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AN ANNOTATED LIST OF THE AMERICAN
CYPRINODONTID FISHES OF THE GENUS *FUNDULUS*,
WITH THE DESCRIPTION OF *FUNDULUS PERSIMILIS*
FROM YUCATAN

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MORE than half a century has elapsed since the publication of a general review of the cyprinodontid fishes of the genus *Fundulus* (Jordan and Evermann, 1896: 632-60). At that time, 92 per cent of the species that are recognized herein were known. As currently understood, *Fundulus* occurs primarily on the mainland of eastern North America, although it has succeeded in populating the Bermuda Islands and Cuba (other West Indian records are not acceptable) and has reached the American west coast. On the Atlantic mainland, it ranges from southern Canada to Yucatán, being replaced farther southward by *Profundulus*.

In surveying the species of *Fundulus*, I am unable to justify the generic recognition of *Plancterus*, originally proposed as a subgenus by Garman (1895: 96), with *F. kansae* as the type species. The long and much convoluted digestive tract and the reduction in size of the pharyngeal teeth are obvious nutritional adaptations, whereas the restricted attachment of the gill membranes (Hubbs, 1926: 14) is found in other species of *Fundulus*, e.g., *F. luciae*. The fundamental points of agreement between *Plancterus* and *Fundulus* impress me more than the few described differences.

The majority of the species of *Fundulus* inhabit the lowland fresh and brackish waters of eastern United States, but two occur along the Pacific Coast from Morro Bay, central California, to Magdalena Bay, Baja California, in salt and fresh water. The supposed occurrence of *Fundulus* at the tip of Baja California is an error (Miller and Hubbs, 1954). Two other species, *F. grandissimus*, and the one described in this paper, are confined to Yucatán, México. At least seven species are reported as Pleistocene or Pliocene fossils from western United States (see p. 12).

The relationships of the Recent species and their distribution and habitat are rather poorly indicated in the large, scattered literature on the genus. Much confusion has been wrought by the marked sexual differences, changes with age, and variable color patterns which characterize many of the species of *Fundulus*. A major purpose of this paper is to clarify the number of recognizable species, their nomenclature, distribution, and habitat. This contribution is intended to set the stage for a thorough revision that will doubtless result in modifications of this presentation.

Since 1895, when *Fundulus kansae* was proposed by Garman (1895: 103–4), the following seven species of *Fundulus* have been described:

Fundulus meeki Evermann (1908: 25–26, Fig. 1), from the outlet of large springs at San Ignacio in central Baja California, México. Equals *F. lima*.

Fundulus balboae Fowler (1916: 423–25, Fig. 2), from “Panamá.” Equals *F. notatus* or *F. olivaceus*.

Fundulus kompi Hildebrand and Towers (1928: 122–24, Fig. 4), from the vicinity of Greenwood, Mississippi. Equals *F. chrysotus*.

Fundulus grandissimus Hubbs (1936: 209–10, Pl. 2, Figs. 3–4), from Progreso, Yucatán, México. A valid species.

Fundulus chaplini Fowler (1940: 8, Pl. I, in color), from Boca Grande and Placita, Florida. Equals *F. confluentus*.

Fundulus bartrami Fowler (1941: 235, Figs. 8–9), from a spring on the south side of Lake Jessup, Seminole County, Florida. Equals *F. confluentus*.

Fundulus waccamensis Hubbs and Raney (1946: 12–17, Pl. I, Figs. 1–2), from Lake Waccamaw, Columbus County, North Carolina. A valid species.

Two of these forms have been placed in synonymy. Myers (1927: 178) showed that *F. meeki* is preoccupied by *F. lima* Vaillant, with identical type locality, and Hubbs (1931: 6) concluded that *F. balboae* is a synonym of *F. notatus* (or of *F. olivaceus*, for in 1931 these two were considered to be conspecific), with erroneous locality data. Of the other five, I regard only *F. grandissimus* and *F. waccamensis* as valid species; the status of *F. kompi*, *F. chaplini*, and *F. bartrami* is discussed below.

Although six nominal species listed by Jordan, Evermann, and Clark (1930: 175–79) and by Jordan and Evermann (1896: 632–60) have been allocated, their placement has been overlooked or ignored by some authors. These forms and their presently understood equivalents are as follows:

F. ocellaris Jordan and Gilbert = *F. confluentus* (Jordan and Evermann, 1898: 2828; Hubbs, 1931: 4-6).

F. pallidus Evermann = *F. grandis* (Garman, 1895: 96; allocation agreed to by Hubbs, 1926: 7. See later discussion herein).

F. vinctus Jordan and Gilbert = *F. heteroclitus*? (Hubbs, 1931: 2-3).

F. dispar (Agassiz) and *F. notti* (Agassiz) are the same species, as indicated by Hubbs and Allen (1944: 123), who used the name *dispar*. A proposed revision in the International Rules of Zoological Nomenclature (1950, Bull. Zool. Nomen., 4: 330), conscientiously followed by some authors, resulted in the replacement of *dispar* by *notti* for reasons of line priority. That ruling was revoked, however, at the Copenhagen Congress in 1953 (Int. Comm. Zool. Nomen., 1953: 66).

F. guttatus (Agassiz) is a synonym of *F. dispar* (Agassiz), as noted by Hubbs and Allen (1944: 123).

F. extensus Jordan and Gilbert = *F. diaphanus* (Hubbs, 1931: 3).

Poecilia melapleura Gosse, assigned to two families by Jordan, Evermann, and Clark (1930: 178, 185), should be removed from the Cyprinodontidae and retained in the Poeciliidae. The species in question is evidently a *Gambusia* (Garman, 1895: 88; Jordan and Evermann, 1898: 2830; Hubbs, 1926: 35).

The status of *F. fonticola* Valenciennes and *F. antillarum* Fowler is not clear (Myers in Rivas, 1948: 216), and *F. nisorius* Fowler, said to come from West Africa, was regarded as identical with *F. heteroclitus* by Hubbs (1926: 6). I have examined the type and paratype of *F. antillarum* (ANSP 7725-26) and the types of *F. nisorius* (ANSP 7227-33; 7293-7303) and find the former to fit *F. heteroclitus* as well as can be expected (the two specimens are in poor condition, especially the smaller one); the latter types show unmistakably the specific traits of *F. heteroclitus*. Fowler (1916: 418-20, Fig. 1) did not distinguish *F. antillarum* in any important way from *F. heteroclitus* and in fact stated: "A large series of *F. heteroclitus* easily covers the structural characters [of *F. antillarum*]." Again, after redescribing *F. nisorius*, Fowler (1916: 418) concluded: "[It] . . . is the exact African counterpart of *F. heteroclitus*. It resembles the latter in almost all respects, and differs in but few minor characters, as shorter pectorals, etc."

The populations of *Fundulus* in Bermuda are commonly referred to as *F. heteroclitus bermudae*, but their status is in need of careful evaluation, for there is more than one form on the islands (Hubbs, 1926: 8; also personal observations).

STATUS OF FOUR NOMINAL SPECIES.—As noted above, I regard as invalid three species described since the preparation of the *Check List* by Jordan, Evermann, and Clark. These are discussed in the order in which they were proposed. A fourth nominal species, *F. pallidus*, is treated because of current confusion regarding its status.

Fundulus kompi Hildebrand and Towers (1928: 122–24, Fig. 4), based on 31 specimens from near Greenwood, Mississippi, was said to differ from *F. chrysotus* in having: (1) a more anterior dorsal fin, (2) generally longer fins, and (3) different coloration of both sexes. No supporting data are given. In comparing the now badly faded paratypes (USNM 126991 and UMMZ 167161) with a fresh collection of *F. chrysotus* from Louisiana (UMMZ 156920), I am impressed by the many points of close resemblance between the two samples: general body shape, fin-ray number, arrangement and number of sensory pores on the head, number of scales and gillrakers, etc. A male 40 mm. in standard length agrees well with the description of the holotype, varying only in features that are subject to fluctuation over the rather wide range of *F. chrysotus*. For example, the number of crossbars varies in the male from about 6 to 13 (*kompi* is described as having 6 or 7). Hence I conclude that *F. kompi* is the same species as *F. chrysotus*. This is further supported by the description of the life colors of a male of *kompi* which fits that of *chrysotus* rather well except that the colors as described were less intense and more restricted in distribution than is known to occur in *chrysotus*. In most killifishes, however, coloration varies individually, seasonally, and with age.

F. chaplini Fowler (1940: 8, Pl. I in color) is based on the holotype (ANSP 69141) from Boca Grande, Florida, and a paratype (ANSP 69142) from Placita, Florida. Although I visited the Academy of Natural Sciences of Philadelphia to examine these and other type specimens, the types of *F. chaplini* were not located until afterward and were then kindly studied for me by C. Richard Robins of Cornell University. From a study of the data he obtained, the original description, and the color plate (of the holotype), I conclude that this form is the same as *F. confluentus*, a common Floridian species (often listed as *F. ocellaris*) that was not mentioned by Fowler in his brief account of the relationships of *F. chaplini*. The nominal species and *F. confluentus* agree in the following characteristics (data for holotype, then paratype, followed, in parentheses, by that for *confluentus*): dorsal rays 10, 11 (9–12); anal rays 9, 9 (8–10); lateral scales 37, 38 (Fowler), 38 or 40, possibly 41, 38 (Robins) (34–39); mandibular pores 4–4 (4–4); caudal fin, broadly rounded (same); anal-fin base stepped into dorsal-fin base, 1.5, 1.5 (1.2–1.5); and vertical bars along the sides,

21, 19 (15–21 in males, 10–16 in females; based on 50 adults, UMMZ 136596, from Florida). In body form and position of fins, the two are essentially alike. Although both sexes of *F. confluentus* often have an ocellus on the dorsal fin and the color plate of *F. chaplini* shows none, this marking is not diagnostic of the male for it is either wholly absent (11) or scarcely evident (1) in 12 nuptial males from Florida (UMMZ 139228). The bright coloration and elongated fins shown for the holotype indicate that it also is a nuptial male (sex not stated by Fowler), and it closely resembles the breeding males mentioned above. In short, no characters are given in the original description by which *chaplini* may be distinguished from *confluentus*, and I know of none. Subsequently, Fowler (1945: 274) thought that *chaplini* might be related to *F. dispar*, a very different species.

Fundulus bartrami Fowler (1941: 235–36, Figs. 8–9) is based on a unique specimen (ANSP 69158) caught in the outlet of a mineral spring on the south side of Lake Jessup, Seminole County, Florida. I have examined the holotype, an immature female 29.5 mm. in standard length, and find it to agree very well with *F. confluentus*. It has 10 dorsal and 9 anal rays, 37 (possibly only 36) lateral scales, about 8 gillrakers (6–9 in *confluentus*), 4–4 mandibular pores, the caudal fin is broadly rounded, and the anal base stepped into the dorsal base gives a ratio of about 1.3. There are about 13 vertical bars on each side; on the back, mostly in advance of the dorsal fin and grading downward on each side to about the level of the pectoral-fin bases, are about 20 (10 on each side) horizontal rows of spots, as rather well shown on Fowler's figure. The agreement between the type of *bartrami* and *confluentus* includes such details as the pigmentation and the size and arrangement of the head pores. Again, Fowler did not compare his fish with *F. confluentus*, although he did compare it with the closely related, allopatric *F. pulvereus*, which has a very different color pattern.

Fundulus pallidus Evermann (1892: 84, Pl. XXXV, Fig. 2), based on a single specimen from Galveston Bay, Texas, is discussed here only because doubt has been expressed recently as to its status (Nichols, 1942; Fowler, 1945: 33, n. 27, Table 1; Baughman, 1950: 133; Gunter and Knapp, 1951: 135). It has already been noted that Garman (1895) synonymized this nominal form with *F. grandis* and that Hubbs (1926) agreed. Recently, Gunter (1950: 97) came to the same conclusion when he stated that small fish agreeing with the descriptions of *pallidus* (which was based on a specimen about 44 mm. in total length) graded into *grandis* at increasing sizes.

Immature individuals of *F. grandis*, *F. similis*, and *F. confluentus* (and of *F. heteroclitus*, *F. majalis*, and *F. diaphanus*) look so much alike that taxonomists have often misidentified small specimens of these species (see Hubbs, Walker, and Johnson, 1943: 2). There is nothing in the original description of *F. pallidus* that will separate it from *F. grandis*. However, since Evermann compared his nominal species only with *F. similis*, a rather distant relative, it appeared to be valid. The numerous vertical bars lend a superficial resemblance to *similis*, but that species is readily separated from *grandis* by having a scaled rather than naked preorbital, 4 rather than 5 mandibular pores, and 6 rather than 5 branchiostegals. In addition, there are differences between the two species in body proportions and coloration (as noted by Evermann). Specimens of "*pallidus*" taken near the type locality (UMMZ 162984, 165000) unquestionably represent *grandis*. There is not the slightest doubt in my mind that *F. pallidus* is the immature (female?) of *F. grandis*, although the jar supposed to contain the holotype (USNM 45564) now holds a male of *F. dispar*. In response to my request that a search be made for the type specimen, Ernest A. Lachner replied on June 23, 1954, that he and Robert Kanazawa were unable to find it. It is obvious that the specimen now listed as the holotype of *F. pallidus* is not the fish on which Evermann based his description and figure. In their key to *Fundulus*, Jordan and Evermann (1896: 634) maintained Evermann's false conclusion that *pallidus* is a close relative of *similis*, and widely separated *pallidus* from *grandis* on the erroneous indication that *pallidus* has fewer scales. It was described as having 31 lateral scales, whereas my counts for *F. grandis* (including the Cuban form, *F. g. saguanus*) vary from 32 to 37, not from 35 to 38 (as listed by Jordan and Evermann).

In identifying fishes collected by Robert Allen during his study of the roseate spoonbill in Florida, Nichols (1942) came to the conclusion that one of the most abundant species was referable, provisionally, to *Fundulus pallidus*. In response to my request, Mr. Nichols kindly loaned the pertinent material which formed the basis for his conclusions. Mr. Allen subsequently supplied me with a detailed map showing that this material came from the Florida Keys (Plantation Key, just below Tavernier) northwestward to just east of Collier City, and that the salinity at the seven stations varied from 17 to 32 ppt. With the exception of one specimen of *F. confluentus* (AMNH 15840), all fish of sufficient size that are in good condition (40 specimens) have 5 mandibular pores on each side of the lower jaw, as typical of *F. grandis*, which they otherwise resemble. In addition to its very different color-

tion and body proportions, the single male of *F. confluentus* has only 4 mandibular pores on each side. Many of the specimens are immature and some are in rather poor condition; all were preserved in alcohol. The black blotch at the front of the dorsal fin, cited by Evermann as a characteristic of *F. pallidus* and mentioned by Nichols as almost always present in Allen's material, is typically well developed in young to half-grown individuals of *F. grandis*, but fades out with increasing age and is lacking in many large adults that I have examined.

The material referred by Nichols to *F. heteroclitus* ssp. in the seventh paragraph of his note is here identified without hesitation as *F. grandis*. To my knowledge, *F. heteroclitus* is unknown from Florida farther south on the Atlantic slope than Matanzas River, St. Johns County, where it is sympatric with *F. grandis*, *F. majalis*, and *F. similis* (see below). The supposition that "*pallidus*" might intergrade or hybridize with *similis* is not substantiated by any specimens that I have seen. *F. grandis* is obviously a close relative of *F. heteroclitus*, as is *F. similis* of *F. majalis*, but neither of the species pairs is especially closely related. Similarly, the purported hybridization of *F. diaphanus*, *F. majalis*, and *F. heteroclitus* in Chesapeake Bay has been refuted by Hubbs, Walker, and Johnson (1943: 1-2). Fowler (1945: 33) accepted without comment the Florida records given by Nichols. Neither Baughman (1950: 133) nor Gunter and Knapp (1951: 135) contributed any new information on the status of *F. pallidus*, although the species was provisionally retained in each of those contributions. Subsequently, Knapp (1953: 88) did not list *pallidus* in his booklet on Texas fresh-water fishes.

SPECIES OF *Fundulus*.—Below are listed the 26 Recent species of *Fundulus* which I accept as valid at this time. Their geographic distribution and habitat are also given in general terms. Since the only recent list available (Jordan, Evermann, and Clark, 1930: 175-79) is outdated, the nomenclature is brought up-to-date. No consideration is given in this paper to subgeneric divisions or to subspecies—matters that require much further study. I strongly suspect that a careful analysis of *Fundulus zebrinus* and *F. kansae* will show them to be conspecific; hence I adopt Plains killifish as the vernacular for both forms. Two allopatric species pairs, *F. confluentus*—*F. pulvereus* and *F. catenatus*—*F. stellifer*, may also eventually be regarded as subspecies.

The following species are arranged in tentative phylogenetic sequence: *Fundulus heteroclitus* (Linnaeus). Mummichog. From Labrador (Kendall, 1909: 221; Halkett, 1913: 69) southward to northeastern Florida (Matanzas River); Bermuda. In salt, brackish, and fresh water (Massmann, 1954: 76).

Fundulus grandis Baird and Girard. Gulf killifish. From northeastern Florida (Matanzas River) south around the Florida Keys, thence northward and westward across the Gulf coast and south along the Mexican coast at least to Laguna de Tamiahua (UMMZ 167538), south of Tampico, Veracruz, México. Also along the north coast of Cuba. Typically in brackish water, less commonly entering full sea water (Reid, 1954: 28), and penetrating fresh water in the southern part of its range (e.g., UMMZ 97504, Río Potosí, México; see also Baughman, 1950: 132).

F. grandis and *F. heteroclitus* occur together in Matanzas River, northeastern Florida (UMMZ 139389, 139391). The mandibular pores appear to be the only consistent meristic character distinguishing them, for these number 5-5 (rarely 4-5, 5-4, or 6-6) in *F. grandis* and 4-4 or fewer in *F. heteroclitus*.

Fundulus grandissimus Hubbs. Giant killifish. Known only from near Progreso, Yucatán, México. In brackish and salt water.

Fundulus parvipinnis Girard. California killifish. From Morro Bay, California, southward to Magdalena Bay, Baja California, México. The specimens reported to have come from Cabo San Lucas, Baja California, have been discussed by Miller and Hubbs (1954). In salt, brackish, and fresh water (Miller, 1943), most commonly over mud-bottomed estuaries.

Fundulus lima (Vaillant). Baja California killifish. Described from springs at San Ignacio, Baja California, México, and probably present in other isolated inland waters of the peninsula. Known only from fresh water.

Fundulus confluentus Goode and Bean. Marsh killifish. From Chesapeake Bay, Maryland, southward to Key West (where recorded as *F. ocellaris* by Hildebrand and Ginsburg, 1927: 207) and northward to a few miles west of the mouth of Pensacola Bay in Alabama (Bailey, Winn, and Smith, 1954). Typically in brackish water, but entering fresh and salt water.

Fundulus pulvereus (Evermann). Bayou killifish. From Bayou Minette (UMMZ 163573), about 9 miles east of Mobile, Alabama, westward at least to Corpus Christi, Texas. A typical brackish-water form, entering fresh and (rarely) salt water. Perhaps only a subspecies of *F. confluentus*, but I have seen no intergrades.

Fundulus diaphanus (LeSueur). Banded killifish. From the Maritime Provinces southward along the Atlantic slope to South Carolina; and from the eastern parts of the Dakotas (Hudson Bay drainage of North Dakota) southeastward across Minnesota, Wisconsin, and Michigan and the northern parts of Iowa, Illinois, Indiana, and Ohio to southernmost Ontario, New York, and eastern Pennsylvania. A fresh-water species,

able to tolerate brackish water (Raney and Massmann, 1954: 429), but rarely penetrating salt water (Greeley, 1939: 84).

Fundulus waccamensis Hubbs and Raney. Waccamaw killifish. A lacustrine modification of *F. diaphanus* known only from Lake Waccamaw, North Carolina.

Fundulus majalis (Walbaum). Striped killifish. From New Hampshire (Jackson, 1953) southward to northeastern Florida (Matanzas River). Chiefly in salt water near river mouths, but also entering brackish water (Massmann, 1954: 76).

Fundulus similis (Baird and Girard). Longnose killifish. Typically in brackish water from northeastern Florida (Matanzas River) southward to Key West, then northward and westward across the Gulf coast and southward into México at least as far as a lagoon 35 miles north of Tampico (UMMZ 157322). This species may also occur in nearly fresh water or in salt water (Gunter, 1945: 43; 1950: 97; Reid, 1954: 28-29). It is sympatric with *majalis* in Matanzas River, northeastern Florida (UMMZ 139388, 139390).

Fundulus seminolis Girard. Seminole killifish. Confined to lakes and streams of central and northern Florida; in brackish to fresh water.

Fundulus luciae (Baird). Spotfin killifish. Coastwise in brackish water from New Jersey to North Carolina (Hildebrand, 1941: 225); rarely northward to Long Island (Nichols and Breder, 1927: 55; Greeley, 1939: 84).

Fundulus catenatus (Storer). Northern studfish. In the headwaters of the Tennessee and Cumberland rivers, and the Green River, in Kentucky, Tennessee, Virginia, and Alabama; in clear streams of the Ozarks in Kansas, Arkansas, and Missouri; in tributaries of the Red River in southwestern Arkansas; and in the Homochitto River, Mississippi; also reported from the upper part of the East Fork of White River, Indiana (Gerking, 1945: 80, Map 69). In moderate to swift, clear streams.

Fundulus stellifer (Jordan). Southern studfish. Known only from the Alabama River and its tributaries in Alabama and Georgia. In moderate to swift, clear streams.

Fundulus rathbuni Jordan and Meek. Speckled killifish. Known only from the Atlantic drainage of North Carolina in the Roanoke, Neuse, Cape Fear, and Yadkin rivers. Confined to moderately fast streams.

Fundulus albolineatus Gilbert. Whiteline topminnow. Known only from clear, cold springs and spring-fed creeks in the lower Tennessee River system, Alabama and Tennessee.

Fundulus cingulatus Valenciennes. Banded topminnow. From southern Georgia south to about Lat. 27° in Florida, westward to the Escam-

bia River basin of Alabama and western Florida; in brackish to fresh water; salt-water records need verification.

Fundulus chrysotus Holbrook. Golden topminnow. In lowlands from South Carolina to Florida, westward to eastern Texas, and northward to southern Missouri and Tennessee (no records from Oklahoma). Typically in fresh water, but also entering brackish water. I am unable to substantiate the repeated statements, made mostly in the aquarium literature, that this species inhabits salt water (Miller, 1953: 198).

Fundulus sciadicus Cope. Plains topminnow, Along the Great Plains, from South Dakota, Wyoming, and Iowa, southward to northeastern Oklahoma (Arkansas River system). Typically inhabiting small to medium-sized, clear, sandy to rocky streams, in moderate to rapid current.

Fundulus notti (Agassiz)¹. Starhead topminnow. In the Mississippi River basin from Iowa and southeastern Wisconsin, and from the Lake Michigan drainage of Michigan and Indiana, southward to eastern Texas and Alabama, thence along the Atlantic slope from Florida to North Carolina. This is typically a fresh-water species but also enters brackish and, reportedly, salt water.

Fundulus jenkinsi (Evermann). Saltmarsh topminnow. From the Escambia River of extreme western Florida (UMMZ 165086) westward at least to the vicinity of Houston, Texas; in salt, brackish, and fresh water. Fowler (1945: 34, Table 1) listed this species from the Río Grande.

Fundulus olivaceus (Storer). Blackspotted topminnow. From the Mississippi and Ohio drainages of Illinois southward to Florida and Texas. This is typically a surface-inhabiting fresh-water fish, but it is known to penetrate brackish water, and may occur in salt water.

Fundulus notatus (Rafinesque). Blackstripe topminnow. From Iowa and southeastern Wisconsin to southern Michigan and the prairie regions of Ohio, south to Kentucky, the Duck River of Tennessee, the Gulf drainages from Mississippi to Texas, and to Missouri and Kansas (modified after Hubbs and Lagler, 1952: 78). Known only from fresh water, where it characteristically lives at the surface along lake and stream margins.

Fundulus zebrinus Jordan and Gilbert. Southwestern Plains killifish. From the upper portions of the Brazos, Colorado, and Pecos drainages of Texas and New Mexico, and from saline waters on the Llano Estacado of northwestern Texas. A midwater swimmer inhabiting shallow, open streams.

¹ See Jerram L. Brown, "Subspecies of the Cyprinodont Fish *Fundulus notti* (Agassiz)," in press.

The range of this species is frequently given as the Río Grande and its tributaries, and for this reason it has been called the Río Grande killifish. It now appears certain that the only basis for its inclusion in the fish fauna of the Río Grande proper is the one record by Jordan (1878: 664) from Brownsville, Texas. Dr. William J. Koster, of the University of New Mexico, assures me (*in litt.*) that he knows of the species in New Mexico only from the Pecos River basin. Jordan's record is open to serious doubt for the following reasons: *F. zebrinus* has not since been taken in the Río Grande, the collection on which Jordan reported had, admittedly, been lying around the United States National Museum for many years, some of the other species reported in the same paper are out of their known ranges, and a number of the fishes supposed to have come from Brownsville actually came from as far away as the Pacific Coast (Clark Hubbs, 1954). Fowler (1945: 373, as *F. zebra*) recorded a specimen from Dallas, Texas, but did not list the species from the Trinity River drainage in Table 1, page 33.

Fundulus kansae Garman. Central Plains killifish. In shallow streams of the Great Plains from South Dakota (where probably introduced) to northern Texas (Red River) and New Mexico (Arkansas River). Two records are known to me from Missouri, one from Clay County (UMMZ 148864; mentioned by Bailey, 1951: 196, as "northwestern Missouri") and the other from Howard County. The data for the latter, the easternmost station for this species, are: UMMZ 167338, 42 yearling to adults, taken by P. W. Frank on June 24, 1954, from Boone's Lick, a salt spring 1½ miles SW of Boonesboro. (Mr. Frank kindly permitted me to publish this record.)

There are also two heretofore unpublished records of this fish from South Dakota: UMMZ 163834, 4 specimens from Cheyenne River above the bridge over U. S. Highways 14-16, Pennington Co., seined on November 29, 1951; and UMMZ 167159, 12 individuals from the same river at Oral, Fall River Co., taken on July 2, 1952. The listing of South Dakota in the range of this killifish, as by Jordan, Evermann, and Clark (1930: 179, as *Plancterus zebra*), was evidently based on the misidentification of *Fundulus diaphanus menona* for this species (Meek, 1892: 246). Consequently, the above two records constitute the sole valid ones for the state, so far as known. Although R. M. and M. K. Bailey collected at the first station listed less than a year and a half earlier (on July 14, 1950), no specimens of *Fundulus* were secured. Simon (1946: 96, 117) obtained *F. kansae* from the Niobrara River, just north of the eastern end of the Platte drainage in western Wyoming, but did not record it from the Cheyenne system. Raymond E. Johnson did not take

it in the Niobrara River in Nebraska, where he found it restricted to the Platte River and southward (Ph.D. thesis, University of Michigan, 1942). It seems probable that the two recent records for South Dakota represent bait introductions, possibly from Angostura Reservoir, a relatively new impoundment on the upper Cheyenne River, into which the species may have been carried from the Platte or Niobrara river.

Although recognizing two species of the subgenus *Plancterus* in Texas, Knapp (1953: 88) included the Brazos and Colorado rivers in the range of this species. It is unlikely, however, that *kansae* and *zebrinus* are specifically distinct, although I have insufficient data to determine this point with complete assurance.

The following fossil species of *Fundulus* have been described²:

Fundulus (Parafundulus) nevadensis Eastman (1917: 291, Pl. 16, Fig. 2; Pl. 17; Pl. 18, Fig. 3) from the "Lahontan beds" (= Truckee Formation), near Hazen, Nevada; early Pliocene. (This dating was provided through the kindness of Dr. D. I. Axelrod, of the University of California at Los Angeles.)

Fundulus (Parafundulus) erdisi Jordan (1924: 45-47, Pls. I-J) from northern Los Angeles County, California; probably Pleistocene (see Miller, 1945: 320).

Fundulus detillai Hibbard and Dunkle (1942: 273-74, Pl. 1) from the Ogallala Formation, Logan County, Kansas; Middle Pliocene.

Fundulus sternbergi Robertson (1943: 305-6, Pl. 52) from the same formation and horizon as *F. detillai*, and evidently the same species.

Fundulus curryi Miller (1945: 315-17, Fig. 1) from Death Valley National Monument, California; reportedly Titus Canyon Formation, which is lower Oligocene (but the beds are more likely Pliocene).

Fundulus eulepis Miller (1945: 319-20, Fig. 2) from the Furnace Creek Tertiary section, Death Valley National Monument, California.

Fundulus davidae Miller (1945: 320-21) from the Mohave Desert near Black Mountain, San Bernardino County, California; horizon undetermined, perhaps Pliocene or early Pleistocene.

While revising the closely related Middle American genus *Profundulus* (Miller, 1955), it was found necessary to examine all of the species of *Fundulus*. Near the completion of that preliminary study, specimens of a *Fundulus* from the tip of the Yucatán Peninsula, México, were received from the ornithologist Robert P. Allen. These proved to be a distinctive species closely allied to *F. similis*, paralleling the occurrence

² A fossil described as *Plancterus kansae?* from beds of presumed Pliocene age in Oklahoma has been reidentified as a species of *Menidia* (Hubbs, 1942).

in Yucatán of *F. grandissimus*, a close relative of *F. grandis*. For his interest and trouble in obtaining these specimens, and for their gift to the Museum of Zoology, University of Michigan (UMMZ), I am most grateful to Mr. Allen.

Fundulus persimilis, new species
Yucatán Killifish

(Pl. I)

HOLOTYPE.—A tuberculate male (Pl. I), UMMZ 163094, 75 mm. in standard length, from Río Lagartos, near the settlement of the same name, at the tip of Yucatán, México, 21° 35' Lat., 88° 10' Long.; collected by Robert P. Allen on August 14, 1952.

PARATOPOTYPES.—UMMZ 163095 (30), 21 to 108 mm. long, collected with the holotype. UMMZ 162303 (2), 60 and 65 mm. long, taken by Allen at the same locality on August 29, 1951.

DIAGNOSIS.—A species of *Fundulus* most closely related to *F. similis* but differing in the conspicuously smaller fins, especially the dorsal and anal, a narrower mouth, fewer dorsal rays, smaller scales, more numerous vertebrae, the absence of a dark spot near the upper base of the caudal fin (variable in *similis*), and in other details discussed below. The two species are allopatric.

DESCRIPTION.—Proportional measurements on 15 specimens were stepped with a pair of precision dividers under appropriate magnification and light: 9 males, 52–89 mm. in standard length, and 6 females, 56–107 mm. long. Except where sexual dimorphism is marked, the data for the sexes are combined. The range of variation is given first, followed by the measurement for the holotype in parentheses and then the average value of the measurement or count.

In standard length: head length, 2.95–3.2 (3.0), ave. 3.0; greatest body depth, 3.75–4.5 (3.8), 4.1; length of caudal peduncle, 4.1–4.5 (4.4), 4.4; origin of dorsal fin to tip of snout, 1.4–1.5 (1.5), 1.5; origin of dorsal to caudal base, in males, 2.8–3.1 (2.9), 2.9, and in females, 3.1–3.25, 3.2; origin of anal fin to tip of mandible, 1.4–1.5 (1.5), 1.5; origin of anal to caudal base, in males, 2.85–3.05 (2.9), 2.9, and in females, 3.1–3.3, 3.2.

In head length: head depth at occiput, 1.7–1.9 (1.7), 1.8; head width, 1.7–1.9 (1.8), 1.8; greatest body depth, 1.25–1.4 (1.25), 1.3; length of caudal peduncle, 1.35–1.45 (1.4), 1.4; least depth of peduncle, 2.2–2.5 (2.2), 2.4; bony interorbital width, 3.2–3.5 (3.35), 3.3; length of snout, 2.6–3.0 (2.9), 2.9; length of orbit, 3.9–4.8 (4.35), 4.3; length of upper jaw, 3.2–3.6 (3.35), 3.3; length of mandible, 3.3–3.65 (3.5), 3.5; greatest width

of mouth, 3.75–4.5 (3.8), 4.0; insertion of pelvic fin to anus, 2.0–2.5 (2.2), 2.3; length of depressed dorsal fin, in males, 1.4–1.7 (1.5), 1.5, and in females, 1.75–2.0, 1.9; length of depressed anal fin, in males, 1.25–1.55 (1.3), 1.4, and in females, 1.55–2.0, 1.7; length of pectoral, 1.55–1.8 (1.6), 1.7; length of pelvic, in males, 2.5–2.8 (2.6), 2.6, and in females, 2.85–3.2, 3.0; length of middle caudal rays, 1.5–1.75 (1.6), 1.6.

Length of caudal peduncle into predorsal length, in males, 2.8–3.05 (3.0), 3.0, and in females, 3.1–3.25, 3.2; depth of peduncle into its length, 1.5–1.8 (1.5), 1.6; length of orbit in snout length, 1.2–1.7 (1.3), 1.4; orbit in interorbital width, 1.15–1.45 (1.3), 1.3; orbit in postorbital, 1.6–2.2 (2.0), 1.9; mouth width in interorbital, 1.1–1.4 (1.1), 1.2; least preorbital width in orbit, 1.0–1.25 (1.05), 1.1; length of depressed dorsal in predorsal length, in males, 2.9–3.7 (3.2), 3.3, and in females, 4.0–4.4, 4.2; and length of depressed anal in predorsal length, in males, 2.7–3.4 (2.75), 3.0, and in females, 3.45–4.4, 3.8.

Methods of counting and measuring are the same as those used by Miller (1948: 9–13). The last two rays of the dorsal and anal fins, divided to the fin base and more closely approximated than the next anterior ray, were counted as a single ray (rather than two rays), as recommended by Hubbs and Lagler (1952: 8).

Most of the fin-ray and scale counts and the number of vertebrae are given in Tables I–III. The pelvic rays (both fins counted) in 33 specimens are as follows: 4 (1), 5 (1), 6 (64). Dorsal origin very slightly in advance of anal origin in males, directly over it in females. Scales around the caudal peduncle (counted in zig-zag fashion around the slenderest part), $10 + 10 = 20$ in 20 specimens, 21 (1) and 22 (1). There is little variation in the head pores of the lateral-line system (Gosline, 1949): mandibular, 4 on each side in 25, 4–3? in 1; preopercular, 7–7 in 26; and preorbital, 4–4 in 25, 3?–4 in 1. The gillrakers number 6 (1), 7 (18), and 8 (7) in 26 specimens. The branchiostegals are constantly 6 on each side in 12 paratopotypes. The genital pouch is moderately developed, extending only about one-fourth of the distance from anal origin to tip of fin in the largest female (108 mm. S.L.).

Coloration.—The color pattern of the sexes differs, as in most cyprinodont fishes. Males have about 10 to 15 narrow, vertical bars (Pl. I, Fig. 1), the first one lying above the base of the pectoral fin and typically only about one-half the length of the second; the succeeding bars are usually conspicuous except posteriorly on the caudal peduncle. Often a very weak bar or two lies between stronger ones, and sometimes the bar above the pectoral base is obsolete. The posteriormost bars, although often faint, appear to be broader than those farther forward. The

TABLE I
 Number of Vertebrae in Two Species of *Fundulus*
 Figures in parentheses are the number of samples.

Species and Locality	Precaudal						Caudal						Total						Ave.									
	14	15	16	17	19	20	21	20	19	18	17	16	15	14	13	12	11	10		9	8	7	6	5	4	3	2	1
<i>F. similis</i>																												
NE México, Texas (8)	3	30	4	..	8	24	5	..	8	29	3	1	41	34.93														
La., Miss., Ala., W Fla. (7)	1	30	7	..	9	26	3	..	5	28	5	..	38	35.00														
Bay Co., W Fla. (1)	..	8	2	..	..	5	5	..	..	4	5	1	10	35.70												
Florida (8)	2	38	1	..	6	28	6	..	7	27	6	..	40	34.97														
Key West, Fla. (2)	2	3	..	..	5	..	..	2	3	..	..	..	5	33.60												
Total	8	109	14	..	28	83	19	2	23	88	19	1	133	34.95														
<i>F. persimilis</i>																												
Yucatán, México (2)	..	3	22	1	..	20	6	..	..	3	16	7	26	36.15												

TABLE II
 Number of Fin Rays in Two Species of Fundulus
 Both pectoral and pelvic fins were counted; see text for pelvic-ray counts.

Species and Fin	Number of Rays											No.	Ave.					
	9	10	11	12	13	14	16	17	18	19	20			21				
<i>F. similis</i>																		
Dorsal	...	1	25	80	30	1	...	...	...	...	...	...	...	...	...	...	137	12.04
Anal	27	101	9	1	...	...	...	...	...	...	...	...	...	...	...	...	138	9.88
Pectoral	...	...	...	...	...	...	9	110	127	27	1	...	...	...	...	...	274	18.64
Caudal	...	...	...	...	...	...	8	51	12	1	1	...	...	...	...	...	128	17.61
<i>F. persimilis</i>																		
Dorsal	4	27	2	...	...	...	...	...	...	...	...	...	...	...	...	...	33	9.94
Anal	30	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33	9.09
Pectoral	...	...	...	...	...	...	10	51	5	...	...	...	...	...	...	...	66	17.92
Caudal	...	...	...	...	...	...	2	13	3	...	...	...	...	...	...	...	18	17.05

TABLE III
Number of Scales in Two Species of Fundulus

Species	Dorsal to Anal										Lateral Scales					
	11	12	13	14	15	No.	Ave.	32	33	34	35	36	37	No.	Ave.	
<i>F. similis</i>	3	24	92	13	..	132	12.87	1	22	85	24	3	..	135	34.04	
<i>F. persimilis</i>	..	..	2	13	8	23	14.26	..	..	1	10	19	2	32	35.69
Circumference of Body																
Species	26	27	28	29	30	31	32	34	36	No.	Ave.					
<i>F. similis</i>	1	1	49	4	74	2	4	..	..	135	29.27				
<i>F. persimilis</i>	..	..	..	..	..	..	11	6	6	23	33.57				

markings scarcely extend onto the belly, or fail to do so, and do not reach the back. The width of the bars varies from about one-third to slightly more than one-half the diameter of the pupil, and that of the much broader interspaces measures about one-half to a little more than three-fourths the diameter of the orbit (measured between the bony rims).

Females possess about 12 to 18 narrow bars (Pl. I, Fig. 2), the first one short and weak or obsolete, as in males. Some of the succeeding bars are much weaker than others, and an occasional one is disrupted. Each of the six mature females has 1 and sometimes 2 or even 3 weak bars that are one-half or less the length of either adjacent bar. The markings do not reach the venter anteriorly but may do so between the origins of the anal and caudal fins. They are narrow, with broad interspaces, about as in the male.

The pigmentation of the male differs notably from that of the female. Melanophores are rather evenly and profusely sprinkled over all of the fins, tending to concentrate as a blackened border at the distal margins in the largest adults. (The dorsal ocellus often seen in large, nuptial males of *F. similis* was not observed.) The outer borders of the scale pockets are boldly outlined along the sides of the body to give a conspicuous crosshatched appearance to the scale rows. Additional concentration of pigment over the back obscures this effect there. The opercle is silvery except beneath its posterior one-fourth to one-third, which is sprinkled with chromatophores. Most of the underlying surface of the preopercle is darkened by a concentration of pigment cells, lending sharp contrast between the appearance of this bone and the opercle. The top of the head is rather evenly and densely pigmented, the venter lightly so—especially between the pelvic and anal fins and under the caudal peduncle. The median predorsal streak is well developed near the origin of the dorsal fin but narrows and fades anteriorly; no such streak is developed posterior to the dorsal fin or underneath the caudal peduncle. There is a slight concentration of pigment just above and behind the upper end of the gill opening that is suggestive of the conspicuously blackened area in this position in nuptial males of *F. similis* (Pl. I). Only a trace or weak development of the narrow, median pigment line on the chin of *similis* may be seen. In that species, the line extends from near the tip of the lower jaw well onto the gill membranes; in *persimilis*, it is present anteriorly in small males, but becomes obsolete in the large ones.

Females lack or nearly lack pigment on the anal and pelvic fins, but the upper one-third to one-half of the pectoral fin and all of the dorsal fin have scattered melanophores (sometimes almost absent on the pectoral). The caudal fin is rather evenly and finely pigmented. The scale pockets are only weakly outlined on the upper sides, if at all; the pigment on the dorsum is essentially as described for the male. The opercle is bright silvery, with some underlying marginal pigment (about as in the male), and the coloration of the preopercle is like that of the male but weaker, contrasting only slightly with the opercle. The venter is immaculate, except for some concentration of chromatophores about the lower lips and chin. As in the male, there is a median predorsal streak but none behind the dorsal or beneath the caudal peduncle. The median pigment line on the chin is well developed in small females (55–65 mm.) but becomes obsolete in large adults; it does not extend onto the gill membranes.

The color pattern of the 18 immature fish (21–41 mm. S.L.) is essentially the same as that of the adult, but is less well developed. There are only 7 to 9 (rather than 10 to 18) vertical bars, the first one (obsolete in some) lying above the pectoral-fin base and typically one-half or less the length of the next bar. The more posterior markings are usually slightly broader than the anterior ones, and no weak bars were observed posterior to the first one. The pigmentation agrees closely with that of the adult female, except that the chromatophores are larger and fewer in the smaller young and the fins of those individuals lack pigment.

Some retention of life colors was noted on October 3, 1952, about six weeks after original preservation in alcohol. In the two largest males, yellow spots were seen beneath the scales—under the scale center or the anterior part—and these were aligned in horizontal rows extending from the head to the base of the caudal fin. The rows were prominent between the third and the ninth scale row below the back (the middorsal row counted as the first). In the second and tenth scale row the spots were indistinct and did not form a continuous horizontal series. In the 3 other large males and the holotype this coloration was much less distinct, and in the 2 largest females the pattern of spots was the same as described for the males but weaker. No yellow spotting was noted on the smaller fish. What effect preservation in alcohol had on intensifying or weakening these colors, and on the pigmentation and barring, is problematical, but it may have contributed measurably to some of the contrasts noted between the coloration of the new species

and that of formalin-preserved specimens of *F. similis* (see Relationships, below).

HABITAT AND ASSOCIATES.—The town of Río Lagartos is a small settlement near the mouth of the channel of the same name that leads to the Laguna de Lagartos (see Map NF-16 of the American Geographical Society, 1927). This locality is about 100 airline miles east of Progreso. The place where the fish were secured in 1951 and 1952 is described by Mr. Allen as a shallow shore on the barrier or Gulf side of the tidal lagoon known as Río Lagartos, directly opposite the settlement of the same name. This site is about 4 nautical miles east of the open pass at the village of San Felipe and about 8 nautical miles west of the salt plant at Los Colorados. Between the collecting site and the open Gulf of Mexico, the lagoon narrows to long, winding mangrove-bordered channels that are evidently fairly shallow throughout. Extensive mud flats are present near the pass, close to San Felipe, where the channel broadens considerably.

Ecological data supplied for the 1952 collection showed that the water was 28°C, the air 30°C, at 8:45 A.M. on August 14. The depth of the water over the area as a whole varied from 8 to 18 inches, but the depth of capture was only about 8 inches. The bottom was of hard mud, with no aquatic vegetation at the point of capture. The salinity (determined for Robert Allen by Dr. Gordon Gunter) was 51.7 ppt.

Three other fishes, two cyprinodontids and an atherinid, were obtained in the same seine hauls with *F. persimilis*. These are identified as *Cyprinodon variegatus* (18 specimens), *Floridichthys carpio barbouri* (26), and *Menidia* species (2). Pending completion of revisionary studies of *Cyprinodon*, I prefer not to allocate the new Yucatán material sub-specifically; specimens from Ciénegas near Progreso have been described as *C. v. artifrons* (Hubbs, 1936: 223).

RELATIONSHIPS.—The new species is most intimately related to *Fundulus similis*, which it resembles in general appearance and in many technical characters. The only other species of *Fundulus* known from Yucatán, *F. grandissimus*, differs from *F. persimilis* in much the same way as *F. grandis* contrasts with *F. similis*. Both *grandis* and *grandissimus* have a naked rather than scaled preorbital, 5 or 6 rather than 4 mandibular pores, and 5 instead of 6 branchiostegals.

F. persimilis differs from *F. similis* in having much smaller dorsal and anal fins (Pl. I), narrower mouth, fewer dorsal rays, and more numerous scales and vertebrae. The conspicuous difference in fin size may be expressed by projecting the length of the depressed dorsal and anal fins into the distance from the origin of the dorsal to the tip of the

snout, and the narrower mouth is emphasized by dividing its width into the head length (Table IV). The difference in number of dorsal rays, scales, and vertebrae is given in Tables I-III. Other characters by which they differ are not easy to quantify. The mandible is heavier in the new species and the lower jaw more oblique. In *F. persimilis*, the scales between the pelvic fins are irregular in number and arrangement, whereas in *F. similis* they are grouped on a triangular flap of skin with 2 or 3 scales at the base diminishing to a single, median scale at the tip of the flap. The scales appear to be developed farther forward on the rostrum in *persimilis* so as to obscure most or all of the pit organs, leaving a narrow scaleless strip anteriorly; whereas in *similis* the scaleless strip is broader and the pit organs are readily seen. In *persimilis* the vertical bars are narrower and the interspaces broader, and the bars tend to be shorter so that they scarcely extend onto the belly, whereas in *similis* they extend ventrally onto this region. No black blotch is developed on the shoulder of tuberculate males in the new species as it is so conspicuously in nuptial males of *similis*. The silvery opercle contrasts sharply with the darkened preopercle in *persimilis*, whereas both areas are pigmented in *similis*. The prominent, median pigment line on the chin and gill membranes of *similis* is weak to obsolete and developed only anteriorly in males of *persimilis* but is better developed in the smaller females, although not extending on the

TABLE IV

Diagnostic Proportional Differences Between Two
Species of *Fundulus*

The dorsal and anal fins were measured in depressed position,
and the mouth in retracted position (to give maximum width).
The measurements were made with dividers under magnification
and stepped into the indicated body parts.

Species	No. of specimens	S. L. in mm.	Measurement		
			Snout to dorsal Dorsal length	Snout to dorsal Anal length	Head length Mouth width
<i>F. similis</i> *					
males ...	39	50-104	2.0 -2.75	2.0 -2.7	3.15-3.75 in both sexes
females ..	39	52-107	2.85-3.5	2.7 -3.3	
<i>F. persimilis</i>					
males....	9	52- 89	2.9 -3.7	2.7 -3.4	3.8-4.5 in both sexes
females ..	6	56-108	4.0 -4.4	3.45-4.4	

* Data based on material from throughout the range of the species.

gill membranes. The genital pouch of the mature female (a generic character of *Fundulus*) is conspicuously less developed in the specimens of *persimilis* than it is in *similis*. The females of the two species differ also in details of pigmentation.

It seems clear that the new species was derived from *F. similis* when that species, or its precursor, ranged as far southward as Yucatán—perhaps during the Wisconsin stage of the Pleistocene glaciation. At present the known ranges of the two species are separated by a gap of about 800 miles.

ETYMOLOGY.—This species is named *persimilis* in reference to its evolution through *F. similis* or the precursor of that species.

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PLATE I

FIG. 1. Above: Holotype, nuptial male, of *Fundulus persimilis*; UMMZ 163094, 75 mm. S.L.

Below: Nuptial male of *Fundulus similis* from Boca Ciega Bay, Florida; UMMZ 153579, 76.5 mm. SL.

FIG. 2. Above: Female paratopotype. UMMZ 162303, of *Fundulus persimilis*, 65 mm. S.L.

Below, Female, UMMZ 153579, of *Fundulus similis*, from Boca Ciega Bay, Florida; 62 mm. S.L.

PLATE I

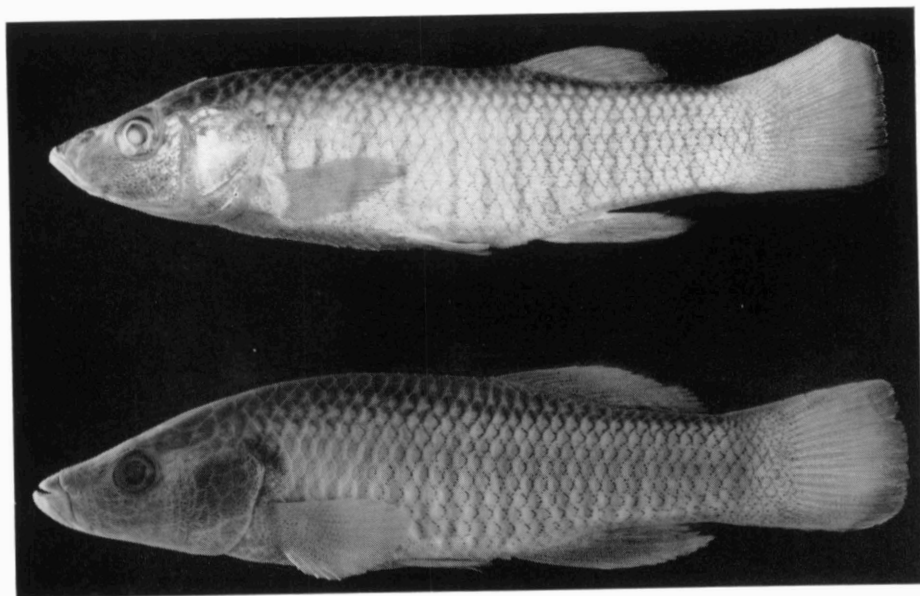


FIG. 1

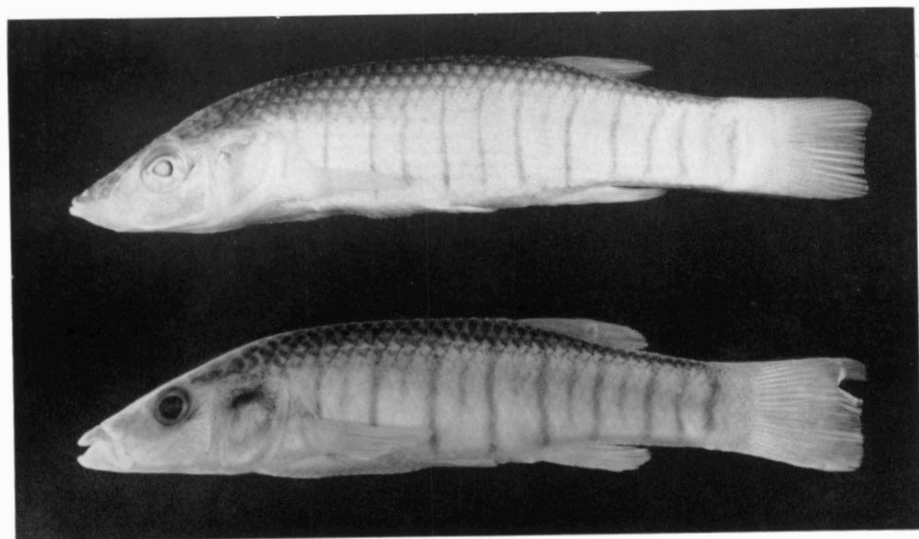


FIG. 2

