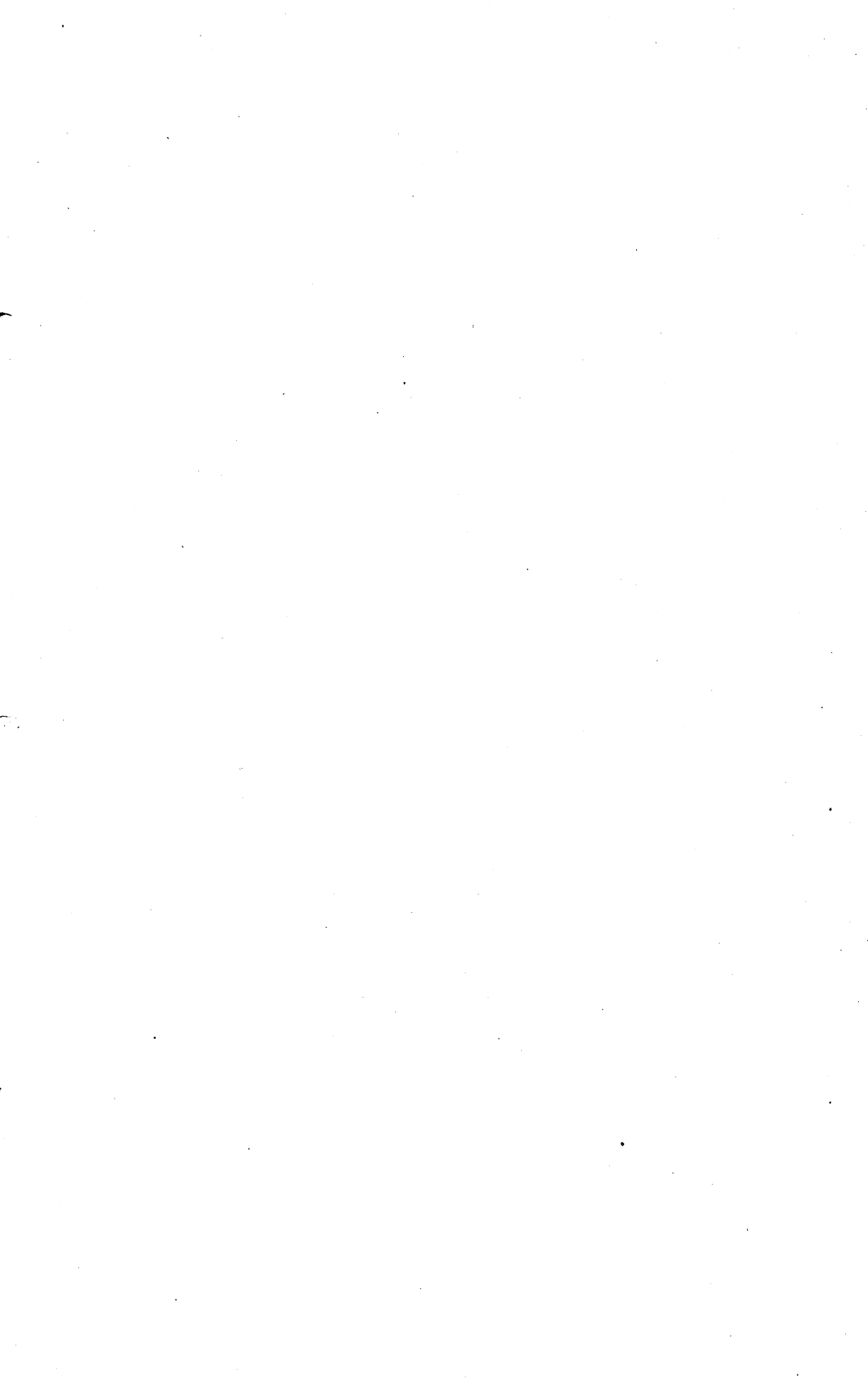


UNIVERSITY OF MICHIGAN
MUSEUM OF ZOOLOGY
MISCELLANEOUS PUBLICATIONS NO. 30

THE DARTERS OF THE GENERA
HOLOLEPIS AND *VILLORA*

BY
CARL L. HUBBS AND MOTT DWIGHT CANNON

ANN ARBOR, MICHIGAN
UNIVERSITY OF MICHIGAN PRESS
October 9, 1935



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FREDERICK M. GAIGE
Director of the Museum of Zoology

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THE DARTERS OF THE GENERA *HOLOLEPIS* AND *VILLORA*

Although the darters—diminutive percid fishes of North America—have long fascinated ichthyologists, they are still very imperfectly known. Few of the groups of darters have been so extensively confused as the one under treatment. The senior author has long appreciated this circumstance, and has recognized several of the new species and new systematic alignments herein proposed. The junior author, taking up the detailed study without the inhibitions derived from continued, routine, systematic investigations, has discovered new sets of characters which have aided greatly in reorganizing the forms under treatment, and which promise to be of great value in the revision of other groups of darters. The new characters, as indicated below, are those of the number and arrangement of the lateral line pores on the head, and those of the genital papillae.

The following new names are proposed:

Villora, new genus.

Villora edwini, new species.

Hololepis serrifer, new species.

Hololepis zonifer, new species.

Hololepis saludae, new species.

Hololepis collis, new species.

Hololepis thermophilus, new species.

Hololepis fusiformis atraquae, new subspecies.

Hololepis fusiformis metae-gadi, new subspecies.

Hololepis fusiformis insulae, new subspecies.

Hololepis gracilis (Girard) and *Hololepis fusiformis erochrous* Cope are names resurrected from synonymy.

To indicate the increase in our knowledge of this group, it may be mentioned that Jordan and Evermann (1896: 1100–1103) and most authors for nearly half a century have recognized only two species in this group, *Cope-landellus quiescens* (= *Hololepis barratti*) and “*Boleichthys*” *fusiformis*. *H. gracilis*, the common Mississippi Valley species, was confounded through this period not only with *H. fusiformis*, but also with *Poecilichthys exilis*.

SOURCES OF MATERIAL

This study has been based on material in the fish collections of the Museum of Zoology of the University of Michigan (Mich.), the United States National Museum (U.S.N.M.), the Museum of Comparative Zoology (M.C.Z.), the Illinois State Laboratory of Natural History (Ill.), and the

Academy of Natural Sciences of Philadelphia (Phila.). Mr. E. M. Burton of the Charleston Museum, and Mr. C. S. Brimley of the North Carolina Department of Agriculture have contributed critical material from the Carolinas. The specimens in each museum which have been examined are indicated under each species, in lists which employ the abbreviations indicated above.

Thanks to the authorities of these several institutions, we have now examined the types of all the forms here referred to *Hololepis* except those of *erochrous*, which apparently are not extant though represented by topotypes. Most of the recorded non-type material has also been checked over. This old material, supplemented by fairly extensive new collections, provides a fairly adequate basis for a revision of the genus *Hololepis*. Much more material, however, is needed from certain critical areas, especially Alabama, the South Carolina Piedmont, Virginia, and Nantucket Island.

CHARACTERS USED

In this study we have made use of the usual proportions and counts, as well as several new characters, one of which has seldom before been used to any extent in the taxonomy of fishes. Of the usual methods of differentiation, measurements have proved the least useful. Except in depth of body and length of paired fins, few significant differences in proportions were discovered. Though to the eye these fishes present considerable variation in proportions, their size is so small that the differences do not show up very strikingly when measured. Indeed it was found virtually impossible to obtain extensive series of accurate measurements with the usual equipment because of the difficulties involved in handling such minute fishes. The technical difficulties were overcome by attaching a mechanical stage to the stage plate of a binocular dissecting microscope and gluing a hair across the diaphragm of one ocular. A specimen to be measured was laid, at right angles to the hair, on a slide held by the mechanical stage. Then a point, for example the tip of the snout, was brought below the hair. After the reading on the vernier scale was recorded, the stage, slide, and fish were moved on until another point on the fish, whose distance from the first was to be measured, lay beneath the hair. The reading on the scale was again recorded. The difference between these two readings indicated the length in millimeters of the part in question, such as the snout, eye, or head. Vertical measurements were made without touching the specimen merely by turning the ocular so that the hair was horizontal and then using the vertical movement of the stage. Each measurement did not always involve recording two points, since one point, the tip of the snout, was used as the common point of origin for several measurements. Other measurements, which under the conventional system would have to be made

separately, were computed from the differences in the readings already obtained. The scale with the vernier read to 0.1 mm., and the magnification allowed one to appreciate even smaller distances. The measurements representing the projection of each part, are expressed as hundredths of the standard length.

In spite of all the effort expended on measurements, counts proved much more useful, especially scale counts. The number of rows above and below the lateral line, the total number of scales in the lateral line row, and the number of pored scales in the lateral line have proved particularly useful. (As enumerated, the pored scales include the occasional unpored scales lying in advance of the last pored scale.) The number of pored scales in lateral line divided by the number of unpored scales following in the same scale row has provided a very useful index figure in distinguishing some of the species. While this index exaggerates differences between forms, it also equally emphasizes individual variations. The degree of development of the lateral line has been indicated also by measurement. The dorsals are the only fins which show sufficient differences in number of rays to separate any of the forms.

Some structural characters which have previously been employed in darter systematics prove valuable in distinguishing the species of *Villora* and *Hololepis*. These characters include the serrate or entire preopercle; the degree of completeness in the squamation of the different parts of the head, especially the parietal region (close scrutiny or even dissection is sometimes necessary to reveal embedded head scales); the degree of elevation and curvature of the lateral line, and the form of the arch. There are also good differences in the coloration of the body, of the first dorsal fin, and especially of the spots at the base of the caudal fin.

Early in the work it was realized that a canvass of structures other than those ordinarily used was desirable, for earlier workers on this group were handicapped by the paucity of trenchant characters. The most important outcome of this search was the discovery that the canals and pores forming the lateral line system on the head provide characters which differ in the several species but are relatively constant for a given species. Not only are these useful in analysis of species, but they also help indicate relationships.

The terminology used in the descriptions, and shown in Figures 1 and 2, is adapted from Allis' (1889) study of the embryology of the lateral line system in *Amia*. These canals are tubes which are either (1) wholly embedded and concealed beneath the smooth surface of the skin, or (2) superficial, appearing as folds of skin (this character varies with age, and perhaps also between species). The canals are lined by a sensory epithelium, and are well innervated. Their external openings are always pores, which open either directly from the canal, or at the ends of short side-branches.

The canals and pores are most readily and definitely seen while a jet of air is maneuvered over the surface of the head. This blows out the preservative and causes the canals and pores to stand out. In this way it can be determined which groups of pores are connected and which are not. A fine pipette drawn from glass tubing, and attached to a compressed air line is the most convenient apparatus. If no air line is available an atomizer bulb or a syringe bulb, preferably the former, may be used to force air through the pipette.

The general pattern of the cephalic pore system, uniform through the darters, needs be understood in order to appreciate the specific differences (Plate II). The *lateral canal*, the direct continuation of the lateral line on the head, extends horizontally from the upper edge of the opercle to just behind the eye, where it branches. The lateral canal in darters opens in five pores: one terminal, on the edge of the opercle; one between this and the point where the supratemporal canal is given off at a right angle; one opposite that point, which is near the middle of the lateral canal; another just anterior thereto; and the fifth just behind the forking of the lateral canal. The supratemporal canal is typically complete in *Hololepis* and *Villora*, forming a commissure across the occiput, connecting the lateral on one side with its fellow on the other side. The supratemporal pores comprise one lateral pore on each side, and a median pore which is rarely doubled by a narrow break in the canal (in many darters the canal in contrast is widely interrupted medially). Just back of the eye the lateral canal divides into a lower branch termed the *infraorbital canal* and an upper branch, the *supraorbital canal*. The pores of the supraorbital series are named, from behind the eye forward, as follows: the *postorbital*, the *interorbital* (usually obsolete in *Hololepis*), the *posterior nasal*, the *anterior nasal*. In *Hololepis*, as contrasted with *Microperca*, the posterior nasal pore is well separated from the posterior nostril. The anterior nasal in *Hololepis* and *Villora* always lies before and above, but close to, the anterior nostril; the posterior nasal is in front of the posterior nostril. The median *coronal* pore is at the end of a tube formed by the junction of a side branch extending outward and backward from each supraorbital. This branch originates in advance of the postorbital and behind the interorbital (if the latter is present). When the infraorbital canal becomes interrupted by the loss of a median portion, as it does in the more advanced species of *Hololepis*, a group of pores is isolated above the jaw. Along the edge of the preopercle and on the mandible there is a canal, the *operculomandibular*. In the two genera under treatment, as also in most if not all darters, this canal connects neither with the lateral canal above nor with the corresponding canal on the opposite side. In *Hololepis* and *Villora* the operculomandibular pores number nine or ten (rarely eight or even seven in *Holo-*

lepis), of which one at either end of the preopercle, as in other darters, constantly bounds four which open at ends of branch tubes.

The so-called "anal papilla," which is usually given as a special feature of the Etheostominae, presents valuable characters. Since the papilla is a modification of the openings of the genital ducts and lies behind the anus, it is more properly termed the *genital papilla*. *Villora* is outstanding in that this papilla is replaced by a ring of matted villi in the adult female. In general the papilla is better developed in the females than in the males, and often shows sexual dimorphism in structure as well as in size. This is true of *Hololepis*, in which, however, the sexual differences in the structure of the papilla are less obvious than the specific differences. The characteristic features of the genital papilla are best shown in breeding fish, though often appreciable during the summer rest period. Sexual development of the papilla (and of coloration) takes place in the fall, as in most of our spring-spawning fishes.

Another character associated with breeding involves the tubercles developed on the lower fins of the mature males in *Hololepis*.

We have confined ourselves largely to superficial characters which can be distinguished in alcoholic material. Visceral organs and the skeleton may also furnish valuable characters. For most of the species we lack adequate color descriptions from life. It would be desirable to have these for males and for females both in the breeding season and at other times, for there seems to be considerable sexual and seasonal variation in color.

Of these fish as living, moving individuals very little is known. That the species of *Hololepis* probably have very interesting breeding habits is indicated by the large and complex genital papilla of the female, probably used in oviposition, and by the development in the breeding male of nuptial tubercles, which are probably adaptations for holding the female in nuptial embrace.

The attractive colors of the southern species, combined with their general preference for still water and their ability to endure high temperatures, should make them desirable aquarium fishes. There are possibilities of interesting genetic investigations. The factors which determine the number of pored scales in the lateral line might well lend themselves to experimentation. Hybridization studies are another interesting possibility.

VILLORA, NEW GENUS

The new species *Villora edwini* is made the type of a new genus, because it possesses distinctive features and has characters in common with *Poecilichthys* as well as with *Hololepis*. In the curvature and elevation of the lateral line, the most consistent feature of *Hololepis*, *Villora* is quite intermediate: the least distance between lateral line and first dorsal base enters

the projection of the depth below lateral line 4.5 times in *Villora*, less than 4.0 times in most species of *Poecilichthys* (about 4.0 times in *Poecilichthys exilis*), and more than 5.0 times in *Hololepis* (about 5.0 in *H. saludae* and *H. collis*). Leaving *edwini* in either *Poecilichthys* or *Hololepis* would make the separation of those genera difficult.

The most trenchant feature of *Villora* is the replacement of the genital papilla of the female, supposedly diagnostic of the Etheostomatinae, by a marginal ring of matted villi.

Except for this fine character, and the higher and more arched lateral line, *Villora* is not distinguishable technically from the combined species-groups commonly referred to *Poecilichthys*, though it differs in other respects from these species-groups considered separately.

A considerable number of characters, some probably of minor taxonomic value, distinguish *Villora edwini* from all or most of the species here referred to *Hololepis*. These characters include:

- (1) The less elevated and less arched lateral line, as indicated above.
- (2) Larger scales (36 to 41, versus 37 to 61, rarely less than 42).
- (3) The less incomplete lateral line, which reaches nearly or quite to below end of second dorsal fin, instead of only to below middle of second dorsal or not even that far.
- (4) The regular presence of 2 interorbital pores (typically 0 in *Hololepis* though often 2 in *H. saludae* and *H. serrifer*); of 8 infraorbital pores (typically fewer than 8 in *Hololepis*, though usually 8 in *H. gracilis*); and of 10 (rarely 9) operculomandibular pores (typically 9 in *Hololepis* though usually 10 in *H. gracilis* and *H. zonifer*).
- (5) The complete infraorbital canal (interrupted in all species of *Hololepis* excepting *H. serrifer* and *H. gracilis*).
- (6) Instead of being more or less connected across the isthmus, the gill membranes are entirely free, slightly overlapping at the acute angle formed where they meet anteriorly.
- (7) The (apparent) lack of nuptial tubercles, on the pelvic and anal fins of the male.
- (8) The lack of definite blackish spots at base of caudal; the strong development of a black humeral spot; the multiple rows of red spots on the first dorsal fin of the breeding male.

Most of these features are primitive, suggesting that *Villora* evolved from an ancestor of *Hololepis*.

If *Villora* is closely related to the ancestor of *Hololepis* it must have differentiated in a direction parallel to that undergone within *Hololepis*, because the less modified species of *Hololepis* retain primitive characters now lost in *Villora*, for instance the more nearly complete head squamation seen in *H. serrifer* and *H. barratti* and the serrate preopercle of *H. serrifer*.

The modification of the genital papilla into a mass of villi appears to be a feature of extreme specialization in *Villora*.

Characters which associate *Villora* with both *Poecilichthys* and *Hololepis*, and distinguish it from one or more other genera in the subfamily according to the generic analyses of Boulenger (1895: 45), Jordan and Evermann (1896: 1018), Hubbs (1926: 55), and Jordan (1929: 153), are as follows: air bladder obsolete; parietal region of skull rather strongly convex in cross section; the bony interorbital narrow; preopercle entire; maxillary normal, free from the preorbital; premaxillaries non-protractile, terminal; no teeth on palate; midline of belly without definite median series of modified scales; dorsal fins of moderate size, separate or just touching; dorsal spines 9 to 12; anal fin distinctly smaller than second dorsal, with two pungent spines; pelvics inserted close together, not sharply pointed and not nearly reaching anus; flesh not hyaline; body moderately elongate; well scaled (except on top of head).

Villora edwini, NEW SPECIES

Plate I, Figure 1, and Plate II, Figures 1 and 2

(?) *Boleosoma Barratti* Holbrook, 1855: 57 (specimen from "Georgia" only).

MATERIAL EXAMINED AND RECORDED

State, Drainage Basin, and Collection Data Reference; Museum No. (specimens)

GEORGIA:

(Drainage Basin ?):

"Georgia"; Dr. Barratt. Holbrook, 1855: 57. M. C. Z. 98 (1).

Chattahoochee River drainage basin:

Tributary of Chattahoochee R., 2 miles
NW. of Jakin, Early Co.; Edwin P.
Creaser and Herbert R. Becker;
Sept. 15, 1929. Mich. 88685 (1).

FLORIDA:

Suwannee River drainage basin:

Santa Fe R. at Poe Springs, Alachua—
Columbia county line; E. T. Board-
man, University of Florida; Feb. 8, Mich. 87892 (1) and 107047 (3); U. S. N.
1928. M. 94684 (1).

Same locality; J. D. Kilby and A. F.
Carr, Jr.; Mar. 19, 1934. Mich. 101680 (2).

The specimen from "Georgia," collected by Dr. Barratt, is very likely the basis for the inclusion of "Georgia" along with "Florida" in the stated range of *Boleosoma Barratti*, as originally described by Holbrook

(1855: 57). There can be no doubt, however, that the type figure and the description were based on the species here called *Hololepis barratti*.

HOLOTYPE.—Cat. No. 87892, Museum of Zoology, University of Michigan, an adult male 38 mm. in standard length, collected by Edward T. Boardman, then of the University of Florida, in Santa Fe River at Poe Springs, Florida, February 8, 1928. All the other specimens examined are paratypes, 25 to 37 mm. long.

BODY.—Elongate, somewhat compressed.

HEAD.—Muzzle blunt; mouth subterminal, slightly inclined; lower jaw included. Preopercle smooth. Branchiostegal membranes not connected, slightly overlapping in front; distance from tip of snout to angle of membranes equal to that from tip of snout to posterior margin of eye, much less than 0.5 length of head.

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length, based on 5 specimens, 28 to 37 mm. in standard length).—Greatest depth 17 to 22 (average 20); least depth 9 to 11 (11); length of caudal peduncle 25 to 29 (27); greatest width 12 to 14 (14); width between lateral lines, below origin of first dorsal 9 to 11 (10); length of head to end of opercular spine 26 to 28 (27); length of snout 5 to 7 (6); length of eye 7 to 8 (8); postorbital length 13 to 15 (14); width of head 9 to 11 (10); width of fleshy interorbital 6; length of upper jaw 7 to 9 (8); distance from tip of snout to origin of dorsal fin 31 to 36 (34); highest dorsal spine 12 to 15 (14); highest dorsal soft ray 11 to 16 (14); length of caudal fin 20 to 22 (21); distance from tip of snout to origin of anal fin 54 to 63 (59); length of anal base 10 to 13 (12); length of pectoral fin 21 to 25 (23); length of pelvic fin 15 to 19 (18).

GENITAL PAPILLA.—In the breeding female scarcely developed as such, represented by matted villi surrounding the oviducal opening; some villi long enough to reach anal fin; in the non-breeding female shrunken, but preserving the villous appearance. Papilla in male a minute tube almost completely broken into villi, situated in a depression behind the anus.

BREEDING TUBERCLES.—Probably absent; not evident in males at hand, all of which were in the breeding condition.

FIN RAYS.—Dorsal, IX to X—9 to 12; anal, II, 7.

SCALE ROWS.—Three to 4—36 to 41—6 to 8.

LATERAL LINE.—Relatively long, 42 to 60 (average 52) hundredths of standard length, reaching nearly or quite to below end of second dorsal fin. Pored scales 23 to 32 (average 28). Scales in same row without pores, 7 to 13, each with a shallow pit containing a minute papilla. Ratio of pored to unpored scales, 1.77 to 4.57 (average 2.79). Lateral line only moderately elevated: separated from first dorsal at point of closest approach by a distance contained about 4.5 times in greatest depth below

lateral line (projection measurements); separated from origin of second dorsal by two-thirds depth below lateral line at that vertical, on same method of measuring.

SQUAMATION.—Breast, nape, cheek, and opercle completely scaled; parietals and interorbital entirely scaleless.

HEAD PORES.—Interorbitals uniformly present. Infraorbital canal complete, embedded, with 7 to 9, usually 8 pores. Operculomandibulars 10 (varying to 9 in 5 out of 17 counts). Supratemporal canal constantly complete. Otherwise as typical in *Hololepis*.

COLORATION.—Median portion of sides with a row of about 9 dark patches, often obscure forward, extending on the ventral surface of the caudal peduncle. Pigment more or less paralleling the entire scale margin, producing a cross-stitch pattern on the dark areas. Back with 8 or 9 dark saddles: 1 located behind the supratemporal canal, 1 before the first dorsal, 2 or 3 below each dorsal fin, and 1 or 2 across the caudal peduncle. Chromatophores densely crowded in these saddles. Pored portion of the lateral line marked by a narrow light line. A very dark bar ("humeral scale" of authors) from upper edge of pectoral base to the lateral line, immediately behind the tip of the opercle. No dark bar behind pectoral base. Base of caudal without definite dark spots, merely marked by a vague bar. Four dark lines radiating from eye, 2 horizontal, and 2 vertical, the one above eye chiefly noticeable for the extension of its pigment on the cornea of the eye; the rostral and suborbital streaks very prominent. Upper half of opercle with a dark patch. Lower half of opercles, cheek, sides of breast, mandibles, and throat, light, with small dark blotches. Parietal region dark.

Breast and belly and adjacent sides light, except for small patches of large intertwined chromatophores in the female; pigmented in the male by many small evenly distributed chromatophores forming a diffusely colored area extending backward on the ventral surface and lower sides of the caudal peduncle, and forward on the opercle, cheek, branchiostegals, throat, and lower mandible. Chromatophores on the breast of the male not markedly larger than those on the belly. All light areas in the male diffusely pigmented with chromatophores, evenly scattered as on the belly, but much less abundant. All vertical fins barred in the female; on the membranes as well as on the rays, except on the anal fin. First dorsal in female with considerable pigment at the extreme base, and often with a narrow submarginal band. First dorsal in male with 4 or 5 longitudinal rows, constituted by 4 or 5 red spots, one above the other, on each interspinous membrane; with a dark submarginal band; the fin elsewhere finely speckled with dark. Second dorsal in male similar, but with submarginal dark band wider and less sharply defined. Anal of male without barring,

but with heavy speckles in addition to reddish areas. Pelvics clear in female, heavily speckled in breeding male. Pectorals similar in the two sexes, clear; the rays outlined by fine dark lines.

Life colors of the female, as indicated by two specimens from Poe Springs, freshly preserved in formalin.—Sides with dark brown, red and yellow pigment. Lateral line bordered by red, above and below anteriorly, chiefly above posteriorly. Median row of dark blotches obscure, especially forward. Lower portion of sides, posterior to anus, with dark brown X-shaped markings; these markings continued somewhat irregularly on the ventral surface of the caudal peduncle. Sides directly above belly with small blotches or X's of dark brown on a whitish background. Breast and belly whitish. Dorsal saddles dark brown. Upper portion of sides yellowish brown (except the red band), with red, yellow, and dark brown specklings intermixed on each scale. On the sides the different pigments are to a large degree segregated on individual scales in more or less X-shaped patterns. Yellow X's, difficult to discern, occur over the back and sides, and even toward the whitish belly. Lower opercular, cheek, and mandibular regions tinged with yellow. Vertical fins barred alternately with dark red and bright watery yellow. Submarginal band on first dorsal red, widened and strengthened posteriorly; the lower bands, reinforcing the barring, chiefly dark, but with considerable red at very base of fin. Base of second dorsal similarly with some red; the markings on membrane mostly dark. Anal clear except for the barring. Pectoral with considerable yellow at base; rays yellow, with fine black outlines. Pelvics clear, tinged with yellow. These females are more brightly colored than most females of *Hololepis*. The males must be gorgeous, as they probably outdo their pretty mates in color.

HABITAT.—This species, within its apparently restricted range, probably selects clear, swift water with vegetation. The specimens from the Santa Fe River were recorded as seined from eel-grass and *Elodea* in swift water. The one from the Chattahoochee River tributary was collected in clear, rapid water, with sparse algae, on a bottom of gravel and sand, in a stream 3 feet deep and 30 feet wide.

Named *edwini* for Dr. Edwin P. Creaser, who collected the first specimen of this and of other fishes to come to the attention of the senior author.

GENUS *HOLOLEPIS* AGASSIZ

HISTORY OF THE GENERIC NAME

The generic name "*Hololepis* Agassiz, MS. 1860 (Nov. gen.)" was proposed by Putnam (1863: 4) to include the species *barratti* and *fusi-formis*, both of which had been described as species of *Boleosoma*. The diagnosis though very brief is adequate for purposes of recognition:

Body much compressed; lateral line strongly arched over the pectorals; dorsal fins of nearly equal size; caudal fin slightly rounded; head covered with small scales. Only two species known.

Hololepis Barratti Agassiz, MS. 1860.

Syn. *Boleosoma tenue* Agassiz, 1850, without description; *Boleosoma Barratti* Holbrook, Jour. Philad. Acad. Nat. Sci. (New Series) III. p. 56, 1855.

Hololepis fusiformis Putnam, MS. 1860.

Syn. *Boleosoma fusiforme* Girard, Proc. Bost. Soc. N. H. V. p. 41, 1854.

This diagnosis applies completely only to *barratti*, for *fusiformis* is virtually devoid of scales on the top of the head. Furthermore *barratti*, as "*Boleosoma barrattii* Holbrook, 1855," was designated as the type species of *Hololepis* by Jordan and Gilbert (1877: 93). The genus was at once accepted by Cope (1864: 233, footnote) and by Vaillant (1873: 126), but was synonymized by Jordan (1876: 220, and 1877a: 47 and 56) with *Boleichthys* Girard (1859: 103). There the name remained buried for about half a century. Jordan and Gilbert (1883a: 514) synonymized *Hololepis* with *Poecilichthys*, because *Boleichthys* was regarded by them (at that time only) as a subgenus of *Poecilichthys*. Boulenger (1895: 64) synonymized *Hololepis*, and *Boleichthys* and *Poecilichthys* as well, with *Etheostoma*. In Jordan and Evermann (1896a: 1101), *Hololepis* is not only buried but also forgotten, not even being mentioned as a synonym of *Boleichthys*. Jordan even failed to remember the genus in his monumental work, *The Genera of Fishes*, though he did include in it *A Classification of Fishes* (1923: 187), with the remark "near *Boleichthys* or identical with it." The name *Hololepis* was definitely resurrected by Hubbs and Greene (1928: 374 and 384).

From 1876 to 1926 the generic name *Boleichthys* was misapplied to the group here called *Hololepis*, because of the confused classification of its type species, *Boleichthys exilis* Girard. Throughout this period, Jordan and his followers assumed that *Boleichthys exilis* was a northwestern species, known chiefly from the types of *Boleichthys exilis* and its synonym *Boleichthys warreni* Girard, and very closely related to *Boleichthys fusiformis*. During this period, however, the same species was described as new under the names of *Boleichthys eos* Jordan, *Poecilichthys borealis* Jordan, *Etheostoma iowae* Jordan and Meek, *Etheostoma quappelle* Eigenmann and Eigenmann, *Etheostoma aubeenaubei* Evermann, and *Etheostoma hildebrandti* Evermann and Clark. In Jordan and Evermann (1896a: 1082, 1083, 1102, and 1103), such of these names as were then proposed were distributed among two subgenera of *Etheostoma* (*Nivicola*, there based on *P. borealis*, and *Oligocephalus*) as well as in *Boleichthys*. This complicated synonymy was untangled by Hubbs (1926: 64-68), who concluded that *Boleichthys*, in the current division of the genera, should be regarded

as a synonym of *Poecilichthys*, while the species *fusiformis*, thus left without a generic name, might be included in *Copelandellus* Jordan.

Hubbs and Greene (1928: 374 and 384) then appreciated that *Copelandellus* Jordan (1896a: 1100) is a strict synonym of *Hololepis*. This synonymy does not involve the question of whether the species scaled on top of head should be separated generically from those having this area scaleless or nearly so, because the type species of both *Copelandellus* (*Poecilichthys quiescens* Jordan) and of *Hololepis* (*Boleosoma Barratti* Holbrook) have the top of the head scaly. In fact, *quiescens* is a synonym of *barratti*.

Palmer and Wright (1920: 373–375) had already synonymized *Copelandellus* with *Boleichthys*, assuming the latter to be the group typified by the species *fusiformis*. They arrived at this action, however, by erroneously synonymizing *Copelandellus quiescens* with *Boleichthys fusiformis*. Our evidence indicates that “*quiescens*” (= *barratti*) and *fusiformis* are quite distinct, though referable to the same genus. The species *barratti* and *fusiformis* are seemingly only the two ends of one very minor line of evolution. There is apparently a gradient in the degree of squamation of the top of the head: in *barratti* of the Florida–South Carolina area this region is scaled completely except that the scales on the parietals are often embedded and are sometimes lacking medially; in *H. thermophilus* of North Carolina the parietals are scaleless except at the sides, though the interorbital remains well scaled; in *fusiformis* the parietals are completely scaleless except for a narrow strip at each side, while the number of interorbital scales decreases northward from an average of about 2 in Maryland to 0, rarely 1, in typical *fusiformis* of Massachusetts. There is a similar and parallel gradient in coloration, leading from the blotches of *barratti* to the lateral band of *fusiformis*. The extremely close relationship of *barratti* and *fusiformis*, mitigating against generic separation, is indicated by all their known characters. The number and arrangement of the head pores, as discussed later, is similar and distinctive in these forms.

CHARACTERS, INTEGRITY, AND RELATIONSHIPS OF *HOLELEPIS*

The naturalness of the whole group here called *Hololepis* is affirmed by the large number of characters which the species share in common. In all the form is more or less slender; the dorsal fins are rather small, subequal, and typically separated or barely touching; the anal fin has two stiff spines and is distinctly smaller than the second dorsal; the caudal fin is slightly rounded; the pectoral fin typically has 14 rays; the scales are of moderate size and not modified along the midventral line; the lateral line is incomplete; the cranium is rather strongly convex in the parietal region, and not broadened between the eyes; the premaxillaries are non-protractile; the lower jaw

is included; the gill membranes considerably connected; the genital papilla large in the female, subconical (except in *H. serrifer*), with a slit-like opening on the front face; belly darkened, in males only, by minute, evenly scattered melanophores; caudal fin barred. There are also common features or tendencies in the number and arrangement of the head pores (see p. 10).

If the genus *Hololepis* be divided, it will probably not be split, at least primarily, on the basis of head squamation. Differences in the number and arrangement of the head pores, particularly the completeness or incompleteness of the infraorbital canal, may prove of use in generic distinction, although the present indications are that interruption of the canal and decrease in the number of pores has occurred repeatedly and independently in different groups of species, not only in *Hololepis* but also *Poecilichthys*. The sharply serrate preopercle of *H. serrifer* is a trenchant feature of this very distinct species, since all the related forms have a smooth preopercle. The degree of elevation and curvature of the lateral line also differs considerably in the several species. The degree of union of the gill membranes is another character showing some difference. The detailed form of the genital papilla in each sex also provides characters of value.

The study of the genus *Hololepis* has constantly impressed us with the truth of Jordan and Evermann's observation (1896a: 1017):

The separation of the Etheostominae into genera is a matter of much difficulty as the structural differences are small, the individual variations great, and the gradations very perfect. We have, hitherto, been disposed to unite them all in one genus, but to do so tends to obscure the relationships of the species. Dr. Boulenger [1895: 45] places them in 8 genera. We are unable, however, to stop with that number of divisions. If they are not all placed in one genus each structural type must stand as a genus by itself.

To follow this statement to its logical conclusion, we should have to erect a genus for almost every species here referred to *Hololepis*, for most of these possess more or less trenchant structural differences. Avoiding at least for the present so radical a treatment, we find it difficult to distinguish this group as a whole from *Poecilichthys*, whether that group be retained as a large genus (as by Hubbs, 1926: 63) or be dismembered (as by Jordan, 1916b: 25; 1929: 153, and Jordan, Evermann, and Clark, 1930: 289).

The only structural characters which seem to characterize *Hololepis* as a whole from the more similar species of *Poecilichthys* are the elevation and the arching of the lateral line. In *Hololepis* the lateral line approaches closely to the base of the first dorsal fin, from which it is separated by a distance less than one-fifth the projection of the greatest depth, and the line is definitely arched anteriorly above a *horizontal* line. There is, however, some variation in the height and arching of the line in *Hololepis*,

and a number of species retained in *Poecilichthys*, notably *exilis* (type of *Boleichthys*) and *jessiae*, have the line considerably elevated and sometimes slightly arched above a horizontal line. These species are connected with others having the lateral line low and nearly straight anteriorly. It is perhaps of significance, that *exilis* and *jessiae* approach the species referred to *Hololepis* in general appearance and in their preference for a quiet-water, generally weedy, mud-bottom habitat—unusual for darters.

Splitting *Hololepis* from *Boleichthys* (*exilis*), the most similar division of *Poecilichthys*, may seem somewhat arbitrary, but the two groups appear to be natural ones, representing distinct lines of evolution. *Boleichthys* seems to grade into *Oligocephalus*, and perhaps should not be separated from that subgenus of *Poecilichthys*. Since each genus (*Hololepis* and *Poecilichthys*) has members with very primitive characters, their separation was probably ancient.

The distinction between *Hololepis* and *Microperca* also involves intergrading characters. In general the size is larger, the body slenderer, the fin rays more numerous, and the lateral line better developed in *Hololepis* than in *Microperca*. Size and depth of body are poor and variable characters. The numerical differences are as follows:

	<i>Hololepis</i>	<i>Microperca</i>
Dorsal spines	8 to 12 (rarely 8)	6 to 9 (rarely 9)
Total anal rays	8 or 9	6 or 7
Lateral line pores	3 to 35 (rarely fewer than 10)	0 to 7
Scale rows (transverse)	37 to 61 (rarely fewer than 40)	34 to 37
Operculomandibular pores	8 to 10 (rarely 8)	6 to 8

These numerical differences, excepting the last cited, are presumably related to a decrease in the number of vertebrae in *Microperca*: Jordan and Eigenmann (1885: 71) counted $16 + 20 = 36$ in "*Etheostoma fusi-forme*" and $14 + 16 = 30$ in *Microperca punctulata*. These authors also noted skull differences which should be more thoroughly investigated. The sharpest differences between the two genera perhaps lie in the modification of the pelvic fins in the males of *Microperca*, in which these fins are brick-red, pointed, elongated (reaching beyond anus), and are provided with a dermal flap attached to the outer side of the spine and folded on the ventral side of the fin.

PHYLOGENY AND COMPARISON OF THE SPECIES OF *HOLOLEPIS*

Specialization in *Hololepis* may be assumed to have taken place along several lines from a common, hypothetical ancestor which, judging from the characters of darters in general, had a serrate preopercle; a conical genital papilla; a rather deep, compressed body; the gill membranes

scarcely joined; the squamation complete over breast, cheeks, interorbital, and parietals; the lateral line long and only moderately arched and elevated; 10 operculomandibular pores; infraorbital canal complete, and with 8 pores, 4 above the upper jaw; the supratemporal canal complete; the interorbital pores developed. Independent modifications of these characters have no doubt taken place, because the several species possess different primitive characters. Thus the primitive and specialized features of *gracilis* and *serrifer* are largely complementary, as indicated in Table I. This table indicates our views as to the degree of specialization of each species referred to *Hololepis*, by numerically evaluating the degree of deviation of each species in each of the listed, primitive characters, from the hypothetical ancestor of the genus.

The degree of specialization and the apparent relationships of the eight species of *Hololepis* are shown in Figure 1. The measure of specialization is the same as indicated in Table I.

TABLE I
DEGREE OF SPECIALIZATION IN EACH SPECIES OF *HOLOLEPIS*

The degree of differentiation shown by each species in each character, from the assumed primitive condition stated in each column heading, is indicated by a figure: 1 representing the least or no modification, 2 a slightly greater change, and 3 to 7, depending on the character, the most extreme specialization. The "index of specialization," given in the last column, is merely the sum of these figures for each species.

	Character (assumed primitive condition stated in parenthesis)																
	Preopercle (sharply serrate)	Genital papilla (conical)	Body (deep)	Gill membranes (separate)	Breast scales (present)	Cheek scales (present, ctenoid)	Parietal scales (numerous)	Interorbital scales (numerous)	Lateral line (very long)	Lateral line (low, little curved)	Operculomandibular pores (10)	Infraorbital canal (complete)	Anterior infraorbital pores (4)	Posterior infraorbital pores (4)	Supratemporal canal (complete)	Interorbital pores (present)	INDEX OF SPECIALIZATION
<i>serrifer</i>	1	4	1	3	1	1	1	1	1	3	2	1	4	2	1	2	29
<i>gracilis</i>	5	2	2	1	3	2	4	4	3	2	1	1	1	1	1	3	36
<i>zonifer</i>	5	2 [♀]	2	2	3	2	4	4	4	2	1	4	1	3	1	4	44
<i>saludae</i>	5	1 [♀]	2 [♀]	3	3	3	4	4	4	1	2	4	2	7	3	1	49
<i>collis</i>	5	1 [♀]	1	3	3	3	4	4	4	1	2	4	3	7	2	4	51
<i>barratti</i>	5	1	2	3	1	1	2	1	2	3	2	4	4	6	1	4	42
<i>thermophilus</i>	5	1	3	3	1	1	4	2	5	3	2	4	4	4	1	4	47
<i>fusifformis</i>	5	1	2	3	1	1	4	3	5	2	3	4	4	5	2	4	49

Hololepis serrifer is clearly indicated as the most primitive species, though specialized in some respects. *H. gracilis* is apparently the next most primitive, but must have diverged early from the ancestor of *serrifer*.

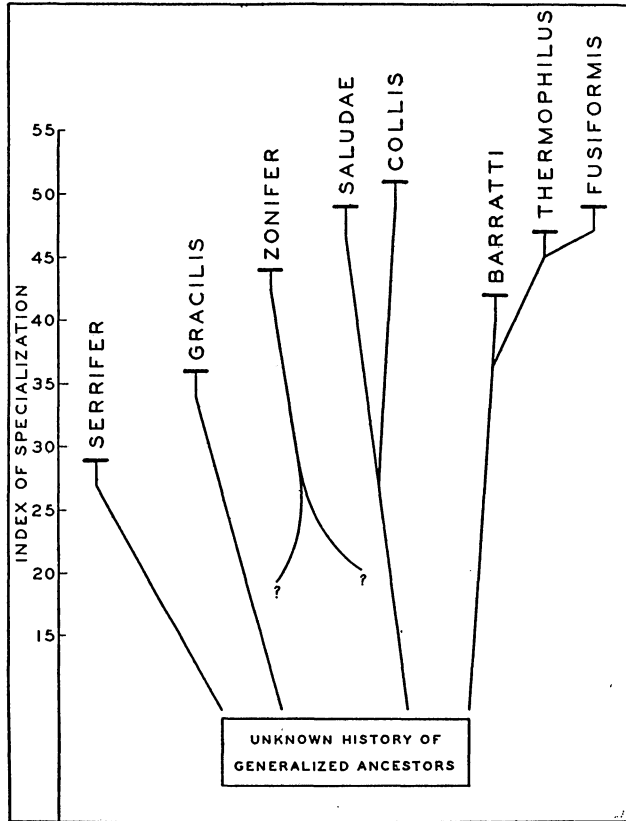


FIG. 1. Degree of specialization of each species, and the indicated species groups in *Hololepis*.

H. barratti also possesses archaic features, especially in head squamation, but its primitive characters are largely different from those of *gracilis*, indicating another early separation. Very likely *barratti* split from the ancestral stock later than *gracilis*.

The rather specialized *H. zonifer*, according to the number of operculo-mandibular pores and to numerous details of form, color, and number of scales and fin rays, is a derivative of *gracilis*. The rather widely joined branchiostegal membranes and the interrupted infraorbital canal, however, associate it with the *barratti-fusiformis* series. Whether it be placed as the derivative or cousin of *gracilis* or of *saludae* or even of *barratti*, or as a connecting form, it must have undergone independent specialization.

H. saludae and *H. collis* are specialized forms which might have been derived from the ancestors of either *gracilis* or *barratti*. Whatever their origin, they presumably came from a primitive stock as they possess some generalized features, especially the relatively low lateral line.

H. fusiformis is obviously a derivative of *barratti*, from which it deviates in a number of specialized features. It is the more primitive only in the number of infraorbital pores. *H. thermophilus* is intermediate between *barratti* and *fusiformis* in the reduction of squamation of the head region; like *fusiformis* in the shortness of the lateral line; extreme in slenderness of the body and in elevation of lateral line. *H. thermophilus* seems to be almost as specialized as even the extreme subspecies of *fusiformis*.

This comparison indicates that the specialized species of *Hololepis* also possess some primitive characters, that the several specialized types have contrasting primitive characters, and finally that the most generalized species are highly specialized in other respects. These circumstances lead to the conclusions that parallel evolution has frequently been operative in *Hololepis*; that several lines of evolution within the genus have been separate throughout most of the history of the group; that the evolution has followed the pattern of a bush rather than that of a tree; that only the more generalized ancestors have given rise to new lines. Thus these seemingly basic principles in the major phylogeny of animals seem applicable to differentiation within this small center of evolution.

The distribution of the various species (Pl. III) lines up well with these ideas of their possible phylogeny, and presents a fairly conventional picture.

The species of *Hololepis* differ more or less sharply in a number of meristic features. These involve the fin rays, the scales, and the pores of the lateral line system on the body and on the head. The ray, scale, and pore counts of the eight species, as well as certain divisions of some species, are given in Table II. The units of comparison in this table are as follows:

1. *Hololepis serrifer*—all material
2. *H. gracilis* (SW.)—Texas, Louisiana, Arkansas, Oklahoma
3. *H. gracilis* (SE.)—Mississippi, Alabama
4. *H. gracilis* (N.)—Illinois, Indiana
5. *H. zonifer*—all material
6. *H. saludae*—all material
7. *H. collis*—all material
8. *H. barratti*—nearly all material
9. *H. thermophilus*—all material
10. *H. f[usiformis] atraquae*—all material
11. *H. f. erochrous* (Del.)—Delaware Bay drainage basin
12. *H. f. erochrous* (coast)—New Jersey coastal waters

- 13. *H. f. erochrous* (Raritan)—Raritan River drainage basin
- 14. *H. f. fusiformis*—all material
- 15. *H. f. metae-gadi*—all material
- 16. *H. f. insulae*—all material

TABLE II

FREQUENCY DISTRIBUTION OF COUNTS OF MERISTIC CHARACTERS IN THE SEVERAL FORMS OF *HOLELEPIS*

	<i>Holelepis serrifer</i>	<i>H. gracilis</i> (SW.)	<i>H. gracilis</i> (SE.)	<i>H. gracilis</i> (N.)	<i>H. zonifer</i>	<i>H. saluda</i>	<i>H. collis</i>	<i>H. barratti</i>	<i>H. thermophilus</i>	<i>H. f. atraquae</i>	<i>H. f. erochrous</i> (Del.)	<i>H. f. erochrous</i> (coast)	<i>H. f. erochrous</i> (Raritan)	<i>H. f. fusiformis</i>	<i>H. f. metae-gadi</i>	<i>H. f. insulae</i>	
Dorsal spines	8	.....	.....	7	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	6
	9	9	5	86	2	11	2	8	6	3	1	4	9	2	5
	10	1	4	24	4	10	10	6	2	2	1	18	14
	11	17	5	1	1	2	6	3
	12	4	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	1	1	.....	.....
Dorsal soft rays	8	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....
	9	1	1	4	2	2	7	3	3
	10	4	1	29	1	6	6	5	7	3	4	12	9	5
	11	1	4	2	73	1	6	1	16	2	1	1	11	6	1
	12	10	1	2	9	2	2	3
	13	8
	14	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Scales above lateral line	2	.....	.....	.....	.....	.....	.....	10	8	2	1	3	.....	14	4	3
	3	11	10	3	30	4	5	4	9	3	11	7	2	23	37	12	7
	4	5	7	.....	4	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....
Scales below lateral line	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	7	.....	.....	.....	.....	.....	.....	.....	7	3	1	.....	14	11	.....	8
	8	.....	8	3	23	4	2	.....	9	13	9	3	13	21	12	3
	9	.....	3	.....	11	.....	6	1	9	.....	1	2	.....	1	8	5
	10	8	.....	.....	.....	.....	1	2	9	.....	.....	.....	.....	.....	.....	.....
	11	10	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
	12	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Transverse scale rows	37	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	40	.....	.....	.....	1	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
	41	.....	.....	.....	1	.....	2	1	.....	.....	.....	.....	.....	.....	.....	1
	42	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
	43	.....	.....	2	3	.....	3	.....	1	1	.....	.....	.....	.....	.....	1
	44	.....	.....	1	10	.....	1	2	.....	2	4	.....	.....	.....	.....	.....
	45	.....	.....	1	14	.....	3	1	.....	3	6	.....	.....	2	.....	2
	46	.....	.....	.....	21	.....	3	.....	1	9	1	6	.....	10	.....	3
	47	.....	.....	1	20	2	.....	1	1	3	7	4	1	.....	6	.....
	48	4	5	30	1	3	3	6	4	4	2	14	3

TABLE II

FREQUENCY DISTRIBUTION OF COUNTS OF MERISTIC CHARACTERS IN THE SEVERAL FORMS OF HOLOLEPIS (cont.)

	<i>Hololepis serrifer</i>	<i>H. gracilis</i> (SW.)	<i>H. gracilis</i> (SE.)	<i>H. gracilis</i> (N.)	<i>H. zonifer</i>	<i>H. saluda</i>	<i>H. collis</i>	<i>H. barratti</i>	<i>H. thermophilus</i>	<i>H. f. atraquae</i>	<i>H. f. erochrous</i> (Del.)	<i>H. f. erochrous</i> (coast)	<i>H. f. erochrous</i> (Raritan)	<i>H. f. fusiformis</i>	<i>H. f. metae-gadi</i>	<i>H. f. insulae</i>
.13*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	3	.....
.18	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	5	.....
.23	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	2	10	.....
.28	.....	.....	.....	.....	.....	.....	.....	.....	2	2	.....	.....	.....	11	23	1
.33	.....	1	.....	.....	.....	.....	.....	.....	4	17	2	.....	.....	20	14	3
.38	.....	2	.....	.....	.....	1	.....	.....	1	8	7	.....	2	19	14	3
.43	.....	1	.....	2	.....	1	1	1	3	6	8	5	9	8	.....	3
.48	.....	1	.....	8	3	1	.....	3	4	.....	3	3	4	7	.....	.....
.53	.....	1	.....	10	.....	2	.....	1	.....	.....	2	6	.....	.....	.....	.....
.58	.....	5	6	13	.....	2	1	3	.....	.....	2	1	.....	.....	.....	.....
.63	.....	3	1	26	.....	3	2	2	.....	.....	.....	.....	.....	.....	.....	.....
.68	.....	6	1	25	.....	2	.....	6	1	.....	.....	1	.....	.....	.....	.....
.73	.....	4	.....	29	.....	3	.....	6	1	.....	.....	.....	.....	.....	.....	.....
.78	.....	1	1	28	.....	.....	1	3	.....	.....	.....	.....	.....	.....	.....	.....
.83	.....	11	.....	20	.....	2	.....	5	.....	.....	.....	.....	.....	.....	.....	.....
.88	.....	1	.....	13	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
.93	.....	3	.....	13	.....	2	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
.98	1	.....	.....	14	.....	.....	.....	6	.....	.....	.....	.....	.....	.....	.....	.....
1.03	1	.....	.....	2	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
1.08	2	1	.....	1	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
1.13	3	.....	.....	2	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
1.18	.....	.....	.....	1	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....
1.23	3	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.28	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.33	2	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.38	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
1.43	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.58	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.73	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.78	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.83	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Ratio of pored to unpored scales

TABLE II
 FREQUENCY DISTRIBUTION OF COUNTS OF MERISTIC CHARACTERS IN THE SEVERAL FORMS OF
HOLELEPIS (cont.)

	<i>Holelepis serrifer</i>	<i>H. gracilis</i> (SW.)	<i>H. gracilis</i> (SE.)	<i>H. gracilis</i> (N.)	<i>H. zonifer</i>	<i>H. saladae</i>	<i>H. collis</i>	<i>H. barratti</i>	<i>H. thermophilus</i>	<i>H. f. atraquae</i>	<i>H. f. erochrous</i> (Del.)	<i>H. f. erochrous</i> (coast)	<i>H. f. erochrous</i> (Raritan)	<i>H. f. fusiformis</i>	<i>H. f. metae-gadi</i>	<i>H. f. insulae</i>
	4	.....	.....	.....	.....	8	5	160	.....	.....	.....	.....	3	6	.....	3
	5	.....	.....	.....	.....	22	1	24	24	36	20	9	20	60	22	18
	6	96	.....	1	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	7	6	1	29	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Infra-orbital canal; pores, condition, and arrangement	8	1	23	9	71	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	9	.....	1	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Complete Interrupted	103	25	10	103	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1+3	.....	.....	.....	.....	8	5	160	.....	.....	.....	.....	3	6	.....	3
	2+3	.....	.....	.....	.....	.....	.....	24	24	36	20	9	20	60	22	18
	1+4	.....	.....	.....	.....	22	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
	2+4	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	3+4	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Operculo-mandibular pores	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
	8	.....	.....	.....	.....	.....	.....	.....	1	6	13	.....	.....	4	2	1
	9	18	.....	.....	5	1	29	5	34	11	27	6	4	17	14	20
	10	.....	32	8	101	3	1	1	.....	.....	.....	.....	.....	.....	.....	.....
Interorbital pores	0	2	18	3	48	2	.....	3	140	21	18	8	5	21	62	33
	1	12	.....	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	2	30	.....	.....	1	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....
Supratemporal canal	Complete Incomplete	48	16	6	96	2	1	2	125	19	13	7	2	6	43	34
	.....	.....	.....	.....	1	.....	14	1	15	.....	5	1	.....	11	2	.....

* Each figure in this column represents the median of its class, thus .13 represents the .11-.15 class.

ANALYSIS OF THE SPECIES OF *HOLELEPIS*

The following analysis of the characters of the eight species referred to *Holelepis* makes use of most of the more trenchant, known characters. Differences in number of dorsal spines and soft rays, and of scales above, below, and in, the lateral line row, and the number of pored and of unpored scales in that row, and the ratio of pored to unpored scales, are not utilized

in the key, because they are adequately presented in Table II. Other good characters, especially those of color and coloration, body form, size of fins, size and shape of the genital papilla of the male, presence of breeding tubercles on the chin (known to occur only in *H. gracilis*), and habitat, are indicated in the descriptions of the species.

The subspecies of *H. fusiformis* are not analyzed in this key. Their characters are mostly given in Tables II and III.

- 1a.—Preopercle sharply and rather strongly serrate (serrations sometimes hidden by skin); genital papilla flattened, bilobate.
- 2a.—Operculomandibular pores 9 (constant); spots at base of caudal 4, the median 2 very intense and equally large and black, the outer pair small and faint.
- 3a.—Infraorbital canal complete; gill membranes rather broadly connected (distance from angle to tip of snout decidedly greater than half length of head).
- 4a.—Breast and nape well scaled; cheek scales exposed and strongly ctenoid, even ventrally in half-grown.
- 5a.—Parietals completely covered with ctenoid scales; lateral line usually extending to below middle of second dorsal, always beyond vertical from origin of second dorsal.
- 6a.—Interorbital covered with ctenoid scales; lateral line remaining high posteriorly, separated from origin of second dorsal by about one-third depth of body below lateral line (projection measurements).
- 7a.—Interorbital pores usually present, at least on one side; infraorbital pores 6 to 8, usually 6; supratemporal canal complete; body relatively deep. *H. serrifer*
- 1b.—Preopercle strictly entire; genital papilla conical (with basal enlargements in females of *gracilis* and *fusiformis*).
- 2b.—Operculomandibular pores 10 (rarely 9); spots at base of caudal 3, all usually faint, median one darkest.
- 3b.—Infraorbital canal complete; gill membranes narrowly connected (distance from angle to tip of snout about half length of head).
- 4b.—Breast scaleless; nape usually incompletely scaled, often scaleless in half-grown; cheek scales exposed and ctenoid, except ventrally in half-grown.
- 5b.—Parietals scaleless; lateral line usually extending to below anterior portion of second dorsal, occasionally not quite to below origin of second dorsal.
- 6b.—Interorbital scaleless; lateral line (its rudimentary extension) sloping downward posteriorly, separated from origin of second dorsal by about one-half depth of body below lateral line (projection measurements).
- 7b.—Interorbital pores absent (rarely present); infraorbital pores 6 to 9, usually 8; supratemporal canal almost constantly complete; body slender. *H. gracilis*
- 3c.—Infraorbital canal interrupted; gill membranes rather widely connected (distance from angle to tip of snout somewhat greater than half length of head).
- 4c.—Breast scaleless; nape largely scaleless (at least forward in half-grown); cheek scales exposed and ctenoid, except ventrally (in half-grown).

- 5c.—Parietals scaleless; lateral line extending to below posterior part of first dorsal.
- 6c.—Interorbital scaleless; lateral line (its rudimentary extension) sloping downward posteriorly, separated from origin of second dorsal by about one-half depth of body below lateral line (projection measurements).
- 7c.—Interorbital pores absent; infraorbital pores 2 + 4, occasionally 3 + 4; supratemporal canal complete; body slender. *H. zonifer*
- 2c.—Operculomandibular pores 9 (rarely 10 in *collis* and *saludae*; sometimes 8 in *thermophilus* and *fusiformis*); spots at base of caudal 3 with the median one intensified, or 4 (especially in *saludae* and *barratti*) with the upper one of the median pair more or less reduced in size and intensity and the lower median one often almost jet black.
- 3d.—Infraorbital canal interrupted; gill membranes rather broadly connected (distance from angle to tip of snout decidedly greater than half length of head).
- 4d.—Breast and nape scaleless or very nearly so; cheek scales embedded, cycloid.
- 5d.—Parietals scaleless; lateral line extending to below posterior part or end of first dorsal, or to slightly beyond vertical from origin of second dorsal.
- 6d.—Interorbital scaleless; lateral line or its rudimentary extension sloping downward rather steeply posteriorly from the moderately elevated anterior arch, separated from origin of second dorsal by two-thirds depth of body below lateral line (projection measurements).
- 7d.—Interorbital pores present; infraorbital pores 1 + 4, occasionally 1 + 3; supratemporal canal incomplete (rarely complete); body slender (?). *H. saludae*
- 7e.—Interorbital pores absent; infraorbital pores 1 + 3, rarely 1 + 4; supratemporal canal complete (2 specimens) or incomplete (1 specimen); body relatively deep. *H. collis*
- 4e.—Breast and nape well scaled; cheek scales exposed and strongly ctenoid, even ventrally in half-grown.
- 5e.—Parietals covered well toward or across median line with ctenoid scales; lateral line normally extending to below posterior half of first dorsal, sometimes nearly to below middle of second dorsal.
- 6e.—Interorbital well covered with ctenoid scales; lateral line remaining high posteriorly, separated from origin of second dorsal by about one-third depth of body below lateral line (projection measurements).
- 7f.—Interorbital pores absent; infraorbital pores 1 + 3, occasionally 2 + 3; supratemporal canal constantly complete; body slender. *H. barratti*
- 5f.—Parietals scaleless; lateral line usually ending below middle of first dorsal, rarely reaching vertical from origin of second dorsal.
- 6f.—Interorbital with several ctenoid scales; lateral line and rudimentary extension both high, the latter separated from origin of second dorsal by about one-third depth of body below extension (projection measurements).
- 7g.—Interorbital pores absent; infraorbital pores 2 + 3; supratemporal canal complete; body very slender. *H. thermophilus*

6g.—Interorbital scaleless, or with one or two more or less embedded scales; lateral line high but its rudimentary extension sloping downward, separated from origin of second dorsal by about one-half depth of body below extension (projection measurements).

7h.—Interorbital pores absent; infraorbital pores usually 2+3, often 1+3; supratemporal canal complete or incomplete; body slender.

H. fusiformis

Hololepis serrifer, NEW SPECIES

Plate I, Figure 2, and Plate II, Figure 3

Etheostoma quiescens *Jordan, 1890: 120 (Va. record); Boulenger, 1895: 75 (reference to Jordan, 1890, only).

Copelandellus quiescens Jordan and Evermann, 1896a: 1100 (in part); 1896b: 366 (in part); Smith, 1907: 269 (in part); Jordan, 2, 1905: 315 (in part); †Hildebrand, 1917: 177; Pratt, 1923: 136 (in part); Brimley and Mabee, 1925: 16 (records); Jordan, 1925: 530 (in part); Wright, 1926: 80 (Wilmington record only).

Copelandella quiescens Brimley, 1909: 130.

Not *Poecilichthys quiescens* Jordan, 1884b: 478.

(??) *Boleichthys fusiformis* Welch, 1916: 56 (S.C. record); Evermann, 1916: 80 (N. C. record).

Not *Boleosoma fusiforme* Girard, 1854: 41; identification very uncertain.

Hololepis barratti Jordan, 1929: 169 (in part); Jordan, Evermann, and Clark, 1930: 294 (in part).

Not *Boleosoma Barratti* Holbrook, 1855: 56.

* Indicates importance reference.

MATERIAL EXAMINED AND RECORDED¹

State, Drainage Basin, and Collection Data Reference; Museum No. (specimens)

VIRGINIA:

Chowan River drainage basin:

Blackwater R. at Zuni. Jordan, 1890: 120. Not seen.²
Specimens lost?

NORTH CAROLINA:

Roanoke River drainage basin:

Windsor, Bertie Co.; C. S. Brimley; Oct. 21, 1924. Brimley 230 (1); Mich. 107056 (2).
Williamston, Martin Co.; Brimley; Oct. 23, 1924. Mich. 107061 (1).
Jamesville, Martin Co.; Brimley; Oct. 23, 1924. Brimley 254 (2); Mich. 107065 (1).

Neuse River drainage basin:

Little R., Wendell, Wake Co.; C. S. Brimley and W. B. Mabee; Dec. 28, 1923. Brimley and Mabee, 1925: 16.
Brimley 213-214 (2); Mich. 107054 (2).

¹ Except as noted, all specimens listed have been examined by us.

² "Not seen" indicates that the specimens referred to have not been reexamined.

- Same locality; Brimley and Harris; Nov. 19, 1925. Mich. 107064 (1).
- Same locality; Brimley and Brady; Nov. 30, 1931. Mich. 94658 (2).
- Buffalo Cr., Wendell, Wake Co.; Brimley and Mabee; Nov. 30, 1923. Brimley and Mabee, 1925: 16.
Brimley 130 (1); Mich. 107060 (2).
- Same data; Mar. 30, 1925. Mich. 107062 (1).
- Same locality; Brimley and Harris; Nov. 19, 1925. Mich. 107053 (1).
- Buffalo Cr. near Archer, Johnston Co.; Brimley and Mabee; Nov. 26, 1923. Brimley and Mabee, 1925: 16.
Brimley 90-98 (5); Mich. 107063 (5).
- Lake Ellis drainage basin:
Lake Ellis, Craven Co.; Brimley. Smith, 1907: 269; Brimley, 1909: 30. Not seen.
- (Drainage basin?):
Vicinity of Beaufort. Hildebrand, 1917: 177. Not seen; species?
- Cape Fear River drainage basin:
Black R., Dunn, Harnett Co.; Brimley and Mabee; Nov. 19, 1923. Brimley and Mabee, 1925: 16.
Mich. 107066 (1).
- Mingo Cr., Cumberland-Sampson county line; Brimley and Mabee; Nov. 19, 1923. Brimley and Mabee, 1925: 16.
Brimley 301-304 (3); Mich. 107055 (3).
- Same data; Dec. 10, 1924. Brimley 30-33 (4); Mich. 107067 (3).
- Lillington, Harnett Co.; Brimley and Mabee; Dec. 11, 1923. Brimley and Mabee, 1925: 16.
Brimley 162-163 (2); Mich. 107059 (1).
- Upper Little R.; Bunlevel, Harnett Co.; Brimley and Mabee; Dec. 11, 1923. Brimley and Mabee, 1925: 16.
Mich. 107058 (1).
- Clinton, Sampson Co.; Brimley and Mabee, Nov. 20, 1923. Brimley 75 (1); Mich. 107057 (1).
- Lakeview, Moore Co.; R. E. Coker; June 12, 1926. Mich. 70705 (1).
- Same data; Nov. 11, 1934. Mich. 107073 (1).
- Wilmington; W. P. Seal. Smith, 1907: 269. U.S.N.M. 93132 (1), 93133 (2).
- Same locality; W. W. Welch; Dec. 26, 1916. U.S.N.M. 86163 (1).
- Peedee River drainage basin:
Lumbee R., between Blue's Bridge (near Pinebluff) and Turnpike Bridge. Evermann, 1916: 80. Specimens preserved?; species?
- SOUTH CAROLINA:
Peedee River drainage basin:

6 miles N. of Bennettsville, Marlboro Co.; E. M. Burton; July 25, 1934.	Charleston Mus. 34.215.1 (1).
Little Peedee R., between its junctions with Lumber [Lumbee] and Big Peedee rivers.	Welch, 1916: 15. Specimens pre- served?; species?
Santee River drainage basin:	
Cedar Cr., Leesville Road, Richland Co.; Bur- ton; Aug. 31, 1933.	Charleston Mus. 33.260.1 (2).
Old concrete dam near Wilson's Mill, Richland Co.; Burton; Aug. 31, 1933.	Charleston Mus. 33.264.1 (1).
Combahee River drainage basin:	
Little Salkehatchie R., 3.5 miles N. of Ehr- hardt, Bamberg Co.; Burton; July 11, 1934.	Charleston Mus. 34.179.1 (2); Mich. 107075 (2).
Little Salkehatchie R. near Bell's Crossroads, Colleton Co.; Burton; July 11, 1934.	Charleston Mus. 34.177.1 (2); Mich. 107074 (2).

Jordan's record (1890: 120) of *Etheostoma quiescens* from Zuni, Virginia, was almost certainly based on *Hololepis serrifer*. His description of the Virginia specimens (now lost?) corresponds well with *serrifer*, not with *barratti* (*quiescens*). The lack of agreement between the description of *Copelandellus quiescens* in *The Fishes of North and Middle America* (Jordan and Evermann, 1896a: 1100), and the original description of *Poecilichthys quiescens* (Jordan, 1884b: 478), to which Palmer and Wright (1920: 373) called attention, was caused by the combination of Jordan's respective accounts of the type material and of the Virginia specimens, in Jordan and Evermann's description. The Virginia record has frequently been quoted, or used as the basis for the extension of the range of *Copelandellus quiescens* (= *Hololepis barratti*) north of South Carolina.

Smith's (1907: 268) account of *Copelandellus quiescens* from North Carolina, quoting Seal, was based on both *H. serrifer* and *H. thermophilus*, as shown by a reëxamination of Seal's specimens. Smith mentions seeing only one of this series, almost certainly an example of *serrifer*. The North Carolina record of Smith (after Milligan) for *Boleichthys fusiformis* was probably based on *H. thermophilus*, though we can not be sure of this point because the specimens have not been restudied. Smith's descriptions and figures of both species were obviously taken from Jordan and Evermann.

HOLOTYPE.—Cat. No. 107053, Museum of Zoology, University of Michigan, an adult male 52 mm. in standard length, collected by C. S. Brimley and Mr. Harris in Buffalo Creek, Wendell, Wake County, North Carolina, November 19, 1925. All other specimens, indicated in the list above as examined, are designated as paratypes, varying in length from 27 to 50 mm.

Maximum size known, 52 mm. (standard length).

BODY.—Rather elongate, though relatively robust for a *Hololepis*.

HEAD.—Muzzle blunt; mouth terminal, somewhat oblique; lower jaw

slightly included. Preopercle sharply and rather strongly serrate along the vertical limb (the serrations often covered by skin). Gill membranes rather broadly connected (distance from tip of snout to angle of membranes markedly greater than half length of head).

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length, based, except as noted, on 8 specimens, 33 to 52 mm. in standard length).—Greatest depth (15 specimens) 18 to 21 (average 20); least depth 11 to 13 (11); length of caudal peduncle 26 to 29 (28); greatest width (7 specimens) 11 to 14 (12); width between lateral lines, below origin of first dorsal (7 specimens) 5 to 9 (7); length of head to opercular spine 22 to 28 (25); length of snout 4 to 5 (4); length of eye 7 to 8 (7); postorbital length 12 to 16 (13); width of head 9 to 11 (10); width of interorbital 4 to 5 (5); length of upper jaw 4 to 9 (7); distance from tip of snout to origin of dorsal fin 30 to 33 (31); highest dorsal spine 10 to 14 (12); highest dorsal soft-ray 13 to 17 (15); length of caudal fin 20 to 25 (22); distance from tip of snout to origin of anal fin 58 to 62 (60); length of anal base 11 to 14 (12); length of pectoral fin 24 to 29 (26); length of pelvic fin 21 to 26 (23).

GENITAL PAPILLA.—In the mature female without basal enlargements, flattened, widened toward the bilobed tip; with a plicate orifice on the ventral (anterior) side; slightly overlapping origin of anal fin. Genital papilla in mature male flattened, obtuse; with a tendency to become bilobate at tip; opening by a slit on ventral side; not quite reaching origin of anal fin. Papilla in non-breeding fish much smaller: that of the female flattened as in mature specimens, but not widened toward tip, appearing not unlike that of the breeding male; that of the non-breeding male very minute, almost indistinguishable.

BREEDING TUBERCLES.—Developed on the soft rays of the anal and pelvic fins in the mature male.

FIN RAYS.—Dorsal X to XII—11 to 14; anal, II, 6 to 7.

SCALE ROWS.—Three to 4—49 to 57—10 to 12.

LATERAL LINE.—Relatively long, longer than in other species (except in extreme variants of *barratti*), 40 to 46 (average 43) hundredths of the standard length; usually reaching to below middle of second dorsal fin, always beyond vertical from origin of second dorsal. Pored scales 26 to 32. Scales in lateral line row without pores 18 to 28, each with a shallow pit containing a minute papilla. Ratio of pored to unpored scales .98 to 1.83. Lateral line high throughout: its least separation from base of first dorsal less than one-fifth greatest depth below lateral line; its separation from origin of second dorsal about one-third depth below lateral line at that vertical (all these measurements on a projection basis). Scales above lateral line at origin of second dorsal 4, occasionally 4½.

SQUAMATION.—Breast and nape well scaled. Cheek scales exposed and strongly ctenoid, even ventrally in half-grown. Opercles covered with strongly ctenoid scales. Parietals and interorbitals covered with one continuous patch of ctenoid scales.

HEAD PORES.—Interorbital pores usually present on both sides, sometimes lacking on one or even on both sides. Infraorbital canal complete, superficial to embedded; with 6 to 8, usually 6 pores. Operculomandibular pores 9. Supratemporal canal constantly complete, that is with a single median pore (incomplete in one, possibly injured, specimen).

COLORATION.—Median portions of sides with a row of generally large and irregular dark blotches, usually confluent at some point and showing a strong tendency in many specimens to form a median stripe reticulated by irregular streaks invading from the light ground color. The first dark blotch typically distinct, located above tip of opercle, rather higher than the following blotches. Melanophores forming the lateral blotches usually large and more or less intertwined. Dark dorsal saddles occasionally developed: 1 just behind the occiput, 1 before the first dorsal fin, 3 or 4 beneath each dorsal, and 2 or 3 on the caudal peduncle. Upper sides with faint vermiculations, which in some specimens continue across the back, or connect the dorsal saddles with the lateral blotches. Light areas of sides above lateral line a monotone, with many small, evenly scattered chromatophores. Pored portion of lateral line marked by a narrow, often not very distinct light line. Base of caudal with a vertical row of 4 dark spots, the median 2 very intense and equally large and black, the outer pair small and faint. No dark bar behind pectoral base. Upper third of opercles dark; lower part of opercles and cheek light, with small dusky patches; lower mandibles and throat light. A dark line before and behind eye, the posterior one continuous with the dark opercular blotch; a dusky bar below eye; a weak bar above eye connected with its fellow across the interorbital, most conspicuous on the cornea. Parietal region little darker than nape.

Female with breast and belly light; sides below lateral blotches light, usually with small dark patches of large melanophores; ventral surface of caudal peduncle light; often with similar patches. Male not in nuptial coloration similar, but these dark patches absent on lower sides, and less prominent or lacking on the ventral surface of the caudal peduncle. Color pattern of the male as sharp as that of the female. The fins of the female and the non-nuptial male are similarly colored: both dorsals barred as usual in the genus, with the pigment confined to the rays; anal and pectorals clear, or faintly barred on rays only; pelvics clear.

Breeding male with belly, sides below lateral blotches, and ventral surface of caudal peduncle diffusely pigmented with many, very small, evenly distributed melanophores. These color cells smaller than the corresponding

ones in *H. barratti*. Breast speckled, with chromatophores larger than those on belly; the speckling often extended on throat, chin, and cheeks. Light areas of the body often with a dark grill outlining the scale pockets, formed of melanophores about as large as those on the breast; the grill pattern not becoming transformed into rows of blackish crescents. Spinous dorsal with a dark submarginal band; a light area below this; lower third to half of fin darker than the upper band and blackened forward; the barring largely obscured. Second dorsal speckled as well as barred. Anal and pelvic fins heavily speckled. Breeding female seemingly not modified in color.

Life colors:

Color dark brown, the pale parts chiefly bright red in life; back with some dark markings; side with a broad black lateral band, mottled and interspersed with red; an area of red along lateral line; some black spots on lower part of side; a black spot at base of pectoral; three black bars about eye; four black spots in a cross-series at base of caudal, the middle ones largest. Fins checkered; dorsal, anal, and caudal finely barred; ventrals, anal, and pectorals plain.

(Jordan, 1890: 120).

Breeding season is probably March, although the males develop fin tubercles and nuptial coloration as early as November. Late summer fish have the genital papilla shrunken, and the males at that time lack tubercles and high colors.

HABITAT.—The species is apparently generally distributed over the Coastal Plain up to the Fall Line, from extreme southeastern Virginia across North Carolina and most of South Carolina north of the Savannah River system. The habitat conditions under which it lives have been briefly indicated by Jordan (1890: 118), by Seal (in Smith, 1907: 269), and by Coker for 1 collection in North Carolina, and by Burton for 5 collections in South Carolina. These descriptions indicate the water inhabited as coffee-colored, but moderately to completely clear; the current none, slight, moderate, or swift; bottom, mud, mud and sand, sand, or mud and gravel; depth, 1 to 4 feet; vegetation, none, moderate, slight along edge, or heavy along edge, and otherwise.

Named *serrifer* in reference to the diagnostically serrate preopercle.

Hololepis gracilis (GIRARD)

Plate I, Figures 3 and 4, and Plate II, Figure 5

Boleosoma gracile *Girard, 1859: 103 (original description); Hay, 1881: 496 (comparison with *Vaillantia chlorosoma* = *Boleosoma camurum*).

Boleichthys gracilis Jordan, 1877c: 16, 18; 1878e: 440; Jordan, Evermann and Clark, 1930: 294.

Poecilichthys gracilis Jordan and Gilbert, 1883a: 521.

Etheostoma fusiforme gracile Jordan, 1890: 118.

- Boleichthys fusiformis gracilis* Jordan and Evermann, 1896a: 1102; Fowler, 1907b: 525.
- Boleichthys elegans* Jordan, 1878b: 43 (records for Union and Johnson cos., Ill.); Forbes, 1878: 75 (food); Jordan, 1878c: 362; Forbes, 1880: 24, 27 (food); 1884b: 95 (reprint of 1880 paper).
- Not *Boleichthys elegans* Girard, 1859: 104; nor Jordan, 1877b: 308.
- Boleichthys barratti* Jordan, 1880, 1884c: 405 (records for Texas and southern Ill., only).
- Poecilichthys barratti* Jordan and Gilbert, 1883a: 519 (in part); 1883b: 599 (*Poecilichthys butlerianus* as a synonym of *Poecilichthys barratti* only, not S. C. record).
- Etheostoma fusiforme barratti* Jordan, 1890: 118 (southern Ill., and diagnosis).
- Boleichthys fusiformis barratti* Jordan and Evermann, 1896a: 1102 (copied from Jordan, 1890).
- Not *Boleosoma Barratti* Holbrook, 1855: 56.
- Poecilichthys butlerianus* *Hay, 1882: 62 (original description); Hay, in Jordan and Gilbert, 1883a: 519.
- Poecilichthys palustris* *Gilbert, 1884: 209 (original description).
- Etheostoma fusiforme palustre* Jordan, 1890: 118.
- Boleichthys fusiformis palustris* Jordan and Evermann, 1896a: 1102; Fowler, 1907b: 525.
- Etheostoma fusiforme* Forbes, 1884a: 64, 88 (presence in southern Ill., synonymy); Jordan, 1885: 869 (in part); *Jordan and Gilbert, 1886: 9, 13, 17 (Ark., Okla., and Texas records, and synonymy); Jordan, 1888, 1891, 1894: 134 (in part); 1890: 165, 166, 167 (Ind. records, and synonymy); Meek, 1891: 137 (Ark. record); Woolman, 1892a: 262, 271, 274 (Ky. records); Eigenmann and Beeson, 1893: 105 (Ind. literature records); Garman, 1894: 40 (Woolman's Ky. records); Evermann and Kendall, 1894: 76, 81, 84, 88, 93, 115 (literature and original Texas records); Hay, 1894: 282 (Ind. literature records); Boulenger, 1895: 75 (in part); Eigenmann, 1896: 257 (not found in Turkey Lake, northern Ind.); Meek, 1896: 344, 348 (Ark., Okla., and Texas records).
- Boleichthys fusiformis* Jordan and Evermann, 1896a: 1101 (in part); 1896b: 366 (in part); Jordan, 1899, 1904, 1910, 1914, 1916a: 134 and 357 (in part); Jordan and Evermann, 1900: 3271, Pl. 177, Fig. 469; Large, 1902: 29 (Ill.); Eigenmann and Beeson, 1905: 155 (Ind. literature records, same as 1893); Fowler, 1906a: Pl. 47; Forbes, 1907: 291, map 15, Pl. 25 (ecology and distribution); Meek, 1908: 170 (southern Ind.); Forbes and Richardson, 1909, 1920: 315, map 98 (description and distribution); Forbes, 1909: 390, 401, 403, 417, 421, 425, 432 (ecology and distribution); Hankinson, 1913: 111 (Ill. record); Cockerell, 1913: 157 (scales); Evermann, 1918: 361, 368 (Woolman's Ky. records); Pratt, 1923: 136 (in part); Thompson and Hunt, 1930: 33, 45 (ecology, Champaign Co., Ill.); Fowler, 1933b: 62 (La. record).
- Hololepis fusiformis* Ortenburger and Hubbs, 1927: 137 (Okla. records); Jordan, 1929: 169 (in part); Thompson and Hunt, 1930: 98.
- Not *Boleosoma fusiforme* Girard, 1854: 41.
- Etheostoma iowae* Forbes and Richardson, 1909, 1920: 307 (Johnson Co., Ill., record only).

* Indicates importance reference.

MATERIAL EXAMINED AND RECORDED³

State, Drainage Basin, and Collection Data Reference; Museum No. (specimens)

INDIANA:

Ohio River drainage basin:

- Great Pigeon Cr., headwaters near Elberfeld coal mine; H. R. Becker; Aug. 20, 1927. Mich. 81406 (16).
Cypress swamp, 5 miles E. of Mount Vernon, Posey Co. Jordan, 1890: 166. U.S.N.M. 40772 (2).

Wabash River drainage basin:

- Wabash R. and tributaries at Terre Haute, Vigo Co. Jordan, 1890: 167. U.S.N.M. 40877 (1).
Switz City Swamp, Green Co.; C. H. Gilbert; Aug., 1883. Gilbert, 1884: 209. U.S.N.M. 34983 (1).
Patoka R., Patoka, Gibson Co.; Becker; Aug. 20, 1927. Mich. 81382 (5).
Gibson Co. (one specimen, at least, from Foote's Lake); Becker and Sager; Aug., 1924. British Museum < Mich. 65050 (3).
Wabash R., "Old Dam" at New Harmony, Posey Co. Jordan, 1890: 165. U.S.N.M. 40915 (1).
Same locality; Becker; Aug. 20, 1927. Mich. 81342 (4).
Wabash R. near Mackey's Ferry; Becker; Aug. 20, 1927. Mich. 81427 (4).
Big Cr., Lynn Township, Posey Co. Jordan, 1890: 165. U.S.N.M. 40958 (6).

ILLINOIS:

Wabash River drainage basin:

- Embarrass R. near Charleston, Coles Co. Hankinson, 1913: 111. Not seen.⁴
Panther Cr., Jasper Co.; S. A. Forbes; Sept. 27, 1900. Ill. 28069 (5).
Little Muddy Cr., Clay Co.; Forbes; Sept. 29, 1900. Ill. 28077 (1).
Little Fox R. near Olney, Richland Co.; Large and Wright; Sept. 29, 1900. Ill. 28075 (2).
Little Fox R., White Co.; Juday; April 28, 1900. Ill. 28051 (1).
French Cr. near Grayville, White Co.; Juday; April 28, 1900. Ill. 28052 (1).
Black Lane Br. of Little Wabash R., Carmi; Forbes; Dec. 20, 1932. Ill. 26346 (1).
Auxier Cr., Hamilton Co.; Forbes; Oct. 3, 1900. Ill. 28089 (1).
South Fork of Saline R., Saline Co.; Forbes; Oct. 8, 1900. Ill. 28102 (10).

³ Except as noted, all specimens listed have been examined by us.⁴ "Not seen" indicates that the specimens referred to have not been reexamined.

- Sugar Cr., Creal Springs, Williamson Co.;
Forbes; Oct. 16, 1900. Ill. 28123 (1).
- Ohio River drainage basin:
- Vienna, Johnson Co.; Forbes; Dec. 15, 1892. Ill. 28264 (5).
Dutchman's Cr. near Vienna. Forbes and Richardson, 1909,
1920: 307. Ill. 26340 (10).
- Outlet of Allard L., Brookport, Massac Co.;
D. H. Thompson; Mar. 23, 1930. Ill. 1905 (1).
- Muddy Cr., Brookport; Thompson; Mar. 21,
1930. Ill. 1910 (6).
- Seven-mile Cr. at old Brookport-Metropolis
road bridge; Thompson; Mar. 29, 1930. Ill. 1912 (7).
- Seven-mile Cr. at Route 45 bridge, Brookport;
Thompson; April 7, 1930. Ill. 1926 (5).
- Four-mile Cr. at Route 45 bridge, Brookport;
Thompson; April 30, 1930. Ill. 1927 (10).
- Illinois River drainage basin:
- Wild Cat Slough, 2 miles S. of Fisher, Cham-
paign Co.; Thompson; Aug. 23, 1928. Thompson and Hunt, 1930: 33.
Ill. 1174 (1).
- Bear Cr., N. of Palver, Christian Co., Large
and Wright; Oct. 27, 1900. Ill. 28160 (1).
- Kaskaskia River drainage basin:
- Big Cr., Fayette Co.; Large; Nov. 24, 1899. Ill. 26024 (1).
- Kaskaskia R., Vandalia, Fayette Co., Forbes;
Nov. 25, 1899. Ill. 26026 (3).
- Kaskaskia R., trib. from old Reilly Lake;
Thompson; Mar. 11, 1930. Ill. 1901 (8).
- Mississippi River drainage basin (south of the Kaskaskia):
- Crab Orchard Cr., Williamson Co.; Forbes;
Oct. 16, 1900. Ill. 28125 (1).
- Makanda, Jackson Co.; T. L. Hankinson;
July 3, 1905. Mich. 107048 (32).
- Clear Cr., Union Co.; Forbes; July 16, 1877. Ill. 4 (3); M.C.Z. 25049 (1);
U.S.N.M. 26300 (1).
- Drainage basin?:
- Anderson's Branch of Clear Cr.; July 18,
1883. Ill. 1334 (5).
- "Fish from various sources, data lost." Ill. 26423 (17).
- KENTUCKY:**
- Ohio River drainage basin:
- Tradewater R. at Dawson. Woolman, 1892a: 262; Garman,
1894: 40; Evermann, 1918:
361. U.S.N.M. 63782 (1).

- Mississippi River drainage basin:
- Mayfield Cr. at Hickory Grove. Woolman, 1892a: 271; Garman, 1894: 40; Evermann, 1918: 361. U.S.N.M. 63783 (1).
- Bayou de Chien near Moscow. Woolman, 1892a: 274; Garman, 1894: 40; Evermann, 1918: 361. Not seen.
- ARKANSAS:
- Mississippi River drainage basin:
- Mississippi R. or bayous opposite Memphis, Tenn. Hay, 1882: 62. U.S.N.M. 32179 (1).
- St. Francis River drainage basin:
- Old R. at Buckhorn Landing near Greenway, Clay Co. Meek, 1896: 348. Not seen.
- Eight-mile Cr. near Paragould, Greene Co. Meek, 1896: 348. Not seen.
- St. Francis R. near Big Bay. Meek, 1896: 348. Not seen.
- Little and St. Francis R. near Marked Tree. Meek, 1896: 348. Not seen.
- "St. Francisco R., Ark.," probably one of collections just cited. Cockerell, 1913: 157.
- White River drainage basin:
- Little Red R. at Judsonia, White Co. Meek, 1891: 137. Not seen.
- Arkansas River drainage basin:
- Lee's Cr., trib. of Arkansas R., Crawford Co. Jordan and Gilbert, 1886: 9. U.S.N.M. 36400 (in part, but only 1 specimen extant).
- Ouachita [Washita] River drainage basin.
- Saline R. at Benton, Saline Co. Jordan and Gilbert, 1886: 13. U.S.N.M. 36470 (6).
- Pools of Washita R. at Arkadelphia, Clark Co. Jordan and Gilbert, 1886: 13. U.S.N.M. 36415.
- OKLAHOMA:
- Arkansas River drainage basin:
- Deep Fork of Canadian R., 1 mile W. of Okmulgee, Okmulgee Co.; A. Trowbridge and E. Strode; March 25, 1932. Mich. 107052 (2).
- Poteau R. near Heavener, LeFlore Co.; Univ. of Oklahoma; June 16, 1934. Okla. P-34-9 (1).
- Poteau R. at Slate Ford, W. of Hackett, Ark. Jordan and Gilbert, 1886: 9. U.S.N.M. 36400 (in part, but only 1 specimen now extant).
- Red River drainage basin:
- Kiamichi R. and Walnut Cr. at Kiamichi, Pushmataha Co. Meek, 1896: 344. Not seen.
- Kiamichi R., 4 miles E. of Tuskahoma, Pushmataha Co. Ortenburger and Hubbs, 1927: 137. Okla. 6075 (1).

- Mountain Fork R., 10 mi. SE. of Broken Bow,
McCurtain Co. Ortenburger and Hubbs, 1927:
137. Okla. 6076 (1); Mich.
73086 (1).
- TEXAS:
- Red River drainage basin:
Red R. and bayous near Arthur, Lamar Co. Meek, 1896: 344. Not seen.
- Neches River drainage basin:
Neches R., 14 miles E. of Palestine, Ander-
son Co. Evermann and Kendall, 1894:
115. U.S.N.M. 46257 (1).
- Trinity River drainage basin:
Spring trib. to Trinity R., N. of Dallas. Jordan and Gilbert, 1886: 17.
U.S.N.M. 36541 (1).
- Galveston Bay drainage basin:
Buffalo Bayou at Houston. Evermann and Kendall, 1894:
115. Not seen.
- Sims Bayou near Houston. Evermann and Kendall, 1894:
115. U.S.N.M. 46256 (4);
M.C.Z. ————— (2); Mich.
86325 (1).
- Hunter Cr. near Houston. Evermann and Kendall, 1894:
115. Not seen.
- Nueces River drainage basin:
Rio Seco near Fort Inge; Dr. Kennerly. Girard, 1859: 103. U.S.N.M.
1328 (1); M.C.Z. 113 (1).
- Leona R. near Fort Inge; Dr. Kennerly. Girard, 1859: 103. U.S.N.M.
1329 (1).
- LOUISIANA:
- Calcasieu River drainage basin:
Lake Charles, Calcasieu Parish. Fowler, 1933b: 62. Not seen.
- Red River drainage basin:
Trib. to Dugdemonna Bayou, 2 miles N. of
Dodson, Winn Parish; D. J. Ameel, E. P.
Creaser, and L. R. Hedrick; May 29, 1932. Mich. 107049 (1).
- MISSISSIPPI:
- Mississippi River drainage basin:
Pool along Big Black R., Vaughan's Station,
Yazoo Co.; O. P. Hay; Aug. 20, 1881. Hay, 1882: 62; Jordan and
Gilbert, 1883: 519. U.S.N.M.
32224 (1).
- Pearl River drainage basin:
Bogue Chitto, 3 miles S. of Brookhaven, Lin-
coln Co.; Ameel, Creaser, Hedrick; May 31,
1932. Mich. 107050 (3).

ALABAMA:

Tombigbee River drainage basin:

Yellow Hell Cr., 7 miles SW. of Vernon,
Lamar Co.; Ameel, Creaser, Hedrick; June
3, 1932.

Mich. 107051 (1).

As indicated in the preceding synonymy, this very distinct species, though rather frequently encountered by ichthyologists, has seldom been recognized as such. It was for a time confused by Jordan with *H. barratti*, but was generally confounded by him and followers with *H. fusiformis*. Its specific distinctness from those species is indicated by the analysis on pp. 29 to 31.

H. gracilis has also been confounded with two species of *Poecilichthys*. Illinois specimens of *gracilis* were identified as *Boleichthys elegans* Girard by Jordan and by Forbes from 1878 to 1884. Thereafter the name *elegans* was largely forgotten; it was scarcely mentioned in *The Fishes of North and Middle America* (1896). It now develops that the types of *Boleichthys elegans* Girard represent some form of the *Poecilichthys coeruleus* group (see Hubbs and Ortenburger, 1929: 104). Prior to confusing *elegans* with the *Hololepis* group, Jordan (1877b: 308) identified as *Boleichthys elegans* some Georgia darters which were probably the same ones more recently identified by Fowler (1923: 26) as *Poecilichthys jessiae*. Jordan also gave this Georgia record for *B. elegans* in several other papers of about the same date: Jordan, in Nelson, 1876: 34; Jordan and Copeland, 1876: 163; Jordan, 1878e: 440; Jordan and Brayton, 1878: 45.

This species has also been confused with *Poecilichthys exilis*. It has apparently been identified with *Etheostoma iowae* (= *Poecilichthys exilis*) only once: Forbes and Richardson's record of *E. iowae* (1909 and 1920: 307) from Johnson County in southern Illinois proves on reëxamination to have been based on a mixed series of *Hololepis gracilis* and *Boleosoma camurum*. This was the only record of *P. exilis* from within the true range of any species of *Hololepis*. The several records by Forbes and Richardson (*l.c.*, and map 98) of *B. fusiformis* from northern Illinois, that is within the range of *P. exilis*, prove on a reëxamination of the material to have been based on *P. exilis* (these misidentified specimens which we have re-identified came from Fox River at McHenry; Cedar and Sand Lakes, Lake County; Plano, Kendall Co.; and "northern Illinois"). Therefore the ranges of *Poecilichthys exilis* and *Hololepis gracilis* in Illinois prove to be entirely complementary.

Poecilichthys exilis has been recorded, rather frequently, from numerous northern localities under the name of *Etheostoma fusiforme* or *Boleichthys fusiformis*, or of *Boleichthys eos*, which, though a clear synonym of *exilis*, was long regarded as a synonym or "variety" of *B. fusiformis* (see Hubbs,

1926: 64). Northern records of *Boleichthys fusiformis* which undoubtedly refer to *P. exilis*, and which were not indicated in our 1926 synonymy, include: Cox, 1896: 610 (Minnesota); Dymond, 1922: 71 (Lake Erie); and Cahn, 1927: 56 (Wisconsin).

The untangling of this synonymy has disclosed that *Poecilichthys exilis* and *Hololepis gracilis* are complementary in distribution, in general as well as in Illinois. The northern limits for *gracilis* are indicated in the preceding list of material and on our map (Pl. III). The southern limits for *Poecilichthys exilis* are: northern Ohio (Turner, 1921: 50, as *Boleichthys fusiformis*), northern Indiana (several authors, including Blatchley, 1901: 257 and 258, have reported both *Etheostoma iowae* and *Boleichthys (sic) fusiformis* from Lake Maxinkuckee, from which, however, Evermann and Clark, 1920: 442, report only *Etheostoma iowae*); Marais des Cygnes, Kansas (one specimen in National Museum, No. 1830, collected by Dr. Hoy; records for this locality of *Etheostoma fusiforme* by Graham, 1885: 76, and of *Boleichthys fusiformis* by Evermann and Cox, 1896: 366 and 423, probably refer also to *P. exilis*); the upland of northern Arkansas (Meek, 1894: 80, as *Etheostoma iowae*; specimens reexamined), and Colorado (Jaffa, 1917: 71, as *E. iowae*). There is some indication that *P. exilis* toward the south is represented by a distinct subspecies or perhaps species, but that question does not concern us now. In connection with the confusion of *Hololepis gracilis* with *Poecilichthys exilis*, it may be pointed out that Forbes and Richardson's figure for *Microperca punctulata* (1909 and 1920: 317, Fig. 76) was obviously based on *P. exilis*.

Poecilichthys palustris, along with *Boleosoma gracile*, has generally been synonymized with *Etheostoma fusiforme* (or *Boleichthys fusiformis*). Examination of the type shows, as would be expected, that it is referable to *Hololepis gracilis*; it has the scales 23 + 30 (24 + 27 on right side); the lateral line extending to below end of first or origin of second dorsal; the infra-orbital canal complete with 7 (8) pores, and other characters as in *gracilis*.

Poecilichthys butlerianus, although synonymized with *H. barratti* by Jordan and Gilbert (1883b: 599), is also clearly a synonym of *H. gracilis*. It may represent a southeastern race with relatively larger scales than in typical *gracilis* from the Southwest (see Table II). These two races are not recognized, however, because northern specimens bridge over the gap. The holotype of *butlerianus* has IX—12 dorsal rays; II, 6 anal rays; 16 + 26 scales (17 + 26 on right side); 3 above and 8 below lateral line; lateral line extending to vertical between last dorsal spine and end of first dorsal base; supratemporal canal with one median pore; no interorbital pores; infra-orbital canal complete, with 8 (9) pores; operculomandibular pores 10 (10).

The lectotype of *Boleosoma gracile* has X dorsal spines; scales 19 + 32 (23 + 28 on right side); 3 above and 9 below lateral line; lateral line extend-

ing to below end of first dorsal (or beginning of second); head pores as usual in species; infraorbital canal complete, with 8 pores. The cotype of *B. gracile* from Rio Leona has X dorsal spines; scales 19 + 35 (24 + 32 on right side); head pores as usual; infraorbital canal complete.

Lectotype of *Boleosoma gracile*, selected by us, is Cat. No. 1328, United States National Museum, an adult 35 mm. in standard length, from Rio Seco, near Fort Inge, Texas, collected by Dr. Kennerly. Two other cotypes seem to be extant: one, Cat. No. 113, Museum of Comparative Zoology, from the lectotype locality; the other, Cat. No. 1329, United States National Museum, from Leona River, near Fort Inge, Texas, also collected by Dr. Kennerly. Holotype of *Poecilichthys butlerianus*, as originally indicated, is Cat. No. 32224, United States National Museum, an adult 43 mm. in standard length; from a pool along Big Black River, near Vaughan's Station, Yazoo County, Mississippi. The smaller specimen mentioned by Hay is apparently not to be regarded as a paratype. Lectotype of *Poecilichthys palustris*, selected by us, is Cat. No. 34983, United States National Museum, an adult specimen from Switz City Swamp, Indiana (we have not seen the second cotype mentioned by Gilbert).

Maximum size known, 45 mm. (standard length).

BODY.—Elongate, somewhat compressed.

HEAD.—Muzzle rather blunt; mouth subterminal, slightly oblique; lower jaw slightly included. Preopercle smooth. Gill membranes slightly connected (more so than in *Villora edwini*, less so than in any other species of *Hololepis*); distance from tip of snout to angle of membranes about one-half length of head; in some slightly less, in others slightly more.

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length; based, except as noted, on 5 specimens, 30 to 42 mm. in standard length).—Greatest depth (12 specimens) 17 to 21 (average 18); least depth (12 specimens) 7 to 11 (10); length of caudal peduncle (12 specimens) 28 to 29 (28); greatest width 12 to 15 (14); width between lateral lines, below origin of first dorsal 9 to 11 (11); length of head to opercular spine (10 specimens) 23 to 29 (26); length of snout (9 specimens) 4 to 7 (5); length of eye (8 specimens) 6 to 8 (7); post-orbital length (8 specimens) 13 to 15 (14); width of head 8 to 10 (10); width of interorbital 4 to 6 (5); length of upper jaw (8 specimens) 5 to 8 (6.5); distance from tip of snout to origin of dorsal fin 32 to 34 (32); highest dorsal spine 13 to 14 (14); highest dorsal soft-ray 11 to 16 (14); length of caudal fin 17 to 22 (20); distance from tip of snout to origin of anal fin 59 to 62 (61); length of anal base 10 to 12 (11); length of pectoral fin (12 specimens) 18 to 25 (22); length of pelvic fin (12 specimens) 16 to 20 (19).

GENITAL PAPILLA.—In the mature female subconical, with prominent

hemispherical enlargements, set off by a shallow groove, at posterior base of papilla; opening in a vertical slit, widened basally, on the flattened upper half of the ventral (anterior) side; base of papilla occupying entire space between anus and origin of anal fin; in actually breeding female, turgid, held out at an angle to body, 1.5 mm. long in a 35 mm. fish. Genital papilla of the male minute, not reaching origin of anal fin; spatulate, flattened dorsoventrally, widened toward tip, opening by a pore on the ventral (anterior) side near tip; not held out at an angle to body. Papilla of female during the summer months shrunken, reaching only about half way to origin of anal fin; appressed to body; basal enlargements completely retracted; opening still slit-like. Papilla of summer male little shrunken, about as long though only about half as wide as in the summer female.

BREEDING TUBERCLES.—Developed on distal parts of the soft rays of the anal and pelvic fins in breeding male. Tubercles also developed, in this species, near the tip of the lower jaw: about 3 on each ramus, all very low and rounded, 0.25 mm. in diameter, often slightly fused.

FIN RAYS.—Dorsal, VIII to X—9 to 12; anal, II, 7.

SCALE ROWS.—Three to 4—40 to 56—7 to 9.

LATERAL LINE.—Moderately long for a species of *Hololepis*, 26 to 35 (average 32) hundredths of the standard length; usually extending to below anterior portion of second dorsal fin, occasionally not quite to below origin of second dorsal. Pored scales 7 to 27, seldom fewer than 15. Scales in lateral line row without pores 20 to 38, seldom more than 34, each with a shallow pit containing a minute papilla. Ratio of pored to unpored scales .16 to 1.35, usually .50 to 1.00. Lateral line, including its rudimentary extension, strongly elevated anteriorly but very definitely sloping downward posteriorly: its least separation from base of first dorsal fin less than one-fifth greatest depth below lateral line; its separation from origin of second dorsal about one-half depth below lateral line at that vertical (all these measurements on a projection basis). Scales above lateral line at origin of second dorsal 4 or 5.

SQUAMATION.—Breast scaleless (often with a few embedded scales laterally). Scales in area between pelvic bases often embedded. Nape usually incompletely scaled, often scaleless in half-grown. Cheek scales exposed and ctenoid, except ventrally in half-grown. Opercles covered with ctenoid scales. Parietals, except for occasional embedded scales on anterolateral edges, and interorbital completely scaleless.

HEAD PORES.—Interorbital pores typically lacking, rarely developed on one or even on both sides. Infraorbital canal invariably complete, embedded; with 6 to 9, usually 8 pores. Operculomandibular pores 10, rarely 9. Supratemporal canal almost constantly complete, that is with a single median pore.

COLORATION.—Very variable. Midlateral rectangular blotches, about 9 in number, distinctly evident in some specimens but more often obscure, especially forward, where light and dark lines, oblique to longitudinal and more or less zigzag, sometimes cover the median and upper sides. Back either a more or less even monotone, or crossed by about 9 dark saddles: 1 just behind the occiput, 1 before first dorsal fin, 2 or 3 beneath each dorsal fin, and 2 on the caudal peduncle. Melanophores forming the dark markings of sides and back large, more or less intertwined. The dark markings occasionally showing a cross-stitch pattern, more often not. Pored portion of lateral line marked by a narrow light line. Base of caudal with a vertical row of 3 spots, all usually faint and the outer ones often scarcely discernible (the median one rarely blackish). No dark bar behind base of pectoral. Opercles light, with the usual exception of a dark patch before the opercular spine; cheeks and mandibles light; all 3 areas speckled with medium-sized chromatophores. Four dark lines radiating outward from eye: 2 vertical and 2 horizontal; bar below eye usually weak; the one behind eye short, not extending on opercle; the pigment extending on the cornea, especially from the dorsal bar.

Female with the throat, breast, belly, and adjacent sides light, rarely with small, sparse chromatophores, which are larger than those on the same parts of the male, but smaller than those forming the specks on the cheek. Non-breeding male with throat and breast light, or marked by a few specks retained from the breeding colors; belly and sides directly above diffusely pigmented by very small, evenly scattered melanophores. Dark lateral blotches in male frequently elongated vertically, separated by sharper light areas than in the female. Lower portion of caudal peduncles in both sexes light, with or without extensions of the pattern of the sides. Dorsal fins of non-breeding male with a trace of the colors of the breeding male, and with only about as much dark pigment as in breeding female. First dorsal in non-breeding female almost clear; the second dorsal slightly barred, with pigment largely confined to the rays. Anal and pelvic fins similar in the two sexes, clear. Pectoral fin clear throughout, or distal portions of rays outlined by fine dark lines.

Breeding male with breast and throat speckled by melanophores, which are slightly larger than those on the belly, but considerably smaller than those on the cheeks. Body without grill pattern. Spinous dorsal distinctively colored, with a dark submarginal band, which becomes wider and darker posteriorly; below this a red band of equal width (opaque white in preserved specimens), consisting of oblique bars anteriorly and of squarish spots as wide as membranes posteriorly; lower half of fin black, broken by clear triangular areas behind base of each spine; spines clear, without bars. Second dorsal barred across rays and membranes; the uppermost band

widest. Anal and pelvic fins speckled. Breeding female showing to some degree the peculiar colors of the dorsal fin of the breeding male.

Life colors of (presumably) non-breeding males, the types of *Poecilichthys palustris* taken in last week of August:

Olivaceous, much mottled with brownish; 11 or 12 cross-blotches of bright green on back and an equal number on middle of sides the two series separated by a light streak along the lateral line; belly, dusky. Cheeks dusky greenish with a black blotch below the eye. Membrane of spinous dorsal mostly black on basal half, above this a translucent streak, then a yellowish-red series of spots. Second dorsal and caudal marked with dusky. In spirits the green blotches on sides appear blackish. (Gilbert, 1884: 209.)

"The spinous dorsal in life usually bright blue, with a median crimson band" (Jordan and Evermann, 1896a: 1103).

Breeding season in Illinois late March and April. Females at that time become distended with eggs to twice their normal width. Mature eggs 1.0 mm. in diameter.

HABITAT.—Forbes (1907 and 1909) and Forbes and Richardson (1909 and 1920) have probably indicated with essential correctness the habitat of this species, although their statement is perhaps not strictly accurate, and is certainly not fully trustworthy, because these authors confounded *Poecilichthys exilis* and *Holelepis gracilis* (see p. 42). The two species, however, appear to select similarly lenitic habitats, *exilis* in cooler and *gracilis* in warmer waters.

H. gracilis is a species of the lowlands of the Mississippi basin, extending into upland areas only along river valleys. It occurs chiefly in swamps, lakes, flood pools, and sluggish streams, though it sometimes inhabits swift water where plant beds provide shelter. It probably seldom straggles into a typical darter habitat. Ecological data accompanying a number of series in the Museum of Zoology indicate the usual conditions as: water, muddy to slightly muddy; current, none to swift; bottom, muddy, muddy and gravelly, soil, shaly, rocky; depth, shallow; vegetation, none, very little, grass, algae along edges, sedges along edges, a few water lilies, and otherwise.

The name *gracilis* refers to the slender body.

Holelepis zonifër, NEW SPECIES

Plate I, Figure 5, and Plate II, Figure 6

MATERIAL EXAMINED AND RECORDED

State, Drainage Basin, and Collection Data	Museum No. (specimens)
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ALABAMA:

Alabama River drainage basin:

Pools of Catoma Cr., 5 miles SW. of Montgomery; E. P. Creaser and H. R. Becker;
Sept. 18, 1929.

Mich. 88803 (1).

Pools of Big Swamp Cr., 25 miles SW. of Montgomery, Lowndes Co.; Creaser and Becker; Sept. 18, 1929.

Mich. 88822 (1).

HOLOTYPE.—Cat. No. 88803, Museum of Zoology, University of Michigan, a female specimen 31 mm. in standard length, with data cited on p. 47. The other specimen, listed above, a female 26 mm. long, is the sole paratype.

BODY.—Elongate, somewhat compressed.

HEAD.—Muzzle rather blunt; mouth subterminal, slightly oblique; lower jaw slightly included. Preopercle strictly entire. Gill membranes rather widely connected (distance from angle of membranes to tip of snout somewhat greater than half length of head).

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length; based, except as noted, on 2 specimens, 26 to 31 mm. in standard length).—Greatest depth 17 to 19 (average 18); least depth 11 to 12 (11); length of caudal peduncle 31; greatest width 11 to 12 (12); width between lateral lines, below origin of first dorsal 7 to 8 (8); length of head to opercular spine 24 to 26 (25); length of snout 3 to 4 (4); length of eye 6 to 8 (7); postorbital length 14 to 15 (15); width of head (1 specimen) 10; width of interorbital (1 specimen) 4; length of upper jaw 7; distance from tip of snout to origin of dorsal fin 32; highest dorsal spine (1 specimen) 14; highest dorsal soft-ray (1 specimen) 15; length of caudal fin (1 specimen) 22; distance from tip of snout to origin of anal fin 60 to 61 (60); length of anal base (1 specimen) 10; length of pectoral fin 22 to 24 (23); length of pelvic fin 18 to 20 (19).

GENITAL PAPILLA.—In immature female small, appressed to body, with a slit-like opening on the ventral (anterior) side; in adult probably more or less similar to that of *H. gracilis*.

FIN RAYS.—Dorsal, IX—10 to 11; anal, II, 7.

SCALE ROWS.—Three—47 to 49—8.

LATERAL LINE.—Almost as long as usual in *gracilis*, 27 to 29 hundredths of the standard length; reaching to posterior part of first dorsal. Pored scales 15 to 18. Scales in same row without pores 29 to 32; each with a shallow pit containing an obscure papilla. Ratio of pored to unpored scales .47 to .49. Lateral line, including its rudimentary extension, markedly elevated anteriorly, but very definitely sloping downward posteriorly: its least separation from base of first dorsal fin less than one-fifth the greatest depth below lateral line; its separation from origin of second about one-half depth below lateral line at that vertical (all these measurements on a projection basis). Scales above lateral line, or its rudimentary extension, at origin of second dorsal 4 to 5.

SQUAMATION.—Breast devoid of scales. Nape usually scaleless, at least forward in half-grown. Cheek scales exposed and ctenoid, except ventrally (in half-grown). Opercles covered with ctenoid scales. Parietals and interorbital scaleless.

HEAD PORES.—Interorbital pores lacking. Infraorbital canal interrupted, superficial to embedded; with 2 pores behind the break (3 on one side of one specimen) and 4 above the upper jaw. Operculomandibular pores, 9 (one side) or 10 (3 sides). Supratemporal canal complete, with a single median pore.

COLORATION.—Posterior sides (behind anus) marked by about 4 well defined, vertical, dark bars; anterior sides with several rather obscure rectangular blotches, irregularly disrupted into oblique to longitudinal, more or less zigzag lines, extending on the upper sides. Small dark patches connecting the posterior bars along the mid-line of the sides. Other small dark patches, involving 3 or 4 scales, on lower sides of caudal peduncle, alternating with the bars. Back with about 9 dark saddles: 1 just behind occiput, 1 before first dorsal fin, 2 or 3 beneath each dorsal fin and 1 or 2 on the caudal peduncle. Posterior saddles in part joined with bars, with or without a dislocation; in part separate and alternating. Chromatophores forming the dark areas of body large, more or less intertwined. Dark areas with cross-stitch pattern more or less evident. Pored portion of lateral line marked by a light streak. Base of caudal with a vertical row of 3 spots, the median one darkest but hardly black, the outer ones indistinct. No dark bar behind base of pectoral. Opercles, except for a dark blotch near upper edge, cheeks, and mandibles light, sparsely speckled with medium-sized melanophores. Four dark lines radiating from eye, 2 vertical and 2 horizontal; the bar below eye as conspicuous as any; line behind eye short, not reaching opercle; the bars extending on the cornea, especially from above. Parietal region darker than the ground color of the nape.

Non-breeding female with throat, breast, belly, and adjacent sides light. Spinous dorsal with a narrow, submarginal, dark band, outside a light band made up of an oblique oval, orange-red in fresh specimens, on each inter-spinous membrane; lower half of fin darkened, especially forward. Second dorsal fin barred across membranes as well as rays. Caudal fin strongly barred. Anal fin mostly plain, with a little pigment at the base of the rays. Pelvics clear. Pectorals clear, or with fine dark lines outlining the rays distally.

HABITAT.—This species is probably restricted to a small range in the central part of the Alabama River system. The water conditions at the holotype station and, in parentheses, of the paratype station were as follows: pools in creek bed (both stations); water, clear (murky); bottom, gravel

(mud); depth to 4 feet (both stations); vegetation, sparse algae (*Chara*); temperature, moderate (warm).

Named *zonifer* in reference to the bars, which are well developed for a *Hololepis*.

Hololepis saludae, NEW SPECIES

Plate I, Figure 6

MATERIAL EXAMINED AND RECORDED

State, Drainage Basin, and Collection Data	Museum No. (specimens).
SOUTH CAROLINA:	
Santee River drainage basin:	
Moore's Cr., tributary to L. Murray, 6 miles SE. of Saluda, Saluda Co.; E. M. Burton; June 21, 1933.	Charleston Mus. 33.139.1 (4); Mich. 107077 (4).
Richland Cr., tributary to L. Murray, 10 miles SE. of Saluda, Saluda Co.; E. M. Burton; June 21, 1933.	Charleston Mus. 33.149.1 (5); Mich. 107079 (1) and 107078 (2); U.S.N.M. 94685 (1).

HOLOTYPE.—Cat. No. 107079, Museum of Zoology, University of Michigan, an immature specimen 21 mm. in standard length, with data just cited. The other specimens listed above, all immature, are all designated as paratypes.

BODY.—Elongate, slightly compressed.

HEAD.—Muzzle sharp; mouth subterminal, somewhat oblique; lower jaw slightly included. Preopercle entire. Gill membranes rather broadly joined; distance from angle to tip of snout 1.5 to 1.7 in head.

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length; based, except as noted, on 5 specimens, 18 to 22 mm. in standard length).—Greatest depth 17 to 20 (average 19); least depth 10 to 12 (10); length of caudal peduncle 27 to 33 (29); greatest width 11 to 14 (13); width between lateral lines, below origin of first dorsal 7 to 10 (9); length of head to opercular spine 29 to 31 (29); length of snout 5 to 7 (6); length of eye 8 to 9 (8); postorbital length 14 to 15 (15); width of head 9 to 12 (11); width of interorbital 4 to 6 (5); length of upper jaw 9 to 11 (10); distance from tip of snout to origin of dorsal fin 31 to 38 (35); highest dorsal spine 11 to 13 (12); highest dorsal soft-ray 9 to 17 (13); length of caudal fin 21 to 25 (23); distance from tip of snout to origin of anal fin 56 to 63 (60); length of anal base 10 to 12 (11); length of pectoral fin (3 specimens) 20 to 23 (22); length of pelvic fin 18 to 20 (19).

GENITAL PAPILLA.—In immature specimens minute, conical, with the opening at tip.

FIN RAYS.—Dorsal, IX to X, usually IX—10 to 11; anal, II, 7.

SCALE ROWS.—Three—37 to 49—8 to 10.

LATERAL LINE.—Of moderate length for a species of this genus, 24 to 35 (average 28) hundredths of standard length; extending to below posterior part of first dorsal, or slightly beyond vertical from origin of second dorsal. Pored scales 12 to 22. Unpored scales in lateral line row 21 to 32, each with a shallow pit containing a minute papilla, often ill-defined. Ratio of pored to unpored scales .39 to .95. Lateral line, including its rudimentary extension, almost as much elevated as usual anteriorly, but sloping rapidly toward a submedian position posteriorly: its least separation from base of first dorsal fin about one-fifth greatest depth below lateral line; its separation from origin of second dorsal two-thirds depth below lateral line at that vertical (all these measurements on a projection basis). Scales above lateral line or its rudimentary extension at origin of second dorsal usually 4.

SQUAMATION.—Breast scaleless. Belly weakly scaled. Nape scaleless or very nearly so. Cheek scales embedded, cycloid, rather difficult to perceive. Opercular scales smooth to weakly ctenoid. Parietal and interorbital region wholly scaleless.

HEAD PORES.—Interorbital pores constantly present on both sides. Infraorbital canal interrupted, with only 1 pore behind the break and 3 or 4, more commonly 4 above the upper jaw. Operculomandibular pores, 9 (10 in one fish). Supratemporal canal incomplete (complete in one specimen).

COLORATION.—Median portion of sides with a row of about 10 rectangular dark blotches. Back with about 10 dark saddles: 1 just behind occiput, 1 just before first dorsal fin, 2 or 3 beneath each dorsal fin and 2 or 3 on the caudal peduncle. The chromatophores of these dark areas large and separated, outlining the scale pockets to produce a grill pattern. Upper sides above lateral blotches often with faint vermiculations connecting the lower ends of the saddles. Pored portion of lateral line often marked by a narrow light line. Base of caudal with a vertical row of 3 or 4 spots; those near upper and lower border weak; upper one of median pair usually minute, occasionally obsolete; lower one of median pair always the most conspicuous, often almost jet black. No dark bar behind base of pectoral. Opercle with a dark blotch; mandibles, throat, and cheeks light, the cheeks often speckled with large chromatophores. Of the 4 dark bars radiating from eye the anterior and ventral are the more prominent; the line behind eye definite but short, not reaching more than half way to edge of preopercle; upper bar extended on cornea of eye. Parietal region dark.

Immature individuals with the breast, belly, and adjacent sides light; lower part of caudal peduncle light, with or without extensions of pigment from the lateral blotches. Spinous dorsal with a trace of a submarginal

dark band, wider and darker posteriorly, and of another dark band at base, which is widened and intensified anteriorly. Both dorsals are barred, with the pigment largely confined to the rays. Anal and pelvic fins clear. Pectoral clear, with fine, broken, dark lines outlining the rays.

HABITAT.—Both of the creeks in which this species was taken are located on the Piedmont some distance above the Fall Line, and are tributary to Lake Murray, an impounded body of water in the Saluda and Congaree divisions of the Santee River system. In all probability the species will be found to have a very restricted distribution. The two creeks were described by Mr. Burton as follows: "Water blackish, but clear; current moderate; bottom mud and gravel; vegetation slight along edge; depth 3 feet."

Named *saludae* for the Saluda River system, in which the types were collected.

Hololepis collis, NEW SPECIES

Plate I, Figure 7, and Plate II, Figure 4

MATERIAL EXAMINED AND RECORDED

State, Drainage Basin, and Collection Data	Reference; Museum No. (specimens)
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SOUTH CAROLINA:

Santee River drainage basin:

Creek near York, York Co.; Donald Ameel; Nov. 11, 1931.	Mich. 94560 (1) and 107085 (1).
Steele Cr., trib. to Catawba R., Rock Hill, York Co.; Ameel; Nov. 11, 1931.	Mich. 94546 (1).

HOLOTYPE.—Cat. No. 94560, Museum of Zoology, University of Michigan, an adult 40 mm. in standard length, with data given above. The paratypes include a 40 mm. female taken with the holotype, and another male 37 mm. long.

BODY.—Somewhat elongate, compressed.

HEAD.—Muzzle rather sharp; mouth subterminal, somewhat oblique; lower jaw slightly included. Preopercle smooth. Gill membranes rather broadly connected: distance from their angle to tip of snout markedly greater than half length of head.

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length, based on 3 specimens, 36 to 41 mm. in standard length).—Greatest depth 20 to 21 (average 21); least depth 12; length of caudal peduncle 28 to 33 (31); greatest width 14 to 15 (15); width between lateral lines, below origin of first dorsal 10; length of head to opercular spine 24 to 28 (26); length of snout 4 to 6 (5); length of eye 6 to 7 (6); postorbital length 13 to 15 (14); width of head

10 to 11 (10); width of interorbital 5; length of upper jaw 7 to 9 (8); distance from tip of snout to origin of dorsal fin 31 to 32 (32); highest dorsal spine 11 to 14 (13); highest dorsal soft-ray 15 to 18 (17); length of caudal fin 21 to 24 (22); distance from tip of snout to origin of anal fin 57 to 60 (59); length of anal base 8 to 13 (11); length of pectoral fin 23 to 26 (24); length of pelvic fin 20 to 22 (21).

GENITAL PAPILLA.—In female conical, small, more than twice as wide as that of the male, but of similar shape (non-breeding fish compared); somewhat plicate about terminal opening. With a terminal pore in male.

FIN RAYS.—Dorsal, VIII to IX—11 to 12; anal, II, 6 or 7.

SCALE ROWS.—Three to 4—41 to 47—9 to 11.

LATERAL LINE.—Twenty-seven to 35 hundredths of the standard length (average, 30); extending considerably beyond middle of first dorsal, sometimes very slightly beyond vertical from origin of second dorsal. Pored scales 13 to 19. Unpored scales in same row 23 to 31; each with a shallow pit containing a minute papilla. Ratio of pored to unpored scales, .42 to .78. Lateral line including its rudimentary extension, almost as much elevated as usual anteriorly, but sloping rapidly toward a submedian position posteriorly: its least separation from base of first dorsal fin about one-fifth greatest depth below lateral line; its separation from origin of second dorsal two-thirds depth below lateral line at that vertical (all these measurements on a projection basis). Scales above lateral line or its rudimentary extension at origin of second dorsal $4\frac{1}{2}$ or 5.

SQUAMATION.—Breast and nape scaleless, or very nearly so. Cheek scales mostly embedded and cycloid, difficult to discern. Opercular scales mostly weakly ctenoid. Parietal and interorbital region completely devoid of scales.

HEAD PORES.—No interorbital pores. Infraorbital canal interrupted, embedded, with only 1 pore behind break and 3 above upper jaw (4 on one side of 1 fish). Operculomandibular pores 9 (10 on one side of 1 specimen). Supratemporal canal complete, with 1 median pore (2 specimens) or incomplete, with 2 closely approximated pores (in third specimen).

COLORATION.—Sides with a narrow median dark stripe, somewhat broken up on the caudal peduncle into oblong blotches. Sides above the lateral stripe and back with somewhat zigzag longitudinal lines, about half as dark as the lateral stripe. Back without dark saddles. None of the chromatophores markedly intertwined. Pored portion of lateral line marked by a series of light dots, or by a light line. Base of caudal fin with 3 dark spots in a vertical row, the central one most prominent. No dark bar behind base of pectoral fin. Opercles, except for a dark spot near the top, cheeks, throat, and jaws light, speckled with large, isolated chromatophores, readily apparent to the unaided eye. A dark line above and below the eye, and

one in front of it; the color extending on the cornea, particularly from above. Occasionally a weak line behind eye.

Female with the breast, belly, and sides directly above light, without any dark markings. Male having the belly and adjacent sides diffusely pigmented with many small, evenly scattered chromatophores. Breast of the male finely speckled with chromatophores much smaller than the ones on the opercles, and cheeks, etc., though larger than those on belly. Spinous dorsal of male evenly pigmented on upper third of membrane; median third to half of fin with a band of another color (possibly red in life), widened and strengthened posteriorly; membranes becoming sooty toward base, especially forward; second dorsal with bands of pigment in the membrane reinforcing the barring on the rays; anal without barring, speckled with small chromatophores. Spinous dorsal of the female with the characteristic barring on the spines; the membrane with little pigment even toward base anteriorly; second dorsal barred, with considerable pigment in the membrane reinforcing the barring, probably without bands; anal clear. Pectorals similar in both sexes, with weak barring. Ventrals clear in female, speckled in male.

November males beginning to assume breeding colors, but showing no sign of tubercles (which may not be developed in this species). The genital papillae seem to be in the non-breeding (summer) condition.

HABITAT.—*H. collis*, like *H. zonifer* and *H. saludae*, probably has a very small and distinctive range. It has been taken only in creeks on the Piedmont (above the Fall Line), in South Carolina near the North Carolina border. It may well be restricted to the Catawba River system, although the data do not indicate whether the collection station, "creek near York," is in the Catawba or the Broad system, on the divide between which York lies. Dr. Ameel described the water conditions in the holotype station (and in the one other station) as follows: water "semi-clear" at each place; current moderate (slow); bottom "sandy, with a few rocks and some sediment" ("sand, with some sediment"); depth to 3 feet (to 2 feet); width of stream 12 to 15 feet (15 to 20 feet). Mr. E. Milby Burton of the Charleston Museum, who also worked Steele Creek, in an unsuccessful effort to obtain more specimens, describes the stream as of red, muddy water, gravel and silt bottom, moderate current, and no vegetation.

The name *collis* signifies "of the high ground": this form seems to occur at a higher elevation than most species.

Hololepis barratti (HOLBROOK)

Plate I, Figures 8 and 9, and Plate II, Figure 4

Boleosoma tenue Agassiz, 1850: 299, 304; Vaillant, 1873: 91. *Nomen nudum*; synonymized with *Hololepis barratti* by Putnam, 1863: 4.

- Boleosoma Barratti* *Holbrook, 1855: 56 (original description; Georgia included in range, probably on the basis of a specimen of *Villora edwini*).
- Hololepis barratti* *Putnam, 1863: 4; Cope, 1864: 233 (in synopsis of species of *Hololepis*); Vaillant, 1873: 127 (specific name misspelled *baratti*); *Hubbs and Greene, 1928: 385; Jordan, 1929: 169 (in part); Jordan, Evermann, and Clark, 1930: 294 (in part).
- Boleichthys (Hololepis) barratti* Jordan and Copeland, 1876: 135.
- Boleichthys barrattii* Jordan and Copeland, 1876: 163.
- Boleichthys barratti* Nelson, 1876: 34 (in key furnished by Jordan); Jordan, 1877c: 16, 18 (synonymy); 1878e: 440; 1880, 1884c: 405 (in part).
- Poecilichthys barratti* Jordan and Gilbert, 1883a: 519 (in part); 1883b: 599, 620 (S. C. record only); True, 1883: 249 (generic name misspelled *Poecilichthys*); Jordan, 1884a: 324 (Fla. record); 1884b: 479 (comparison with *Poecilichthys beani* = *Boleosoma nigrum*).
- Etheostoma fusiforme barratti* Jordan, 1888, 1891, 1894: 134 (wholly or in part); 1890: 118 (S. C. reference only).
- Boleichthys fusiformis barratti* Jordan, 1899, 1904, 1910, 1914, 1916a: 134 and 357 (wholly or in part).
- Poecilichthys quiescens* *Jordan, 1884b: 478 (original description); Jordan and Meek, 1885: 482 (Ga. record).
- Etheostoma quiescens* Jordan, 1885: 869; Woolman, 1892b: 294, 297, 299, 300, 302 (Fla. records), Pl. 53, Fig. 3; Lönnberg, 1894: 126 (Fla. records); Boulenger, 1895: 75 (except reference to Jordan, 1890: 120).
- Copelandellus quiescens* Jordan and Evermann, 1895a: 1100 (in part); 1896b: 366 (in part); 1900: 3271, Pl. 176, Fig. 468; Evermann and Kendall, 1899: 72 (Fla. literature and original records); Jordan, 2, 1905: 315 (in part); Pratt, 1923: 136 (in part); Jordan, 1925: 530 (in part); Wright 1926: 80 (wholly or in part).
- Etheostoma fusiforme* Jordan, 1885: 869 (in part); Jordan and Gilbert, 1886: 9 (*barratti* considered as synonym); Gilbert, 1890: 229 (Ga. records); Boulenger, 1895: 75 (in part).
- Boleichthys fusiformis* Evermann and Bean, 1897: 243 (Fla. record); Evermann and Kendall, 1899: 72 (Fla. literature records); *Palmer and Wright, 1920: 359, 373 (synonymy); Hildebrand, 1923: 8 (Ga. record); Wright, 1926: 80 (in part), Pl. 2, Fig. 8.
- Not *Boleosoma fusiforme* Girard, 1854: 41.

* Indicates important reference.

MATERIAL EXAMINED AND RECORDED⁵

State, Drainage Basin, and Collection Data Reference; Museum No. (specimens)

SOUTH CAROLINA:

Peedee River drainage basin:

Lumber [Lumbee] R., Nichols, Marion Co.;

E. M. Burton; July 25, 1934.

Charleston Mus. 34.211.1 (1).

⁵ Except as noted, all specimens listed have been examined by us.

- 18.5 miles N. of Conway, near Green Sea,
Horry Co.; Burton; July 25, 1934. Charleston Mus. 34.209.3 (3);
Mich. 107076 (3).
- 12 miles SE. of Bethune, Lee Co.; Burton;
July 26, 1934. Charleston Mus. 34.228.3 (1).
- Black River drainage basin:
- Black R., Kingstree, Williamsburg Co.; Bur-
ton; July 1, 1933. Charleston Mus. 33.165.8 (1).
- Black R. [without other locality]. Jordan and Gilbert, 1883: 599.
Not seen.⁶
- Santee River drainage basin:
- Borrow pit near Wateree R., Richland Co.;
Burton; July 22, 1934. Charleston Mus. 34.310.1 (2).
- Temple Country Club stream, 8 miles E. of
Columbia, Richland Co.; Burton; Aug. 31,
1933. Charleston Mus. 33.268.1 (3);
Mich. 107082 (2).
- Gill's Cr., 3 miles E. of Columbia, Richland
Co.; Burton; Aug. 31, 1933. Charleston Mus. 33.257.1 (1).
- Charleston Harbor drainage basin (Cooper and Ashley rivers):
- 5 miles N. of Mount Holly, Berkeley Co.;
Burton; June 27, 1933. Charleston Mus. 33.156.2 (2);
Mich. 107080 (2).
- Summerville, Dorchester Co.; S. F. Baird;
1851. U.S.N.M. 1185 (6).
- 4 miles W. of Summerville, Dorchester Co.;
Burton; Oct. 10, 1933. Charleston Mus. 33.312.1 (4);
Mich. 107084 (3).
- 7 miles S. of Bacon's Bridge, Dorchester Co.;
Burton; June 29, 1934. Charleston Mus. 34.156.3 (1).
- Grove Plantation, Charleston. Agassiz, 1850: 299, 304; Vail-
lant, 1873: 91. M.C.Z. 24596
[original 99] (15); Mich.
86580 (3).
- Charleston; Girard. U.S.N.M. 1143 + 1161 (5).
- Edisto River drainage basin:
- Wassamasaw Swamp, Berkeley Co.; Burton;
Oct. 30, 1930. Charleston Mus. 30.209.2 (2);
Mich. 107081 (1).
- Same data; Oct. 10, 1933. Charleston Mus. 33.309.1 (25);
Mich. 107083 (24).
- 2 miles SE. of Wassamasaw Swamp, Berkeley
Co.; Burton; Oct. 10, 1933. Charleston Mus. 33.310.1 (1).
- Edisto R. at Highway 64, Colleton Co.; Bur-
ton; June 29, 1934. Charleston Mus. 34.158.4 (2).
- 2 miles SW. of Edisto R., Highway 64, Colle-
ton Co.; Burton; June 29, 1934. Charleston Mus. 34.159.2 (2).
- Edisto R., Jacksonboro, Charleston Co.; Bur-
ton; Jan. 27, 1932. Charleston Mus. 32.14.7 (1).

⁶ "Not seen" indicates that the specimens referred to have not been reexamined.

Combahee River drainage basin:

Lemon Swamp, 2 miles S. of Bamberg, Bamberg Co.; Burton; July 11, 1934.

Charleston Mus. 34.180.1 (2).

GEORGIA:

Savannah River drainage basin:

Levee Pond, Augusta.

Hildebrand, 1923: 8. U.S.N.M.
82624 (3).

Brickyard Pond, Augusta.

Hildebrand, 1923: 8. U.S.N.M.
82625 (5), 86194 (6).

Altamaha River drainage basin:

Tobesofkee Cr., trib. Ocmulgee R., 5 miles S. of Macon, Bibb Co.; E. P. Creaser and H. R. Becker; Sept. 4, 1929.

Mich. 88324 (14).

Ogeechee R., SW. of Milan.

Gilbert, 1890: 229. U.S.N.M.
43457 (8), 61567 (7).

Pendleton Cr. overflow pond, 5 miles S. of Oak Park, Toombs Co.; Creaser and Becker; Sept. 6, 1929.

Mich. 88447 (2).

Little Rocky Cr., 3 miles S. of Lyons, Toombs Co.; Creaser and Becker; Sept. 6, 1929.

Mich. 88472 (2).

Altamaha R. backwater at U. S. Highway 1, Toombs Co.; Creaser and Becker; Sept. 7, 1929.

Mich. 88484 (1).

Satilla River drainage basin:

Satilla R. sloughs near Walerstown, Ware Co.; Creaser and Becker; Sept. 8, 1929.

Mich. 88511 (1).

Satilla R. at Waycross.

Gilbert, 1890: 229. Not seen.

15 miles SE. of Waycross, N. edge of Okefenokee Swamp, Ware Co.; Creaser and Becker; Sept. 8, 1929.

Mich. 88535 (4).

Satilla R. trib., 1 mile W. of Lulaton, Brantley Co.; Creaser and Becker; Sept. 10, 1929.

Mich. 88602 (3).

St. Mary's River drainage basin:

St. Mary's R. overflow ponds, U. S. Highway 1 at Fla. line; Creaser and Becker; Sept. 8, 1929.

Mich. 88550 (3).

Suwannee River drainage basin:

Okefenokee Swamp.

Palmer and Wright, 1920: 373;
Wright, 1926: 80. Not seen.

Pond trib. to Suwanoochee Cr., 0.5 mile W. of Du Pont, Clinch Co.; Creaser and Becker; Sept. 11, 1929.

Mich. 88637 (12).

"Tributary of the Altamaha [error for Allapaha] River, a branch of the Suwannee, at Nashville, Ga.;" Taylor.

Jordan, 1884b: 478; Jordan and Meek, 1885: 482. U.S.N.M.
28509 (1).

Bank L., 1.5 miles S. of Lakeland, Lanier Co.; Creaser and Becker; Sept. 12, 1929.

Mich. 88638 (7).

- South Twin L., 20 miles SE. of Valdosta,
Lowndes Co.; Creaser and Becker; Sept. 13,
1929. Mich. 88658 (11).
- Withlacoochee R. trib., 9 miles E. of Quitman,
Lowndes Co.; Creaser and Becker; Sept. 14.
Mich. 88665 (32).
- FLORIDA:
- Suwannee River drainage basin:
- New R., New River station, Bradford Co. Woolman, 1892b: 302. Not seen.
- Sampson Cr., trib. to Santa Fe R. at Sampson,
Bradford Co. Woolman, 1892b: 302. Not seen.
- Santa Fe R., 3 miles SW. of Hampton, Brad-
ford Co. Woolman, 1892b: 302. U.S.N.M.
63779 (21); Mich. 61506 (3);
British Museum ——— (1).
- Newnan's L., Alachua Co.; Univ. Fla. (Board-
man); Feb. 13, 1928. Mich. 87907 (2).
- Prairie Cr., E. of Gainesville, Alachua Co.;
O. C. Van Hynning; Jan. 30, 1927. U.S.N.M. 88490 (2).
- Withlacoochee River drainage basin:
- Pond Cr., Dragem Junction. Woolman, 1892b: 300. Not seen.
- Little Withlacoochee R., 2 miles N. of Withla-
coochee Station. Woolman, 1892b: 300. Not seen.
- Withlacoochee R., 3 miles E. of Richland,
Pasco Co. Woolman, 1892b: 300. Not seen.
- Lake Butler drainage basin:
- Lake Butler near Tarpon Springs, Hillsbor-
ough Co. Evermann and Kendall, 1899:
72. Not seen.
- Hillsboro River-Tampa Bay drainage basin:
- Pemberton Cr., Seffner, Hillsborough Co. Woolman, 1892b: 299. Not seen.
- Mill Cr., 0.5 mile SE. of Kathleen, Polk Co. Woolman, 1892b: 299. Not seen.
- Pond near Tampa, Hillsborough Co. Evermann and Kendall, 1899:
72. Not seen.
- Peace River drainage basin:
- Joshua Cr., near Nocatee, De Soto Co. Woolman, 1892b: 297. Not seen.
- Alligator Cr., 1 mile S. of Zolfo Springs,
Hardee Co. Woolman, 1892b: 297. Not seen.
- Alligator River drainage basin:
- Alligator R., 5 miles SE. of Punta Gorda,
Charlotte Co. Woolman, 1892b: 294. Not seen.
- Atlantic Coast drainage basins:
- St. John's R. at Welaka, Putnam Co. Evermann and Kendall, 1899:
72. Not seen.
- Lake near Welaka, Putnam Co. Evermann and Kendall, 1899:
72. Not seen.
- Lake Monroe, Sanford, Seminole-Volusia
county line. Evermann and Kendall, 1899:
72. Not seen.

Indian R. near Titusville.	Jordan, 1884a: 324; Evermann and Bean, 1897: 243. U.S.N.M. 25343 (1).
Fern Creek near Orlando, Orange Co.	Lönnberg (1894: 126).
Small lakes S. of Orlando, Orange Co.	Lönnberg (1894: 126).
"Orlando, Fla. Dr. Lönnberg"; probably one of the preceding.	U.S.N.M. 44413 (1).
Lake John near Oakland, Orange Co.	Lönnberg (1894: 126). Not seen.
Small lake near McDonald, Orange Co.	Lönnberg (1894: 126). Not seen.
Creek SW. of Kissimmee, Osceola Co.	Lönnberg (1894: 126). Not seen.
Drainage basin not located:	
Silver L.; C. R. Aschemeier; Jan. 12, 1933.	U.S.N.M. 92896 (118).
L. Jackson; Aschemeier; Dec. 22, 1932.	U.S.N.M. 92864 (1).
Recorded merely as from "Florida."	Holbrook (1855: 56). M.C.Z., 24571 (5); Mich. 86598 (1).

We have studied the type specimens of *Boleosoma tenue*, *Boleosoma Barratti*, and of *Poecilichthys quiescens*. All seem to represent a single species, which has been wrongly identified by a few authors (see synonymy) with *Etheostoma fusiforme* or *Boleichthys fusiformis*. *Hololepis serrifer* (which see) has been identified as *Etheostoma quiescens*, *Copelandellus quiescens*, and *Hololepis barratti*. As mentioned on p. 33, that erroneous identification has led to a lack of agreement between the descriptions of *quiescens* by Jordan (1884b: 478) and by Jordan and Evermann (1896a: 1100). This was apparently one reason that led Palmer and Wright (1920: 373) to identify *Copelandellus quiescens* with *Boleichthys fusiformis*. *Poecilichthys butlerianus* Hay was wrongly identified with *P. barratti* by Jordan and Gilbert (1883b: 599). The name *barratti* was for a time wrongly associated by Jordan with Illinois specimens of *Hololepis gracilis*.

Maximum size known, 52 mm. (standard length).

BODY.—Elongate, somewhat compressed.

HEAD.—Muzzle rather sharp; mouth subterminal, slightly oblique; lower jaw slightly included. Preopercle smooth or with at most a few slight crenations. Gill membranes rather broadly connected: distance from angle to tip of snout decidedly greater than half length of head.

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length, based on 17 specimens, 21 to 38 mm. in standard length).—Greatest depth 15 to 22 (average 18); least depth 7 to 11 (10); length of caudal peduncle 27 to 32 (29); greatest width 9 to 12 (10); width between lateral lines, below origin of first dorsal 7 to 9 (7); length of head to opercular spine 24 to 28 (26); length of snout 4 to 6 (5); length of eye 6 to 8 (7); postorbital length 12 to 15 (14); width of

head 8 to 10 (9); width of interorbital 4 to 5 (5); length of upper jaw 6 to 9 (7); distance from tip of snout to origin of dorsal fin 31 to 34 (32); highest dorsal spine 11 to 15 (13); highest dorsal soft-ray 11 to 17 (15); length of caudal fin 19 to 24 (21); distance from tip of snout to origin of anal fin 58 to 62 (61); length of anal base 9 to 13 (11); length of pectoral fin 20 to 26 (22); length of pelvic fin 16 to 24 (21).

GENITAL PAPILLA.—In the mature female conical, without basal enlargements, opening by a slit on the ventral (anterior) side; always slightly overlapping, often for half its length, the origin of anal fin; in fully mature females, turgid; held out at an angle to the body, 1 mm. long in a 30 mm. fish. Genital papilla of the male very minute, flattened, conical, in a slight depression back of the anus. Papilla of the female during summer months shrunken, about $\frac{1}{3}$ its size at other times. Papilla of the male varying little through the year.

Breeding tubercles developed on spines and distal portions of the soft rays of the anal and pelvic fins in breeding male.

FIN RAYS.—Dorsal, IX to XII—9 to 12; anal, II, 6 to 7.

SCALE ROWS.—Two to 3—47 to 60—9 to 10.

LATERAL LINE.—Moderately long for a species of *Hololepis*, 21 to 43 (average 34) hundredths of the standard length; usually ending below posterior part of first dorsal; occasionally extending scarcely beyond vertical from middle of first dorsal; in 20% of the 132 specimens examined extending beyond vertical from origin of second dorsal. Pored scales 16 to 35; seldom more than 30. Unpored scales in same row 20 to 37; each with a shallow pit containing a minute papilla, best developed on caudal peduncle. Ratio of pored to unpored scales .43 to 1.38, usually not more than 1.20. Lateral line, including its rudimentary extension, strongly elevated throughout: its least separation from base of first dorsal fin less than one-fifth greatest depth below lateral line; its separation from origin of second dorsal about one-third depth below lateral line at that vertical (all these measurements on a projection basis). Scales above lateral line or its rudimentary extension at origin of second dorsal typically 3.

SQUAMATION.—Breast covered with weakly ctenoid scales, often embedded. Nape well scaled. Cheek scales exposed and ctenoid, even ventrally in half-grown. Opercles covered with ctenoid scales. Parietals entirely scaled except for a naked area on the crown behind the coronal pore. Typically the posterior half of the top of the parietal region is completely scaled; exceptionally there is a median scaleless strip continuous with the scaleless area forward. Interorbital with numerous ctenoid scales.

HEAD PORES.—Interorbital pores constantly lacking. Infraorbital canal interrupted, superficial; with 1, occasionally 2, pores behind the break,

and with 3 pores above the upper jaw. Operculomandibular pores 9. Supratemporal regularly complete in adult fish, usually incomplete in young.

COLORATION.—Median sides with a row of 9 to 12 rectangular dark blotches, the first above the tip of the opercle, the others curving down to follow the mid-line of the sides. These blotches show more or less of a cross-stitch pattern, particularly in the lighter males and in the females and young. Back with about 9 dark saddles: 1 located just behind the occiput, 1 in front of the first dorsal, 2 or 3 beneath each dorsal, and 2 on the caudal peduncle. Melanophores forming the dark areas of sides and back large, but so intertwined that all individuality is lost. Upper sides, that is the area between dorsal saddles and lateral blotches, almost without pigment in the lighter adults and in young individuals, varying to a monotone about half as dark as the spots in dark individuals. Lateral line marked by a narrow light line. Base of caudal usually with 4 dark spots in a vertical row; the upper one of the median pair more or less reduced in size and intensity, occasionally obsolescent; the lower spot of median pair often almost jet black, darker than any of the others. Dark bar posterior to base of pectoral absent or weak. Opercle mostly dark. Cheeks and mandibles light, with small rectangular dark blotches. Four dark lines radiating from the eye: 2 vertical and 2 horizontal; the pigment extending on the cornea, especially from the dorsal bar. Parietal region dark.

Female with the throat, breast, and belly light; sides below lateral blotches and lower surface of caudal peduncle light, except for small dark patches of large, intertwined chromatophores. These patches twice to several times as large on the lower sides of the caudal peduncle as on the lower sides in front of the anus; often combined with the lateral blotches, lying between them, or extending on the ventral surface of the caudal peduncle. Non-breeding male with the throat and breast light, occasionally showing some of the specks developed here in the breeding season; sides adjacent to belly lacking the dark patches evident in the female; this area as well as the belly diffusely pigmented with very many, small, evenly scattered melanophores. Lower surface of the caudal peduncle as in the female. Color pattern of the male not sharp as in the female. Light areas of the body, except the belly and adjacent sides, with a dark grill outlining the scale pockets, made up of melanophores about the size of those forming the specks on the breast of breeding males. Spinous dorsal of the non-breeding male with a dark submarginal band, darker and wider posteriorly; below this a clear (or at least lighter) band; these two bands occupying upper third of fin; the lower portion dark, especially forward. Barring scarcely apparent. Second dorsal with fine speckling in addition to barring. Dorsal fins in the female barred on rays only, first occasionally with a trace of pigment in the membrane. Anal fin of male sparsely speckled, but with-

out barring. Anal fin of female barred on rays only; otherwise without pigment. Pectorals similar in both sexes, clear or with weak barring. Pelvics often sparsely speckled in male; clear in female. Males during the summer rest period losing most of their fin color, except the barring in the dorsals.

Breeding males with the breast and throat speckled with melanophores 3 to 4 times the size of those on the belly. Grill pattern becoming transformed into rows of blackish crescents, one beneath almost every scale, except on lower sides and belly. Amount of pigment in the dorsal fin increased, and the anal and pelvic fins very heavily speckled. Breeding females seemingly not modified in color.

Life colors.—We have no first-hand data on the appearance of this fish in life. The only authentic account seems to be the following brief description by Woolman (1892b: 297), based on Florida specimens collected in "black water," dark-bottomed streams: "Color dark brown, with very dark green between the darker spots on the body."

Breeding season probably March, perhaps even earlier in Florida. Distinctive sexual characters of both male and female developed in September and persistent until late spring.

HABITAT.—*Hololepis barratti* is an abundant and widespread species through the low Coastal Plain, below the Fall Line, sharing this distinctive faunal area with many other species of animals. Its habitat preferences are indicated by 39 brief ecological descriptions of collection stations—11 published by Woolman (1892b), 16 kindly furnished us by E. Milby Burton of the Charleston Museum, and 12 others made by Edwin P. Creaser and Herbert R. Becker on a collecting trip for the Museum of Zoology, University of Michigan. The water inhabited is either muddy or clear, usually "black water" or "coffee colored" (that is, bog stained). Current: none to swift, generally none or slight, as the species seems to prefer overflow pools, lakes, and quiet streams. Bottom: mud for about half of collections, a mixture of mud with leaf mold, sand, or gravel for several collections, sand for several, sand and clay once, and rock and gravel once. Depth: to 5 feet, generally less. Vegetation: very variable, none to dense, often none to slight, often confined to edge of stream, or consisting of algae only or algae and sedges; genera of flowering plants noted were *Ericolum*, *Pontederia*, *Polygonum*, *Potamogeton*, and *Cabomba*. Temperatures noted: 48° to 65° F. in Florida in December and January; moderate or warm in Georgia in September; 69°, 80°, 80°, 86°, and 88° F. in South Carolina in June and July.

This beautiful little species I have dedicated to Dr. John P. Barratt, of Abbeville District, South Carolina, an excellent Naturalist, who has done much for the advancement of Zoology and Botany. (Holbrook.)

Holelepis thermophilus, NEW SPECIES

Plate I, Figure 10

Etheostoma fusiforme Jordan, 1890: 117 (Va. record only); Boulenger, 1895: 75 (reference to Jordan, 1890: 117 only).—Identification almost certain.

Boleichthys fusiformis ? Milligan, 1901: 134 (wholly or in part); ? Smith, 1907: 268 (reference to Milligan); Brimley and Mabee, 1925: 16 (as *B. fusiforme*).

Not *Boleosoma fusiforme* Girard, 1854: 41.

Copelandellus quiescens Smith, 1907: 269 (in part).

Not *Poecilichthys quiescens* Jordan, 1884b: 478.

MATERIAL EXAMINED AND RECORDED⁷

State, Drainage Basin and Collection Data Reference; Museum No. (specimens)

VIRGINIA:

Northwest River drainage basin:

Ditch on Dover Farm at Wallaceton, Dismal Swamp. Jordan, 1889: 117. Not seen; identification almost certain.

NORTH CAROLINA:

Lake Mattamuskeet drainage basin:

Lake Mattamuskeet, Hyde Co. Milligan, 1901: 134; Smith, 1907: 268. Not seen; identification doubtful.

Neuse River drainage basin:

Buffalo Cr., Wendell, Wake Co. Brimley and Mabee, 1925: 16. Mich. 107070 (1).

Same data; Nov. 30, 1923. Brimley and Mabee, 1925: 16. Mich. 107069 (1).

Small temporary overflow pool in Big Swamp, Kenly, Johnston Co.; Brimley and Mabee; Nov. 26, 1923. Brimley and Mabee, 1925: 16. Brimley Coll. 84 (1); Mich. 107068 (1).

Cape Fear River drainage basin:

Millpond at Kipling, Harnett Co.; Brimley and Mabee; Dec. 11, 1923. Brimley Coll. 154-155 (2). Mich. 107071 (2), 107072 (1).

Wilmington; W. P. Seal. Smith, 1907: 269; U. S. N. M., 52060 (8), 52071 (6).

Ditch, Wilmington; W. W. Welsh; Dec. 29, 1916. U. S. N. M. 86165 (9).

Lake, Wilmington; "Grampus"; Jan. 3, 1917. U. S. N. M. 86160 (2).

Two literature records are referred to this species with some doubt, as we have not located the specimens. Jordan's description of a single specimen of "*Etheostoma fusiforme*" from Dismal Swamp, Virginia, nicely fits this species, and proves that he did not have *H. serrifer* from this locality; the

⁷ Except as noted, all specimens listed have been examined by us.

characters given do not correspond well with those of *H. fusiformis atraquae*, the subspecies of *fusiformis* which occurs nearest Dismal Swamp. The record of *Boleichthys fusiformis* from Lake Mattamuskeet, North Carolina, by Milligan and by Smith, is referred to *thermophilus* with more doubt, solely on geographical considerations, for Smith also had a specimen of the very different *H. serrifer* from North Carolina (the series of specimens containing this *serrifer* consisted chiefly of *thermophilus* but Smith mentioned seeing only one example). Smith's description of *Boleichthys fusiformis* was, unfortunately, taken from Jordan and Evermann's monograph.

This form, *thermophilus*, is regarded as specifically distinct from *barratti* on the one side and from the various subspecies of *fusiformis* on the other or northern side. Its range is not known to be continuous with that of either *barratti* or *fusiformis*. Collections of *barratti* from near the northern border of South Carolina and of *thermophilus* from Wilmington, North Carolina, not far to the northward, show no distinctive approach in characters. Instead of approaching *thermophilus*, the southernmost form of *fusiformis* now recognized, namely *H. f. atraquae* from Maryland, diverges strongly from it. Furthermore, an attempt to collect specimens of this genus from the intervening region, near the northern coast of Virginia, failed, though favorable habitats were seined.

Distinctive features of *fusiformis* and *thermophilus* are as follows:

	<i>fusiformis</i>	<i>thermophilus</i>
Interorbital	Scaleless; or with 1 or 2 more or less embedded scales	With several ctenoid scales
Lateral line to origin of second dorsal in depth below lateral line	About 2	About 3
Body	Slender (very slender in <i>H. f. metae-gadi</i> ; relatively robust in <i>H. f. fusiformis</i>)	Very slender, terete
Scales between lateral line and first dorsal	2 to 3, usually 3	2 to 3, usually 2
Scales between rudimentary extension of lateral line and origin of second dorsal	Usually 4 (often 3½ and rarely 3 in <i>H. f. fusiformis</i> ; 4 to 5 in <i>H. f. metae-gadi</i>)	3, occasionally 3½, very rarely 4
Scales on edges of parietal region	1 row, rarely 2, lowermost occasionally reaching eye.	2 rows, the lowermost reaching eye, occasionally a few scales in a third row.
Minimum size at maturity	30 mm.	25 mm.

The differences between *thermophilus* and *barratti* are well marked, as indicated in the key to the species (p. 30), and in the table of counts (pp. 24 to 28): top of head less completely scaled; lateral line shorter; dorsal rays IX or X, 8 to 10, instead of IX to XII, 9 to 12; scales below lateral line 7 or 8, rather than 9 or 10; transverse scale rows 43 to 52, instead of 47 to 60; pored scales 10 to 20, *versus* 16 to 35; infraorbital pores 2 + 3, rather than 1 + 3, rarely 2 + 3.

H. thermophilus can readily be distinguished from any of the subspecies of *fusiformis* considered separately. From all of them with the exception of *H. f. metae-gadi*, it can be distinguished by its slenderer form, as well as by various average characters. From *H. f. metae-gadi* it is separable by the larger size of its scales, especially between the rudimentary extension of the lateral line and the origin of the second dorsal fin.

HOLOTYPE.—Cat. No. 107072, Museum of Zoology, University of Michigan, an adult male 33 mm. in standard length, from millpond at Kipling, Harnett County, North Carolina, collected by C. S. Brimley and W. B. Mabee, on December 11, 1923. The paratypes are the other specimens listed above with museum numbers.

Maximum size known, 35 mm. (standard length).

BODY.—Very elongate and terete, more so than in any subspecies of *H. fusiformis*, except *H. f. metae-gadi*.

HEAD.—Muzzle rather blunt; mouth subterminal, very slightly oblique; lower jaw included. Preopercle smooth. Distance from angle of gill membranes to tip of snout decidedly greater than half length of head.

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length; based, except for greatest depth, on 5 specimens, 30 to 32 mm. in standard length).—Greatest depth (10 specimens) 15 to 17 (average 16); least depth 9 to 11 (10); length of caudal peduncle 26 to 27 (27); greatest width 10 to 12 (11); width between lateral lines, below origin of first dorsal 6 to 7 (7); length of head to opercular spine 22 to 26 (24); length of snout 5; length of eye 6 to 7 (6); postorbital length 12 to 14 (13); width of head 8 to 9 (8); width of interorbital 5; length of upper jaw 6 to 7 (7); distance from tip of snout to origin of dorsal fin 31 to 33 (32); highest dorsal spine 11 to 15 (13); highest dorsal soft-ray 13 to 16 (15); length of caudal fin 20 to 24 (22); distance from tip of snout to origin of anal fin 59 to 62 (61); length of anal base 12 to 14 (13); length of pectoral fin 19 to 22 (21); length of pelvic fin 17 to 22 (19).

GENITAL PAPILLA.—In the mature female conical, without basal enlargements, opening by a short slit on the ventral side; slightly overlapping origin of anal fin. Papilla turgid in nearly ripe females, held out at an angle to body. Genital papilla of the mature male small, conical, slightly flattened, opening by a pore at tip; usually not reaching origin of anal fin.

Breeding tubercles not apparent on fall and winter males; perhaps developed in breeding season.

FIN RAYS.—Dorsal, IX to X—8 to 10; anal, II, 6 to 7.

SCALE ROWS.—Two to 3, usually 2—43 to 52—7 to 8.

LATERAL LINE.—High and relatively short, 13 to 33 (average 24) hundredths of the standard length; usually ending below middle of first dorsal, rarely reaching vertical from origin of second dorsal. Pored scales 10 to 20, usually not more than 16. Unpored scales in same row 26 to 37, usually more than 31; each with a shallow pit containing a minute papilla. Ratio of pored to unpored scales .28 to .73, usually not more than .50. Lateral line, including its rudimentary extension, very high anteriorly and maintaining its height posteriorly: its least separation from base of first dorsal fin less than one-fifth greatest depth below lateral line (despite the very slender body); its separation from origin of second dorsal fin about one-third depth below lateral line row at that vertical (all these measurements on a projection basis). Scales above rudimentary extension of lateral line at origin of second dorsal usually 3, occasionally $3\frac{1}{2}$, very rarely 4.

SQUAMATION.—Breast well scaled, but the scales usually embedded, cycloid. Nape well scaled. Cheek scales exposed and ctenoid, even ventrally in half-grown. Opercles covered with ctenoid scales. Parietal region scaleless dorsally; its posterolateral edges above the lateral canal and in front of the supratemporal canal with 2 horizontal rows of scales, the lowermost reaching to eye, occasionally with a few scales representing a third row. Interorbital with 3 or more weakly ctenoid scales.

HEAD PORES.—Interorbital pores constantly lacking. Infraorbital canal always interrupted, embedded, and with 2 pores behind the break and 3 pores above the upper jaw. Operculomandibular pores 9 (8 in one specimen). Supratemporal canal constantly complete, that is, with a single median pore. Coronal pore occasionally covered by skin.

COLORATION.—Sides with a row of about 10 (8 to 14) rectangular dark blotches, the first above the tip of the opercle, the others following the midline of the sides. Back with about 9 dark saddles, 1 just behind the occiput, 1 before the first dorsal, 2 or 3 beneath each dorsal, and 2 on the caudal peduncle. Chromatophores of the saddles and lateral blotches, large, intertwined. Upper portion of sides, between the dorsal and lateral rows of blotches, a monotone about half as dark as the blotches. Lateral line marked by a narrow light line, often obscure. Base of caudal with 3 dark spots, in a vertical row, the submedian one the darkest (the upper one of the usual median pair obsolete). Base of pectoral frequently with a weak bar posteriorly. Opercle mostly dark. Cheek light, with a few small dark blotches. Lower jaw and throat light. A wide line behind the eye, a bar below the eye, a faint bar in front, and another above the eye, the last chiefly noticeable for

the extension of its pigment on the cornea. Occiput light, or about half as dark as the dark spots.

Female with the breast, belly, and adjacent sides light. Ventral surface of caudal peduncle light, or with dark extensions from the lateral blotches. Non-breeding male with the breast and throat light or sparsely speckled; the belly, sides directly above, and the ventral surface of the caudal peduncle diffusely pigmented with many small, evenly distributed chromatophores. Color pattern of the male not sharp as typically in the female: the light areas more or less suffused with pigment. Chromatophores not confined to the edges of the scale pockets, generally more common toward the base; grill pattern therefore not evident. Spinous dorsal of the male with a narrow, dark, submarginal band, wider posteriorly; below this a lighter area, occasionally clear but usually with some pigment; lower half of fin dark, blackish anteriorly, and grading into the light area above; barring more or less persistent. Second dorsal of the male speckled in addition to the barring, the pigment in the membrane tending to reinforce the barring. Dark areas of the female, but not of the male, often showing a cross-stitch pattern. First and second dorsal of the female barred on rays only; the membrane usually but not always without pigment. Anal fin without barring in both sexes: speckled in male; clear in female. Pectorals similar in both sexes, clear or with weak barring. Pelvics clear in female; often speckled in male.

HABITAT.—This species appears to occupy the northern half of the range of *H. serrifer*, namely the Coastal Plain of southeastern Virginia and of North Carolina up to the Fall Line. Incidentally these two forms, in some ways the most unlike pair, are the only species of the genus which have been taken together in single collections.

Dr. George S. Myers, who has collected this species about Wilmington, tells us that it occurs abundantly in very warm, quiet waters reaching summer temperatures of 85° to 90° F. or even more, at the depth of 3 or 4 inches in masses of filamentous algae along banks of "black water" streams.

The name *thermophilus* refers to the warm water inhabited, at least commonly, by this species.

Hololepis fusiformis (GIRARD)

This species is divisible into at least five subspecies, for it shows most remarkable local variation. It may also eventually prove to include, as another subspecies, the form here specifically separated as *H. thermophilus*. The form called *erochrous* is a very poor unit, as it exhibits marked local differences. Some of these may prove subspecifically separable.

The five subspecies of *Hololepis fusiformis* recognized by us, with ranges, are as follows:

1. *H. f. atraquae*: Maryland between Potomac and Chesapeake estuaries.

2. *H. f. erochrous*: Delaware, Pennsylvania, and New Jersey, from northeastern part of Chesapeake Bay drainage to Raritan River drainage.
3. *H. f. fusiformis*: Pawtuxet River in Rhode Island, and Massachusetts Bay and Merrimac River drainage basins of Massachusetts.
4. *H. f. metae-gadi*: Tempies Pond (and other ponds?) on southern side of Cape Cod, Massachusetts.
5. *H. f. insulae*: Gibbs Pond (and other ponds?) on Nantucket Island, Massachusetts, south of Cape Cod.

The two southern subspecies, *atraquae* and *erochrous*, are perhaps the most primitive, as would be expected if the center of distribution for the genus was in the south. Both regularly have scales on the interorbital: *atraquae* more often has two scales than one on the interorbital; *erochrous*, usually has one; and *fusiformis* none (rarely one). The color pattern in adult *atraquae* is similar to that of *barratti*. It is interesting that the young of *fusiformis* show this same pattern. *H. erochrous* is perhaps more primitive than the Maryland form (*atraquae*) in having a greater number of pored scales, but is closer to *fusiformis* in coloration. It seems likely that in both Maryland and Massachusetts the pored scales have been reduced, and the two forms have arrived at the same number independently. *H. f. metae-gadi* represents the extreme in slenderness of body and increased number of scales. *H. f. insulae* is extreme in the reduction of fin rays and apparently of ctenii on the scales.

The differential characters of the subspecies of *H. fusiformis* are indicated in Table III.

Hololepis fusiformis atraquae, NEW SUBSPECIES

Plate I, Figure 11

Hololepis fusiformis Hubbs, 1933: 106.

MATERIAL EXAMINED AND RECORDED

State, Drainage Basin, and Collection Data	Reference; Museum No. (specimens)
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MARYLAND:

Potomac River drainage basin:

Mattawoman Creek, Prince George-Charles County line; C. L. Hubbs, G. S. Myers, and E. D. Reid; May 21, 1933.	Hubbs, 1933: 106. Mich. 107090 (1), 107089 (17); U.S.N.M. 92946 (4).
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These specimens were the basis of the new state record for Maryland incidentally given by Hubbs (1933).

HOLOTYPE.—An adult male 32 mm. long to caudal, Cat. No. 107090, Museum of Zoology, University of Michigan, and the paratypes in the Michigan and National collections, all bear the data indicated above.

TABLE III
DIFFERENTIAL CHARACTERS OF THE SUBSPECIES OF *HOLOLEPIS FUSIFORMIS*

Body	<i>atraquae</i>	<i>erochrous</i>	<i>fusiformis</i>	<i>metae-gadi</i>	<i>insulae</i>
	fairly robust; slightly com- pressed	relatively slim and compressed	robust and chunky	very elongate and slender	fairly robust; slightly com- pressed
MEASUREMENTS:*					
Greatest depth	19-21(20)	16-20(18)	17-21(19)	16-17(16)	15-18(16)†
Least depth	10-11(11)	9-11(11)	9-12(11)	9-12(10)	8-9 (9)†
Length of caudal peduncle	24-26(25)	26-28(27)	23-28(26)	29-30(29)	24-28(26)
Greatest width	13-14(13)	11-12(11)	12-14(13)	10-12(10)	9-10(10)†
Width between lateral lines	8-9 (8)	7-8 (8)	8-10(9)	7-8 (8)	—
Length of head	26-27(26)	25-27(26)	21-32(27)	21-25(23)	25-31(27)
Distance from snout to origin of dorsal	31-34(33)	30-33(31)	31-41(35)	30-32(31)	35-38(37)
Highest dorsal spine..	11-12(11)	12-14(13)	10-13(12)	8-10(10)	8-11(10)
Highest dorsal soft- ray	15-17(16)	14-15(14)	12-16(14)	12-14(14)	8-14(13)
Distance from snout to origin of anal	62-64(63)	60-62(61)	58-66(62)	58-60(59)	62-64(63)
Dorsal spines	9-10(9.7)	9-12(10.0)	9-12(10.0)	9-11(10.0)	8-9(8.5)
Dorsal soft rays	10-11(10.0)	9-11(9.9)	9-12(10.3)	9-11(10.2)	9-11(9.8)
Scales above lateral line	2-3(2.9)	2-3(2.9)	2-3(2.7)	2-3(2.8)	2-3(2.7)
Scales below lateral line	7-9(7.9)	7-9(7.7)	7-9(7.9)	8-9(8.3)	6-8(7.1)
Transverse scale rows	43-50(46.7)	46-55(49.7)	45-54(48.8)	51-61(56.0)	41-49(46.2)
Pored scales in lat- eral line row	8-14(12.3)	12-19(14.9)	5-17(12.6)	3-15(11.6)	7-14(11.9)
Unpored scales in lat- eral line row	31-39(34.7)	29-40(34.8)	31-44(36.7)	38-54(44.5)	29-37(33.8)
Ratio of pored to un- pored scales .....	.22-.45(.35)	.31-.66(.43)	.12-.49(.35)	.13-.37(.27)	.26-.43(.37)
Scales from rudimen- tary extension of lateral line to origin of second dorsal	4	4-4½	3½-4, rarely 3	4-5	3½-4
Usual number of in- terorbital scales	2	1	0	0	0
COLORATION:					
Medial sides	with a row of distinct blotches in adult	with a dark band in adult	with a dark band in adult	with a dark band in adult	? adult
Blotches on cheeks	usually re- duced to specks, or absent	usually coarse and conspicuous	usually coarse and conspicuous	usually coarse and conspicuous	usually coarse and conspicuous
Suborbital bar	weak or absent	present, oc- casionally weak	present, normal	present, normal	present, normal

* Measurements are of projection of parts along a horizontal or vertical axis expressed in hun-
dreds of the standard length.

† The slenderness of the types of *H. f. insulae* is probably due to their youth and poor preservation.

Maximum size known, 33 mm. (standard length).

BODY.—Elongate, appearing somewhat less robust and slightly more compressed than *H. f. fusiformis*, but not so slim as *H. f. erochrous*.

HEAD.—As in *H. f. fusiformis* (as described in p. 79).

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length, based on 5 specimens, 28 to 31 mm. in standard length).—Greatest depth 19 to 21 (average 20); least depth 10 to 11 (11); length of caudal peduncle 24 to 26 (25); greatest width 13 to 14 (13); width between lateral lines, below origin of first dorsal 8 to 9 (8); length of head to opercular spine 26 to 27 (26); length of snout 5; length of eye 7; postorbital length 14 to 15 (14); width of head 9 to 10 (10); width of interorbital 5 to 6 (6); length of upper jaw 6; distance from tip of snout to origin of dorsal fin 31 to 34 (33); highest dorsal spine 11 to 12 (11); highest dorsal soft-ray 15 to 17 (16); length of caudal fin 22 to 23 (22); distance from tip of snout to origin of anal fin 62 to 64 (63); length of anal base 11 to 13 (12); length of pectoral fin 21 to 22 (22); length of pelvic fin 17 to 19 (18).

GENITAL PAPILLA.—In female and male similar to that of *H. f. fusiformis*.

Breeding tubercles not found in probably postnuptial males, but very likely developed for a short period at the actual time of breeding.

FIN RAYS.—Dorsal, IX to X—10 to 11, usually X—10; anal, II, 7.

SCALE ROWS.—Two to 3, usually 3—43 to 50—7 to 9, usually 8.

LATERAL LINE.—Seventeen to 23 (average 20) hundredths of the standard length; ending below middle of first dorsal. Pored scales 8 to 14, averaging about the same as in *H. f. fusiformis*. Unpored scales in lateral line row 31 to 39, averaging 2 scales fewer than in *H. f. fusiformis*. Ratio of pored to unpored scales .22 to .45, averaging the same as in *H. f. fusiformis*. Lateral line high and distinctly arched; its rudimentary extension sloping downward, separated from origin of second dorsal by about one-half depth below lateral line at that vertical (all these measurements on a projection basis). Scales above rudimentary extension of lateral line at origin of second dorsal usually 4.

SQUAMATION.—Breast well scaled, but the scales embedded, cycloid. Nape well scaled. Cheek scales exposed and ctenoid, even ventrally in half grown. Opercles covered with ctenoid scales. Parietal region scaleless dorsally; lateral edges above lateral canal with a row of rather obscure, partially embedded scales, often extending to eye. Interorbital with 1 or more often 2 more or less embedded scales.

HEAD PORES.—Interorbital pores constantly lacking. Infraorbital canal interrupted, superficial to embedded, constantly with 2 pores behind the break and 3 pores above the upper jaw. Operculomandibular pores typically 9, occasionally 8. Supratemporal canal usually complete, that is, with a single median pore, but frequently interrupted.

COLORATION.—Median sides with a series of about 11 separated dark blotches, never joined to form a band. Back occasionally with about 9 dark saddles, 1 just behind the occiput, 1 in front of the first dorsal fin, 2 or 3 beneath each dorsal fin, and 1 on the caudal peduncle. Melanophores forming the dark areas on sides and back of the same type as in *H. barratti* and *H. f. fusiformis* but relatively more distinct. These dark areas showing more or less of a cross-stitch pattern. Upper third of sides and usually the back a more or less even monotone, about half as dark as the blotches. Lateral line marked by a narrow light line, not conspicuous against the light background. Base of caudal with 3 dark spots in a vertical row; the median one much darker than the outer 2, almost jet black. Dark bar, posterior to base of pectoral generally lacking, particularly in the female. Upper half of opercles dark, lower half, together with the cheek, mandibles, and throat light, usually with blotches reduced to specks or absent. A dark line before and behind eye; line above eye short, chiefly noticeable for its extension on the cornea; line below eye usually absent, if present narrow and faint. Parietal region relatively dark.

Female with the breast, belly, and adjacent sides, and ventral surface of the caudal peduncle light, without dark blotches. About half the males (about same size as others but possibly still immature) with these parts as in the female. Other males with breast sparsely speckled, the belly and adjacent sides with relatively few evenly scattered melanophores, about as large as those of *H. f. fusiformis*. These males showing a trace of a grill pattern on sides and back. Spinous dorsal of mature male with a dark submarginal band, somewhat wider posteriorly; below this band a clear area of equal width; basal two-thirds of fin dark, especially forward. Barring present but not noticeable except in the seemingly immature males, which have the dorsals as in the female. First dorsal of female barred on spines only. Second dorsal of mature male barred on rays, evenly speckled on membranes. Second dorsal of the female barred on rays only. Anal clear or, more usually, with weak barring in female; without barring and more or less speckled in male. Pectorals similar in both sexes, clear or with weak barring. Pelvics similar in non-breeding fish, clear (with a few speckles in some males).

In general color tone the type specimens are much lighter than any of the other subspecies of *fusiformis*. This is doubly remarkable since these specimens were taken in bog stained or "black water," which usually causes deep pigmentation, and in company with other species which were as dark or darker than usual.

Life colors.—Sides with a flush of greenish yellow to orange yellow. First dorsal with indistinct blotches of orange on rays and membranes, but no definite red markings.

Breeding season probably the first half of May. Most of the fish appear to have bred prior to collection.

HABITAT.—The ecological conditions at the type locality are as follows: water deeply bog-stained; pools and riffles above a swamp; bottom largely fine gravel with some sand, clay, and mud; depth to 6 feet; considerable emergent vegetation; temperature moderate. This form may be confined to the lower Potomac River drainage of Maryland or to the immediate vicinity thereof. Collections for some distance both to the north and south have yielded no samples of the species.

The name *atraquae*, of the "black water," refers to the type and probably the usual habitat.

Hololepis fusiformis erochrous COPE

Plate I, Figure 12

Boleosoma fusiforme Baird, 1855: 328 (N. J. record).

Hololepis fusiforme Abbott, 1868: 808.

Etheostoma fusiforme Jordan, 1885: 869 (in part); 1888, 1891, 1894: 134 (in part); Boulenger, 1895: 75 (in part).

Boleichthys fusiforme Bean, 1888: 132, 144, 150 (N. J. record).

Poecilichthys fusiformis Nelson, 1890: 730 (N. J. record); Abbott, 1894: 477 (N. J. records).

Boleichthys fusiformis Jordan and Evermann, 1896a: 1101 (in part); 1896b: 366 (in part); Jordan, 1899, 1904, 1910, 1914, 1916a: 134 and 357 (in part); Bean, 1903: 520 ("will doubtless be found in New York"); Fowler, 1906a: 302 (not Pl. 47; N. J. records); 1906b: 595 (Pa. record); 1911: 13 (Del. records); 1912: 41 (N. J. record); 1917: 112 (N. J. record); Nichols, 1918: 63 and 109 (record within 50 miles of N. Y. City); Fowler, 1919: 71 (Pa. record); 1920a: 295 (N. J. record); 1920b: 159 (N. J. literature records); 1921a: 390 (Del. record); 1921b: 68 (Pa. record); Pratt, 1923: 136 (in part); Jordan, Evermann, and Clark, 1930: 294 (in part); Fowler, 1933a: 124 (N. J. record); 1934: 210 (N. J. record).

Hololepis fusiformis Jordan, 1929: 169 (in part).

Not *Boleosoma fusiforme* Girard, 1854: 41.

Hololepis erochrous *Cope, 1864: 232 (original description); Abbott, 1871: 718; Vailant, 1873: 133; Abbott, 1894: 360.

Boleichthys (Hololepis) erochrous Jordan and Copeland, 1876: 135.

Boleichthys erochrous Jordan and Copeland, 1876: 163; Jordan, 1876: 220; 1877c: 16, 18; 1878d, 1880, 1884c: 22; 1878e: 440.

Poecilichthys erochrous Jordan and Gilbert, 1883a: 520; Cope, 1883: 132, 133 (N. J. record); Nelson, 1890: 730; Abbott, 1894: 477.

Boleichthys fusiformis erochrous Fowler, 1907a: 20 (1906 Pa. record); 1907b: 525; 1908: 175 (N. J. records).

Poecilichthys coemius Abbott, 1868: 808. "Evidently lapsus for *erochrous*" (Fowler, 1906: 304).

* Indicates important reference.

Microperca punctulata Abbott, 1868: 808 (almost certainly young of *H. f. erochrous*);
Nelson, 1890: 730 (included on Abbott's authority).

Not *Microperca punctulata* Putnam, 1863: 4.

MATERIAL EXAMINED AND RECORDED⁸

State, Drainage Basin, and Collection Data Reference; Museum No. (specimens)

NEW JERSEY:

Raritan River drainage basin:

Bound Brook, Somerset Co. Nelson, 1890: 730. Not seen.⁹
Cranbury Brook, Cranbury, Middlesex Co.
M. D. and M. M. Cannon; Oct. 6, 1933. Mich. 107092 (17).

Great Bay drainage basin:

"Wading R. near Waretown." Fowler, 1934: 210. Not seen.
Wading R., at Speedwell, Burlington Co. Fowler, 1906a: 302. Not seen.
Batsto R., Burlington Co. Cope, 1883: 132. Not seen.

Great Egg Harbor drainage basin:

Gravelly Run, Atlantic Co. Bean, 1888: 144. U.S.N.M.
45142 (2).
Tributary to Tuckahoe R., at Wallace's Mill,
Cape May Co. Fowler, 1912: 41. Phila. 40702.
Cedar Swamp Cr., Cape May Co. Baird, 1855: 328. M.C.Z. 24554
(3).

Atlantic Ocean drainage (stream not mentioned):

May's Landing [Cape May Co.] Fowler, 1920a: 295. Not seen.

Delaware Bay drainage basin:

Muddy Cr., Elmer, Salem Co. Fowler, 1917: 112. Phila.
40709-40710.

Delaware River drainage basin:

Stoney Brook, near Princeton, Mercer Co. Abbott, 1871: 718. Not seen.
Ten-foot Ditch, "Prospect Hill," Trenton. Abbott, 1894: 360. Not seen.
Crosswicks Cr., near Trenton, Mercer Co. Fowler, 1906a: 302; 1906b:
595; 1908: 175.

Watsons Cr., Trenton; Abbott and Fowler;
Aug. 1909. Phila. 40411-40427.

Delaware R., Trenton; Abbott and Fowler;
Aug. 23, 1903. Phila. 40671-40701.

Rancocas Cr., at Brown's Mills, Burlington
Co.; Jesse Burke. Cope, 1864: 232. Specimens
lost.

Same locality; Cannon and Cannon; Oct. 6,
1933. Mich. 107091 (8).

Rancocas Cr., at Birmingham, Burlington Co. Fowler, 1933a: 124. Not seen.

Rancocas Cr., near Medford, Burlington Co. Fowler, 1908: 175. Not seen.

⁸ Except as noted, all specimens listed have been examined by us.

⁹ "Not seen" indicates that the specimens referred to have not been reexamined.

PENNSYLVANIA:

Delaware River drainage basin:

Mill Cr., near Bristol, Bucks Co.

Fowler, 1906b: 595; 1907a: 20;
1919: 71; 1926: 68. Phila.
40670.

DELAWARE:

Delaware Bay drainage basin:

Mispillion Cr., Milford, Kent-Sussex county
line.

Fowler, 1911: 13. Phila. 40728.

Chesapeake Bay drainage basin:

West Branch of Nanticoke R., Sussex Co.
Cedar Cr. at both dams, S. of Lincoln City,
Sussex Co.

Fowler, 1921a: 390. Not seen.

Laurel Cr., Laurel, Sussex Co.

Fowler, 1921a: 390. Not seen.

Broad Cr.; Klein and Fowler; Oct. 1911.

Fowler, 1911: 13. Not seen.

Phila. 40668-40669.

Types, from Brown's Mills, New Jersey, were presumably deposited by Cope in the Philadelphia Academy of Natural Sciences, but are now seemingly lost, according to Mr. Fowler. Topotypes, however, were collected at Brown's Mills by the junior writer on October 6, 1933, 70 years after the types were taken.

The fish observed by Jordan from Lake Michigan, and tentatively identified by him as *H. erochrous* (1875: 28) were in all likelihood *Poeciliichthys exilis*.

Maximum size known, 39 mm. (standard length).

BODY.—Elongate, appearing less robust and less chunky than *H. f. fusiformis*; more compressed than *H. f. fusiformis* or even *H. f. atraquae*.

HEAD.—As in *H. f. fusiformis* (as described on p. 79).

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length; based, except as noted, on 6 specimens, 30 to 36 mm. in standard length).—Greatest depth (9 specimens) 16 to 20 (average 18); least depth 9 to 11 (11); length of caudal peduncle (3 specimens) 26 to 28 (27); greatest width 11 to 12 (11); width between lateral lines, below origin of first dorsal, 7 to 8 (8); length of head to opercular spine 25 to 27 (26); length of snout 5 to 7 (6); length of eye 6 to 8 (7); postorbital length 14 to 16 (15); width of head (3 specimens) 7 to 8 (8); width of interorbital (3 specimens) 4 to 5 (5); length of upper jaw (3 specimens) 7 to 8 (8); distance from tip of snout to origin of dorsal fin (3 specimens) 30 to 33 (31); highest dorsal spine (3 specimens) 12 to 14 (13); highest dorsal soft-ray (3 specimens) 14 to 15 (14); length of caudal fin (3 specimens) 24 to 25 (24); distance from tip of snout to origin of anal fin (3 specimens) 60 to 62 (61); length of anal base (3 specimens) 12 to 13

(12); length of pectoral fin (14 specimens) 20 to 24 (21); length of pelvic fin (9 specimens) 14 to 20 (17).

GENITAL PAPILLA.—In non-breeding female and male similar to those described for *H. f. fusiformis*.

FIN RAYS.—Dorsal, IX to XII—9 to 12; anal, II, 7.

SCALE ROWS.—Two to 3—46 to 55—7 to 9.

LATERAL LINE.—In specimens from Brown's Mills, 22 to 29 (average 25), in specimens from Cranbury, 19 to 24 (average 22) hundredths of the standard length; usually ending below posterior half of first dorsal. Pored scales 12 to 19, averaging 2 (Cranbury) to 4 (N. J. coast) more than in *H. f. fusiformis*. Unpored scales in lateral line row 29 to 40, averaging 0.5 (Cranbury) to 4.5 (N. J. coast) fewer than in *H. f. fusiformis*. Ratio of pored to unpored scales .31 to .60, averaging .05 (Cranbury) to .15 (N. J. coast) higher than in *H. f. fusiformis*. Lateral line high and distinctly arched, its rudimentary extension sloping downward, separated from origin of second dorsal by about one-half depth below lateral line at that vertical (all these measurements on a projection basis). Scales above rudimentary extension of lateral line at origin of second dorsal 4 or $4\frac{1}{2}$.

SQUAMATION.—As in *H. f. fusiformis*, on all areas except interorbital, which usually has one more or less embedded scale (occasionally 2 or none).

HEAD PORES.—Interorbital pores constantly lacking. Infraorbital canal interrupted, superficial to embedded, with 1 or 2, typically 2 pores behind the break, and with 3 pores above the upper jaw. Operculomandibular pores 8 in specimens from Brown's Mills (9 on one side in 2 specimens, and 7 on one side of another); 9 in all fish examined from other localities. Supratemporal canal usually complete, that is with a single median pore; except in Cranbury specimens, in about two-thirds of which it is interrupted.

COLORATION.—Lateral band of adult fish more striking and with better defined and more even edges than in *H. f. fusiformis*. Young with the lateral band disrupted into rectangular blotches as in young of *H. f. fusiformis*. Melanophores of lateral band very large and much intertwined. Edges of lateral band occasionally showing an indication of a cross-stitch pattern. Back often with irregular small darkened areas marking the position of the dorsal saddles of other species of *Hololepis*. Upper sides and back usually an even monotone, formed by chromatophores slightly larger than those on the belly in the male. Lateral line marked by a narrow light line. Base of caudal with 3 dark spots in a vertical row; the median one much darker than either of the outer 2, almost jet-black; the lowermost spot usually darker than the upper one. A dark bar posterior to base of pectoral. Upper half of opercles dark, lower half, together with the cheek, mandibles, and throat light, except for well-defined, small, dark blotches. Four dark lines radiating from eye, 2 horizontal and 2 vertical; line above the eye chiefly noticeable

for its extension on cornea; line below the eye occasionally weak; the one behind eye often merged with some of the dark blotches on the cheek. Parietals dark.

Female with the breast, belly, and adjacent sides, and ventral surface of the caudal peduncle light, without dark blotches. Non-breeding male with the breast light; belly, sides below the lateral band, and ventral surface of the caudal peduncle diffusely pigmented with small, more or less evenly scattered melanophores. Color pattern not so sharp in the male as in the female. Light areas of the body, including to some extent the sides above the belly and the ventral surface of the caudal peduncle, with a dark grill outlining the scale pockets. Scales of the nape in the male often with a row of small, very dark melanophores at the base of the ctenii. Spinous dorsal of the male with a dark submarginal band, somewhat wider posteriorly; below this band a clear area of equal width; basal two-thirds of fin dark, blackened anteriorly. Barring on spines present but not very apparent. First dorsal of the female barred on spines only, without pigment in the membrane. Second dorsal in both sexes barred on rays, that of male in addition speckled on membranes; these specklings not aligned with the bars. Anal barred on rays only in female; more or less speckled and with little or no barring in the male. Paired fins similar in both sexes; pectoral rays outlined by fine, interrupted, dark lines; pelvics clear.

Life colors.—Lateral stripe and markings on the head dark brown. Lower parts pearly. A brilliantly iridescent, greenish gold spot in front of pectoral base. Caudal, dorsal, and anal fins alternately barred with dark red and yellow on the rays only.

Female with the upper sides and back brownish gray instead of golden tan as in the male; lacking the dark edges on the scales of the nape present in the male. These differences are marked in the Brown's Mills specimens, of which the females have a rosy tinge on the paired fins.

HABITAT.—Taken in clear swift water about 2 feet deep, at Cranbury, New Jersey; bottom mud and gravel with dense vegetation, sticks, and débris. The following conditions occurred at Brown's Mills, where collections were obtained from the inlet of the mill pond: water free from silt but so deeply bog stained that one's hand a foot below the surface was hardly visible; current moderate to none; bottom mostly turf as pond was over its banks; fished to 4 feet.

As indicated in the list of specimens, this subspecies ranges throughout New Jersey, Delaware, and southeastern Pennsylvania, in several drainage basins from the Raritan to the Chesapeake. Through this area it shows considerable variations, brought out in Tables II and III.

Specimens from Cranbury, in the Raritan drainage, differ only slightly from those from Massachusetts in number of lateral line scales, while those

from the short streams flowing into the Atlantic in southern New Jersey (Gravelly Run and Cedar Swamp Creek) are the most widely divergent from typical *fusiformis*. The specimens from the type locality (Brown's Mills) are intermediate. One or two scales on the interorbital are present on all specimens in collections other than that from Cranbury, in which as many individuals lack interorbital scales as have them. The operculomandibular pores are 9 in the Cranbury collection, as in *fusiformis*, but typically 8 in those from Brown's Mills. The number was not noted in specimens from Gravelly Run and Cedar Swamp Creek. The specimens from Cranbury might well be considered as intergrades between *erochrous* and *fusiformis*, because of the intermediate squamation, but they are typical of *erochrous* in form and color. Those from Brown's Mills seem sufficiently like the extreme form isolated on the peninsular part of New Jersey to justify the use of Cope's name for that form. Specimens from Broad Creek, in the north-eastern part of the Chesapeake Bay drainage basin, show no approach toward *H. f. atraquae*.

Hololepis fusiformis fusiformis (GIRARD)

Plate I, Figure 13

Boleosoma fusiforme *Girard, 1854: 41 (original description).

Hololepis fusiformis Putnam, 1863: 4; Cope, 1864: 233 (synopsis of the species of *Hololepis*); Storer, 1867: 256 (Mass. records); Vaillant, 1873: 131; Jordan, 1929: 169 (in part).

Boleichthys (Hololepis) fusiformis Jordan and Copeland, 1876: 135.

Boleichthys fusiformis Jordan and Copeland, 1876: 163; Jordan, 1876: 220; 1877c: 16, 18; 1878a: 94; 1878d, 1880, 1884c: 228; 1878e: 440; Goode and Bean, 1879: 19 (Mass. records); Jordan and Evermann, 1896a: 1101 (in part); 1896b: 366 (in part); Jordan, 1899, 1904, 1910, 1914, 1916a: 134 and 357 (in part); Kendall, 1908: 94 (Mass. records); Pratt, 1923: 136 (in part); Jordan, Evermann, and Clark, 1930: 294 (in part).

Poecilichthys fusiformis Jordan and Gilbert, 1883a: 519.

Etheostoma fusiforme Jordan, 1885: 869 (in part); 1888, 1891, 1894: 134 (in part); Boulenger, 1895: 75 (in part).

Copelandellus fusiformis Hubbs, 1926: 67.

* Indicates important reference.

MATERIAL EXAMINED AND RECORDED¹⁰

State, Drainage Basin, and Collection Data Reference; Museum No. (specimens).

MASSACHUSETTS:

Atlantic Ocean drainage basin north of Cape Cod:

Spiggot R., Lawrence; F. W. Putnam; April
30, 1859.

M.C.Z. 108 (1).

N. Andover, R. H. Wheatland.

M.C.Z. 24595 (8).

¹⁰ Except as noted, all specimens listed have been examined by us.

Bennett Brook and Pond, 2 miles E. of Ayer; C. L. Hubbs and L. C. Hubbs; Aug. 5, 1928.	Mich. 107087 (34).
Maple Meadow Brook, 3 miles W. of Reading; Hubbs and Hubbs; Aug. 11, 1928.	Mich. 107088 (6).
Wenham Lake.	Goode and Bean, 1879: 19; Kendall, 1908: 94. Not seen. ¹¹
Ditch of Middleton Pond; Wheatland.	M.C.Z. 24593 (5); Mich. 86583 (1).
Newhall's Pond, Danvers; Wheatland.	Goode and Bean, 1879: 19. M.C.Z. 24558 (5); Mich. 86591 (1).
Salem; Wheatland.	M.C.Z. 24548 + 24560 (4); Mich. 86581 (1).
Brook tributary to Melrose Pond, Melrose; J. W. Lovering and F. W. Putnam; May 1 to 12, 1860.	Goode and Bean, 1879: 19; Kendall, 1908: 94. M.C.Z. 24522 + 24584 + 24588 + 24599 (25); U.S.N.M. 1829 (1) ¹² ; Mich. 86567 (6).
East Lexington; A. C. Clark; Mar. 18, 1903.	M.C.Z. — (4); Mich. 86552 (1).
Waltham.	Kendall, 1908: 94. Not seen.
Fresh Pond [near Cambridge?].	M.C.Z. 24691 (6); Mich. 86586 (1).
Auburndale.	M.C.Z. 24552 (2).
Tributary of Charles R. at Framingham; S. F. Baird.	Girard, 1854: 41. M.C.Z. 24589 (4); Mich. 86582 (1); U.S.N.M. 1188 (1) and 94686 (—).

RHODE ISLAND:

Narragansett Bay drainage basin:

Pawtuxet R., S. of Providence; Hubbs and
Hubbs; July 29, 1928.

Mich. 107086 (250).

Cotypes are the specimens collected by Professor S. F. Baird in a tributary of Charles River at Framingham, Massachusetts. Cat. No. 1188, United States National Museum, is retained for the lectotype selected by us, an adult female 33 mm. in standard length. The other specimens originally in the same lot become Cat. No. 94686. Other cotypes of the same original lot are

¹¹ "Not seen" indicates that the specimens referred to have not been reexamined.

¹² This specimen was likely from the Melrose Pond series, although its jar has borne the obviously erroneous outside label "River Ho, L. I. Prof. S. F. Baird." Dr. George S. Myers writes "There has been a mix-up in our old catalogue book and it is not certain whether No. 1829 came from 'Brook of Melrose Pond, Massachusetts,' 'North Red River, Minnesota' or 'River Head, Long Island' (*not* River Ho)." Baird (1855) in reporting on material from River Head, Long Island, did not mention this species from that locality. The North Red River is of course out of the question. We therefore suppose the specimen came from Melrose Pond.

4 in the Museum of Comparative Zoology (No. 24589) and 1 in the Museum of Zoology, University of Michigan (No. 86582).

Maximum size known, 43 mm. (standard length).

BODY.—Robust for a form of *Hololepis*, though elongate by comparison with most other darters; relatively little compressed.

HEAD.—Muzzle rather blunt; mouth subterminal, slightly oblique; lower jaw slightly included. Preopercle smooth. Gill membranes rather broadly connected: distance from angle to tip of snout decidedly greater than half length of head.

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length; based, except as noted, on 21 specimens, 16 to 43 mm. in standard length).—Greatest depth (40 specimens) 17 to 21 (average 19); least depth 9 to 12 (11); length of caudal peduncle 23 to 28 (26); greatest width (19 specimens) 12 to 14 (13); width between lateral lines, below origin of first dorsal (19 specimens) 8 to 10 (9); length of head to opercular spine 21 to 32 (27); length of snout 3 to 6 (5); length of eye (30 specimens) 6 to 9 (7); postorbital length 13 to 18 (15); width of head 8 to 11 (9); width of interorbital 3 to 7 (5); length of upper jaw 6 to 10 (7); distance from tip of snout to origin of dorsal fin 31 to 41 (35); highest dorsal spine 10 to 13 (12); highest dorsal soft-ray 12 to 16 (14); length of caudal fin 20 to 26 (22); distance from tip of snout to origin of anal fin 58 to 66 (62); length of anal base 10 to 15 (13); length of pectoral fin 18 to 24 (21); length of pelvic fin 15 to 23 (18).

GENITAL PAPILLA.—In the mature female conical, somewhat enlarged at the base; opening by a slit on the ventral (anterior) side; usually extending for one-third its length beyond origin of anal fin. In actually breeding females, turgid; held out at an angle to the body; beet-shaped, the bulbous basal half of the papilla surmounted by the relatively attenuate tip. Genital papilla of the male conical without basal enlargements, opening by a pore at the tip; small (slightly larger than in *H. gracilis* and *H. thermophilus*), approaching or barely reaching origin of anal fin; in actually breeding males, turgid and held out at an angle to the body as in the female. Papilla of both sexes during summer months flaccid and appressed to body, showing little sexual difference in length, but that of female twice as wide as that of male.

Breeding tubercles developed on the distal portions of the soft rays of the anal fin and probably also on pelvic fins, though not apparent there in available specimens.

FIN RAYS.—Dorsal, IX to XII—9 to 12, usually X—10 or 11; anal, II, 6 to 7.

SCALE ROWS.—Two to 3, usually 3—45 to 54—7 to 9, usually 8.

LATERAL LINE.—Eight to 23 (average 20) hundredths of the standard length; averaging the same as in all other subspecies of *H. fusiformis*, with

the exception of *H. f. erochrous*, and shorter than in any of the other species assigned to *Hololepis*; ending below anterior half of first dorsal. Pored scales 5 to 17. Unpored scales in lateral line row 31 to 44, each with a shallow pit containing a minute papilla. Ratio of pored to unpored scales .12 to .49, usually more than .25. Lateral line high and distinctly arched, its rudimentary extension sloping downward, separated from origin of second dorsal by about one-half depth below lateral line at that vertical (all these measurements on a projection basis). Scales above rudimentary extension of lateral line at origin of second dorsal usually 4, often $3\frac{1}{2}$, rarely 3.

SQUAMATION.—Breast covered with cycloid, embedded scales. Nape well scaled. Cheek scales exposed and strongly ctenoid, even ventrally in half grown. Opercles covered with ctenoid scales. Parietal region scaleless dorsally; lateral edges above the lateral canal with a row of scales, occasionally extending to eye, and rarely with a portion of a second row. Interorbital typically naked, rarely with 1 and very rarely (in 1 specimen examined) with 2 embedded cycloid scales.

HEAD PORES.—Interorbital pores constantly lacking. Infraorbital canal interrupted, superficial to embedded, with 1 or 2, typically 2 pores behind the break and 3 pores above the upper jaw. Operculomandibular pores 9, occasionally 8. Supratemporal regularly complete, in adult fish, usually incomplete in young specimens.

COLORATION.—Median sides with large rectangular, dark blotches, distinct in young fish but joined to form a ragged band in adult specimens. Upper third of sides and back with small, irregular, dark blotches not much darker than the ground color into which they merge. Melanophores forming the dark blotches of sides and back large, but so intertwined that all individuality is lost. Lateral line marked by a series of light dots often joined to form a light line. Base of caudal usually with 4 dark spots in a vertical row; the upper one of the median pair usually reduced in size and intensity, occasionally obsolete; lower spot of median pair often almost jet black, darker than any of the others. A dark bar posterior to base of pectoral. Upper half of cheek and opercles dark; lower half of cheek and opercles, as also the mandibles and throat, light with well defined dark blotches. A dark line above, below, and in front of eye; the pigment extending on the cornea, particularly from above. Line behind eye usually merged with dark upper half of cheek and opercles. Parietal region dark.

Female with the breast, belly, sides below the lateral band, and ventral surface of the caudal peduncle light; with small dark blotches of large intertwined melanophores on some or all of these areas. Non-breeding male with the breast light, occasionally showing some of the specks developed here in the breeding season. The belly, sides below the lateral band, and ventral surface of the caudal peduncle diffusely pigmented with many, small, evenly

scattered melanophores; usually, but not always, lacking the dark blotches present in the female. The melanophores on the belly and adjacent sides are somewhat larger, fewer, and sparser than in *H. barratti*. No evidence of a grill pattern on the body of the male. Spinous dorsal of the male with a dark submarginal band, below which is a clear area of equal width; basal half of fin dark, blackened forward. Spinous dorsal of the female barred chiefly on rays; pigment if present in membrane, confined to basal part of fin. Second dorsal and anal fins in non-breeding male and female similarly barred, but with more pigment on the membranes in the male than in the female. Paired fins similar in the sexes: pectorals weakly barred; pelvics clear or with weak barring.

Breeding male with the breast and throat speckled with melanophores about as large as those on the belly, or slightly larger. Second dorsal and especially the anal and pelvic fins heavily speckled. Breeding female seemingly not modified in color.

Life colors.—Body usually a reddish brown; in specimens from Rhode Island usually a peculiar bluish gray. First dorsal (in August collections) without red markings or other bright colors; the spines marked with pinkish amber and dusky dashes, irregularly spaced.

Breeding season probably early May.

HABITAT.—The ecological situations in which this form occurs are indicated in 3 original collections made in 1928: water, moderately clear to heavily bog stained; current, none to moderately swift; bottom, mud to fine gravel in one collection, mud, sand, and rock in 2; depth, to 5 feet; vegetation, abundant and dense. Probably this form occurs on riffles only where abundant vegetation provides shelter. Many of the older collections are from ponds, indicating that this form, in Massachusetts and Rhode Island, replaces *Poeciliichthys exilis* as the darter typical of static waters, just as *H. gracilis* replaces *P. exilis* in southern Indiana and southern Illinois.

Hololepis fusiformis metae-gadi, NEW SUBSPECIES

Plate I, Figure 14

Boleosoma nigrum Cockerell, 1913: 144, 155 (description of scales; materials from Osterville only).

Boleichthys fusiformis Cockerell, 1913: 120 (correction of misidentification of Osterville material).

MATERIAL EXAMINED AND RECORDED

State, Drainage Basin, and Collection Data Reference, Museum No. (specimens)

MASSACHUSETTS:

Cotuit Harbor drainage basin:

Tempies Pond, Osterville, Barnstable Co.
(Cape Cod); Vinal Edwards; Nov. 12, 1902.

Cockerell, 1913: 144, 155. U.S.
N.M. 77860 (1) and 94683
(34); Mich. 107093 (2).

This form is almost distinct enough in appearance and in high number of scales, to warrant specific separation from *H. f. fusiformis*. It is almost or quite as slender and thin as *H. thermophilus*. Its distinctive features, as compared with the other subspecies, are shown in Table III.

HOLOTYPE.—Cat. No. 77860, United States National Museum, an adult male 33 mm. long to caudal fin, with data just given. The other specimens from the same collection are all designated as paratypes.

Maximum size known, 40 mm. (standard length).

BODY.—Very slender and elongate, more so than in any other form of *Hololepis* with the exception of *H. thermophilus*. Young fish appearing more terete, older ones more compressed than *H. f. fusiformis* of equal size.

HEAD.—As in *H. f. fusiformis* (as described on p. 79).

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length; based, except as noted, on 3 specimens, 31 to 39 mm. in standard length).—Greatest depth (14 specimens) 16 to 17 (average 16); least depth (6 specimens) 9 to 12 (10); length of caudal peduncle 29 to 30 (29); greatest width (11 specimens) 10 to 12 (10); width between lateral lines, below origin of first dorsal (11 specimens) 7 to 8 (8); length of head to opercular spine (11 specimens) 21 to 25 (23); length of snout (6 specimens) 4 to 5 (5); length of eye (14 specimens) 6 to 7 (6); postorbital length (6 specimens) 13; width of head 8 to 9 (8); width of interorbital 5; length of upper jaw 6 to 8 (7); distance from tip of snout to origin of dorsal fin 30 to 32 (31); highest dorsal spine 8 to 10 (10); highest dorsal soft-ray 12 to 14 (14); length of caudal fin 19 to 23 (22); distance from tip of snout to origin of anal fin 58 to 60 (59); length of anal base 11 to 13 (12); length of pectoral fin (6 specimens) 19 to 22 (21); length of pelvic fin (6 specimens) 16 to 20 (19).

GENITAL PAPILLA.—In mature female and male as in *H. f. fusiformis*.

FIN RAYS.—Dorsal, IX to XI, usually X—9 to 11; anal, II, 7.

SCALE ROWS.—Two to 3, usually 3—50 to 61—8 to 9, usually 8.

LATERAL LINE.—Sixteen to 22 (average 20) hundredths of the standard length, ending below anterior half of first dorsal. Pored scales 3 to 15, averaging 1 fewer than in *H. f. fusiformis*. Unpored scales in lateral line row 38 to 54, averaging 8 more than in *H. f. fusiformis*. Ratio of pored to unpored scales .13 to .37, averaging .08 less than in *H. f. fusiformis*. Lateral line high and distinctly arched, its rudimentary extension sloping downward, separated from origin of second dorsal by about one-half depth below lateral line at that vertical (all these measurements on a projection basis). Scales above rudimentary extension of lateral line at origin of second dorsal 4 to 5, averaging more than in other forms.

SQUAMATION.—As in *H. f. fusiformis*. Interorbital typically naked, rarely with a single embedded cycloid scale.

HEAD PORES.—As in *H. f. fusiformis*. Infraorbital constantly with 2 pores behind the break and 3 above the upper jaw.

COLORATION.—Similar to that described for *H. f. fusiformis* except in the following respects: upper sides and back a more or less even monotone, merging with the lateral band, which is less darkened than in the typical subspecies. Dark areas of the body showing the cross-stitch pattern more distinctly than in *H. f. fusiformis*. Base of caudal usually with 3 dark spots in a vertical row, the median one the darkest, often almost jet black; upper spot of outer two fainter than lower, often obsolescent.

Breeding changes unknown.

HABITAT.—Tempies Pond, from which alone this distinct form is known, lies on the south side of Cape Cod, about 25 feet above sea-level and 500 feet from the shore of Cotuit Harbor. Like many of the smaller Cape Cod ponds, it has no outlet. It is about one-fourth mile in diameter, and has rather low, sandy banks.

The name *metae-gadi* is the genitive of the Latinization for Cape Cod.

Hololepis fusiformis insulae, NEW SUBSPECIES

Plate I, Figure 15

MATERIAL EXAMINED AND RECORDED

State, Drainage Basin, and Collection Data	Reference; Museum No. (specimens)
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MASSACHUSETTS:

Gibbs Pond Drainage Basin:

Gibbs Pond, Nantucket Island; Dr. Harrison	M.C.Z. 28274 (1), 33547 (8);
Allen; "Rec'd Aug. 10, 1893."	Mich. 86601 (2).

A diligent attempt by the junior writer to obtain more specimens in Gibbs Pond and adjacent sloughs, in October, 1933, failed completely. It is possible that this fish has become extinct in recent years, because of fluctuations in level caused by pumping water from the pond on cranberry bogs.

Though represented by rather small and poorly preserved specimens, this island form seems distinct enough from either *H. f. fusiformis* or *H. f. metae-gadi* of the near-by mainland to warrant subspecific separation. Its distinctive characters are listed in Table III. The dorsal spines average fewer than in any of the other subspecies. The scales average somewhat fewer than in typical *fusiformis* and much fewer than in *metae-gadi*. The scales apparently are much less distinctly ctenoid than in the other forms.

HOLOTYPE.—A probably half-grown fish, 24 mm. in standard length, Cat. No. 28274, the Museum of Comparative Zoology, with data just given. The other specimens listed are designated as paratypes.

Maximum size known, 26 mm. (standard length).

BODY.—Elongate, shaped about as in *H. f. fusiformis* of the same size, possibly somewhat deeper; certainly not so slender as *H. f. metae-gadi*.

HEAD.—As in *H. f. fusiformis* (as described on p. 79).

MEASUREMENTS (projection of parts along a horizontal or vertical axis, expressed in hundredths of the standard length, based on 4 specimens, 16 to 26 mm. in standard length).—Greatest depth 15 to 18 (average 16); least depth 8 to 9 (9); length of caudal peduncle 24 to 28 (26); greatest width 9 to 10 (10)?; width between lateral lines, below origin of first dorsal 6?; length of head to opercular spine 25 to 31 (27); length of snout 4 to 6 (5); length of eye 7 to 9 (8); postorbital length 15 to 16 (15); width of head 9 to 11 (10); width of interorbital 3 to 6 (4); length of upper jaw 7 to 9 (8); distance from tip of snout to origin of dorsal fin 35 to 38 (37); highest dorsal spine 8 to 11 (10); highest dorsal soft-ray 8 to 14 (13); length of caudal fin 19 to 23 (21); distance from tip of snout to origin of anal fin 62 to 64 (63); length of anal base 10 to 18 (11); length of pectoral fin 20 to 24 (21); length of pelvic fin 11 to 20 (16). Measurements of the greatest width of body and of width between lateral lines are probably of little value because of the shrunken condition of the specimens.

GENITAL PAPILLA.—In female and male (distinguishable in several fish) similar in summer condition to that of *H. f. fusiformis* of the same size.

FIN RAYS.—Dorsal, VIII to IX—9 to 10, occasionally 11; anal II, 7.

SCALE ROWS.—Two to 3—41 to 49—6 to 8, usually 7.

LATERAL LINE.—Nineteen to 22 (average 20) hundredths of the standard length; ending below anterior half of second dorsal. Pored scales 7 to 14, averaging very slightly fewer than in *H. f. fusiformis*. Unpored scales in lateral line row 29 to 37, averaging 3 fewer than in *H. f. fusiformis*. Ratio of pored to unpored scales .26 to .43, averaging very slightly more than in *H. f. fusiformis*. Lateral line high and distinctly arched, its rudimentary extension sloping downward, separated from origin of second dorsal by about one-half the depth below lateral line at that vertical (all these measurements on a projection basis). Scales above rudimentary extension of lateral line at origin of second dorsal $3\frac{1}{2}$ or 4.

SQUAMATION.—Probably as in *H. f. fusiformis*. Ctenii of both head and body scales apparently not nearly so well developed; the scales often almost or quite cycloid, to a degree which hardly seems attributable solely to the condition of the specimens.

Head pores as in *H. f. fusiformis*.

COLORATION.—Similar, as nearly as can be told, to specimens of the same size of *H. f. fusiformis*. Dark blotches of median sides distinct in most specimens, tending to merge in a few. Vertical fins barred, showing a trace of pigment in one probable male, indicating a pattern similar to that of the other subspecies. Paired fins as in *H. f. fusiformis*.

HABITAT.—Gibbs Pond was found to be circular and about one-half mile in diameter, and to lie in the fosse between the almost level outwash plain and the Altar Rock Hills, which are part of the morainic ridge forming the backbone of the island (Woodworth, 1934: 101–103). There are a number of fresh-water ponds on Nantucket, but most of them are merely stream estuaries cut off from the ocean by a bar at the mouth. Gibbs Pond lies about 2 miles inland and is almost certainly wholly of glacial origin. It has no real outlet, but the water drains (or is pumped) through extensive cranberry bogs to the southeast. The shore is of hard packed sand. *Scirpus*, which grows far out in shallow water, forms almost the only vegetation present. On the south side, behind small beach ridges, are sloughs filled with vegetation.

Residents say that the fresh-water ponds of the island have never been stocked, and that perch and pike (or pickerel) occur in them. It seems certain that the state of Massachusetts has never done any stocking here, due to the peculiar legal status of the ponds. Sharp and Fowler (1904: 509) say little about the fresh-water ponds beyond reporting the occurrence of perch and pike, on the basis of islanders' statements.

The most plausible explanation of the presence of this and other fresh-water fishes on Nantucket Island is that the southern New England mainland extended farther seaward in early postglacial times than at present, and that fresh-water lakes then existed in what is now Long Island Sound and the lower Hudson Valley (Antevs, 1928: 83–86; Lougee, MS).¹³ The land area, it is hypothesized by these geologists, extended seaward about 90 miles beyond the present coast line, so that Long Island, Block Island, Martha's Vineyard, and Nantucket were part of the mainland. This theory of land connection harmonizes with the observation of botanists (Hollick, 1893: 189–202, and others), that the flora of Nantucket and Martha's Vineyard includes many species typical of the New Jersey Pine Barrens, for the greater extent of land would provide means for the migration of sand-loving plants.

When Nantucket Island was a hill on the coastal plain, it could have derived its fresh-water fish fauna from the large lake into which its waters presumably drained. This lake, occupying most of the trough which is now Long Island Sound, was, we are assured by Mr. Lougee, surely temperate in its later stages. Although this lake probably did not extend west of Stamford, Connecticut, it could probably have derived its fauna readily from Lake Hackensack (in the present lower Hudson Valley), by passage over a low

¹³ We are grateful to Mr. Richard J. Lougee and Professor Douglas W. Johnson, of Columbia University, for a discussion of this problem, and especially for information from Mr. Lougee's unpublished work. A map of the lake postulated to have existed in what is now Long Island Sound, has just been published by Lougee (1935).

marshy divide. Lake Hackensack was presumably populated with fresh-water fishes relatively early in postglacial times, because the level country to the southward probably presented few barriers to their rapid redispersal.

The name *insulae*, referring to the island habitat, was chosen because this subspecies seems to be the first fresh-water fish of temperate North America thought to be characteristic of an island.

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PLATE I

THE SPECIES AND SUBSPECIES OF *VILLORA* AND *HOLELEPIS*

- Fig. 1. *Villora edwini*: female paratype from Santa Fe River at Poe Springs, Florida; 35 mm. long to caudal; Mus. Zool. Univ. Mich. 101680.
- Fig. 2. *Hololepis serrifer*: female paratype from Cedar Creek near Leesville, South Carolina; 35 mm. long to caudal; Charleston Museum 33.260.1.
- Fig. 3. *Hololepis gracilis*: male from tributary to Kaskaskia River from old Reilly Lake, Illinois; 43 mm. long to caudal; Illinois State Laboratory of Natural History 1901.
- Fig. 4. Female from same collection; 41 mm. long to caudal.
- Fig. 5. *Hololepis zonifer*: female holotype from Catoma Creek, Alabama; 31 mm. long to caudal; Mus. Zool. Univ. Mich. 88803.
- Fig. 6. *Hololepis saludae*: immature paratype from Richland Creek, Saluda Co., South Carolina; 23 mm. long to caudal; Mus. Zool. Univ. Mich., 107078.
- Fig. 7. *Hololepis collis*: male holotype from creek near York, South Carolina; 40 mm. long to caudal; Mus. Zool. Univ. Mich. 94590.
- Fig. 8. *Hololepis barratti*: male from Wassamassaw Swamp, South Carolina; 40 mm. long to caudal; Mus. Zool. Univ. Mich. 107083.
- Fig. 9. Female from same collection; 37 mm. long to caudal.
- Fig. 10. *Hololepis thermophilus*: male holotype from Kipling, North Carolina; 33 mm. long to caudal; Mus. Zool. Univ. Mich. 107072.
- Fig. 11. *Hololepis fusiformis atraquae*: male holotype from Mattawoman Swamp, Maryland; 32 mm. long to caudal; Mus. Zool. Univ. Mich. 107090.
- Fig. 12. *Hololepis fusiformis erochrous*: male topotype from Brown's Mills, New Jersey; 37 mm. long to caudal; Mus. Zool. Univ. Mich. 107091.
- Fig. 13. *Hololepis fusiformis fusiformis*: female from near Reading, Massachusetts; 37 mm. long to caudal; Mus. Zool. Univ. Mich. 107088.
- Fig. 14. *Hololepis fusiformis metae-gadi*: male paratype from Osterville, Massachusetts; 32 mm. long to caudal; Mus. Zool. Univ. Mich. 107093.
- Fig. 15. *Hololepis fusiformis insulae*: immature paratype from Gibbs Pond, Nantucket, Massachusetts; 26 mm. long to caudal; Mus. Zool. Univ. Mich. 86601.

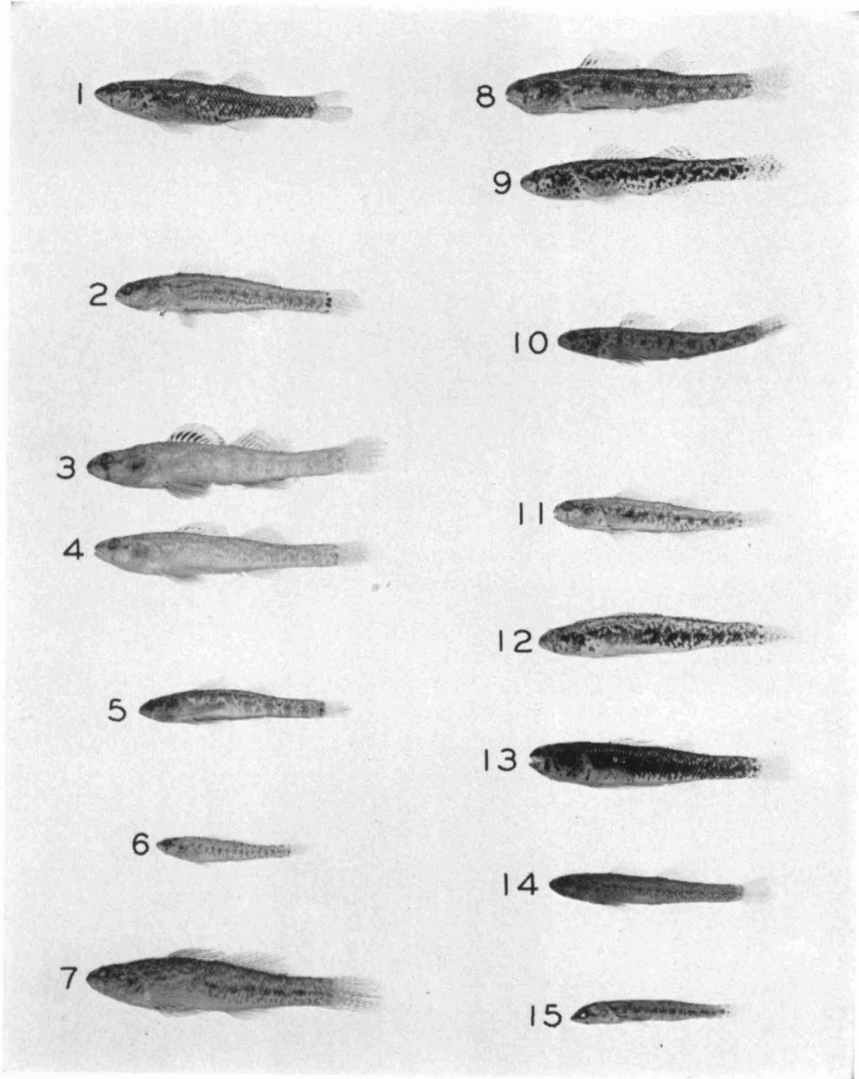


PLATE II

MAIN TYPES OF HEAD PORE ARRANGEMENT IN *VILLORA* AND *HOLELEPIS*

Fig. 1. Dorsal view of the head of *Villora edwini* indicating the terminology of the lateral line system.

ST, supratemporal canal (complete, pores 1-1-1). *LAT*, lateral canal. *SO*, supraorbital canal. *PO*, postorbital pore. *COR*, coronal pore. *INT*, interorbital pore. *PN*, posterior nasal pore. *AN*, anterior nasal pore. All of the pores named are paired, except the coronal.

Fig. 2. Lateral view of the head of *Villora edwini* indicating the terminology of the lateral line system.

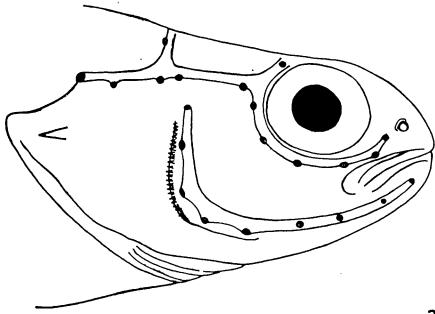
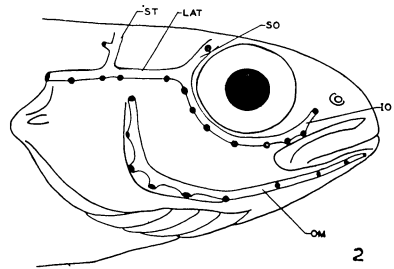
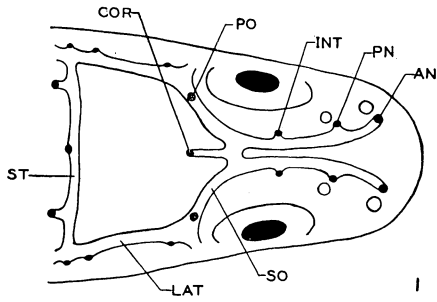
ST, supratemporal canal. *LAT*, lateral canal. *SO*, supraorbital canal. *IO*, infraorbital canal (complete, pores 8). *OM*, operculomandibular canal (pores 10).

Fig. 3. *Hololepis serrifer* (infraorbital canal complete, its pores 6 (3-3); operculomandibular pores 9).

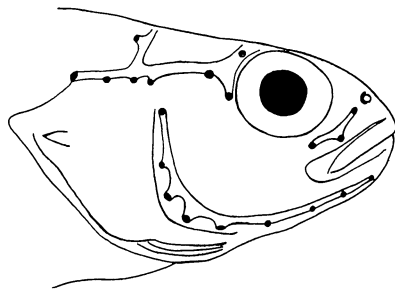
Fig. 4. *Hololepis collis* (infraorbital canal interrupted, its pores 1+3; operculomandibular pores 9). This drawing represents equally well the typical condition in *H. barratti*. *H. thermophilus* and *H. fusiformis* usually have one more infraorbital pore behind the eye, that is, a total of 2+3 infraorbital pores.

Fig. 5. *Hololepis gracilis* (infraorbital canal complete, its pores 8 (4-4); operculomandibular pores 10).

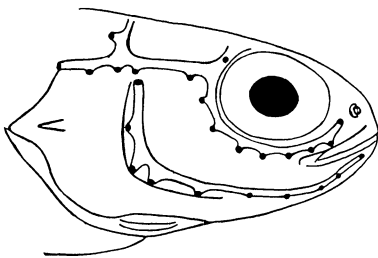
Fig. 6. *Hololepis zonifer* (infraorbital canal interrupted, its pores 2+4; operculomandibular pores 10).



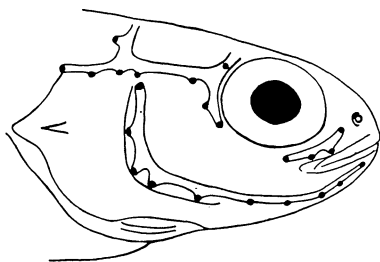
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PLATE III

THE DISTRIBUTION OF THE SPECIES AND SUBSPECIES OF *VILLORA* AND *HOLELEPIS*

