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STUDIES OF THE FISHES OF THE ORDER
CYPRINODONTES

V. NOTES ON SPECIES OF GOODEA AND SKIFFIA

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I

The species of *Goodea* and *Skiffia* belong to a peculiar group of viviparous cyprinodonts, the family Goodeidae, which has been discussed in the first paper of this series. The fishes of this family form a large element in the highly distinctive Lerma River fauna of Mexico.¹

II

GENUS GOODEA JORDAN

Goodea Jordan, Proc. U. S. Nat. Mus., 2, 1879, p. 299; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 685; Meek, Publ. Field Mus., Zool., 3, 1902, p. 100; *ibid.*, 5, 1904, p. 136; Regan, Biol. Cent.-Am., Pisces, 1908, p. 90; Ann. Mag. Nat. Hist., (8)7, 1911, p. 325.—Haplotype, *Goodea atripinnis* Jordan.

Xenendum Jordan and Snyder, Bull. U. S. Fish Comm., 19, 1899 (1900), p. 127.—Orthotype, *Xenendum caliente* Jordan and Snyder = *Goodea atripinnis* Jordan.

¹ See Meek, *Publ. Field Mus., Zool.*, 5, 1904, pp. xxxvii–lii, 109–124, 136–144.

The identity of *Xenendum* with *Goodea* has already been indicated by Meek.

It may be of some historic interest to mention here that the viviparity of *Goodea* was noted as early as 1896, by Dr. Herrera.²

1. *Goodea luitpoldi* Steindachner

Characodon luitpoldi Steindachner, Denk. Akad. Wiss. Wien, 42, 1895, p. 528, pl. 2, fig. 3; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 3, 1898, p. 2832; Pellegrin, Bull. Mus. Hist. Nat. Paris, 7, 1901, p. 205.

Goodea luitpoldi Meek, Publ. Field Mus., Zool., 3, 1902, p. 101, pls. 22-24; *ibid.*, 5, 1904, p. 139, fig. 42, pl. 1-2.

Characodon (Goodea) atripinnis Herrera, Cat. Col. Peces, Mus. Nac., Mexico, 1896, p. 31 (not of Jordan).

Goodea atripinnis Regan, Biol. Centr.-Am., Pisces, 1908, p. 91; Ann. Mag. Nat. Hist., (8)7, 1911, p. 235, pl. 8 (not of Jordan).

(?) *Goodea atripinnis* Fowler, Proc. Acad. Nat. Sci. Phila., 68, 1916, p. 432 (not of Jordan).

Xenendum xaliscone Jordan and Snyder, Bull. U. S. Fish Comm., 19, 1899 (1900), p. 128, fig. 9; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 4, 1900, p. 3153.

Specimens from Lake Chapala ("*Xenendum xaliscone*") have a band of fine teeth behind the main row, as in topotypes of *luitpoldi* from Lago de Pátzcuaro, and agree also in other respects.

Goodea luitpoldi is a species of the larger lakes. It is not known from the smaller streams, which are inhabited by *Goodea atripinnis*. Specimens of the latter form from Lake Cuitzeo, in fact, show an approach, in some respects, toward *luitpoldi*.

The present species is a larger fish than *atripinnis*, and usually differs from it in the more anterior position of the dorsal fin, and constantly in the smaller size of the scales.

The young of *luitpoldi* are blotched like those of *atripinnis*. The blotches soon become obsolete, however, the color pattern of the adult of both sexes consisting of longitudinal streaks between the scale rows.

² *Cat. Col. Peces, Mus. Nac., Mexico, 1896, p. 31.*

2. *Goodea atripinnis* Jordan

Goodea atripinnis Jordan, Proc. U. S. Nat. Mus., 2, 1879, p. 299; Bean, *ibid.*, 21, 1898, p. 541; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 685; Meek, Publ. Field Mus., Zool., 3, 1902, p. 100; *ibid.*, 5, 1904, p. 140, fig. 43; *ibid.*, 7, 1907, p. 156 (in part: specimens from San Miguel only).

Characodon variatus Woolman, Bull. U. S. Fish Comm., 14, 1894, p. 62 (in part).

Xenendum caliente Jordan and Snyder, Bull. U. S. Fish Comm., 19, 1899 (1900), p. 127, fig. 8; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 4, 1900, p. 3152.

Goodea calientis Meek, Publ. Field Mus., Zool., 3, 1902, p. 100; Regan, Biol. Centr.-Am., Pisces, 1908, p. 91.

The material described and recorded by Jordan, Woolman, Jordan and Snyder, and by Meek, has been re-examined. The specimens recorded by Woolman from Salamanca as *Characodon variatus* represent the females of both that species and of *Goodea atripinnis*. Having identified specimens of the present species with *Characodon variatus*, it is not surprising that he was unable to satisfy himself of the identity of *Characodon variatus* (male) with *C. ferrugineus* (female, of *variatus*).

Goodea atripinnis is essentially a stream species. It is not represented in the collections from lakes Chapala, Pátzcuaro and Zirahuen which have been examined. All of the specimens from these three lakes represent the larger, finer scaled species, *Goodea luitpoldi*. It is highly probable that all records of this species from Lake Pátzcuaro refer to *luitpoldi*.

The only lake specimens of *atripinnis* seen are from the small Lake Cuitzeo.³ In addition to their lighter color, they have the dorsal fin farther forward than usual. The distance from the origin of the dorsal to the end of the caudal when measured forward extends nearly to the eye, instead of little beyond the opercular margin, as usual in the several series of

³ In recording these specimens Meek (1900) mentioned that "the specimens from Lake Cuitzeo are very light in color, a feature characteristic of all the fishes taken from this and Pátzcuaro Lake." Regan (1908) erroneously construed this sentence to mean that specimens of *atripinnis* were being recorded from Pátzcuaro.

atripinnis at hand (for example, the topotypes of *X. caliente*). In other lots, however, for instance that from San Miguel, the dorsal may occupy either position, or an intermediate one. Provisionally these differences are interpreted as of only racial, not subspecific, value.

As noted by Dr. Meek (1902), the young are blotched, in coloration resembling *Zoogoneticus robustus* and the young of *Characodon variatus*, species of other genera (but of the same family). These brown blotches are usually retained more or less distinctly by the female, but soon become obsolete in the male, which is the more deeply colored. In the adult the color pattern, exclusive of the brown blotches on the female, consists of dark marks, one on each scale. Each of these is usually wedge-shaped, but not infrequently becomes narrowed dorsoventrally and bordered with a very fine lighter streak. In other specimens the dark pigment is mostly concentrated toward the base and upper and lower angles of the scales, leaving the center whitish, as in *G. luitpoldi*. The vertical fins are often black in either sex.

3. *Goodea captiva* Hubbs, new species

Goodea atripinnis Meek, Publ. Field Mus., Zool., 7, 1907, p. 156 (in part: specimens from Jesus Maria only).

This species is closely related to *Goodea atripinnis*, from which it has doubtless been derived by isolation following stream capture. The type-specimens come from one of those tributaries of the Rio Panuco which are known to have extended their course backward until they have drained what was formerly a part of the Lerma System. Another set of specimens from the Panuco Basin, namely that from San Juan del Rio, remains typical of *G. atripinnis*. *Goodea toweri*, also from the tributaries of the Rio Panuco, is a very different species.

Goodea captiva differs from *G. atripinnis* in the form of the body, the contours being more arched, the caudal peduncle more slender; in the more anterior position of the dorsal fin, the origin of which is equidistant from end of caudal and a

point near the front margin of the eye, rather than some point in the postorbital part of the head; in coloration; on the average in the larger scales, these being in 32 to 36 instead of 34 to 38 transverse series; and in the shorter gill-rakers, few more than half as numerous as in *atripinnis*.

Holotype.—Taken by Dr. S. E. Meek, together with the numerous paratypes, in an upper tributary of the Rio Panuco, at Jesus Maria, Mexico; an adult male 46 mm. long to caudal base; Cat. No. 5557, Field Museum. Regarding this collection, Dr. Meek (*l. c.*, p. 153) remarks: "There is a small stream at Jesus Maria which belongs to the Rio Panuco system. It is almost without water during the dry season. At the Hacienda a dam is built across the narrow valley forming above it a small lake. In this 4 species of fishes were taken," including the types of *G. captiva*. The following description is based upon the type, 46 mm. long to caudal base, and is supplemented by measurements and counts of five males 40 to 45 mm. long, and of five females, 45 to 49 mm. long.

The body is deeper and with more arched contours than in *G. atripinnis*; the dorsal contour is slightly elevated at the occiput and gradually curved thence to the origin of the dorsal; the ventral contour is deeply curved—more deeply in the female than in the male—from the mouth to the anus, the deepest point in the curve being before the front of ventrals; greatest depth, 2.55 (2.5 to 2.7 in adult male paratypes; 2.6 to 2.8 in adult female paratypes; in young specimens of equal size, the males are a little deeper than the females). From the origins of the dorsal and anal fins the contours of the male converge to the slender caudal peduncle so abruptly that if produced they would meet at an angle of nearly ninety degrees (the contours converge less rapidly in the female, as in that sex the greatest depth is farther forward than in the male; the distance between the origin of the dorsal and of the anal fins is about the diameter of the eye greater in the adult male than in the adult female). Least depth of the caudal peduncle, a little more than half its length behind anal fin; its length about equal to length of head.

Head deep and heavy, the contour straight from occiput to tip of snout. Length of head, 3.35 (3.35 to 3.5, in male paratypes; 3.65 to 3.85 in females); length of snout, 3.4 (3.4 to 3.6, males; 3.3 to 3.5, females); length of eye, 3.6 (3.4 to 3.7, males; 3.6 to 4.0, females); width of slightly convex inter-orbital, 2.3 (2.2 to 2.4, each sex). Mouth wide, transverse, the width of the cleft about equal to length of snout; mandible heavy, but flexible; broadly projecting beyond the premaxillaries. Teeth of two kinds, an outer row of incisors and an inner series of small villiform teeth. The incisors are dilated and bifid distally, and are movable; as in *atripinnis*, the teeth of the outer row are crowded into a biserial arrangement, alternating in their insertion. Gill-rakers short and flat, the longest only one-third as long as the eye; 24 to 26 gill-rakers on the first arch (40 to 45 in *atripinnis*). Intestines long and much convoluted. Viviparous, the largest females containing small embryos.

Fins all of decidedly greater expanse in the male than in the female. The dorsal especially broad and elevated in the male, reaching when depressed to the first of the procurrent caudal rays; in the female reaching little more than two-thirds as far. Height of anal more than half length of head in male, less than half head in female; length of pectoral 1.4 in head in male, 1.6 in female; pelvic reaching anus in male; not so far in female. Fin-rays: dorsal, 13; anal, 14 or 15 (in each sex); the first 6 anal rays unbranched and shortened in the male.

Scales large, in 35 (32 to 36, numerous paratypes) series from above branchial aperture to caudal base (34 to 38, in *atripinnis*; 39 or more in *luitpoldi*); in 14 (13 to 16) rows from pelvic base up to mid-dorsal line.

Color of type (adult male): very dark; sides of body blackish brown, the dark color extending farthest downward above anus; the caudal peduncle, black; scale margins everywhere light; back of trunk lighter; belly and edges of caudal peduncle, light; top of head black; upper half of opercle black, lower half silvery. Dorsal fin blackish at base, grading to

clear distally; caudal fin dusky at base, shading to black posteriorly, but with an abrupt, clear margin; lower fins clear.

The development of the color pattern in the two sexes offers some points of interest. Young males 23 to 26 mm. long are colored very much like the young females. The body is marked with rather small black spots of various shapes, mostly absent along light streaks just above and just below an irregular axial dark stripe. In males of 30 mm., the spots have become obsolete, or rendered indistinct by the deepening of the ground color. Even in the half grown, however, the widened and deepened axial band remains; there is also frequently evident a dark blotch between this streak and the anus. Females less than 30 mm. long have the rather faint axial streak intensified by the concentration along it, and the partial absence just above and below it, of the small black irregular spots which scatteringly cover the body. In the females over 30 mm. long the spots are smaller, and in those over 35 mm. long they have become indistinct. In females over 45 mm. long the lateral band is also very indistinct or not evident, the pattern consisting of the cross-hatching caused by the disposition of pigment about the margins of the scales. The coloration of the adult female has thus come to resemble that of the adult male, but by a slower rate of change. The color of the body is less intense in the female than in the male, however, in all specimens over 28 mm. long. The dorsal and caudal fins become dusky, but not blackish as in the male.

III

GENUS SKIFFIA MEEK

Skiffia Meek, Publ. Field Mus., Zool., 3, 1902, p. 102; *ibid.*, 5, 1904, p. 141.

The species referred to *Skiffia* differ from those of *Goodea* chiefly in the more advanced location of the dorsal fin.

4. *Skiffia bilineata* Bean

Characodon bilineatus Bean, Proc. U. S. Nat. Mus., 10, 1887, p. 371, pl. 20, fig. 2; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 668; pt. 4, 1900, pl. 119, fig. 293.

Skiffia bilineatus Meek, Publ. Field Mus., Zool., 3, 1902, p. 105.

Skiffia bilineata Meek, Pub. Field Mus., Zool., 5, 1904, p. 144, fig. 45.

Goodea bilineata Regan, Biol. Centr.-Am., Pisces, 1908, p. 92.

Sexual dimorphism has been carried to an extreme in this well-marked species. Four males, 19 to 22 mm. long to the caudal fin, collected by Meek at Huingo, Lake Cuitzeo, Mexico, have been examined. In these the body is more slender than in the female, and the vertical fins are much larger. The black dorsal fin reaches to the base of the upper caudal rays. The highly characteristic color pattern of the female is not developed in the male, only the anterior portion of the main median streak being apparent. In contrast the male has 12 to 20 spindle-shaped vertical bars, of greatly varying height, distributed along a line occupied by the lateral band in the female. In both sexes the edges of the caudal peduncle are black.

5. *Skiffia lermæ* Meek

Skiffia lermæ Meek, Pub. Field Mus., Zool., 3, 1902, p. 102, pl. 25; *ibid.*, 5, 1904, p. 142, pl. 8.

Goodea lermæ Regan, Biol. Centr.-Am., Pisces, 1908, p. 92.

(?)*Skiffia variegata* Meek, Publ. Field Mus., Zool., 3, 1902, p. 104, pl. 25; *ibid.*, 5, 1904, p. 143, fig. 44.

The types of *Skiffia variegata*, from Lake Zirahuen, are similar in form to specimens of like size from Lake Pátzcuaro (*lermæ*). They have the same number of fin rays (usually 13 in both dorsal and anal fins) and the same number of scales (usually 35 or 36 rows).

The differences which are apparent involve only the coloration. The spots are larger in those from Zirahuen (*variegata*) than in those from Pátzcuaro (*lermæ*), but the spot on the base of the caudal rays is not vertically elongate as in those from Pátzcuaro. Those from Chalco resemble "*variegata*" in coloration, while those from Celaya are like typical *lermæ*.

It remains to be determined, however, whether these color differences are of taxonomic significance.