MISCELLANEOUS PUBLICATIONS
MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, NO. 65

ENDEMIC FISH FAUNA OF LAKE WACCAMAW, NORTH CAROLINA

BY
CARL L. HUBBS AND EDWARD C. RANEY

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ENDEMIC FISH FAUNA OF LAKE WACCAMAW, NORTH CAROLINA[1]

CERTAIN lakes in various parts of the world, though young in geological view, are known to be centers of endemism (see particularly Herre, 1933; Worthington, 1937; Hubbs, 1940: 209). In some of these lakes, as in the rift lakes of Africa and Lake Lanao in the Philippines, the speciation of fishes seems to have been so rapid and so extensive as to warrant the attributive "explosive." Many fishes that are confined to lakes show parallel adaptations to the special conditions of lacustrine existence, and species that are characteristic of open waters, whether fresh or salt, are more or less elongate, terete, and stream-lined (Hubbs, 1941: 184–85). New examples of these speciational phenomena are presented in this paper.

THE ENDEMIC FAUNA OF LAKE WACCAMAW

Endemic fishes, seemingly modified for lacustrine existence, have recently been discovered (Raney, 1942) in Lake Waccamaw, which is on the Coastal Plain of Columbus County, North Carolina, 32 miles west of Wilmington (Maps 1–2). Series of specimens of 3 new species were collected by night seining on March 30, 1941.[2] Later, Fowler (1942: 6–8, Figs. 6–7) described, from Lake Waccamaw, a new *Notropis* which we, lacking adequate material, had set aside for further study. These forms, and the presumably ancestral, wide-ranging cognates are:

LAKE WACCAMAW ENDEMICS		WIDESPREAD COGNATES
	Cyprinidae	
Notropis waccamanus		*Notropis petersoni* (?)
	Cyprinodontidae	
Fundulus waccamensis		*Fundulus diaphanus diaphanus*
	Percidae	
Boleosoma perlongum		*Boleosoma nigrum olmstedi*
	Atherinidae	
Menidia extensa		*Menidia beryllina*

An endemic mussel, *Elliptio waccamawensis* (Lea) has long been known from Lake Waccamaw (Lea, 1863: 193; 1864: 20–21, Pl. 5, Fig. 14; Simpson, 1914: 620–21). Another Waccamaw mollusk of unusual occurrence is a

[1] Edward C. Raney, the junior author, worked on this paper as a staff member of the Department of Zoology, Cornell University. He received from the Faculty Research Fund of Cornell University a grant which made possible the exploration of Lake Waccamaw and other waters on the Atlantic slope.

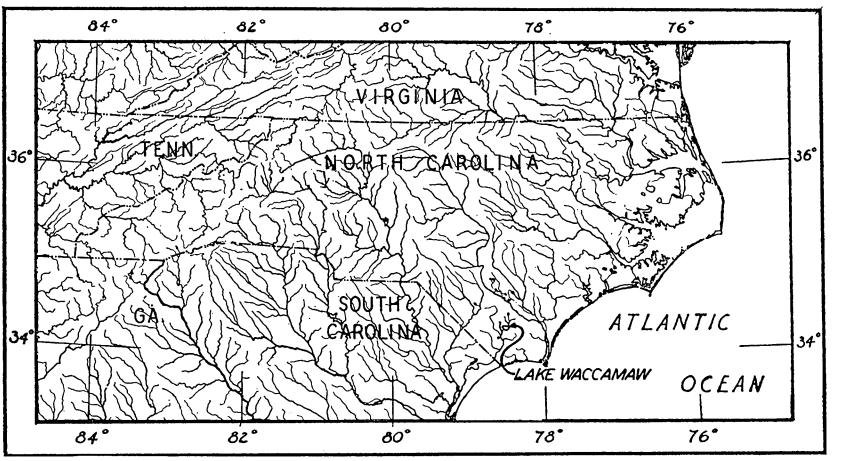
[2] At this time, and later, very helpful co-operation was received from W. D. Jones, proprietor of a local hotel.

species of *Vivipara,* which seems to be either a local form or a far-northern population of a southern species. We are indebted to our colleagues, Calvin Goodrich and Henry van der Schalie, for this malacological information.

A peculiar crustacean fauna, very limited and of strikingly northern affinities, has been reported for White Lake, a similar body of water in North Carolina, about 20 miles north of Lake Waccamaw (Coker, 1938). One of the species was recorded also from Lake Waccamaw. Later, McKee and Coker (1940) indicated that this fauna is not confined to White Lake, though it seems to be restricted to a small area on the Coastal Plain of North Carolina. The fishes of White Lake are not known. The endemic fishes of Lake Waccamaw are not northern relicts.

HYDROGRAPHY AND HISTORY OF LAKE WACCAMAW

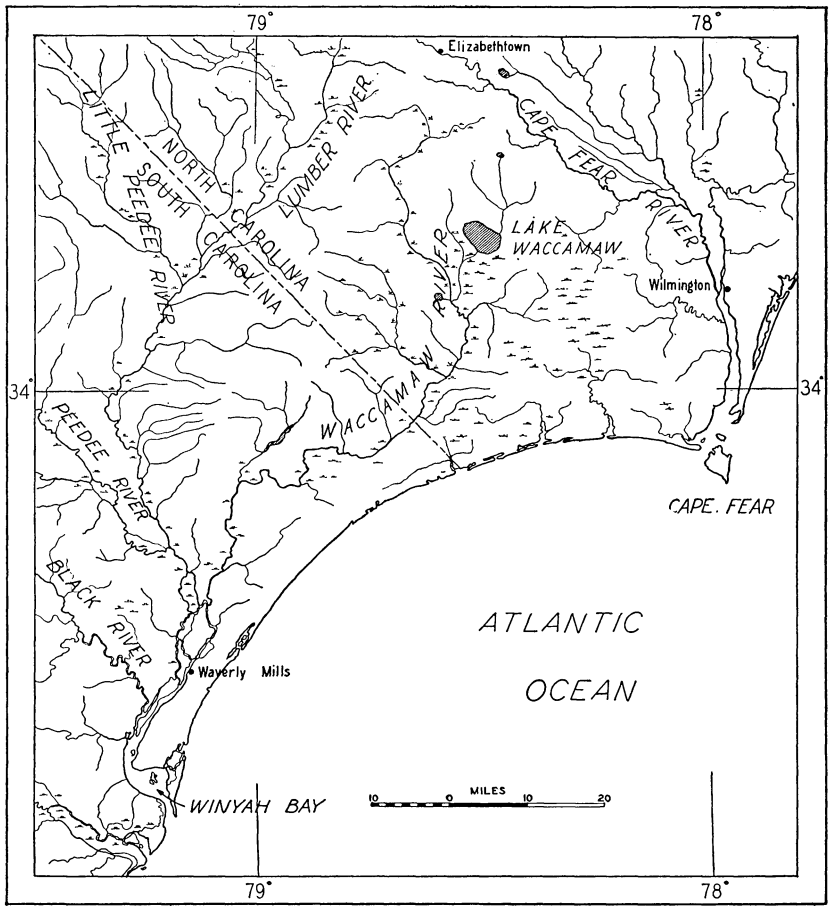
When one encounters a fauna so peculiar and so strongly endemic as that of Lake Waccamaw, one naturally seeks information on any peculiar features



MAP 1. Drainage of North Carolina and adjacent regions, showing the general location of Lake Waccamaw.

of the habitat. Lake Waccamaw is not known to be highly distinctive, though its generally very clear waters contrast rather sharply with the bog-stained "black-water" that characterizes most of the lakes and streams of the Coastal Plain region. When the lake was visited on March 30, 1941, the water was almost colorless, but it was said to be light brown at times. The quality of the water confirms the local testimony that "numerous springs feed the lake." Three very small inlets, known locally as First, Second, and Big creeks, enter the north shore. The small, sluggish outlet (not shown on the North Carolina base map of the U. S. Geological Survey) flows southwestward a short distance through swampy land into the headwaters of Waccamaw River. Waccamaw is a rather large inland lake (about 3.5 by

5.5 miles, as measured on the state base map; 5 by 7 miles according to local report). It has a surface area of over 6,000 acres (Harrelson, 1932: 64). It is very shallow: the maximum depth is about 8 to 10 feet, and out 300 yards from the north shore there is only 2 feet of water. The lake level fluctuates a few feet, depending on rainfall, and on whether or not the dam in the outlet is in service (Harrelson, 1932: 65). The bottom, at least along



MAP 2. Waccamaw River system and parts of adjacent drainages.

the north shore, is of white sand, with some algae. The other shores merge into the surrounding swamp. According to Francis Harper (in letter), "vegetation in the lake includes *Nelumbo lutea, Nuphar sagittaefolia* (these two I have rarely met with elsewhere), *Pontederia,* and maiden-cane (presumably *Panicum hemitomon*)." Ice is said to have formed over the lake in the winter of 1939–40, for the first time in 20 years.

According to C. Wythe Cooke, a leading authority on the physiography of the Coastal Plain:

> The clearness of its water probably indicates that Lake Waccamaw is fed by springs and that little water enters through swamps. A spring-fed lake would be expected to have a more equable temperature—warmer in winter, cooler in summer—than one filled with swamp water, particularly if the flow were abundant. The chemical quality of its water would be different. Organic acids would be less abundant and might be neutralized by alkalies. The spring water may be delivered from the underlying Upper Cretaceous Peedee formation, which yields water unusually high in sodium bicarbonate (see *U. S. Geol. Surv. Bull.*, 867: 181), or it may be high in calcium carbonate. The temperature, the chemical quality, and the deeper penetration of light may be factors that led to the development of peculiar fishes and mollusks in Lake Waccamaw, but the lake itself is not very old.[3]
>
> The map of the surficial formations of North Carolina by Stephenson in volume 3 of the *North Carolina Geological Survey*, published in 1912, shows Lake Waccamaw on the inner edge of the Chowan terrace, now called Talbot. The shore line of the Talbot sea lay approximately 42 feet above the present sea level. The altitude of Lake Waccamaw station on the Atlantic Coast Line Railroad north of the lake is given as 65 feet above sea level in *U. S. Geol. Surv. Bull.*, 274. The railroad crosses Stephenson's Wicomico terrace, which included the Wicomico terrace as later restricted by me (altitude of shore line 100 feet) and the Penholoway terrace (altitude of shore line 70 feet). Most geomorphologists admit that the terraces as high as 100 feet are marine, though some disagree with my contention that early Pleistocene seas covered the land to a height of about 270 feet above present sea level. According to my tentative correlation (*Wash. Acad. Sci. Journ.*, 25, 1935: 333), the Wicomico, Penholoway, and Talbot terraces together correspond to the Sangamon interglacial stage, during which the sea first stood at the 100-foot level (Wicomico), then dropped to the 70-foot level (Penholoway), and finally to the 42-foot level (Talbot). Therefore the site of Lake Waccamaw was covered by the sea during all of Sangamon time. At the beginning of the Iowan glacial stage sea level dropped below the present level and Lake Waccamaw presumably came into being. The next rise of sea level, during the Peorian interglacial stage, raised the tides only 25 feet (Pamlico shore line) over the present level, probably leaving Lake Waccamaw above tide. If this correlation is correct, Lake Waccamaw is not older than Iowan, i.e., it came into existence sometime during the last quarter of Pleistocene time.[4]

SPECIATION OF FISHES IN THE LAKE

In view of this physiographical testimony it seems probable that *Notropis waccamanus, Fundulus waccamensis, Boleosoma perlongum,* and *Menidia extensa* have become specifically differentiated since some time in the latter part of the Pleistocene. They are probably to be regarded as coastwise, but not marine relicts. *Menidia beryllina,* the most probable ancestor of *M. extensa,* is chiefly a brackish-water fish, but it is known to occur also in purely fresh water and some of its subspecies and certain related species are confined to fresh-water habitats. *Boleosoma nigrum olmstedi,* from an ances-

[3] Information kindly furnished by C. Wythe Cooke, with permission to quote, in letter dated January 10, 1942.

[4] Data supplied by C. Wythe Cooke, in letter of February 12, 1942.

tor of which *Boleosoma perlongum* presumably stemmed, is essentially a lowland, fresh-water type, which is commonly replaced toward headwaters by other forms of the genus. *Fundulus diaphanus diaphanus,* parent to *Fundulus waccamensis,* is also a lowland, fresh-water fish. *Notropis petersoni* or some other member of the *Notropis xaenocephalus* group probably gave rise to *Notropis waccamanus* and in the Carolinas this fresh-water group occurs on the lower elevations.

None of the Waccamaw forms is definitely indicated to be either a northern or a southern relict. *Notropis petersoni* occurs in North Carolina north of Lake Waccamaw and, with other species closely related to *N. waccamanus,*

TABLE I

SUMMARY OF CATCH RECORD BY LICENSED TROT-LINE FISHERMEN IN LAKE WACCAMAW FOR THREE WINTERS (1929–30, 1930–31, AND 1931–32)

Name (as listed)	Presumed Identification	Number Reported
Catfish	*Ictalurus catus* (and others?)	2,397
Blackfish or Grinnel	*Amia calva*	206
Gars or Gar Pike	*Lepisosteus osseus osseus*	74
Eels	*Anguilla bostoniensis*	151
Pike or Jack	*Esox niger*	76
Black Bass	*Huro salmoides*	52
White Perch	*Morone americana*	726
Goggle Eye	*Chaenobryttus coronarius*	71
Crappie or Speckled Perch	*Pomoxis nigro-maculatus*	.....
Blue Bream	*Lepomis macrochirus purpurescens*	.....
Robin or Red Belly	*Lepomis auritus*	4
Sand Perch or Yellow Breast	*Lepomis gibbosus*	14
Redfin or Yellow Perch	*Perca flavescens*	173
Grass Perch	*Lepomis* sp. (?)	6

inhabits Georgia and Florida. *Fundulus diaphanus diaphanus,* apparent ancestor of *waccamensis,* seems to reach its southern limit just south of Lake Waccamaw. Forms of *Boleosoma* related to *Boleosoma perlongum* occur along the Atlantic coast from Quebec to Georgia; *Boleosoma nigrum olmstedi,* possibly its closest relative among named kinds, ranges south to North Carolina, but not to the Waccamaw system; another form, perhaps closer than *olmstedi* to the ancestors of *Boleosoma perlongum,* inhabits eastern Georgia. Subspecies of *Menidia beryllina,* the most plausible parent species of *Menidia extensa,* range from southern New England to northeastern Mexico.

The 4 endemic species are apparently the common forage fishes of Lake Waccamaw, perhaps the only ones. They are no doubt all preyed upon by the predaceous fishes which abound in this lake—witness its reputation among anglers (Harrelson, 1932: 64, and local evidence). Largemouth bass (*Huro salmoides*) is the chief game fish. Specimens of yellow perch (*Perca flavescens*), white catfish (*Ictalurus catus*), and white perch (*Morone americana*) were collected. Warmouth and crappies (presumably *Chaenobryttus*

coronarius and *Pomoxis nigro-maculatus*) are also caught, according to local testimony. Gars (no doubt *Lepisosteus osseus osseus*) are also reported. Statistics on the catch in Lake Waccamaw over 3 winters, by licensed trot-line fishermen, taken from the report by Harrelson (1932: 65), are summarized in Table I. Dr. F. Willis King of the North Carolina Department of Conservation and Development has assisted us in obtaining these and other records.

The high predation to which the forage fishes of Lake Waccamaw have no doubt been subjected appears to have been a factor in determining the type of endemism exhibited here. The Waccamaw differentiates contrast with the endemic fishes of certain African and Philippine lakes. Those endemics, unhampered by intense predation, have settled in and have become adapted on a radiative pattern to a variety of habitats (Herre, 1933; Worthington, 1937). The peculiar species of Lake Waccamaw, on the contrary, have been held in a relatively uniform environment, under the endless attack of predators. In the clear, open waters of Lake Waccamaw a special premium must be placed on a rapid escape from predaceous fishes (and birds). In harmony with these circumstances the forage fishes of Waccamaw have not undergone a multiplication of species, but have become modified, and the differentiation has been in features which should allow for more effective and speedy escape. They are all more slender, trimmer, more terete, and otherwise modified (as indicated below) so as to be less retarded by friction in their swimming movements.

The present abundance of forage fishes in Lake Waccamaw hardly bespeaks severe predation, but since the lake has long been subjected to a heavy fishing load it seems probable that the numbers of predatory fish have been decreased, thus allowing the forage fishes to become more abundant. Furthermore, the great numbers of the smaller species may be attributed in part to their successful adaptation to predator pressure in open water.

The differentiation of 4 endemic fishes of Lake Waccamaw has followed a pattern of parallel speciation. As is shown in the descriptions which follow:

All 4 forms are decidedly slenderer and more terete than their cognates and probable ancestors.

Three of the 4 (all but the *Notropis*) have, at least on the average, smaller heads.

Three of the 4 (all but the *Notropis*) show a markedly increased number of scales, and a smaller though significant increase in the number of vertebrae.

There is an increase in the number of dorsal rays in the *Boleosoma* and of anal rays in the *Menidia* (these are the fins which most commonly exhibit geographical differentiation in the Percidae and Atherinidae, respectively).

All 4 are more or less noticeably paler than their relatives—but this difference may be partly or entirely a direct response to the environment.

There is obviously a need for a thorough field study of the peculiar fish fauna of Lake Waccamaw. Indeed, a general biological survey is called for. The junior writer's work of 1 night was, of course, inadequate, and the only other fish collecting in the lake was done by Jane Roller, who obtained a few specimens[5] on April 10, 1938, and by Francis Harper, who collected the types of *Notropis waccamanus* during a recent examination of Lake Waccamaw. We had hoped to make another trip to the lake, but conditions beyond the control of biologists have prevented this being done. Sufficient data have been accumulated, however, to warrant this initial paper on the Waccamaw fish fauna.

WACCAMAW SHINER

Notropis waccamanus Fowler

Notropis waccamanus.—Fowler, 1942: 6–8, Figs. 7–8 (original description; comparisons; Lake Waccamaw, North Carolina); 1945: 116 (reference to type description and to types).

This shiner, locally known as "smelt minnow" and reputed to be very common, is probably to be included among the endemic species of Lake Waccamaw. On the basis of the 1 half-grown and 1 adult specimen seined by Raney on March 30, 1941, and of 2 adults in the National Museum, collected by Jane Roller on April 10, 1938, we provisionally regarded it as a distinct form of the *Notropis xaenocephalus* group. Lacking adequate series, however, we hesitated to name it. More recently Fowler, having at hand specimens collected by Francis Harper, named this local form *Notropis waccamanus.*

The four specimens seen by us correspond satisfactorily with the type description and figure. In the slender, stream-lined body, the attenuation of the caudal peduncle, and the lightness of color they differ from the nearest relatives and appear to exhibit a modification for lacustrine existence, though the specialization is less extreme than that exhibited by the other endemic fishes of Lake Waccamaw. The "bright shining lateral band reflecting like tin or mercury" would seem to adapt the species for life in the middle layers of open water.

Though Fowler referred the species to the subgenus *Coccotis* and compared it only with *Notropis brimleyi,* it appears to have no close affinity with *Notropis coccogenis,* a species of the mountain tributaries of the Tennessee River (we synonymize *N. brimleyi* with *N. coccogenis*). It appears to be much more closely related to *Notropis petersoni* Fowler (1942: 1–2, Figs.

[5] These specimens, in the U. S. National Museum, were examined, with comparative material, through the kind co-operation of Curator Leonard P. Schultz.

1–2), which was referred to the subgenus *Hudsonius* and compared only with *Notropis saludanus* (which we treat as the southernmost subspecies of *Notropis hudsonius*). Both *waccamanus* and *petersoni* are small species with 7 anal rays, typically 2 teeth in the outer row, large scales, a dusky lateral band ending in a caudal spot, little red color, a moderately oblique mouth, a thick body, and other features that seem to align them with the *xaenocephalus* group—of which there are several southeastern species.

Provisionally, it seems best to regard *Notropis waccamanus* as a local, lacustrine, specific derivative of *Notropis petersoni,* or of some similar member of the *Notropis xaenocephalus* series. *Notropis petersoni* probably occurs both to the south as well as to the north of Lake Waccamaw. It was described from 2 tributaries of Cape Fear River, to the northward in North Carolina. There are at hand a series of subtopotypic specimens (30 breeding adults), collected by R. E. Coker on June 12, 1926, at Lakeview, North Carolina, and 1 half-grown, seined by Raney, Lachner, and Pfeiffer a short distance north of Lake Waccamaw, in a tributary of Cape Fear River 1 mile south of Elizabethtown, North Carolina (Map 2). What appears to be the same species is represented in the Museum of Zoology by several other series, from the coastal drainages of South Carolina, Georgia, and western Florida.

The more attenuate form of *Notropis waccamanus,* as contrasted with *N. petersoni,* is indicated by certain proportional measurements (Table II). There is considerable variation in these proportions in what we identify as *N. petersoni,* and were it not for the apparently sharp difference in color, we should accord the 2 nominal species only subspecific separation. *N. waccamanus* is also slenderer than most other related species of the genus.

WACCAMAW KILLIFISH

Fundulus waccamensis, new species

(Pl. I, Figs. 1, male, and 2, female)

Fundulus diaphanus diaphanus (misidentification).—Fowler, 1945: 125 (Lake Waccamaw; coloration; habitat).

This species, locally known as "sand shiner," swarms around the shores of Lake Waccamaw. Many thousands were seen resting on or near the sand shoals of the north shore, on the night of March 30, 1941, when a large series was preserved. Fowler's 4 specimens were taken later in the same habitat.

Because of its abundance and hardiness this killifish is widely used as a bait minnow. At times, particularly in the winter, it is not readily obtainable along the shore. To ensure a supply, a stock is kept by W. D. Jones in a small cement pool, in which, he says, they live throughout the winter.

It seems obvious that *Fundulus waccamensis* was derived from *F. diaphanus diaphanus* (LeSueur). It is more extreme than *F. d. diaphanus* in the characters by which that Atlantic coast subspecies differs from the western

TABLE II

CERTAIN PROPORTIONAL MEASUREMENTS OF *Notropis waccamanus* AND *Notropis petersoni*
Averages in parentheses.

	Body Depth in Standard Length	Depth of Caudal Peduncle		Head Depth in Head Length
		In Head	In Length, C. Ped.	
N. waccamanus, topotypes				
Half-grown (25 mm.)	5.5	3.4	2.7	1.8
Ripe female (39 mm.)	4.7	3.0	2.7	1.7
Adult (43 mm.)	5.6	3.6	3.3	1.8
Nuptial male (53 mm.)	5.0	2.9	2.6	1.6
N. petersoni, subtopotypes				
30 adults (42–56 mm.)*	4.0–4.8(4.46)	2.3–2.9(2.66)	2.1–2.6(2.32)	1.5–1.7(1.61)
N. petersoni, other series				
Half-grown (33 mm.)†	5.2	2.8	2.4	1.6
8 half-grown (26–31 mm.)‡	4.8–5.4(5.14)	2.8–3.2(2.98)	2.2–2.4(2.33)	1.6–1.8(1.70)
8 adults (37–47 mm.)‡	4.6–5.4(4.94)	2.6–3.0(2.81)	2.1–2.5(2.34)	1.6–1.7(1.65)

* Series from Lakeview, North Carolina.
† Specimen from tributary of Cape Fear River near Elizabethtown, North Carolina.
‡ Series from Ohoopee River, Emanuel County, Georgia.

form, *F. d. menona* Jordan and Copeland (Hubbs and Lagler, 1941: 67). The most tangible differences between *F. waccamensis* and *F. d. diaphanus* lie in the number of scales: in *waccamensis* the count is 54 to ~~56~~ 64 (mean for 40 specimens, 58.8); in *diaphanus diaphanus* the count by Hubbs and Shapiro (in Hubbs and Lagler) is 41 to 52, with a usual range from 43 to 46. In correlation with the higher number of scales and the slenderer body, *waccamensis* has more vertebrae than there are in *Fundulus diaphanus* from North Carolina, but the difference is only an average one (Table III). The body is more attenuate, almost constantly so in specimens of the same sex, season, and size: the depth measures 5.3 to 6.4 in the standard length, with an average of 5.7 for 23 specimens; in *F. d. diaphanus* the usual ratios are 3.8 to 4.8, but the subspecies is subject to much variation in this respect. The attenuation particularly affects the caudal peduncle, which is longer in *waccamensis* than in *diaphanus diaphanus:* the length of the peduncle enters

TABLE III

NUMBER OF VERTEBRAE IN *Fundulus diaphanus diaphanus* AND IN *Fundulus waccamensis*

	Number of Vertebrae			Average
	34	35	36	
Fundulus diaphanus diaphanus (Knotts Island Bay, North Carolina)	5	5	.....	34.5
Fundulus waccamensis	1	4	5	35.4

the standard length 3.1 to 3.4 (average 3.2) times, rather than about 3.2 (rarely) to 3.8 times. The peduncle is also slenderer (depth, 2.8 to 3.6, average, 3.0, rather than about 2.2 to 2.8, in the head). The depth-in-length ratio for the caudal peduncle is 3.2 to 3.6 in *waccamensis,* 2.2 to 2.8 in *diaphanus diaphanus.* The head is slenderer and narrower, and averages slightly smaller: the head-in-length measurement runs from 3.4 to 3.8, with an average of 3.6, rather than 3.1 to 3.7 (average 3.4). The least interorbital width measures 3.3 to 4.2 (average 3.8) times in the head, instead of 2.9 to 3.3 times.

There may be an overlap in the ranges of variation for each of the character differences that separate *Fundulus waccamensis* from *Fundulus diaphanus diaphanus,* but the 2 can probably always be separated by the ensemble of characters. For that reason we accord full specific status to the form which seems to be confined to Lake Waccamaw. No populations of *F. diaphanus diaphanus* show any confusing approach in characters to *F. waccamensis.* So far as known the 2 forms do not exist together, though both occur in the Waccamaw River system. Specimens from Waverly Mills, near the mouth of Waccamaw River, in South Carolina, are seen to be typical of *diaphanus diaphanus* from Fowler's account (1935: 20, Fig. 30) and by a re-examination of 4 specimens, kindly loaned by E. M. Burton, director of

the Charleston Museum; 2 of these examples yield scale counts of 38 and 42, respectively. *F. d. diaphanus* has also been collected near the coast just east of Lake Waccamaw, by Myers (1925: 371); 3 of his specimens, from a quarry pond at Wilmington, have, respectively, 42, 42, and 47 scales. Other characters of the specimens from these 2 southernmost record stations for *diaphanus diaphanus* are typical of that form.

TYPES.—The holotype, University of Michigan Museum of Zoology, No. 138473, is an adult male 76 mm. in standard length, collected by E. C. Raney, E. A. Lachner, and R. A. Pfeiffer on the north shore of Lake Waccamaw, Columbus County, North Carolina, March 30, 1941. All of the 259 other specimens examined are designated as paratypes. With one exception they were all collected with the holotype, and they are deposited in the collections of the University of Michigan (No. 138474) and Cornell University (No. 9287). The other paratype, U.S.N.M., No. 106717, was collected in Lake Waccamaw by Jane Roller, on April 10, 1938. The largest specimen is 85 mm. in standard length.

DESCRIPTION.[6]—The resemblance of *Fundulus waccamensis* to *Fundulus diaphanus diaphanus* is so close as to render unneeded a very detailed description. The following account is based primarily on the holotype.

As shown in the figures (Pl. I, Figs. 1–2) the body is attenuate, with similarly curved dorsal and ventral contours—convex before the origins of the dorsal and anal fins and concave behind those points. The greatest depth steps into the standard length 5.3 times. The males average slightly the deeper (Table IV), but the sexual dimorphism seems to be weaker than in *F. d. diaphanus*. The caudal peduncle is long and slender (length, 3.3 in standard length; depth, 2.7 in head).

The length of the head enters the standard length 3.5 times. The head is long, slender, and narrow, with flat top and rather sharply marked dorsolateral angulation. Measurements of the head parts into the head length in the holotype are as follows: depth of head at occiput, 1.8; width of head, 2.1; bony interorbital, 3.8; snout length, 2.8; preorbital width, 5.6; length of orbit, 4.5; length of upper jaw, 3.3. The muzzle as seen from above is broadly U-shaped, and about as broad as long (in *F. d. diaphanus* it is broader than long). Rather large teeth in each jaw form a strongly arched series, which is well separated from an inner, scarcely more than biserial band of smaller teeth. The gill-opening remains free above the pectoral fin for a distance equal to more than half the height of the base of that fin. The gill-rakers, of moderate size, number 1 + 5 (as usually in *F. d. diaphanus*).

Variations in certain proportions of the body and head are indicated in Table IV. Variations in counts are given in Table V.

[6] The methods of counting and measuring used in this paper are those proposed by Hubbs and Lagler (1941: 12–20, Figs. 2–3).

TABLE IV

VARIATIONS IN CERTAIN PROPORTIONS OF THE BODY AND HEAD, IN PARATYPES OF *Fundulus waccamensis*

	Males (12)		Females (11)	
	Min.–Max.	Ave.	Min.–Max.	Ave.
In standard length				
Body depth	5.3–6.1	5.6	5.3–6.4	5.8
Caudal peduncle length	3.1–3.4	3.3	3.2–3.3	3.2
Head length	3.4–3.7	3.5	3.4–3.8	3.6
Predorsal length	1.8–1.9	1.8	1.8–1.9	1.9
In head length				
Caudal peduncle depth	2.8–3.3	3.0	2.8–3.6	3.1
Head depth	1.9–2.1	2.0	1.8–2.1	2.0
Bony interorbital	3.6–4.1	3.8	3.3–4.2	3.7
Snout length	2.8–3.2	2.9	2.9–3.3	3.1
Preorbital width	5.1–7.6	6.1	5.6–8.0	6.2
Orbital length	3.7–4.7	4.3	3.4–4.7	4.1
Upper jaw length	3.2–3.5	3.3	3.2–3.7	3.4

The scales on the top of the head as well as those on the body are small. The nonimbricate scale near the occiput is definitely smaller than in *F. d. diaphanus:* its length enters the distance from its anterior border to the rostral fold 3.3 to 4.7 times, rather than 2.2 to 3.1 times (as measured on 10 types of *waccamensis* and 10 specimens of *F. d. diaphanus* from Knotts Island Bay, North Carolina).

The size and form of the fins, shown in the figures, are not markedly different from those of *F. d. diaphanus.* The dorsal fin is placed well forward: the distance from its origin to the caudal base, when stepped forward, reaches in the males about to the front of the eye and in the females at least to the middle of the eye.

TABLE V

VARIATIONS IN SCALE AND RAY COUNTS IN *Fundulus waccamensis*

	Holotype	Paratypes (40)	
		Min.–Max.	Ave.
Scales, transverse series	56	54–64	58.8
Scales, around caudal peduncle	24	19–25	22.5
Scales in series from origin of anal upward and forward*	18	16–21	18.3
Dorsal rays	13	13–15	14.1
Anal rays	11	10–12	11.3
Caudal rays	16	15–17	16.0
Pectoral rays	16–16	15–15—18–18	16.8
Pelvic rays	6–6	6–6—6–6	6.0
Total, dorsal and anal	24	23–27	25.4

* Starting just lateral to the anal origin and not including the mid-dorsal line.

The coloration (Pl. I) is like that of *F. d. diaphanus* and shows a similar sexual dimorphism. The scale pockets, as in *F. d. diaphanus* but not as in *F. d. menona,* are strongly set off by fine penciled lines. The bars near the caudal often become more or less shortened vertically and somewhat fused horizontally, in which respects only *F. waccamensis* approaches *F. d. menona* more clearly than *F. diaphanus.*

In life the branchiostegal area of the adult males is yellow, as it also is in *F. d. diaphanus* (Webster, 1942: 172, Fig. 33).

Nuptial tubercles ("contact organs") in the form of slight elevations from which hard hairlike spinelets may protrude, occur, as in *F. d. diaphanus,* on the sides of the body (one near the tip of each scale) and along the anal fin rays. The scaly-sided oviducal pouch of the females is very low, but long; it embraces about half the length of the anal fin base.

The name *waccamensis* refers to the type locality and probable range of this interesting new *Fundulus.*

WACCAMAW DARTER

Boleosoma perlongum, new species

(Pl. I, Fig. 3)

Seventeen maturing to fully mature specimens of this distinct species of *Boleosoma* were caught with *Fundulus waccamensis* on the sandy shoals along the north side of Lake Waccamaw, on the night of March 30, 1941. One of these darters contained the eyed eggs of some fish, possibly a bass, in its stomach.

Comparison with other members of the genus is difficult, because several local kinds remain undescribed and all are in great need of revision. Among the named forms the approach seems closest to *Boleosoma nigrum olmstedi* (Storer), *Boleosoma nigrum eulepis* Hubbs and Greene, and *Boleosoma nigrum nigrum* (Rafinesque), but full specific differentiation is indicated. Perhaps the sharpest single differential character is the number of scales (Table VI). There is a slight overlap in the frequencies, for the finest-scaled individuals of *olmstedi,* particularly from the Chesapeake Bay region, have the count as high as in the coarser-scaled examples of *perlongum.* In other respects the fine-scaled specimens of *olmstedi* are unlike the new species, and at every locality, so far as known, *olmstedi* usually has fewer than 55 scales from head to caudal. Other kinds of *Boleosoma* from the Atlantic coast drainage—including several which are unnamed—have fewer scales than *olmstedi,* and therefore contrast sharply with *perlongum.* The range of variation for the several other forms of the Atlantic coast, occurring from Maryland to South Carolina, is 35 to 53 (as determined by numerous scale counts). One of the two kinds of eastern Georgia, approaching *perlongum* in some respects, has a scale count of 45 to 57.

Boleosoma perlongum differs from *B. n. olmstedi* in a convincing array

TABLE VI

SCALE COUNT FREQUENCIES IN *Bolcosoma*

The counts for *B. n. eulepis* and *B. n. nigrum* are taken from Hubbs and Greene (1935: 98).

Scale count	*B. nigrum olmstedi*	*B. nigrum eulepis*	*B. nigrum nigrum*	*B. perlongum*
40	.....	2	.....	.....
41	1	1	1	.....
42	.....	.....	4	.....
43	4	4	3	.....
44	15	6	14	.....
45	26	13	18	.....
46	40	12	29	.....
47	41	18	34	.....
48	58	13	29	.....
49	50	21	29	.....
50	46	12	20	.....
51	30	9	15	.....
52	26	7	5	.....
53	22	7	1	.....
54	11	3	3	.....
55	8	1	.....	.....
56	8	1	.....	.....
57	4	.....	.....	.....
58	5	.....	.....	2
59	1	.....	.....	.....
60	1	.....	.....	6
61	.....	.....	.....	2
62	.....	.....	.....	3
63	.....	.....	.....	.....
64	.....	.....	.....	2
65	.....	.....	.....	1
66	.....	.....	.....	1
No.	397	130	205	17
Ave.	49.1	48.2	47.6	61.4

of other characters, as outlined in Table VII supplemented by Tables VIII and IX.

TYPES.—The holotype, University of Michigan Museum of Zoology, No. 138475, is a fine mature male specimen, 71 mm. in standard length (Pl. I, Fig. 3). It was collected with 16 maturing and mature male and female paratypes (U.M.M.Z., No. 138476), 44 to 75 mm. long, on the north shore of Lake Waccamaw, North Carolina, by E. C. Raney, E. A. Lachner, and R. A. Pfeiffer, on March 30, 1941.

DESCRIPTION.—The diagnostic features of this darter are indicated in the preceding comparisons, in the figure of the holotype, and in the tabulated measurements (Table X). Supplementary items follow:

Usually the nape is only partly scaled, with a strip of scales down the midline, flanked on either side by a scaleless area. The cheeks are fully scaled. The breast either bears a few scales or is naked. The belly is largely devoid of scales near the mid-line.

TABLE VII

COMPARISON OF *Boleosoma perlongum* WITH *B. nigrum olmstedi*

Character	*B. nigrum olmstedi*	*B. perlongum* (based on all 17 specimens, except for vertebrae)
Vertebrae (Table VIII)	37 to 39	39 to 40, usually 40
Scales, head to caudal (Table VI)	41 to 60, usually 44 to 53	58 to 66
Scales above lateral line	4 to 6 (average 4.7 for 147)	5 to 7 (average 5.7)
Scales below lateral line	6 to 10 (average 8.0 for 147)	9 to 11 (average 10.1)
Dorsal spines	7 to 10 (average 8.9 for 260)	9 to 12 (average 9.9)
Dorsal soft rays*	11 to 16 (average 13.3 for 437)	13 to 15 (average 14.2)
Dorsal rays (total)*	19 to 25 (average 22.2 for 199)	23 to 26 (average 24.2)
Anal spines†	Constantly 1 (181 counts)	2 (2 in 16, 1 in 1)
Squammation of nape‡	Usually fully scaled, or scaleless near midline	Usually scaled near midline, with a scaleless strip on either side
Muzzle in side view§	Subtriangular; premaxillaries definitely terminal	Decurved and rounded; premaxillaries weakly projecting to subinferior
Head†	Larger (3.3 to 4.2, average 3.6 for 98)	Smaller (3.9 to 4.3, average 4.1)
Body†	Deeper (depth 4.5 to 6.4, average 5.3 for 95)	More slender (depth 6.3 to 7.3, average 6.6)
Pectoral fins†	Rather strongly barred	Immaculate or nearly so
Dorsal fin markings†	Darker, distinct nearly to base	Lighter, becoming faint toward base
Caudal fin bars†	Blackish	Dusky
Subocular bar†	Large, blackish	Smaller, dusky
Head pores averaging (Table IX)	Fewer	More

* In this character *B. perlongum* differs more trenchantly from *B. n.eulepis* and *B. n. nigrum* (data in Hubbs and Greene, 1935 : 99) than from *B. n. olmstedi.*

† In these characters *B. n. eulepis* and *B. n. nigrum* agree with or approach *B. n. olmstedi;* head and depth measurements were tabulated by Hubbs and Greene (1935 : 100).

‡ *B. n. eulepis* has the nape fully scaled; typical *B. n. nigrum* has a scaleless nape.

§ In this character *B. perlongum* closely resembles *B. n. eulepis* and *B. n. nigrum.*

TABLE VIII

NUMBER OF VERTEBRAE IN *Boleosoma*

	Number of Vertebrae				No.	Ave.
	37	38	39	40		
B. n. olmstedi (New Jersey)	2	5	.....	.....	7	37.7
B. n. olmstedi (Virginia)*	2	2	3	.....	7	38.1
B. n. eulepis (Wisconsin)	1	6	3	.....	10	38.2
B. n. nigrum (Michigan)	2	6	2	.....	10	38.0
B. perlongum (North Carolina)	.....	.....	1	3	4	39.75

* This lot, from Hunting Creek in the Potomac basin, was separately counted for vertebrae, because in number of scales and some other characters the races of *olmstedi* about Chesapeake Bay seem to approach *perlongum* slightly.

The dorsal and anal spines are flexible. The anal soft rays number 8 or 9. The pectoral rays are usually 13 (rarely 14 on one or both sides).

The genital papilla, as usual in *Boleosoma,* is large and prominently bilobed in the females. In the males this structure is small and oval.

The lateral line system of the head displays features that separate *perlongum* from some other kinds of *Boleosoma.* On the basis of the nomenclature of Hubbs and Cannon (1935: 10, Pl. 2), the laterals number 5 on each side of all 17 specimens; the postorbital, coronal, interorbital, and the anterior and posterior narial pores are present in all; the supratemporal canal is complete (1–1–1); the infraorbital canal is complete (it is typically complete in *B. n. olmstedi* but variously incomplete in *B. n. eulepis* and *B. n. nigrum*): the infraorbital pores are 5–3 in 22 counts and 5–4 in 12. The operculomandibular canal is also complete (usually not so in *eulepis* and *nigrum*), and its pores number 6–4, 7–4, or 8–4. Summaries of certain pore

TABLE IX

HEAD PORE COUNTS IN *Boleosoma*

Data kindly furnished by Mott D. Cannon.

Pore Series	Number of Pores								No.	Ave.
	5	6	7	8	9	10	11	12		
Infraorbital										
B. n. olmstedi	.....	.....	5	19	2	.....	.....	.....	26	7.88
B. n. eulepis	.....	24	21	9	.....	.....	.....	.....	54	6.72
B. n. nigrum	2	22	4	.....	2	.....	.....	.....	30	6.27
B. perlongum	.....	.....	.....	22	12	.....	.....	.....	34	8.35
Operculomandibular										
B. n. olmstedi	.....	1*	1	1	4	8	10	1	25	10.12
B. n. eulepis	1*	30*	.....	5	13	4	1	.....	23	9.04
B. n. nigrum	.....	.....	.....	3	14	13	.....	.....	30	9.33
B. perlongum	.....	.....	.....	.....	.....	1	27	6	34	11.15

* These very low counts were probably taken from young specimens which had not yet developed the anterior pores on the chin. They are disregarded in computing the number and averages.

counts make up Table IX. Cannon generously made all these pore counts. As usual in the genus, bright colors are lacking, even in the mature males. The anterior regions and the fins are darkened in breeding males (Pl. I, Fig. 3), as in most forms of *Boleosoma.* The general pattern, including the W-shaped marks on the sides, is also typical of the genus. Shown rather weakly and hardly at all in the adults is another *Boleosoma* mark—3 dark dashes on the lower edge of the urosome, respectively at the beginning and

TABLE X

MEASUREMENTS OF *Boleosoma perlongum*

Measurements taken with dividers and stepped into the stated part.

	Holotype	All 17 specimens	
		Min.–Max.	Ave.
In standard length			
Body depth	6.9	6.3–7.3	6.6
Head length	4.3	3.9–4.3	4.1
In head length			
Caudal peduncle depth	3.0	2.8–3.5	3.2
Head depth	1.7	1.6–1.9	1.7
Head width	1.8	1.6–1.9	1.8
Snout length	4.2	3.6–4.2	3.8
Eye length	4.4	3.7–4.4	4.0
Upper jaw length	3.4	3.4–3.6	3.5
Highest dorsal spine	1.8	1.6–2.2	1.9
Highest dorsal soft ray	1.4	1.4–2.0	1.7
Highest anal ray	1.7	1.7–2.4	2.0
Longest caudal ray	1.2	1.2–1.3	1.2
Longest pectoral ray	0.9	0.8–1.0	0.9
Longest pelvic ray	1.3	1.1–1.4	1.3
In snout length			
Eye length	1.1	1.0–1.3	1.1
In eye length			
Least fleshy interorbital	1.9	1.8–2.3	2.0

end of the anal fin base and just before the caudal fin. The general pallor, probably in part with a genetic basis, is no doubt correlated with the open-sand habitat.

The name *perlongum* signifies extremely long.

WACCAMAW GLASSMINNOW

Menidia extensa, new species

(Pl. I, Figs. 4–5)

Atherinids of this species were encountered in thousands on the north shore of Lake Waccamaw, at night, on March 30, 1941. They were found in the region also occupied by *Fundulus waccamensis,* but instead of resting near the bottom they were swimming close to the surface. In the field they were taken to be *Labidesthes sicculus.* A large series was preserved.

TABLE XI

ANAL RAY COUNTS IN THE SPECIES OF *Menidia*

	Number of Anal Soft Rays																				No.	Ave.
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
*M. colei**	2	27	20	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	53	10.49
*M. conchorum**	.....	.....	3	25	17	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49	12.45
M. beryllina peninsulae	.....	.....	.....	.....	2	37	64	18	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	123	14.85
M. beryllina, subsp.																						
New Jersey	.....	.....	.....	.....	.....	1	3	10	5	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20	16.10
North Carolina	.....	.....	.....	.....	.....	.....	3	5	8	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20	16.65
M. audens	.....	.....	.....	.....	.....	.....	.....	2	3	8	4	3	.....	.....	.....	.....	.....	.....	.....	.....	20	18.15
M. extensa	.....	.....	.....	.....	.....	.....	.....	1	3	8	15	13	3	.....	.....	.....	.....	.....	.....	.....	43	19.05
M. menidia menidia†	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	11	18	20	9	3	1	.....	.....	66	22.48
M. menidia notata†	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	8	23	72	72	40	16	10	1	245	23.80

* Counts from Hubbs (1936 : 251).
† Counts kindly made available by Alfred Perlmutter, from his doctoral thesis at the University of Michigan.

The systematic position of this new atherine fish is rather difficult to ascertain. In the number of anal rays (Table XI), it and to some extent *M. audens* bridge the supposed gap between the 2 main sections into which the genus has been divided. The division has been made on the basis of the anal soft rays numbering either 15 to 19, or 20 to 27, but the most frequent ray counts for *extensa* are 19 and 20. The 2 supposed groups, indicated by the primary key division in the revision by Kendall (1902: 256), and accorded subgeneric status by Jordan and Hubbs (1919: 15, 49–54), can hardly be delimited in the light of present evidence. The distinction in number of anal rays even breaks down somewhat when we disregard the 2 intermediate species. Wherever they occur together in northeastern Florida *Menidia beryllina peninsulae* and *Menidia menidia menidia* overlap slightly in anal ray counts and hybridize rather frequently (Hubbs, MS).

It is possible, however, that, on the basis of characters as yet unemployed, a subgenus or even genus *Ischnomembras* may yet be validated for the group with a few anal rays, typified by *M. beryllina*. In fact one character of possible group significance has already been pointed out. Hildebrand (1922: 118) discovered that *M. beryllina* has an egg with relatively few filaments, of which one is notably thickened, whereas *M. menidia* has an egg with a large cluster of very slender adhesive filaments, none of which is markedly thickened. Thus, the egg of *M. beryllina,* which freely penetrates into fresh water, definitely approaches that of the brook silversides, *Labidesthes sicculus*. In that strictly fresh-water species the egg possesses a single, enormously long filament (Hubbs, 1921: 271). Some forms of the *Ischnomembras* type slightly approach *Labidesthes* in the length and sharpness of the snout. A group (*Ischnomembras*) transitional between *Menidia* (in restricted sense) and *Labidesthes* may be indicated. It remains to be demonstrated, however.

Menidia extensa is thought to be related more closely to the *Menidia beryllina* complex than to the *Menidia menidia* series. In the number of anal rays it is intermediate, but accords better (through *audens*) with *beryllina* than with *menidia*. A more cogent reason is that the *menidia* series (*M. m. menidia* and *M. m. notata*) is almost exclusively marine, and nowhere is known to be permanently established in fresh water, whereas the *beryllina* series is essentially a brackish-water type in the north and has many fresh-water populations along the entire Gulf coast. *Menidia audens* of the central Mississippi Valley seems to belong to the *beryllina* series and to represent a stock that has inhabited the interior fresh waters since Pliocene times (Hubbs, 1942). *M. audens* seems to be closest to *M. extensa.*

The conclusion that *extensa* is more closely related to *beryllina* than to *menidia* is confirmed by an examination of the ovarian eggs. Ova that seem to be approaching maturity, though only about 0.25 mm. in diameter, possess

numerous filaments. These are usually wrapped around the egg membrane in a zigzag pattern, but sometimes float free. They are much longer than the diameter of the eggs and much longer than in *M. beryllina* as figured by Hildebrand (1922: 119, Figs. 95–97), but are not so excessively elongate as in *Labidesthes*. These filaments in *extensa* are much coarser than in *M. menidia,* as indicated by Hildebrand's figures for that species, and one of the threads is much coarser than the others. These are seemingly diagnostic features of *beryllina,* and perhaps of the subgenus or genus *Ischnomembras.*

From all known forms of *Menidia,* the Waccamaw species differs trenchantly in the structure of the scales, which are very degenerate. They are as thin as fine tissue and much smaller than one would expect from the moderately increased number. They are, therefore, imbricated less widely than usual. The form is more or less oval and higher than long, rather than being strongly shield-shaped. The anterolateral angles of the ridges and scale margins are obsolescent. The anterior radii are very weak and often not discernible. On many scales the circuli are so weak as to be scarcely apparent, but on some scales the ridges are stronger and spaced as is usual in *Menidia:* very close on the posterior field, less close on the anterior field, and farthest apart on the lateral fields. The lateral fields, however, are not strongly developed, as they are in other kinds of *Menidia;* they are often hardly distinguishable.

In superficial characters *extensa* shows some approach to the subspecies of *Menidia menidia.* Thus, it agrees with *M. m. menidia* in having the first dorsal fin inserted little in advance of the origin of the anal. It differs from that form in the higher number of scales and vertebrae, and in the much slenderer body. In these characters by which it differs from *M. m. menidia, M. extensa* approaches or resembles *M. m. notata.* It differs from *notata* in the more posterior position of the first dorsal in reference to the anal fin (in *notata* the origin of the first dorsal lies well in advance of the anus). The structure of the egg and of the scale, of course, clearly proves the specific distinction of *extensa* from either subspecies of *M. menidia.*

M. extensa differs from the northern subspecies of *M. beryllina*[7] in scale structure, as indicated above, in the higher number of anal rays (Table XI) and of vertebrae and scales (Table XII), and in the much slenderer body and the more anteriorly inserted pelvic fin (Table XIII). The anal fin is also inserted farther forward: the distance from the caudal base to the anal origin when measured forward extends approximately to the middle of the snout, rather than to some point in the posterior half of the eye. In correlation with the more anterior origin of the anal fin, the air bladder is extended farther into the urosome: the urosome is thus excavated for about

[7] The treatments of Kendall (1902) and of Jordan and Hubbs (1919) both require revision. Subspecies limits in the north are undetermined.

10 segments instead of 8, and the length of the cavity, measured from the front of the interhemal complex, is about two-thirds instead of less than half as long as the head. The anus lies approximately under rather than distinctly behind the vertical from the origin of the first dorsal fin.

TABLE XII

MERISTIC COUNTS IN *Menidia*

Number of specimens counted is indicated in parentheses. See Table XI for anal ray counts.

	Min.–Max.	Ave.
Vertebrae		
M. beryllina, New Jersey (8)	39–40	39.1
North Carolina (10)	37–40	38.6
M. audens, Arkansas (10)	38–42	39.5
M. extensa, types (13)	42–45	43.4
Scales, gill-opening to C. base		
M. beryllina, New Jersey (20)	36–40	37.8
North Carolina (20)	37–40	38.0
M. audens, Arkansas (20)	39–44	40.9
M. extensa, types (25)	44–50	46.4
Scales, predorsal		
M. beryllina, New Jersey (13)	14–16	15.3
North Carolina (20)	15–18	16.3
M. audens, Arkansas (20)	17–23	20.0
M. extensa, types (18)	19–25	22.0
Scales above anal origin*		
M. beryllina, New Jersey (11)	8–9	8.4
North Carolina (11)	8–9	8.6
M. audens, Arkansas (20)	8–11	10.3
M. extensa, types (16)	9–11	10.4
Scales around caudal peduncle		
M. beryllina, New Jersey (11)	12–14	12.6
North Carolina (11)	13–15	13.5
M. audens, Arkansas (20)	14–16	14.9
M. extensa, types (14)	14–17	15.4
First dorsal, spines		
M. beryllina, New Jersey (16)	4–6	5.0
North Carolina (16)	4–6	4.9
M. audens, Arkansas (16)	4–6	4.6
M. extensa, types (43)	3–6	4.8
Second dorsal, soft rays		
M. beryllina, New Jersey (16)	8–10	9.1
North Carolina (16)	8–10	9.6
M. audens, Arkansas (16)	8–11	9.6
M. extensa, types (43)	7–11	9.4

* Counted from beside anal origin upward and forward to but not including the mid-dorsal row.

The details of pigmentation are different. In *extensa* the lower surface of the caudal peduncle is particularly different in appearance. Instead of being stippled with melanophores, with an indistinct development of a biserial row on the mid-line, this area is nearly clear of pigment, except for

a very strong double line of large confluent melanophores. There are other differences, but these which have been cited suffice to prove the specific distinctness of *M. extensa*.

In the number of anal rays (Table XI) *Menidia extensa* agrees rather

TABLE XIII

PROPORTIONAL MEASUREMENTS IN *Menidia*

Measurements were made with dividers and stepped into stated part; number of specimens is indicated in parentheses.

	In Paratypes of *M. extensa* and in Other Species		Holotype, *M. extensa*
	Min.–Max.	Ave.	
COMPARATIVE MEASUREMENTS			
In standard length			
Body depth			
M. beryllina			
New Jersey (10)	4.9–5.6	5.1	.....
North Carolina (16)	5.2–6.4	5.8	.....
M. audens, Arkansas (10)	5.4–6.3	5.8	.....
M. extensa, types (19)	7.3–8.1	7.7	7.8
Head length			
M. beryllina			
New Jersey (10)	4.0–4.3	4.2	.....
North Carolina (20)	3.1–4.3	3.9	.....
M. audens, Arkansas (10)	4.1–4.4	4.3	.....
M. extensa, types (19)	4.1–4.6	4.3	4.5
Snout tip to pelvic insertion			
M. beryllina			
New Jersey (10)	2.4–2.6	2.5	.....
North Carolina (10)	2.5–2.7	2.5	.....
M. audens, Arkansas (10)	2.6–2.8	2.7	.....
M. extensa, types (10)	2.7–2.8	2.7	2.7
ADDITIONAL DATA, *M. extensa* (10 paratypes, and holotype)			
In standard length			
Anal base length	3.4–4.8	4.1	3.8
Caudal peduncle length	4.2–4.9	4.6	4.8
In head length			
Caudal peduncle depth	3.4–3.7	3.5	3.4
Head depth	1.9–2.1	2.0	1.9
Head width	2.1–2.3	2.2	2.1
Snout length	2.9–3.7	3.3	3.3
Upper jaw length	3.8–4.7	4.2	4.3
Bony interorbital	3.7–4.9	4.3	4.2
Eye length	2.9–3.5	3.2	3.2
First dorsal height	2.3–2.7	2.5	2.4
Between dorsal origins	1.5–1.9	1.7	1.6
Second dorsal, highest ray	1.7–2.0	1.8	1.8
Caudal fin length	1.0–1.2	1.1	1.0
Anal fin, highest ray	1.4–1.7	1.6	1.5
Pectoral fin length	1.3–1.5	1.5	1.4
Pelvic fin length	1.9–2.3	2.1	1.9

well with the Mississippi Valley species, *M. audens* Hay (1882: 64–66).[8] The 2 agree also in the anterior position of the pelvic fin (Table XIII). The anal fin originates a little farther forward than it does in *audens* (in which the distance from caudal base to anal origin when measured forward extends to any point within the eye). *M. audens* is intermediate in the position of the origin of the first dorsal (in approximate terms the first dorsal origin lies over the origin of the anal in *extensa,* over the anus in *audens,* before the anus in *beryllina*). The meristic counts of *audens* further suggest a tendency toward intergradation between *beryllina* and *extensa* (Tables XI–XII). *M. extensa* and *audens* also agree in the coloration of the ventral surface of the caudal peduncle. There would be some question as to the specific distinctness of *extensa,* on the basis of the characters just discussed. The scale structure, however, provides a clear-cut distinction: the scales of *audens* do not show the degeneration described above for *extensa.*

TYPES.—The holotype, University of Michigan Museum of Zoology, No. 135845, an adult 59 mm. in standard length, was seined on the north shore of Lake Waccamaw, North Carolina, by E. C. Raney, E. A. Lachner, and R. A. Pfeiffer, on March 30, 1941. The 535 specimens taken with the holotype, measuring 30 to 66 mm. in standard length, are all designated as paratypes, as they are very uniform in characters and have all been examined in the preparation of this account. They are deposited in the University of Michigan Museum of Zoology (No. 135846) and Cornell University (No. 9289). Six additional paratypes, in the United States National Museum, were collected in Lake Waccamaw by Jane Roller on April 10, 1938.

The diagnostic features of *Menidia extensa* are brought out in the preceding comparisons and in the photographs of a paratype (Pl. I, Figs. 4–5). Only a few supplementary details seem needed. Scale and ray counts for the holotype, not included in Table XII, are as follows: scales between gill-opening and caudal base, 47; predorsal scales, 24; scales upward and forward from beside anal origin, 10; scales around caudal peduncle, 15. Dorsal rays, V–1, 11; anal, I, 20. Measurements of the holotype make up the last column in Table XIII.

The lateral line system of the body, as would be expected in a fresh-water species of this group, is of a rather extreme juvenile type (Hubbs, 1936: 251). Along the upper (anterior) line and along all but the posteriormost part of the main lateral line neither pores nor tubes are evident (except on an occasional scale in some specimens). Their place is taken by neuromast organs (minute, round "pits"), which are often doubled vertically. Only

[8] Nichols (1911: 276–77) indicated *M. audens* as a probable synonym of *gracilis* (= *beryllina*), but after re-examining some of his material, and other series from the Mississippi Valley, we find it to be a probably related and valid though perhaps only subspecifically distinct form.

on the caudal peduncle are tubes developed, and these are weak and often are not covered over by thin membrane.

The teeth of the jaws are in very narrow bands. The outer row is a little enlarged about the very slightly hooked tip of the premaxillaries, which fits into the slightly excavated median part of the lower jaw. The outer row of the mandible is moderately enlarged, especially toward the sides. In general, the comparable teeth are larger in the lower than in the upper jaw. These characters are not unlike those of other forms in the *beryllina* group and show no definite approach toward the beaklike structures of *Labidesthes.*

The name *extensa* means "stretched out."

SUMMARY

In certain lakes throughout the world the speciation of fishes has been extensive and rapid. Lake Waccamaw on the Coastal Plains of North Carolina may now be added to this list. Four endemic species, of which three are herein described as new, are attributed to this body of water. The complete differentiation of these species seems to have taken place within the history of the lake, which is estimated to have been confined to the last fourth of the Pleistocene epoch. The four endemic species, belonging to as many families, all appear to be of fresh-water origin. All four differ from their nearest relatives in being slenderer and more terete. Three of the four differ in having smaller heads and in the markedly increased number of scales and slightly more numerous vertebrae. Some or all have a lighter color. These distinctive characters are largely interpretable as adaptations to open-water lacustrine existence and are strikingly parallel. Intense predation appears to have been a factor in the rapid speciation.

ADDENDUM

Further study throws more doubt on the full specific distinctness of *Notropis waccamanus.* One of the specimens in the United States National Museum is a nuptial male. It has tubercles like those of *N. petersoni.* They are coarse on the mandible and along the edge of the snout, but are small on the side of the muzzle before the eye and on the cheek. On the top of the pectoral rays they form a fine shagreen.

In the National Museum there is a specimen (No. 106718) of *Gambusia affinis holbrookii* from Lake Waccamaw, collected by Jane Roller on April 19, 1938. It has 7 dorsal and 10 anal rays and is typical also in gonopodial structure. Twenty-one other specimens of this poeciliid were taken on April 20 in a tributary to the north side of Lake Waccamaw.

LITERATURE CITED

COKER, R. E.
1938 Notes on the Peculiar Crustacean Fauna of White Lake, North Carolina. Arch. Hydrob., 34: 130–33, Fig. 1.

FOWLER, HENRY W.
1935 Notes on South Carolina Fresh-water Fishes. Contrib. Charleston Mus., 7: 1–28, Figs. 1–54.
1942 Descriptions of Six New Fresh-water Fishes (Cyprinidae and Percidae) from the Southeastern United States. Notulae Naturae, 107: 1–11, Figs. 1–11.
1945 A Study of the Fishes of the Southern Piedmont and Coastal Plain. Acad. Nat. Sci. Phila. Monogr., 7: i–vi, 1–408, Figs. 1–313.

HARRELSON, J. W.
1932 Fourth Biennial Report of the Department of Conservation and Development of the State of North Carolina. Pp. 1–120, Fig. 1.

HAY, O. P.
1882 On a Collection of Fishes from the Lower Mississippi Valley. Bull. U. S. Fish Comm., 2: 57–75.

HERRE, ALBERT W. C. T.
1933 The Fishes of Lake Lanao: a Problem in Evolution. Amer. Nat., 67: 154–62.

HILDEBRAND, SAMUEL F.
1922 Notes on Habits and Development of Eggs and Larvae of the Silversides Menidia menidia and Menidia beryllina. Bull. U. S. Bur. Fish., 38 (1921–22): 113–20, Figs. 85–98.

HUBBS, CARL L.
1921 An Ecological Study of the Life-history of the Fresh-water Atherine Fish Labidesthes sicculus. Ecology, 2: 262–76, Figs. 1–4.
1936 Fishes of the Yucatan Peninsula. Carn. Inst. Wash. Publ., 457: 157–287, Pls. 1–15, Fig. 1.
1940 Speciation of Fishes. Amer. Nat., 74: 198–211.
1941 The Relation of Hydrological Conditions to Speciation in Fishes. *In:* A Symposium on Hydrobiology. Madison: Univ. Wis. Press. Pp. 182–95.
1942 An Atherinid Fish from the Pliocene of Oklahoma. Journ. Paleontol., 16: 399–400.

HUBBS, CARL L., and MOTT DWIGHT CANNON
1935 The Darters of the Genera Hololepis and Villora. Misc. Publ. Mus. Zool. Univ. Mich., 30: 1–93, Pls. 1–3.

HUBBS, CARL L., and C. WILLARD GREENE
1935 Two New Subspecies of Fishes from Wisconsin. Trans. Wis. Acad. Sci., Arts, and Letters, 29: 89–101, Pls. 2–3.

HUBBS, CARL L., and KARL F. LAGLER
1941 Guide to the Fishes of the Great Lakes and Tributary Waters. Bull. Cranbrook Inst. Sci., 18: 1–100, Figs. 1–118.

JORDAN, DAVID STARR, and CARL L. HUBBS
1919 A Monographic Review of the Family of Atherinidae or Silversides. Leland Stanford Jr. Univ. Publ. (Univ. Ser.), pp. 1–87, Pls. 1–12.

KENDALL, W. C.
1902 Notes on the Silversides of the Genus Menidia of the East Coast of the United States, with Descriptions of Two New Subspecies. Rept. U. S. Comm. Fish and Fish., 1901, pp. 241–67, 6 figs.

LEA, ISAAC
1863 Descriptions of Twenty-four New Species of Unionidae of the United States. Proc. Acad. Nat. Sci. Phila., pp. 191–94.
1864 Observations on the Genus Unio, together with Descriptions of New Species in the Family Unionidae, and Descriptions of New Species of the Melanidae, Limneidae, Paludinae and Helicidae. Philadelphia: Printed for the author. 11: 1–146, Pls. 1–24.

MCKEE, PAUL W., and R. E. COKER
1940 Notes on Plankton Entomostraca of the Carolinas. Journ. Elisha Mitchell Sci. Soc., 56: 177–87.

MYERS, G. S.
1925 Results of Some Recent Studies of the American Killifishes. Fish Culturist, 4: 370–71.

NICHOLS, JOHN TREADWELL
1911 Notes on Teleostean Fishes from the Eastern United States. Bull. Amer. Mus. Nat. Hist., 30: 275–78, Pl. 11, Fig. 1.

RANEY, EDWARD C.
1942 Three New Species of Lacustrine Fishes Endemic to Lake Waccamaw, North Carolina. Abstracts of Papers Presented at the 25th Annual Meeting of the Amer. Soc. Ichthyologists and Herpetologists. (Mimeographed), p. 13.

SIMPSON, CHARLES TORREY
1914 A Descriptive Catalogue of the Naiades, or Pearly Fresh-water Mussels. Pt. II, Unionidae, Unio—Nodularia. Detroit: Bryant Walker. Pp. 527–1045.

WEBSTER, DWIGHT A.
1942 The Life Histories of Some Connecticut Fishes. *In:* A Fishery Survey of Important Connecticut Lakes. Bull. Conn. Geol. and Nat. Hist. Surv., 63: 122–227, Figs. 1–60.

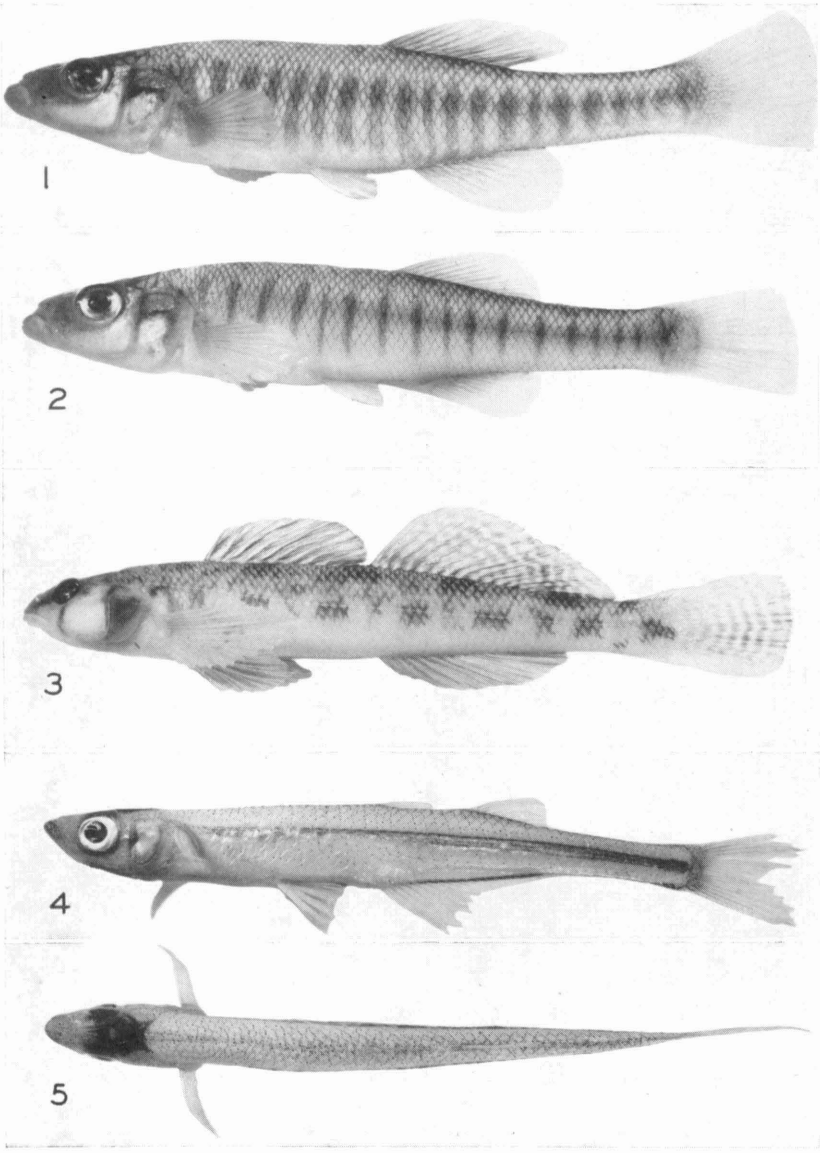
WORTHINGTON, E. B.
1937 On the Evolution of Fish in the Great Lakes of Africa. Intern. Rev. ges. Hydrob. und Hydrogr., 35: 304–17.

PLATE I

New endemic fishes from Lake Waccamaw, North Carolina, collected by E. C. Raney, E. A. Lachner, and R. A. Pfeiffer, March 30, 1941.

FIG. 1. *Fundulus waccamensis:* adult male paratype, 72 mm. in standard length.
FIG. 2. *Fundulus waccamensis:* adult female paratype, 72 mm. long.
FIG. 3. *Boleosoma perlongum:* holotype, 71 mm. long.
FIG. 4. *Menidia extensa:* adult male paratype, 65 mm. long.
FIG. 5. *Menidia extensa:* dorsal aspect of the same specimen.
All photographs by Art Smith.

PLATE I



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