened, but never black; blotch above anus always large, conspicuous, blackish; sides mottled or definitely barred or definitely streaked, or showing intermediate or combined phases. *Swollen area between anus and genital opening of males* longer than wide, only moderately swollen, little constricted toward gently concave posterior border, not flasklike. *Anterior anal lobe of males* with scarcely any definite dermal thickening toward base; lobe about two-fifths as high as highest anal ray; the rays very much crowded, gently curved backward; lobe separated by a rather shallow notch from rest of fin.

13b.—Posterior pair of trophotaeniae of moderate length, not reaching end of caudal fin (Pl. II, Fig. 8). *Body* typically deeper (the adults usually more than one-third as deep as long), distinctly more oblong in outline.

Headwaters of Río Lerma (on the plateau):
20. *Lermichthys multiradiatus*

6c.—Trophotaeniae always 3, forming a regular trident, with a median branch which is often divided at tip in *Skiffia lermae* (Pl. III, Fig. 1). *Fins:* dorsal and anal with rays in about equal number (12 to 17); caudal with upper angle scarcely or not at all produced, the margin rounded or only very slightly concave and the lower angle not distinctly cut off; unpaired fins without blackish band near margin.

7o.—Teeth of even outer row uniformly bifid, with truncate lobes; rather weak and long, strongly and flatly compressed anteroposteriorly, little curved backward; about 18 or 19 in each jaw, scarcely to moderately alternating; very loosely attached to rather weak jaws; teeth of inner row conic or round-tipped, obsolescent except where thickly developed outward and backward in lower jaw. *Mouth* narrow (width over all 3.0 to 4.0 in head); with greatly restricted lateral gape (almost strictly transverse). *Intestine* elongate, evenly coiled on right side (with 6 to 8 transverse segments). *Gill-rakers* on first arch about 25. *Scales* in 33 to 37 rows. *Dorsal rays* 12 or 13. *Origin of dorsal fin* distinctly (females) or much (males) nearer tip of snout than end of caudal fin. *Innermost (sixth) rays of the two pelvic fins* rather well separated, but largely bound down by membranes which are narrowly conjoined on mid-line. *Swollen area between anus and genital opening of males* longer than wide, only moderately swollen, little constricted toward distinctly concave posterior border. *Anterior anal lobe of males* wholly retractable within a dermal pocket; lobe less than one-third as high as highest anal ray; the rays very much crowded, gently curved backward; lobe separated by a deep notch from rest of fin.

SKIFFIA

14a.—*Coloration:* densely variegated with dusky in each sex. *Median posterior trophotaenia* about three-fourths as long as the lateral ones, simple or divided (Pl. III, Fig. 1).

15a.—*Body* slenderer, and more conspicuously mottled; bar at base of caudal tending to be horizontal. *Median posterior trophotaenia* consistently simple.

Río Grande de Santiago system (Lago de Zirahuen) and Valle de México (Lago de Chalco), on the plateau:
21. *S. variegata*

15b.—*Body* deeper, and rather inconspicuously mottled; bar at base of caudal tending to be vertical. *Median posterior trophotaenia* divided at tip in two-thirds of the individuals (Pl. III, Fig. 1).

Río Grande de Santiago system (Lago de Pátzcuaro, Celaya), on the plateau:
22. *S. lermae*

7p.—*Teeth* of outer row uniformly bifid, with broadly rounded lobes; moderately weak and long, strongly and flatly compressed anteroposteriorly, rather strongly curved backward; about 30 in each jaw, some alternating; very loosely attached to rather weak jaws; teeth of inner row mostly bifid but occasionally blunt or conic, obsolescent except for 1 or 2 rows in lower jaw along outer edge of each band and its posterior extension. *Mouth* narrow (width over all 3.0 to 3.5 in head); with greatly restricted lateral gape (almost strictly transverse). *Intestine* elongate, evenly coiled on right side (with 6 to 8 transverse segments). *Gill-rakers* on first arch about 29. *Scales* in 33 to 35 rows. *Dorsal rays* 15 to 17. *Origin of dorsal fin* decidedly nearer tip of snout than end of caudal fin in both sexes. [*Pelvic fin characters* and *male reproductive characters* as in *7o*.]

14b.—Coloration: upper and posterior parts of body with definite rows of blackish spots, one to each scale, more conspicuous in females than in males; often coarsely blotched with black on lower posterior sides. *Median posterior trophotaenia* about as long as lateral ones, simple.

Lower portion of Río Grande de Santiago system, on the plateau:
23. *Ollentodon multipunctatus*

7q.—Teeth of outer row uniformly bifid, with broadly rounded lobes; fairly robust, strongly and flatly compressed anteroposteriorly, weakly curved backward; about 16 in each jaw, not or barely alternating; rather loosely attached to moderately strong jaws; teeth of inner row likewise bicuspid, not obsolescent toward mid-line and not thickly developed outward and backward, forming instead a narrow, moderately curved band. *Mouth* narrow (width over all 3.3 to 4.0 in head); with considerably restricted lateral gape (forming a wide arch). *Intestine* not much elongated, kinked but not evenly coiled on right side (with about 3 or 4 transverse segments). *Gill-rakers* on first arch about 20. *Scales* in 29 to 33 rows. *Dorsal rays* 13 to 15. *Origin of dorsal fin* slightly (females) or considerably (males) nearer tip of snout than end of caudal fin. *Innermost (sixth) rays of the two pelvic fins* not bound down to body, and separated from one another by about one-half width of pelvic base. *Swollen area between anus and genital opening of males* longer than wide, only moderately constricted toward the medially convex posterior border. *Anterior anal lobe of males* with moderately developed dermal thickening near base, forming only a very slight pocket; lobe a little more than half as high as highest anal ray; the rays very much crowded, gently curved backward; lobe separated by a deep notch from rest of fin.

14c.—Coloration: females with a black axial stripe, and a shorter, lower stripe over the belly in advance of a black blotch or bar above the anus; males with a single dark band more or less broken into bars. *Median posterior trophotaenia* distinctly longer than the lateral ones, and undivided (rarely with incipient division at tip or largely fused with lateral ones).

Lower part of Río Grande de Santiago system, on the plateau:
24. *Neotoca bilineata*

ATAENIOBIINAE, NEW SUBFAMILY

GENUS *ATAENIOBIUS* HUBBS AND TURNER

Ataeniobius.—[Hubbs and Turner], in Turner 1937*a*: 4; 1937*b*: 495, 510–11, 513–14 (name *Ataeniobius toweri* indicated as taken from the manuscript for the present paper and used with statement that the trophotaeniae are lacking).

Genotype, *Goodea toweri* Meek.

A new subfamily and genus are erected for *Goodea toweri* because this species, alone among all the Goodeidae, lacks any trace of the trophotaeniae or nutritive rectal processes. Since the yolk-sac is less reduced in this species than in other goodeids and the embryonic fin folds are especially well developed, as though in compensation for the lack of these nutritive processes, it is plausible to assume that *Ataeniobius toweri* or its ancestral line diverged from the goodeid stem before any of the other living genera were differentiated (Turner, 1937*b*: 510, 513). It is of interest in this connection to recall that this species has the most easterly range of any goodeid, most removed in that direction from the Río Lerma basin which is the center of distribution for the family (see p. 10).

It is therefore assumed that the close agreement between *Ataeniobius* and *Goodea* in dentition, jaw structure, and intestinal length, which led Meek to refer *toweri* to *Goodea,* is the product of independent parallel evolution (see p. 17). Rather distinctive superficial characters (see items *11a* and *11b* in key on p. 74) confirm this view.

It is not necessary to repeat here the diagnostic features of *Ataeniobius,* for these are given, so far as known to us, in items *1a, 2a, 3a,* and *7a* of the analytic key (p. 23), which provides a comparison between *Ataeniobius* and all other genera of the family on the basis of these features.

Ataeniobius, living [as embryo] without trophotaeniae, from ἁ privitive, ταινία band, and βίος, means of living.

1. *Ataeniobius toweri* (Meek)

(Pl. I, Fig. 6, section of ovary.)

Goodea toweri.—Meek, 1904: xxxvii, 137, *138*–39, Fig. 41 (original description; Río Verde, San Luis Potosí). Regan, 1907: 90–*91* (description). Eigenmann, 1909: 298 (distribution). Hubbs, 1924*b*: 4. Jordan, Evermann, and Clark, 1930: 184 (listed). Turner, 1933*c*: 210 (distribution). Mendoza, 1937: 113 (lack of trophotaeniae).

Ataeniobius toweri.—Turner, 1937*a*: 4; and 1937*b*: 495, 510–11, 513–14 (lack of trophotaeniae; relation).

We have re-examined Meek's types, the only known specimens of this very interesting species. The embryonic and ovarian characters were determined by Turner on the specimens in the Field Museum, and by Hubbs on one of the two paratypes in the National Museum. The last-mentioned specimen, 50 mm. long, contains 9 developed embryos about 12 mm. long.

These show no trace of nutritive processes, but the fleshy fin fold is well developed, especially about the anal fin; a median flap immediately in advance of the anus is obviously a continuation of the fin fold. The left lobe of the ovarian septum is short and very compact and largely adherent to the ovarian wall. The right lobe is larger, square-edged, and mostly free from the ovarian wall, against which one face of the lobe is appressed; the inner or left face of this lobe is deeply emarginate. The distal ends of the two ovarian lobes are widely separated. The ovarian characters of this specimen are at some variance with those indicated on Plate I, Figure 6.

SUBFAMILY GOODEINAE

GENUS *ALLOOPHORUS* HUBBS and TURNER

Alloophorus.—[Hubbs and Turner], in Turner, 1937*b*: 507–9, 513 (name *Alloophorus robustus* used, and indicated as taken from the manuscript for the present paper; trophotaeniae described).

Genotype, *Fundulus robustus* Bean.

This, the first of our segregates from the genus *Zoogoneticus* as recognized by Meek, Regan, and Hubbs, is characterized chiefly by fundamental differences in the structure of the ovary (Pl. I, Fig. 1) and of the trophotaeniae (Pl. III, Fig. 4). These characters are stated respectively in items *3b* and *5a* of the analytical key (pp. 24–25) so as to contrast with the corresponding characters given for other genera under items in the key with the same number but with other letters. On the basis of these internal as well as the external characters, we regard *Alloophorus* as the most primitive of all Goodeidae possessing trophotaeniae, that is, of all excepting *Ataeniobius toweri*. In many respects, especially those related to nutrition, *Alloophorus* is more primitive than *Ataeniobius*. Other characters descriptive if not diagnostic of *Alloophorus* are given as items *1b*, *2b*, and *7b* of the analytical key.

Alloophorus, different ovary, from ἄλλος, other or different, ᾠόν, egg, and φορὸς, bearing (ᾠοφόρος, ovary).

2. *Alloophorus robustus* (Bean)

(Pl. I, Fig. 1, section of ovary; Pl. III, Fig. 4, trophotaeniae.)

Fundulus robustus.—Bean, 1892: *285*–86, Pl. 44, Fig. 2 (original description; "Mexico"). Jordan and Evermann, 1896: 634, *644* (description; holotype designated; streams of Guanajuato); 1896*a*: 310 (listed). Bean, 1898: 541 (Lake Quitzeo = Lago de Cuitzeo, Michoacán). Jordan and Snyder, 1900: 116, *126* ("mouth of Laguna de Chapala, Jalisco"). Pellegrin, 1901: 206 (vicinity of Guadalajara).

Zoogoneticus robustus.—Meek, 1902: 87, *92*–94, 96, 100–101 (characters; comparison; size; color; embryos; food; Ocotlán; Pátzcuaro; Zirahuen); 1903: 779 (anal fin); 1904: xl, l, lv, 110, 112–13, 121, Fig. 31 (description). Regan, 1904: 257 (comparison); 1907: 85, *86*–87 (description; records; *Z. maculatus* a synonym). Eigenmann, 1909: 304 (listed); 1910: 454 (listed).

Jordan, Evermann, and Clark, 1930: 182 (synonymy). Hubbs, 1932*a*: 69 (listed; *maculatus* a synonym).

Alloophorus robustus.—Turner, 1937*b*: 507–9, 513, Pl. 3, Fig. 16 (trophotaeniae).

Fundulus parvipinnis (erroneous identification).—Garman, 1895: *100*–101 (synonymy in part).

Zoogoneticus maculatus.—Regan, 1904: *256*–57 (original description; comparisons; Río Santiago). Meek, 1904: xl, 110, *113*–14 (description, after Regan). Eigenmann, 1909: 304 (listed).

The synonymy of this species is largely self-explanatory. Regan recognized his own *Zoogoneticus maculatus* as a synonym of *Z. robustus*.

The holotype of this species, as selected by Jordan and Evermann (1896: 644), U.S.N.M. No. 43760, is an adult female labeled "Patzcuaro, Mex.," not "Guanajuato" as stated by these authors. The other type specimen mentioned by Bean (1892: 285), the male, No. 43762, is labeled as from Guanajuato, as also the nontype specimens bearing Nos. 37834 and 41973, likewise mentioned by Bean (p. 286). Other specimens of this species in the National Museum are from "Alberca, Valle de Santiago, Mex. Duges" and from "Lake Quitzeo, Mex. Aug. 5, 1892. E. W. Nelson." Our new material of this species was collected by Turner and Dildine in Río Grande de Santiago, between Ocotlán and Laguna de Chapala.

The largest specimen of the last-named collection measures 122 mm. in standard length.

GENUS *XENOTOCA* HUBBS and TURNER

Xenotoca.—[Hubbs and Turner], in Turner, 1937*b*: 508–9, 513 (name *Xenotoca variata* used, and indicated as taken from the manuscript for the present paper; trophotaeniae described).

Genotype, *Characodon variatus* Bean.

We erect this new genus for *Characodon variatus* because this species differs from *Characodon* (*lateralis*) in numerous internal as well as external features. Characters distinguishing *Xenotoca* from *Characodon* involve the ovarian anatomy (items *2b* and *3b* of the analytical key, contrasted with items *2c* and *3f*, respectively), the form and structure of the trophotaeniae (item *5a* contrasted with item *5g*), and some superficial features (item *7c* contrasted with item *7j*). *Xenotoca* is apparently much more closely related to *Chapalichthys*, from which it differs in the characters contrasted in items *7c* and *7d*, and in items *8a* and *8b*. It is also close to *Goodea*, differing however in characters related to nutrition and in superficial features (as contrasted in items *7c* and *7e*). Except in its bifid teeth, *Xenotoca* does not differ sharply from its more primitive relative *Alloophorus*. A full characterization of *Xenotoca* is given in the analytical key, as items *1b, 2b, 3b, 5a, 7c,* and *8a*.

Xenotoca, strange offspring (embryo), from ξένος, strange, and τόκος offspring.

3. *Xenotoca variata* (Bean)

(Pl. I, Fig. 1, section of ovary; Pl. III, Fig. 3, trophotaeniae.)

Characodon variatus.—Bean, 1887: *370*–71, Pl. 20, Fig. 1 (original description; comparison; probably streams of Guanajuato); 1892: 286 (sexual dimorphism; *C. ferrugineus* a synonym; state of Guanajuato). Eigenmann, 1893: 56 (Guanajuato). Woolman, 1894: 62 (characters; confused with *Goodea atripinnis*—see Hubbs, 1924*b*: 3; *ferrugineus* doubted as a synonym; Río de Lerma, Salamanca). Rutter, 1896: 266 (comparison). Jordan and Evermann, 1896: 669 (description; synonymy; tributaries of Río de Lerma about Guanajuato and City of Mexico—the latter locality erroneous); 1896*a*: 314 (listed); 1898: 2831 (not a synonym of *C. lateralis*). Jordan and Snyder, 1900: 116, *126* (sexual dimorphism; Río Verde, Aguas Calientes). Jordan and Evermann, 1900: 3256, Pl. 111, Figs. 295–95*a* (Guanajuato). Meek, 1902: *96*–97, 100 (description; viviparity; records); 1904: xl, 118, *120*–21, Figs. 34–35 (synonymy; description; viviparity). Regan, 1907: 88–*89* (synonymy; description; records). Meek, 1908: 155 (San Miguel). Eigenmann, 1909: 304; and 1910: 455 (listed). Fowler, 1916: 432 (Río Verde, Rascon). Hubbs, 1924*b*: 3–4 (Woolman's 1894 confusion of this species and *Goodea atripinnis*); 1926: 18 (*C. eiseni* as a synonym). Jordan, Evermann, and Clark, 1930: 183 (synonymy).

Xenotoca variata.—Turner, 1937*b*: 508–9, 513, Pl. 3, Fig. 18 (trophotaeniae).

Characodon ferrugineus.—Bean, 1887: *372*–73, Pl. 20, Figs. 3–4 (original description; probably streams of Guanajuato). Eigenmann, 1893: 56 (listed). Therese von Bayern and Steindachner, 1895: 520, *529*–30 ("Cuitzeo-See").

Characodon lateralis (erroneous synonymizing).—Garman, 1895: 36 (synonymy in part).

(?) *Characodon lateralis* (probably erroneous identification).—Pellegrin, 1901: 205 (state of Jalisco).

Characodon eiseni.—Rutter, 1896: *266*–67 (original description; comparison; branch of Río Grande de Santiago, Tepic). Jordan and Evermann, 1896*a*: 314 (listed); 1898: 2831 (description repeated). Jordan and Snyder, 1900: 127; and Jordan and Evermann, 1900: 3151 (comparison). Meek, 1904: xl, 118, *119*–20 (description, from Jordan and Evermann; lowland streams of Jalisco and Tepic). Eigenmann, 1909: 304; and 1910: 455 (listed; range).

Soon after describing the two species, Bean (1892: 286) correctly interpreted *Characodon ferrugineus* as the female of *C. variatus*. Regan (1907: 89) and Hubbs (1926: 18) have indicated *C. eiseni* Rutter as another synonym.

This appears to be the most widely ranging species of the family, for it is reported to occur on and below the plateau in both the Río Grande de Santiago and Río Panuco systems. Fowler (1916: 432) recorded it from Río Verde at Rascon (the type locality of *Ataeniobius toweri*), in the Río Panuco system below the plateau escarpment, and we have specimens from the Río Santa María, a tributary of the Río Panuco on the plateau (taken by Gordon, Whetzel, and Ross at Santa María del Río, San Luis Potosí). Our other new material is from the Río Grande de Santiago between Ocotlán and Laguna de Chapala. Specimens of this species in the National Museum include the cotypes of *Characodon variatus* from "Mexico," U.S.N.M. No. 37809 (not No. 37808 as stated by Jordan and Evermann, 1896: 668); the type of *C. ferrugineus,* from "Mexico" (No. 37810), and specimens collected by Dugès at "Alberca, Valle de Santiago."

We have noticed no evident differences between specimens from these several localities, but have not had available sufficient material to make a thorough comparison. Such a study should be made.

Genus *Chapalichthys* Meek

Chapalichthys.—Meek, 1902: 97 (original description; comparison); 1904: xlix, 99, *123* (distribution; description; comparison). Eigenmann, 1910: 456 (listed). Hubbs, 1924*a*: 4 (classification). Jordan, Evermann, and Clark, 1930: 184 (listed wrongly under Poeciliidae). Turner, 1933*a*: 93 (spelled *Chapalicthys;* structures related to viviparity); 1933*c*: 208–18 (classification and distribution; structures related to viviparity).

Orthotype, *Characodon encaustus* Jordan and Snyder.

The new evidence leaves unquestionable the need for separating *Chapalichthys* from *Characodon,* but aligns it very intimately with *Xenotoca* and *Goodea.* The features distinguishing *Chapalichthys* from those genera, though all rather minor according to usual standards, are numerous and in our judgment warrant generic separation.

4. *Chapalichthys encaustus* (Jordan and Snyder)

(Pl. III, Fig. 5, trophotaeniae.)

Characodon encaustus.—Jordan and Snyder, 1900: 116–17, *126*–27, Fig. 7 (original description; comparison; Lago de Chapala, near Ocotlán). Jordan and Evermann, 1900: *3150*–51 (description repeated). Pellegrin, 1901: 205 (state of Jalisco). Regan, 1907: *88*–89 (description).

Chapalichthys encaustus.—Meek, 1902: 97 (characters; La Barca; Ocotlán; La Palma): 1904: xl, *123*–24, Fig. 36 (description). Eigenmann, 1909: 304; and 1910: 456 (listed). Jordan, Evermann, and Clark, 1930: 184 (listed). Turner, 1937*b*: 508–10, 513, Pl. 3, Fig. 17, and Pl. 4, Fig. 24 (trophotaeniae).

Our characterization of this genus and species, given in the analytical key, has been based largely on our new material, a fine series of specimens collected by Turner and Dildine in Río Grande de Santiago, between Ocotlán and Laguna de Chapala. There are specimens in the National Museum from this lake, collected by P. J. Jouy in February and April, 1892, before the types of the species were obtained.

The coloration of the young of this species approaches the mottled pattern of the goodeids with more generalized color pattern, but the short, narrow, lateral bars soon become much intensified while the other markings fade more or less completely. The bars in the adult vary considerably, from roundish dots to high streaks. In some individuals they form 2 irregular rows instead of only 1.

Genus *Goodea* Jordan

Goodea.—Jordan, 1880: *299*–300 (original description). Jordan and Gilbert, 1883: 327, 348 (after Jordan). Bean, 1892: 286 (genus valid). Jordan and Evermann, 1896: 632, *685* (description; comparison); 1896*a*: 316 (listed). Jordan and Snyder, 1900: 127 (comparison). Jordan and Evermann, 1900: 3152 (comparison). Meek, 1902: 95, 97, *100* (characters; dentition; *Xenendum* a synonym); 1904: xlix, lvi, 100, 123, *136*–37 (in part; distribution; description; synonymy; key to species). Jordan, 1905, 2: *199*–201 (distribution; teeth). Regan, 1907: 76–*90* (in part; synonymy; description; synopsis of species). Eigenmann, 1910: 458 (in part; species listed; range). Regan, 1911: 325 (listed); 1915: 109 (in part; distribution). Hubbs, 1924*a*: 4 (classification); 1924*b*: 1–2 (synonymy; species); 1926: 19 (comparison). Jordan, Evermann, and Clark, 1930: 183 (synonymy). Turner, 1933*a*: 93 (structures related to viviparity); 1933*c*: 208–10 (classification; distribution).

Haplotype, *Goodea atripinnis* Jordan.

Xenendum.—Jordan and Snyder, 1900: 117, *127* (original description; sexual dimorphism; comparison). Jordan and Evermann, 1900: *3151*–52 (Jordan and Snyder's account repeated).

Orthotype, *Xenendum caliente* Jordan and Snyder.

The erection of *Xenendum* was due to the erroneous original description of the teeth of *Goodea* as being trifid.

Through the separation of *Skiffia* by Meek and of *Balsadichthys* by Hubbs, and of *Ataeniobius, Xenoophorus, Ollentodon,* and *Neotoca* in the present work, *Goodea* has been cleared of these several genera which resemble it very closely in superficial and nutritional characters, but which differ trenchantly in internal features and are probably not very closely related (see p. 17). There are left in *Goodea* only 2 species, *atripinnis* and *luitpoldii,* to which we now add the following form.

5. ***Goodea gracilis,*** new species

(Pl. IV, Fig. 1, holotype.)

Goodea caliente (presumably a misidentification, not *Xenendum caliente* = *Goodea atripinnis*).—Meek, 1902: *100*–101; and 1903: 778 (record from San Juan del Río only).

Goodea calientis.—Regan, 1907: 91 (San Juan del Río record). Eigenmann, 1910: 459 (Panuco basin).

Goodea atripinnis (presumably a misidentification).—Meek, 1904: xxxvii, 140 (record from San Juan del Río only). Eigenmann, 1910: 459 (Panuco basin). Hubbs, 1924*b*: 4 (San Juan del Río only). Mayer, 1937: 97–98, 1 fig. (aquarium culture; reproduction; synonymy excepted).

Goodea gracilis.—Turner, 1937*b*: 496, 499 (*nomen nudum*).

Of the 3 species from the Río Panuco system referred to *Goodea,* 2 are now shown to represent distinct genera (*Ataeniobius* and *Xenoophorus*), but the third form, hitherto confounded with *Goodea atripinnis,* is apparently a true *Goodea.* This form, *G. gracilis,* seems to differ specifically from *G. atripinnis* and *G. luitpoldii* of the Río Lerma system in certain superficial characters, as outlined in the analytical key on pages 27–28.

HOLOTYPE.—An adult female 39 mm. in standard length, collected by Gordon, Whetzel, and Ross in Río Santa María, of the Río Panuco system, at Santa María del Río, San Luis Potosí, Mexico, on March 21, 1932; U.M.M.Z. No. 108552.

The paratypes, in the same Museum, comprise 3 adult males 34 to 43 mm. long, taken with the holotype; 4 half-grown of the specimens previously identified as "*Goodea caliente*" and "*Goodea atripinnis*," collected by Meek in Río San Juan, tributary of Río Moctezuma of the Río Panuco system, at San Juan del Río, Queretaro, Mexico, May 16, 1901; and 18 young to adult specimens, 12 to 53 mm. in standard length, of the aquarium stock originally obtained at San Juan del Río, and received from the importer, C. Basil Jordan, and from Albert Greenberg and F. H. Stoye. The account and figure given by Mayer (1937) for *Goodea atripinnis* was undoubtedly based on specimens of the same stock.

Body rather slender but thick, particularly chunky and turgid just behind the head, where the width is about two-thirds the depth. Greatest depth, 3.4 (3.3 to 3.7 in paratypes). Dorsal contour rather evenly and gently curved from origin of dorsal to tip of snout, often more or less flattened on top of head. Ventral contour equally but less evenly curved, rather steep at the chin, and sometimes prominent below pectoral fin, especially in males. Dorsal base forming an angle of about 20° with the horizontal; anal base one of 20° to 25° in adult females, increasing to 40° in adult males. Edges of the caudal peduncle nearly horizontal and weakly concave. Least depth of peduncle, 1.4 (1.3 to 1.5) in length of peduncle; 2.0 (1.75 to 2.05) in head.

Length of head, 3.5 (3.2 to 3.7). Head approximately as deep as its greatest width, which enters the head length 1.55 (1.4 to 1.6) times. Least width of the moderately convex interorbital, 2.2 (2.0 to 2.3). Orbit, 1.8 (1.6 to 2.3) in interorbital; 3.7 (3.4 to 4.3) in head. Snout, 3.5 (3.3 to 3.7). Mouth moderately wide (extreme over-all width, 2.5 to 2.6, rarely 2.7 or 2.8, in head); with almost strictly transverse gape; lips rather full. Teeth, jaws, gill-rakers (39 in one paratype), and intestines as described for the genus in item *7e* of analytical key (p. 27).

Fin rays: dorsal, 13 (12 to 14, usually 12 or 13); caudal, 19 (18 to 21) branched rays; anal, 16 (14 to 16, usually 15 or 16), including a minute first ray; pelvic, 6; pectoral, 15 (14 to 16, usually 15). Origin of dorsal fin slightly behind that of anal (rarely on the same vertical) in females and low males, usually directly over anal origin in well-developed males. Distance from dorsal origin to end of middle ray of caudal fin, 1.35 (1.3 to 1.4 in females, 1.25 to 1.35 in males) in distance from dorsal fin to tip of premaxillaries. Distance from caudal base to dorsal origin, 2.1 (1.9 to 2.3 in females, 1.9 to 2.1 in males) in predorsal length. Broadly rounded dorsal fin reaching about two-thirds distance to first procurrent caudal ray in females and low males, almost to the procurrent rays in high males; length of depressed dorsal in head, 1.5 (1.3 to 1.6 in females, 1.1 to 1.3 in adult males). Posterior margin of caudal fin weakly rounded; length of fin, 1.4 (1.3 to 1.45 in females, 1.25 to 1.4 in males). Characters of pelvic fin, of anal lobe in adult male, and of swollen area between anus and genital opening all as described for the genus on p. 27).

Scales rather large, in 38 (35 to 39) transverse and 14 (12 to 16) longitudinal rows.

Sides with brown spots and blotches thickly set on a cream background, in holotype and other small adults. Larger adults are almost uniform, deep purplish brown, except on yellowish belly, breast, and throat. Young with relatively few (about 30) spots, mostly vertically elongate, scattered over sides. Middorsal dusky stripe rather indistinct; axial band on sides rather well developed in small adults, but very weak in young and in large adults; no distinct stripe on lower edge of caudal peduncle. Vertical fins dark, becoming deep dusky in adults; pectoral pale dusky; pelvic clear, mottled, or uniformly dark.

The name *gracilis* refers to the slender form.

6. *Goodea atripinnis* Jordan

(Pl. II, Fig. 1, trophotaeniae.)

Goodea atripinnis.—Jordan, 1880: 299–*300* (original description; León, Guanajuato). Jordan and Gilbert, 1883: 348 (after Jordan). Jordan and Evermann, 1896: 685 (description; Guanajuato); 1896*a*: 316 (listed). Bean, 1898: 541 (L. de Quitzeo). Jordan and Evermann, 1900: 3257, Pl. 114, Fig. 301 (figure of type). Meek, 1902: 93, 100–*102* (teeth; comparisons); 1904: xl, l, 137, *140*, Fig. 43 (synonymy; description; records, San Juan del Río excepted). Jordan, 1905, 2: 199 (''tricuspid teeth''). Regan, 1907: 91 (in part; reference to original description and locality only). Meek, 1908: 156 (in part; San Miguel). Eigenmann, 1909: 298, *304* (in part; listed); 1910: 459 (range, in part). Hubbs, 1924*b*: 2, *3*–6 (synonymy; variation; distribution; record for San Juan del Río excepted). Jordan, Evermann, and Clark, 1930: 183 (listed). Turner, 1933*c*: 210; 1937*b*: 498–99, 501–2, 511, Pl. 1, Fig. 2, and Pl. 4, Fig. 20 (trophotaeniae).

Characodon atripinnis.—Bean, 1887: 370 (genus). Eigenmann, 1893: 56 (listed). Garman, 1895: *37*–38 (description, after Jordan; synonymy; genus).

Goodea [species].—Bean, 1880: 302 (specimens collected by Dugès [types of *G. atripinnis* Jordan?] from salt lake in the middle of a little volcanic plain in Valle de Santiago, Guanajuato).

Characodon variatus (erroneous identification).—Woolman, 1894: 62 (in part—see Hubbs, 1924*b*: 3).

Xenendum caliente.—Jordan and Snyder, 1900: 116–17, *127*–29, Fig. 8 (original description; comparison; Río Verde near Aguas Calientes). Jordan and Evermann, 1900: *3152*–53 (Jordan and Snyder's account repeated). Pellegrin, 1901: 207 (comparison).

Goodea caliente.—Meek, 1902: 87, *100*–102 (viviparity; variation; records, San Juan del Río excepted); 1903: 778–79 (anal fin; except San Juan del Río record).

Goodea calientis.—Regan, 1907: 90–91 (description; records, excluding those for San

Juan del Río and Lake Pátzcuaro). Eigenmann, 1910: 459 (range, in part). Jordan, Evermann, and Clark, 1930: 184 (listed).

Material of this species in the United States National Museum, collected by A. Dugès includes the types from León, Guanajuato (No. 23137); other series labeled Guanajuato (Nos. 38006, 41814–15); Alberca, Valle de Santiago (No. 23132), and Mexico (No. 37833).

7. *Goodea luitpoldii* (Therese von Bayern and Steindachner)

(Pl. I, Fig. 2, section of ovary; Pl. II, Fig. 2, trophotaeniae.)

Characodon Luitpoldii.—Therese von Bayern and Steindachner, 1895: *528*–30, Pl. 2, Figs. 3–3*b* (original description; Lago de Pátzcuaro). Garman, 1895: 37 (description, after original). Jordan and Evermann, 1896*a*: 314 (as *C. luitpoldi;* listed); 1898: 2832 (as *C. luitpoldii;* description, after original). Pellegrin, 1901: 205–6 (as *Luitpoldi;* to 17 cm.; vicinity of Guadalajara and Lago de Zacoalco, Jalisco).

Xenendum luitpoldi.—Jordan and Snyder, 1900: 127–29 (comparison; genus). Jordan and Evermann, 1900: *3152*–53 (as *X. luitpoldii;* genus; *caliente* compared).

Goodea luitpoldi.—Meek, 1902: *101*–2, Pls. 22–24 (characters; variation; viviparity; *G. xaliscone* a probable synonym; Ocotlán; La Palma; La Barca; Pátzcuaro); 1903; figure on p. 780; 1904: xl, lv, 135, 137, *139*–40, Fig. 42, Pls. 1–2 (synonymy; description; viviparity). Jordan, 1905, 1: 126, Fig. 93, and 2: 200, Fig. 160 (viviparity). Eigenmann, 1909: 304; and 1910: 459 (listed). Hubbs, 1924*b*: *2*–5 (synonymy; comparison; distribution). Jordan, Evermann, and Clark, 1930: 184 (synonymy). Mendoza, 1937: 97–98, 100, 108–9, 111 (trophotaeniae). Turner, 1937*b*: 498–99, 502, 511, Pl. 1, Fig. 1, and Pl. 4, Fig. 19 (trophotaeniae).

Characodon (*Goodea*) *atripinnis* (presumably an error in identification).—Herrera, 1896: 31 (viviparous; Lago de Pátzcuaro; specimens from this lot referred to *G. calientis* by Regan, 1907: 91).

Goodea atripinnis.—Regan, 1907: 90–*91* (not reference to original description and locality; description; synonymy; Lago de Chapala and Lago de Pátzcuaro); 1911: 325, 327; Pl. 8 (osteology). Fowler, 1916: 432 (identification not checked; "Lake Patscuaro" = Lago de Pátzcuaro).

Xenendum xaliscone.—Jordan and Snyder, 1900: 116–17, *128*–29, Fig. 9 (original description; comparison; Lago de Chapala near Ocotlán). Jordan and Evermann, 1900: 3153 (original account repeated). Pellegrin, 1901: 207 (comparisons).

Goodea xaliscone.—Meek, 1902: 101 (regarded as a probable synonym of *G. luitpoldi*).

Goodea calientis (presumably an error in identification).—Regan, 1907: 91 (Pátzcuaro record only).

Of this species the material which we have studied in greatest detail was collected in Río Grande de Santiago, between Ocotlán and Laguna de Chapala, by Turner and Dildine. Some specimens were preserved in the field, and an aquarium stock was brought back alive and bred in the laboratory at Northwestern University. The National Museum material includes 1 lot collected by P. L. Jouy in Laguna de Chapala.

Genus *Zoogoneticus* Meek

Zoogoneticus.—Meek, 1902: 76, 89, *91*, 126 (in part; original description; compared with *Fundulus*); 1904: xlix, 99, *109*–10 (in part; distribution; description; key to species). Regan, 1907: 85 (in part; description; synopsis of species). Eigenmann, 1910: 454 (in part; species listed; type-species properly designated). Regan, 1911: 325 (listed). Hubbs, 1924*a*: 4 (classification); 1926: 17 (in part; characters; relationships). Jordan, Evermann, and Clark, 1930: 182 (in part; species listed). Hubbs, 1932*a*: *68*–69 (in part; discussion of species); 1932*b*: 2 (dentition). Turner, 1933*a*: 93 (structures related to viviparity); 1933*c*: 208–19 (distribution; classification).

"Type, *Poecilia* [lapsus for *Platypoecilus*] *quitzeoensis* B. A. Bean," by original designation, taking precedence over the "logotype *Z. diazi* Meek" as designated subsequently by Jordan (1920: 500) and by Jordan, Evermann, and Clark (1930: 180).

As indicated in the keys on pages 25–31 and 73, we find grounds for separating in distinct monotypic genera all of the goodeid species which agree with *Zoogoneticus quitzeoensis* in the retention of the primitively strong jaws and conic teeth. These genera and species are:

Alloophorus robustus (Bean)
Allodontichthys zonistius (Hubbs)
Neoophorus diazi (Meek)
Allotoca dugèsii (Bean)

8. *Zoogoneticus quitzeoensis* (Bean)

(Pl. I, Fig. 5, section of ovary; Pl. III, Fig. 6, trophotaeniae.)

Platypoecilus quitzeoensis.—Bean, 1898: 540, 1 fig. (original description; Lake Quítzeo = Lago de Cuitzeo). Jordan and Evermann, 1898: 2873 (description).

Zoogoneticus quitzeoensis.—Meek, 1902: *91*–92, 94 (description; La Barca; Ocotlán). Regan, 1904: 257 (comparison). Meek, 1904: xl, *110*–11, Fig. 29 (as *Z. cuitzeoensis;* description). Regan, 1907: 85–*86* (as *Z. cuitzeoensis;* description). Eigenmann, 1909: 304; and 1910: 454 (as *cuitzeoensis;* listed). Jordan, Evermann, and Clark, 1930: 182 (as *Z. quitzeoensis;* listed). Hubbs, 1932*a*: 69 (as *Z. cuitzeoensis;* listed). Turner, 1933*a*: 94; and 1933*c*: 218–45, Pl. 1, Fig. 8, and Pl. 5, Figs. 22–23 (as *Z. cuitzeoensis;* structures related to viviparity). Mendoza, 1937: 97–98, 105, 108–11, Pl. 1, Figs. 1 and 4, and Pl. 3, Fig. 2 (as *Z. cuitzeoensis;* trophotaeniae). Turner, 1937*b*: 496, 508–10, 513, Pl. 3, Fig. 15 (trophotaeniae).

The material of this species studied by us includes the types labeled "L. Quitzeo, Mex., Aug. 5, 1892, E. W. Nelson" (U.S.N.M. No. 48209), Meek's specimens from Ocotlán, and a good series collected by Turner and Dildine on March 31, 1932, in Río Grande de Santiago, between Ocotlán and Laguna de Chapala.

The young, somewhat like the probably more primitively colored *Alloophorus robustus* in coloration, are mottled, but the blotches which form the diagnostic posteroventral bars and the pair of spots at the caudal base are already intensified, even before birth. There are occasional irregularities in these color markings of the sides, and the caudal spots are vertically fused in some specimens.

Allodontichthys, New Genus

Genotype, *Zoogoneticus zonistius* Hubbs.

We tentatively erect this new genus for *Zoogoneticus zonistius*, chiefly on the basis of the form of the jaw teeth, which instead of being regularly conic (everywhere evenly round in cross section) are definitely compressed and shouldered within the slender conic tip and are keeled (rather weakly) at either edge of the anterior face. The teeth of the outer row number about 16 in the upper and 20 in the lower jaw. They form an even, moderately curved row (not alternating). Small, conic teeth form a narrow, curved band behind the main row.

This genus differs further from *Zoogoneticus* in having the sixth rather than fifth pelvic rays of the 2 fins in contact and in having the innermost pelvic rays free from the body as well as from each other. From *Neophorus* it differs in the closely approximated pelvic fins, fewer dorsal rays, and different form.

In superficial characters, other than the form of the teeth, *Allodontichthys* is very much like *Alloophorus* (*robustus*), but we find some differences in the swollen area between anus and genital opening. In *Allodontichthys* this area is longer than wide, rather than the reverse; its posterior edge is approximately straight and even instead of being slightly concave and fimbriate; and the anterior sides of this area are largely scaled instead of being scarcely invaded by scales.

In the feature last mentioned, *Allodontichthys* approaches *Ilyodon* and *Balsadichthys*, the other genera occurring in the coastal waters of Colima. This resemblance in characters and distribution suggests a possibly close relationship. Consequently it would not be surprising, when females of *Allodontichthys* are obtained, to find that this genus possesses the ovarian and trophotaenial characters of the Girardinichthyinae rather than of the Goodeinae to which *Alloophorus*, *Zoogoneticus*, and *Allotoca* are referred, and therefore that *Allodontichthys* may be regarded as ancestral to *Ilyodon*. Until these characters of the female and embryo are discovered, the position of *Allodontichthys* in the system will remain uncertain.

The anterior anal lobe in *Allodontichthys* is somewhat distinctive. Basally the lobe has a rather well-developed dermal thickening, forming a moderate pocket. The lobe is two-thirds as high as the highest anal ray. The first 4 of the 6 moderately crowded rays of the anal lobe are somewhat curved forward, and the last 2 rays are slightly strengthened and divergent. Only the last ray or the last 2 are branched (near tip).

Allodontichthys, different-tooth fish, from ἄλλος, other or different, ὀδούς, tooth, and ἰχθύς, fish.

9. *Allodontichthys zonistius* (Hubbs)

(Pl. IV, Fig. 2, paratype.)

Zoogoneticus zonistius.—Hubbs, 1932*a*: *69*–71 (original description; comparisons; Colima).

Alloophorus zonistius.—Turner, 1937*b*: 496 (trophotaeniae not studied).

No specimens of this well-marked species were secured by Oliver about the type locality (Colima, Mexico), although large series of *Ilyodon furcidens* and *Balsadichthys xantusi* were collected there.

This species can be distinguished from other goodeids by the size of the scales (in 40 rows) and particularly by its coloration: there are some rounded dark spots above and behind the pectoral fin; the scale borders are blackened posterodorsally; a large, black, comma-shaped mark lies behind the opercle; there are no ventrolateral spots or bars; the dorsal fin is crossed by jet-black bands.

Genus *Neoophorus* Hubbs and Turner

Neoophorus.—[Hubbs and Turner], in Turner, 1937*b*: 498–502, 511 (name *Neoophorus diazi* used, and indicated as taken from the manuscript for the present paper; trophotaeniae described).

Genotype, *Zoogoneticus diazi* Meek.

This is one of the genera which we are segregating from *Zoogoneticus* on the basis of differences in ovarian and trophotaenial characters (see items *5* and *7* in the key, on pp. 28–29). It differs from *Zoogoneticus* and *Alloophorus* in having the sixth (innermost) pelvic rays of the two fins well separated, instead of having the fifth (*Zoogoneticus*) or sixth (*Alloophorus*) in contact. The dorsal fin, longer than in *Alloophorus,* has 15 to 19 rather than 12 to 14 rays.

Neoophorus, new [type of] ovary, from νέος new, ὠὸν egg, and φορὸς, bearing (ὠοφόρος, ovary).

10. *Neaophorus diazi* (Meek)

(Pl. I, Fig. 4, section of ovary; Pl. II, Fig. 3, trophotaeniae.)

Zoogoneticus diazi.—Meek, 1902: 71, *93*–94, Pl. 21, upper fig. (original description; comparison; Lago de Pátzcuaro, Pátzcuaro, Michoacán; also Zirahuen); 1904: xl, 110, *114*, Fig. 32 (description; reproduction). Regan, 1907: 85–*86* (description; *miniatus* a synonym). Eigenmann, 1909: 304; and 1910: 454 (listed). Hubbs, 1926: 18 (*miniatus* a synonym). Jordan, Evermann, and Clark, 1930: 182 (synonymy). Hubbs, 1932*a*: 69 (listed; *miniatus* a synonym). Mendoza, 1937: 97–98, 106–7, 111, Pl. 1, Fig. 5, and Pl. 3, Fig. 1 (trophotaeniae).

Neoophorus diazi.—Turner, 1937*b*: 498–502, 511, Pl. 1, Fig. 3, and Pl. 4, Fig. 21 (trophotaeniae).

Zoogoneticus miniatus.—Meek, 1902: 71, *94*, 124, Pl. 21, lower fig. (original description; comparison; Lago de Chalco, Chalco, Mexico); 1903: 778 (Valle de México); 1904: xli, 110, *115*, Fig. 33 (description). Eigenmann, 1910: 454 (listed).

Of this species we have had available the material reported upon by Meek, and a series collected by Hobart M. Smith in a small, open lake near Uruapan, Michoacán, on August 6, 1936. This series includes a female 38 mm. in standard length containing 10 embryos 12 mm. long, and another 41 mm. long, with 12 embryos of 12 mm. The adult females are weakly barred and rather heavily spotted (more so than in Meek's figures). The dorsal rays number 15 to 18, the anal rays 14 or 15. The origin of the dorsal fin lies midway between the base of the caudal fin and the posteriormost part or middle of the opercle; or about midway between the end of the caudal fin and the nostrils. The head measurements are 3.25 to 3.4; the depth, about 3.2 to 3.5. These determinations confirm the synonymizing of *miniatus* with *diazi.*

GENUS *XENOOPHORUS* HUBBS AND TURNER

Xenoophorus.—[Hubbs and Turner], in Turner, 1937*b*: 501 (as genus); 496, 498, 500, 502, 512 (in combination *Xenoophorus erro*) and 498, 500, 502, 512 (in combination *Xenoophorus captivus;* indicated as taken from the manuscript for the present paper; trophotaeniae described).

Genotype, *Goodea captiva* Hubbs.

This new group is distinguished primarily on the basis of the ovarian and trophotaenial characters given as items *1b, 2b, 3d, 4b,* and *5e* of the analytical key (pp. 24–30). It seems to be the fork-toothed derivative of *Neoophorus,* and to have been derived independently from *Goodea* and other genera with similar dentition, jaws, and intestines.

The more superficial characters of the genus, given as item *7h* of the key (p. 30), are adequate for purposes of identification, as is indicated in the artificial key on pages 73–76.

In *Xenoophorus* the minute, slender, anteriormost anal ray characteristic of all 3 species of *Goodea* is lacking, or represented by a very minute stump; consequently the anterior anal lobe has ordinarily a total of 6 rather than 7 rays.

Differential characters of the 3 species referred to *Xenoophorus* are given as items *11a* to *11c* of the key (pp. 30–31). These species are among the few goodeids of the Atlantic drainage, and appear to be isolated representative forms of a single *Formenkreis.*

Xenoophorus, strange ovary, from ξένος, strange, ὠὸν egg, and φορὸς bearing (ὠοφόρος, ovary).

11. *Xenoophorus captivus* (Hubbs)

(Pl. I, Fig. 3, section of ovary; Pl. II, Fig. 5, trophotaeniae; Pl. V, Fig. 1, paratype.)

Goodea atripinnis.—Meek, 1908: 156 (in part; not of Jordan; Jesús María specimens only, later made types of *G. captiva*). Eigenmann, 1909: 298 (after Meek).

Goodea captiva.—Hubbs, 1924*b*: *4*–7 (original description; Jesús María, in tributary of Río Panuco). Jordan, Evermann, and Clark, 1930: 184 (listed). Turner, 1933*c*: 210 (distribution); 1937*b*: 498, 500, 502, 512, Pl. 1, Fig. 7 (trophotaeniae).

In differentiating the species of this genus we have had the privilege of re-examining the types of *Goodea captiva,* the only known specimens of the species.

12. *Xenoophorus erro* Hubbs and Turner

(Pl. II, Fig. 6, trophotaeniae; Pl. V, Fig. 2, holotype.)

Xenoophorus erro.—[Hubbs and Turner], in Turner, 1937*b*: 496, 498, 500, 502, 512, Pl. 1, Fig. 4 (trophotaeniae; name indicated as taken from the manuscript for the present paper; it is doubtful whether the species is recognizably differentiated in Turner's account).

This species is compared with *X. captivus* and *X. exsul* in the key on pages 30–31.

HOLOTYPE.—An adult female 49 mm. in standard length, collected with numerous paratypes by Gordon, Whetzel, and Ross in Río Santa María, of the Río Panuco system, at Santa María del Río, San Luis Potosí, Mexico, on March 21, 1932; U.M.M.Z. No. 108555.

Body in adults heavy-set, deep through middle of trunk. Greatest depth almost twice the greatest width of body, 2.8 (2.6 to 3.3 in adult female paratypes, 2.4 to 3.0 in adult male types). Dorsal contour strongly arched between head and dorsal fin, especially in the larger males, in which the anterior profile, straight in the young and only slightly concave in the adult females, becomes deeply concave, so that the contour from snout to dorsal fin becomes strongly sigmoid. Ventral contour from mouth to anal fin rather evenly arched in females, rather less curved in adult males except toward the upturned muzzle. Dorsal base forming an angle of about 20° to 25° with the horizontal in adult females, and one of about 30° in adult males. Anal base with a greater slope, 25° to 40° in adult females, 45° to 55° in adult males. Edges of the caudal peduncle scarcely concave, diverging forward. Least depth of peduncle, 1.7 (1.6 to 2.0, 1.5 to 1.9) in length of peduncle, 2.1 (1.8 to 2.3, 1.8 to 2.3; usually about 2.0 or 2.1) in head. Females tapering posteriorly; males maintaining the depth to origins of dorsal and anal fins, the distance between which points is contained 3.4 (3.3 to 3.8) times in the standard length in adult females, 2.75 to 3.3 times in adult males.

Length of head, 3.4 (3.2 to 3.6 in adult females, 2.9 to 3.3 in adult males). Head about one-fifth deeper than its greatest width, which enters the head length 1.5 (1.4 to 1.7, 1.4 to 1.7) times. Least width of slightly convex interorbital, 2.35 (2.3 to 2.5, 2.2 to 2.4). Orbit, 1.7 (1.3 to 1.7, 1.3 to 1.8) in interorbital, 4.1 (3.5 to 4.3, 3.4 to 4.3) in head. Snout, 3.5 (3.2 to 3.8, 3.3 to 3.7). Mouth moderate in width; extreme over-all width, 2.6 (2.7 to 3.4 in each sex); not strictly transverse but with markedly restricted lateral gape. Jaws rather narrow and weakly joined, but heavier and more strongly united than in *Goodea*. Teeth as described for genus (in item *7h*, p. 30). Gill-rakers, 23 to 25 (in 5 paratypes), the longest only about one-fourth as long as eye. Intestine considerably coiled, with about 6 transverse segments.

Fin rays: dorsal, 13 (12 to 14); caudal, 18 (16 to 18, usually 16 or 17), branched rays; anal, 14 (13 to 15), the first ray well developed (the anteriormost minute ray of *Goodea* and some other genera lacking); pelvic, 6; pectoral, 14 (14 or 15, very rarely 13, commonly 15; the lowest ray usually rather well developed in 14-rayed fins); not counting the more or less rudimentary uppermost ray. Origin of dorsal fin directly over that of anal in females, very slightly farther forward in males. Distance from dorsal origin to end of middle caudal ray into distance forward to tip of upper lip, 1.2 (1.1 to 1.4, usually about 1.3 in females; 0.95 to 1.2, usually about 1.05 in males). Distance from caudal base to dorsal origin, 1.7 (1.6 to 1.8, 1.4 to 1.7) in predorsal length. The rounded dorsal fin short and low in adult females, reaching about two-thirds distance to first procurrent caudal ray; much more expansive (longer basally and with higher rays) in adult males, reaching first procurrent ray in highest males. Length of depressed dorsal in head, 1.3 (1.2 to 1.4, 0.9 to 1.2). Distance from origin of small rounded anal to caudal base, 2.75 (2.5 to 2.8, 2.4 to 2.7) in standard length. Hind margin of caudal fin almost straight; length of middle ray, 1.55 (1.35 to 1.6, 1.3 to 1.5). Characters of pelvic fin, of anal lobe in adult males, and of swollen area between anus and genital opening, all as described for the genus on page 30.

Scales rather large, in 38 (34 to 39, usually 36 or 37) transverse rows and 14 (14 to 16) longitudinal rows, not counting 2 or 3 scales at extreme base of anal fin, minute and difficult to find and sometimes probably absent in females, but larger and distinct in males.

Coloration varies greatly with age and sex. Half-grown, 20 to 25 mm. in standard length boldly spotted with more or less X-shaped purple-brown spots on a light yellow background; these spots enlarged and thickly set in the vicinity of the diffuse, dusky, axial stripe, leaving a more or less immaculate stripe on either side; the spots also concentrated along lower edge of caudal peduncle and on either side in the same horizontal line on abdomen; dorsally the spots become smaller and fainter, so that they are relatively inconspicuous on the darkened back. Males at about 25 mm. length abruptly changing over to a deep brown color—almost black in a broad, irregular, blotched submedian band, which has a downward extension toward anus; dorsal and caudal fins dusky, lower fins pale. Females changing less rapidly, the spots retained to a size (standard length) of about 35 mm., becoming gradually more numerous and more uniformly spread until they virtually disappear in the adults, which become almost uniformly dark except for creamy scale centers. Adult males darker than females at all sizes. Caudal fin of high males sooty toward the merely dusky posterior margin, but apparently with the contrast less sharp than in *X. captivus.*

The species is named *erro,* wanderer, because it occurs outside the Río Lerma system, which is the center of abundance for the family.

13. *Xenoophorus exsul,* new species

(Pl. V, Fig. 3, paratype.)

This species is very closely related to *X. captivus* and *X. erro* and appears to represent the genus in an isolated valley in the hills of the state of San Luis Potosí, Mexico, north of the Río Santa María. Here it occurs in spring-fed streams in the vicinity of Venado and Moctezuma. These streams probably never reach the sea, but the area in a past period of greater rainfall in all probability drained into the Río Panuco system—the home of the other species of the genus.

As indicated in the key (pp. 30–31), this species bridges over the gap between the large-headed *X. erro* and the small-headed *X. captivus,* in respect to size of head. The anterior profile as in *X. captivus* is little concave, not becoming strongly sigmoid in adult males as it does in *X. erro.* It differs on the average from both species in the slenderer caudal peduncle and more posteriorly inserted anal fin; also in having with rare exceptions 13 or 14 instead of 14 or 15 pectoral rays. The dorsal fin averages larger than in *X. erro.* Later collections may indicate further intergradation of characters, calling for the reduction of the 3 species as here differentiated to subspecific rank.

HOLOTYPE.—An adult female 45 mm. in standard length, collected with many paratypes by C. L. Lundell and party on July 21, 1934, in Agua del Medio, a cold mountain stream with rock and mud bottom, midway between Venado and Moctezuma, San Luis Potosí; U.M.M.Z. No. 118122. Numerous other paratypes were collected by the same party at Venado on July 11, 1934, in a small, cold, clear, spring-fed stream with rock and mud bottom, and with sedges, grasses, and algae; and at Moctezuma on July 20, 1934, in a cold mountain stream with rock and mud bottom.

The description just given for *X. erro* is to be taken as applicable in full to this species, except as indicated by the following figures and annotations.

Depth, 2.65 (2.6 to 3.2 in adult female paratypes, 2.4 to 2.8 in adult male paratypes). As noted above, the anterior profile is scarcely concave in adult females and only weakly concave in the highest males, in which the muzzle does not become conspicuously upturned. Least depth of caudal peduncle, 1.7 (1.6 to 1.9, usually about 1.75; 1.5 to 1.8, usually about 1.65) in length of peduncle, 2.15 (2.1 to 2.5, usually about 2.3; 2.0 to 2.2) in head. Distance between origins of dorsal and anal fins, 3.4 (3.4 to 3.7, 2.75 to 3.1).

Head, 3.4 (3.4 to 3.8, 3.2 to 3.5). Width of head, 1.5 (1.4 to 1.6 in each sex). Interorbital width, 2.3 (2.2 to 2.5 in each sex). Orbit, 1.4 (1.2 to 1.6, 1.2 to 1.7) in interorbital, 3.6 (3.3 to 4.3, 3.3 to 4.0) in head. Snout, 3.5 (3.2 to 3.8). Width of mouth, 2.8 (2.6 to 3.4). Gill-rakers, 21 to 24 (in 5 paratypes). Intestine with 4 to 7 transverse folds. Ovarian and trophotaenial characters not showing any consistent differences from those of *X. erro* as indicated by Turner's description for that species and by our analytical key.

Fin rays: dorsal, 13 (12 to 14); caudal, 16 (16 to 19, very rarely 19); anal, 14 (14 or 15), lacking a small first ray (occasionally represented by a mere stub, not included in the count); pelvic, 6; pectoral, 13 (13 or 14, very rarely 15, 13 in about half the specimens, the lowest ray more or less rudimentary when 14 rays are counted), with rudimentary uppermost ray seldom evident (not counted). Measurements into predorsal length: distance from end of caudal to origin of dorsal, 1.25 (1.15 to 1.35, usually about 1.25; 1.05 to 1.2, usually about 1.1); from base of caudal to origin of dorsal, 1.8 (1.7 to 1.9, 1.5 to 1.7). Length of depressed dorsal, 1.2 (1.1 to 1.3, 0.8 to 1.1). Distance from origin of anal to base of caudal, 3.1 (2.6 to 2.9, 2.7 to 3.2) in standard length. Length of caudal, 1.5 (1.4 to 1.6, 1.3 to 1.5).

Scales, 35 (35 to 39, usually 36 to 38)–14 (14 to 17, this count seemingly higher in males than females).

Coloration changes as in *X. erro*. Young about 15 mm. in standard length with indistinct dark spots on the dusky back; one row of irregular blackish spots down the otherwise nearly clear sides; a spot at base of caudal fin at each edge of peduncle, the lower one the larger; an irregular streak along lower edge of peduncle and a more or less disrupted horizontal blackish stripe running thence horizontally forward above anal base.

The name *exsul,* exile, refers to the lonely occurrence of the species beyond the ancestral territory of the family.

Genus *Allotoca* Hubbs and Turner

Allotoca.—[Hubbs and Turner], in Turner, 1937*b*: 498–99, 501, 511 (name *Allotoca dugèsii* used, and indicated as taken from the manuscript for the present paper; trophotaeniae described).

Genotype, *Fundulus dugèsii* Bean.

This genus can be distinguished readily from the other cone-toothed genera of goodeids by the posterior insertion of the dorsal fin, far behind middle of total length including caudal fin; also by the highly distinctive coloration of the single species. The more fundamental characters of *Allotoca,* however, are ovarian and trophotaenial—as described in items *1b, 2b, 3d, 4c,* and *5f* of the analytical key (pp. 24–31).

Allotoca, different offspring (embryo), from ἄλλος, other or different and τόκος, offspring.

14. *Allotoca dugèsii* (Bean)

(Pl. II, Fig. 4, trophotaeniae.)

Fundulus dugèsii.—Bean, 1887: *373*–74, Pl. 20, Fig. 5 (original description; comparison; probably from streams of Guanajuato). Eigenmann, 1893: 56 (spelled *dugèsi;* listed). Garman, 1895: *109*–10 (spelled *Dugesii;* description, after Bean). Pellegrin, 1901: 206 (spelled *Dugesi;* vicinity of Guadalajara).

Adinia dugesii.—Jordan and Evermann, 1896: 660–*61* (description, after Bean; Guanajuato); 1896*a*: 313 (listed); 1900: 3256, Pl. 108, Fig. 290 (Guanajuato).

Zoogoneticus dugesii.—Meek, 1902: *92,* 94 (number and size of embryos; Lagos; Pátzcuaro); 1904: xl, 110, *111*–12, Fig. 30 (spelled *dugesi;* synonymy; description). Regan, 1907: 85–*86* (spelled *dugesii;* characters). Eigenmann, 1909: 304 (spelled *dugesi;* listed); 1910: 454 (spelled *dugesii;* listed). Hubbs, 1926: 18 (spelled *dugèsii;* Salamanca). Jordan, Evermann, and Clark, 1930: 182 (spelled *dugesii;* listed). Hubbs, 1932*a*: 69 (spelled *dugèsii;* listed).

Allotoca dugèsii.—Turner, 1937*b*: 498–99, 501, 511, Pl. 1, Fig. 5 (trophotaeniae).

The material of this species studied by us was collected by Dugès and by Meek.

SUBFAMILY CHARACODONTINAE

Genus *Characodon* Günther

Characodon.—Günther, 1866: 308 (original description); 1869: 480 (description). Jordan, 1880: 300 (comparison). Bean, 1887: 370 (in part; *Goodea* regarded as a synonym). Eigenmann and Eigenmann, 1891: 18 (distribution). Eigenmann, 1893: 56 (in part; species listed). Garman, 1895: 18, *35,* 38 (description). Jordan and Evermann, 1896: 631, *667*–68 (in part; description); 1896*a*: 314 (in part; species listed). Jordan and Snyder, 1900: 127 (characters; comparison). Jordan and Evermann, 1900: 3151 (comparison). Meek, 1902: 89, 95–97, 125 (characters); 1904: xlix, lvi, 99, *118*–19, 129 (in part; distribution; characters; key to species). Jordan, 1905, 2: 201 (in part; teeth). Regan, 1907: 76, *88* (in part; description; synopsis of species). Eigenmann, 1907: 425, *428* (comparison); 1910: 455 (in part; species listed); 1911: 325 (listed). Hubbs, 1924*a*: 4 (classification); 1926: 18 (in part). Jordan, Evermann, and Clark, 1930: 182 (in part; list of species). Hubbs, 1932*b*: 2 (dentition). Turner, 1933*a*: 93 (spelled *Charcodon;* structures related to viviparity); 1933*c*: 208–11, 218 (in part; classification and distribution).

Haplotype, *Characodon lateralis* Günther.

The ovarian and trophotaenial characters of *Characodon,* described as items *1b, 2c, 3f,* and *5g* (pp. 24–32), are so distinctive that we have erected the subfamily Characodontinae for its sole reception (see also p. 12). The isolated systematic position of the genus is correlated with its apparent restriction to the Sonoran plateau (in the interior drainage basin and in the headwaters of the Río Mezquital), where it occurs alone, and farther north than any other goodeid.

The genus *Characodon* is here restricted to the single species *lateralis* (with *garmani* as a synonym). On the basis of the structures of ovary and trophotaeniae, other species commonly placed in *Characodon* are now set apart in the genera *Xenotoca, Chapalichthys, Ilyodon,* and *Lermichthys.*

15. *Characodon lateralis* Günther

(Pl. I, Fig. 8, section of ovary; Pl. II, Fig. 9, trophotaeniae.)

Characodon lateralis.—Günther, 1866: 308 (original description; "Central America"—no doubt by error); 1869: 480, Pl. 82, Fig. 2 (description; "Southern Central America"). Bean, 1887: 370–71 (comparison). Eigenmann, 1893: 56 (listed). Garman, 1895: 36, Pl. 1, Fig. 9 (description; teeth described and figured; part of synonymy excepted; Parras, Coahuila). Jordan and Evermann, 1896: 668 (description, after Günther); 1896*a*: 314 (listed); 1898: 2831 (synonymy). Meek, 1902: 87, 96; and 1903: 779 (anal fin); 1904: xl, l, 119, *121* (description, after Günther). Philippi, 1906: *235*–37 (viviparous; anal wrongly said to be unmodified). Regan, 1907: 88–*89*, 90 (description; *garmani* as a synonym; distribution). Eigenmann, 1909: 304; and 1910: 455 (listed; range). Jordan, Evermann, and Clark, 1930: 183 (listed). Turner, 1937*b*: 496, 506, 512, Pl. 3, Fig. 14 (trophotaeniae).

Characodon garmani.—Jordan and Evermann, 1898: *2831*–32 (original description—based on material recorded as *C. lateralis* by Garman, 1895: 36, Pl. 1, Fig. 9, from Parras, Coahuila). Meek, 1903: 778 (distribution); 1904: xxxiv, xxxvii, 119, *121*–22, 127 (description; Durango and Labor, Durango). Eigenmann, 1910: 455 (range). Jordan, Evermann, and Clark: 1930: 183 (listed).

Our study of this species has been based on Meek's material from the headwaters of the Río Mezquital. We find no reason to doubt the correctness of Meek's reference of this material to *C. garmani,* or of Regan's synonymizing of *garmani* with *lateralis.* Probably the types of *lateralis,* like all other known specimens of this form, came from the Sonoran plateau rather than from "Central America" or "Southern Central America." Pellegrin's record (1901: 205) of *C. lateralis* from the state of Jalisco needs confirmation; we suspect it was based on specimens of *Xenotoca variata.* The occurrence of the species in the headwaters of the Río Mezquital as well as in the interior drainage basin—both on the Sonoran plateau—is in line with the distribution of other fishes (Meek, 1904: xxxvii).

GIRARDINICHTHYINAE, NEW SUBFAMILY[7]

GENUS *ILYODON* EIGENMANN

Ilyodon.—Eigenmann, 1907: 427 (original diagnosis; compared with *Characodon*); 1910: 455 (listed). Hubbs, 1924*a*: 4 (relationships doubtful). Turner, 1937*b*: 496,

[7] See pp. 12, 15–16, and *32*.

503, 505–6, 512 (synonymy, from present paper; trophotaeniae).
Orthotype, *Ilyodon paraguayense* Eigenmann.

As indicated below the hitherto enigmatic *Ilyodon paraguayensis* proves to be a synonym of *Characodon furcidens*. This discovery makes the generic name *Ilyodon* available for *furcidens*, which may be regarded as generically separable from *Characodon* on the basis of its very different ovarian and trophotaenial characters (see analytical key).

16. *Ilyodon furcidens* (Jordan and Gilbert)

Characodon furcidens.—Jordan and Gilbert, 1882*a*: *354*–55 (original description; type specimens of *Balsadichthys xantusi* included, but description obviously drawn from the specimens of *furcidens;* "Cape San Lucas"—a virtually impossible locality as pointed out by subsequent authors); 1882*b*: 371 (Colima; other types of *B. xantusi* included among these specimens which were also designated as cotypes of *furcidens,* and permissibly so because the two papers involved were issued simultaneously, on September 5). Jordan, 1885: 368 (Cape San Lucas). Eigenmann, 1893: 56 (listed). Garman, 1895: *36*–37 (description, after Jordan and Gilbert; Cape San Lucas). Jordan and Evermann, 1896: 669–70 (description; about Cape San Lucas, or, probably, lagoons near La Paz; also about Colima); 1896*a*: 314 (listed). Pellegrin, 1901: 205 (fresh colors; Río Tuxpan, Jalisco[8]). Meek, 1902: 96 (modification of anal doubted); 1904: xxxvii, xxxix, xlvi, 119, *122*–23 (range; description, after Jordan and Evermann). Regan, 1907: 88, *90*, Pl. 12, Fig. 2 (description; Cape San Lucas or lagoons near La Paz; Río de Mascota in Jalisco). Evermann, 1908: 29 (type locality doubted; other possible localities in Lower California suggested). Eigenmann, 1910: 456 (range). Jordan, Evermann, and Clark, 1930: 183 (listed). Hubbs, 1931: 2 (distribution; Lower California locality held to be an error); 1932*a*: 68 (distribution).

Ilyodon furcidens.—Turner, 1937*b*: 496, 505 (synonymy, from present paper; trophotaeniae).

Ilyodon paraguayense.—Eigenmann, 1907: *428*–29 (original description; Paraguay, "mixed in with some Characins"); 1910: 455 (spelling corrected to *paraguayensis;* listed). Von Ihering, 1931: 246 (classification, characters).

An examination of the type specimens of the two nominal species, in the United States National Museum, shows conclusively that *Ilyodon paraguayense* Eigenmann is specifically identical with *Characodon furcidens* Jordan and Gilbert. The two crushed types of *I. paraguayense* were assigned the locality of Paraguay because they "were mixed in with some Characins" supposed to have been collected by E. Palmer in that country. They agree very closely not only in characters but also in superficial appearance with the types of *Characodon furcidens,* and it is probable that they were part of the same material, collected by Xantus in Colima. Contrary to Eigenmann's description, there were fine teeth in a broad inner band, still represented by remnants. The scales, numbering about 48, are more

[8] Presumably not the "Rio San Pedro at Tuxpan, Jalisco," as stated by Meek (1904: 122)—see Hubbs (1932*a*: 68).

numerous than he indicated. Dorsal rays, 16 or 17; anal rays, 14. The ovary of the holotype is completely divided by a median septum, and the ovigerous lobes are entirely separated. The 6 embryos in this specimen have 6 anterior trophotaeniae, about one-third as long as the 2 posterior ones, which extend slightly beyond the end of the caudal fin.

As held by Hubbs (1931: 2), the type locality of Cape San Lucas for *Characodon furcidens* was obviously an error, though generally accepted (see also annotations through synonymy). An examination of the catalogue in the National Museum explains the source of the error by which this species was accredited to Lower California. The item under "Locality" is blank for the cotype series (No. 30971) reported as from Cape San Lucas, and someone assumed without warrant that this and nearby blanks signified dittos from an entry above of Cape San Lucas. One of this lot is in the University of Michigan Museum of Zoology.

Rather extensive material of this species has been examined. Series in the National Museum, all collected by Xantus, in addition to the one just discussed, are 2 cotype lots (Nos. 5093 and 35338) entered as from Colima, Mexico, and one collection (No. 5105), previously unrecorded, from "Chocan R., Sierra Madre, Mex." The University of Michigan Museum of Zoology has two series seined by James A. Oliver and Anderson Bakewell in 1935 in the state of Colima. One set of 99 specimens, 24 to 68 mm. in standard length, was taken on July 4 in Río Colima (tributary of Río Armeria) at Colima, where the clear running stream, 2 to 15 feet wide and 6 to 18 inches deep, has a very uneven gravelly bottom and no vegetation except marginal grass; temperature, 80° F. The other collection (20 fish, 17 to 86 mm.) was made August 3 in quiet pools of a small tributary of the Río Colima flowing through Hacienda Los Limones, 2 kilometers southwest of Villa Alvarez (west of Colima); water clear; no vegetation; bottom of gravel and mud; temperature 78° F.; width 2 to 4 feet.

The coloration of the body in this species shows much variation, with age, sex, and individuals. A young specimen about 17 mm. in standard length shows a lateral row of irregular blackish spots and bars crossing the inconspicuous axial streak, about which there is a slight diffusion of dark pigment; also an irregular dorsolateral row of smaller spots, and traces of other dark markings. In larger young, to about 30 mm. in length, the lateral bars are occasionally lacking; rarely fused into a lateral band; faint to intense; small and roundish to high and narrow; often restricted to the anterior, posterior, or median section. As these several variations are independent, many types of pattern are developed. In the males the bars fade out more or less completely at a length of about 35 mm., and are then replaced by rather dense speckling, which is strongest forward and is more or less reticulated in the adult males (largest 82 mm.). Some males retain roundish anterior bars to a length of 53 mm. or more. The remnants of these bars, together with a crowding of the specklings, form a usually indistinct and irregular lateral dark band in adult males. In the females the bars show the same variations, are usually retained until the fish is 55 mm. long, and can be seen faintly in even the largest females (86 mm. in standard length). The dorsolateral spots usually become obsolete in the smaller females (as in males), but occasionally persist rather strongly to a length of at least 56 mm. The speckling which is more characteristic of males is usually little developed in the smaller females (to about 40 mm.), but gradually increases in intensity so that old females are rather distinctly speckled—though more faintly and in a finer pattern than the males. The larger females, like the males, show a rather indistinct and irregular dusky stripe.

The coloration of the vertical fins has somewhat similar variations. In the 17 mm. young these fins are clear. At a length of about 24 mm. black specks or spots on the dorsal and anal fins represent the posterior portions of a future submarginal bar, and occasionally some specks appear near the margin of the caudal fin. In the males the dorsal fin markings at a length of about 35 mm. either fade out or become a marginal band, which when present in the adult males is always marginal and narrow and usually dusky; the basal three-fourths of the fin is either plain or weakly speckled or reticulated with dusky. In the females the dorsal stripe remains submarginal, and varies in both young and adult fish from dusky to black, narrow to wide, and short (at posterior part of fin) to long (rarely almost complete); the major basal part of the dorsal is uniform dusky or very faintly speckled—never so strongly as in many males. The anal fin in the males is not boldly marked, but often has small, faint to blackish, irregularly spaced specks, and sometimes a narrow marginal or submarginal blackish band, which is almost never conspicuous. The females at all sizes usually have a narrow to wide and typically intense, often irregular, submarginal band on the anal fin, and occasionally a few blackish dashes on the median part of the fin. The caudal fin in the males usually bears a blackish band of variable width, usually submarginal in the smaller males, but marginal in the larger ones; within this is a usually inconspicuous submarginal light band, then a series of vertical rows of dusky to blackish spots of variable development, but seldom very bold, grading to a smaller size toward the base of the fin and becoming smaller in the adults. In the females the main caudal bar tends to be more disrupted and remains submarginal throughout life; usually lacking or very faint in smaller females, which seldom have the median or basal blackish bars which are developed on this fin in some of the larger females.

In formalin the fins showed relatively little yellow, as compared with specimens of *Balsadichthys xantusi* in the same collections. The females were lemon on the posterior lower half of the body.

Hybrids Between *Ilyodon furcidens* and *Balsadichthys xantusi*

The intimate relationship of *Ilyodon* and *Balsadichthys,* as indicated by their common ovarian and trophotaenial characters, is further evidenced by the discovery that these genera commonly hybridize in nature. This circumstance might even be considered a reason for synonymizing *Balsadichthys* and *Ilyodon,* but to do so would violate the consistent judgment of authors that the species with weak teeth movably set in loosely conjoined jaws of a wide, transverse mouth should be separated generically from those with stronger teeth tightly set in the firmly joined jaws of narrower mouths with better-developed lateral gape.

These natural hybrids, the first to be reported in the family Goodeidae, are intermediate in all characters of teeth, jaws, and mouth, as these are contrasted in items *7k* and *7l* of the key (pp. 33–34). For example, the overall width of the mouth as measured into the head is just intermediate, as shown by the data in Table III. The extreme variability and the slight overlap shown by this ratio is due more to age than to individual variation; the differences indicated for the 2 series of *I. furcidens* are due to the same factor—young predominate in the first set, adults in the latter. The hybrids, of course, also have other differences.

In coloration and color the hybrids have age and sexual differences similar to those exhibited by the parent species, but, as often in hybrids, the approach is greater toward the more deeply and brightly colored parent form, in this case *B. xantusi.* A male 25 mm. long has the bars rather weak, the body speckling already evident, a submarginal black band on each vertical fin (posteriorly on dorsal and anal, medially on caudal), and also a basal black bar on the caudal. In larger males (largest 78 mm.) the bars gradually fade out, the speckling becomes more prominent, the anal markings break up, and more or less conspicuous black dashes develop over the basal three-fourths of each fin—most prominently on the caudal. On the dorsal and caudal a bright lemon yellow band separates the marginal black band from the area covered by dashes. In the smaller females (about 33 mm. long), the bars are prominent, the dorsolateral spots scarcely evident, the speckling of the body hardly developed, the dorsal fin with a few spots posteriorly or a submedian black band, and anal with a submedian black band posteriorly, and the caudal with a few dusky specklings. In grading to the largest female (81 mm.), the bars weaken but do not wholly disappear; the body speckling (or striping) becomes more evident, though not so conspicuous as in males; the dorsal fin becomes uniformly dusky; the anal usually retains a narrow, disrupted, submarginal black band; the caudal

TABLE III

COMPARISON WITH THE PARENT SPECIES OF HYBRIDS BETWEEN *ILYODON FURCIDENS* AND *BALSADICHTHYS XANTUSI*

Data based on all specimens, regardless of sex or age, collected by Oliver and Bakewell in Colima, Mexico (for full collection data see under *Ilyodon furcidens*).

	Over-all width of mouth measured into head															
	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5
Río Colima, at Colima																
I. furcidens (99) ...	......	......	......	......	......	......	1	7	9	9	14	22	17	13	4	3
HYBRIDS (7)	......	......	......	......	1	......	3	3	......	......	......	......	......	......	......	......
B. xantusi (61)	3	6	13	22	9	7	1	......	......	......	......	......	......	......	......	......
Tributary at Los Limones																
I. furcidens (20) ...	......	......	......	......	......	......	......	1	5	6	6	1	1	......	......	......
HYBRIDS (11)	......	......	......	......	......	4	6	1	......	......	......	......	......	......	......	......
B. xantusi (27)	......	4	10	9	4	......	......	......	......	......	......	......	......	......	......	......
Both collections																
I. furcidens (119)...	......	......	......	......	......	......	1	8	14	15	20	23	18	13	4	3
HYBRIDS (18)	......	......	......	......	1	4	9	4	......	......	......	......	......	......	......	......
B. xantusi (88)	3	10	23	31	13	7	1	......	......	......	......	......	......	......	......	......

develops submedian dashes in some individuals about 47 mm. long, but in the larger adult females is plain dusky or bears a submarginal to marginal black band.

Genus *Balsadichthys* Hubbs

Balsadichthys.—Hubbs, 1926: 19 (original description). Jordan, Evermann, and Clark, 1930: 183 (listed). Hubbs, 1932*a*: 68 (type). Turner, 1933*a*: 93 (spelled *Balsdichthys;* structures related to viviparity); 1933*c*: 209, 211 (classification and distribution); 1937*b*: 503–4, 512 (trophotaeniae).

Orthotype, *Goodea whitei* Meek.

The validity of this genus, as separable from *Goodea* and other genera with similar tooth, jaw, and mouth structure, seems to be sufficiently confirmed by the ovarian and trophotaenial characters, as indicated in the analytical key (pp. 23–38). It may also be identified on the basis of the superficial characters outlined in the artificial key on pp. 73–76.

Balsadichthys now appears to be much more closely related to *Ilyodon* (part of the old *Characodon* assemblage) than to *Goodea.* It is not at all improbable that it will be found expedient to synonymize *Balsadichthys* with *Ilyodon,* as suggested in the account just given of the natural hybrids between *Ilyodon furcidens* and *Balsadichthys xantusi.*

17. *Balsadichthys whitei* (Meek)

(Pl. III, Fig. 2, trophotaeniae.)

Goodea whitei.—Meek, 1904: xlvi, lv, *137*–38, Fig. 40 (original description; Cuautla; Yautepec). Regan, 1907: 90, *92* (as *G. whitii;* description). Eigenmann, 1910: *458*–59 (as *G. whitei;* listed).

Balsadichthys whitei.—Hubbs, 1926: 19 (listed). Jordan, Evermann, and Clark, 1930: 183 (listed). Turner, 1933*c*: 218, 236–41, Pl. 1, Fig. 9, and Pl. 3, Fig. 13 (viviparity and related structures). Ahl, 1935: 107 (Tlapa, Guerrero). Turner, 1937*b*: 496, 504, 506–7, Pl. 1, Fig. 6, and Pl. 4, Figs. 22 and 23 (trophotaeniae).

Of this species we have studied Meek's types, and other specimens collected on March 13, 1932, by Turner and Dildine in a slack-water pool with stony and sandy bottom and some algae, in the stony Río Cuautla, at Cuautla, Morelos (basin of Río Balsas); temperature, 72° F.; depth, to 2 feet.

18. *Balsadichthys xantusi,* new species

(Pl. IV, Fig. 3, holotype.)

Characodon furcidens.—Jordan and Gilbert, 1882*a*: *354*–55; and 1882*b*: 371 (type specimens of *B. xantusi* included in the two cotype series of *C. furcidens,* but apparently not used in type description).

Balsadichthys xantusi.—[Hubbs and Turner], in Turner, 1937*b*: 496, 505 (*nomen nudum,* because merely mentioned as not studied).

This species of the Río Colima basin seems to be most closely related to *Balsadichthys whitei* of the Río Balsas system, with which it is compared in items *12b* and *12c* of the analytical key on p. 34. It is also very close to *Ilyodon furcidens* with which all known specimens of *B. xantusi* have been obtained. It differs from *I. furcidens* in the structure of its teeth, jaws, and mouth, as contrasted in items *7k* and *7l* of the key; also in the bolder coloration and in other superficial characters (items *12a* and *12c* of the key). The close relationship between *Balsadichthys xantusi* and *Ilyodon furcidens* is attested not only by the similar ovarian and trophotaenial characters, but also by certain minor resemblances in coloration and other superficial characters, by the similar distribution, and by natural hybridization (see p. 61).

HOLOTYPE.—An adult male 78 mm. in standard length, U.M.M.Z. No. 105997, collected with 26 paratypes, 41 to 88 mm. long, by James A. Oliver and Anderson Bakewell on August 3, 1935, in quiet pools of a small tributary of the Río Colima (Río Armeria basin), at Haciendo Los Limones, 2 kilometers southwest of Villa Alvarez (west of Colima, Colima, México); water clear; no vegetation; bottom of gravel and mud; temperature, 78° F.; width, 2 to 4 feet.

Sixty-one paratypes, 25 to 66 mm. long, were collected by Oliver and Bakewell on July 4, 1935, in Río Colima at Colima, where the clear running stream, 2 to 15 feet wide and 6 to 18 inches deep, had a very uneven gravelly bottom and no vegetation except marginal grass; temperature, 80° F.

Seven additional paratypes, 32 to 57 mm. long, U.S.N.M. No. 92901–2, were found in the cotype series (No. 35338) of *Characodon furcidens,* collected long ago at Colima, México, by John Xantus. Fourteen others, 25 to 57 mm. long, U.S.N.M. No. 92903, were removed from the cotype series (No. 30971) of *C. furcidens,* erroneously recorded as from Cape San Lucas (see statement on p. 59).

Body in adult moderately slender except for the disproportionately heavy trunk, particularly just behind the head. Greatest depth (about 1.7 or 1.8 times greatest width) contained in standard length 3.0 times (2.8 to 3.6 in medium to large adult males, 3.0 to 3.6 in similar females). Dorsal contour rising abruptly just behind occiput at an angle of about 35° in large males, less abruptly in younger males and in females, then ascending slightly in a weak curve to a flat section in advance of origin of dorsal fin, along base of which the slightly convex contour falls at an angle of less than 20°. Ventral contour strongly and often angularly curved from isthmus to pelvic fin, usually reaching the lowest point in advance of that fin; rising along base of anal fin at an angle of about 60° in large males, less steeply in young males, and at an angle of about 30° in females. Caudal peduncle long and slender, but less so than in *B. whitei,* with contours gently diverging forward and backward. Least depth of peduncle, 2.0 (1.8 to 2.0, 1.8 to 2.3) in length of peduncle, 2.0 (1.8 to 2.2, 1.7 to 2.0) in head. Distance from origin of dorsal to origin of anal, including dermal pocket in male, 3.6 (3.4 to 3.7, 3.65 to 4.1).

Length of head, 3.8 (3.7 to 4.1 in males, 3.8 to 4.3 in females). Head about one-fifth deeper than its greatest width, which enters the head length 1.5 (1.4 to 1.7, 1.3 to 1.8) times. Least width of weakly convex interorbital, 2.1 (2.0 to 2.3, 2.0 to 2.3). Orbit, 1.8 (1.6 to 1.9, 1.6 to 2.1) in interorbital, 4.2 (3.2 to 4.2, 3.2 to 4.4) in head. Mouth very wide (see Table III, p. 62), with narrow lips; almost strictly transverse (lateral projection shorter than pupil, only about one-fifth width of mouth). Muzzle almost square as seen from above. Jaws very thin, soft, and flabby; weakly conjoined. Teeth and intestine as described for genus (in item *7l*, p. 34). Gill-opening bound down by membrane to a point about midway between upper end of subopercle and origin of pectoral. Upper arm of branchial arches much shortened. Gill-rakers (in one paratype), 2 + 39, the longest about one-fourth length of orbit.

A study of the ovaries and trophotaeniae of the embryos in freshly preserved specimens of this species and of *Ilyodon furcidens* strikingly confirmed our prior conclusions, which were based on an examination (see Turner, 1937*b*: 505–6) of the very old and poorly preserved specimens collected by Xantus. For *Balsadichthys xantusi* the ovarian and trophotaenial characters are as described in the analytical key, under items *1b, 2d, 3f, 5h, 6a,* and *12c*. The ovaries in this species and in *I. furcidens* are of the type which possesses a thin nonovigerous septum such as is found in *Balsadichthys whitei, Girardinichthys, Lermichthys,* and *Skiffia*. The trophotaeniae are distinctly of the sheathed type, which also relates them to the same group (Girardinichthyinae). *Ilyodon furcidens* has an elaborate group of processes with 8 to 10 terminal branches, the posterior pair of which are considerably flattened. No other genus with the sheathed processes, except *Balsadichthys,* has so many branches, so that we can feel rather certain about the close relationship of these genera. The 10 to 13 trophotaeniae of *B. xantusi* are almost exactly like those of *B. whitei,* except that the long posterior processes are very much more flattened.[9]

Fin rays: dorsal, 15 (14 to 17); caudal, 18 (17 to 20) branched rays; anal, 13 (11 to 14), not counting a very short ray frequently developed at base of first developed ray; pelvic, 6; pectoral, 14 (13 to 16), not counting a rudimentary ray sometimes discernible at base of upper edge of fin. Origin of dorsal fin in males slightly behind the mid-point between verticals through insertion of pelvic and origin of dorsal fin; in females, somewhat in advance of anus. Distance from dorsal origin to end of middle caudal ray

[9] A more detailed description of the trophotaeniae of *Ilyodon furcidens* and of *Balsadichthys xantusi* will be published by Turner.

into distance forward to tip of upper lip, 0.9 to 1.0 in males, 0.95 to 1.1 in females. Distance from caudal base to dorsal origin, 1.35 (1.25 to 1.4, 1.35 to 1.6) in predorsal length. Dorsal fin rounded posteriorly and low anteriorly, especially in males; failing to reach procurrent caudal rays by nearly an orbital length in males and by more than an orbital length in females; basal length of dorsal a little greater than distance from end of dorsal base to origin of caudal in males, about an orbital diameter less than that distance in females. Length of depressed dorsal fin in head, 0.7 (0.65 to 0.85, 0.9 to 1.2). Distance from origin of rather squarish anal fin to caudal base, 2.7 (2.65 to 2.9, 2.6 to 2.9) in standard length. Caudal fin slightly concave medially and with a broadly rounded lower lobe and a somewhat narrower, sharper, and longer upper corner; length of middle ray, 1.35 (1.2 to 1.4, 1.3 to 1.5). Characters of pelvic fin, of anal lobe in adult male, and of swollen area between anus and genital opening, all as described in item *7l* of key (p. 34).

Scales in 47 (43 to 50) transverse and about 18 longitudinal rows.

In age and sexual variation this species agrees remarkably well with its apparent relative *Ilyodon furcidens* (see pp. 59–61), but is brighter in color and typically bolder in coloration.

Young males, 26 to 30 mm. long, already transforming, retain the bars in variable intensity, number, shape, and position (in some best developed anteriorly, in others posteriorly), but the speckling, strongest on the lower median sides, is already beginning to dominate the pattern. This speckling, on a light background, becomes finer with age, but remains on the average coarser and bolder than in *Ilyodon furcidens.* In the adult males (largest 88 mm.) the speckling tends to be concentrated along the middle of the sides, in an irregular band of variable intensity. This band is reinforced by a diffusion of pigment (starting along the axial streak of the young) and by the remnants of the vertical bars, which almost disappear at a length of about 40 mm. The dorsolateral row of spots is weakly evident, and only in the smallest males.

Young females of 25 to 40 mm. are considerably less modified than the males of like size. The 6 to 11 bars are developed along the entire length of the sides, are usually high, and vary in width inversely with the number; the dorsolateral spots are conspicuous in some specimens, though often absent; the speckling is inconspicuous. The bars remain conspicuous to a length of 60 mm., and are faintly discernible in some of the largest females (to 88 mm.). The largest specimen showing dorsolateral spots is 46 mm. long. The speckling becomes more conspicuous with age, but at all stages is fainter and finer than in males. In large females the specklings on the trunk tend to form zigzag lines between the scale rows.

The fins of the male are very boldly marked with black. Almost without exception the males have a jet-black band on the caudal, changing from a subterminal position to a marginal one at a length of about 50 mm. In young males 26 to 30 mm. long there is a prominent basal bar or row of spots on this fin, and often some submedian spots or dashes, which at larger sizes become conspicuous while the basal mark often fades. To a length of about 50 mm. the jet-black dashes are usually in 1 or 2 vertical rows, but in larger fish these break up into numerous blackish to jet-black specks and dashes covering the fin from the base to a clear submarginal streak of variable width. In life this submarginal band is very characteristically colored bright lemon yellow. Smaller males (to about 50 mm.) have the dorsal variably colored, in some fish plain, or with a few black spots more or less aligned in a submarginal or a subbasal band, or both. At larger sizes and in some smaller fish the outer band becomes marginal and narrow, bordering a wide band of bright lemon yellow, below which the fin is spotted or reticulated with blackish. The smaller males have a few submarginal spots or a band of jet-black. At lengths greater than 30 mm. the fin has an increasing number of dusky to black dashes scattered over its whole surface, and in some large adults the dorsal shows a black margin of spots or band.

In females 25 to 35 mm. long the caudal fin is usually plain dusky; the dorsal fin is commonly plain, or marked with a few black specks or spots in a submarginal position; and the anal fin consistently has a submarginal band or spots in the same position. Medium-sized females, about 50 to 65 mm. long, have the caudal plain, or commonly marked over the whole surface with about 4 rows of jet-black dashes, usually without a submarginal band; the dorsal is usually plain, occasionally with a submarginal row of spots or scattered spots; and the anal has a submarginal black band partially disrupted into dashes in some specimens. Larger females (70 to 88 mm.) usually have a submarginal row of spots on caudal, within which is a trace of a yellowish streak, and faint dashes about the basal three-fourths of fin; the dorsal tends to develop a dusky to black, almost marginal band, with dusky base and with dusky rays separating clear areas on the membranes submedially.

The adult females have little of the lemon yellow on the vertical fins, but are strongly washed with lemon yellow on the pelvic fin and the lower sides, especially posteriorly. The males are only weakly so colored on the body. Both sexes are dark above, light below.

This species is named *xantusi* in honor of John Xantus, who collected the first specimens long ago.

GENUS *GIRARDINICHTHYS* BLEEKER

Girardinichthys.—Bleeker, 1860: 481 (new name; characters in key). Jordan and Gilbert, 1883: 327, *342*–43 (diagnosis). Eigenmann and Eigenmann, 1891: 18 (distribution). Garman, 1895: 18, *38* (description). Jordan and Evermann, 1896: 631, *666* (description); 1896*a*: 313 (listed). Meek, 1902: 89 (in key); 1904: xlix, 99, *115* (distribution; description; records). Eigenmann, 1910: 455 (listed). Regan, 1911: 325 (listed). Hubbs, 1924*a*: 4 (classification); 1926: 17–*18* (teeth). Jordan, Evermann, and Clark, 1930: 182 (synonymy). Turner, 1933*a*: 93; and 1933*c*: 208–11, 218 (distribution; structures related to viviparity); Turner, 1937*b*: 503, 506–7, 512 (trophotaeniae).

Haplotype, *Girardinichthys innominatus* Bleeker.

Limnurgus.—Günther, 1866: 309 (original description; replacing the ''barbarous name'' *Girardinichthys*). Regan, 1907: 76, *87* (description).

Haplotype, *Limnurgus variegatus* Günther = *Girardinichthys innominatus* Bleeker.

This is the oldest and one of the best-known genera of the Goodeidae.

19. *Girardinichthys innominatus* Bleeker

(Pl. II, Fig. 7, trophotaeniae.)

Lucania [species].—Girard, 1859: 118–*19* (description; ''vicinity of the city of Mexico'').

Girardinichthys innominatus.—Bleeker, 1860: *484*–85 (''= Lucaniae sp. Proc. Acad. Philad., 1859, p. 119. Am. sept., Mexico''). Jordan and Gilbert, 1883: 343. Eigenmann, 1893: 56 (listed). Garman, 1895: 39, Pl. 1, Fig. 11 (description; synonymy; teeth figured; ''City of Mexico''). Jordan and Evermann, 1896: 666 (description; ''vicinity of City of Mexico''); 1896*a*: 313 (listed). Seurat, 1898: 25–26; and 1900: 404–6 (records in Valle de México; viviparous). Meek, 1902: 87–88, *95*, 124 (description; viviparity; Chalco; Texcoco; Xochomilcho); 1903: 778 (distribution); 1904: xli, *116*–19 (synonymy; description; early account of viviparity quoted; Viga Canal, etc.). Eigenmann, 1910: 455 (synonymy). Jordan and Evermann, 1927: 502 (comparison). Jordan, Evermann, and Clark, 1930: 182 (synonymy). Gordon, 1933*a*: 260, 1 fig. (Lago de Xochimilco and Lago de Texcoco). Turner, 1933*c*: 218, *220*, 224, 236–51, Pl. 1, Fig. 7, Pl. 6, Fig. 24, Pl. 7, Fig. 31, and Pl. 8, Fig. 30 (viviparity and related structures). Stoye, 1935: *77*, 280 (introduction as aquarium fish). Del Campo, 1936: 272 (Lagunilla, Actopan). Mendoza, 1937: 97–98, 100, 105–6, Pl. 1, Fig. 3 (trophotaeniae). Turner, 1937*b*: 496, 504, 507, Pl. 2, Fig. 12 (trophotaeniae).

Limnurgus innominatus.—Regan, 1907: 87, Pl. 12, Fig. 1 (description; synonymy; records).

Limnurgus variegatus.—Günther, 1866: 309 (original description; synonymy; ''vicinity of the city of Mexico'').

Mollienesia [species].—Gill, 1882: 8 (identification of early account, quoted, of viviparity).

Lucania Richi.—Girard, in Goode, 1891: 85 (this specific name, not referred to by subsequent authors, was intended to have been used by Girard, 1859, for his new *Lucania;* the name disappeared from the text as the paper was going through the press).

Characodon Geddesi.—Regan, 1904: 257 (original description; Lago de Texcoco).

This synonymy though rather complex involves no apparent uncertainties. The species shows exceptional variation, but the different types occur together through its limited range (Valle de México). Color variants in newly collected material will be illustrated in a forthcoming contribution by Hubbs and Gordon.

Genus *Lermichthys* Hubbs

Lermichthys.—Hubbs, 1926: 18 (original diagnosis; comparison). Jordan, Evermann, and Clark, 1930: 183 (listed). Turner, 1933*a*: 93 (spelled *Lermicthys;* struc-

tures related to viviparity); 1933*c*: 209, 211, 218–*19* (classification; distribution; viviparity and related structures); 1937*b*: 503, 507, 512 (trophotaeniae).
Orthotype, *Characodon multiradiatus* Meek.

The erection of this new genus for *Characodon multiradiatus* has been well justified by the discovery and application of the trenchant ovarian and trophotaenial characters. As indicated in the analytical key, *Lermichthys* is a close relative, and probably a derivative, of *Girardinichthys,* and shows no very close affinity with *Characodon* and other genera having similar dentition.

20. *Lermichthys multiradiatus* (Meek)

(Pl. II, Fig. 8, trophotaeniae.)

Girardinichthys innominatus (erroneous identification).—Evermann and Goldsborough, 1902: 149 (description; viviparity; Lago de Lerma).

Characodon multiradiatus.—Meek, 1904: xl, 118–*19* (original description; based on specimens referred by Evermann and Goldsborough to *Girardinichthys innominatus;* Lago de Lerma). Regan, 1907: 88, Pl. 12, Figs. 3–4 (description; same locality). Eigenmann, 1909: 304; and 1910: 455 (listed).

Lermichthys multiradiatus.—Hubbs, 1926: 19 (synonymy); 1927: 66 (*Girardinichthys limnurgus* as a synonym). Jordan, Evermann, and Clark, 1930: 183 (synonymy). Gordon, 1933*b*: 90 (Río Lerma). Turner, 1933*c*: *217,* 219–*20,* 236–51, Pl. 1, Figs. 1–4, Pl. 3, Figs. 14–15, Pl. 6, Fig. 25, and Pl. 8, Fig. 29 (viviparity and related structures); 1937*b*: 496, 504, 507, Pl. 2, Fig. 13 (trophotaeniae).

Girardinichthys limnurgus.—Jordan and Evermann, 1927: 502 (original description; also based on specimens referred by Evermann and Goldsborough to *Girardinichthys innominatus;* Lago de Lerma).

New records for this species will be given, with an illustration of its varying color phases, in a paper by Hubbs and Gordon.

Genus *Skiffia* Meek

Skiffia.—Meek, 1902: 90, *102* (original description); 1904: xlix, lvi, 101, *141* (distribution; description; key to species). Eigenmann, 1910: 459 (listed). Hubbs, 1924*a*: 4 (name misspelled *Skiffea;* classification); 1924*b*: 7; 1926: 19 (species). Jordan, Evermann, and Clark, 1930: 183 (listed). Turner, 1933*a*: 93 (structures related to viviparity); 1933*c*: 208–9, 211, 218 (classification; distribution; viviparity and related structures); 1937*b*: 503, 512 (trophotaeniae).
Orthotype, *Skiffia lermae* Meek.

The distinction of *Skiffia* from *Goodea* is abundantly justified by the ovarian and trophotaenial characters, on the basis of which the two genera are now placed in different subfamilies. In the Girardinichthyinae, *Skiffia* represents the limnophagous type with long intestine and bifid teeth movably set in weak and loosely conjoined jaws.

Largely on the basis of superficial characters, we set 2 species of *Skiffia* apart in distinct genera, *Ollentodon* and *Neotoca* (see following pages).

21. *Skiffia variegata* Meek

Skiffia variegata.—Meek, 1902: 71, 94, *104*–5, 124, Pl. 25, lower fig. (original description; comparison; Lago de Zirahuen, Zirahuen, Michoacán; also Chalco); 1903: 778

(Valle de México); 1904: xl–xli, 141, *143*, Fig. 44 (description). Eigenmann, 1909: 304; and 1910: 459 (listed). Hubbs, 1924*b*: 8 (a doubtful synonym of *lermae*); 1926: 19 (characters; probably a distinct species). Jordan, Evermann, and Clark, 1930: 183 (listed). Turner, 1937*b*: 503, 507, Pl. 2, Fig. 10 (trophotaeniae).

Goodea lermae (probably unjustified synonymizing).—Regan, 1907: 90, *92* (in part; description).

We provisionally separate this species from *S. lermae* on the somewhat dubious distinctions given in our key (p. 37).

22. *Skiffia lermae* Meek

(Pl. III, Fig. 1, trophotaeniae.)

Skiffia lermae.—Meek, 1902: 71, *102*–5, Pl. 25, upper and lower figs. (original description; comparisons; Lago de Pátzcuaro, Pátzcuaro, Michoacán; also Celaya); 1903: 777, 1 fig.; 1904: xl, 141, *142*–43, Pl. 8 (description). Eigenmann, 1909: 304; and 1910: 459 (listed). Hubbs, 1924*b*: 8 (*variegata* as a doubtful synonym); 1926: 19. Jordan, Evermann, and Clark, 1930: 183 (listed). Turner, 1937*b*: 503, 507, Pl. 2, Fig. 11 (trophotaeniae).

Goodea lermae.—Regan, 1907: 90, *92* (in part; description).

Only Meek's types of this species and of *S. variegata* have been available for study.

Genus *Ollentodon* Hubbs and Turner

Ollentodon.—[Hubbs and Turner], in Turner, 1937*b*: 503, 507, 512 (name *Ollentodon multipunctatus* used, and indicated as taken from the manuscript for the present paper; trophotaeniae described).

Genotype, *Xenendum multipunctatum* Pellegrin.

On the basis of ovarian and trophotaenial characters, *Ollentodon* shows relationship with the other genera grouped in the Girardinichthyinae. The fact that the trophotaeniae number 3 separates it from *Ilyodon* and *Balsadichthys,* which have many of these embryonic nutritional organs, and from *Girardinichthys* and *Lermichthys,* which have 4 trophotaeniae. *Ollentodon* also differs from these genera in the external characters of the adult, as indicated in the analytical key (pp. 33–38) as well as in the artificial key (pp. 74–76).

Ollentodon differs from *Skiffia* in having the teeth of the inner band mostly bifid, instead of conic or round-tipped; the dorsal fin larger (with 15 to 17 in place of 12 or 13 rays); the median posterior trophotaeniae about as long as the lateral ones, rather than about three-fourths as long. The single species differs markedly from both forms of *Skiffia* in coloration and slightly in the number of gill-rakers (approximately 29 instead of 25).

Ollentodon, referring to the largely obsolescent inner teeth, from ὄλλω, to lose or occasion a loss, ἐντὸς, within, and ὀδοὺς, tooth.

23. *Ollentodon multipunctatus* (Pellegrin)

Xenendum multipunctatum.—Pellegrin, 1901: *206*–7 (original description; comparison; "Sources, mares et fossés d l'Agua Azul. Environs de Guadalajara, Jalisco").

Skiffia multipunctata.—Meek, 1902: *103*–5 (description; comparison; Ocotlán); 1904: xl, *141*–42 (description; synonymy). Eigenmann, 1909: 304; and 1910: 459 (listed). Jordan, Evermann, and Clark, 1930: 183 (listed).

Goodea multipunctata.—Regan, 1907: 90, *92*, Pl. 12, Figs. 5–6 (description).

Ollentodon multipunctatus.—Turner, 1937*b*: 503, 507, Pl. 2, Fig. 9 (trophotaeniae).

Of this interesting species we have re-examined the material recorded by Meek.

Genus *Neotoca* Hubbs and Turner

Neotoca.—[Hubbs and Turner], in Turner, 1937*b*: 496–97, 503, 507, 512 (name *Neotoca bilineata* used, and indicated as taken from the manuscript for the present paper; trophotaeniae described).

Genotype, *Characodon bilineatus* Bean.

The single species of this rather well-marked genus has often been placed either in *Characodon* or *Goodea,* and indeed is somewhat intermediate in the differential mouth structures which have been grossly overemphasized in the classification of the group. The ovarian and trophotaenial characters, as given in the analytical key (pp. 24–36), indicate no very close affinity with either *Characodon* or *Goodea.* These characters point toward relationship with *Skiffia,* to which genus Meek referred the type species. In our opinion there are enough differences, however, to warrant a generic separation.

Neotoca differs from *Skiffia* in having the inner band of teeth well developed instead of obsolescent medially; the teeth of this band uniformly bifid rather than conic or blunt-tipped; the teeth of the outer row less loosely set and the mouth less definitely transverse; the intestine shorter, with 3 or 4 instead of 6 to 8 transverse elements; the median trophotaenia distinctly longer, not shorter than the lateral ones; the inner pelvic rays free from body rather than largely bound down; the dermal pouch on the front of the anal fin of the adult male only slightly instead of very well developed; the anterior anal lobe of the male half or slightly more than half, instead of less than one-third as high as the longest anal ray; and the transverse genital opening of male convex rather than concave medially. *Neotoca bilineata* differs very strikingly from the species of *Skiffia* in coloration, particularly in the much greater sexual dimorphism, and slightly in the size of the scales (29 to 33 *vs.* 33 to 37); number of gill-rakers (about 20 *vs.* about 25); and number of dorsal rays (13 to 15 *vs.* 12 or 13).

Neotoca differs sharply from *Ollentodon* in the characters of the teeth, jaws, mouth, intestine, pelvic fin, and the sexual characters associated with the anal fin, in the same way that it differs from *Skiffia* (except that the inner teeth are bifid as in *Ollentodon*). There are also marked distinctions in coloration and slight differences in the various counts.

Neotoca, new [type of] offspring (embryo), from *νέος*, new, and *τόκος*, offspring.

24. *Neotoca bilineata* (Bean)

(Pl. I, Fig. 7, section of ovary.)

Characodon bilineatus.—Bean, 1887, *371*–72, Pl. 20, Fig. 2 (original description; comparison; probably streams of Guanajuato). Eigenmann, 1893: 56 (Guanajuato). Jordan and Evermann, 1896: *668*–69 (description, after Bean; Río Lerma, Guanajuato); 1896*a*: 314 (listed); 1898: 2831 (not a synonym of *C. lateralis*); 1900: 3256, Pl. 109, Fig. 293 (Guanajuato).

Skiffia bilineata.—Meek, 1902: 102, 105 (spelled both *bilineatus* and *bilineata*; description; comparison; Huingo); 1904: xl, 141, *144*, Fig. 45 (description; synonymy). Eigenmann, 1909: 304; and 1910: 459 (listed). Hubbs, 1924*b*: 7–8 (sexual dimorphism; Lago de Cuitzeo; Huingo). Jordan, Evermann, and Clark, 1930: 183 (listed). Mayer, 1936: 51–52, 1 fig. (as aquarium fish). Mendoza, 1937: 97–116, Pl. 1, Fig. 2, and Pls. 2 and 4 (trophotaeniae).

Goodea bilineata.—Regan, 1907: 90, *92* (comparisons). Turner, 1933*a*: 94; and 1933*c*: *213*–45, Pl. 1, Figs. 5–6, Pl. 2, Figs. 10, 12, Pl. 3, Fig. 16, Pl. 4, Fig. 21, and Pl. 7, Figs. 26–28 (viviparity and related structures).

Neotoca bilineata.—Turner, 1937*b*: 496–97, *503*, 507, Pl. 2, Fig. 8 (trophotaeniae).

Characodon lateralis (erroneous synonymizing).—Garman, 1895: 36 (synonymy in part).

Of this species we have re-examined the type and Meek's material. Other specimens were collected by Turner and Dildine in Río Grande de Santiago, between Ocotlán and Laguna de Chapala, and an aquarium stock was obtained there. Aquarium specimens, having the remarkable sexual dimorphism of this species (Hubbs, 1924*b*: 8), were figured on the back cover of *The Aquarium* for August, 1935.

APPENDIX

Artificial Key to the Genera and Species of Goodeidae

1a.—*Teeth* not bifid (a few to most may be weakly forked in *Girardinichthys*), firmly attached to the jaws.

2a.—*Teeth* all more or less sharply conic. *Mouth* with a wide lateral gape. *Dorsal and anal fins* each with 11 to 19 rays. *Pelvic fins* in contact, and more or less bound down to body by membrane (except in *Allodontichthys*).

3a.—*Origin of dorsal fin* close to middle of total length including caudal fin. *Coloration:* body not crossed by regular blackish bars extending on the back.

4a.—*Teeth* regularly conic, everywhere round in cross section, without trace of keel at either edge of anterior face. *Coloration:* no scapular mark; no black bands on dorsal fin; no definite rounded dark spots above pectoral fin.

5a.—Sixth *pelvic rays* of the two fins in contact (*Alloophorus*) or rather widely separated (*Neoophorus*). *Coloration:* no posteroventral row of black bars or spots, and none at base of caudal.

6a.—*Dorsal rays,* 12 to 14. *Scale rows,* 36 to 39. *Coloration:* no bars, but much speckled.

2. *Alloophorus robustus*

6b.—*Dorsal rays,* 15 to 19. *Scale rows,* 32 to 39. *Coloration:* several irregular, narrow dusky bars, and some speckling.

10. *Neoophorus diazi*

5b.—Fifth *pelvic rays* of the 2 fins in contact, forcing the sixth ray to lie between fifth ray and body. *Coloration:* a posteroventral row of black bars or spots, and a pair at base of caudal.

6c.—*Dorsal rays,* 12 to 14. *Scale rows,* 29 to 34.

8. *Zoogoneticus quitzeoensis*

4b.—*Teeth* compressed and shouldered within the slender conic tip, with a low keel at either edge of anterior face. *Coloration:* a black, comma-shaped scapular mark; several black bands on dorsal fin; rounded dark spots above and behind pectoral fin.

5c.—Sixth *pelvic rays* of the 2 fins closely approximated.

6d.—*Dorsal rays,* about 13. *Scale rows,* about 40.

9. *Allodontichthys zonistius*

3b.—*Origin of dorsal fin* far behind middle of total length including caudal fin. *Coloration:* body crossed by regular blackish bars extending onto the back.

4c.—*Teeth* regularly conic.

5d.—Sixth *pelvic rays* of the 2 fins approximated.

6e.—*Dorsal rays,* 15 to 17. *Scale rows,* 29 to 35.

14. *Allotoca dugèsii*

2b.—*Teeth* conic to truncate, and some arrow-shaped or slightly bifid or trifid. *Mouth* with reduced lateral gape. *Dorsal and anal fins* each with 18 to 26 rays. *Pelvic fins* well separated, and not bound down to body.

3c.—*Origin of dorsal fin* slightly before middle of total length including caudal fin in females, decidedly before that point in adult males. *Coloration:* breeding males jet black; a dark blotch often developed above anus; sides speckled, barred, or streaked.

19. *Girardinichthys innominatus*

1b.—Teeth regularly bifid, either firmly or loosely attached to jaws.

7a.—Dorsal and anal fins each with fewer than 18 rays.

8a.—Teeth firmly attached to strong, well-united jaws. *Mouth* with lateral gape more or less well developed. *Intestine* short to long.

9a.—Dorsal fin inserted far behind middle of total length including caudal fin. *Coloration:* females with short, irregular black bars; males with a black longitudinal stripe.

10a.—Scale rows, 31 to 33. *Intestine* rather short, with about 4 short transverse segments. *Dorsal rays,* 11 to 13. *Teeth* of inner band conic.

15. *Characodon lateralis*

9b.—Dorsal fin inserted near middle of total length including caudal fin. *Coloration:* crossbars lacking or merely dusky.

10b.—Scale rows, 33 to 38. *Intestine* short, with only 1 extra coil about second bend. *Dorsal rays,* 13 or 14. *Mouth* with wide lateral gape. *Teeth* of inner band conic. *Coloration:* females spotted; males with an irregular blackish stripe.

3. *Xenotoca variata*

10c.—Scale rows, 46 to 50. *Intestine* long, with 8 to 12 high transverse segments. *Dorsal rays,* 14 to 17. *Mouth* with reduced lateral gape. *Teeth* of inner band bifid. *Coloration:* females with irregular dark stripe and dusky bars; males spotted.

16. *Ilyodon furcidens*

9c.—Dorsal fin inserted well in advance of total length including caudal fin. *Coloration:* body crossed by regular (occasionally irregular) blackish bars, in both sexes.

10d.—Scale rows, 34 to 37. *Intestine* considerably elongate and coiled, with about 5 transverse segments. *Dorsal rays,* about 15. *Mouth* with much reduced lateral gape. *Teeth* of inner band conic. *Coloration:* strongly barred along middle of sides in both sexes.

4. *Chapalichthys encaustus*

8b.—Teeth loosely attached to weakly joined jaws. *Mouth* essentially transverse. *Intestine* elongate.

11a.—Dorsal fin smaller, with 10 or 11 rays, and placed farther back, beginning distinctly behind origin of anal fin, more than twice as far from tip of snout as from base of caudal fin. *Inner teeth* bifid.

1. *Ataeniobius toweri*

11b.—Dorsal fin larger, with 12 to 17 rays, and placed farther forward, beginning approximately over origin of anal fin (*Goodea gracilis* and *G. atripinnis*), or in advance of anal origin, about twice as far (*G. gracilis* and *G. atripinnis*) or less than twice as far from tip of snout as from base of caudal, much less than twice as far in the genera (*Balsadichthys, Ollentodon,* and *Neotoca*) having the *inner teeth* bifid.

12a.—Swollen area between anus and genital opening of males wholly scaleless. *Caudal fin* symmetrically truncate or rounded. *Scales,* 32 to about 45. *Coloration:* females without diffuse dark axial stripe (with an even black stripe in *Neotoca bilineata*); vertical fins never with a black bar.

13a.—Gill-rakers on first arch, about 40 to 45. *Origin of dorsal fin* distinctly nearer end of caudal fin than tip of snout (not much nearer caudal tip in *Goodea luitpoldii*). *Anterior lobe of anal fin of males* about three-fourths as high as highest anal ray, with rays relatively little crowded. *Innermost pelvic rays* in contact.

Goodea

(For characters of species see items 9 and 10 in the analytical key, on pp. 27–28.)

13b.—Gill-rakers on first arch, about 20 to 30. *Origin of dorsal fin* a little nearer end of caudal fin than tip of snout, or nearer tip of snout. *Anterior lobe of anal fin of males* at most little more than half as high as main lobe, with rays much crowded. *Innermost pelvic rays* slightly (*Xenoophorus*) or considerably separated.

14a.—Origin of dorsal fin a little nearer end of caudal fin than tip of snout in females, about equidistant between these points in adult males. *Swollen area between anus and genital opening of males* wider than long. *Innermost pelvic rays* slightly separated.

Xenoophorus

(For characters of species see items 11a to 11c in the analytical key, on pp. 30–31.)

14b.—Origin of dorsal fin considerably nearer tip of snout than end of caudal fin in females, much nearer tip of snout in adult males. *Swollen area between anus and genital opening of males* longer than wide. *Innermost pelvic rays* considerably separated.

15a.—Inner band of teeth obsolescent, except at side posteriorly; *teeth of outer row* very loosely attached to rather weak jaws. *Mouth* almost strictly transverse, with scarcely any lateral gape. *Intestine* much elongated, with 6 to 8 even coils on right side. *Scales* in 33 to 37 rows. *Transverse genital opening of males* concave medially. *Anterior lobe of anal fin of males* less than one-third as high as highest anal ray, completely retractable within a dermal pouch. *Innermost pelvic rays* largely bound down to body by membrane.

16a.—Dorsal rays, 12 or 13. *Gill-rakers,* about 25. *Teeth* of inner band (developed at sides) conic to blunt. *Coloration:* densely variegated with dusky in each sex.

Skiffia

(For characters of species see items 14 and 15 in the analytical key, on p. 37.)

16b.—Dorsal rays, 15 to 17. *Gill-rakers,* about 29. *Teeth* of inner band (developed at sides) mostly bifid, some conic. *Coloration:* upper and posterior sides with definite rows of blackish spots in each sex.

23. *Ollentodon multipunctatus*

15b.—Inner band of teeth not obsolescent medially, forming a narrow, moderately curved band; *teeth of outer row* rather loosely attached to moderately strong jaws. *Mouth* with considerably reduced lateral gape (forming a wide arch). *Intestine* not much elongated, kinked but not evenly coiled on right side, with about 3 or 4 transverse segments. *Scales* in 29 to 33 rows. *Transverse genital opening of males* convex medially. *Anterior lobe of anal fin of males* one-half or a little more than one-half as high as highest anal ray, with a moderately developed dermal thickening near base forming only a trace of a pocket. *Innermost pelvic rays* not bound down to body by membrane.

16c.—Dorsal rays, 13 to 15. *Gill-rakers,* about 20. *Teeth* of inner band uniformly bifid. *Coloration:* females with a black axial stripe and a shorter, lower stripe over the belly in advance of a black blotch or bar above the anus; males with a single dark band more or less broken into bars.

24. *Neotoca bilineata*

12b.—Swollen area between anus and genital opening of males covered with scales on anterior half (except for a median strip). *Caudal fin* asymmetric: upper angle more or less produced and pointed; lower angle cut off and rounded. *Coloration:* females with a diffuse axial stripe and more or less evident and definite dark crossbars; one or more of the vertical fins with a marginal or submarginal black stripe.

Balsadichthys

(*For characters of species see items 12b and 12c in the analytical key, on p. 34.*)

7b.—Dorsal and anal fins each with more than 25 rays.

20. *Lermichthys multiradiatus*

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PLATE I

Diagrammatic cross sections of gravid ovaries of goodeid fishes, after removal of embryos. Ovigerous tissue is indicated by black spots.

FIG. 1. *Alloophorus robustus* (applicable also to *Xenotoca variata*).
FIG. 2. *Goodea luitpoldii* (drawn facing backward).
FIG. 3. *Xenoophorus captivus.*
FIG. 4. *Neoophorus diazi* (drawn facing forward).
FIG. 5. *Zoogoneticus quitzeoensis.*
FIG. 6. *Ataeniobius toweri* (drawn facing backward).
FIG. 7. *Neotoca bilineata.*
FIG. 8. *Characodon lateralis.*

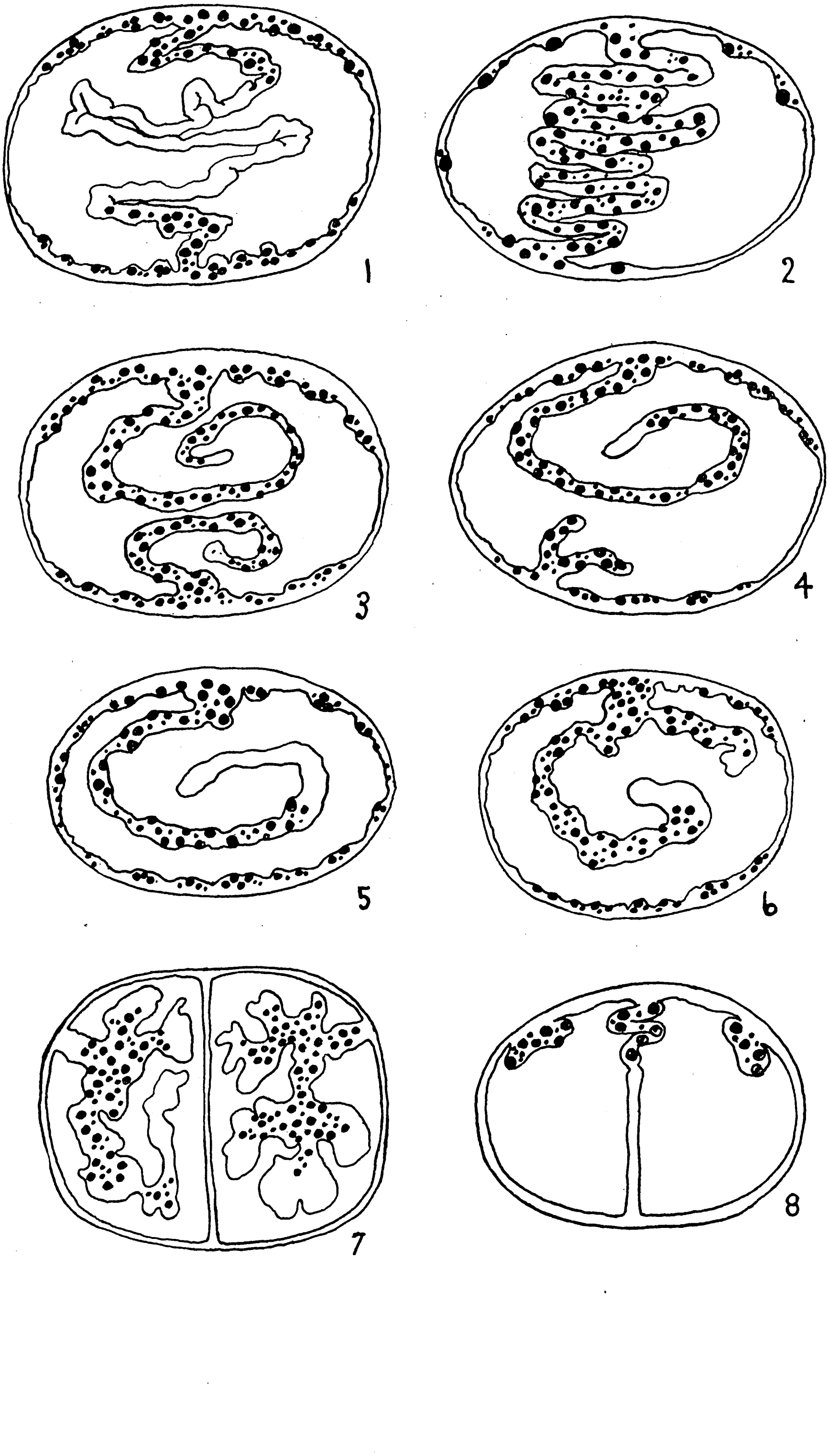
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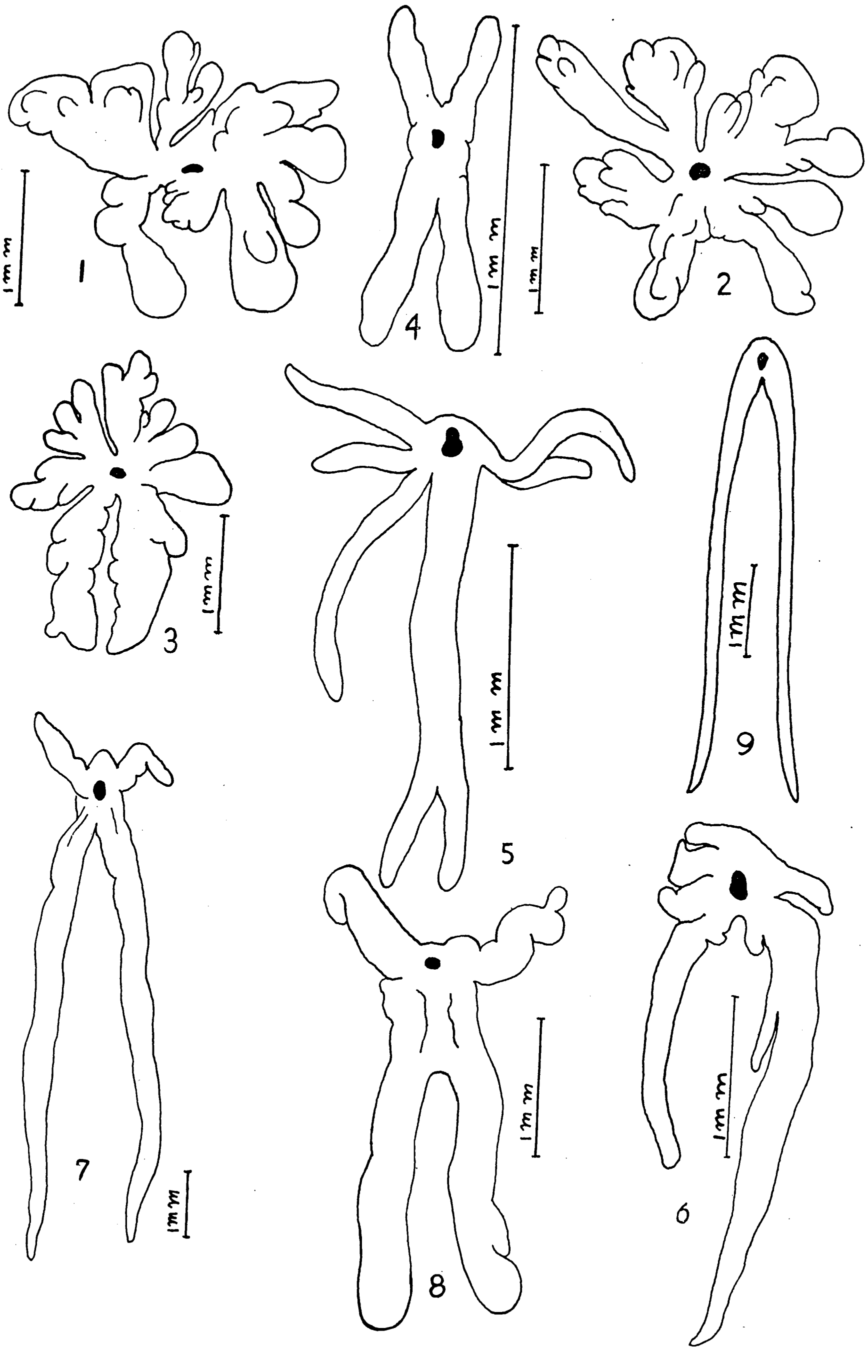
PLATE II

Outline drawings of trophotaeniae of embryos of goodeid fishes. The anus is indicated by a black circle or ellipse.

FIG. 1. *Goodea atripinnis,* 13 mm. embryo.
FIG. 2. *Goodea luitpoldii,* 16 mm. embryo.
FIG. 3. *Neoophorus diazi,* 13 mm. embryo.
FIG. 4. *Allotoca dugèsii,* 3 mm. embryo.
FIG. 5. *Xenoophorus captivus,* 8 mm. embryo.
FIG. 6. *Xenoophorus erro,* 8 mm. embryo.
FIG. 7. *Girardinichthys innominatus,* 13 mm. embryo.
FIG. 8. *Lermichthys multiradiatus,* 7 mm. embryo.
FIG. 9. *Characodon lateralis,* 9 mm. embryo.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1 mm

PLATE III

Outline drawings of trophotaeniae of embryos of goodeid fishes. The anus is indicated by a black circle or ellipse.

FIG. 1. *Skiffia lermae*, 4 mm. embryo.

FIG. 2. *Balsadichthys whitei,* 11 mm. embryo.

FIG. 3. *Xenotoca variata,* 10 mm. embryo.

FIG. 4. *Alloophorus robustus,* 15 mm. embryo.

FIG. 5. *Chapalichthys encaustus,* 11 mm. embryo.

FIG. 6. *Zoogoneticus quitzeoensis,* 8 mm. embryo.

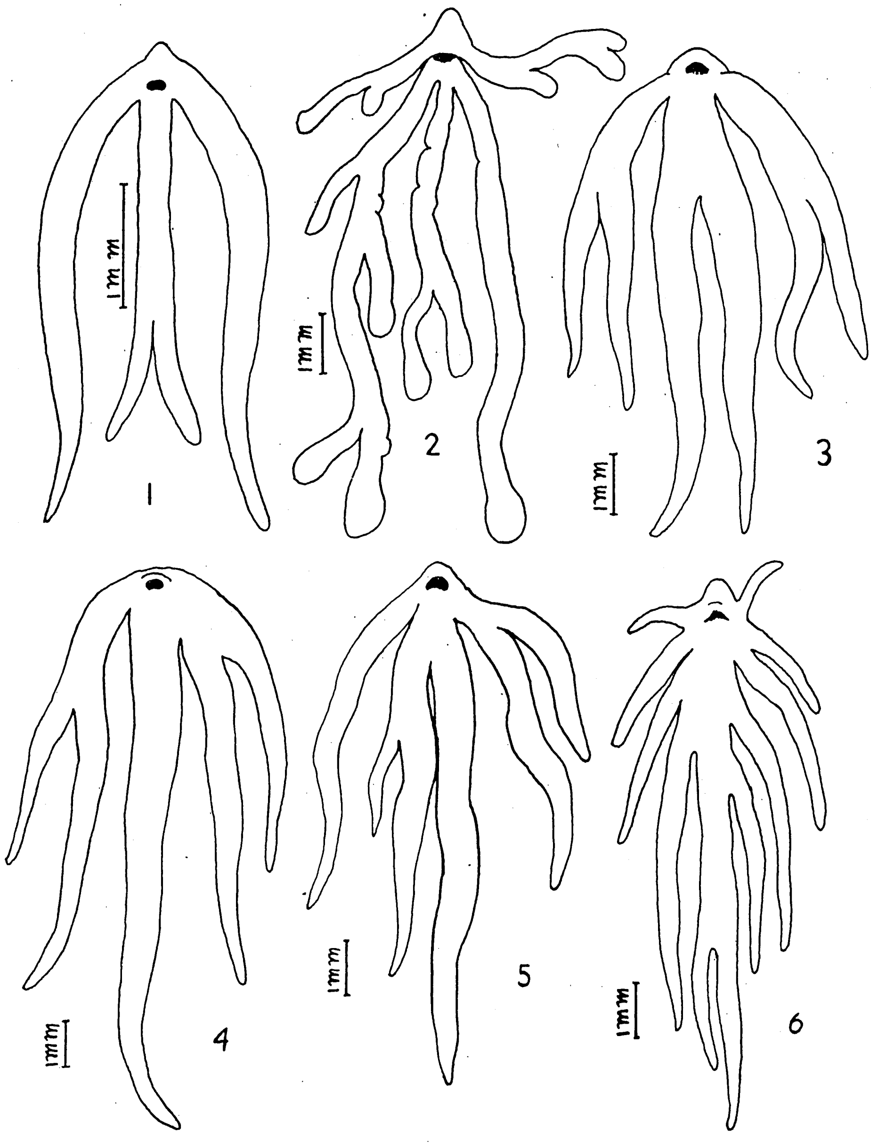
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PLATE IV

FIG. 1. *Goodea gracilis*—holotype. An adult female, 39 mm. in standard length.
FIG. 2. *Allodontichthys zonistius*—paratype. An adult male, 48 mm. in standard length.
FIG. 3. *Balsadichthys xantusi*—holotype. An adult male, 78 mm. in standard length.

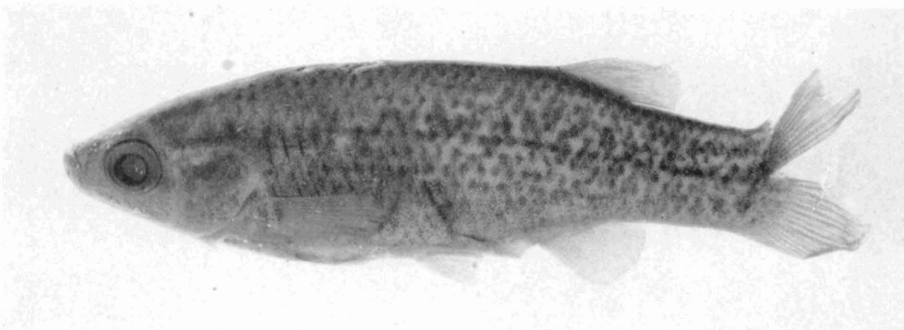

Fig. 1.

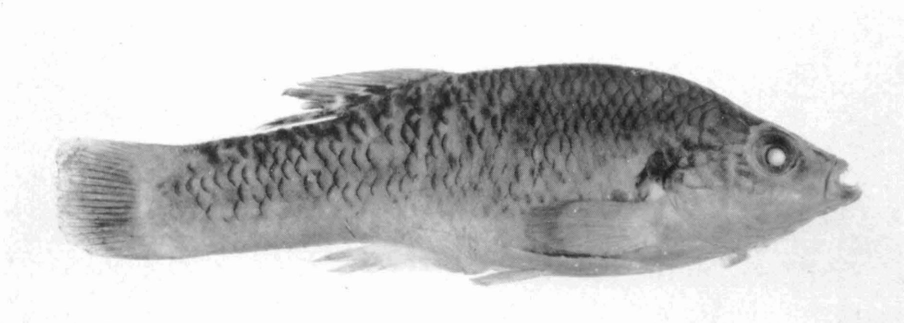

Fig. 2.

Fig. 3.

PLATE V

FIG. 1. *Xenoophorus captivus*—paratype. An adult female, 44 mm. in standard length.
FIG. 2. *Xenoophorus erro*—holotype. An adult female, 49 mm. in standard length.
FIG. 3. *Xenoophorus exsul*—holotype. An adult female, 45 mm. in standard length.

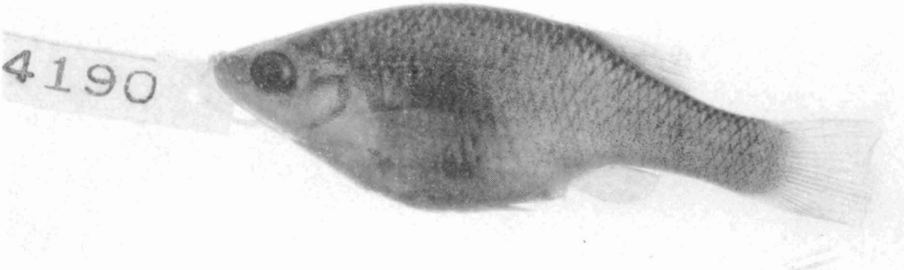

Fig. 1.

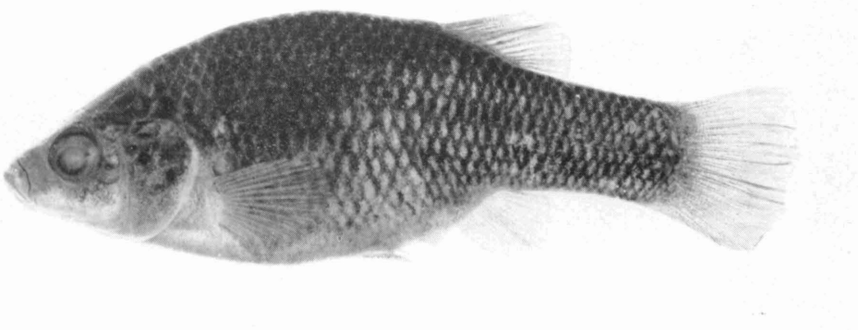

Fig. 2.

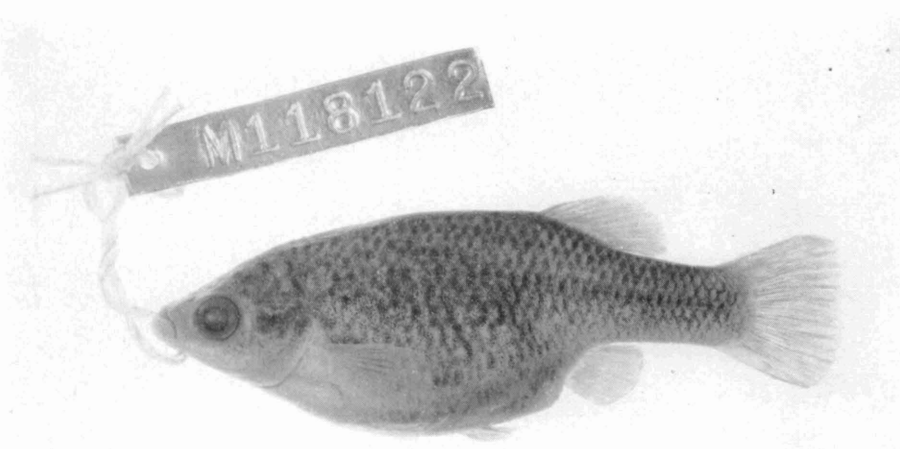

Fig. 3.