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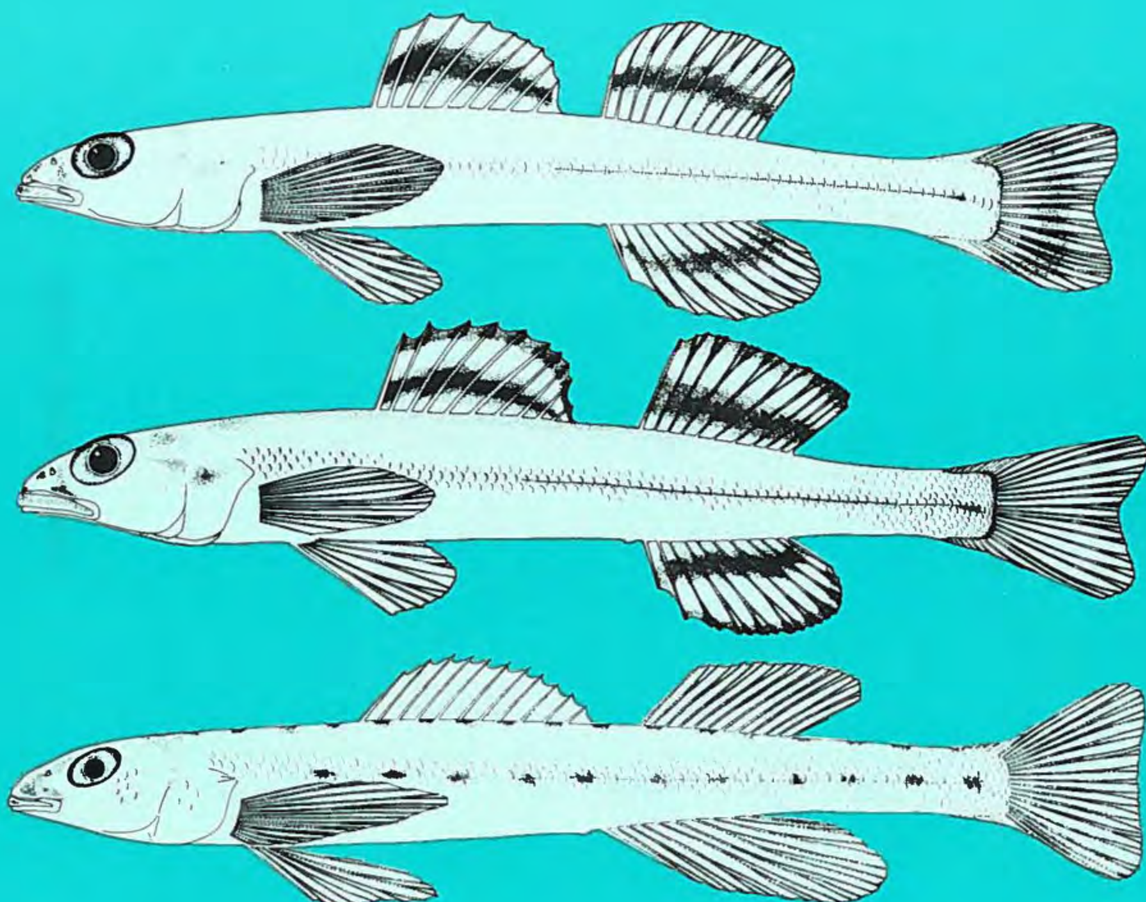

Systematics of the Percid Fishes of the Subgenus *Ammocrypta*, Genus *Ammocrypta*, with Descriptions of Two New Species

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Systematics of the Percid Fishes of the Subgenus *Ammocrypta,* Genus *Ammocrypta,* with Descriptions of Two New Species

James D. Williams, Ph.D.

THE UNIVERSITY OF ALABAMA
UNIVERSITY, ALABAMA
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ABSTRACT

Williams, James D., Systematics of the Percid Fishes of the Subgenus *Ammocrypta*, Genus *Ammocrypta*, with Descriptions of Two New Species. Bulletin Alabama Museum of Natural History, Number 1, 56 pages, 8 figures, 38 tables, 1975. The purpose of this study is to clarify the systematics, taxonomy, zoogeography, and intraspecific variation of the subgenus *Ammocrypta*, genus *Ammocrypta*. More than 20 taxonomic characters were examined on approximately 550 specimens of *A. beani* Jordan; 325 specimens of *A. bifascia* Williams, new species; 500 specimens of *A. clara* Jordan and Meek; 700 specimens of *A. vivax* Hay; 200 specimens of *A. meridiana* Williams, new species; and 800 specimens of *A. pellucida* (Agassiz). Twenty-two proportional measurements were taken from 10 or more specimens of each species. Distribution maps and a figure of a male specimen of each species are included. Information available from both personal observations and from previously published studies on the habitat, life history, and burying behavior of each species is reported. A key to the species of the subgenus is presented. A diagnosis is given for the subgenus *Ammocrypta*. The subgenus includes six species that typically inhabit sandy streams of the Gulf Coastal Plain, the Mississippi Valley and the Great Lakes drainages.

A new species, *A. bifascia*, is described from the Perdido, Escambia, and Choctawhatchee Bay drainages in western Florida and southeastern Alabama. The new species is closely related to *A. beani* but differs in having a dark marginal and submarginal band on the median fins, whereas *A. beani* has a dark blotch on the anterior spines of the first dorsal fin and a median band on the anal and soft dorsal fins. The range of *A. beani* extends from the Mobile Basin west to the Big Black River, a Mississippi River tributary. The presence of a disjunct population in the Hatchie River in southwestern Tennessee may have resulted from stream capture of the upper Tombigbee River drainage.

Ammocrypta clara is distinguished by the presence of a strong opercular spine, absence of blotches or bands of pigment in the fins, and well developed tubercles on the pelvic, anal, and caudal fins. *A. clara* inhabits moderate to large rivers throughout the Mississippi Valley with the exception of the Tennessee, Missouri, and Arkansas drainages. It also occurs in the Sabine and Neches rivers on the western Gulf Slope and in the Waupaca River, a tributary of Lake Michigan.

The most variable species of the subgenus is *A. pellucida*. The variation appeared to be random with no clinial or geographic trends. *A. pellucida* is distributed throughout most of the Ohio Basin and the southern end of Lake Huron, Lake St. Clair, Lake Erie, and below Lake Ontario in the St. Lawrence River drainage. A new species, *A. meridiana*, closely related to *A. pellucida*, is described from the Coastal Plain in the Mobile Basin. In the past *A. meridiana* has been confused with *A. vivax*. It is distinguished from *A. vivax* by the absence of dark bands on the median fins, horizontal orientation of the long axis of the lateral blotches, and in the absence of breeding tubercles on the anal fin. *A. meridiana* differs from *A. pellucida* in having more complete squamation of the body, tip of snout usually pigmented, usually 42 vertebrae, and the first interneural spine between the neural spines of the seventh and eighth vertebrae.

A. vivax is the most completely scaled species of the subgenus. It is also characterized by presence of dark bands on the first and second dorsal fin, and usually the caudal fin; long axis of the lateral blotches being vertically oriented; and breeding tubercules on the pelvic and anal fins. *A. vivax* is primarily a Coastal Plain species, having its center of distribution in the central portion of the Mississippi embayment. Its range extends from the San Jacinto River in eastern Texas, north to the St. Francis River drainage in southeastern Missouri. In eastern tributaries of the Mississippi River it is known from the Hatchie,

Yazoo, Big Black, and Bayou Pierre river drainages. East of the Mississippi River it occurs along the Gulf Slope throughout the Pearl River, Biloxi Bay, and Pascagoula Bay drainages.

The genus *Ammocrypta* is considered to be a derivative of the *Imostoma* line of the genus *Percina*. This is based on morphological characters shared by species of the genus *Ammocrypta* and the subgenus *Imostoma*. *Crystallaria* is tentatively regarded as a subgenus of the genus *Ammocrypta*. Within the subgenus *Ammocrypta* there are two species groups: the *beani* group, containing *A. beani, A. bifascia,* and *A. clara,* and the *pellucida* group, containing *A. pellucida, A. meridiana,* and *A. vivax*. The *beani* group is characterized by body almost naked, usually 3 to 6 transverse scale rows; breast and prepectoral area without scales; posterior margin of preopercle entire; preoperculomandibular canal pores usually 8 or 9; vertebrae usually 40; and pelvic fins unpigmented. The *pellucida* group has the following characters: body partially to almost completely scaled, edge of breast, prepectoral area frequently with few embedded scales, usually 9 to 15 transverse scale rows; posterior margin of preopercle usually serrate; preoperculomandibular canal pores usually 10; and vertebrae usually 42 or 43.

The *pellucida* species group appears to be the most primitive of the two species groups by virtue of having retained the more generalized conditions. Within the *pellucida* species group *A. vivax* appears to be the most primitive, while *A. pellucida* appears to be the most advanced.

In the more advanced *beani* species group, *Ammocrypta clara* appears to be the most primitive. *Ammocrypta beani* and *A. bifascia* are the most advanced and probably the most specialized species of the entire subgenus.

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Contents

Systematics of the Percid Fishes of the Subgenus *Ammocrypta,* Genus *Ammocrypta,* with Descriptions of Two New Species

James D. Williams

Introduction

There are presently three genera, *Ammocrypta, Etheostoma,* and *Percina,* in the tribe Etheostomatini, subfamily Percinae of the family Percidae (Collette, 1963). *Ammocrypta* is the smallest of the three genera (*Etheostoma* has more than 80 species and *Percina* more than 25 species) with seven species recognized herein, referable to two subgenera. Six species are assigned to the subgenus *Ammocrypta* and the remaining species, *Ammocrypta asprella,* to the subgenus *Crystallaria* (Bailey and Gosline, 1955). *Crystallaria* was recognized by Moore (1968) as a distinct genus. The status of *Crystallaria* is presently being examined by me and several other workers. It is presently being treated as a subgenus of the genus *Ammocrypta.*

The subgenus *Ammocrypta,* commonly known as the sand darters, comprises a group of elongate percid fishes with variously scaled, translucent bodies. It is distributed across the central portion of the Gulf Coastal Plain, up the Mississippi and Ohio Valleys and through the Lake St. Clair, southern Lake Huron, Lake Erie, and St. Lawrence River drainages. The sand darters typically inhabit moderate to large sized creeks and rivers with sand or sand gravel bottoms and are most frequently found in a moderate current. They are perhaps best known for their unusual habit of burying themselves in sand with only their eyes and snout exposed. This behavior has been reported for *Etheostoma nigrum* and *Etheostoma vitreum,* which typically inhabit sand or sand and gravel-bottomed streams. *Etheostoma vitreum* exhibits several morphological adaptions to the sand habitat that parallel those of the subgenus *Ammocrypta* and has been referred to as a relative of species in the subgenus *Ammocrypta.*

In recent years there has been a considerable number of publications on North American percid fishes but only a few of these have included any mention of the species of the subgenus *Ammocrypta.* Some of the recent publications that have included information on species of the subgenus *Ammocrypta* are: Bailey and Gosline, 1955 (vertebral counts); Linder, 1959 (validation of *A. clara* and *A. pellucida*); Collette, 1965 (breeding tubercles); Collette and Knapp, 1967 (types and nomenclature). The objectives of this paper are to describe two new species of sand darters from the southeastern Gulf Coastal Plain and to clarify the systematics, zoogeography, and evolution of all species in the subgenus. The six species of the subgenus *Ammocrypta* are:

1. *Ammocrypta beani* Jordan
2. *Ammocrypta bifascia* new species
3. *Ammocrypta clara* Jordan and Meek
4. *Ammocrypta meridiana* new species
5. *Ammocrypta pellucida* (Agassiz)
6. *Ammocrypta vivax* Hay

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This study came about as a result of the enthusiasm toward the field of ichthyology inspired by Herbert T. Boschung. His guidance and encouragement throughout my years of graduate study were instrumental in the successful completion of my graduate work and this research.

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Finally, credit far beyond mention is due my wife Anna for her help and moral support during the period of this research as well as for the hours spent in typing and proofing the manuscript.

Materials and Methods

The materials examined include samples selected from all parts of the ranges of the species studied. Data were taken from approximately 500 specimens of *Ammocrypta clara*, 550 specimens of *A. beani*, 325 specimens of *A. bifascia*, 700 specimens of *A. vivax*, 800 specimens of *A. pellucida*, and 200 specimens of *A. meridiana*. Additional specimens of the six species were examined to determine the consistency of taxonomic characters. To reduce possible bias due to year-class variation, data were taken from different size groups within a series; however, this was not always possible since the amount of material available from some drainages was limited. Data for the sexes were combined. The fin rays were well developed and usually countable (depending upon preservation) on individuals over 20 millimeters (mm) standard length (SL). On specimens 20 to 25 mm SL pored lateral line scales were present along the length of the body. Squamation of the cheeks, opercles, and body appeared complete on specimens over 30 mm SL. Specimens less than 30 mm SL were not used for scale-counts (except lateral-line scales), and individuals less than 25 mm SL were not used for fin-ray counts or lateral line scale counts. The specimens are deposited in the museum collections of the following institutions: Mississippi Wildlife Museum (Af); Academy of Natural Sciences of Philadelphia (ANSP); Auburn University (API & AU); Cornell University (CU); Field Museum of Natural History (Chicago) (FMNH); Florida State University (FSU); Illinois Natural History Survey (INHS); Iowa State University (ISU); University of Kansas (KU); Mississippi State University (MSU); Missouri Department of Conservation (MDC); Harvard University Museum of Comparative Zoology (MCZ); Northeast Louisiana State University (NLU); Ohio State University (OSU); Oklahoma State University (OAM); Royal Ontario Museum (ROM); Texas A&M University (TAM); University of Texas Natural History Collection (TNHC); Tulane University (TU); University of Alabama Ichthyological Collection (UAIC); University of Florida (UF); University of Kentucky (UK); University of Louisville (UL); University of Minnesota (UM); University of Michigan Museum of Zoology (UMMZ); University of Oklahoma (UO); U.S. National Museum of Natural History (USNM); and Wisconsin State University (WSU).

The following abbreviations were used in addition to standard compass directions: Hwy=highway, I=interstate, jct=junction, mi=mile, R=range, Rd=road, rmi=rivermile, rt=route, Sec.=section, T=township, trib.=tributary, uncat.=uncatalogued.

Scale and fin ray counts were made using the techniques defined by Hubbs and Lagler (1958) except as noted. The incompletely scaled body of most species of the subgenus *Ammocrypta* required a minor change in the method of counting scale rows above and below the lateral line and the transverse scale rows. Scale rows above the lateral line represent the number of rows crossing an imaginary line from the origin of the first dorsal fin downward and backward at an angle of approximately 45° to, but not including, the lateral line scale row. Counts of transverse scale rows and scale rows below the lateral line were taken in a similar manner to those of scale rows above the lateral line. Transverse scale rows were counted from the origin of the second dorsal downward and backward at an angle of approximately 45° to the anal fin base. Scale rows below the lateral line were counted upward and forward at an angle of approximately 45° to, but not including, the lateral line scale row.

Vertebral counts were made using the techniques outlined by Bailey and Gosline (1955). The terminology and techniques of Hubbs and Cannon (1935) were used in describing the cephalic canal system.

Diagnosis of the Subgenus *Ammocrypta*

Ammocrypta Jordan, 1877a:5. Type species: *Ammocrypta beani* Jordan, 1877, by original designation.

Body elongate, slender, subcylindrical in shape, up to 64mm SL; body depth 7-9 times into standard length; flesh pellucid; squamation of body variable, usually incomplete; lateral line complete with 55-81 pored scales; 0-2 pored scales on base of caudal fin, usually 0; cephalic lateral canal pores usually 5; supratemporal canal complete, 3 pores; supraorbital canal complete, 4 pores; coronal pore usually present; infraorbital canal complete, 7-9 pores, usually 8; preoperculomandibular canal pores 8-11, usually 9 or 10; vomer and palatine teeth absent; premaxillary frenum usually absent; preopercle margin entire or partially serrate; branchiostegal membranes narrowly conjoined; branchiostegal rays usually 6; margin of breast and prepectoral area naked or with scattered embedded to partially exposed scales; interpelvic area and midline of belly without specialized ctenoid scales; vertebrae 38-45; ribs 17-23; first interneural spine between neural spines of sixth to tenth vertebrae; frontal bones reduced, interorbital area very narrow; hiatus between first and second dorsal fins present, 3%-6% of standard length; first dorsal fin with 7-14 spines; second dorsal fin with 8-13 rays; anal fin with 1 spine and 7-12 rays; pectoral fin with 11-17 rays, caudal fin with 11 to 14 branched rays, usually 13; gas bladder absent; pyloric caeca 3-6, usually 4 or 5; breeding tubercles absent in females, variously developed on pelvic, caudal, and anal fins in males; dorsal and lateral surfaces of head and body flushed with yellow to yellow-orange pigment; fins usually with light yellow pigment; black bands in fins variously developed or absent.

Key to Species of the Subgenus *Ammocrypta*

1. Sides of body with a longitudinal row of oval to round blotches; pelvic fins of males pigmented; 9 to 16 transverse scale rows; vertebrae usually 42 or 43; preoperculomandibular canal pores, usually 10 2

   Sides of body without a longitudal row of blotches, a row of melanophores may form a line laterally in some individuals; pelvic fins unpigmented; 3 to 6 transverse scale rows; vertebrae usually 40; preoperculomandibular canal pores usually 8 or 9 4

2. Long axis of lateral blotches vertical, usually extending to or above lateral line; dorsal fins of males with a marginal and submarginal band; breeding tubercles of males present on pelvic and anal spines and rays . . . . *Ammocrypta vivax* Hay
   Most drainages in central portion of Mississippi Embayment. Pascagoula drainage in southeastern Mississippi west to the San Jacinto drainage in eastern Texas, north to the St. Francis drainage in southeastern Missouri.

   Long axis of lateral blotches horizontal, usually entirely below lateral line; median fins of males without bands; breeding tubercles present on pelvic rays, absent on pelvic spine and anal spine and rays . . 3

3. Scale rows below lateral line usually 8 or 9; transverse scale rows usually 14 to 16; vertebrae usually 42; first interneural spine usually between neural spines of seventh and eighth vertebrae . . . . *Ammocrypta meridiana* new species
   Below the Fall Line in the Alabama and Tombigbee river drainages.

   Scale rows below lateral line usually 4 to 7: transverse scale rows usually 11 to 13; vertebrae usually 43; first interneural spine usually between neural spines of eighth and ninth vertebrae. . . . . *Ammocrypta pellucida* (Agassiz)
   Ohio River, Lake Erie, and St. Lawrence River drainages.

4. Opercular spine present; cheeks and opercles partially scaled; median fins of males and females unpigmented; males with breeding tubercles on anal, pelvic, and caudal fins . . . . *Ammocrypta clara* Jordan and Meek
   Sabine and Nesches rivers, moderate to large rivers throughout the Mississippi Valley (except Tennessee, Arkansas, and Missouri) and the Waupaca drainage, tributary to Lake Michigan, western Wisconsin.

   Opercular spine absent; cheeks and opercles naked; median fins of males pigmented; males with breeding tubercles present only on anal and pelvic fins 5

5. Dorsal and anal fins of males with a marginal and submarginal band; breeding tubercles of males present on ventral surface of pelvic spine and rays. . . . . *Ammocrypta bifascia* new species
   Gulf Slope drainages from the Perdido River east to the Choctawhatchee River.

   Dorsal and anal fins of males without marginal bands, submarginal band or blotch variously developed; breeding tubercles of males present on dorsal and ventral surface of pelvic spine and rays. . . . . *Ammocrypta beani* Jordan
   Gulf Slope drainages from the Mobile basin west to the eastern tributaries of the Mississippi River in southern Mississippi and southwestern Tennessee.

Ammocrypta beani Jordan

Naked sand darter

FIGURE 1

TYPE.—Holotype, USNM 17833 (male, 52 mm SL), Louisiana, Notalbany River, near Tickfaw; T. H. Bean and O. P. Maxson; 23 December 1876.

NOMENCLATURAL HISTORY.—*Ammocrypta beani* was described by Jordan (1877a:5) and named in honor of Tarleton H. Bean, who collected the holotype. Hay (1881:490) described a new species of sand darter, *Ammocrypta gelida*, from the Chickasawhay River in Clarke County, Mississippi, which he later (Hay, 1883:59) placed in synonymy of *A. beani*. The darter described by Jordan (1884:479) as *Poecilichthys beani* is a synonym of *Etheostoma nigrum* Rafinesque and should not be confused with *A. beani* Jordan, 1877a. The validity of *Ioa vigil* described by Hay (1883:59), was questioned by Jordan and Evermann (1896:1069), who suggested that it was possibly *A. beani*. It was treated by Cook (1959:210) as a synonym of *A. beani*. Collette and Knapp (1967:53) examined the holotype of *Ioa vigil* and found it to be a species of *Percina*, and not of *Ammocrypta*.

DIAGNOSIS.—*Ammocrypta beani* is distinguished from other species of the genus by: opercular spine absent; lateral line complete, usually with 65 to 70 scales; posterior 3 to 5 scales of lateral line deflected ventrally; scale rows above lateral line usually 0 to 1; scale rows below lateral line usually 1; transverse scale rows usually 3 or 4; cheeks, opercles and nape naked; dorsal rays usually IX-X, 11; anal rays usually I, 9-10; pectoral rays usually 13; vertebrae usually 40; first interneural spine usually between neural spines of seventh and eighth vertebrae; preopercle margin usually entire; preoperculomandibular canal pores usually 9; breeding tubercles in males present on dorsal and ventral surfaces of pelvic spine and rays, as well as anal spine and rays; first dorsal fin of males with black blotch anteriorly, followed by smaller blotches or submarginal band posteriorly; central half to three-fourths of second dorsal and anal fins dusky to gray-black, the margins without dark pigment.

DESCRIPTION.—The general body shape and pigmentation of *A. beani* is illustrated in Fig. 1. Proportional measurements of *A. beani* are presented in Table 1. Frequency distributions of fin ray, vertebrae and scale counts are given in Tables 2-10.

Body slender, depth usually 7 to 9 times in standard length; tip of snout moderately pointed; mouth moderate to large, maxilla extending posteriorly to or slightly beyond anterior rim of orbit; anal fin origin usually under the first ray of the soft dorsal fin; standard length up to 58mm.

Dorsal rays VII-XII, 9-13 (usually IX-X, 11); anal rays I, 8-11 (usually I, 9-10); pectoral rays 11-14 (usually 13); vertebrae 39-42 (usually 40).

Lateral line complete with 57-77 scales. Scale rows above lateral line 0-3 (usually 0-1); scale rows below lateral line 0-3 (usually 1); transverse scale rows 1-6 (usually 3-4). Cheeks, opercles and nape naked; caudal peduncle variously scaled.

Cephalic sensory canals complete. Lateral canal pores 4-6 (usually 5); supratemporal canal pores 3; supraorbital canal pores 4; coronal pore present; infraorbital canal pores 7-10 (usually 8); preoperculomandibular canal pores 8-10 (usually 9).

Counts for the holotype: dorsal rays X, 10; anal rays I, 9; pectoral rays 13, lateral line scales 70, scale rows above the lateral line 0, scale rows below the lateral line 1, transverse scale rows 3.

LIFE COLORS.—The body is lightly washed with yellow to yellow-orange pigment. The pigment is most prominent on the dorsum and decreases ventrally to the ventral lateral surfaces. In some specimens the venter is devoid of yellow pigment. The lateral line and the area just above and below the lateral line are an iridescent greenish yellow. Jordan (1877a), in presenting the observations of T. H. Bean, reported the lateral line as "shining golden in life".

The connective tissue surrounding the vertebral column, which can be seen through the translucent body of live and freshly preserved (5-10 minutes) specimens, is orange to yellow-orange. Melanophores concentrated

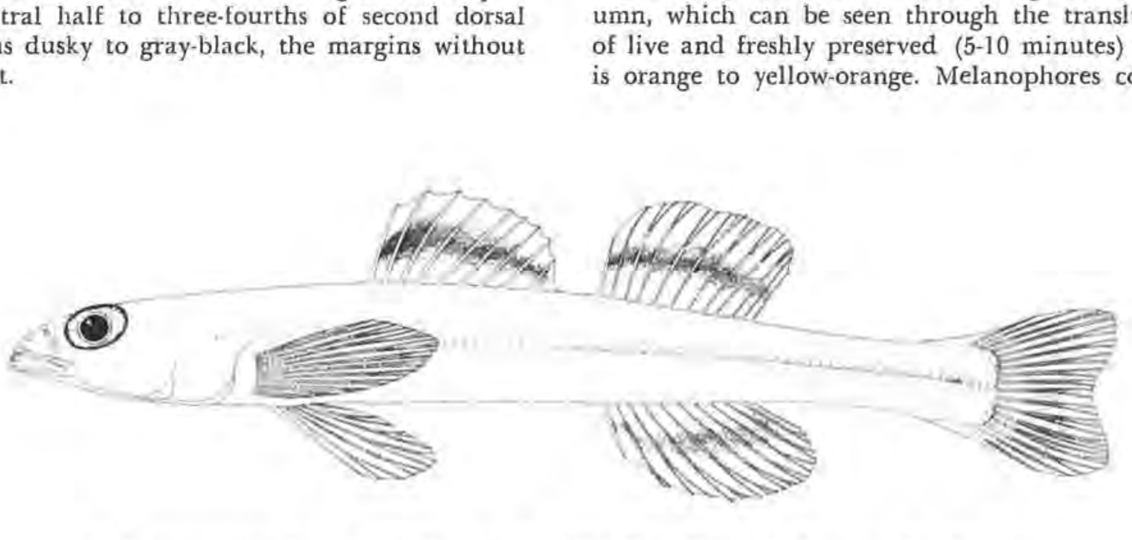

Fig. 1. *Ammocrypta beani*. Male 42.9 mm SL; MSU 3510, Big Black River on U.S. Hwy 51, 1 mi S of Pickens, Madison County, Mississippi; 29 July 1973. (Drawn by HECTOR HARIMA).

into blotches along the vertebral column give it the appearance of a dashed line with orange to yellow-orange interspaces. In most specimens there are 11 to 13 dark blotches, each blotch covering 1 to 2 vertebrae. In most specimens there are melanophores along approximately every other vertebral spine and a few of the ribs.

On the head, the cheeks, opercles and lower jaw are iridescent bluish-green colors. The snout and occiput are lightly washed with yellow-orange pigment that is most prominent on the snout. The dorsal and anal fin have a milky white margin with a yellowish base. The spinous dorsal usually has a black blotch that occupies a portion, or all in some specimens, of the central portion of the anterior four membranes. Posterior to the blotch there is usually a gray-black band of pigment. There is also a gray-black band through the central portion of the soft dorsal and anal fins. The caudal fin has a milky white margin with melanophores scattered through it. The basal portion of the caudal fin is grayish with a concentration of yellow-orange pigment at the base. The pectoral fins are yellowish with some milky white pigment present. The pelvic fins are milky white.

COLORATION IN ALCOHOL.—The body is white to cream color with scattered melanophores on the dorsum. In some specimens melanophores are concentrated into spots or blotches along the midline of the dorsum. Laterally, there is a row of melanophores beneath the middle of the lateral line scale row on the posterior half of the body. Occasionally the row of melanophores is present anteriorly along the ventral margin of the lateral line scale row. Ventrally, below the lateral line scale rows, pigment is usually absent except for a row of melanophores extending from the last anal ray posteriorly to the caudal fin base. The exposed margins of scales along the sides and around the caudal peduncle are typically outlined with melanophores. The above description is applicable to most specimens; however, some preserved individuals have no melanophores present on the body.

The pigment pattern of the median fins is similar in males and females, but darker in males. In adult males the first dorsal has a black blotch, usually on the four anterior spines and membranes; however, the blotch may be absent on the first membrane and poorly developed on the fourth membrane. The size of the blotch is variable, but usually covers the central two-thirds to three-fourths of the spines and membranes. Posteriorly, the fin is dusky to gray-black through the central two-thirds to three-fourths of the fin and may extend from the base to the margin on the last two to four membranes. The second dorsal fin and the anal fin have a dusky to gray band covering the central half to three-fourths of the fins. In most individuals the band is slightly wider in the soft dorsal fin than in the anal. The margin and base of the fins are unpigmented except for scattered melanophores. The basal two-thirds to three-fourths of the caudal fin (rays and membranes) is dusky to gray. The distal one-fourth to one-third of the fin is usually unpigmented, but some individuals have scattered melanophores along the posterior margin. The dorsal half of the pectoral fin has melanophores scattered on and along the margins of the rays. Scattered melanophores may be present on the base of the rays on the ventral half of the pectoral fins. The pelvic fins of females and most males are unpigmented. When pigment is present in the males it consists of a few scattered melanophores on and along the margin of the rays.

With the exception of melanophores along the rami of the jaws, the ventral surface of the head is unpigmented. The upper part of the operculum has scattered melanophores that often extend ventrally along the posterior margin of the preopercle. The cheek, which is usually unpigmented, may have a row of melanophores along the lower margin of the orbit. The dusky to brown pigment of the occiput extends anteriorly to the interorbital area. The upper lip and snout up to the anterior nostrils are covered with scattered melanophores. The concentration of melanophores is variable, often producing spots and blotches, particularly on the tip of the snout and in the preorbital area.

BREEDING TUBERCLES.—Tuberculate specimens are known to occur from early March (Collett, 1965:583) until the end of August. On the ventral surface of the pelvic spine and rays tubercles are present from the base to near the margin and are best developed on the spine and anterior rays. Smaller tubercles are present on the dorsal surface of the pelvic spine and the segmented portion of the outer three rays. On the pelvic rays there is usually one tubercle per segment, rarely one on the joint between two segments.

Tubercles are developed on the segmented portion of the rays and occasionally one to three tubercles are present on the unsegmented portion of the anal fin. Posteriorly tubercles gradually increase in size to the last two to four rays where they again become smaller. As in the pelvic rays, there is usually one tubercle per segment. Tubercles are usually absent from the anal spine, but were observed on a few individuals collected during late June and early July.

DISTRIBUTION.—*Ammocrypta beani* is known from the Hatchie River drainage, a Mississippi River tributary in southwestern Tennessee, and Mississippi River tributaries from the Big Black drainage in south central Mississippi south to the Lake Pontchartrain drainage in Louisiana. The record of *A. pellucida* reported by Fowler (1945:369) from New Orleans is based on a specimen of *A. beani* (ANSP 54698). East of Lake Pontchartrain it occurs along the Gulf Slope throughout the Pearl River, St. Louis Bay, Biloxi Bay, and Pascagoula Bay drainages. The eastern limit of distribution is in the Mobile Basin, where it is found below the Fall Line in the Tombigbee, Warrior, Cahaba, Alabama, and Tallapoosa drainages (Fig. 4).

GEOGRAPHIC VARIATION.—The fin ray counts of *Ammocrypta beani* exhibited little variation with the exception of the dorsal spines (Table 2). Dorsal spines ranged from 7 to 12 with a mode of 9 in most populations. Three populations (Pascagoula River, Pearl River, and Lake Pontchartrain) each had a mode of 10. The Hatchie River population was the most divergent, with a mode of 11. The modal number of dorsal rays was 11 and that of the pectoral rays 13 in all populations. The modal number of anal rays was 9 in all populations except those from the Alabama, Cahaba, and Hatchie rivers, where the mode was 10. The modal number of vertebrae was 40 in all populations except those in the Cahaba (mode=41) and the Warrior rivers (mode=40-41).

The number of lateral line scales exhibited weak clinal variation, with a slight increase from west to east (Table 7). The western group included specimens from the Mississippi River drainage (except the Hatchie River) east to the Pascagoula River. Lateral line scales ranged from 57 to 74, with means ranging from 63.65 to 66.36. The eastern group included specimens from the Mobile Bay drainage. Lateral line scales of this group ranged from 60 to 77, with means from 66.91 to 71.52. The high scale count of the Warrior River ($\overline{X}$=71.52) and the Cahaba River ($\overline{X}$=70.80) specimens may relate to their existence at a slightly lower temperature resulting from higher elevations. The modal number of scale rows above the lateral line was zero in the Hatchie River and Mobile Bay populations (except the Warrior River, mode=1) and one in populations westward along the Gulf Coast. The modal number of scale rows below the lateral line was one in all populations. There was a slight increase in the number of transverse scale rows from east (Alabama River, mode=3, $\overline{X}$=2.52) to west (Mississippi River, mode=4, $\overline{X}$=3.76).

Although scalation of the caudal peduncle was irregular and incomplete, there appeared to be a slight increase in scales on specimens from the western portion of the range. A small amount of variation was evident in the pigmentation of the median fins of males. In populations from the Hatchie River and Mobile Bay drainages the characteristic blotch, followed by a dusky band or scattered blotches on the spinous dorsal fin, was typically absent. In the Hatchie River population (based on two collections) the spinous dorsal was very similar to the soft dorsal and anal fins, which were dusky from just above the base to near the margin. Populations inhabiting the Mobile Bay drainages usually had a black to dusky band through the central one-third of the fin. The dusky pigment in the soft dorsal and anal fins was reduced in width compared to other populations of *A. beani*.

HABITAT AND LIFE HISTORY.—The habitat of *Ammocrypta beani* is clean streams ranging in size from 10 to 15 feet wide to rivers with moderate current over shifting sand bottoms. Although present in small creeks, it shows a preference for larger streams where it is taken in water 6 inches to 4 feet deep.

Hubbs and Walker (1942) reported *A. beani* as the most characteristic associate of *Notropis longirostris*. In the Mobile Basin, where *Notropis longirostris* is absent, an undescribed *Notropis* that is the ecological equivalent of *N. longirostris* is one of the most common associates of *A. beani*. Other species frequently associated with *A. beani* are *Ericymba buccata, Hybopsis aestivalis, Percina ouachitae, Ammocrypta vivax,* and *Ammocrypta meridiana*. Species collected with the holotype include *Notropis chrysocephalus, Notropis texanus, Notropis venustus, Hybopsis amblops, Percina nigrofasciata,* and *Etheostoma nigrum*.

Gravid females were collected between early June and the last week of August. During June and the first week of July, egg counts ranged from 52 to 71 in females measuring 39 to 50 mm SL. The large eggs were golden yellow and measured approximately 1 mm in diameter. Small, white, undeveloped ova were also present in most specimens. After the first week of July, a reduction in the number of large eggs indicated the beginning of spawning. During the first part of August, females 38 to 47 mm SL had egg counts ranging from 22 to 38 each. During the latter part of August, egg counts ranged from 0 to 18 each. There were no eggs present in the ovaries of females taken during the first part of September.

Material Examined

Alabama River Drainage. **Alabama:** AUTAUGA COUNTY: UAIC 2312 (1) Swift Creek 2 mi N of Billingsley, 1 July 1966; TU 12065 (3) Little Mulberry River 12.4 mi W of Autaugaville, 17 Sept. 1955. DALLAS COUNTY: TU 35242 (25) Alabama River near Cahaba, 27-28 June 1964. MACON COUNTY: UAIC 1478 (3) Uphapee Creek E of Tuskegee, 26 Sept. 1964; UAIC 1514 (1) Uphapee Creek NW of Tuskegee, 8 Nov. 1964; UAIC 1516 (2) Uphapee Creek 0.2 mi N of Franklin, 8 Nov. 1964. MONROE COUNTY: TU 41787 (1) Alabama River at St. James Bar, rmi 104, 5 Aug. 1966; TU 44452 (8) Flat Creek 8.6 mi NW of Monroeville, 18 March 1967; TU 47443 (4) Alabama River at Bates Bar, rmi 99.4, 8 Aug. 1967; TU 48024 (3) Alabama River at Stein Island, rmi 107.5, 27 Sept. 1967; TU 78604 (1) Alabama River at Davis Ferry Landing, rmi 97, 15 Aug. 1972; TU 78636 (1) Alabama River at mouth of Limestone Creek, rmi 80, 16 Aug. 1972; TU 78646 (11) Alabama River at mouth of Flat Creek, rmi 81.5, 16 Aug. 1972; TU 78655 (5) Alabama River at rmi 80.2, 16 Aug. 1972; TU 78665 (3) Alabama River at U.S. Hwy 84 bridge, rmi 79.2, 16 Aug. 1972. WILCOX COUNTY: TU 41646 (1) Alabama River at Taits Bar, rmi 122.5, 4 Oct. 1966; TU 41719 (2) Alabama River at Holly Ferry Crossing, rmi 131, 5 Aug. 1966; TU 47367 (4) Alabama River at Yellow Jacket Bar, rmi 129.8, 7 Aug. 1967; TU 47413 (26) Alabama River at Ohio Bar, rmi 111.7, 8 Aug. 1967; TU 47521 (28) Alabama River at Hobbs Bar, rmi 149.5, 18 Aug. 1967; TU 47847 (3) Alabama River at St. John Bar, rmi 164.8, 19 Aug. 1967; TU 47987 (1) Alabama River at Wilcox Bar, rmi 120.6, 27 Sept. 1967; TU 55868 (5) Alabama River at Evans Upper Bar, rmi 135.8, 17 Dec. 1968; TU 65385 (1) Alabama River at Clifton Ferry Landing, rmi 136.5, 27 Aug. 1970; TU 76291 (4) Alabama River at Wilcox Bar, rmi 120.4, 17 March 1972.

Cahaba River Drainage. **Alabama:** BIBB COUNTY: TU 37671 (1) Cahaba River 2.1 mi N of Centreville, 11 May 1965; UAIC 403 (1) Sandy Creek 5 mi S of Centreville, 7 July 1954; UAIC 404 (1) Cahaba River 2 mi S of Centreville, 5 July 1954; UAIC 2035 (4) Cahaba River 2.5 mi SE of Harrisburg, 4 June 1966; UAIC 2513 (1) Cahaba River at Pratt Ferry bridge, 29 March 1967. DALLAS COUNTY: TU 35056 (9) Oakmulgee Creek 7.2 mi NW of Selma, 26 June 1964; TU 40452 (3) Big Mulberry Creek, 10.1 mi E of Selma, 9 April 1966; TU 52496 (25) 4.4 mi N of jct of Alabama Hwy 14 and 219, 6 June 1968. PERRY COUNTY: TU 30083 (8) Cahaba River 5 mi E of Marion, 2 Nov. 1963; TU 52515 (5) Oakmulgee Creek 9.9 mi N of jct of Alabama Hwy 14 and 219, then E 0.9 mi, 6 June 1968; UAIC 1437 (26) Cahaba River 1 mi W of Sprott, 16 Sept. 1964; UAIC 2015 (3) Cahaba River behind

Marion Fish Hatchery, 11 May 1966; UAIC 2166 (3) Cahaba River behind Marion Fish Hatchery, 11 July 1966.

Lower Tombigbee River Drainage. **Alabama:** CLARKE COUNTY: TU 59958 (2) Jackson Creek, trib. to Tombigbee River, 9.7 mi NW of Jackson, 25 Sept. 1969; UAIC 434 (1) Satilpa Creek 8 mi S of Coffeeville, 24 Aug. 1954. CHOCTAW COUNTY: UAIC 336 (3) Tukabum Creek N of Butler, 5 Aug. 1953; UAIC 445 (8) Okatuppa Creek 1.5 mi N of Gilbertown, 25 Aug. 1954. MARENGO COUNTY: UAIC 430 (11) Horse Creek N of Putnam, 24 Aug. 1954. SUMTER COUNTY: UAIC 492 (10) Unnamed Creek 17 mi SE of York, 20 Aug. 1956.

Upper Tombigbee River Drainage. **Alabama:** GREENE COUNTY: UAIC 3586 (2) Sipsey River 6 mi NNW of Snoddy, 26 June 1969. PICKENS COUNTY: TU 77018 (1) Big Creek, trib. to Tombigbee River, 1.4 mi SE of Pickensville, 3 April 1972; UAIC 2593 (4) Tombigbee River at Vienna, 24 June 1967; UAIC 2705 (1) Tombigbee River above Vienna, 29 Sept. 1967; UAIC 4331 (2) Tombigbee River 2 mi downstream from Vienna boat landing, 19 Aug. 1971; UAIC 4390 (1) Tombigbee River 1 mi downstream from mouth of Big Creek, 6 June 1972. SUMTER COUNTY: UAIC 2511 (5) Tombigbee River 7 mi N of Gainesville, 23 March 1967. TUSCALOOSA COUNTY: UAIC 1058 (4) Sipsey River on U.S. Hwy 82 W of Tuscaloosa, 25 Oct. 1963; UAIC 1062 (11) Sipsey River on U.S. Hwy 82 W of Tuscaloosa, 31 Oct. 1963; UAIC 1434 (10) Sipsey River on U.S. Hwy 82 W of Tuscaloosa, 10 Sept. 1964; UAIC 1625 (3) Sipsey River on U.S. Hwy 82 W of Tuscaloosa, 24 Sept. 1964; UAIC 1785 (1) Sipsey River near Echola, 26 Sept. 1964. **Mississippi:** ITAWAMBA COUNTY: UAIC 2294 (1) Tombigbee River 4 mi S of Fulton, 12 July 1966; UAIC 4424 (1) Tombigbee River near Beans Ferry bridge, at mouth of Reeds Creek, 20 July 1972. LOWNDES COUNTY: Af 6721 (1) Buttahatchie River near Caledonia, 20 July 1953; TU 40480 (3) Tombigbee River 9.3 mi NW of Columbus, 9-10 April 1966; UAIC 4425 (18) mouth of Buttahatchie River, 24 July 1972; UAIC 4442 (6) mouth of Town Creek 3.5 mi E of Amory, 3 Aug. 1972. NOXUBEE COUNTY: UAIC 2161 (2) Hashugua Creek 7 mi W of Macon, 8 July 1966. TISHOMINGO COUNTY: UAIC 2642 (1) Mackeys Creek below Mississippi Hwy 4, 24 Aug. 1967; UAIC 4417 (6) Mackeys Creek at jct of McDougal Branch, 7 July 1972. WINSTON COUNTY: UAIC 2631 (5) Noxubee River N of Louisville, 22 Aug. 1967.

Warrior River Drainage. **Alabama:** TUSCALOOSA COUNTY: UAIC 1181 (3) North River N of Tuscaloosa, 23 Sept. 1963; UAIC 1194 (1) North River N of Tuscaloosa, 18 Nov. 1964; UAIC 2411 (2) Unnamed trib. to Warrior River near Tuscaloosa, 3 Oct. 1966; USNM 43500 (15) Warrior River at Tuscaloosa, 1889.

Pascagoula River Drainage. **Alabama:** MOBILE COUNTY: UAIC 438 (10) Escatawpa River at Alabama-Mississippi border, 25 Aug. 1954. **Mississippi:** CLARKE COUNTY: Af 3593 (11) Bucatunna Creek, 12 Sept. 1947; TU 37482 (3) Chunky River 1 mi N of Enterprise, 5 Oct. 1968; TU 59979 (14) Chickasawhay River 1 mi SE of Shubuta, 25 Sept. 1969. COVINGTON COUNTY: Af 2851 (1) Big Swamp Creek, trib. to Okatoma Creek, 3 Aug. 1947; TU 28596 (154) Leaf River 10 mi ENE of Collins, 23 Nov. 1962; TU 68457 (65) Okatoma Creek near Samford, 9 June 1970. FORREST COUNTY: Af 5979 (3) Leaf River near Hattiesburg, 24 Feb. 1950; Af 6284 (1) Leaf River near Hattiesburg, 19 May 1950; TU 61279 (2) Bowie River, trib. to Leaf River, 28 Jan. 1970; USNM 129036 (10) Leaf River at McCallum bridge, 5 May 1933; USNM 129168 (2) Leaf River at McCallum bridge, 5 May 1933. GEORGE COUNTY: TU 65840 (66) Pascagoula River 6.1 mi SE of Benndale, 14 Nov. 1970. GREENE COUNTY: TU 28461 (1) Leaf River 2 mi SE of McLain, 9 Nov. 1962; TU 67187 (23) Leaf River 2 mi N of McLain, 14 Nov. 1970. JACKSON COUNTY: UAIC 875 (5) Bluff Creek at Vancleave, 28 July 1962. JEFFERSON COUNTY: TU 815 (1) below mill pond on Hatton Farm near Bassfield, 17 April 1948. JONES COUNTY: TU 30063 (35) Leaf River 1 mi N of Moselle, 2 Nov. 1963; TU 57928 (48) Leaf River 2.0 mi W of Moselle, 21 June 1969; TU 59674 (112) Leaf River 1 mi W of Eastabutchia, 26 Oct. 1969. LAMAR COUNTY: TU 65869 (21) Little Black Creek at I-59 bridge, 13 Nov. 1970. PERRY COUNTY: TU 53686 (3) Tallahala Creek 4.9 mi WNW of New Augusta, 4 Oct. 1968. SMITH COUNTY: NLU 5794 (1) Fisher Creek 0.5 mi N of Taylorsville, 29 Dec. 1966; TU 53782 (41) Leaf River 3.1 mi W of Sylvarena, 5 Oct. 1968; TU 53809 (148) Leaf River 1.4 mi E of Taylorsville, 5 Oct. 1968. STONE COUNTY: TU 32389 (118) Black Creek 13.6 mi E of Wiggins, 27 May 1964; TU 45480 (1) Red Creek, 16 April 1967; UAIC 893 (15) Black Creek 13 mi E of Wiggins, 27 Oct. 1962. WAYNE COUNTY: TU 15403 (1) Chickasawhay River near Waynesboro, Nov. 1956; TU 52097 (4) Buckatunna River, trib. to Chickasawhay River, 8.9 mi NE of Waynesboro, 22 May 1968; TU 58754 (2) Yellow Creek, trib. to Chickasawhay River, 2.1 mi NW of Waynesboro, 15 Aug. 1969; TU 58768 (4) Chickasawhay River 2.1 mi NW of Waynesboro, 15 Aug. 1969.

Biloxi River-Bay St. Louis Drainage. **Mississippi:** HANCOCK COUNTY: TU 79459 (15) Hickory Creek, trib. to Jordan River, 7.8 mi SE of Caesar, 23 Sept. 1972; UAIC 1734 (1) Bayou La Terre, T7S,R14W, Sec.9, 15 July 1965. HARRISON COUNTY: TU 9728 (3) Big Biloxi River 6.5 mi S of Saucier, 16 March 1955; TU 27092 (2) Saucier Creek, trib. to Big Biloxi River 11 mi N of Gulfport, 26 Aug. 1962; TU 79821 (46) Wolf River 7.6 mi NW of Lizana, 23 Sept. 1972; UAIC 877 (2) Little Biloxi River on Hwy 49, 5 Aug. 1962; UAIC 989 (3) Big Biloxi River on Hwy 49, 24 March 1963; UAIC 1708 (5) Tchoutacabouffa River, T5S,R9W,Sec.33, 25 June 1965; UAIC 1717 (1) Saucier Creek, T5S,R11W,Sec.33, 1 July 1965; UAIC 1718 (4) Big Biloxi River at Big Biloxi Recreation Area, T5S, R11W,Sec.31, 1 July 1965; UAIC 1719 (1) Big Biloxi River, T5S, R12W,Sec.11, 1 July 965. PEARL RIVER COUNTY: TU 59490 (1) Wolf River 2.1 mi N of Poplarville exit (Hwy 26) from I-59, 24 Oct. 1969; UAIC 1738 (2) Wolf River on Mississippi Rt 26, 26 July 1965; UAIC 1740 (1) Wolf River at Silver Run, 26 July 1965.

Pearl River Drainage. **Louisiana:** ST. TAMMANY PARISH: TU 31469 (2) W Pearl River 1 mi upstream from U.S. Hwy 11 bridge, 12 Sept. 1963; TU 31485 (3) E Pearl River 0.25 mi below Walkiah Bluff, 5.7 mi NE of Talisheek, 11 Oct. 1963; TU 34152 (1) Pearl River across from mouth of Byrd Bayou, 20 Aug. 1964; TU 34182 (1) Pearl River at rmi 46, 17.5 mi below Pools Bluff Sill, 21 Aug. 1964; TU 34198 (1) Pearl River at jct Wilson Slough and W Pearl River, 3.5 mi E of Talisheek, 21 Aug. 1964; TU 34260 (2) W Pearl River at Bear Island, 4 mi below jct of Wilson Slough and W Pearl River, 22 Aug. 1964; TU 38493 (1) Holmes Bayou 2 mi below head of Holmes Bayou and E Pearl River, 29 Aug. 1965; TU 39171 (1) Pearl River at rmi 51, 12.5 mi below Pools Bluff Sill, 28 Oct. 1965; TU 39277 (3) W Pearl River 0.25 mi below mouth of Holmes Bayou, 30 Oct. 1965. WASHINGTON PARISH: NLU 4630 (10) Pearl River on Hwy 26, 11 July 1966; TU 7912 (3) Bogue Chitto River 0.5 mi S of Enon, 26 Sept. 1953; TU 7963 (6) Pushepatapa Creek 0.8 mi S of Varnado, 16 Feb. 1952; TU 11205 (1) Pearl River 7 mi E of Varnado, 23 Sept. 1955; TU 27924 (1) Pearl River near Bogalusa, 11 Sept. 1964; TU 31185 (2) Pearl River above mouth of Colburn Creek, 19 May 1963; TU 31646 (1) Pearl River below dam at Pools Bluff, 4 mi S of Bogalusa, 19 March 1964; TU 33609 (1) Pearl River at rmi 54, 2.3 mi SE of Bogalusa, 9 July 1964; UMMZ 170699 (16) Bogue Chitto River near Franklinton, 10 Sept. 1940. **Mississippi:** COPIAH COUNTY: TU 23412 (2) trib. to Pearl River 6 mi N of Georgetown, Hwy 27, 22 July 1960; TU 23526 (1) Copiah Creek 2.4 mi S of Georgetown, 22 July 1960. LAWRENCE COUNTY: TU 27213 (10) Pearl River 1.5 mi SE of Monticello, 28 Aug. 1962. LEAKE COUNTY: TU 23292 (12) Pearl River 1 mi S of Carthage, 4 July 1960; TU 28981 (19) Pearl River 2 mi S of Carthage, 23 Sept. 1968. MADISON COUNTY: Af 6644 (12) Pearl River on Natchez Trace N of Jackson, 12 Sept. 1952. MARION COUNTY: TU 9717 (5) Pearl River trib. 5 mi S of Columbia, 30 June 1954; TU 14910 (3) Pearl River 2.3 mi E of Sandy Hook, 13 Jan. 1957; TU 28287 (49) Pearl River 1.5 mi SE of Foxworth, 17 Oct. 1962; TU 38893 (2) Upper Creek, trib. to Pearl River, 4 mi SE of Columbia, 2 Oct. 1965; TU 4862 (3) trib. to Pearl River 4.3 mi S of Foxworth, 19 Aug. 1951. NESHOBA COUNTY: TU 28999 (10) trib. to Pearl River 2 mi E of Edinburg, 23 Sept. 1962. PIKE COUNTY: TU 46854 (9) Bogue Chitto River near McComb, 13 May 1967. RANKIN COUNTY: TU 23165 (3) Pearl River 20 mi NE of Jackson, 4 July 1960; UAIC 2672 (4) Pearl River on sand bar at Jackson, 8 Sept. 1967. SIMPSON COUNTY: TU 17728 (5) Strong River 2.3 mi W of Pinola, 3 April 1958.

Lake Pontchartrain Drainage. **Louisiana:** EAST BATON ROUGE PARISH: NLU 4346 (10) Comite River at Hwy 64, 22 June 1966. EAST FELICINA PARISH: NLU 1226 (2) Redwood Creek 1 mi W of Hwy 19, 1 Oct. 1964; NLU 4396 (1) Amite River at Hwy 10, 23

June 1966; TU 4678 (5) Redwood Creek 1.7 mi NE of Ethel, 18 July 1952; TU 81520 (2) Comite River 8.9 mi S of Clinton, 17 March 1973. LIVINGSTON PARISH: NLU 6425 (14) Hog Branch at Hwy 190, 7 June 1967; TU 4932 (18) Tickfaw River 0.5 mi W of Holden, 17 June 1952; TU 29053 (3) Amite River 2 mi NW of Denham Springs, 17 March 1963. ST. HELENA PARISH: NLU 1628 (3) Darling Creek, T2S,R4E,Sec.42, 10 Nov. 1964; NLU 4380 (11) Darling Creek on Hwy 38, 23 June 1966; TU 4596 (2) Amite River at Dennis Mills, 19 July 1952; TU 45310 (1) Tickfaw River 3 mi E of Greensburg, 8 April 1967; TU 75881 (20) Tickfaw River 0.8 mi E of Easleyville, 28 Jan. 1972; UAIC 2075 (3) East Branch of Tickfaw River at Hwy 38, 4 Jan. 1965. ST. TAMMANY PARISH: NLU 7097 (13) Tchefuncte River at Hwy 16, 20 July 1967; TU 245 (10) Bayou Falaya, trib. of Tchefunte River at Covington, 10 Dec. 1950; TU 75179 (9) Bogue Falaya River near Covington, 5 June 1971; TU 81048 (2) Bogue Falaya River 5.6 mi SSE of Folsom, 13 Sept. 1971; TU 81099 (4) Bogue Falaya River near Covington, 16 Oct. 1971. TANGIPOHOA PARISH: TU 1298 (1) Tangipohoa River 1 mi E of Amite, 9 June 1948; TU 3943 (1) Notalbany River 0.7 mi W of Baptist, 17 Feb. 1951; TU 9882 (5) Tangipahoa River 2 mi off Frankleton Rd, 26 May 1955; TU 45549 (11) Tangipahoa River 0.8 mi E of jct of Louisiana Hwy 10 and U.S. Hwy 51, 22 April 1967; TU 45324 (12) Tangipahoa River 2 mi E of Amite, 8 April 1967; TU 75600 (7) trib. to Tangipohoa River 1 mi E of Kentwood, 28 Jan. 1972; TU 81951 (4) Natalbany River 2 mi W of Tickfaw, 25 Feb. 1972; UMMZ 170650 (25) Tangipahoa River 1.5 mi E of Amite, 9 Sept. 1940. **Mississippi:** AMITE COUNTY: TU 75634 (6) E Fork Amite River 7.3 mi E of Liberty, 29 Jan. 1972; TU 76064 (91) W Fork Amite River 3.2 mi SW of Liberty, 29 Jan. 1972; UAIC 1578 (2) Beaver Creek below jct of Centerville Creek, near Liberty, 17 April 1965; UMMZ 144729 (1) W Amite River, 21 Oct. 1947. PIKE COUNTY: TU 67115 (8) Tangipahoa River 0.7 mi S of Magnolia, 29 Dec. 1969.

Mississippi River Drainage. **Louisiana:** WEST FELICIANA PARISH: TU 71495 (1) Tunica Bayou at Tunica, April 1962.

Buffalo River Drainage. **Mississippi:** WILKINSON COUNTY: TU 14005 (1) Buffalo River 10.3 mi N of Woodville, 14 Aug. 1956; TU 55590 (174) Buffalo Bayou 9.6 mi N of Woodville, 15 Nov. 1968; TU 55650 (37) Buffalo River 0.3 mi S of Wilkinson, 14 Dec. 1968; TU 57686 (1) Buffalo River 11.1 mi E of Woodville, 23 May 1969; TU 57950 (15) Little Buffalo River 8 mi NW of Centerville, 30 June 1969; TU 60038 (10) Little Buffalo Bayou 8 mi NW of Centerville, 28 Sept. 1969; TU 60097 (4) Buffalo River 4.1 mi NW of Centerville, 14 Nov. 1969; TU 60496 (2) Buffalo River 5.2 mi SW of Dolonoso, 24 Oct. 1969; TU 65041 (9) Little Buffalo River 6.8 mi NW of Centerville, 30 June 1970; TU 66541 (2) Little Buffalo Bayou 9.0 mi N of Centerville, 31 Aug. 1970.

Homochitto River Drainage. **Mississippi:** AMITE COUNTY: TU 7441 (3) Brushy Creek, trib. to Homochitto River, at Homochitto, 1 May 1953; UMMZ 155344 (26) Brushy Creek 1 mi above mouth Homochitto River, 4 mi of Homochitto, 1 April 1948. FRANKLIN COUNTY: FSU 9831 (1) Homochitto River 3 mi S of Meadville, 1 July 1963; TU 2932 (1) trib. to Homochitto River at Lucien, 24 May 1952; TU 19884 (5) Homochitto River 3.0 mi SE of Meadville, 2 May 1959; TU 19992 (16) Homochitto River 3.6 mi SE of Meadville, 26 April 1959; UMMZ 161205 (2) McCall Creek 3 mi E of McCall, 5 April 1949. LINCOLN COUNTY: TU 32926 (1) Homochitto River 4.6 mi E of Union Church, 17 May 1964.

Bayou Pierre Drainage. **Mississippi:** COPIAH COUNTY: TU 37299 (1) Bayou Pierre 15 mi SW of Utica, 19 March 1965; TU 37463 (1) Bayou Pierre 9 mi SW of Utica, 28 April 1965; TU 44487 (2) Bayou Pierre 8.4 mi SW of Utica, 1 March 1967; TU 53172 (3) Bayou Pierre 3.5 mi W of Martinsville, 13 June 1968; TU 73302 (5) Bayou Pierre 5.8 mi E of Carlisle, 16 Nov. 1971; TU 75243 (1) Bayou Pierre 1.7 mi W of Carpenter, 14 Jan. 1972; TU 75510 (1) Bayou Pierre 5.8 mi E of Carlisle, 29 Dec. 1971; USNM 200629 (1) Bayou Pierre 5 mi SW of Utica Institute, 6 May 1966.

Big Black River Drainage. **Mississippi:** ATTALA COUNTY: TU 73122 (24) Big Black River 1 mi ESE of Durant, 9 Nov. 1971. HINDS COUNTY: AF 13 (1) Bakers Creek 5 mi SW of Clinton, 1 April 1936. MADISON COUNTY: AF 2922-2924 (4) Big Black River at Moors Ferry Rd 10 mi N of Canton, 8 Aug. 1947; MSU 3510 (59) Big Black River on U.S. 51, 1 mi S of Pickens, 29 July 1973; MSU 3547 (32) Big Black River NNW of Canton, 29 July 1973; TU 4019 (18) Big Black River 1.7 mi S of Pickens, 23 May 1952; TU 54560 (26) Big Black River 1.6 mi S of Pickens, 7-8 Oct. 1968; UAIC 1267 (8) Big Black River 0.5 mi S of Illinois Central Railroad trestle N of Flora, 30 May 1964. WEBSTER COUNTY: FSU 9179 (7) Calabrella Creek 11.7 mi E of Kilmichael, 2 July 1963.

Hatchie River Drainage. **Tennessee:** HARDEMAN COUNTY: USNM 190785 (13) Spring Creek 1.2 mi S of Bolivar, 31 Aug. 1959. MCNAIRY COUNTY: USNM 190757 (13) Moss Creek 2.5 mi ENE of Pocahontas, 31 Aug. 1959.

Ammocrypta bifascia new species

Florida sand darter

FIGURE 2

Etheostoma beani.—Bollman, 1886:464 (Escambia River, Flomaton, Alabama).—Gilbert, 1891:159 (4 collections from Escambia River System).

Ammocrypta beani.—Evermann and Kendall, 1900:72 (listed from Florida).—Bailey, Winn and Smith, 1954:141 (reported from Escambia River).—Briggs, 1958:274 (listed from Florida).—Carr and Goin, 1959:99 (distribution in Florida), *A. beani* is correctly illustrated on plate 29.

Ammocrypta beanii.—Collette, 1965:583 (tubercle description, in part).—Smith-Vaniz, 1968:101, 134 (includes range of *A. bifascia*, in part).

TYPES.—Holotype, TU 82632 (male, 61.2 mm SL), Florida, Holmes County, Choctawhatchee River, 1.5 mi W of Pittman on Florida Hwy 2 (T5N,R16W,Sec.9); 5 July 1973; James D. Williams and Charles Baldwin. Paratypes taken with the holotype are: TU 82633 (25 specimens, 32.5-61.5 mm SL). Paratopotypes were taken in September 1959 (FSU 5447, 30), 22 November 1968 (UAIC 3195, 18), and 28 September 1968 (UMMZ 195243, 12). Localities for other paratypes and non-paratypic material are listed at the end of *A. bifascia* section. Only specimens from the Choctawhatchee River Drainage are designated as type specimens.

DIAGNOSIS.—A species of the subgenus *Ammocrypta* distinguished in having the opercular spine absent; lateral line complete, with 63 to 78 scales; last 3 to 5 scales of lateral line deflected ventrally; scale rows above lateral line usually 1; scale rows below lateral line usually 1; transverse scale rows usually 3 or 4; cheeks, opercles, and nape naked; dorsal rays usually IX-X, 11; anal rays usually I, 9-10; pectoral rays usually 13; vertebrae usually 40; first interneural spine usually between neural spines of seventh and eighth vertebrae; preopercle margin usually entire; preoperculomandibular canal pores usually 9.

Ammocrypta bifascia differs from the closely related *Ammocrypta beani* in having the first dorsal fin with two dark bands, one marginal and one submarginal (*A. beani* has a single submarginal band or blotches on the anterior spines and membranes which may be followed by a band through the central portion of fin); second dorsal fin and anal fin with dark marginal and submarginal bands (*A. beani* has a dark band covering the central two-thirds to three-fourths of second dorsal fin and anal fin, margins unpigmented); caudal fin with marginal and submarginal dark bands, the pigment of

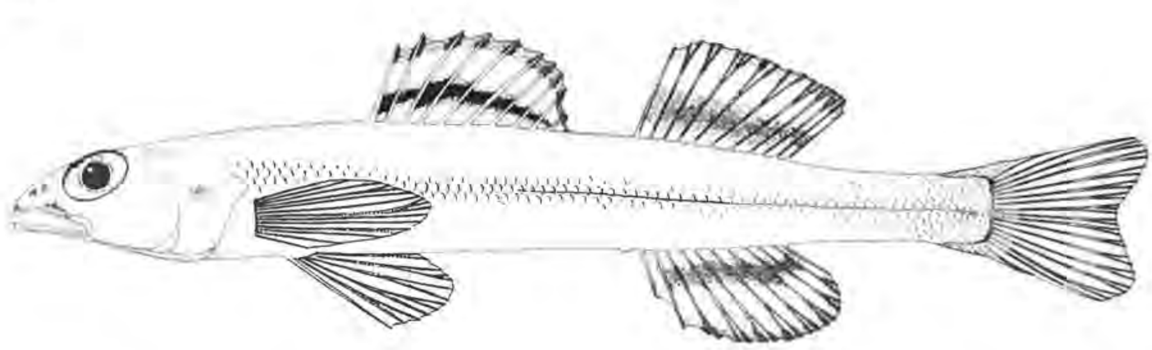

Fig. 2. *Ammocrypta bifascia* new species. Male 61.2 mm SL; TU 82632, Choctawhatchee River, 1.5 mi W of Pittman on Florida Hwy 2, Holmes County, Florida; 5 July 1973. (Drawn by HECTOR HARIMA).

submarginal band usually absent from membranes (*A. beani* has marginal band poorly developed or absent, pigment of submarginal band present on rays and membranes); and breeding tubercles present on ventral surface of pelvic spine and rays, and anal spine and rays, but absent from dorsal surface of pelvic spine and rays (*A. beani* has breeding tubercles on dorsal and ventral surfaces of pelvic spine and rays, and anal spine and rays). At maximum development, breeding tubercles of *A. bifascia* are approximately half the size of those of *A. beani*.

DESCRIPTION.—*Ammocrypta bifascia* is the largest known species of the subgenus *Ammocrypta*, the largest specimen examined (a male) measured 64 mm SL. Body elognate, subcylindrical in shape; greatest body depth near dorsal origin; body depth usually 11 to 13 percent of SL; greatest body width at or close behind pectoral fin base; snout moderately pointed, slightly longer than eye; mouth horizontal, maxilla extending posteriorly to beyond anterior rim of orbit; eyes positioned high on head. Proportional measurements are given in Table 1.

Dorsal rays VII-XII, 9-12 (usually IX-X, 11); anal rays I, 8-12 (usually I, 9-10); pectoral rays 12-14 (usually 13). Vertebrae ranged from 39-41 (usually 40). Frequency distributions of fin-ray counts and vertebrae are given in Tables 2-6.

Lateral line complete, with 63-78 scales. Scale rows above lateral line 0-3 (usually 1); scale rows below lateral line 0-3 (usually 1); transverse scale rows 3-7 (usually 3-4). Caudal peduncle variously covered with embedded and exposed scales. Ventral midline of caudal peduncle typically naked. Remainder of body, cheeks and opercles naked. Frequency distributions of scale counts are given in Tables 7-10.

Cephalic sensory canals complete. Lateral canal pores 4-6 (usually 5); supratemporal canal pores 3; supraorbital canal pores 4; coronal pore usually present; infraorbital canal pores 7-9 (usually 8); preoperculomandibular canal pores 8-10 (usually 9).

Counts for the holotype: dorsal rays IX, 10; anal rays I, 9; pectoral rays 13; lateral line scale rows 69; scale rows above the lateral line 1; scale rows below the lateral line 1; transverse scale rows 4.

LIFE COLORS.—The dorsal half of the translucent body is lightly washed with yellow to yellowish-orange pigment, which is more concentrated along the myosepta. The yellowish pigment of the dorsum gradually decreases ventrally towards the lateral line, often ending on or just below the lateral line scale row. On the ventrolateral and ventral surfaces of the body the yellowish pigment, if present, is very faint. It is frequently restricted to the myosepta and the area around the base of the anal fin. Melanophores that are present in varying concentrations on the dorsal half of the body form irregular blotches in some specimens. Melanophores are usually absent ventrally. There is a row of melanophores forming a thin line under the lateral line scale row on the posterior two-thirds to three-fourths of the body. The large melanophores on the peritoneum are easily visible through the body wall.

The connective tissue surrounding the vertebral column is yellow-orange, with melanophores scattered along its entire length. There are 7 to 10 gray-black rectangular blotches, which give it the appearance of a dashed line. The blotches are variable in length covering two to four vertebrae. In most specimens there are a few melanophores along some of the ribs and vertebral spines.

The occiput is brownish with a faint wash of yellow-orange pigment. The yellow-orange pigment extends anteriorly towards the snout where the orange pigment becomes more prominent. The snout, including the preorbital area and upper lip is orange to yellowish orange with scattered melanophores. The melanophores are frequently concentrated into small blotches just below the anterior nasal openings. The cheeks and opercles are iridescent bluish green. The branchiostegal rays and membranes are washed with a faint yellowish pigment.

On the median fins the light area between the gray to black marginal and submarginal bands is yellow. The yellow pigment is present on the rays and membranes of the fins and is usually more intense towards the base of the fins. The pectoral fin is light yellow, with the pigment more prominent on the upper 5-8 rays towards the base of the fin. The pelvic spine and membrane are yellow. The remainder of the fin is clear, with the exception of faint yellow pigment along the margin of the rays in some specimens.

COLORATION IN ALCOHOL.—In preserved specimens the distribution of pigment on the head and body is essentially the same as that of *A. beani*. Like *A. beani*, a few individuals were encountered in which melanophores were absent from the body. Sexual dichromatism is evident, males being darker than females.

The pigmentation pattern of the median fins is strikingly different from that found in *A. beani*. In males the first dorsal fin has a gray-black marginal band and a black submarginal band. The marginal band covers approximately the outer one-fourth of the fin, spines, and membranes. The light area between the marginal and submarginal band is slightly wider than the marginal band. The black submarginal band covers the upper two-thirds of the basal half of the fin, leaving the base of the fin unpigmented. The second dorsal and anal fins have a gray marginal band and a gray-black submarginal band. The bands, variable in width, generally widen posteriorly. The relative position of the bands in the second dorsal and anal fins is similar to that of the first dorsal. The most noticeable difference is the narrowness of the marginal bands, which often consist of a few scattered melanophores on the anterior membranes. The caudal fin has two well developed bands, equal in intensity to the soft dorsal and anal fin bands. The broad submarginal band covers the central one-third of the fin. Melanophores in this band are usually confined to the rays. The narrow marginal band covers approximately half of the outer one-third of the fin. Melanophores in this band are present on the rays and membranes. The dorsal half of the pectoral fins have melanophores on and along the margins of the rays. Occasionally the ventral half of the pectoral fins will have a few scattered melanophores along the rays. Melanophores are usually larger and more concentrated towards the base of the fins. The pelvic fins in males and females are usually unpigmented.

BREEDING TUBERCLES.—The distribution and size of tubercles on *Ammocrypta bifascia* is reduced when compared to that of *A. beani*. In *A. bifascia* tubercles are present on the ventral surface of the pelvic spine and rays from the base to near the margin, whereas on the anal fin, they are usually present only on the segmented portion of the rays. Tubercles are usually absent from the anal spine, but 3 to 6 poorly developed tubercles are present on a few individuals. On the segmented portion of the anal and pelvic rays there is usually one tubercle per ray segment. At maximum development the tubercles on *A. bifascia* are approximately half the size of those on *A. beani*. Tubercles begin to develop during April and are present through early September. Tubercles are absent in females.

DISTRIBUTION.—*Ammocrypta bifascia* is known, in southern Alabama and western Florida, from the Perdido River system, east to the Choctawhatchee River system (Fig. 4). East of Perdido Bay *A. bifascia* is found throughout the Escambia, Blackwater and Yellow river systems and most of the Choctawhatchee River system. It is absent from all tributaries to Choctawhatchee Bay, except for the Choctawhatchee River itself.

GEOGRAPHIC VARIATION.—Most meristic caracters in *Ammocrypta bifascia* exhibited little variation throughout its geographic range. Frequency distributions of meristic characters in *A. bifascia* and *A. beani* are presented in Tables 2-10.

Dorsal rays ranged from VII-XII, 9-12, with a mode of IX, 11 in all populations. The anal rays ranged from I, 8-12 with a mode of I, 9 in all populations. Pectoral rays were the least variable, ranging from 12 to 14, with a mode of 13 in all populations.

The total number of vertebrae ranged from 39 to 41, with a mode of 40 in all populations.

Lateral line scales ranged from 63 to 78, with means ranging from 69.36 (Blackwater River) to 70.30 (Yellow River). The scales above the lateral line ranged from 0 to 2, with a mode of 1, and scales below the lateral line ranged from 0 to 3, with a mode of 1. Transverse scale rows exhibited a slight increase from west to east. The western most population (Perdido River) had a mean of 3.40 while the easternmost population (Choctawhatchee River) had a mean of 4.55. Scalation of the caudal peduncle, which was almost complete in the Choctawhatchee River population, decreased westward from the Choctawhatchee. Caudal peduncle scale counts, taken from the most completely scaled individuals, ranged from 21 to 26. On the most completely scaled specimens the rows were irregular and some were partially embedded, which made counting very difficult.

Several meristic characters in *Ammocrypta beani* and *A. bifascia* have exhibited, to varying degrees, east-west and west-east clinal variation. Similar clinal variation has been reported for two species of *Notropis* (Cyprinidae), one species of *Fundulus* (Cyprinodontidae), and two species of *Noturus* (Ictaluridae) distributed along the Gulf Slope (Snelson, 1972:52 and references therein).

HABITAT AND LIFE HISTORY.—*Ammocrypta bifascia* is an inhabitant of streams with shifting sand bottoms and moderate to swift current. It is most frequently encountered in moderate current, in moderate to large streams, but occasionally enters small streams. It is taken at depths ranging from 6 inches to 5 feet, but is most common at depths of 2 to 4 feet. Throughout its range *A. bifascia* is most frequently associated with *Notropis longirostris* and *Ericymba buccata*, except in the Blackwater River drainage in Florida where *Ericymba buccata* is apparently absent. Bailey, Winn, and Smith (1954) reported this association in the Escambia River.

Fishes collected at the type locality are: *Alosa chrysochloris, Ericymba buccata, Hybopsis aestivalis, Hybopsis amblops, Notropis longirostris, Notropis texanus, Notropis venustus, Carpiodes velifer, Moxostoma poecilu-*

rum, Ictalurus punctatus, Noturus leptacanthus, Aphredoderus sayanus, Lepomis megalotis, Micropterus punctulatus, Micropterus salmoides, Etheostoma davisoni, Etheostoma swaini, Percina caprodes, Percina nigrofasciata, Trinectes maculatus.

Based on the dissection of approximately 20 gravid females, the spawning period of *A. bifascia* appears to begin during the latter part of May or first part of June. This is three to four weeks earlier than the spawning period of *A. beani*. Females measuring 42 to 53 mm SL, taken during early to mid-May, each had 49 to 69 large (diameter approximately 1 mm) golden yellow eggs. During the first part of June egg counts ranged from 17 to 60 each, indicating that some females had begun to spawn. Egg counts per female for July and early August ranged from 12 to 35. No female collected during the latter part of August had more than 25 eggs each; some individuals were totally spent.

Etymology.—The specific name, *bifascia*, is from the Latin *bi*, two; *fascia*, band, in reference to the presence of two bands of pigment on the median fins.

Material Examined

Paratypes.—Choctawhatchee River Drainage: **Alabama:** COFFEE COUNTY: TU 37399 (2) Cripple Creek, trib. to Pearl River, 1.1 mi N of Kinston, 23 April 1965 DALE COUNTY: UAIC 369 (2) Judy Creek 5.5 mi E of Ozark, 22 Aug. 1953. GENEVA COUNTY: UAIC 378 (5) Flat Creek 7 mi W of Samson, 23 Aug. 1953; UAIC 1930 (2) Sandy Creek, trib. to Pea River, 5 mi W of Geneva, 7 April 1966; UAIC 1596 (8) Choctawhatchee River 0.5 mi N of bridge at Geneva, 27 May 1965; USNM 210662 (2) Flat Creek 5 mi W of Samson, 24 April 1965. HOUSTON COUNTY: USNM 210649 (9) Choctawhatchee River 2 mi E of Clayhatchee, 4 April 1969. **Florida:** HOLMES COUNTY: FSU 199 (3) Wrights Creek 5.9 mi N of Bonifay, 28 May 1951; FSU 671 (1) Holmes Creek 4.6 mi W of Chipley, 4 May 1952; FSU 4406 (2) East Pittman Creek 0.8 mi N of East Pittman, 27 Jan. 1959; FSU 6308 (2) East Pittman Creek 0.8 mi N of East Pittman, 30 April 1960; TU 2278 (4) trib. to Choctawhatchee River 3.5 mi NW of jct Hwy 79 and 177, 28 May 1951; TU 20405 (1) Wrights Creek 6.4 mi N of Bonifay, 12 July 1959; TU 20816 (8) Choctawhatchee River 3 mi S of Browns, 24 July 1959; TU 46129 (2) Wrights Mill Creek 3.8 mi N of jct Florida Hwy 79 and 177, 1 May 1967; TU 46435 (1) Wrights Mill Creek 6.9 mi N of jct Florida Hwy 79 and U.S. 90, 30 April 1967; TU 82174 (1) Pittman Creek on Hwy 177A 2 mi N of Hwy 2, 17 May 1973; UAIC 2998 (1) Wrights Creek 7 mi N of Bonifay, 7 June 1968; UMMZ 166318 (1) Parrott Creek 6 mi SW of Geneva, Alabama, 3 May 1952. WASHINGTON COUNTY: UAIC 3191 (2) Choctawhatchee River 11.2 mi W of Ebro, 9 Nov. 1968.

Additional material examined but not designated as paratypes includes the following: *Yellow River Drainage:* **Alabama:** COVINGTON COUNTY: TU 72893 (15) Yellow River 12 mi W of Florida, 5 Oct. 1971; TU 73015 (6) Five Runs Creek, trib. to Yellow River, 15 mi NW of Florala, 20 Nov. 1971; TU 73160 (13) Yellow River 10 mi SW of Opp, 21 Nov. 1971; UAIC 372 (8) Yellow River 5 mi W of Opp, 23 Aug. 1953. **Florida:** OKALOOSA COUNTY: TU 24061 (2) mouth of Long Creek, trib. of Shoal River, 17 Aug. 1960; TU 24073 (7) Shoal River cutoff 6 mi upstream from Hwy 85 bridge, 2 Nov. 1960; TU 24703 (1) trib. on W side of Shoal River 0.25 mi below railroad trestle, 7 Sept. 1960; TU 48327 (4) Shoal River at Hwy 85 crossing S of Crestview, 3 May 1967; TU 48368 (7) Yellow River 0.5 mi S of Hwy 90 bridge, 7 May 1967; TU 72817 (41) Yellow River 4.6 mi W of Hwy 85 on Hwy 2, 4 Oct. 1971; TU 79699 (23) Yellow River 7 mi SW of Laurel Hill, 24 June 1972; TU 80485 (42) Yellow River 0.2 mi downstream from Florida Hwy 2 T5N,R23W,Sec.20, 12 April 1972; TU 81256 (5) Yellow River 2.9 mi S of Holt, 22 April 1972; TU 81447 (5) Yellow River 7 mi SW of Laurel Hill, 9 April 1973; UAIC 3052 (14) Yellow River 4 mi W of jct Florida Hwys 85 and 2, 7 Sept. 1968; UAIC 3053 (16) Shoal River on N side of Doreas, 7 Sept. 1968; UAIC 3056 (11) Yellow River 4 mi W of Florida Hwy 85 and 2, 8 Sept. 1968; UAIC 3183 (8) Yellow River 4 mi W of jct Florida Hwys 2 and 85, 1 Nov. 1968; UAIC 3555 (5) Yellow River 5 mi E of Blackman, 3 June 1969. WALTON COUNTY: FSU 4208 (1) Shoal River 1.3 mi S of Stella, 28 Jan. 1959; FSU 4359 (5) Pine Log Creek 6.4 mi S of Clear Springs, 28 Jan. 1959; FSU 6059 (5) Shoal River 12.5 airline mi NW of De Funiak Springs, 23 Jan. 1960; FSU 13598 (2) Shoal River at crossing of Florida Hwy 285, 3 April 1966; TU 46106 (1) Shoal River 3.5 mi N of jct of Hwy 90 and Hwy 285, 23 April 1967.

Blackwater River Drainage. **Florida:** OKLAOOSA COUNTY: TU 23681 (1) Blackwater River 4.3 mi NW of Baker, 23 Oct. 1960; TU 46423 (1) Blackwater River 9.4 mi N of jct Florida Hwy 4 and U.S. Hwy 90, 1 May 1967; UAIC 2713 (5) Blackwater River 5.5 mi NW of Baker, 15 Oct. 1967. SANTA ROSA COUNTY: FSU 8231 (23) Pond Creek 2.0 mi SW of Milton, 11 July 1962; TU 9756 (6) Pond Creek 2 mi SW of Milton, 6 March 1955; TU 10496 (4) Pond Creek 2 mi SW of Milton, 14 Aug. 1955; TU 56719 (2) Pond Creek 2 mi SW of Milton, 7 March 1969; UAIC 630 (7) Blackwater River 10 mi E of Milton, 10 April 1955; UAIC 2400 (9) East Coldwater Creek 12 mi N of Milton, 9 Sept. 1966; UAIC 2707 (15) East Fork Coldwater Creek 13 airline mi N of Milton, 13 Oct. 1967; UAIC 2708 (6) Blackwater River 10 mi NE of Milton, 13 Oct. 1967; UAIC 2711 (19) Big Coldwater Creek 1 mi upstream from mouth of Wolfe Creek, 15 Oct. 1967; UAIC 2767 (5) Big Coldwater Creek 9 mi NE of Milton, 10 June 1967; UAIC 2790 (10) East Coldwater Creek 12 mi N of Milton, 7 Aug. 1967; UAIC 2818 (2) Big Coldwater Creek 6.3 mi NE of Milton, 22 Jan. 1968; UMMZ 155484 (6) Pond Creek 1.8 mi SW of Milton, 6 April 1948.

Escambia River Drainage. **Alabama:** BUTLER COUNTY: USNM 43490 (3) Persimmon Creek at Greenville, 1889; USNM 43549 (6) Hawkins Creek at Greenville, 1889; USNM 125383 (1) Persimmon Creek at Greenville, 1889. CONECUH COUNTY: API 553 (1) Burnt Corn Creek, 8 Oct. 1937; UAIC 414 (8) Sepulga River 22 mi NW of Andalusia, 16 Aug. 1954; USNM 43510 (1) Evergreen, 1889. COVINGTON COUNTY: UAIC 415 (15) Pidgeon Creek 12.4 mi NW of Andalusia, 16 Aug. 1954. ESCAMBIA COUNTY: AU 1084 (1) Escambia River NE of Atmore on I-65, 17 March 1968; FSU 8152 (6) Little Escambia Creek 1 mi SW of Pollard, 10 July 1962; TU 15230 (4) Big Escambia Creek at Flomaton, 16 March 1957; TU 15938 (5) Conecuh River 3 mi SE of Flomaton, 18 July 1957; TU 15262 (5) Little Escambia Creek 1 mi S of Pollard, 15 March 1957; TU 81364 (52) Conecuh River 9.4 mi E of East Brewton, 23 April 1972; UAIC 416 (2) Conecuh River 18.3 mi E of Brewton, 16 Aug. 1954; UAIC 421 (1) Little Escambia Creek 3 mi E of Flomaton, 17 Aug. 1954; UAIC 422 (5) Big Escambia Creek at Flomaton, 17 Aug. 1954; UAIC 1823 (11) Escambia River proper on Hwy 29, 26 Dec. 1965; USNM 43524 (6) Pollard, 1889.

Perdido River Drainage. **Alabama:** BALDWIN COUNTY: AU 655-12 Dyas Creek, trib. to Perdido River, 0.25 mi above jct with river, 4 June 1965; FSU 5951 (8) Perdido River W of Muscogee, 12 Aug. 1959; UAIC 517 (2) Unnamed stream between Loxley and Gateswood, 23 Aug. 1956; UAIC 2428 (1) Styx River 5 mi ENE of Rosinton, 16 July 1960; UAIC 2431 (8) Styx River near Taylors Camp, 16 July 1960; UAIC 2437 (1) Styx River 7.2 mi ENE of Loxley, 11 Aug. 1960; UAIC 2445 (1) Styx River 1 mi below concrete hwy bridge halfway between Eight Mile Creek and Dry Branch Creek, 17 June 1961; UAIC 2448 (1) Styx River 0.5 mi downstream from mouth of Beetree Creek, 17 June 1961; UAIC 2452 (2) Styx River 0.25 mi downstream from mouth of Joe's Creek, 31 Aug. 1961; UAIC 2453 (6) Styx River 1 mi downstream from mouth of Joe's Creek, 31 Aug. 1961; UAIC 2455 (5) Styx River 1.5 mi upstream from U.S. Hwy 90 bridge, 31 Aug. 1961.

Ammocrypta clara Jordan and Meek

Western sand darter

FIGURE 3

TYPES.—Lectotype, USNM 35828 (1, 42 mm SL), Iowa, Des Moines River at Ottumwa; D. S. Jordan and

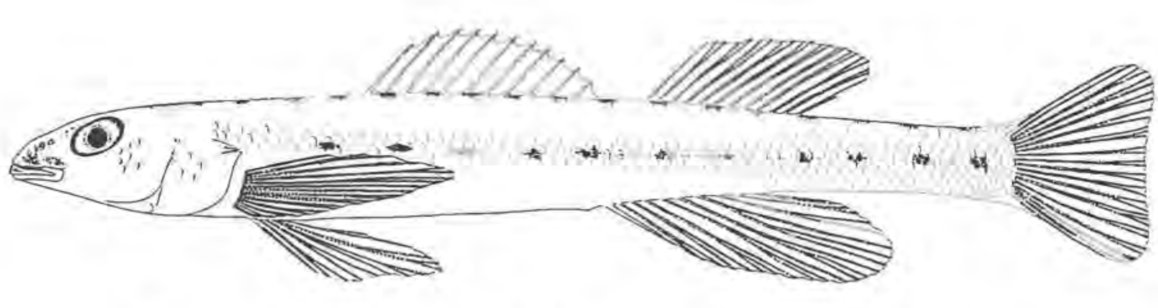

Fig. 3. *Ammocrypta clara*. Male 50.0 mm SL; UAIC 3267, Waupaca River, 2 mi below Waupaca, Waupaca County, Wisconsin; 8 June 1960. (Drawn by HECTOR HARIMA).

S. E. Meek, August 1884. Lectotype was designated by Linder (1959:180). Paralectotypes, USNM 164166 (3, 33-51 mm SL), were removed from USNM 35828 by Linder (1959:180). Additional paralectotypes, Stanford University 1500 (1, 46 mm SL) and UMMZ 187510 (2, disintegrated), originally Indiana University 753, then Indiana University 7323, are from the original type series. Collections from Texas and Arkansas mentioned in the original description by Jordan and Meek (1885) are not considered to be type material (Collette and Knapp, 1967:12).

NOMENCLATURAL HISTORY.—*Ammocrypta clara* was described by Jordan and Meek (1885:8). The specific name *clara* is from the Latin *clarus* referring to the clear or transparent flesh. In the original description Jordan and Meek compared *A. clara* with *A. pellucida* and stated that *A. clara* was "allied to *Ammocrypta pellucida*, but with the squamation much less perfect". They also mentioned the presence of a well developed opercular spine in *A. clara*. Evermann and Jenkins (1889:49-50) reduced *A. clara* to a subspecies of *A. pellucida*, based on the supposed gradation in cheek, opercle, and body squamation in specimens from the Wabash River at Delphi, Indiana. Examination of this collection (USNM 39608) revealed specimens of both *A. clara* and *A. pellucida*, with no sign of intergradation. Apparently what Evermann and Jenkins (1889) interpreted as intergradation in squamation was the more completely scaled *A. clara* and the incompletely scaled *A. pellucida*, which would appear to be intergrades between the two species. Other characters (morphological and pigmentation) serving to distinguish the two species showed no signs of intergradation. Workers after Evermann and Jenkins (1889) variously treated *A. clara* as a valid species, a synonym of *A. pellucida*, or as a subspecies of *A. pellucida*. Eddy and Surber (1947) regarded *A. clara* and *A. pellucida* as distinct species based on information in correspondence from Carl L. Hubbs. Linder (1959) reviewed the specific status of *A. clara* and *A. pellucida* and presented information to substantiate recognition of the two species.

Based on the known distribution of *A. clara* and *A. pellucida*, literature records for *A. pellucida clara*, *A. pellucida*, *Etheostoma pellucidum*, and *Etheostoma pellucidum clarum* from the Mississippi River and its tributaries in Illinois, and Missouri, and more northerly areas are referable to *A. clara*. The record of *A. pellucida* reported by Linder (1959) from the Cumberland drainage was probably based on specimens of *A. clara*, but this could not be confirmed since his specimens were not located. Linder did not list all material upon which his study was based.

DIAGNOSIS.—*Ammocrypta clara* differs from other species of the subgenus *Ammocrypta* in having a well developed opercular spine; lateral line complete with 63 to 81 scales; last 3 to 5 scales of lateral line deflected ventrally; body incompletely scaled; scale rows above lateral line usually 1; scale rows below lateral line 2; cheeks and opercles variously scaled; dorsal rays usually XI, 11; anal rays usually I, 9; pectoral rays usually 13 or 14; vertebrae usually 39 or 40; first interneural spine between neural spines of sixth and seventh vertebrae; origin of anal fin anterior to origin of second dorsal; preopercle margin usually entire; preoperculomandibular canal pores usually 8; breeding tubercles in males present on pelvic spine and rays, anal spine and rays, and lower two or three caudal fin rays; bands of pigment absent in median fins; and pelvic fins unpigmented.

DESCRIPTION.—The pigmentation and physiognomy of *A. clara* are illustrated in Fig. 3. Proportional measurements are given in Table 1. Frequency distributions of fin ray, vertebrae and scale counts are given in Tables 11-19.

Body moderately elongate; standard length to 59 mm; depth of body contained six to eight times in standard length; origin of anal fin anterior to origin of second dorsal fin; head contained approximately four times in standard length; orbit length less than snout length; mouth small to moderate in size; posterior extent of maxilla not reaching anterior rim of orbit.

Dorsal rays IX-XIII, 9-13 (usually XI, 11); anal rays I, 8 to I, 11 (usually I, 9); pectoral rays 12-15 (usually 13-14); vertebrae 38-42 (usually 39-40).

Lateral line complete, with 63 to 81 scales; posterior 3 to 5 scales of lateral line deflected ventrally. Scale rows above lateral line 0 to 2 (usually 1); scale rows below lateral line 1 to 5 (usually 2); transverse scale rows 3 to 12 (usually 5 or 6). Squamation of checks and opercles variable, usually partially scaled; nape and dorsum along base of dorsal fins naked or with few scattered scales; lateral and ventrolateral areas posterior to base of pectoral and pelvic fins partially scaled; caudal peduncle mostly scaled, completely scaled in some; caudal peduncle scales (individuals with completely scaled caudal peduncle) 21 to 26, usually 23 to 25, with 10 or 11 scales above lateral line and 11 or 12 scales below lateral line.

Cephalic sensory canals complete. Lateral canal pores usually 5; supratemporal canal pores usually 3; supraorbital canal pores usually 4; coronal pore present; infraorbital canal pores usually 8; preoperculomandibular canal pores usually 8.

Counts for the lectotype are: dorsal rays XI, 10; anal rays I, 9; pectoral rays 14; lateral line scales 72; scale rows above lateral line 1; scale rows below lateral line 2.

LIFE COLORS.—The following notes are based on observation of six subadult specimens. The dorsal half of the translucent body is light yellow. There is a trace of yellowish pigment below the lateral line scale row that disappears ventrally. Small clusters of melanophores form dusky blotches along the midline of the dorsum in some specimens. The dark rectangular blotches present along the vertebral column of *A. beani* and *A. bifascia* were not evident in the few specimens observed.

The snout, dorsal and dorsolateral surfaces of the head are yellowish. Cheeks and opercles are greenish yellow. Fin membranes are unpigmented.

Color notes presented in the original description (Jordan and Meek, 1885) are similar to those given above. They did report faint orange spots connected by a lateral streak which was not evident on specimens observed during this study.

COLORATION IN ALCOHOL.—Melanophores, in varying concentrations, are present on the upper half of the body. There are 12 to 16 dusky to brown blotches (variable in size, shape, and intensity) along the midline of the dorsum. Blotches are usually evenly spaced, two or three on the nape; three to five under the spinous dorsal fin; one between the spinous and soft dorsal fin; usually three under the soft dorsal and two or three on the caudal peduncle. Individuals with poorly developed blotches often have a dusky stripe along the midline of the dorsum. Laterally there is a narrow stripe extending the length of the body. The stripe is usually more prominent in males than females. Anteriorly the stripe consists of two or three poorly defined rows of melanophores beneath the first row of scales below the lateral line scales. Melanophores gradually concentrate into a single row beneath the middle of the lateral line scale row on the posterior half of the body. There are 9 to 13 horizontal brownish blotches along the stripe, which are more intense posteriorly. These blotches are usually centered on the lateral stripe, and are one to two scales high and two to four scales long. The exposed margins of all body scales, except those along the ventral margin of the caudal peduncle, are typically lined with melanophores. A row of melanophores is present from the base of the last anal ray posteriorly to the caudal base.

Pigment in the median fins is restricted to the margins of the spines and rays. In the first dorsal fin melanophores are concentrated along the posterior margins of the spines, occasionally with a few along the anterior margins. Second dorsal and anal fins have melanophores along the anterior and posterior margins, but are usually more numerous on the second dorsal, often being absent on the anterior rays of the anal fin. Caudal fin rays have melanophores along the margins from just above the base of the fin to the margin. Pectoral fins have melanophores on and along margins of the rays of the dorsal half of the fin. Occasionally melanophores are present on the ventral half of the fin. Pelvic fins are unpigmented.

The lower part of the head is unpigmented with the exception of a few melanophores along the rami of the jaw. Scales on the cheeks and opercles have melanophores along their exposed margins and often on the central portion. Upper margins of the opercle and preopercle are usually heavily pigmented and merge dorsally with the dusky to dark brown occiput. A solid band of pigment extends around the tip of the snout dorsally to just below the level of the anterior nostrils. Pigment is concentrated and usually restricted to the central part of the upper lip.

BREEDING TUBERCLES.—In males breeding tubercles begin to develop in late May and early June and are fully developed by late June or early July. Tubercles first develop on the anal and pelvic fins, then on the caudal fin rays. At maximum development males have tubercles on the dorsal and ventral surfaces of the pelvic spine and rays, anal spine and rays, and the ventralmost three to four caudal rays. Large tubercles are present on the ventral surface of the pelvic spines and rays from the base to near the margin. Tubercles are usually absent on the upper surface of the pelvic fin and, when present, are very small and restricted to the distal two-thirds of the spine and to the segmented portion of the rays. On anal fin rays tubercles similar to those one the ventral surface of the pelvic rays are present along the distal half to three-fourths of the fin rays. Smaller tubercles are scattered along the distal half of the anal spine. Tubercles on the lower three or four caudal rays are present along the entire length of the ventralmost unbranched ray and the distal one-fourth to one-third of the branched rays. Tubercles on all fin rays are evenly spaced, usually one per segment on the articulated portion of the ray.

DISTRIBUTION.—*Ammocrypta clara* is known from the Neches and Sabine rivers in eastern Texas northward through the Mississippi Valley to southern Minnesota and Wisconsin (Fig. 4). In the lower Mississippi Valley it is known from the Red, Ouachita, White, and St. Francis rivers. Meek (1894) reported specimens from Illinois Bayou at Russellville, Arkansas (Arkansas River drainage), but this record is apparently based on specimens of *A. vivax* (USNM 59254). Presently there are no known records of *A. clara* from the Arkansas River system. Cross (1967) discussed the early record of *A.*

clara from Kansas reported by Graham (1885) and concluded that its former occurrence in Kansas seemed possible. In view of the absence of *A. clara* in the Missouri and Arkansas river systems, which comprise the drainage of western Kansas, its occurrence in Kansas is open to question. Three collections from the Big Black River in west central Mississippi (Madison County) are the only records from an eastern tributary to the Mississippi River in the lower Mississippi Valley.

In the Ohio Basin *A. clara* is known from one locality in the Cumberland River (UMMZ 67075), Wayne County, Kentucky; one locality in the Green River (USNM 202473), Green County, Kentucky; and two localities in the Wabash River (UMMZ 121623), Posey County, Indiana, and (USNM 39608) Carroll County, Indiana. Three specimens found in a collection of *A. pellucida* (FMNH 6827) from Red Bird Creek, Clay County, Kentucky (Kentucky River drainage), are questionable, since the condition of the specimens indicated that they were from different collections.

In the upper Mississippi Valley it is known from the Mississippi River proper in Missouri to St. Anthony Falls in southern Minnesota; the Kaskaskia, Illinois, and Rock rivers in Illinois; the Salt River in Missouri; the Des Moines, Iowa, and Cedar rivers in Iowa; the Wisconsin and Black rivers in Wisconsin; and the Minnesota, Blue Earth, and St. Croix rivers in Minnesota. Records from lakes in Aitkin and Itasca counties in central Minnesota reported by Eddy and Surber (1947: 218) are doubtful. The records were obtained from the Conservation Department and the specimens, if retained, have not been relocated (Samuel Eddy, personal communication).

At present there are no known records, specimens, or literature reports validated by me of *A. clara* from the Tennessee, Arkansas, and Missouri river basins. The collection reported by Becker (1965:241) from the Waupaca River, tributary to Green Bay of Lake Michigan, is the only record of *Ammocrypta clara* from the Great Lakes drainage. The dispersal route of *A. clara* and *Lepisosteus platostomus* into the Green Bay drainage of Lake Michigan was reportedly through the Fox-Wisconsin River Canal at Portage, Wisconsin (Becker, 1965; Priegel, 1963). Considering the size and habits of *A. clara*, an alternative explanation of its occurrence in the Fox River, tributary to Green Bay, is that this area was once part of the Wisconsin River drainage. Evidence presented by Van der Schalie (*in* Goodrich and Van der Schalie, 1939), based on the distribution of freshwater mussels, indicates that the Green Bay drainage (including the Fox River) once flowed southward into the Wisconsin River.

GEOGRAPHIC VARIATION.—Variation in the number of dorsal, anal, and pectoral rays was random with no clinal trends. The modal number of dorsal spines was 11, except in the Sabine-Neches and Red river populations, which had a mode of 10. The modal number of anal rays was 9 in all populations. Pectoral rays had a mode of 14 in approximately two-thirds of the populations and 13 in the remaining one-third, with no geographic trends apparent.

The modal number of vertebrae was 40, except in the Sabine-Neches and Red river populations where the mode was 39. Lateral line scales exhibited geographical variation in the form of an irregular cline, with a slight increase in the number of scales in specimens from the northern part of the range. The means ranged from 68.85 in the Sabine-Neches population (south) to 74.85 in the Waupaca population (north). The most notable deviation was the Ohio population, which had a mean of 76.67. One other population had a high mean (Iowa, $\overline{X}=76.50$), but was not considered significant since it was based on two specimens. Variation in scale rows above the lateral line (mode=2) exhibited no clinal trends. Variation in the modal number of transverse scale rows was irregular and varied from four to six, usually six.

Squamation of the cheeks, opercles, and nape was extremely variable, ranging from completely scaled cheeks and opercles with one to three rows of scales along the midline of the nape, scattered scales along the base of the dorsal fins, to a few scattered embedded scales on the cheeks and opercles with no scales on the nape and dorsum. These extremes were often encountered in a series of specimens from a single locality. Because of the extreme variability well defined trends were not apparent, but the northern populations appeared to have more scales on the cheeks, opercles, and caudal peduncle than the southern populations. This trend was not observed in nape squamation. In all populations the cheeks were generally more completely scaled than the opercles.

HABITAT AND LIFE HISTORY.—*Ammocrypta clara* is an inhabitant of modernate to large rivers and is most frequently taken in moderate current over a sand bottom. Starrett (1950) reported *A. clara* in 11 percent of the collections taken over sand bottoms in moderate current at depths up to 2.5 feet in the Des Moines River. Specimens were also taken in two percent of the collections over sand and gravel bottoms at depths up to 2.5 feet and three percent of the collections from pools with a sand and silt bottom at depths up to 5 feet. Additional references to the habitat preference of *A. clara* (Jordan and Meek, 1885; Call, 1892; Cox, 1896; Cleary, 1952; Harlan and Speaker, 1956; Johnson and Becker, 1970) generally included sand or sand and gravel bottoms in rivers with moderate current. Pflieger (1971) reported the habitat as silt free sand bottomed streams along the quiet margins of channels and shallow backwaters. Based on the number of individuals per collection, *A. clara* appears to be more abundant in the northern part of the range.

Species associates are few in number, *A. clara* often being the only species present in its habitat. In the southern part of its range *A. clara* is frequently taken with *Notropis sabinae, Hybopsis aestivalis, Percina ouachitae,* and *Ammocrypta vivax*. Species associates

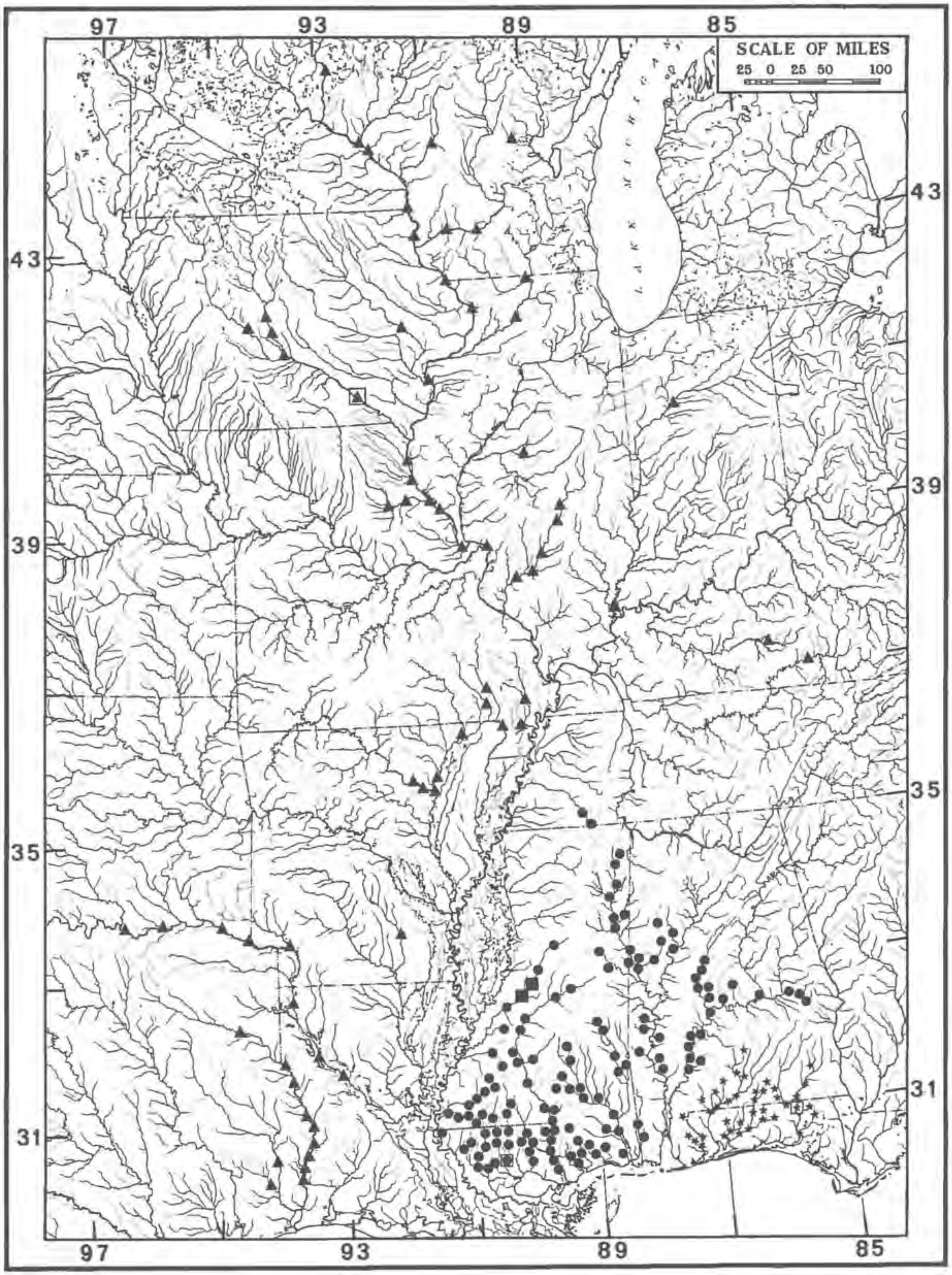

Fig. 4. Distribution of the three species of the *Ammocrypta beani* species group. *Ammocrypta bifascia* (stars), *A. beani* (circles), and *A. clara* (triangles). Symbols enclosed by a square represent the type locality for that species. Solid squares represent the two localities where three species, *A. beani, A. clara,* and *A. vivax* occur syntopically. Broadly overlapping symbols and uncertain localities are not plotted.

have not been reported in the northern part of its range, but *Notropis dorsalis* has been reported by Eddy and Surber (1947) to prefer the same type of habitat as *A. clara*.

Examination of the ovaries and the development of breeding tubercles in males indicates that the breeding season is at its height in July and early August. Starrett (1950) reported increased activity of *A. clara* in mid-summer, apparently associated with spawning as evidenced by the presence of gravid females. Large ova occasionally present in specimens taken in late August indicate the spawning season may be prolonged. In most collections females outnumber males and are usually slightly larger than males.

Material Examined

Sabine-Neches River Drainage. **Louisiana:** BEAUREGARD PARISH: TU 58433 (2) Sabine River 0.5 mi below mouth of Circle Lake outlet, rmi 75, 24 July 1969; TU 59018 (5) Sabine River along sand bar at Eaves Old River, 27 Aug. 1969; TU 63333 (6) Sabine River at Gulf, Colorado and Santa Fe railroad bridge, 14 July 1970; TU 67818 (6) Sabine River 0.5 mi below mouth of Anacoco Bayou, 23 Feb. 1971; TU 79440 (4) Sabine River 5.7 mi SW of Merryville, 6 Oct. 1972. DESOTO PARISH: TU 35547 (3) Sabine River at Logansport, 14 July 1964. SABINE PARISH: TU 33990 (3) Sabine River 7.4 mi W of Noble, 8 July 1963; TU 36577 (22) Sabine River 8 mi SW of Toro, 9-10 July 1963. VERNON PARISH: NLU 4858 (6) Sabine River, rocks area, T2N,R12W,Sec.30, 28 June 1966; TU 64099 (3) Sabine River 2.5 mi above mouth of Bayou Anacoco, 21 Aug. 1970; UAIC 2678 (3) Sabine River W of Leesville, 10 Sept. 1967. **Texas:** GREGG COUNTY: USNM 36488 (1) Sabine River at Longview, no date. HARDEN COUNTY: TAM 1F-13-J-9 (5) Neches River W of Silsbee 26 Oct. 1952; TU 21756 (6) Village Creek at U.S. Hwy 96, 29 Oct. 1956. NEWTON COUNTY: TU 51562 (3) Sabine River 18.4 mi SW of Leesville, 25 April 1968; TU 54412 (1) Sabine River 11.7 mi NE of Burkeville, 11-12 Aug. 1968; TU 58318 (4) Sabine River opposite mouth of Old River, 23 July 1969; TU 58338 (6) Sabine River at rmi 90.5, mouth of Middle River, 23 July 1969; TU 58399 (2) Sabine River just below mouth of Cow Creek, 23 July 1969; TU 58470 (22) Sabine River at upper mouth of Carter Creek, rmi 66, 24 July 1969; TU 62425 (8) Sabine River along sandbar opposite Moon Lake, 21 May 1970; 62439 (7) Sabine River at bend E of Kinney Lake, 21 May 1970; TU 63302 (9) Sabine River 1.6 mi E of Bon Wier, 14 July 1970; TU 63525 (2) Sabine River at rmi 70, 17 July 1970; TU 63549 (10) Sabine River at rmi 67, 17 July 1970; TU 64019 (1) Sabine River 1.6 mi E of Bon Weir, 21 Aug. 1970; TU 64109 (6) Sabine River below bend at Armstrong Lake, 22 Aug. 1970. SABINE COUNTY: TU 33303 (2) Sabine River 8 mi SW of Toro, 27 June 1963. TYLER COUNTY: TU 72707 (8) Neches River 4.9 mi W of Mount Union, 21 Oct. 1971.

Red River Drainage. **Arkansas:** HEMPSTEAD COUNTY: USNM 36337 (2) Red River at Fulton, no date. **Louisiana:** BOSSIER PARISH: NLU 4602 (1) Red River at Beene Place T18N,R13W,Sec.7, 6 July 1966. NATCHITOCHES PARISH: UAIC 2675 (2) Red River 0.8 mi N of Natchitoches, 10 Sept. 1967. RED RIVER PARISH: NLU 5059 (3) Red River at Coushatta, 11 Aug. 1966. **Oklahoma:** BRYAN COUNTY: OAM 5000 (4) mouth of Blue River, 1953; UO 33011 (2) Red River at old bridge site, 10 July 1963; UO 36970 (2) Red River near mouth of Blue River, 25 July 1959. MCCURTAIN COUNTY: CU 52528 (2) N shore of Red River at Hwy 37 bridge, Oklahoma-Texas line, 4 June 1967; UO 32736 (5) Red River at Oklahoma-Arkansas state line T5S,R14E,Sec.23, 6 July 1963.

Ouachita River Drainage. **Arkansas:** BRADLEY COUNTY: UMMZ 127887 (6) Saline River 5 mi N of Warren, 20 June 1939.

Big Black River Drainage. **Mississippi:** MADISON COUNTY: AF 2925 (1) Big Black River 10 mi N of Canton, 8 Aug. 1947; MSU 3549 (1) Big Black River NNW of Canton, 29 July 1973; TU 81744 (1) Big Black River 1.7 mi S of Pickens, 23 May 1952.

White River Drainage. **Arkansas:** INDEPENDENCE COUNTY: TU 43501 (1) Black River 2 mi N of Lockhart Ferry, 12 Aug. 1965; TU 44808 (1) along shoreline of White River 2 mi upstream from Ferry, 10 Aug. 1965; TU 44832 (4) Black River 2 mi upstream from Lockhart Ferry, 12 Aug. 1965; TU 49217 (10) Black River 0.5 mi above mouth, 22 July 1965; TU 49232 (16) White River 1.5 mi above ferry, 10 Aug. 1965; UMMZ 123598 (1) White River at Batesville below Dam No. 1, 9 July 1938. JACKSON COUNTY: TU 44134 (15) Black River, 22 July 1965; TU 44730 (1) White River 1 mi below confluence with Black River, 4 Aug. 1965. RANDOLPH COUNTY: TU 57174 (6) Current River 8 mi NE of Pocahontas, 19 April 1969. **Missouri:** BUTLER COUNTY: KU 9487 (4) Black River 9.5 mi SE of Poplar Bluff, 25 June 1964.

St. Francis River Drainage. **Missouri:** DUNKLIN COUNTY: UMMZ 139697 (4) St. Francis River 2.5 mi W of Holcomb, 13 mi N of Kennett, T20N,R9E,Sec.11, 18 Aug. 1941. NEW MADRID COUNTY: INHS uncat. (1) drainage ditches 4 mi SE of Gideon, T21N, R11E,Sec.26, 9 June 1962. STODDARD COUNTY: UAIC 2994 (12) Little River (also called Castor River) trib. to St. Francis River at U.S. Hwy 60 bridge, 23 June 1968. WAYNE COUNTY: UMMZ 139550 (4) St. Francis River below Wappapella Dam, T26N,R7E,Sec.3, 14 July 1941.

Ohio River Drainage. **Indiana:** CARROLL COUNTY: USNM 39608 (6) Wabash River at Delphi, 1887. POSEY COUNTY: UMMZ 121623 (1) Wabash River at Mackey's Ferry 7 mi W of Mt. Vernon, 20 Aug. 1927. **Kentucky:** GREEN COUNTY: USNM 202473 (1) Green River at Greensburg, 7 Aug. 1890. WAYNE COUNTY: UMMZ 67075 (1) Cumberland River at Mill Springs, 9 June 1925.

Mississippi River Proper (Missouri-Illinois). **Illinois:** CARROLL COUNTY: INHS uncat. (1) Mississippi River 0.5 mi S of Sabula (Iowa), 20 Sept. 1963. JO DAVIES COUNTY: INHS uncat. (3) Mississippi River E of Dubuque, 23 Aug. 1963. MERCER COUNTY: INHS uncat. (2) Mississippi River 2 mi W of New Boston, 6 Aug. 1963. PIKE COUNTY: INHS uncat. (10) Mississippi River 8 mi S of Hull, 3 July 1961; INHS uncat. (18) Mississippi River 1 mi NW of Ashburn, Missouri, 26 June 1963. **Missouri:** LEWIS COUNTY: UMMZ 149995 (1) Mississippi River at Canton, 6 Sept. 1941. LINCOLN COUNTY: UMMZ 149952 (5) Mississippi River 3 mi W of Winfield, 5 Sept. 1941. MARION COUNTY: KU 10065 (1) Mississippi River near Quincy, 6 Sept. 1941. PIKE COUNTY: KU 9718 (7) Mississippi River at Clarksville, 25 Sept. 1963, UMMZ 149974 (2) Mississippi River at Clarksville, 5 Sept. 1941. ST. CHARLES COUNTY: UMMZ 149934 (6) Mississippi River across from Alton, 4 Sept. 1941.

Mississippi River Proper (Minnesota-Wisconsin). **Minnesota:** WABASHA COUNTY: INHS uncat. (1) mouth of Zumbro River 2 mi S of Alma, 23 Aug. 1966. **Wisconsin:** CRAWFORD COUNTY: INHS uncat. (7) Mississippi River 1.5 mi NE of Lansing, 30 July 1963. PEPIN COUNTY: INHS uncat. (3) mouth of Chippewa River 3.5 mi S of Pepin, 22 Aug. 1966. VERNON COUNTY: UMMZ 78176 (4) Mississippi River 2 mi N of Geneva, 22 Aug. 1928.

Illinois-Kaskaskia River Drainage. **Illinois:** BOND COUNTY: UAIC 2722 (9) Kaskaskia River at Keyesport, 20 Aug. 1929. FAYETTE COUNTY: INHS uncat. (5) 2.5 mi ESE of Pittsburgh, 1 Sept. 1961; INHS uncat. (1) 5 mi NE of Avena, summer 1962; INHS uncat. (2) 4 mi SE of Ramsey, 13 Aug. 1965; UAIC 3180 (12) Kaskaskia River 7 mi NNE of Vandalia, 2 Sept. 1968. LOGAN COUNTY: INHS uncat. (1) Kickapoo Creek at Lincoln, July 1900. SHELBY COUNTY: INHS uncat. (1) 4.5 mi SW of Shelbyville, 4 Aug. 1965. WASHINGTON COUNTY: UAIC 3178 (13) Kaskaskia River at Venedy Station, 28 Aug. 1929.

Salt River Drainage. **Missouri:** MONROE COUNTY: KU 10497 (1) Salt River at Middle Fork, 30 Aug. 1965. PIKE COUNTY: UMMZ 118570 (12) Salt River 8 mi NW of Louisiana, 28 July 1941. RALLS COUNTY: INHS uncat. (1) 6 mi N of Center, 6 Aug. 1948; UMMZ 149366 (2) Salt River 6 mi N of Center, 20 Aug. 1941; UMMZ 165935 (1) Salt River near Center, 12 July 1947.

Des Moines River Drainage. **Iowa:** BOONE COUNTY: CU 17884 (2) Des Moines River at U.S. Hwy 30, 29 Sept. 1938; ISU 184 (12) 3.5 mi SW of Boone, 29 Sept. 1939; ISU 837 (8) Des Moines River 2.5 mi SW of Boone, 15 May 1940. GREENE COUNTY: UMMZ 146821 (2) Raccoon Creek, Grant Township, 16 Oct. 1943. POLK COUNTY: FMNH 1119 (7) Des Moines, no date; USNM 39943 (5) Raccoon

River at Des Moines, 5 July 1887. WAPELLO COUNTY: USNM 35828 (1) Des Moines River at Ottamwa, August 1884.

Iowa River Drainage. **Iowa:** LINN COUNTY: FMNH 1502 (2) Cedar River at Mt. Vernon, no date.

Rock River Drainage. **Illinois:** OGLE COUNTY: MCZ 25054 (1) Pine Creek, 29 March 1881. WINNEBAGO COUNTY: INHS uncat. (2) Sugar Creek 3.5 mi NW of Shirland, 17 Aug. 1968.

Wisconsin River Drainage. **Wisconsin:** IOWA COUNTY: WSU 1149 (14) Wisconsin River at Spring Green, 8 July 1962. RICHLAND COUNTY: WSU 1153 (30) Wisconsin River, T9N,R1W,Sec.33-34, 19 June 1962.

Black River Drainage. **Wisconsin:** JACKSON COUNTY: FMNH 59576 (2) Black River drainage, 1908; UF 14630 (6) Black River 5 mi S of Black River Falls, 9 July 1927; UMMZ 76089 (21) Black River 5 mi S of Black River Falls, 9 July 1927; UMMZ 76136 (2) Black River at Black River Falls, 11 July 1927.

St. Croix River Drainage. **Minnesota:** CHISAGO COUNTY: UM 19278 (33) St. Croix River at Taylor Falls, 11 Aug. 1961.

Waupaca River Drainage. **Wisconsin:** WAUPACA COUNTY: UMMZ 181269 (3) Waupaca River 2 mi below Waupaca, 8 June 1960; WSU 1155 (25) Waupaca River 2 mi below Waupaca, 8 June 1960.

Ammocrypta pellucida (Agassiz)

Eastern sand darter

FIGURE 5

TYPES.—Lectotype, USNM 1311 (1, 50 mm SL), Ohio, Black River, below at Elyria; S. F. Baird; August 1853; original No. 17. Lectotype was designated by Linder (1959:182). Paralectotypes, USNM 164165 (20, 40-48 mm SL), were removed from USNM 1311 by Linder (1959:182). Additional paralectotypes, MCZ 24616 (9, 30-47 mm SL) and UMMZ 86489 (3, 47-50 mm SL), originally out of USNM 1311, then MCZ 270, were not mentioned by Linder (1959) or by Jordan and Evermann (1896:1063), but were part of the original material. The following specimens were probably part of the original material: USNM 1289 (1, 49 mm SL), Michigan, Port Huron; Baird, August 1853. USNM 1295 (1, 39 mm SL) Michigan, Detroit River; Baird; August 1853. MCZ 24626 (4, 44-49 mm SL) and UMMZ 86479 (1, 46 mm SL), Ohio, Rockport, Kirtland (Collette and Knapp, 1967:60).

NOMENCLATURAL HISTORY.—*Ammocrypta pellucida* was described by Agassiz *in* Putnam (1863:5). The name *pellucida* is derived from the Latin word *pellucidus* (clear, transparent) alluding to the transparent flesh of this species. Agassiz listed *Etheostoma pellucidum* Baird as a synonym in his description of *Pleurolepis pellucidus;* therefore, the name proposed by Baird has no status. The genus name *Pleurolepis,* proposed by Agassiz *in* Putnam (1863:5), was preoccupied by a genus of fossil ganoid fish (Neave, 1939).

Ammocrypta clara and *A. vivax* have been referred to as subspecies or synonyms of *A. pellucida* by various authors. Based on the known distribution of *A. clara, A. vivax,* and *A. pellucida,* records of *A. pellucida* from the upper Mississippi River, above the mouth of the Ohio, are referable to *A. clara.* Records of *A. pellucida* from the lower Mississippi Valley could represent *A. clara* or *A. vivax,* as the two species are frequently taken together.

Specimens on which several records were based have been reexamined and the following corrections made. Meek's (1889a:348) record of *Etheostoma pellucidum* from the St. Francis River at Marked Tree, Arkansas (FMNH 2939) was based on specimens of *A. vivax.* Evermann and Jenkins' (1889:49) record of *Etheostoma pellucidum clarum* from the Wabash River at Delphi, Indiana is referable to *A. clara.* The collection of *Etheostoma pellucidum* reported by Woolman (1892:259) from the Green River, 0.5 miles east of Greensburg, Kentucky, contained specimens of both *A. clara* and *A. pellucida.* Records of *A. pellucida* from Louisiana that were reported by Fowler (1945:369) were based on *A. beani* (New Orleans, ANSP 54698) and *A. vivax* (Calcasieu River, at Kinder, ANSP 5539-64). The record of *A. clara* from Ohio by Trautman in 1946 was based on specimens of *A. pellucida* (Trautman, 1957:33).

Woolman (1892) reported *A. pellucida* from the Cumberland and upper Tennessee rivers. *Ammocrypta pellucida* was listed by Kuhne (1939:92) as occurring in the Tennessee drainage, but the record was not documented. Linder (1959) reported *A. pellucida* from the Cumberland River, but this could not be confirmed because he did not list the material upon which the record was based.

DIAGNOSIS.—*Ammocrypta pellucida* is characterized by long axis of lateral blotches horizontal, usually entirely

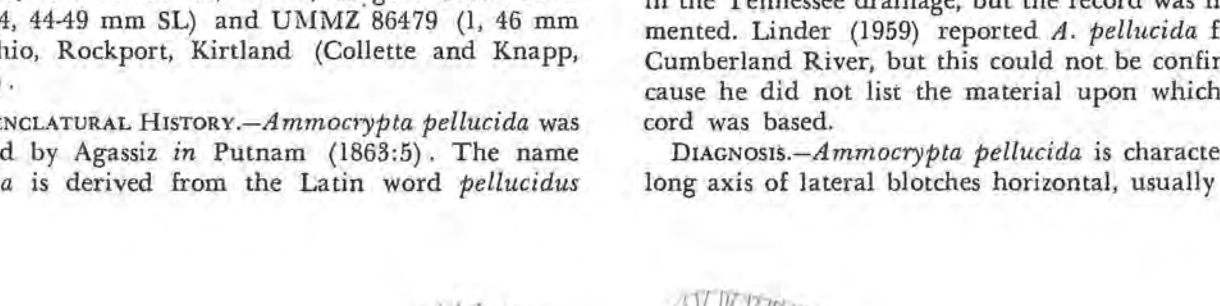

Fig. 5. *Ammocrypta pellucida.* Male 51.0 mm SL; OSU 14015, Muskingum River, Morgan County, Ohio; 21-22 June 1966. (Drawn by HECTOR HARIMA).

below lateral line scale row; median fins without dark bands, pigment restricted to margin of spines and rays; pelvic fins of males with melanophores on membranes, rarely on rays; opercular spine absent; posterior margin of preopercle partially serrate; preoperculomandibular canal pores 9 to 11; usually 10; breeding tubercles present on pelvic rays of males, absent from pelvic spine, anal spine, and anal rays; lateral line complete, with 65 to 84 scales; scale rows above lateral line usually 1 to 4; scale rows below lateral line usually 4 to 7; transverse scale rows usually 11 to 13; cheeks, opercles, and nape variously scaled; vertebrae usually 44; first interneural spine usually between neural spines of eighth and ninth vertebrae.

DESCRIPTION.—*Ammocrypta pellucida* is the most elongate species of the subgenus *Ammocrypta*. The general body proportions and pigmentation are illustrated in Fig. 5. Proportional measurements of *A. pellucida* are presented in Table 20. Frequency distributions of fin rays, vertebrae, and scale counts are presented in Tables 21-29.

Body elongate, depth into standard length 7 to 10 times, usually 8 to 9 times; head moderate 4 to 5 times into standard length; mouth small, horizontal; maxilla extending posteriorly to or almost to anterior rim of orbit; orbit length less than snout length; origin of anal fin under or slightly anterior to first ray of soft dorsal fin.

Dorsal rays VII-XII, 8-12 (usually IX-XI, 10); anal rays I, 7-11 (usually I, 8-9); pectoral rays 12-16 (usually 14-15); vertebrae 42-45 (usually 43).

Lateral line complete, with 65-84 scales; scale rows above lateral line 0-6 (usually 1-4); scale rows below lateral line 2-10 (usually 4-8); transverse scale rows 6-16 (usually 8-14). Cheeks and opercles usually moderately to well scaled; nape variously scaled, usually partially scaled; caudal peduncle scale rows above lateral line 8-10, usually 9; caudal peduncle below lateral line, when completely scaled, with 10-13 scale rows, usually 11-12.

Cephalic sensory canal system complete. Lateral canal with 5 pores; supratemporal canal with 3 pores; supraorbital canal with 4 pores; coronal pore present; infraorbital canal with 8 pores; preoperculomandibular canal pores 9-11, usually 10.

Counts for the lectotype are: dorsal rays X, 11; anal rays I, 9; pectoral rays 15; lateral line scales 74; scale rows above lateral line 5; scale rows below lateral line 6; transverse scale rows 15.

LIFE COLORS.—Three field trips were taken to obtain live specimens for a description of life colors, but these attempts were unsuccessful. Trautman (1957) gave the following account of the life colors of *Ammocrypta pellucida*.

> Dorsal half of head and body a pellucid-white with a yellowish cast. Ventral half of head and body white or silvery. A series of 12-16 small, olive spots along dorsal ridge; these become rows of paired spots along the base of the dorsal fins, with one row on each side of fin. Series of 9-14 oblong, dusky-olive spots along lateral line; these posteriorly tending to become confluent; in some specimens a suffused band of yellow is present along the lateral line. Webbing of fins transparent; some have a yellowish tinge. *Breeding male*—Like adults, except that the body is flushed with yellowish. *Young*—Like adults, except more silvery, and with little or no yellow (p. 562).

COLORATION IN ALCOHOL.—Laterally the body is marked with 9 to 15 dusky to dark brown longitudinal blotches of variable size, shape, and horizontal position. The blotches are usually larger and darker posteriorly, those on the anterior third of the body being very irregularly shaped, and often consisting of a cluster of melanophores. The anterior blotches are usually centered on the second scale row below the lateral line. In some specimens melanophores are present ventrally on the third scale row, and occasionally dorsally on the first scale row below the lateral line. On the posterior two-thirds of the body the blotches are usually three to five scales long and oval to rectangular in shape. In some specimens posterior blotches appear to be connected by a sparsely pigmented lateral line stripe equal to or slightly narrower than the blotches. Blotches along the midsection of the body usually cover all of the second scale row, the ventral half of the first scale row, and the dorsal half of the third scale row below the lateral line. On the posterior third of the body blotches usually cover the ventral half of the lateral line scale row, all of the first scale row, and the dorsal half of the second scale row below the lateral line. Lateral blotches rarely extend above the middle of the lateral line scale row, except the last one or two blotches which are situated near the base of the caudal fin.

The dorsum is variously marked by 11 to 19 dusky to brown blotches, extremely variable in size, shape, and position. Blotches that extend across the dorsum are frequently broken along the midline, forming rows of paired spots, particularly along the base of the dorsal fins. In most individuals there are two to five blotches or pairs of spots, or a combination of both, present on the nape. The fusion of these spots and blotches in a variety of combinations results in an extremely variable pattern. There are usually three to five pairs of spots evenly spaced along the base of the first dorsal fin. This pattern is occasionally interrupted by the absence of some spots and by uneven alignment of the pairs of spots, resulting in a zig-zag pattern. There is usually one, occasionally two, blotches or pairs of spots between the first and second dorsal fins. There are two to four pairs of spots evenly spaced along the base of the second dorsal fin. Deviations from this pattern usually result from the irregular alignment of spots or the absence of spots. From the base of the last dorsal ray posteriorly to the base of the caudal fin there are three to six blotches, which vary greatly in size, shape, and position. Most individuals have melanophores scattered over the dorsum and occasionally these are numerous enough to give the dorsum a dusky appearance, partially obscuring the underlying blotches.

The exposed margins of the scales are lined with melanophores, except around the base of the anal fin and the lower edge of the caudal peduncle. The venter is unpigmented, except for a line of melanophores extending from the base of the last anal ray posteriorly to the procurrent caudal rays.

Membranes of the fins, except the pelvic fins, are unpigmented. In the first dorsal fin melanophores are usually restricted to the posterior margins of the spines. The second dorsal fin and the caudal and anal fins have melanophores in varying concentrations along the anterior and posterior margins of the rays.

Pelvic fins of males have melanophores concentrated on the basal half to two-thirds of the membranes. Melanophores are present along the basal three-fourths to four-fifths of the margins of rays The pelvic spine and the adjacent membrane are usually unpigmented. Pelvic fins of females are unpigmented except for occasional melanophores along the margins of rays.

The ventral surface of the head, cheeks, and lower two-thirds to three-fourths of the opercle are usually unpigmented. The upper one-fourth to one-third of the opercle is usually dusky, except the area just below the lateral canal which is unpigmented. The occiput is dusky to dark brown. A sparsely pigmented interorbital bar is usually present. The internasal area is variously pigmented by small clusters of melanophores. Dusky to dark brown preorbital pigment extends downward and forward, terminating below the anterior nostrils. The tip of the snout is unpigmented. The median portion of the upper lip is usually heavily pigmented and, in most specimens, joins the preorbital pigment to form a continuous band. The lateral portion of the upper lip and the entire lower lip are usually unpigmented.

BREEDING TUBERCLES.—Collette (1965) reported tubercles on the pelvic rays of males taken May 31, June 8, and August 22. Tubercles were absent from most males and, when present, were very small, appearing as an enlargement of the articulation between segments. At maximum development tubercles are present on the ventral surface of the outer three or four pelvic rays. They are usually restricted to the basal half to two-thirds of the segmented portion of the ray, rarely being present on the unsegmented portion of the ray. The tubercles are usually centered on the articulation between two segments.

DISTRIBUTION.—*Ammocrypta pellucida* occurs throughout most of the Ohio River Basin, the southern end of Lake Huron, Lake St. Clair, Lake Erie, and the southern part of the St. Lawrence River drainage (Fig. 8). In the Ohio River basin it is present as far downstream as the Wabash River drainage (north side of the Ohio River) and the Cumberland River drainage (south side of Ohio River). Linder (1959) and Smith (1965) reported *A. pellucida* from the Ohio River in Illinois, but specimens on which these reports were based were not found during this study.

In the Great Lakes *A. pellucida* is known from the Black and Ausable rivers, tributaries to the southern end of Lake Huron, and from Lake St. Clair and its tributaries. In Lake Erie it is known from the sandy shoals around the islands, along the shore of the lake, and in tributaries to the lake, except those along the northeast shore. It is apparently absent below Niagara Falls and throughout the Lake Ontario drainage, but is present below Lake Ontario in the St. Lawrence River. Its absence in the Lake Ontario drainage may be attributed to the absence of available habitat. Recent extirpation resulting from alteration of existing habitat is another possibility. In the St. Lawrence River drainage it is known from the Little Salmon River in New York, which enters the St. Lawrence near Cornwall, Ontario, and northeastward to Montreal, Quebec. One collection was examined from a tributary to Lake Champlain in northwestern Vermont.

Ammocrypta pellicuda was reported by Woolman (1892) from both the upper Tennessee drainage (Powell River, 8 mi south of Cumberland Gap) and the Cumberland River. Specimens on which the above records are based were not found except a single specimen (UMMZ 197715) which was taken in the Cumberland River at Kuttawa, Kentucky, 26 July 1890. Kuhne (1939) reported *A. pellucida* as occurring in the state of Tennessee, but did not document the record. The collection of *A. pellucida* reported by Linder (1959) from the Cumberland River could not be confirmed because he did not list the material on which the record was based. The records of *A. pellucida* from the Tennessee and Cumberland rivers by Jenkins, *et al.* (1972) are based on records reported by Woolman and Linder (Jenkins, per. comm.).

GEOGRAPHIC VARIATION.—Frequency distributions of meristic characters of *A. pellucida* are presented in Tables 22-29. In general the variation in *A. pellucida* appears to be random, with no clinal or geographic trends. The modal values of meristic characters vary from drainage to drainage, with the exception of fin rays which were relatively constant.

In *Ammocrypta pellucida* the modal number of dorsal spines was generally 10, except the Hocking and Muskingum populations, which had a mode of 11, and the southeastern Lake Erie population, which had a mode of nine. The modal number of dorsal rays was usually 10. The anal rays were the least variable of all meristic characters examined with a mode of nine in all populations except those from Licking River and Lake Erie proper, which had a mode of eight. In most populations the modal number of pectoral rays was 14. The most notable deviation was in populations from the southern tributaries to the Ohio River (Green, Rolling Fork, Kentucky, and Licking rivers) each of which had a mode of 15.

The modal number of vertebrae in *Ammocrypta pellucida* was usually 43. The Kentucky River population had a mode of 42, and the Miami, Hocking, and upper Ohio populations had a mode of 44.

In *A. pellucida* the lateral line scales ranged from 65 to 84, with the modes varying from 70 to 74. The mean number of lateral line scales ranged from 68.20 (Rolling Fork River) to 75.00 (Western Lake Erie). Scale rows above the lateral line, scale rows below the lateral line, and transverse scale rows are extremely variable. The modal number of scale rows above the lateral line varied from one to four. The modal number of scale rows below the lateral line varied from four to eight, but only three populations had a mode greater than six, and the Muskingum population had a bimodal distribution, with one mode at six and the other at eight. The modal number of transverse scale rows varied from 9 to 14, but was usually 11, 12, or 13.

Cheek and opercle squamation varied from completely scaled to almost naked. In most specimens the cheeks were more completely scaled than the opercle. Reduction in squamation of the cheeks and opercles was usually along the ventral margins. In some specimens the only scales present were one to three rows under the eye and across the upper margin of the cheek and opercle.

The nape was usually naked. Scales, when present, consisted of a small patch around the anterior base of the dorsal fin and scattered scales along the midline of the nape.

HABITAT AND LIFE HISTORY.—*Ammocrypta pellucida* is found in a variety of habitats. It inhabits streams ranging in size from small creeks to large rivers and wave-protected beaches in Lake Erie (Trautman, 1957). It has been taken over stream bottoms consisting of limestone with a thin layer of mud and clay mixed with sand (Vladykov, 1942), pools with silt and gravel (Schurrager, 1932), riffles and shallow pools with clean sand bottoms (Smith, 1968), and sandy riffles (Lachner, Westlake and Handwerk, 1950). In Lake Erie it has been reported from sandy shoals of islands and in the channel at the mouth of East Harbor (Langlois, 1954). In streams of the Ohio River and Great Lakes drainages it is most frequently encountered in moderate to large streams over a clean sand bottom in moderate current (Gilbert, 1885; Meek, 1889b; Kirsch, 1895; Thompson and Hunt, 1930; Larimore and Smith, 1963). Forbes and Richardson (1920) found the food of *A. pellucida* from Illinois to consist primarily of *Chironomus*. Turner (1922) found midge larvae to comprise 90 percent of the stomach content of specimens from Bass Island in Lake Erie.

In the Ohio Basin the spawning period usually begins during the first part of June and ends during the latter part of July. The spawning period of the Great Lakes and St. Lawrence River populations appears to be two or three weeks later than that of the Ohio Basin populations. The ovaries of specimens taken in mid-May in the Ohio Basin contained eggs at various stages of development. The ovaries of specimens taken in mid-June were variable, as some individuals had just begun to spawn whiles others were partially spent. By mid-July most females were spent, but some large eggs were present in a few individuals. No eggs were found in females taken after the first week of August.

Materials Examined

Cumberland River Drainage. **Kentucky:** LYON COUNTY: UMMZ 197715 (1) Cumberland River at Kuttawa, 26 July 1890.

Wabash River Drainage. **Illinois:** CUMBERLAND COUNTY: CU 51183 (1) Embarras River, 1 Nov. 1958; UAIC 2744 (6) Embarras River 3 mi SW of Greenup, 23 Aug. 1967; UAIC 3022 (1) Embarras River 1 mi SW of Greenup, 7 July 1968. JASPER COUNTY: UAIC 3021 (3) Embarras River 3 mi WNW of Rose Hill, 7 July 1968. VERMILION COUNTY: CU 42022 (1) Middle Fork of Vermilion River 3 mi E of Callison, 30 April 1962. **Indiana:** CARROLL COUNTY: USNM 39608 (8) Wabash River at Delphi, 1887; USNM 66770 (20) Wabash River at Delphi, Aug. 1887. FULTON COUNTY: UMMZ 99936 (59) Tippecanoe River N of Rochester 0.25 mi above U.S. Hwy 31 bridge, 1 June 1930. HUNTINGTON COUNTY: USNM 69248 (31) Salmonie River at Mt. Etna, 1899. LAWRENCE COUNTY: CU 1849 (8) White River at Bedford, May 1886. MIAMI COUNTY: CU 4012 (16) Eel River at Chili, 26 July 1892. OWEN COUNTY: USNM 36494 (23) White River at Gosport, no date. POSEY COUNTY: USNM 40694 (1) Wabash River at Mackay's Ferry, 1888; USNM 40960 (3) Wabash River, at New Harmony, 1888. COUNTY UNKOWN: MCZ 24379 (3) White River, 1879; USNM 20127 (20) White River, 1876; USNM 83719 (15) Wildcat Creek, 1899.

Green River Drainage. **Kentucky:** EDMONSON COUNTY: USNM 89464 (1) Green River at Mamouth Cave, 31 Aug. 1929. GREEN COUNTY: USNM 63793 (17) Green River at Greensburg, 7 Aug. 1890. MUHLENBERG COUNTY: ANSP 96284 (5) Green River at Kinchloe's Bluff SE of Carrollton below mouth of Nelson Creek at rmi 85.5, 11 July 1961. OHIO COUNTY: ANSP 96108 (1) Green River between rmi 101 and 101.5 near mouth of Jacobs Creek, 30 Aug. to 11 Sept. 1961.

Rolling Fork River Drainage. **Kentucky:** LARUE COUNTY: USNM 36102 (5) Rolling Fork, New Haven, 1884.

Kentucky River Drainage. **Kentucky:** CLAY COUNTY: FMNH 6827 (14) Redbird Creek, no date; UF 15294 (1) Goose Creek 3.5 mi SW of Oneida, 12 Sept. 1967; UMMZ 159048 (4) Redbird Creek 1-3 mi S of Big Creek, 1.6-3.3 mi S Hwy 80, 25 June 1949; USNM 63794 (5) Redbird Creek at Big Creek, 7 Aug. 1890. OWSLEY COUNTY: UMMZ 168891 (5) Redbird Creek at mouth of Sextons Creek 9 mi N of Oneida, 14 Sept. 1954. COUNTY UNKNOWN: CU 697 (7) Kentucky River, 19 July 1925.

Miami River Drainage. **Indiana:** DEARBORNE COUNTY: OSU 6965 (2) Whitewater River, 14 Aug. 1946. WAYNE COUNTY: FMNH 45028 (5), 1933. **Ohio:** CLERMONT COUNTY: OSU 9689 (1) Little Miami River, 17 Aug. 1930. CLINTON COUNTY: OSU 5276 (3) Todd's Fork, 17 Oct. 1942. HAMILTON COUNTY: OSU 9685 (3) Whitewater River, 20 July 1929.

Licking River Drainage. **Kentucky:** BREATHITT COUNTY: UMMZ 73246 (3) Quicksand Creek, 13 July 1925. MORGAN COUNTY: UMMZ 104295 (18) Licking River at West Liberty, 31 July 1937; USNM 177292 (3) Licking River at U.S. Hwy 460 W of West Liberty, 30 Aug. 1958. NICHOLAS COUNTY: UMMZ 132247 (7) Licking River at Blue Licks, 19 Sept. 1940. COUNTY UNKNOWN: UMMZ 114934 (3) Triplett Creek 0.5 mi from Licking, 15 April 1936.

Scioto River Drainage. **Ohio:** PICKAWAY COUNTY: FMNH 37149-37151 (3) Big Darby Creek, 26 Sept. 1939; OSU 550 (2) Big Darby Creek, 26 Sept. 1939; OSU 4860 (2) Big Darby Creek, 21 April 1942; OSU 5056 (27) Big Darby Creek, 8 June 1942; OSU 8372 (2) Big Darby Creek, 11 Aug. 1947; OSU 9686 (5) Big Darby Creek, 21 Oct. 1928; OSU 12125 (1) Big Darby Creek, 3 June 1949; OSU 12701 (2) Big Darby Creek, 18 Oct. 1960. PIKE COUNTY: OSU 3189 (1) Scioto River, 17 Nov. 1939. ROSS COUNTY: OSU 5652 (6) Salt Creek, 20 Aug. 1942; OSU 6608 (11) Paint Creek, 3 Oct. 1945; OSU 7038 (1) Deer Creek, 15 Oct. 1946; OSU 9691 (1) Salt Creek, 30 June 1929; OSU 14740 (3) Salt Creek, 26 May 1964. SCIOTO COUNTY: OSU 825 (4) Scioto River, 16 Oct. 1939; OSU 2530 (1) Scioto River, 22 June 1940.

Ohio River Proper. **Ohio:** HAMILTON COUNTY: CU 1861 (4) Cincinnati, Ohio, 1886. LAWRENCE COUNTY: OSU 599 (37) Ohio River at Dam 29, 22-23 Aug. 1939.

Big Sandy-Kanawha River Drainage. **Kentucky:** LAWRENCE COUNTY: UMMZ 118287 (2) Levisa Fork of Big Sandy River at mouth, 4 March 1937. **West Virginia:** BOONE COUNTY: CU 20824 (2) Big Coal River, 6 Sept. 1949. BRAXTON COUNTY: CU 32376 (3) Birch River 0.5 mi above mouth, 5 Sept. 1951; USNM 210665 (2) Little Kanawha River below falls at Falls Mill, 3 Aug. 1956. CALHOUN COUNTY: CU 4529 (2) Little Kanawha River, 2 July 1931; CU 21032 (2) Little Kanawha River, 14 Sept. 1949. CLAY COUNTY: UMMZ 119638 (1) Elk River 9 mi below Ivydale, 3 July 1936. KANAWHA COUNTY: CU 4981 (1) Kanawha River, 7 July 1931; UMMZ 119355 (2) Kanawha River at Point Creek mouth, 1 Aug. 1935; UMMZ 119668 (2) Elk River 2.5 mi above Charleston, 5 July 1936. WAYNE COUNTY: CU 14826 (1) Big Sandy River, 3 Oct. 1949; CU 32590 (8) Twelvepole Creek 1 mi N of Wayne, 7 Sept. 1949. COUNTY UNKNOWN: USNM 210664 (2) Pinnicle Bend, Coal River System, 28 Aug. 1956.

Hocking River Drainage. **Ohio:** ATHENS COUNTY: FMNH 37152-37158 (7) Coolsville, 28 Sept. 1939; OSU 9-290 (28) Hocking River, 28 June 1939.

Muskingum River Drainage. **Ohio:** MORGAN COUNTY: OSU 14015 (73) Muskingum River, 21-22 June 1966. WASHINGTON COUNTY: USNM 41020 (6) Muskingum River at Beverly, 1888.

Upper Ohio River Drainage. **Pennsylvania:** CRAWFORD COUNTY: CU 5612 (4) French Creek, 17 June 1938; CU 6206 (8) French Creek, 24 Aug. 1938. WASHINGTON COUNTY: FMNH 1095 (1) Monogahela River, no date.

Southern Lake Huron Drainage. **Ontario:** MIDDLESEX COUNTY: UMMZ 85543 (1) Ausable River W of Ailsa (Craig), 26 Oct. 1928. **Michigan:** ST. CLAIR COUNTY: USNM 1289 (1) Port Huron, Aug. 1853; USNM 68807 (42) Black River near Port Huron, 9 June 1894.

Lake St. Clair Drainage. **Ontario:** ELGIN: UMMZ 60433 (34) Thames River at Munsey Indian Reserve, 4 Sept. 1923. MIDDLESEX: ROM 3702 (1) Sydenham River near Strathroy, 9 Sept. 1927; ROM 8571 (4) Thames River, no date; ROM 8649 (3) Sydenham River at Lambton, Ontario, 9 July 1929. **Michigan:** ST. CLAIR COUNTY: UMMZ 163788 (2) Bouvier Bay, Lake St. Clair, T3N,R15E,Sec.35, 12 June 1942.

Northern Lake Erie Drainage. **Ontario:** ELGIN: ROM 14094 (5) Catfish Creek 2 mi above mouth, 14 June 1941; ROM 18078 (6) Otter Creek, Bayham Township, 21 July 1955; UMMZ 56853 (1) Catfish Creek 1 mi W of Jaffa, 21 July 1922; UMMZ 60423 (1) Otter Creek 1.25 mi S of Forge Rd, Tillsanberg, 25 Aug. 1923. NORFOLK: ROM 18077 (1) Big Creek, S Walsingham Township, 2 July 1955; UMMZ 60486 (9) Big Creek 2 mi W of Port Rowan, 7, 9, & 10 Sept. 1923.

Western Lake Erie Drainage. **Michigan:** LENAWEE COUNTY: UMMZ 89946 (5) Little Raisin River, trib. of Raisin River, Dover Township, 12 May 1927. LIVINGSTON COUNTY: UMMZ 157337 (1) Strawberry Lake near W end, T1N,R5E,Sec.28, 17 July 1949; UMMZ 168945 (2) S shore of Big Gallager Lake in Huron River chain, Hamburg Township, 27 Aug. 1955. MONROE COUNTY: UMMZ 177546 (26) Saline River near mouth, Aug. 1929; USNM 58640 (28) Raisin River at Monroe, 1894. WAYNE COUNTY: UMMZ 104381 (5) Rouge River, Rouge Park, 19 May 1936.

Maumee River Drainage. **Indiana:** ADAMS COUNTY: USNM 69231 (3) St. Mary's River at Decatur, 15 Aug. 1893. **Michigan:** HILLSDALE COUNTY: UMMZ 56097 (2) St. Joseph River of the Maumee, 28 June 1922. **Ohio:** DEFIANCE COUNTY: OSU 6458 (1) Maumee River, 2 Oct. 1944. PAULDING COUNTY: FMNH 1446 (15) Maumee River at Cecil, no date; USNM 69230 (6) Maumee River at Antwerp, 15 Aug. 1893; USNM 70083 (2) Auglaize River at Oakwood, 23 July 1894. PUTNAM COUNTY: USNM 70082 (2) Sugar Creek at Cloverdale, 23 July 1894. WILLIAMS COUNTY: OSU 1065 (1) West Branch of St. Joseph River, 24 Oct. 1939; OSU 1225 (2) St. Joseph River, 24 Oct. 1939; OSU 3205 (1) West Branch of St. Joseph River, 16 May 1941; OSU 13-365 (5) Fish Creek, 13 July 1939.

Lake Erie Proper. **Ontario:** UF 9911 (1) South Harbor, Pelee Island, 16 July 1953. **Ohio:** ERIE COUNTY: OSU 11983 (1) North Harbor, 1 July 1949. OTTAWA COUNTY: OSU 3076 (2) East Harbor, 13 July 1929; OSU 3079 (2) East Harbor, 18 July 1929; OSU 3875 (1) Put in Bay Harbor, 7 Nov. 1941; OSU 7162 (1) Squaw Harbor, South Bass Island, 25 March 1947; OSU 9015 (2) Lake Erie, Middle Bass Island, 29 June 1949; OSU 9684 (4) Lake Erie, 13 Sept. 1928; OSU 12142 (4) Lake Erie, 29 June 1949; OSU 12463 (1) Lake Erie, 28 Dec. 1953; USNM 58681 (2) Put in Bay, 13 June 1894. **Pennsylvania:** ERIE COUNTY: USNM 58678 (3) N side of Bay, Erie, 23 Jan. 1894; USNM 62840 (7) Lake Erie at Erie, 4 Aug. 1893.

Southwestern Lake Erie Drainage. **Ohio:** ASHTABULA COUNTY: KU 2770 (21) Grand River near Mechanicsville, 18 Aug. 1944; KU 2771 (1) Mechanicsville, Spring 1943; KU 2794 (1) Grand River at Mechanicsville, 18 March 1945. CARROLL COUNTY: OSU 9690 (7) Sandusky Creek, 4 July 1930. CUYAHOGA COUNTY: USNM 62838 (1) Cuyahoga River, South Park in Independence, 25 July 1893; USNM 69610 (17) Cuyahoga River at Independence, 25 July 1893. LAKE COUNTY: USNM 69611 (5) Grand Rapids River at Painsville, 21 July 1893. LORAIN COUNTY: USNM 1311 (1) Black River below falls at Elyria, Aug. 1853; USNM 164165 (20) Black River below falls at Elyria, Aug. 1853. SANDUSKY COUNTY: USNM 69562 (15) Sandusky River at Fremont, 13 July 1893. WYANDOTE COUNTY: OSU 9687 (5) Tymochtee Creek, 1 June 1930.

Southeastern Lake Erie Drainage. **New York:** ERIE COUNTY: USNM 62839 (33) Cattaraugus Creek at Irving, 5 Aug. 1893; USNM 62841 (7) Cassonova Creek at Buffalo, 8 Aug. 1893; USNM 69959 (2) Cattaraugus Creek at Gowanda, 7 Aug. 1893.

St. Lawrence River Drainage. **Quebec:** UF 14631 (7) Chateauguay River at Chateauguay Village near Montreal, 12 Aug. 1943; UMMZ 136397 (1) Lake of Two Mountains, cove at mouth of Ottawa River, 11 July 1941; UMMZ 146691 (29) Chateauguay River, Chateauguay Village near Montreal, 12 Aug. 1943. **New York:** FRANKLIN COUNTY: CU 48186 (2) Little Salmon River, no date. **Vermont:** CHITTENDEN COUNTY: UMMZ 102885 (2) Lamoille River 4 mi above mouth at Milton, 24 July 1934.

Ammocrypta meridiana new species

Southern sand darter

FIGURE 6

Ammocrypta vivax.—Bailey and Gosline, 1955:38 (reported vertebral counts on specimens from Tallapoosa River drainage, UMMZ 111226).—Suttkus and Ramsey, 1967:140 (reported from Cahaba River).—Smith-Vaniz, 1968:101 (distribution in Mobile Bay dainage); Fig. 136 of *Ammocrypta vivax* from the Hatchie River, McNairy County, Tennessee is correctly identified.

TYPES.—Holotype, USNM 213494 (male 50.8 mm SL), Alabama, Dallas County, Cedar Creek 7.5 mi SSW of Sardis on Alabama Hwy 41 (T14N,R10E,Sec.16), 11 October 1966, Charles E. Tucker and Tom Ely. Paratypes taken with the holotype are: USNM 213495 (10 specimens, 42.0-50.0 mm SL). Locality data for other paratypes and non-paratypic material is listed at the end of the *A. meridiana* section. Only specimens from the Alabama River drainage are designated as type specimens.

DIAGNOSIS.—*Ammocrypta meridiana* is a species of the subgenus *Ammocrypta* characterized by long axis of lateral blotches horizontal, usually below lateral line scale row; median fins without dark bands; pigment restricted to margins of spines and rays; pelvic fins of males with melanophores on membranes, rarely on rays; premaxillary frenum usually absent; opercular spine absent; posterior margin of preopercle partially serrate; preoperculomandibular canal pores 9 to 11, usually 10; breeding tubercles present on pelvic rays of males, absent from pelvic spine, anal spine, and anal rays; lateral

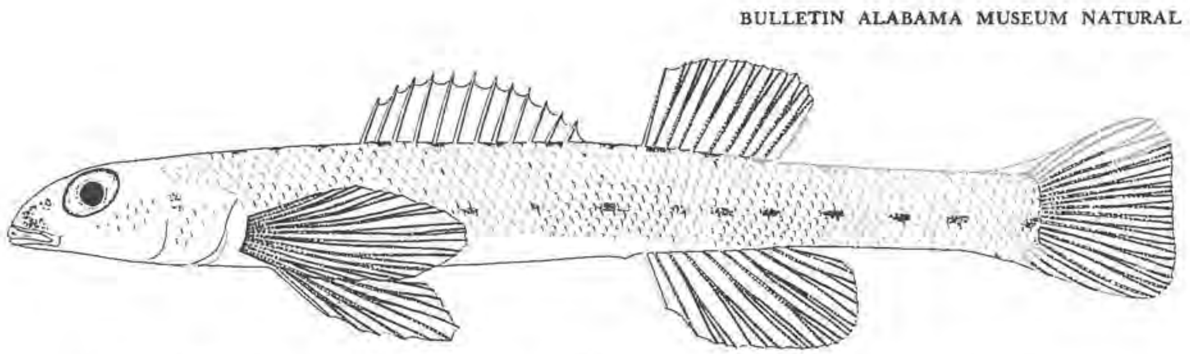

Fig. 6. *Ammocrypta meridiana* new species. Male 50.0 mm SL; UAIC 539, Cedar Creek on Alabama Hwy 21, 5 mi E of Snow Hill, Wilcox County, Alabama; 30 Aug. 1956. (Drawn by HECTOR HARIMA).

line complete, with 63 to 79 scales; cheeks, opercles, and nape variously scaled.

Ammocrypta meridiana is most closely related to *A. pellucida*, but is distinguished from that species by the following: scale rows below lateral line usually 8 or 9 (scale rows below lateral line in *A. pellucida* usually 4 to 7); transverse scale rows usually 14 to 16 (transverse scale rows in *A. pellucida* usually 11 to 13); vertebrae 41 to 43, usually 42 (vertebrae in *A. pellucida* 42 to 45, usually 43 or 44); first interneural spine between neural spines of seventh and eighth vertebrae (first interneural spine usually between neural spines of eighth and ninth vertebrae in *A. pellucida*).

DESCRIPTION.—*Ammocrypta meridiana* is a small to moderate sized sand darter, attaining a maximum size of 58 mm SL. Proportional measurements are given in Table 20. The physiognomy and pigmentation are illustrated in Fig. 6. Frequency distributions of fin ray, vertebrae and scale counts are given in Tables 21-29.

Body moderately elongate, subcylindrical in shape; body depth contained 7 to 9, usually 8, times in standard length; origin of anal fin usually under to slightly posterior to origin of second dorsal fin; head length contained 4 to 5, usually 4.5 times in standard length; mouth horizontal, of moderate size; snout somewhat rounded, not pointed, slightly longer than orbit; maxilla extending posteriorly to or just beyond anterior rim of orbit.

Dorsal rays VII-XIII, 9-11 (usually IX-XI, 10); anal rays I, 7-10 (usually I, 9); pectoral rays 12-15 (usually 14); vertebrae 41-43 (usually 42).

Lateral line complete, with 63-79 scales (usually 67-72); scale rows above lateral line 2-7 (usually 4-5); scale rows below lateral line 5-11 (usually 8-9); transverse scale rows 10-19 (usually 14-16). Cheeks and opercles usually completely scaled; nape incompletely scaled; caudal peduncle, when completely scaled, with 8-11 scale rows (usually 9) above the lateral line, 10-13 scale rows (usually 11) below the lateral line; total caudal peduncle scale rows usually 22. Few embedded cycloid to weakly ctenoid scales frequently present on pectoral fin base; along margin of breast.

Cephalic sensory canal system typically complete; lateral canal, 5 pores; supratemporal canal, 3 pores; supraorbital canal, 4 pores; coronal pore present; infraorbital canal, usually 8 pores; preoperculomandibular canal, 9-11 pores, usually 10.

Counts for the holotype: dorsal rays XI, 10; anal rays I, 9; pectoral rays 14; lateral line scale rows 72; scale rows above the lateral line 5; scale rows below the lateral line 9; transverse scale rows 15.

LIFE COLORS.—The body is washed with pale yellow-orange to orange pigment, which tends to be most prominent along the midline of the dorsum and dorsolateral surfaces. A broad (3-5 scales) yellow-green iridescent band is also present along the lateral line. The band is usually wider and somewhat more diffuse anteriorly. Below the lateral iridescent band the pale yellow-orange body pigment is gradually reduced ventrally. On the dorsal and ventral surfaces of the body pigment tends to be most concentrated along the myosepta. The vertebral column, which is visible in live and freshly preserved specimens, is yellow-orange with 9 to 13 dark rectangular blotches, 1 to 2 vertebrae long.

The occiput and upper portion of the opercles and preopercles are yellowish-orange. Laterally the cheeks and opercles are iridescent bluish green. The rami of the lower jaw are iridescent blue. The snout is orange to orange-yellow.

On the median fins, yellow-orange pigment is present on the membranes and along the margins of the spines and rays. The dorsal fin pigment grades from yellow-orange near the margin to orange along the base. The caudal fin pigment is similar to that of the dorsal, but is more prominent, especially in the crotches of the rays and along the base. The anal fin has faint yellowish pigment on the membranes. Yellow pigment is absent from the anal fins of some individuals.

The pectoral fins have a small amount of yellow pigment along the margin of the rays, the pigment is usually more evident towards the base of the fin. Membranes of the pelvic fins are yellow-orange from the base to near the margin. Traces of milky white pigment are present along the margin of the pelvic fin and the membrane between the spine and first ray.

The yellow-orange pigment, described above, is present in males and females but is more intense in males.

COLORATION IN ALCOHOL.—The sides of the body have 8 to 13 brownish blotches, which are variable in size, shape, and horizontal position. On the anterior third of the body blotches generally involve one to two scales along their horizontal and vertical axis. In some individuals these blotches are reduced to a few scattered melanophores and are occasionally absent. Blotches along the body midsection are larger and darker than those anteriorly and are round to rectangular, covering portions (all in some specimens) of two to four scales along their horizontal axis and two to three scales along their vertical axis. On the posterior third of the body the blotches are slightly darker than those of the midsection and are usually rectangular, covering portions of two to four scales along their horizontal axis and one to two scales along their vertical axis. In some specimens a poorly developed lateral stripe is evident along the posterior third of the body. The position of lateral blotches in relation to the lateral line scale row is essentially the same as described for *A. pellucida*.

There are 10 to 15 blotches or paired spots along the dorsum, characterized by extreme variability in size, shape, position, and intensity. Dorsal blotches are usually less numerous than in *A. pellucida*. Melanophores scattered over the dorsum are occasionally numerous enough to give the dorsum a dusky appearance. Pigment on the body scales and melanophores along the ventral midline of the caudal peduncle are like those described for *A. pellucida*.

Distribution of melanophores along the rays of the median fins is essentially the same as that of *A. pellucida*. Melanophores on the pectoral fins are usually restricted to rays of the dorsal two-thirds to three-fourths of the fins, but are occasionally present along all of the rays. Except for scattered melanophores, the pelvic fins of females are unpigmented. In males, membranes and margins of the pelvic rays (except the spine and the adjacent membrane) are pigmented from the base to near the margin of the fin.

Pigmentation of the head, except the snout, is like that of *A. pellucida*. In most specimens the preorbital pigment extends forward, around the tip of the snout, forming a continuous band. In some specimens there are fewer melanophores on the tip of the snout than in the preorbital area, but the band is usually discernible. Melanophores on the upper lip are concentrated on the central portion, decreasing laterally to a few melanophores on or near the corner of the jaw. The concentration of melanophores on the central portion of the upper lip is greater than on the tip of the snout.

BREEDING TUBERCLES.—Tubercles are absent from most males and, when present, are reduced in size and number compared to those of *A. pellucida*. Males taken during the latter part of June and the first week of July had three to six tubercles on the ventral surface of the segmented portion of the outer three pelvic rays. Tubercles are usually situated at joints between segments.

DISTRIBUTION.—*Ammocrypta meridiana* is known only from the Mobile Basin (Fig. 8). It is found throughout the Alabama River, upper and lower Tombigbee River drainages and the Coastal Plain portion of the Warrior, Cahaba, and Tallapoosa river drainages.

GEOGRAPHIC VARIATION.—Populations of *Ammocrypta meridiana* exhibited only slight variation in meristic characters. There was no well defined pattern to the variation, but the means of meristic values of the Tombigbee population were usually slightly higher.

Fin ray counts were fairly consistent with the exception of the dorsal spines. In the population from the Alabama drainage dorsal spines ranged from 9 to 13, with a mode of 11. Dorsal spines in the population from the Tombigbee drainage ranged from 7 to 12 with a mode of 10. Dorsal rays ranged from 9 to 11, with a mode of 10 in both populations. The modal number of anal rays was 9 and that of the pectoral rays 14 in both populations. Vertebrae ranged from 41 to 43, with a mode of 42 in both populations.

Lateral line scales ranged from 63 to 75 ($\bar{X}$=69.31) in the Alabama River population and 63 to 79 ($\bar{X}$=70.20) in the Tombigbee. Both populations had a mode of 69. Scale rows above the lateral line ranged from 2 to 6 (mode=4) in the Alabama population and 2 to 7 (mode=5) in the Tombigbee population. Scale rows below the lateral line ranged from 5 to 11 (mode=9) in the Alabama population and 7 to 10 (mode=8) in the Tombigbee population. With the exception of lateral line scales, the transverse scale rows were the most variable. In the Alabama population the transverse scales ranged from 10 to 19, and in the Tombigbee population the transverse scales ranged from 13 to 18. Both populations had a mode of 15. Squamation of the cheeks, opercles and nape was variable, but no differences between the Alabama and Tombigbee rivers populations were detected.

HABITAT AND LIFE HISTORY.—*Ammocrypta meridiana* is known to occur in moderate to large creeks and rivers with clean sandy bottoms and moderate current at depths ranging from 6 inches to 5 feet.

The most characteristic associates are *Ericymba buccata*, an undescribed *Notropis*, which is the ecological equivalent of *Notropis longirostris*, and *A. beani*. In larger streams *Hybopsis aestivalis* and *Percina ouachitae* are frequently taken with *A. meridiana*.

Examination of ovaries and tubercle development in males indicates that spawning begins during the first week of June and ends during the latter part of July. Ovaries of females taken during the first part of April were filled with small, white, undeveloped ova. By mid-May most of the ova had increased from .75 to 1.00 mm in diameter and were pale yellow. During the second and third weeks of June there was a reduction in the number of large eggs, indicating the onset of spawning. Females taken after the third week of July were spent.

ETYMOLOGY.—The name *meridiana* is from the Latin *meridionalis*, southern, in reference to this species being a southern relative of a northern species.

Materials Examined

Paratypes.—Alabama River Drainage. **Alabama:** BIBB COUNTY: AU 1222 (62) Cahaba River 8.3 mi N of Centreville, 2 Oct. 1968; TU 29137 (1) Cahaba River 7 mi NE of Centreville, 17-18 July 1962; TU 69108 (3) Cahaba River 8.4 mi NNE of Centreville, 9 April 1971; UAIC 2580 (1) Cahaba River on Piper-West Blockton Rd, 13 April 1967. DALLAS COUNTY: UAIC 2364 (11) Pine Barren Creek on Alabama Hwy 41, 11 Oct. 1966. MACON COUNTY: AU 5633 (3) Uphapee Creek 3.5 airline mi N of Tuskegee, 12 March 1970; UAIC 1478 (3) Uphapee Creek 2 mi E of Tuskegee, 26 Sept. 1964; UAIC 1514 (1) Uphapee Creek NW of Tuskegee, 8 Nov. 1964; UMMZ 111226 (5) 3 mi E of Tuskegee, 3 June 1931; UMMZ 111227 (1) 4 mi E of Tuskegee, 27 June 1931; USNM 210650 (4) Cubahatchee Creek on I-85 E of Montgomery, 13 Aug. 1964; USNM 210651 (6) Opintolocca Creek 3 mi E of Tuskegee, 26 Sept. 1964. MONROE COUNTY: TU 32565 (2) Limestone Creek, trib. to Alabama River, 3.3 mi NW of Monroeville, 30 May 1964; TU 32590 (1) Robinson Creek, trib. to Flat Creek, 3.9 mi N of Tunnel Springs, 30 May 1967; TU 40420 (7) Flat Creek 8.8 mi NW of Monroeville, 9 April 1966; TU 44436 (23) Flat Creek 8.6 mi NW of Monroeville, 18 March 1967; TU 58708 (1) Alabama River at mouth of Limestone Creek, rmi 80, 14 Aug. 1969; TU 78624 (1) Alabama River just below Haines Island, rmi 94.8, 15 Aug. 1972; TU 78647 (1) Alabama River at mouth of Flat Creek, rmi 81.5, 16 Aug. 1972; UAIC 523 (4) Limestone Creek 4 mi NE of Monroeville, 23 Aug. 1956; UAIC 2372 (2) Robinson Creek 3 mi NE of Tunnel Springs, 23 Oct. 1966; USNM 210661 (5) Robinson Creek, trib. to N fork Flat Creek S of Beatrice, 27 Nov. 1962. MONTGOMERY COUNTY: AU 6772 (37) Line Creek 3.1 mi NE of Waugh, 2 Nov. 1971; UMMZ 197722 (16) Line Creek 3.1 mi NE of Waugh, 24 Oct. 1971. PERRY COUNTY: TU 29914 (7) Cahaba River 1 mi W of Sprott, 15 April 1963; TU 30080 (1) Cahaba River 5 mi E of Marion, 2 Nov. 1963; TU 35115 (1) Cahaba River 2 mi SW of Sprott, 26 June 1964; TU 52497 (1) 4.4 mi N of jct Alabama Hwy 14 and 219, 6 June 1968; TU 52516 (1) Oakmulgee Creek 9.9 mi N of jct of Alabama Hwy 14 and 219, then E 0.9 mi, 6 June 1968; UAIC 1437 (3) Cahaba River 1 mi W of Sprott, 16 Sept. 1964; UAIC 2015 (1) Cahaba River behind Marion fish hatchery, 11 May 1966; UAIC 2166 (2) Cahaba River behind Marion fish hatchery, 11 July 1966. WILCOX COUNTY: TU 41702 (1) Alabama River at Evans Lower Bar, rmi 133, 5 Aug. 1966; TU 44499 (12) Turkey Creek 1.0 mi S of Kimbrough, 18 March 1967; TU 53491 (3) Alabama River at Evans Upper Bar, rmi 135.7, 24 Sept 1968; TU 58622 (1) Alabama River at Yellow Jacket Bar, rmi 129.7, 11 Aug. 1967; TU 64600 (17) Alabama River at Evans Upper Bar, rmi 135.8, 24 Sept. 1970; TU 65063 (16) Alabama River at Evans Upper Bar, 27-28 Aug. 1970; TU 65080 (1) Alabama River at Yellow Jacket Bar, rmi 129.8, 28 Aug. 1970; TU 70627 (1) Alabama River at Wilcox Bar, rmi 129.7, 1 Aug. 1971; TU 70639 (1) Alabama River at Tait Bar, rmi 122.4, 1 Aug. 1971; TU 71602 (6) Alabama River at Evans Upper Bar, rmi 135.7, 17 Sept. 1971; TU 71616 (1) Alabama River at Evans Lower Bar, rmi 133, 17 Sept. 1971; TU 71646 (1) Alabama River at Tait Bar, rmi 122.4, 17 Sept. 1971; TU 79037 (7) Alabama River at Evans Upper Bar, rmi 135.7, 14 Sept. 1972; TU 79016 (1) Alabama River at Evans Lower Bar, rmi 133.1, 14 Sept. 1972; TU 79046 (2) Alabama River at Yellow Jacket Bar, rmi 129.7, 14 Sept. 1972; TU 80065 (1) Alabama River at Evans Upper Bar, rmi 135.7, 6 Dec. 1972; TU 81501 (1) Alabama River at Tait Bar, rmi 122.4, 22 March 1973; UAIC 537 (1) Pine Barren Creek 3 mi W of Snow Hill, 30 Aug. 1956; UAIC 539 (12) Cedar Creek 5 mi E of Snow Hill, 30 Aug. 1956.

Additional material examined but not designated as paratypes includes the following: *Tombigbee River Drainage.* **Alabama:** CLARKE COUNTY: UAIC 431 (1) Bashi Creek 2 mi N of Campbell, 24 Aug. 1954; UAIC 434 (2) Satilpa Creek 8 mi S of Coffeeville, 24 Aug. 1954; UAIC 435 (1) Jacksön Creek 4.5 mi S of Salitpa, 24 Aug. 1954. GREENE COUNTY: TU 76921 (4) Trusells Creek 7.6 mi N of Boligee, 1 April 1972; UAIC 2511 (5) gravel island in Tombigbee River 7 mi N of Gainesville near Warsaw, 23 March 1967; UAIC 2587 (3) Trussell's Creek, T21N,R1W,Sec.1, 17 June 1967; UAIC 3586 (4) Sipsey River 6 mi NNW of Snoddy, 26 June 1969. MARENGO COUNTY: TU 60930 (13) Beaver Creek 11.9 mi SW of Linden, 18 Dec. 1969; UAIC 428 (5) Beaver Creek on Hwy 69 SW of Linden, 24 Aug. 1954; UAIC 430 (12) Horse Creek N of Putnam, 24 Aug. 1954. MARION COUNTY: UAIC 4314 (2) Buttahatchee River 2.5 mi S of Hamilton, 9 Aug. 1971; UAIC 4400 (1) Bull Mountain Creek 10 mi N of jct U.S. Hwy 78, 19 June 1972. PICKENS COUNTY: TU 76533 (20) Big Creek, trib. to Tombigbee River, 1.4 mi SE of Pickensville, 2 April 1972; TU 77019 (49) Big Creek, trib. to Tombigbee River, 1.4 mi SE of Pickensville, 3 April 1972; UAIC 2593 (8) Tombigbee River on gravel bar in area of Vienna Landing, 24 June 1967; UAIC 2705 (4) Tombigbee River N of Vienna Landing, 29 Sept. 1967; UAIC 4390 (1) Tombigbee River 1 mi downstream from mouth of Big Creek, 6 June 1972. SUMTER COUNTY: TU 54855 (1) Noxubee River 3.4 mi N of Geiger, 19 Oct. 1968; UAIC 492 (4) 17 mi SE of York, 20 Aug. 1956; UAIC 1470 (1) Tombigbee River 1 mi N of mouth of Noxubee Creek, 27 Sept. 1964. TUSCALOOSA COUNTY: UAIC 676 (1) Big Sandy Creek, T24N,R5E,Sec.21, 26 Feb. 1959; UAIC 1055 (2) unnamed trib. to Warrior River 1 mi N of U.S. Hwy 82 bypass at Tuscaloosa, 4 Oct. 1963; UAIC 1058 (1) Sipsey River 12 mi W of Tuscaloosa, 25 Oct. 1963; UAIC 1062 (1) Sipsey River 12 mi W of Tuscaloosa, 31 Oct. 1963; UAIC 1150 (1) North River on Alabama Hwy 69 N of Tuscaloosa, 10 Jan. 1963; UAIC 1182 (1) North River on Watermelon Rd NE of Tuscaloosa, 1 Oct. 1963; UAIC 1194 (1) North River 2 mi upstream from bridge on Alabama Hwy 69, 18 Nov. 1964; UAIC 1200 (1) North River 1 mi upstream from Warrior River, 21 July 1966; UAIC 1304 (4) Sipsey River at U.S. Hwy 82, 15 June 1964; UAIC 1570 (1) Black Warrior River at mouth of Big Sandy Creek, 7 Nov. 1964; UAIC 1584 (1) trib. to Big Sandy Creek SW of Duncanville, 5 May 1965. **Mississippi:** CLAY COUNTY: UAIC 4325 (1) Houlka Creek 7 mi NW of West Point, 16 Aug. 1971. ITAWAMBA COUNTY: UAIC 4308 (3) Twenty Mile Creek on Mississippi Hwy 371, 5 Aug. 1971; UAIC 4404 (7) Tombigbee River 6 mi S of Marietta, 23 June 1972; UAIC 4423 (3) Tombigbee River at mouth of Mantachie Creek, 19 July 1972. LOWNDES COUNTY: TU 39438 (3) Tombigbee River 9 mi NW of Columbus, 13 Dec. 1965; TU 40474 (4) Tombigbee River 9.3 mi NW of Columbus, 9-10 April 1966; TU 48850 (3) Tombigbee River 10 mi NW of Columbus, 9 Nov. 1967; TU 54804 (10) Tombigbee River 9 mi NW of Columbus, 19 Oct. 1968; UAIC 4338 (1) Tombigbee River 3 mi upstream from Columbus, 25 Aug. 1971; UAIC 4355 (1) Luxapalila Creek 7.5 mi NE of Columbus, 1 Oct. 1971; UAIC 4357 (1) Yellow Creek 2 mi NE of Steens, 19 Aug. 1971; UAIC 4418 (1) Tombigbee River 0.5 mi below mouth of Luxapalila Creek, 12 July 1972; UAIC 4419 (4) Buzzards Island 4 mi S of Columbus, 12 July 1972; UAIC 4422 (2) Tombigbee River at pipeline crossing 1 mi downstream from Nashville Ferry, 13 July 1972. MONROE COUNTY: MSU 2653 (4) Nichols Creek 2 mi E of Aberdeen, 31 Aug. 1971; TU 40498 (2) Tombigbee River 3.9 mi W of Amory, 10 April 1966; UAIC 2189 (3) Tombigbee River, T12S,R7E,Sec.34, W of Amory, 18 Aug. 1966; UAIC 4356 (1) Buttahatchee River 1 mi N of U.S. Hwy 278, 17 Aug. 1971; UAIC 4429 (3) Tombigbee River 0.4 mi SE of Aberdeen, 25 July 1972; UAIC 4432 (4) Buttachatchee River 6.5 mi S of Greenwood Spring, 29 July 1972; UAIC 4440 (3) Tombigbee River 0.2 mi upstream from mouth of Boguefala Creek, 3 Aug. 1972; UAIC 4442 (3) mouth of Town Creek 3.5 mi E of Amory, 3 Aug. 1972. NOXUBEE COUNTY: UAIC 2161 (6) Hashugua Creek 7 mi W of Macon, 8 July 1966. PRENTISS COUNTY: UAIC 4341 (1) Mackey's Creek 1.3 mi WNW of Moore's Mill, 15 Sept. 1971. WINSTON COUNTY: MSU 134 (1) Noxubee River south of Oktibbeha County line, 26 Sept. 1968; UAIC 2631 (1) Noxubee River 1 mi S of Winston-Oktibbeha County line, 24 Aug. 1967.

Ammocrypta vivax Hay

Scaly sand darter

FIGURE 7

TYPE.—Holotype, USNM 32213 (1, 39 mm SL), Mississippi, Pearl River at Jackson; O. P. Hay; summer 1881.

NOMENCLATURAL HISTORY.—*Ammocrypta vivax* was described by Hay (1883:58). The specific name, *vivax*, is derived from the Latin word *vivious*, which means vigorous, lively. Jordan and Gilbert (1886:9) briefly compared *A. vivax* and *A. pellucida*, mentioning the possibility that "the two species may be found to vary into each other". Jordan (1888:123) reduced *A. vivax* to a subspecies of *A. pellucida*, giving the range of southern Illinois, west and south. Subsequently *A. vivax* was variously treated as a valid species and as a subspecies of *A. pellucida*, until Hubbs and Greene (1927:384) recognized its distinctiveness and regarded it as a valid species. Since 1927 it has been treated as a distinct species, except by Schrenkeisen (1938:226), who reported it as *A. pellucida vivax*. Literature record of *A. pellucida vivax* and *A. pellucida*, within the presently recognized range of *A. vivax* (Fig. 8), are referable to *A. vivax*, except for Fowler's (1945:369) record of *A. pellucida* from New Orleans, which is based on *A. beani*. Records of *A. vivax* from the Mobile Basin are referable to *A. meridiana*.

DIAGNOSIS.—*Ammocrypta vivax* is characterized by having the long axes of the lateral blotches vertically oriented, usually extending to or above the lateral line scale row; first dorsal fin of males with narrow dark marginal and submarginal bands or with one wide marginal band; second dorsal and caudal fins with a dark submarginal band and usually a dark marginal band; pelvic fins of males with melanophores on rays and membranes; opercular spine absent; posterior margin of preopercle usually partially serrate; preoperculomandibular canal pores 9 to 11, usually 10; breeding tubercles in males present on pelvic spine and rays and on anal spine and rays; lateral line complete, with 58 to 79 scales; transverse scale rows usually 13 to 16; cheeks and opercles usually scaled; nape partially scaled; first interneural spine between neural spines of sixth and seventh or seventh and eighth vertebrae.

DESCRIPTION.—*Ammocrypta vivax* is a moderately large species of the subgenus *Ammocrypta*. The largest specimen examined is a male 61 mm SL. Proportional measurements are presented in Table 20. Frequency distribution of certain characters are presented in Tables 30-38.

Body moderately elongate, the depth into standard length 7 to 9 times, usually 8; origin of anal fin under or posterior to origin of soft dorsal; body width slightly less than depth; head length 4 to 5 times in standard length; gill membranes narrowly conjoined to slightly overlapping; mouth moderately large, extending posteriorly slightly beyond anterior rim of orbit; orbit length slightly less than snout length; snout slightly rounded, not pointed.

Dorsal rays VIII-XIV, 9-12 (usually X-XII, 10-11); anal rays I, 7-10 (usually I, 9); pectoral rays 13-17 (usually 14-15); vertebrae 41-43 (usually 42).

Body almost completely scaled, more so than for any other species of the subgenus *Ammocrypta;* lateral line complete, with 58-79 scales; scale rows above lateral line 1-7 (usually 4-6); scale rows below lateral line 6-12 (usually 8-10); transverse scale rows 10-18 (usually 13-16); cheeks and opercles typically fully scaled; nape squamation variable, usually partially scaled; caudal peduncle fully scaled; total caudal peduncle scale rows usually 22, with 9 rows above lateral line and 11 below. Scattered embedded cycloid to weakly ctenoid scales usually present on pectoral fin base and margin of breast.

Cephalic sensory canal system complete; lateral canal pores 5; supratemporal canal pores 3; supraorbital canal pores 4; coronal pore present; infraorbital canal pores usually 8; preoperculomandibular canal pores 9-11, usually 10.

Counts for the holotype are dorsal rays XI, 10; anal rays I, 9; pectoral rays 14; lateral line scales 63; scale rows above lateral line 5; scale rows below lateral line 10; transverse scale rows 15.

LIFE COLORS.—The body is lightly washed with yellow-orange pigment, which is most heavily concentrated on the dorsal and dorsolateral surfaces, and decreases ventrally from the lateral line to the ventrolateral surfaces, gradually disappearing on the venter except along the myosepta. There are 12 to 14 dark rectangular blotches (1 to 3 vertebrae long) along the vertebral colum, which are visible in live or freshly preserved specimens.

The dorsal and dorsolateral surfaces of the head are yellowish orange, this being most prominent on the snout. Laterally, the cheeks and opercles are iridescent yellowish green.

On the median fins the membranes above and below the dark submarginal bands are yellow to yellow-orange. Light yellowish pigment is present on the membranes of the pectoral and pelvic fins.

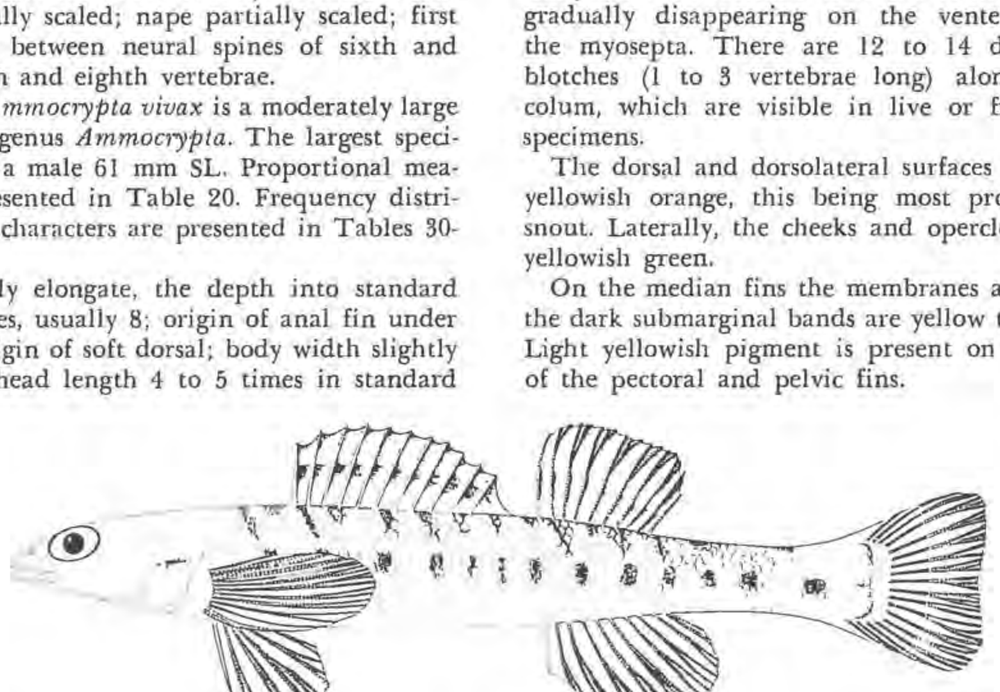

Fig. 7. *Ammocrypta vivax*. Male 56.2 mm SL; UAIC 4735, Bayou Anacoco on Louisiana Hwy 111, Vernon Parish, Louisiana; 24-25 May 1973. (Drawn by HECTOR HARIMA).

The above notes were taken from observations of approximately 10 specimens from three collections.

COLORATION IN ALCOHOL.—The 9 to 16 brownish, lateral blotches vary in size, shape, intensity, and position. Blotches are usually circular to oval, with the long axis oriented vertically. The smallest blotches are on the anterior part of the body, one to two scales wide, and two to four scales high, and rarely extend above the lateral line scale row. The blotches along the midsection of the body are two to three scales wide and three to five scales high, with the dorsal margin of these blotches usually being located on the scale rows above the lateral line. The blotches posterior to the midsection are smaller, usually being two to three scales wide and two to three scales high. The dorsal margin of these blotches is usually on the lateral line scale row except for the last one or two blotches, which are centered on the lateral line scale row.

The midline of the dorsum is crossed by 10 to 15 blotches, varying greatly in size, shape, and arrangement. Blotches under the dorsal fins are frequently broken along the midline, forming rows of paired spots. The relative position of blotches or rows of spots varies from two to four across the nape, three to five under the first dorsal fin, zero or one between the first and second dorsal fin, three or four under the second dorsal fin, and three to five posterior to the second dorsal fin. The dorsolateral surface of the anterior half of the body is often pigmented by spots, blotches, and bars or a combination of these, which are extremely variable in size and intensity. The dorsolateral pigment occasionally merges with the lateral or dorsal blotches, resulting in a reticulated pattern. Except around the base of the anal fin, the exposed margins of scales on the cheeks, opercles, and body are usually lined with melanophores. The venter is unpigmented, except for a line of melanophores extending from the base of the last anal ray posteriorly to the caudal fin.

Pigmentation in the spinous dorsal fin is variable. In most males there is a narrow marginal band and a slightly wider submarginal band through the central portion of the fin. In some individuals the marginal and submarginal bands merge, forming a poorly developed band on the distal half to one-third of the fin. Patterns similar to those found in males are present in females, but the concentration of pigment is reduced. The second dorsal fins of males and females have a narrow marginal band and a slightly wider basal band. Pigment in the marginal bands is concentrated around rays and may or may not form a solid band. On the basal band pigment is concentrated on rays and adjacent membranes, rarely forming a solid band. The banding pattern in the caudal fin is similar to that of the second dorsal, the primary difference being the absence of melanophores on membranes in the basal band. The marginal band on the caudal fin is variously developed and is occasionally absent. On the anal fin, melanophores are present on and along margins of the basal two-thirds to three-fourths of fin rays and occasionally on membranes of the fins. Melanophores are usually present on rays of the dorsal half to two-thirds of the pectoral fin. In males the basal two-thirds to three-fourths of the pelvic fins have melanophores on the rays and membranes, but these are usually concentrated around rays. The pelvic fins of females are usually unpigmented.

The lower part of the head is usually unpigmented. The cheeks and ventral two-thirds or three-fourths of the opercles are unpigmented except for scattered melanophores. The dorsal margin of the preopercle and upper one-fourth to one-third of the opercle are variously pigmented. Anterior to the interorbital area the occiput is moderately to well pigmented. The sparsely pigmented interorbital bar is absent in some individuals. There is a continuous band of melanophores from the preorbital area around the tip of the snout below the level of the anterior nostrils. Concentration of melanophores in the band is variable, but is usually greatest in the preorbital area and just below the nostrils. A cluster of melanophores is usually present along the medial and ventral margins of the anterior nostril. Pigment between the posterior nostrils is variable. The median section of the upper lip is moderately to well pigmented with scattered melanophores laterally to the corner of the jaw.

BREEDING TUBERCLES.—Tuberculate males have been collected from mid-April until mid-August. At maximum development tubercles are present on the ventral surface of the pelvic spine and pelvic rays, dorsal surface of pelvic rays, anal spine, and anal rays. Tubercles are best developed on the ventral surface of the segmented portion of pelvic rays. Although present on the distal half to three-fourths of the pelvic spine, they are smaller there than on the rays. On the upper surface of the pelvic fins small tubercles are usually absent and, when present, are restricted to the segmented portion of rays.

Tubercles on the anal rays are best developed on the segmented portion of the posterior rays, and are rarely present on the basal unsegmented portion of rays. Small tubercles are occasionally present on the distal two-thirds of the anal spine.

Tubercles on the segmented portion of the pelvic and anal rays are usually situated on the articulation between two segments.

DISTRIBUTION.—*Ammocrypta vivax* is primarily a Coastal Plain species, having its center of distribution in the central portion of the Mississippi embayment (Fig. 8). West of the Mississippi River it occurs along the Gulf Slope in the Calcasieu, Sabine, Neches, Trinity, and San Jacinto river drainages in southwestern Louisiana and eastern Texas. The western range limit of *A. vivax* in Texas generally corresponds to the boundary of the pine-oak hickory biome (Hubbs, 1957). In western tributaries to the Mississippi River this species is known from the Red, Ouachita, Arkansas, White, and St. Francis river drainages. The western and northernmost distribution of *A. vivax* in these drainages

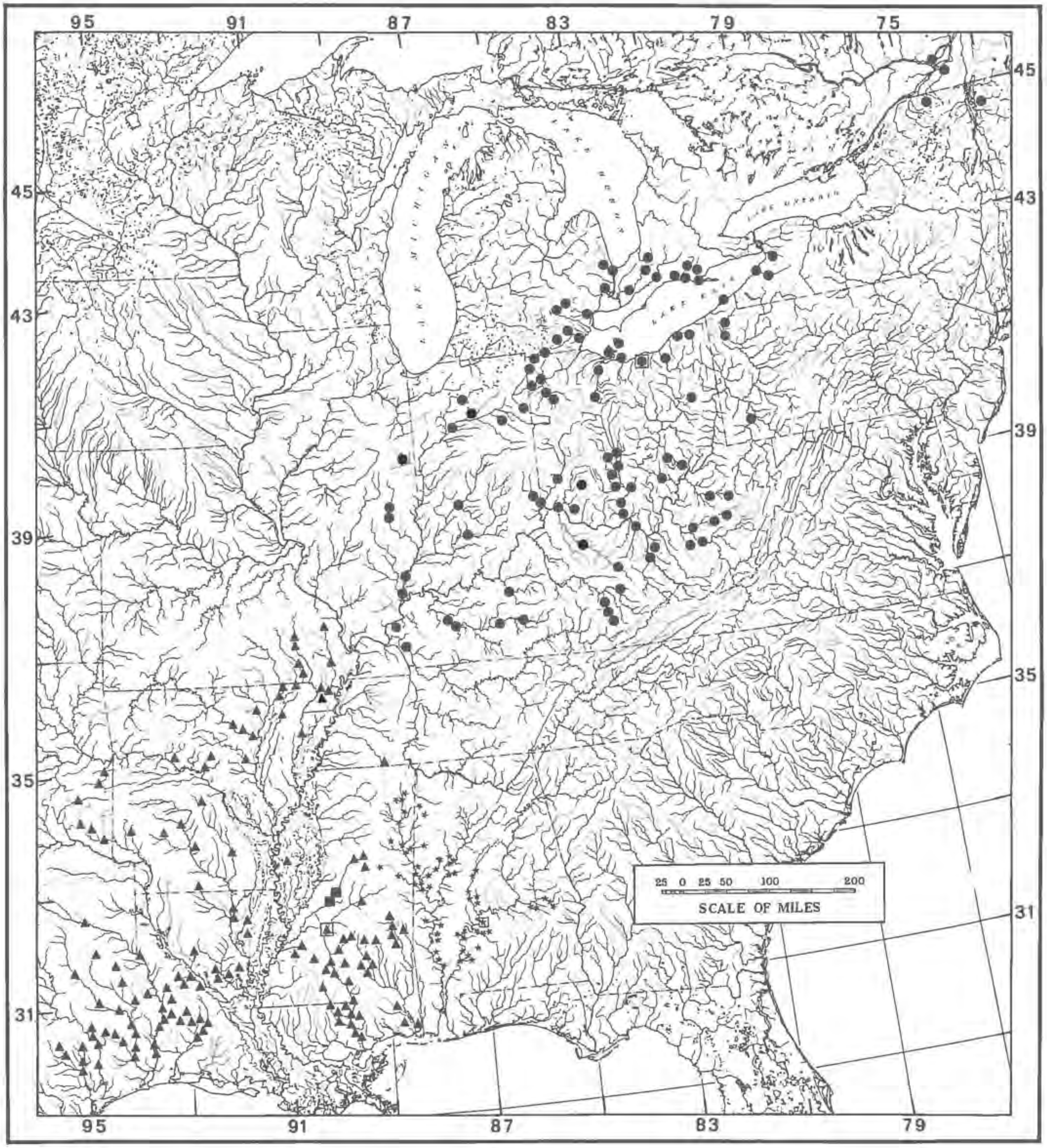

Fig. 8. Distribution of the three species of the *Ammocrypta pellucida* species group, *Ammocrpta meridiana* (stars), *A. pellucida* (circles), and *A. vivax* (triangles). Symbols enclosed by a square represent the type locality for that species. Solid squares represent the two localities where three species, *A. vivax*, *A. beani*, and *A. clara*, occur syntopically. Broadly overlapping symbols and uncertain localities are not plotted.

generally corresponds to the margin of the Coastal Plain, except along major rivers where its range extends beyond the Coastal Plain. *A. vivax* ranges as far west as the Kiamichi River, Pushmataha County, Oklahoma (Red River drainage); Poteau River, Le Flore County, Oklahoma (Arkansas River drainage); and White River, Stone County, Arkansas (White River drainage). In eastern tributaries of the Mississippi River, *A. vivax* is known from the Hatchie River drainage in southwestern Tennessee; the Yazoo (one locality in Washington County), Big Black, and Bayou Pierre river drainages in east central Mississippi. East of the Mississippi River it occurs along the Gulf Slope, throughout the Pearl River, Biloxi Bay, and Pascagoula Bay drainages in south central and southeastern Mississippi.

GEOGRAPHIC VARIATION.—Tables 30-38 give the frequency distributions of meristic characters in *Ammocrypta vivax*. The number of dorsal spines ranged from 8 to 14, with a mode of 11, in most populations. The modal number of dorsal rays was 10 in all populations except the Hatchie, which had a mode of 11. In all populations the modal number of anal rays was nine. The modal number of pectoral rays varied from 14 to 15 and, with one exception (Trinity population), populations with a mode of 15 were those of the middle and upper Mississippi Valley (Big Black-Yazoo, Hatchie, St. Francis, White, Arkansas, and Ouachita rivers).

Lateral line scales ranged in number from 58 to 79 with means ranging from 63.79 (Lower Red River) to 72.12 (White River). The lateral line scale counts, like those of the pectoral rays, were slightly higher in the middle and upper Mississippi Valley ($\overline{X}$=67.23 and 72.12). The upper Red River population exhibited similarly high counts ($\overline{X}$=71.13). The modal number of scale rows above the lateral line was five in most populations. The modal number of transverse scale rows was 15 in most populations. In populations west of the Mississippi River there was a slight increase from the St. Francis population (mode=14, $\overline{X}$=13.49) southwest to the San Jacinto population (mode=16, $\overline{X}$=15.92).

Vertebral counts exhibited no clinal trends. All populations had a modal number of 42 except the Big Black (mode=41) and White (mode=43). The precaudal vertebrae were equally consistent, with a mode of 22 in all populations except the Big Black (mode=21-22) and White (mode=23). The modal number of caudal vertebrae was 20 in all populations except the Big Black (mode=21).

The cheeks and opercles were usually fully scaled, but occasionally individuals were encountered with the lower margin of the cheek and opercle unscaled. Nape squamation varied from completely scaled to naked. In most individuals, throughout the range, 30 percent to 60 percent of the nape was covered with scales.

Materials Examined

Pascagoula Bay Drainage. **Mississippi:** CLARKE COUNTY: TU 37478 (2) Chunky River 1 mi N of Enterprise, 6 May 1965; TU 53738 (2) Chunky River 4.4 mi N of Enterprise, 5 October 1968; UMMZ 144700 (1) Long Creek, trib. to Bucatunna Creek, 12 Sept. 1947; UMMZ 144702 (2) Shubuta Creek, trib. to Chickasawhay River, 13 Sept. 1947; UMMZ 175364 (1) Hassanlawaha Creek at Pachuta, 17 July 1958. COVINGTON COUNTY: NLU 8490 (6) Big Swamp Creek near Seminary, 22 Nov. 1967; NLU 8543 (4) Curries Creek at Sanford, 22 Nov. 1967; NLU 10965 (4) Okatoma Creek 5 mi S of Seminary, 5 Sept. 1968; NLU 12757 (7) Okatoma Creek at Seminary Falls, 1 March 1969; TU 28604 (4) Leaf River 10 mi ENE of Collins, 23 Nov. 1962. JACKSON COUNTY: FSU 13364 (3) Cedar Creek, trib. to Escatawpa River, 2.5 mi N of U.S. Hwy 90, 28 April 1966; TU 28081 (55) Bluff Creek at Vancleave, 27 Oct. 1962; UAIC 1092 (14) Bluff Creek at Vancleave, 5 Aug. 1963. JASPER COUNTY: UMMZ 144703 (1) Tallahoma Creek, 14 Aug. 1947. JONES COUNTY: NLU 12086 (4) Leaf River on I-59 near Moselle, 26 Nov. 1968; TU 59675 (10) Leaf River 1 mi W of Eastabuchie, 26 Oct. 1969; TU 61172 (6) Leaf River 2 mi W of Moselle, 28 Jan. 1970. LAUDERDALE COUNTY: UMMZ 113821 (1) Tallahatta River, trib. to Chickasawhay River, 9 mi W of Meridian, 2 June 1932; UMMZ 113845 (1) trib. of Tallahatta Creek 7 mi W of Meridian, 2 June 1932. SMITH COUNTY: TU 53783 (23) Leaf River 3.1 mi W of Sylvarena, 5 Oct. 1968; TU 53810 (3) Leaf River 1.4 mi E of Taylorsville, 5 Oct. 1968. STONE COUNTY: TU 32383 (2) Black Creek, trib. to Pascagoula River, 13.6 mi E of Wiggins, 27 May 1964.

Pearl River Drainage. **Louisiana:** ST. TAMMANY PARISH: NLU 11715 (6) Bogue Chitto River, T5S,R13E,Sec.45, 31 Oct. 1968; TU 29983 (1) W Pearl River 5 mi SE of Talisheek, 11 Sept. 1963; TU 31766 (1) W Pearl River 2 mi below jct Wilson Slough and W Pearl River, 4.7 mi ESE of Talisheek, 11 Sept. 1963; TU 34303 (9) W Pearl River 0.5 mi below mouth of Holmes Bayou, 22 Aug. 1964; TU 34728 (1) Pearl River 2 mi below mouth of Twin Bayou, 7.5 mi SE of Talisheek, 25 Sept. 1964; TU 34713 (8) Pearl River 1 mi below mouth of Twin Bayou, 7 mi ESE of Talisheek, 25 Sept. 1964; TU 42022 (2) E Pearl River across from mouth of Lots Creek, 18 Oct. 1966; TU 42525 (36) Pearl River at rmi 46, 17.5 mi below Pools Bluff Sill, 29 Nov. 1966; TU 45104 (5) Bogue Chitto River below Lock 3, 8 April 1967; TU 81691 (1) W Pearl River at Bear Island, 15 Nov. 1972. WASHINGTON PARISH: NLU 4662 (4) Bogue Chitto River 14 mi SE of Franklinton, 14 July 1966; NLU 6498 (22) Silver Creek near Mt. Hermon, T1S,R9E, Sec.49, 7 June 1967; NLU 6536 (8) Lawrence Creek, T2S,R11E, sec.38, 7 June 1967; NLU 6597 (2) Bogue Chitto River at Hwy 438, 7 June 1967; NLU 11391 (9) Pearl River at Pools Bluff 6 mi S of Bogalusa, 11 Oct. 1968; NLU 11664 (12) Pearl River at Pools Bluff 6 mi S of Bogalusa, 30 Oct. 1968; TU 27932 (1) Pearl River at E edge of Bogalusa, 11 Sept. 1964; TU 31002 (1) Pearl River above mouth of Coburn Creek, 1.5 mi E of Bogalusa, 12 Dec. 1963; TU 42905 (44) Pearl River below sill at Pools Bluff, 4 mi S of Bogalusa, 6 Jan. 1967; TU 45921 (2) Pearl River at rmi 54, 2.3 mi SE of Bogalusa, 26 April 1967; TU 46209 (1) Pushepatapa Creek 0.8 mi S of Varnado, 29 April 1967; TU 46334 (1) trib. to Bogue Chitto River 3 mi S of jct Hwy 10 and 16, 29 April 1967; TU 46362 (5) Pushepatapa Creek 1 mi upstream from Hwy 22, 29 April 1967. **Mississippi:** CHOCTAW COUNTY: FSU 10607 (3) headwaters of Yockanookany River 0.5 mi W of Ackerman, 21 April 1964. COPIAH COUNTY: TU 27307 (1) Bahala Creek 6 mi S of Rockport, 28 Oct. 1961. JEFFERSON DAVIS COUNTY: CU 12488 (2) White Sand Creek 4.5 mi W of Mt. Charmel, 2 Sept. 1948. HINDS COUNTY: USNM 32213 (1) Pearl River at Jackson, Mississippi, July-August 1881. LAWRENCE COUNTY: TU 27211 (1) Pearl River 1.5 mi SE of Monticello, 28 Aug. 1962; TU 27252 (2) Pearl River 2 mi downstream from Wilson Lake, 5 mi SE of Monticello, 28 Aug. 1962. LEAKE COUNTY: FSU 10698 (9) Standing Pine Creek 5 mi SE of Carthage, 22 April 1964. LINCOLN COUNTY: CU 16265 (1) trib. of Pearl River 8.8 mi W of Monticello, 14 June 1949. MARION COUNTY: NLU 8425 (1) Holiday Creek 8 mi N of Columbia, 24 Nov. 1967; TU 28715 (2) Pearl River at Sandy Hook, 21 Oct. 1961; TU 43006 (1) Pearl River 2.3 mi E of Sandy Hook, 27 Jan. 1967. PEARL RIVER COUNTY: TU 45937 (1) W Hobolochitto Creek 10.4 mi E of Pearl River, 27 April 1967. PIKE COUNTY: TU 43143 (2) Bogue Chitto River 9.5 mi E of McComb, 31 Jan. 1967. RANKIN COUNTY: FSU 10590 (1) Campbells Creek at Johns, 23 April 1964; FSU 10675 (17) Purvis Creek 6.7 mi SW of Polkville, 23 April

1964; FSU 10833 (5) Strong River 2 mi ESE of Puckett, 23 April 1964. SIMPSON COUNTY: NLU 8354 (1) Strong River 2 mi W of Pinola, 19 Nov. 1967; TU 39454 (11) Strong River 2.2 mi. W of Pinola, 13 Dec. 1965; TU 43888 (8) Strong River at rapids, 2 mi W of Pinola, 1 March 1967.

Bayou Pierre Drainage. Mississippi: CLAIBORNE COUNTY: NLU 8089 (1) Bayou Pierre at Carlisle, 11 Nov. 1967; NLU 9181 (1) Bayou Pierre at Carlisle, 30 Jan. 1968. COPIAH COUNTY: NLU 3773 (3) White Ooak Creek, T12N,R5E,Sec.11, 4 May 1966; NLU 5224 (2) Bayou Pierre, T12N,R5E,Sec.22, 15 Oct. 1956; NLU 9112 (1) Favorite Creek W of Carpenter, 30 Jan. 1968; NLU 11498 (7) Bayou Pierre 4 mi SW of Carpenter, 18 Oct. 1968; TU 44491 (1) Bayou Pierre 8.4 mi SW of Utica, 1 March 1967; TU 53173 (2) Bayou Pierre 3.5 mi W of Martinsville, 13 June 1968; TU 68093 (1) Bayou Pierre 5.8 mi E of Carlisle, 13 March 1971; TU 73303 (1) Bayou Pierre 5.8 mi E of Carlisle, 16 Nov. 1971; UMMZ 144701 (1) Bayou Pierre, 27 Aug. 1947. HINDS COUNTY: NLU 5300 (1) White Oak Creek below jct of Favorite Creek, 15 Oct. 1966. JEFFERSON COUNTY: NLU 8366 (1) Little Bayou Pierre 4 mi S of Hermansville, 19 Nov. 1967.

Big Black-Yazoo River Drainage. **Mississippi:** CHOCTAW COUNTY: MSU 201 (1) Big Black River 1 mi S of Eupora, 31 Oct. 1968. MADISON COUNTY: MSU 3511 (2) Big Black River 1 mi S of Pickens, 29 July 1973; MSU 3549 (1) Big Black River NNW of Canton, 29 July 1973. WASHINGTON COUNTY: USNM 129131 (1) Bogue Phalia, Leland, 1 June 1933. WEBSTER COUNTY: FSU 9172 (3) Calabrella Creek 11.7 mi E of Kilmichael, 2 July 1963.

Hatchie River Drainage. **Tennessee:** MCNAIRY COUNTY: USNM 190758 (9) Moss Creek 2.5 mi ENE of Pocahontas, 31 Aug. 1959.

St. Francis River Drainage. **Arkansas:** CLAY COUNTY: CU 42195 (1) Diversion Canal W of St. Francis River 6 mi E of Holly Corners, 25 April 1962. POINSETT COUNTY: FMNH 2939 (115) Marked Tree, 1894. **Missouri:** CAPE GIRARDEAU COUNTY: CU 63586 (4) Whitewater River in Burfordsville, 21 Aug. 1967. DUNKLIN COUNTY: KU 9542 (1) ditch 2 mi SE of Holcomb, 15 July 1964; UMMZ 152996 (39) the Little River Drainage district flooding ditches 81 and 1, 4 mi E of Kennett, 19 Sept. 1940. PEMISCOTT COUNTY: KU 9567 (4) ditch 290, 4.5 mi W of Wardell, 15 July 1964; TU 54589 (65) ditch system of Little River 4.3 mi E of Kennett, 9 Oct. 1968. STODDARD COUNTY: UAIC 2994 (8) Little River (also called Castor River), trib. to St. Francis River, at U.S. Hwy 60 bridge, 23 June 1968. WAYNE COUNTY: INHS uncat. (10) St. Francis River, 22-24 April 1948; KU 3495 (1) Middle St. Francis River, Sam Baker State Park, 1 May 1955; UMMZ 117927 (3) St. Francis River at Kine bridge, T27N,R6E,Sec.4, Clark National Forest, 14 July 1937; UMMZ 117969 (4) St. Francis River at N boundary of Clark National Forest, T28N,R5E,Sec.2, 27 July 1937; UMMZ 117993 (5) St. Francis River 0.5 mi above Greenville, T28N,R5E,Sec.15, Clark National Forest, 27 July 1937; UMMZ 118017 (3) St. Francis River 1 mi S of N boundary of Clark National Forest, T28N,R5E, Sec.27, 29 July 1937; UMMZ 118055 (2) St. Francis River 3.5 mi from Chaonia, T27N,R6E,Sec.15, Clark National Forest, 4 Aug. 1937.

White River Drainage. **Arkansas:** CRAIGHEAD COUNTY: UMMZ 123638 (2) Cache River 13 mi NW of Jonesboro, 10 July 1938. INDEPENDENCE COUNTY: TU 29248 (2) White River below dam at Batesville, 17 Aug. 1962; TU 49227 (2) White River 1.5 mi above ferry 10 Aug. 1965; TU 55356 (2) White River 3 mi above ferry, 25 July 1966; USNM 59188 (3) Polk Bayou at Batesville, 1893; USNM 59189 (2) White River at Batesville, 1893; USNM 59253 (1) White River at Batesville, 1893. LAWRENCE COUNTY: FMNH 1067 (4) Smithville, 1894. RANDOLPH COUNTY: TU 59703 (26) Current River 8 mi E of Pocahontas, 20 Sept. 1969; TU 59735 (13) Current River 0.3 mi NW of Biggers, 20 Sept. 1969; TU 59769 (3) Current River 4.8 mi NW of Success, 20 Sept. 1969. STONE COUNTY: NLU 10461 (3) White River on sandbar 300 yards below Lock 3, 5 June 1968. WHITE COUNTY: USNM 59225 (3) Little Red River (middle fork), 1893; USNM 59255 (5) Little Red River at Judsonia, 1893; USNM 62103 (2) Judsonia, 1893. **Missouri:** BUTLER COUNTY: INHS uncat. (1) Black River 3 mi N of Poplar Bluff, 19-23 July 1948; INHS uncat. (6) Black River 3 mi N of Poplar Bluff, 25-27 April 1948; UMMZ 117300 (2) Black River 0.25 mi below Hilliard Bridge, T25N,R6E,Sec.16, Clark National Forest, 9 July 1937; UMMZ 117326 (4) Black River 0.5 mi below Keene Resort, T26N, R5E, Clark National Forest, 9 July 1937; UMMZ 117364 (5) Black River 1 mi beow Hilliard Bridge, T25N,R6E,Sec.15, Clark National Forest, 15 July 1937; UMMZ 117429 (7) Black River at S boundary below feeder streams, Clark National Forest, 22 July 1937.

Arkansas River Drainage. **Arkansas:** FAULKNER COUNTY: UMMZ 169953 (1) N Fork Caldram River 14 mi N of Conway, 17 July 1940; USNM 59256 (1) Chadron Creek, Conway, 1893. POPE COUNTY: USNM 59254 (4) Illinois River at Russellville, 1893. **Oklahoma:** LEFLORE COUNTY: OAM 778 (3) Slate Fork E of Shady Point, 1947; UMMZ 127261 (1) Plateau River 4 mi SW of Wister, 7 July 1939.

Ouachita River Drainage. **Arkansas:** BRADLEY COUNTY: UMMZ 127888 (2) Saline River 5 mi N of Warren, 20 June 1939. CLARK COUNTY: USNM 36414 (8) Washita River at Arkadelphia, 1884. OUACHITA COUNTY: TU 45703 (13) Tulip Creek, trib. to Ouachita River, 3 mi S of Ouachita, 14 April 1967. PIKE COUNTY: USNM 101170 (2) Antoine, 10 July 1884. SALINE COUNTY: USNM 36444 (4) Saline River at Benton, 1884. UNION COUNTY: UMMZ 113706 (2) Little Cornie Bayou 2 mi N of Junction City, 28 May 1952. **Louisiana:** CATAHOULA PARISH: NLU 4806 (18) Greens Creek, T8N, R5E,Sec.53, 20 July 1966. FRANKLIN PARISH: NLU 6762 (14) Big Creek, T15N,R7E,Sec.9, 11 Aug. 1964. GRANT PARISH: NLU 3267 (7) Fish Creek, T8N,R1W,Sec.36, 14 Dec. 1965; NLU 4470 (8) Big Creek, T7N,R1E,Sec.31, 29 June 1966; UAIC 2072 (7) Fish Creek, T8N,R1W,Sec.25-27, 29 Oct. 1965. LA SALLE PARISH: NLU 12622 (21) at White Sulfur Springs Camp, 9 mi SW of Trout, 9 Feb. 1969. OUACHITA PARISH: TU 48242 (11) Ouachita River 8.3 mi NW of Lampkin, 11 Oct. 1967; USNM 172362 (2) Ouachita River, E shore, T20N,R4E,Sec.31 and T20N,R3E,Sec.36, 28 Jan. 1956. RICHLAND PARISH: USNM 172969 (1) Boeuf River N of Rayvine, T18N,R7E,Sec.32, 23 June 1955.

Lower Red River Drainage. **Louisiana:** NATCHITOCHES PARISH: NLU 1765 (2) Middle Creek, T6N,R8W,Sec.9, 24 June 1965; NLU 1779 (4) Middle Creek, T6N,R8W,Sec.9, 24 June 1965; NLU 2021 (3) Saline Bayou, T21N,R5W,Sec.21, 22 June 1965; NLU 4264 (3) Little Sandy Creek, T5N,R7W,Sec.18, 16 June 1966; NLU 4296 (1) Bayou Pierre Springs, T5N,R4W,Sec.36, 16 June 1966; TU 13343 (119) Bayou Kisatchie 6.8 mi SE of Bellwood, 10 Aug. 1956; TU 13679 (29) Middle Creek 11.5 mi S of Provencal, 24 May 1956; TU 13733 (28) Bayou Kisatchie 18.3 mi S of Provencal, 24 May 1956; TU 13740 (7) Bayou Santa Barb 8.5 mi S of Provencal, 3 March 1956. GRANT PARISH: TU 37281 (6) Big Creek at Fishville, 19 March 1965.

Upper Red River Drainage. **Arkansas:** SEVIER COUNTY: UO 7728 (5) Sevier County, 1927; UMMZ 81129 (4) Saline River 6 mi W of Dierk, 1 July 1927. **Oklahoma:** MCCURTAIN COUNTY: KU 2101 (1) Little River above Sugar Creek, 16 Aug. 1950; OAM 4011 (3) Oklahoma Lake, 1948; OAM 4542 (5) Little River, 1950; UMMZ 129695 (1) Glover River 0.25 mi W of Glover, 16 June 1938; UO 30409 (5) Little River, 18 June 1960; UO 31007 (2) Little River, 25 July 1955; UO 37323 (1) McCurtain County, 17 June 1955. PUSHMATAHA COUNTY: KU 4519 (4) Kiamichi River at Kiamichi, 18 April 1959.

Calcasieu River Drainage. **Louisiana:** ALLEN PARISH: ANSP 55359-64 (6) Kinder, no date; NLU 2906 (13) Whiskey Chitto Creek, T5N,R6W,Sec.13, 10 Aug. 1965; TU 1339 (69) Calcasieu River 4 mi W of Oberlin, 24 June 1948; TU 41524 (8) Ten Mile Creek 1 mi E of Hwy 377, 26 Sept. 1966; TU 41545 (6) Six Mile Creek 3 mi W of Hwy 377, 26 Sept. 1966; TU 50221 (41) Calcasieu River 1.6 mi NW of Oakdale, 8 Feb. 1968. BEAUREGARD PARISH: TU 41858 (1) Bundick Creek 2 mi E of Hwy 190 and 171, 26 Sept. 1966; TU 79841 (140) Whiskey Chitto Creek 1.5 mi N of intersection of Hwy 113 and 26, 7 Oct. 1972. VERNON PARISH: UAIC 2679 (27) Whiskey Chitto Creek 2 mi W of Cravens, 10 Sept. 1967.

Sabine River Drainage. **Louisiana:** BEAUREGARD PARISH: TU 60735 (39) Sabine River at Gulf, Colorado and Santa Fe Railroad, 20 Nov. 1969; TU 64163 (11) Bayou Anacoco upstream from Hwy 111, 16 July 1970. CALCASIEU PARISH: TU 44581 (17) Sabine River at Hwy 12, 24 March 1967; TU 58493 (10) Sabine River 2 mi below mouth of Nichols Creek, rmi 54, 24 July 1969; TU 63599 (4) Sabine River opposite mouth of Cypress Creek, 19 July 1970. DESOTO PARISH: NLU 6774 (11) Sabine River 1 mi S of Logansport Bridge, 22 Aug. 1966; TU 35550 (63) Sabine River at Logansport, 14 July 1964. SABINE PARISH: TU 790 (14) Toro Creek 4.1 mi S of

Florum, 3 Aug. 1951. VERNON PARISH: TU 50305 (1) Sabine River at lower end of Toledo Bend 13.2 mi SW of Anacoco, 9 Feb. 1968; TU 60662 (10) Bayou Anacoco 1 mi SE of Ollieville, 19 Nov. 1969; TU 62343 (9) Bayou Anacoco at Louisiana Hwy 111, 20-21 May 1970; TU 62359 (12) Bayou Anacoco near the Sabine River, 21 May 1970; TU 80198 (54) Anacoco Bayou 3.5 mi E of Knight, 7 Oct. 1972; UAIC 2677 (36) Prairie Creek 2.5 mi NW of Leesville, 10 Sept. 1967; UAIC 2678 (37) Sabine River W of Leesville, 10 Sept. 1967; UAIC 4735 (3) Bayou Anacoco on Louisiana Hwy 111, 24-25 May 1973. **Texas:** NEWTON COUNTY: TU 58340 (6) Sabine River at rmi 90.5, mouth of Middle River, 23 July 1969; TU 58537 (15) Sabine River 19 mi W of Leesville, 25 July 1969. SABINE COUNTY: TU 35498 (3) Housen Bayou SE of Hemphill, 13 July 1964. UPSHUR COUNTY: UMMZ 170039 (9) Sabine River 2 mi S of Big Sandy, 20 Aug. 1940.

Neches River Drainage. **Texas:** CHEROKEE COUNTY: TAM 1F-13-J-11 (4) Neches River 5 mi E of Fastrill, 24 Oct. 1952. HARDIN COUNTY: TAM 1F-13-J-8 (36) Village Creek 2 mi S of Village Mills, 26 Oct. 1952; TU 21872 (5) Village Creek above U.S. Hwy 96 crossing, 2 March 1957; TU 67563 (100) Neches River 6 mi ENE of Silsbee, 21 Feb. 1971; UMMZ 166496 (1) Neches River above Beaumont, 13, 15, 16 Aug. 1953. POLK COUNTY: TAM 1F-13-J-14 (7) Neches River 3 mi S of Diboll, 25 Oct. 1952; TNHC 2417 (14) Big Sandy Creek 13.6 mi E of Livingston, 8 March 1952. RUSK COUNTY: TNHC 3833 (16) Bernhardt Creek 9 mi S of Henderson, 10 Aug. 1953; TU 3851 (20) Attoyac River 5.6 mi SW of Timpson, 6 April 1952. SABINE COUNTY: UMMZ 170500 (2) McKim Creek 0.5 mi N of Brookeland, 5 Sept. 1940. SAN AUGUSTINE COUNTY: TAM 1F-13-J-2 (2) 12 mi W of San Augustine, Attoyac Bayou, 25 Oct. 1952. TYLER COUNTY: TAM 1F-13-J-3 (1) Neches River 14 mi SW of Jasper, 25 Oct. 1952; TAM 1F-13-J-6 (2) Neches River 12 mi S of Zavalla, 25 Oct. 1952; TAM 1F-13-J-7 (1) Village Creek 10 mi W of Warren, 26 Oct. 1952; TU 21672 (5) Big Turkey Creek 6 mi SE of Warren, 2 Dec. 1956; TU 21840 (12) Hickory Creek 3.5 mi W of Warren, 6 Dec. 1958; TU 21906 (28) Horsebend Creek 3 mi W of Warren Farm Rd 1943, 6 Dec. 1958; TU 72024 (21) Neches River 4.9 mi W of Mount Union, 22 July 1971.

Trinity River Drainage. **Texas:** LIBERTY COUNTY: TU 69986 (1) Trinity River 5.3 mi W of Moss Hill, 27 May 1971. POLK COUNTY: FSU 811 (1) trib. of Trinity River 1.5 mi W of Livingston, 14 April 1952; TNHC 1349 (3) trib. of Trinity River 6 mi E of Livingston, 23 March 1951; TU 71819 (20) Trinity River at Taylor Lake Estates 2 mi NW of Ace, 21 July 1971.

San Jacinto River Drainage. **Texas:** HARRIS COUNTY: TAM 1F-13-J-12 (12) San Jacinto River E of New Caney, 20 Sept. 1940; TU 73384 (16) Spring Creek 1.5 mi ENE of Spring, 9 Nov. 1971; UMMZ 170414 (12) San Jacinto River 19 mi NNE of Houston, 4 Sept. 1940. LIBERTY COUNTY: TAM 1F-13-J-13 (3) San Jacinto River 10 mi W of Humble, 13 Oct. 1940; TAM 1F-13-J-14 (2) E Fork of San Jacinto River 4.5 mi NW of Cleveland, 25 June 1940; TNHC 1584 (10) E Fork of San Jacinto River 0.5 mi W of Cleveland, 23 March 1951. MONTGOMERY COUNTY: TNHC 1162 (10) W Fork of San Jacinto River 3 mi W of Conroe, 22 March 1951; TNHC 1391 (7) W Fork of San Jacinto River 3 mi W of Conroe, no date; TU 61897 (25) San Jacinto River 3 mi W of Conroe, 24 Dec. 1969; TU 73611 (14) Caney Creek 0.5 mi N of New Caney, 9 Nov. 1971; TU 74166 (4) San Jacinto River 5 mi S of Conroe, 23 Feb. 1971; TU 74180 (1) W Fork of San Jacinto River S of Conroe, 25 Sept. 1968; USNM 118478 (4) Spring Creek, 23 April 1940; USNM 118479 (1) Spring Creek, 10 May 1940. WALKER COUNTY: TU 73869 (14) W Fork of San Jacinto River at Lake Stubblefield, 24 Sept. 1968.

Behavior

Various species of marine and freshwater fishes are known to burrow or bury themselves in search of food, for protection from predators and to avoid desiccation (Schultz and Stern, 1948; Nikolsky, 1963). Although there are numerous references to the burying habit of the sand darters, only three (one dealing with *A. clara* and two with *A. pellucida*) have presented observations of the burying act.

Observations on the burying behavior of *A. pellucida* in aquaria were reported by Jordan and Copeland (1877). According to their observations the tip of the snout was placed against the sandy bottom with the body in a nearly vertical position. Burying was accomplished by the fish swiftly beating its tail to the right and left, pushing itself into the sand. This act required less than 5 seconds. In less than 30 seconds after burial the snout and eyes were pushed out of the sand, leaving the remainder of the body buried. Trautman (1957) observed *A. pellucida* in clean sandy streams where the sand darter would bury itself with only its eyes exposed. From this retreat the fish would dash out to catch passing prey, after which it rapidly reburied itself in the sand tail first.

There are several possible explanations to account for the differences between the burying behavior of *A. pellucida* as reported by Jordan and Copeland (1877) and Trautman (1957). One possibility is that the burying behavior is variable and both head first and tail first burrowing are practiced. Another alternative is that the burying behavior observed by Jordan and Copeland (1877) was atypical due to limitations imposed by the aquarium habitat. Winn (1958a) found that substrate, size of aquaria, number of individuals present, light, and temperature markedly affected the behavioral response of darters (*Percina* and *Etheostoma*) in aquaria.

Aquarium observations on *Ammocrypta* sp. (=*A. clara*) from the Red River south of Bennington, Oklahoma were reported by Linder (1953) and are summarized as follows: The sand darter dives head-first into the sand and, with rapid movements of the pectoral and caudal fins, completely buries itself. It has been found to bury itself an inch or more below the surface of the sand. It is not known to what extent the aquarium habitat affects the burying behavior of *A. clara*, if indeed it affects it at all.

Burying behavior of *A. bifascia* was observed during October 1967 and January 1968 in Coldwater Creek, a tributary to the Blackwater River in Santa Rosa County, Florida. The observations were made between 0900 and 1100 in clear to slightly stained water at depths up to 38 cm over a shifting sand bottom. Approximately 15 individuals, including both males and females, were observed. The burying behavior consisted of a rapid dart along the bottom for a distance of 23 to 38 cm, after which a sudden head-first plunge into the sand left the body buried. Only the eyes and snout were exposed. The midsection of the body was usually buried to a depth of 5 to 8 mm below the surface of the sand. The burying act usually required less than 3 seconds.

The burying behavior of *Ammocrypta* has usually been explained in terms of protection from predators; however, this may not be the most important factor in the adaptive value of this behavior. The habitat of species of the subgenus *Ammocrypta* is shifting sand bottoms, generally considered to be the most unproductive lotic ecosystem (Odum and Odum, 1959; Macan, 1963). The sterile nature of the habitat of sand darters generally precludes the presence of predatory species, with the exception of transient individuals. The absence of predators suggests that survival value of the burying behavior of *Ammocrypta* may not be due to the protection afforded. Actually this behavior may be more important in energy conservation than in protection. The energy required for an individual to maintain itself against a moderate current on a sand bottom would be considerably greater than the amount required for the same individual lying buried in the sand. Also, the lower temperature below the surface of the sand probably results in a reduction of the metabolic rate. Although no experimental evidence is available, it appears that the adaptive value of burying behavior in *Ammocrypta* is possibly attributable to both conservation of energy and protection.

Phylogeny of the Subgenus *Ammocrypta*

The genus *Ammocrypta* is generally considered to be a highly specialized end-line group and is regarded as a derivative of *Percina* or a *Percina*-like ancestor (Jordan, 1877b; Jordan and Eigenman, 1886; Bailey and Gosline, 1955). The results of recent biochemical studies (Page and Whitt, 1973a and b) suggest a common origin for *Etheostoma* and *Ammocrypta*, and indicate that these two genera are more closely related to each other than either is to the genus *Percina*. They base the above relationships, in part, on the similarity of enzyme characteristics that indicate *Ammocrypta pellucida* and *Etheostoma* (*Vaillantia*) *chlorosomum* are related. I think it is equally likely that the genus *Ammocrypta* was derived from the *Imostoma* line of the genus *Percina*. This hypothesis is based on the following characteristics, which are shared by members of the subgenus *Imostoma* and the genus *Ammocrypta:* anal fin of males extremely elongated, usually extending posterior to or beyond caudal fin base; similar tubercle pattern; eyes situated dorsally on the head; frontal bones reduced, the interorbital width very narrow; branchiostegal membranes narrowly conjoined or separate; prepectoral area and portions of the breast with embedded or exposed scales.

The two subgenera, *Crystallaria* and *Ammocrypta*, of the genus *Ammocrypta* are recognized by some workers as distinct genera, but are generally regarded as subgenera. The two subgenera, which are very different morphologically, represent different phyletic lines, apparently with a common origin. The morphological characters by which the two subgenera differ so trenchantly are, in most cases, adaptations reflecting selection pressure subsequent to the invasion of a new habitat by the subgenus *Ammocrypta*. The more conservative character states shared by the two subgenera suggest a common origin and thus their recognition as subgenera instead of genera. These characters are: single anal spine; breeding tubercle arrangement; frontal bones reduced; interorbital area narrow; branchiostegal membranes narrowly conjoined; median fin rays elongate. Additional data, which will further clarify the relationship of the subgenera *Crystallaria* and *Ammocrypta* and the relationship of these to the subgenus *Imostoma* of the genus *Percina*, will be presented in a forthcoming paper on *Ammocrypta asprella*.

Within the subgenus *Ammocrypta* are two well defined species groups, each of which contain three species. The *beani* group contains *A. beani*, *A. bifascia*, and *A. clara;* the *pellucida* species group contains *A. pellucida*, *A. meridiana*, and *A. vivax*. The species within each group are allopatric with the exception of *A. beani* and *A. clara*. These two species are sympatric at two localities in the Big Black River in Mississippi.

The *beani* species group is characterized by having an almost naked body; usually three to six transverse scale rows; edge of breast and prepectoral area without scales; posterior margin of preopercle entire; preoperculomandibular canal pores usually eight or nine, with three pores on mandible, and five or six on preopercle; vertebrae usually 40; lateral blotches poorly developed to absent; pelvic fins unpigmented; breeding tubercles well developed and present on segmented and unsegmented portions of anal and pelvic fin rays (also caudal rays in *A. clara*); breeding tubercles usually situated on ray segments, rather than on an articulation between ray segments.

The *pellucida* species group has the following characters: body partially to almost completely scaled, usually 9 to 15 transverse scale rows; embedded scales often present along edge of breast and prepectoral area; posterior margin of preopercle usually serrate; preoperculomandibular canal pores usually 10, with four pores on mandible, and six on preopercle; vertebrae usually 42 or 43; lateral blotches moderately to well developed; membranes of pelvic fins of males pigmented; breeding tubercles poorly developed, usually restricted to the segmented portions of the pelvic and anal rays; breeding tubercles usually situated on the articulation between two segments.

The relationships between the two species groups do not appear to be very close. None of the extant forms are intermediate between the groups.

In the genera *Ammocrypta*, *Percina*, and *Etheostoma* many of the characters used to define and delimit the species, species groups, and subgenera are highly variable and commonly are the product of convergent evolution (Bailey *in* Bailey, Winn, and Smith, 1954). Characters that are generally believed to represent the generalized or primitive condition in these genera are 10 preoperculomandibular canal pores; infraorbital canal complete with eight pores; supratemporal canal complete; lateral line complete; serrate preopercle; 41 to 45 vertebrae; relatively large body; squamation of cheeks, opercles and body complete; females equal to or larger than males; large numbers of colorless eggs; spawning season beginning later in the spring or in the summer; premaxillary frenum present; two anal spines; more meristic elements; large stream habitat (Hubbs & Cannon, 1935; Bailey & Gosline, 1955; Winn, 1958b).

Based on the above compendium of characters, the *pellucida* species group appears to be the most primitive (generalized) of the two species groups in having: 10 preoperculomandibular canal pores; serrate preopercle; more complete squamation of cheeks, opercles, and body; the spawning period in early summer; females equal in size to males; and more meristic elements. Within the *pellucida* species group, *A. vivax* has retained the most primitive characters, the most notable being the almost completely scaled body. Conversely, *A. pellucida* appears to be the most advanced in having reduced squamation of the cheeks, opercles, and body. *Ammocrypta meridiana* appear to be intermediate between the more completely scaled *A. vivax* and the less scaled *A. pellucida*. Reduced squamation and absence of pigmentation in the median fins of *A. pellucida* and *A. clara* of the *beani* species group have been erroneously interpreted as indicating a close relationship between the two species. The similarity of these characters apparently is the result of convergent evolution, as the majority of the characters of the two species indicate that they are not closely related.

Most characteristics of species of the *beani* group are divergent from the primitive condition; hence its designation as the most advanced species group of the subgenus. Of the three species in the *beani* group, *A. clara* appears to be the most primitive in having more complete squamation of cheeks, opercles, and body; females equal in size or larger than males; more meristic elements; and spawning season beginning later in summer. *Ammocrypta bifascia* and *A. beani* are the most advanced species of the subgenus *Ammocrypta*.

Examination of selected morphometric and meristic characters revealed evolutionary trends in both species groups of the subgenus *Ammocrypta*. In most cases the trend of a particular character was the same in both species groups; however, some exceptions did occur. The characteristics exhibiting similar trends within each species group include: vertebrae (low counts in primitive species, higher counts in advanced species) ; dorsal spines and pectoral rays (high counts in primitive species, lower counts in advanced species) ; squamation of cheeks and opercles (more scales in primitive species, fewer scales in advanced species) ; breeding tubercles (tubercles more extensive and better developed in primitive species) ; hiatus between dorsal fins (shorter in primitive species) ; origin of spinous dorsal fin (origin anterior in primitive species with the first interneural spine between the neural spines of the sixth and seventh vertebrae; in advanced species it is placed more posteriorly with the first interneural spine between the neural spines of the seventh and eighth or eighth and ninth vertebrae) .

Evolution and Dispersal of the Subgenus *Ammocrypta*

The origin and center of dispersal of the subgenus *Ammocrypta* was probably the lower Mississippi Valley. This hypothesis is based primarily on the present geographical distribution of species of the subgenus *Ammocrypta*. Like the subgenus *Ammocrypta*, the subgenus *Crystallaria* of the genus *Ammocrypta* has its center of distribution in the Mississippi River Valley. The distribution and divergent nature of four of the six species suggest that they evolved prior to the Pleistocene. The lack of extensive morphological and ecological divergence of the new species, *A. bifascia* and *A. meridiana*, suggests a more recent differentiation, possibly during the beginning of the Pleistocene epoch.

The limited diversity (6 species) of the subgenus *Ammocrypta* could be explained in terms of recent origin; however, in view of the divergent nature of some of the existing forms the paucity of species probably results from the lack of available niches in a rather restricted habitat. It appears, based on geographic distribution, that there are at most two niches available in any given stream: one niche for a scaled species (*A. vivax*, *A. meridiana*, and *A. pellucida*) and one for a naked species (*A. clara*, *A. beani*, and *A. bifascia*) . In river systems traversing the Gulf Coastal Plain west of the Mississippi River, *A. vivax*, a scaled species, and *A. clara*, a naked species, occur together. On the Gulf Coastal Plain east of the Mississippi River, *A. vivax* occurs syntopically with *A. beani* in the Big Black, Bayou Pierre, Pearl, and Pascagoula river systems. East of the Pascagoula River system in the Mobile Basin *A. vivax* is replaced by another scaled species, *A. meridiana*, which occurs with *A. beani*. The only river system where three species of the subgenus *Ammocrypta* occur together is the Big Black River in west central Mississippi (Figures 4 & 8). At the two localities (Big Black River, Madison County, Mississippi) one scaled species, *A. vivax*, and two naked species, *A. clara* and *A. beani*, have been taken together. Of the three species, *A. beani* is by far the most common. *Ammocrypta clara* is known from three specimens (two localities) and *A. vivax* is known from eight specimen (four localities) .

There are several possible explanations for the syntopic occurrence of three species of the subgenus *Ammocrypta*. One possibility is that the degree of divergence between *A. clara* and *A. beani* is sufficient to permit coexistence of these species without excluding *A. vivax*, which occupies a separate but similar or adjacent niche. Another explanation is that *A. vivax* and *A. clara* were the original inhabitants and *A. beani* has only recently invaded the Big Black drainage. If this is the case conditions are apparently more favorable for *A. beani* and it is in the process of replacing *A. clara*.

In the upper Mississippi River Valley *A. clara* is the only species of the subgenus *Ammocrypta*. In the Ohio River Basin one scaled species, *A. pellucida*, and one naked species, *A. clara*, have been collected together at two localities in the Wabash River system and one locality in the Green River system. Above the Wabash and Green river systems in the Ohio Basin and in southern Lake Huron, Lake St. Clair, Lake Erie, and St. Lawrence River drainages, *A. pellucida* is the only species of the subgenus present.

The precursor of the *beani* species group was probably once distributed throughout the Gulf Coastal Plain and possibly ranged northward into the Ohio, Misouri, and Teays river systems. Speciation that eventually gave rise to *A. clara* and *A. beani* could have been initiated by the cessation of gene flow resulting from geographical isolation of populations east of the Mississippi River drainage along the Gulf Coast. The marked differentiation between *A. beani* and *A. clara* indicates that they probably have been isolated for a considerable period of time.

Ammocrypta bifascia probably evolved during the Pleistocene. Lowering of the sea level during a Pleistocene glacial stage and conjoining of drainage systems along the Gulf coast provided an avenue of dispersal for *A. beani* eastward to the Choctawhatchee River drainage. The sea level rise during one of the interglacial stages flooded lower portions of the coastal drainages and could have resulted in the isolation of *A. beani* stock east of Mobile Bay. This stock subsequently differentiated, giving rise to *A. bifascia* (Figure 4). The degree of differentiation is much less than between *A. beani* and *A. clara*, but there are no signs of intergradation between the two forms. *A. bifascia* is one of a number of endemic plants and animals in the Florida panhandle that apparently evolved in isolation resulting from the oscillations in sea level during the Pleistocene.

The apparent absence of *A. beani* in the northwestern part of Mississippi was unexpected in view of its presence in the Hatchie drainage in southwestern Tennessee (Figure 4). Its presence in the Hatchie may be explained by stream capture from the upper Tombigbee. The presence in the Hatchie River drainage of several other species that typically occur in streams tributary to the Gulf lends supports to this hypothesis.

Ammocrypta clara is present in most of the moderate to large rivers of the Mississippi Valley (Figure 4). Outside of the Mississippi Valley it occurs in the Neches and Sabine river drainages in Texas and in the Fox River drainage, a tributary to Green Bay of Lake Michigan. The dispersal route of *A. clara* into the Lake Michigan drainage may have been through the Fox-Wisconsin Canal linking the Mississippi and Lake Michigan drainages (Becker, 1965); however, the possibility exists that the Fox River was once a tributary to the Mississippi River (Van der Schalie, *in* Goodrich and Van der Schalie, 1939). The apparent absence of *A. clara* from the Tennessee, Missouri, and Arkansas rivers was surprising and is unexplained at this time.

The precursor of the *pellucida* group was probably present throughout most of the Gulf Coastal Plain and lower portions of the Ohio, Missouri, and Teays river drainages. Differentiation appears to have taken place east (*A. pellucida*) and west (*A. vivax*) of the Mississippi River. The divergence of *A. pellucida* from *A. vivax* does not appear to be so great as that of *A. beani* from *A. clara*. This may be due to the more generalized condition of *A. pellucida* and *A. vivax* in relation to the more specialized *A. beani* and *A. clara*.

With the advance of glacial ice at the beginning of the Pleistocene, *A. vivax* and *A. pellucida* were probably forced southward, with the possible exception of isolated populations of *A. pellucida* that may have remained in the southernmost tributaries of the Ohio River. The distribution of *A. pellucida* east and *A. vivax* west of the Mississippi River probably continued until near the end of the Pleistocene. A recent invasion of *A. vivax* east of the Mississippi River is indicated by its apparent absence in the Homochitto, Buffalo, Amite, Tickfaw, and Tangipahoa river drainages in southwestern Mississippi and eastern Louisiana. *A. beani*, which occurs sympatrically with *A. vivax* in the Big Black, Pearl and Pascagoula river drainages, is present throughout southwestern Mississippi and eastern Louisiana. Thus it appears that *A. vivax* crossed the Mississippi River and spread eastward to the Mobile Basin near the close of the Pleistocene and possibly more recently. The invasion of *A. vivax* east of the Mississippi and the resulting competition were probably prime factors in the elimination of *A. pellucida* in eastern Gulf Coast tributaries.

Following the retreat of the Wisconsin ice sheet, *A. pellucida* dispersed throughout most of the Ohio Basin and eventually gained entrance into the Great Lakes drainage. Inasmuch as *A. pellucida* is absent from the upper Mississippi Valley and Lake Michigan drainages, dispersal through the Chicago and upper Mississippi river outlets is doubtful. The most likely route of dispersal was through the outlet of the glacial lake Maumee (Greene, 1935; Radforth, 1944). The successive lowering of the glacial lakes provided a route of dispersal for *A. pellucida* northeastward into the St. Lawrence River drainage. *A. pellucida* is not known to occur in the Lake Ontario drainage.

Literature Cited

Bailey, R. M. and W. A. Gosline. 1955. Variation and systematic significance of vertebral counts in the American fishes of the family Percidae. Misc. Pub. Mus. Zool. Univ. Mich. 93:1-44.

Bailey, R. M., H. E. Winn, and C. L. Smith. 1954. Fishes from the Escambia River, Alabama and Florida, with ecologic and taxonomic notes. Proc. Acad. Nat. Sci. Phila. 106:109-164.

Becker, G. C. 1965. The western sand darter, *Ammocrypta clara*, in the Great Lakes Basin. Copeia 1965(2):241.

Bollman, C. H. 1886. Notes on a collection of fishes from the Escambia River, with description of a new species of Zygonetes (*Zygonectes escambiae*). Proc. U.S. Nat. Mus. 9:462-465.

Briggs, J. C. 1958. A list of Florida fishes and their distribution. Bull. Fla. State Mus. 2(8):223-318.

Call, R. E. 1892. The fishes of the Des Moines Basin. Proc. Iowa Acad. Sci. 1(2):43-56.

Carr, A. and C. J. Goin. 1959. Guide to the reptiles, amphibians, and fresh-water fishes of Florida. Univ. Fla. Press, Gainesville, Fla. 341 pp.

Cleary, R. E. 1952. An annotated check-list of fishes of the Wapsipinicon River drainage system in Iowa. Proc. Iowa Acad. Sci. 59:435-441.

Collette, B. B. 1963. The subfamilies, tribes and genera of the Percidae (Teleostei). Copeia 1963(4):615-623.

Collette, B. B. 1965. Systematic significance of breeding tubercles in fishes of the family Percidae. Proc. U.S. Nat. Mus. 117:567-614.

Collette, B. B. and L. W. Knapp. 1967. Catalog of type specimens of the darters (Pisces, Percidae, Etheostomatini). Proc. U.S. Nat. Mus. 119:1-88.

Cook, F. A. 1959. Freshwater fishes in Mississippi. Miss. Game and Fish Comm., Jackson, Miss. 239 pp.

Cox, U. O. 1896. A report upon the fishes of southwestern Minnesota. Rept. U.S. Fish Comm. 20:605-616.

Cross, F. B. 1967. Handbook of fishes of Kansas. Univ. Kansas Mus. Nat. Hist. Misc. Pub. No. 45. 357 pp.

Eddy, S. and T. Surber. 1947. Northern fishes with special reference to the upper Mississippi Valley, 2nd ed. Charles T. Branford Co., Newton Center, Mass. 276 pp.

Evermann, B. W. and O. P. Jenkins. 1889. Notes on Indiana fishes. Proc. U.S. Nat. Mus. 11:43-57.

Evermann, B. W. and W. C. Kendall. 1900. Check-list of the fishes of Florida. Rept. U.S. Fish Comm. 25 (1899), 35-103.

Forbes, S. A. and R. E. Richardson. 1920. The fishes of Illinois, 2nd ed. Ill. Nat. Hist. Surv. 3:1-357.

Fowler, H. W. 1945. A study of the fishes of the southern Piedmont and Coastal Plain. Acad. Nat. Sci. Phila., Monogr. 7:1-408.

Gilbert, C. H. 1885. A list of fishes collected in the East Fork of White River, Indiana, with description of two new species. Proc. U.S. Nat. Mus. 7:199-205.

Gilbert, C. H. 1891. Report of explorations made in Alabama during 1889, with notes on the fishes of the Tennessee, Alabama and Escambia Rivers. Bull. U.S. Fish Comm. 9 (1889):143-159.

Goodrich, C. and H. van der Schalie. 1939. Aquatic mollusks of the upper peninsula of Michigan. Part II. The Naiades (freshwater mussels). Misc. Pub. Mus. Zool. Univ. Mich. 43:35-45.

Graham, I. D. 1885. Preliminary list of Kansas fishes. Trans. Kansas Acad. Sci., 9:69-78.

Greene, W. C. 1935. The distribution of Wisconsin fishes. State Wisc. Conser. Comm., Madison, Wisc. 235 pp.

Harlan, J. R. and E. B. Speaker. 1956. Iowa fish and fishing, 3rd ed. Iowa Conser. Comm., Ames, Iowa. 337 pp.

Hay, O. P. 1881. On a collection of fishes from eastern Mississippi. Proc. U.S. Nat. Mus. 3:488-515.

Hay, O. P. 1883. On a collection of fishes from the lower Mississippi Valley. Bull. U.S. Fish Comm. 2:57-75.

Hubbs, C. L. and M. D. Cannon. 1935. The darters of the genera *Hololepis* and *Villora*. Misc. Pub. Mus. Zool. Univ. Mich. 30:1-93.

Hubbs, C. L. and C. W. Greene. 1927. Further notes on the fishes of the Great Lakes and tributary waters. Pap. Mich. Acad. Sci. 8:371-392.

Hubbs, C. L. and K. F. Lagler. 1958. Fishes of the Great Lakes region. Cranbrook Inst. Sci. Bull. 26:1-213.

Hubbs, C. L. and B. W. Walker. 1942. Habitat and breeding behavior of the American cyprinid fish *Notropis longirostris*. Copeia 1942(2):101-104.

Hubbs, Clark. 1957. Distribution patterns of Texas freshwater fishes. Southwestern Naturalist 2(2-3):89-104.

Jenkins, Robert E., E. A. Lachner, and F. J. Schwartz. 1972. Fishes of the Central Appalachian drainages: Their distribution and dispersal. *In* The distributional history of the biota of the southern Appalachians, Part III: Vertebrates. Research Div. Monograph 4. Virginia Polytechnic Inst. and State Univ., Blacksburg, Va.:43-117.

Johnson, M. and G. C. Becker. 1970. Annotated list of the fishes of Wisconsin. Wisc. Acad. of Sci., Arts and Letters 58:265-300.

Jordan, D. S. 1877a. Contributions to North American ichthyology. No. 2A. Notes on Cottidae, Ethestomatidae, Percidae, Centrarchidae, Aphredoderidae, Dorsomatidae, Cyprinidae, Catostomidae and Hyodontidae, with revisions of the genera and descriptions of new or little known species. Bull. U.S. Nat. Mus. 10:5-19.

Jordan, D. S. 1877b. On the fishes of northern Indiana. Proc. Acad. Nat. Sci. Phila. 29:42-82.

Jordan, D. S. 1884. Descriptions of four new species of *Poecilichthys* in the United States National Museum. Proc. U.S. Nat. Mus. 7: 477-480.

Jordan, D. S. 1888. A manual of the vertebrate animals of the northern United States including the district north and east of the Ozark Mountains, south of the Laurentian Hills, north of the southern boundary of Virginia, and east of the Mississippi River inclusive of marine species, 5th ed. A. C. McClurg and Co., Chicago. 375 pp.

Jordan, D. S. and H. E. Copeland. 1877. The sand darter. Am. Nat. 11:86-88.

Jordan, D. S. and C. H. Eigenman. 1886. On skeletons of Etheostomatinae. Proc. U.S. Nat. Mus. 8:68-72.

Jordan, D. S. and B. W. Evermann. 1896. The fishes of North and Middle America: A descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama. Bull. U.S. Nat. Mus. 47(1). 1240 pp.

Jordan, D. S. and C. H. Gilbert. 1886. List of fishes collected in Arkansas, Indian Territory, and Texas, in September, 1884, with notes and descriptions. Proc. U.S. Nat. Mus. 9:1-26.

Jordan, D. S. and S. E. Meek. 1885. List of fishes collected in Iowa and Missouri in August, 1884, with descriptions of three new species. Proc. U.S. Nat. Mus. 8(1):1-17.

Kirsch, P. H. 1895. A report upon investigations in the Maumee River Basin during the summer of 1893. Bull. U.S. Fish Comm. 14:315-334.

Kuhne, E. R. 1939. A guide to the fishes of Tennessee and the Mid-South. Tenn. Dept. Conser., Nashville. 124 pp.

Lachner, E. A., E. F. Westlake, and P. S. Handwerk. 1950. Studies on the biology of some percid fishes from western Pennsylvania. Am. Midl. Nat. 43(1):92-111.

Laglosis, T. H. 1954. The west end of Lake Erie and its ecology. J. W. Edwards, Inc., Ann Arbor, Mich. 479 pp.

Larimore, W. R. and P. W. Smith. 1963. The fishes of Champaign County, Illinois, as affected by 60 years of stream change. Ill. Nat. Hist. Surv. Bull. 28(2):299-382.

Linder, A. D. 1953. Observations on the care and behavior of darters, Etheostomatinae, in the laboratory. Proc. Okla. Acad. Sci. 43:28-30.

Linder, A. D. 1959. The American percid fishes *Ammocrypta clara* Jordan and Meek and *Ammocrypta pellucida* (Baird). Southwestern Naturalist 4(4):176-184.

Macan, T. T. 1963. Freshwater ecology. John Wiley and Sons, Inc., New York. 338 pp.

Meek, S. E. 1889a. A list of fishes and mollusks collected in Arkansas and Indian Territory in 1894. Bull. U.S. Fish Comm. 15:341-349.

Meek, S. E. 1889a. A list of fishes and mollusks collected in Maumee Valley, Ohio. Proc. U.S. Nat. Mus. 11:435-440.

Meek, S. E. 1894. A catalogue of the fishes of Arkansas *in* Annual Report of the Geological Survey of Arkansas for 1891. Brown Publishing Co., Little Rock, Ark. 216-276.

Moore, G. A. 1968. Fishes. Pages 21-165 *in* W. F. Blair, et al. Vertebrates of the United States, 2nd ed. McGraw-Hill Book Co., New York.

Neave, S. A. 1939. Nomenclator zoologicus. Zool. Soc. of London 3:1-1065.

Nikolsky, G. V. 1963. The ecology of fishes. Academic Press, New York. 352 pp.

Odum, E. P. and H. T. Odum. 1959. Fundamentals of ecology, 2nd ed. W. B. Saunders and Co., Philadelphia. 546 pp.

Page, L. M. and G. S. Whitt. 1973a. Lactate dehydrogenase isozymes of darters and the inclusiveness of the genus *Percina*. Ill. Nat. Hist. Surv. Biol. Notes No. 82:1-7.

Page, L. M. and G. S. Whitt. 1973b. Lactate dehydrogenase isozymes, malate dehydrogenase isozymes and tetrazolium oxidase mobilities of darters. (Etheostomatini). Comp. Biochem. Physiol. 44B:611-623.

Pflieger, W. L. 1971. A distributional study of Missouri fishes. Univ. Kansas Mus. Nat. Hist. 20(3):225-570.

Priegel, G. R. 1963. Dispersal of the shortnose gar, *Lepisosteus platostomus,* into the Great Lakes drainage. Trans. Am. Fish. Soc. 92(2):178.

Putnam, F. W. 1863. List of the fishes sent by the museum to different institutions, in exchange for other specimens, with annotations. Bull. Mus. Comp. Zool. 1(1):2-16.

Radforth, I. 1944. Some considerations on the distributions of fishes in Ontario. Contrib. Royal Ontario Mus. Zool., No. 25: 1-116.

Schrenkeisen, R. 1938. Field book of fresh-water fishes of North America north of Mexico. G. P. Putnam's Sons, New York. 312 pp.

Schultz, L. P. and E. M. Stern. 1948. The ways of fishes. Van Nostrand Co., New York. 264 pp.

Shurrager, S. P. 1932. An ecological study of the fishes of the Hocking River, 1931-1932. Ohio State Univ. Bull. 37(6):377-409.

Smith, P. W. 1965. A preliminary annotated list of the lampreys and fishes of Illinois. Illinois Nat. Hist. Surv., Biol. Notes 54: 1-12.

Smith, P. W. 1968. An assessment of changes in the fish fauna of two Illinois rivers and its bearing on their future. Trans. Ill. State Acad. Sci. 61(1):31-45.

Smith-Vaniz, W. F. 1968. Freshwater fishes of Alabama. Paragon Press, Montgomery, Ala. 211 pp.

Snelson, Franklin F., Jr. 1972. Systematics of the subgenus *Lythrurus*, genus *Notropis* (Pisces:Cyprinidae). Florida State Mus. Bull. 17(1):1-92.

Starrett, W. C. 1950. Distribution of the fishes of Boone County, Iowa, with special reference to the minnows and darters. Am. Midl. Nat. 43(1):112-127.

Suttkus, R. D. and J. S. Ramsey. 1967. *Percina aurolineata*, a new percid fish from the Alabama River system and a discussion of ecology, distribution and hybridization of darters of the subgenus *Hadropterus*. Tulane Stud. Zool. 13(4):129-145.

Tarzwell, C. M. 1937. Experimental evidence on the value of trout stream improvement in Michigan. Trans. Am. Fish. Soc. 66:177-187.

Thompson, D. H. and F. D. Hunt. 1930. The fishes of Champaign County: A study of the distribution and abundance of fishes in small streams. Ill. Nat. Hist. Surv. Bull. 19(1):1-101.

Trautman, M. B. 1957. The fishes of Ohio. Ohio State Univ. Press, Columbus, Ohio. 683 pp.

Turner, C. L. 1922. Notes on the food habits of young *Cottus ictalops* (Millers thum). Ohio Jour. Sci. 22(3):95-96.

Vladykov, V. D. 1942. Two fresh-water fishes new for Quebec. Copeia 1942(3):193-194.

Winn, H. E. 1958a. Observations on the reproductive habits of darters (Pisces—Percidae). Am. Midl. Nat. 59(1):190-212.

Winn, H. E. 1958b. Comparative reproductive behavior and ecology of fourteen species of darters (Pisces—Percidae). Ecol. Monog. 28:155-191.

Woolman, A. J. 1892. Report of the examination of the rivers of Kentucky with lists of the fishes obtained. Bull. U.S. Fish Comm. 10:249-289.

Table 1. Comparison of Proportional Measurements of *Ammocrypta bifascia, A. beani,* and *A. clara* Expressed as Thousandths of Standard Length.

	Ammocrypta bifascia					*Ammocrypta beani*				*Ammocrypta clara*			
	Holotype TU 82652	MSU 351, UAIC 3056 UAIC 3195, UAIC 3646				MSU 3510, MSU 3547, UAIC 1062, UAIC 3612, UAIC 4417				ISC 184, ISC 837, MSU 3548, TAM IF-13-J-9, UAIC 2994, UM 19278, UO 36970			
		N=5 *Range* ♂	$\bar{X}$♂	*N=5* *Range* ♀	$\bar{X}$♀	*N=5* *Range* ♂	$\bar{X}$♂	*N=5* *Range* ♀	$\bar{X}$♀	*N=7* *Range* ♂	$\bar{X}$♂	*N=7* *Range* ♀	$\bar{X}$♀
Standard length	61.2	53.0-57.1	55.3	50.6-54.5	52.1	43.9-51.3	47.9	41.4-46.3	43.9	37.6-49.6	42.1	35.2-48.1	43.6
Snout tip-origin 1st D	387	371-387	379	383-399	391	381-394	387	379-396	387	253-366	360	351-375	365
Snout tip-origin 2nd D	642	631-652	640	639-657	646	647-694	667	621-647	638	627-643	636	622-647	633
Snout tip-origin anal fin	639	616-639	630	633-653	641	621-658	634	629-648	638	592-615	602	590-617	599
Snout tip-pelvic fin insertion	286	280-290	285	282-295	289	273-300	286	270-287	278	258-277	269	249-277	266
Snout tip-jct. gill membrane	150	142-155	148	144-163	154	141-161	148	138-154	149	133-149	142	135-146	141
Caudal peduncle length	223	217-224	220	213-220	216	214-241	227	205-237	221	238-255	247	244-268	257
Caudal peduncle depth	67	64-70	67	65-70	67	66-74	70	61-71	67	69-76	74	64-81	70
Body depth, 1st D origin	132	115-136	125	117-137	129	119-152	136	119-145	127	118-144	130	138-149	144
Body width	123	101-120	112	109-118	114	99-138	119	98-126	115	92-123	107	96-131	112
Longest dorsal spine	123	116-133	121	106-111	109	106-116	112	88-109	97	85-98	93	83-102	94
Longest dorsal ray	116	109-121	115	112-120	116	120-132	125	95-131	109	106-120	114	94-117	109
Caudal fin length	158	152-173	161	161-172	166	158-165	162	163-174	165	168-190	178	162-177	172
Anal spine length	65	53-70	58	42-51	48	55-76	61	42-48	45	56-82	69	57-67	64
Longest anal ray	139	122-142	132	123-135	128	132-148	144	121-139	130	147-183	163	123-157	139
Pectoral fin length	212	201-220	210	206-217	210	199-233	215	198-226	210	203-219	210	194-219	204
Pelvic fin length	162	156-160	158	147-157	153	155-179	168	153-163	160	162-182	172	148-184	162
Head length	252	244-256	250	252-262	257	245-269	258	237-270	252	239-256	245	227-249	238
Orbit length	60	55-62	59	56-67	63	58-65	62	63-73	67	56-67	62	58-65	60
Snout length	77	73-84	78	80-83	81	74-80	78	72-76	74	69-77	72	65-71	68
Upper jaw length	85	79-87	84	77-86	82	82-91	86	76-86	79	59-65	62	58-65	61
Bony interorbital	16	14-17	16	13-18	15	15-17	16	13-17	15	17-21	19	15-22	18
Dorsal hiatus	60	26-65	49	29-64	49	36-66	53	43-60	51	16-35	30	10-38	28

Table 2. Frequency Distribution of Dorsal Spines in *Ammocrypta bifascia* and *Ammocrypta beani*.

Drainage	7	8	9	10	11	12	N	$\overline{X}$	SD	SE
A. bifascia										
Choctawhatchee		3	36	33	4	2	78	9.56	.77	.09
Yellow		6	42	21	2		71	9.27	.65	.08
Blackwater		11	42	22	2		77	9.19	.71	.08
Escambia		1	38	18	1		58	9.33	.54	.07
Perdido	1	10	31	7			49	8.90	.65	.09
A. beani										
Alabama	1	10	38	9	1		59	8.98	.68	.09
Cahaba		12	30	9			51	8.94	.65	.09
Lower Tombigbee	1	5	24	3			33	8.88	.60	.10
Upper Tombigbee		9	24	10	4		47	9.19	.85	.12
Warrior		5	12	4			21	8.95	.67	.15
Pascagoula		5	41	47	2		95	9.48	.63	.06
Biloxi-Bay St. Louis		3	8	3	3		17	9.35	1.00	.24
Pearl		5	46	58	11	1	121	9.64	.74	.07
Lake Pontchartrain		1	25	27	5		58	9.62	.67	.09
Mississippi		2	24	21	3		50	9.50	.68	.10
Hatchie			7	6	13		26	10.23	.86	.17

Table 3. Frequency Distribution of Dorsal Rays in *Ammocrypta bifascia* and *Ammocrypta beani*.

Drainage	9	10	11	12	13	N	$\overline{X}$	SD	SE
A. bifascia									
Choctawhatchee		7	65	6		78	10.99	.41	.05
Yellow		10	53	8		71	10.97	.51	.06
Blackwater	1	11	52	13		77	11.00	.61	.07
Escambia		16	39	3		58	10.78	.53	.07
Perdido		1	39	9		49	11.16	.43	.06
A. beani									
Alabama		9	42	8		59	10.98	.54	.07
Cahaba		7	35	8	1	51	11.06	.61	.09
Lower Tombigbee	1	9	23			33	10.67	.54	.09
Upper Tombigbee		16	29	2		47	10.70	.55	.08
Warrior		5	14	2		21	10.86	.57	.13
Pascagoula	1	22	65	7		95	10.82	.56	.06
Biloxi-Bay St. Louis		2	13	2		17	11.00	.50	.12
Pearl		18	90	14		122	10.97	.51	.05
Lake Pontchartrain		10	42	6		58	10.93	.53	.07
Mississippi		4	43	3		50	10.98	.38	.05
Hatchie		1	21	4		26	11.12	.43	.08

Table 4. Frequency Distribution of Anal Rays in *Ammocrypta bifascia* and *Ammocrypta beani*.

Drainage	8	9	10	11	12	N	$\bar{X}$	SD	SE
A. bifascia									
Choctawhatchee	2	52	23	1		78	9.29	.54	.06
Yellow	1	36	32	1	1	71	9.51	.63	.07
Blackwater		47	29	3		77	9.43	.57	.07
Escambia	2	30	26			58	9.41	.56	.07
Perdido		25	21	3		49	9.55	.61	.09
A. beani									
Alabama		20	35	4		59	9.73	.58	.08
Cahaba		20	28	3		51	9.67	.59	.08
Lower Tombigbee	3	26	4			33	9.03	.47	.08
Upper Tombigbee	2	34	10	1		47	9.21	.55	.08
Warrior		15	6			21	9.29	.46	.10
Pascagoula	4	50	38	3		95	9.42	.63	.06
Biloxi-Bay St. Louis		11	6			17	9.35	.49	.12
Pearl	3	84	34	1		122	9.27	.51	.05
Lake Pontchartrain	1	30	24	3		58	9.50	.63	.08
Mississippi	4	33	13			50	9.18	.56	.08
Hatchie		10	16			26	9.62	.50	.10

Table 5. Frequency Distribution of Left Pectoral Rays in *Ammocrypta bifascia* and *Ammocrypta beani*.

Drainage	11	12	13	14	N	$\bar{X}$	SD	SE
A. bifascia								
Choctawhatchee		6	72		78	12.92	.27	.03
Yellow		4	63	4	71	13.00	.34	.04
Blackwater		6	58	13	77	13.09	.49	.06
Escambia		6	48	4	58	12.97	.42	.05
Perdido		1	45	3	49	13.04	.29	.04
A. beani								
Alabama		14	42	3	59	12.81	.51	.07
Cahaba	1	12	36	2	51	12.76	.55	.08
Lower Tombigbee		4	27	2	33	12.94	.43	.07
Upper Tombigbee	1	14	29	3	47	12.72	.62	.09
Warrior		4	16	1	21	12.86	.48	.10
Pascagoula		14	74	7	95	12.93	.47	.05
Biloxi-Bay St. Louis		1	11	5	17	13.24	.56	.14
Pearl		5	98	19	122	13.11	.43	.04
Lake Pontchartrain		15	41	2	58	12.78	.50	.07
Mississippi		3	39	8	50	13.10	.46	.07
Hatchie		1	20	5	26	13.15	.46	.09

Table 6. Frequency Distribution of Total Vertebrae in *Ammocrypta bifascia* and *Ammocrypta beani*.

Drainage	39	40	41	42	N	$\bar{X}$	SD	SE
A. bifascia								
Choctawhatchee	2	20	6		28	40.14	.52	.10
Yellow	1	15	6		22	40.23	.53	.11
Blackwater	1	12	6		19	40.26	.56	.13
Escambia	2	21	1		24	39.96	.36	.07
Perdido	1	15	8		24	40.29	.55	.11
A. beani								
Alabama	1	13	10		24	40.38	.58	.12
Cahaba		4	12	1	17	40.82	.53	.13
Lower Tombigbee		15	7		22	40.32	.48	.10
Upper Tombigbee		18	5	1	24	40.29	.55	.11
Warrior		3	3		6	40.50	.55	.22
Pascagoula	5	23	5		33	40.00	.56	.10
Pearl	6	16	7		29	40.03	.68	.13
Lake Pontchartrain	2	25	7		34	40.15	.50	.09
Mississippi	2	30	10		42	40.19	.51	.08

Table 7. Frequency Distribution of Lateral Line Scales in *Ammocrypta bifascia* and *Ammocrypta beani*.

Drainage	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	N	$\bar{X}$	SD	SE
A. bifascia																										
Choctawhatchee							1	1	2	5	5	10	8	8	10	10	7	4	3	2	1	1	78	70.28	3.17	.36
Yellow								1	3	4	6	8	6	8	7	10	8	6	2	1	1		71	70.30	2.95	.35
Blackwater							2	4	4	8	5	9	8	6	9	7	6	5	3	1			77	69.36	3.26	.37
Escambia							1	2	2	3	5	5	10	9	6	8	5	4		1			61	69.72	2.81	.36
Perdido							1	2	1	3	3	4	7	5	6	5	8	2	1	1			49	69.98	2.95	.42
A. beani																										
Alabama					2		2	1	3	3	6	7	10	8	6	7	2	1	1				59	68.78	2.98	.39
Cahaba							1	2	1	1	1	4	5	6	8	8	5	3	3	2	1		51	70.80	3.12	.44
Lower Tombigbee				1	2	3	2	2	2	2	3	3	3	4	3	1	1	1					33	66.91	3.81	.66
Upper Tombigbee				1	1	2	3	3	4	5	4	4	5	7	4	1	1	1					46	67.26	3.30	.49
Warrior											1	2	2	2	3	2	4	3	2				21	71.52	2.40	.52
Pascagoula	1	2	4	5	3	5	8	10	15	15	13	6	6	2	2	1							98	64.88	3.13	.32
Biloxi-Bay St. Louis		1		2	1	1	3	2	3	2		1	1										17	63.65	2.89	.70
Pearl	1	2	1	6	6	9	15	15	15	10	12	11	6	7	4	2							122	65.08	3.24	.29
Lake Pontchartrain		1	3	2	3	5	6	7	10	6	6	3	4	2									58	64.52	2.93	.38
Mississippi			1	2	1	1	2	4	6	9	5	9	3	4	2			1					50	66.36	3.00	.42
Hatchie			2	2	3	3	3	3	6	2	2												26	63.23	2.37	.47

Table 8. Frequency Distribution of Scales Above the Lateral Line in *Ammocrypta bifascia* and *Ammocrypta beani.*

Drainage	0	1	2	3	N	$\bar{X}$	SD	SE
A. bifascia								
Choctawhatchee	1	76	1		78	1.00	.16	.02
Yellow	2	69			71	.97	.17	.02
Blackwater	5	70	2		77	.96	.30	.03
Escambia	11	51	1		63	.84	.41	.05
Perdido	20	30			50	.60	.49	.07
A. beani								
Alabama	35	15	8	1	59	.58	.79	.10
Cahaba	38	13			51	.25	.44	.06
Lower Tombigbee	23	10			33	.30	.47	.08
Upper Tombigbee	24	23			47	.49	.51	.07
Warrior	5	16			21	.76	.44	.09
Pascagoula	22	75			97	.77	.42	.04
Biloxi-Bay St. Louis	5	12			17	.71	.47	.11
Pearl	15	107			122	.88	.33	.03
Lake Pontchartrain	8	50			58	.86	.35	.04
Mississippi	2	48			50	.96	.20	.03
Hatchie	15	11			26	.42	.50	.10

Table 9. Frequency Distribution of Scales Below the Lateral Line in *Ammocrypta bifascia* and *Ammocrypta beani.*

Drainage	0	1	2	3	N	$\bar{X}$	SD	SE
A. bifascia								
Choctawhatchee	1	54	22	1	78	1.29	.51	.06
Yellow	3	58	10		71	1.10	.42	.05
Blackwater		72	5		77	1.06	.25	.03
Escambia	7	54	2		63	.92	.37	.05
Perdido	5	45			50	.90	.30	.04
A. beani								
Alabama	19	31			50	.62	.49	.07
Cahaba	10	41			51	.80	.40	.06
Lower Tombigbee	3	30			33	.91	.29	.05
Upper Tombigbee	7	39	1		47	.87	.40	.06
Warrior	2	19			21	.90	.30	.07
Pascagoula	5	92			97	.95	.22	.02
Biloxi-Bay St. Louis	1	16			17	.94	.24	.06
Pearl	4	118			122	.97	.18	.01
Lake Pontchartrain		56	2		58	1.03	.18	.02
Mississippi	2	37	10	1	50	1.20	.53	.08
Hatchie	3	23			26	.88	.33	.06

Table 10. Frequency Distribution of Transverse Scale Rows in *Ammocrypta bifascia* and *Ammocrypta beani.*

Drainage	1	2	3	4	5	6	7	N	$\overline{X}$	SD	SE
A. bifascia											
Choctawhatchee			7	18	18	7	1	51	4.55	.97	.14
Yellow			18	27	8	1		54	3.85	.74	.10
Blackwater			42	29	5			76	3.51	.62	.07
Escambia			21	17	5			43	3.63	.69	.11
Perdido			31	15	2			48	3.40	.57	.08
A. beani											
Alabama	8	8	34					50	2.52	.76	.11
Cahaba	2	2	47					51	2.88	.43	.06
Lower Tombigbee		2	31					33	2.94	.24	.04
Upper Tombigbee	1	1	39	1				42	2.95	.38	.06
Warrior		1	16	4				21	3.14	.48	.10
Pascagoula			41	5	1			47	3.15	.42	.06
Biloxi-Bay St. Louis		1	15	1				17	3.00	.35	.09
Pearl			38	22	9	2		71	3.65	.81	.10
Lake Pontchartrain		1	36	16	5			58	3.43	.68	.09
Mississippi		1	20	21	6	2		50	3.76	.85	.12
Hatchie		1	23	2				26	3.04	.34	.07

Table 11. Frequency Distribution of Dorsal Spines in *Ammocrypta clara.*

Drainage	9	10	11	12	13	N	$\overline{X}$	SD	SE
Sabine-Neches	1	14	38	1		54	10.72	.53	.07
Red		4	14	6		24	11.08	.65	.13
Ouachita		1	4	1		6	11.00	.63	.26
Big Black	1	2				3	9.67	.58	.33
White		13	22	15	1	51	11.08	.80	.11
St. Francis		9	11	2		22	10.68	.65	.14
Ohio			7	2		9	11.22	.44	.15
Mississippi (Mo.-Ill.)	1	15	31	6	1	54	10.83	.72	.10
Illinois & Kaskaskia		10	26	8		44	10.95	.65	.10
Salt		3	12	2		17	10.94	.56	.13
Des Moines	1	12	21	8		42	10.86	.75	.12
Iowa			2			2	11.00	.00	.00
Rock		1	2			3	10.67	.58	.33
Wisconsin		17	29	8		54	10.38	.67	.09
Black		10	17	2		29	10.72	.59	.11
Mississippi (Minn.-Wisc.)		3	16	4	1	24	11.13	.68	.14
St. Croix	3	19	10			32	10.22	.61	.11
Waupaca		2	14	11	1	28	11.39	.69	.13

Table 12. Frequency Distribution of Dorsal Rays in *Ammocrypta clara*.

Drainage	9	10	11	12	13	N	$\bar{X}$	SD	SE
Sabine-Neches	4	32	18			54	10.26	.59	.08
Red		12	10	2		24	10.58	.65	.13
Ouachita			6			6	11.00	.00	.00
Big Black		2	1			3	10.33	.58	.33
White		7	37	6	1	51	11.02	.58	.08
St. Francis		1	13	8		22	11.32	.57	.12
Ohio			7	2		9	11.22	.44	.15
Mississippi (Mo.-Ill.)		6	36	11	1	54	11.13	.62	.08
Illinois-Kaskaskia		5	32	7		44	11.05	.53	.08
Salt		4	11	2		17	10.88	.60	.15
Des Moines		8	27	7		42	10.98	.60	.09
Iowa		1		1		2	11.00	1.41	1.00
Rock			2	1		3	11.33	.58	.33
Wisconsin		4	35	13	2	54	11.24	.64	.09
Black		3	19	7		29	11.14	.58	.11
Mississippi (Minn.-Wisc.)		4	18	2		24	10.92	.50	.10
St. Croix		11	18	3		32	10.75	.62	.11
Waupaca		3	19	6		28	11.11	.57	.11

Table 13. Frequency Distribution of Anal Rays in *Ammocrypta clara*.

Drainage	7	8	9	10	N	$\bar{X}$	SD	SE
Sabine-Neches		14	38	2	54	8.78	.50	.07
Red		8	14	2	24	8.75	.61	.12
Ouachita			5	1	6	9.17	.41	.17
Big Black		1	1	1	3	9.00	1.00	.58
White	1	14	34	1	50	8.70	.54	.08
St. Francis		1	16	5	22	9.18	.50	.11
Ohio			6	3	9	9.33	.50	.17
Mississippi (Mo.-Ill.)		2	32	20	54	9.33	.55	.07
Illinois-Kaskaskia		3	27	14	44	9.25	.58	.09
Salt		3	13	1	17	8.88	.49	.12
Des Moines		3	28	11	42	9.19	.55	.09
Iowa			2		2	9.00	.00	.00
Rock			2	1	3	9.33	.58	.33
Wisconsin		4	35	15	54	9.20	.56	.08
Black			18	11	29	9.38	.49	.09
Mississippi (Minn.-Wisc.)		1	18	5	24	9.17	.48	.10
St. Croix		2	17	13	32	9.34	.60	.11
Waupaca			14	14	28	9.50	.51	.10

Table 14. Frequency Distribution of Left Pectoral Rays in *Ammocrypta clara*.

Drainage	12	13	14	15	N	$\bar{X}$	SD	SE
Sabine-Neches	1	28	25		54	13.44	.54	.07
Red		10	14		24	13.58	.50	.10
Ouachita		6			6	13.00	.00	.00
Big Black		2	1		3	13.33	.58	.33
White		23	28		51	13.55	.50	.07
St. Francis	1	7	14		22	13.59	.59	.13
Ohio		7	2		9	13.22	.44	.15
Mississippi (Mo.-Ill.)	2	27	25		54	13.43	.57	.08
Illinois-Kaskaskia	1	19	23	1	44	13.55	.59	.09
Salt		12	4	1	17	13.35	.61	.15
Des Moines	1	15	25	1	42	13.62	.58	.09
Iowa		1	1		2	13.50	.71	.50
Rock		1	2		3	13.67	.58	.33
Wisconsin	2	22	29	1	54	13.54	.61	.08
Black		13	16		29	13.55	.51	.09
Mississippi (Minn.-Wisc.)	1	6	16	1	24	13.71	.62	.13
St. Croix	1	13	18		32	13.53	.57	.10
Waupaca	1	13	12	2	28	13.54	.69	.13

Table 15. Frequency Distribution of Total Vertebrae in *Ammocrypta clara*.

Drainage	38	39	40	41	42	N	$\overline{X}$	SD	SE
Sabine-Neches	2	34	3	1		40	39.08	.47	.07
Red		13	7	1		21	39.43	.60	.13
White		11	20	1		32	39.69	.53	.09
St. Francis		6	6			12	39.50	.52	.15
Mississippi (Mo.-Ill.)		3	5			8	39.63	.52	.18
Illinois-Kaskaskia	1	9	10	1		21	39.52	.68	.15
Des Moines	1	10	10			21	39.43	.60	.13
Wisconsin		2	7			9	39.78	.44	.15
St. Croix		1	12	2	1	16	40.19	.66	.16
Waupaca		6	12	1		19	39.74	.56	.13

Table 16. Frequency Distribution of Lateral Line Scales in *Ammocrypta clara*.

Drainage	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	N	$\bar{X}$	SD	SE
Sabine-Neches	1	2	3	3	7	7	7	8	7	5	2	1								53	68.85	2.53	.35
Red					1	1	1	2	2	3	3	4	4	1	2					24	72.79	2.69	.55
Ouachita						1	2	2	1											6	69.50	1.05	.43
Big Black								1			1			1						3	73.00	3.00	1.73
White						2	3	2	6	4	10	8	7	5	2	2				51	73.22	2.47	.35
St. Francis		1	1				2	3	1	4	2	5	1	1	1					22	71.82	3.20	.68
Ohio									1			1	1	1	2		1	1	1	9	76.67	3.12	1.04
Mississippi (Mo.-Ill.)						2	4	1	6	11	10	8	6	2	1	3				54	72.87	2.37	.32
Illinois-Kaskaskia					1	2	3	3	5	8	7	8	4	2	1					44	72.34	2.30	.35
Salt					1	1	1	2	2	4	2	2	2							17	71.65	2.32	.56
Des Moines						1	1	2	6	8	6	6	5	5	1			1		42	73.17	2.35	.36
Iowa													1			1				2	76.50	2.12	1.50
Rock												2	1							3	74.33	.58	.33
Wisconsin						3	4	8	10	8	4	5	3	5	3		1			54	72.28	2.67	.36
Black							1	1	2	3	3	4	7	4	1	1	1	1		29	74.31	2.54	.47
Mississippi (Minn.-Wisc.)				1			2	1	2	2	2	6	6	1	1					24	73.04	2.60	.53
St. Croix						1	2	3	2	4	6	6	4	2	1	1				32	72.97	2.39	.42
Waupaca							1	1	2	2	2	4	3	4	3	2	2	1		27	74.85	2.86	.55

Table 17. Frequency Distribution of Scale Rows Above the Lateral Line in *Ammocrypta clara*.

Drainage	0	1	2	N	$\bar{X}$	SD	SE
Sabine-Neches		52		52	1.00	.00	.00
Red		24		24	1.00	.00	.00
Ouachita		6		6	1.00	.00	.00
Big Black		3		3	1.00	.00	.00
White	8	43		51	.84	.37	.05
St. Francis	2	16	4	22	1.09	.53	.11
Ohio	3	6		9	.67	.50	.17
Mississippi (Mo.-Ill.)		54		54	1.00	.00	.00
Illinois-Kaskaskia	2	42		44	.95	.21	.03
Salt	2	15		17	.88	.33	.08
Des Moines	7	30		37	.81	.40	.06
Iowa		2		2	1.00	.00	.00
Rock	1	2		3	.67	.58	.33
Wisconsin	2	51	1	54	.98	.24	.03
Black	10	19		29	.66	.48	.09
Mississippi (Minn.-Wisc.)	2	22		24	.92	.28	.06
St. Croix	2	30		32	.94	.25	.04
Waupaca	9	18	1	28	.71	.53	.10

Table 18. Frequency Distribution of Scale Rows Below the Lateral Line in *Ammocrypta clara*.

Drainage	1	2	3	4	5	N	$\bar{X}$	SD	SE
Sabine-Neches	5	28	20	1		54	2.31	.67	.09
Red		15	9			24	2.38	.49	.10
Ouachita	1	5				6	1.83	.41	.17
Big Black	2	1				3	1.33	.58	.33
White	15	35	1			51	1.73	.49	.07
St. Francis	1	12	8	1		22	2.41	.67	.14
Ohio	4	5				9	1.56	.53	.18
Mississippi (Mo.-Ill.)	10	26	17			53	2.13	.71	.10
Illinois-Kaskaskia	6	20	15	2		43	2.30	.77	.12
Salt	1	7	8	1		17	2.53	.72	.17
Des Moines	9	25	3			37	1.84	.55	.09
Iowa		2				2	2.00	.00	.00
Rock		3				3	2.00	.00	.00
Wisconsin	9	28	14	2	1	54	2.22	.85	.11
Black	13	15	1			29	1.59	.57	.11
Mississippi (Mo.-Ill.)	10	13	1			24	1.63	.58	.12
St. Croix	4	22	6			32	2.06	.56	.10
Waupaca	12	12	4			28	1.71	.71	.13

Table 19. Frequency Distribution of Transverse Scale Rows in *Ammocrypta clara*.

Drainage	3	4	5	6	7	8	9	10	11	12	N	$\bar{X}$	SD	SD
Sabine-Neches			6	22	16	7	2				53	6.57	.99	.14
Red			2	8	6	6	2				24	6.92	1.14	.23
Ouachita			5	1							6	5.17	.41	.17
Big Black			3								3	5.00	.00	.00
White	3	14	20	13	1						51	4.90	.92	.13
St. Francis		3	3	7	2	3	2		1	1	22	6.73	2.14	.46
Ohio	1	6	2								9	4.11	.60	.20
Mississippi (Mo.-Ill.)	3	7	16	19	6	2	1				54	5.52	1.24	.17
Illinois-Kaskaskia	1	3	13	14	6	4	2				43	5.95	1.33	.20
Salt		2	1	8	4	2					17	6.18	1.13	.27
Des Moines	2	10	11	8	2						33	4.94	1.03	.18
Iowa			2								2	5.00	.00	.00
Rock			1	2							3	5.67	.58	.33
Wisconsin	1	10	11	15	3	1	2		1		44	5.59	1.54	.23
Black	7	14	6	2							29	4.10	.86	.16
Mississippi (Minn.-Wisc.)	2	9	6	5	2						24	4.83	1.13	.23
St. Croix	1	7	11	11	2						32	5.19	.97	.17
Waupaca	4	10	7	6	1						28	4.64	1.10	.21

Table 20. Comparison of Proportional Measurements of *Ammocrypta meridiana, A. pellucida,* and *A. vivax* Expressed as Thousandths of Standard Length.

	Ammocrypta meridiana					*Ammocrypta pellucida*				*Ammocrypta vivax*			
	Holotype USNM 213494	AU 5633, USNM 213495 UAIC 2653, UAIC 539				OSU 14015, UL 11744, UL 10542				UAIC 3945, TAM 1-F-13-J-8 UAIC 4735, UAIC 2994, MSU 800, UAIC 2072			
		N=5 Range ♂	X̄ ♂	*N=5* Range ♀	X̄ ♀	*N=5* Range ♂	X̄ ♂	*N=5* Range ♀	X̄ ♀	*N=6* Range ♂	X̄ ♂	*N=6* Range ♀	X̄ ♀
Standard length	50.80	45.5-51.0	48.5	48.9-50.7	49.8	46.8-50.2	47.7	44.9-52.4	47.9	52.7-57.2	55.7	47.9-54.5	50.4
Snout tip-origin 1st dorsal	365	350-371	362	352-372	363	369-391	378	368-392	381	345-353	349	344-360	354
Snout tip-origin 2nd dorsal	630	623-642	634	633-646	642	631-655	644	632-659	649	629-639	634	632-649	642
Snout tip-origin anal fin	638	623-640	631	629-651	640	618-638	634	638-657	645	634-648	640	637-653	645
Snout tip-pelvic fin insertion	251	249-270	256	246-260	253	259-274	267	253-272	260	260-275	264	256-274	265
Snout tip-jct. gill membrane	132	132-141	136	129-134	132	143-149	147	132-143	139	129-141	133	128-143	136
Caudal peduncle length	247	246-262	253	222-247	236	234-252	242	233-248	239	236-241	222	218-235	226
Caudal peduncle depth	69	68-74	71	66-82	75	62-67	65	63-67	65	68-79	75	66-76	73
Body depth, 1st dorsal origin	128	115-135	123	126-136	130	99-125	116	122-149	135	119-139	131	112-130	122
Body width	114	102-116	109	104-114	109	93-115	107	91-126	112	98-117	108	96-111	103
Longest dorsal spine	95	88-97	94	87-99	93	88-92	90	83-91	86	90-108	98	82-103	92
Longest dorsal ray	110	98-111	106	104-111	107	107-120	113	106-111	109	114-127	120	105-118	112
Caudal fin length	165	151-166	160	155-168	160	153-165	159	151-165	160	159-173	165	154-167	161
Anal spine length	51	41-53	48	36-46	41	50-56	52	40-54	46	49-61	54	38-48	44
Longest anal ray	130	128-138	132	123-143	137	123-130	127	116-129	121	138-151	143	130-141	135
Pectoral fin length	213	201-213	205	194-221	209	202-214	207	200-223	208	210-226	219	201-223	214
Pelvic fin length	180	163-182	173	168-185	174	172-180	176	171-180	174	177-191	184	173-184	179
Head length	226	206-229	222	215-232	225	218-235	224	216-227	221	222-240	233	223-241	234
Orbit length	57	51-58	54	50-58	55	55-62	59	55-59	57	52-60	56	57-61	59
Snout length	62	61-67	63	61-66	64	67-72	69	60-72	65	63-70	66	63-69	66
Upper jaw length	63	62-68	65	61-67	64	60-68	63	57-65	61	66-76	71	63-67	65
Bony interorbital	15	13-17	15	15-16	16	15-17	16	15-18	16	16-19	17	14-16	15
Dorsal hiatus	44	40-61	47	41-72	51	31-71	51	45-82	61	21-46	30	21-45	31

Table 21. Frequency Distribution of Dorsal Spines in *Ammocrypta meridiana* and *Ammocrypta pellicuda.*

Drainage	7	8	9	10	11	12	13	N	$\bar{X}$	SD	SE
A. meridiana											
Alabama			8	26	44	5	1	84	10.58	.79	.09
Tombigbee	3	10	34	39	16	4		106	9.63	1.06	.10
A. pellucida											
Cumberland			1					1	9.00	.00	.00
Wabash	1	11	23	75	10			120	9.68	.79	.07
Green			5	17	2			24	9.88	.54	.11
Rolling Fork				4	1			5	10.20	.45	.20
Kentucky		1	13	16	6			36	9.75	.77	.13
Miami			1	12	1			14	10.00	.39	.10
Licking			1	19	9	5		34	10.53	.79	.14
Scioto			17	35	18	1		71	10.04	.75	.09
Ohio Proper			7	18	4	1		30	9.97	.72	.13
Sandy-Kanawha		2	6	17	4			29	9.79	.77	.14
Hocking				8	26	1		35	10.80	.47	.08
Muskingum			6	24	32	4		66	10.52	.75	.09
Upper Ohio			1	5	4			10	10.30	.67	.21
S Lake Huron		1	10	18	3			32	9.72	.68	.12
Lake St. Clair			7	22	14			43	10.16	.69	.10
N Lake Erie		1	3	11	6	2		23	10.22	.95	.20
W Lake Erie			3	25	16	2		46	10.37	.68	.10
Maumee		1	10	24	5			40	9.82	.68	.11
Lake Erie			1	12	9	2		24	10.50	.72	.15
SW Lake Erie		1	11	50	28	3		93	10.23	.74	.08
SE Lake Erie			11	5	1			17	9.41	.62	.15
St. Lawrence			9	15	5			29	9.86	.69	.13

Table 22. Frequency Distribution of Dorsal Rays in *Ammocrypta meridiana* and *Ammocrypta pellucida.*

Drainage	8	9	10	11	12	N	$\bar{X}$	SD	SE
A. meridiana									
Alabama		10	61	13		84	10.58	.79	.09
Tombigbee		23	70	13		106	9.91	.58	.06
A. pellucida									
Cumberland			1			1	10.00	.00	.00
Wabash		7	87	26		120	10.16	.50	.05
Green		1	7	14	2	24	10.71	.69	.14
Rolling Fork			3	2		5	10.40	.55	.24
Kentucky		8	26	2		36	9.83	.51	.08
Miami			11	3		14	10.21	.43	.11
Licking		3	30	1		34	9.94	.34	.06
Scioto	1	9	47	15		72	10.06	.63	.07
Ohio Proper		3	20	7		30	10.13	.57	.10
Sandy-Kanawha		14	12	3		29	9.62	.68	.13
Hocking		3	19	12	1	35	10.31	.68	.11
Muskingum		5	46	15		66	10.15	.53	.07
Upper Ohio			3	8		11	10.73	.47	.14
S Lake Huron		5	16	11		32	10.19	.69	.12
Lake St. Clair		2	32	9		43	10.16	.48	.07
N Lake Erie		1	16	6		23	10.22	.52	.11
W Lake Erie			23	23		46	10.50	.51	.07
Maumee		6	28	6		40	10.00	.55	.09
Lake Erie		1	16	7		24	10.25	.53	.11
SW Lake Erie		1	49	41	2	93	10.47	.56	.06
SE Lake Erie			8	8	1	17	10.59	.62	.15
St. Lawrence			19	10		29	10.34	.48	.09

Table 23. Frequency Distribution of Anal Rays in *Ammocrypta meridiana* and *Ammocrypta pellucida*.

Drainage	7	8	9	10	11	N	$\overline{X}$	SD	SE
A. meridiana									
Alabama		13	65	6		84	8.92	.47	.05
Tombigbee	1	13	70	22		106	9.07	.61	.06
A. pellucida									
Cumberland		1				1	8.00	.00	.00
Wabash		29	87	4		120	8.79	.48	.04
Green		3	12	8	1	24	9.29	.75	.15
Rolling Fork		1	4			5	8.80	.45	.20
Kentucky		13	23			36	8.64	.49	.08
Miami		4	10			14	8.71	.47	.13
Licking		19	15			34	8.44	.50	.09
Scioto		24	48			72	8.67	.47	.06
Ohio Proper		4	23	3		30	8.97	.49	.09
Sandy-Kanawha		9	19	1		29	8.72	.53	.10
Hocking		9	23	3		35	8.83	.57	.10
Muskingum	1	20	44	1		66	8.68	.53	.07
Upper Ohio		2	10	1		13	8.92	.49	.14
S Lake Huron		11	19	2		32	8.72	.58	.10
Lake St. Clair		11	32			43	8.74	.44	.07
N Lake Erie		11	11	1		23	8.57	.59	.12
W Lake Erie		8	34	4		46	8.91	.51	.08
Maumee	1	10	29			40	8.70	.52	.08
Lake Erie		13	11			24	8.46	.51	.10
SW Lake Erie		15	74	4		93	8.88	.44	.05
SE Lake Erie	1	1	11	4		17	9.06	.75	.18
St. Lawrence		8	18	3		29	8.83	.60	.11

Table 24. Frequency Distribution of Left Pectoral Rays in *Ammocrypta meridiana* and *Ammocrypta pellucida*.

Drainage	12	13	14	15	16	N	$\overline{X}$	SD	SE
A. meridiana									
Alabama		5	65	14		84	14.11	.47	.05
Tombigbee	1	11	83	11		106	13.98	.50	.05
A. pellucida									
Cumberland			1			1	14.00	.00	.00
Wabash		8	65	40	2	115	14.31	.63	.06
Green			6	15	3	24	14.88	.61	.13
Rolling Fork			1	3	1	5	15.00	.71	.32
Kentucky		1	16	19		36	14.50	.56	.09
Miami			7	7		14	14.50	.52	.14
Licking			10	22	2	34	14.76	.55	.09
Scioto			39	32	1	72	14.47	.53	.06
Ohio Proper			15	14	1	30	14.53	.57	.10
Sandy-Kanawha			19	10		29	14.34	.48	.09
Hocking		1	21	13		35	14.34	.54	.09
Muskingum		1	44	21		66	14.30	.50	.06
Upper Ohio		1	7	4		12	14.25	.62	.18
S Lake Huron		3	22	7		32	14.13	.55	.10
Lake St. Clair		3	20	18	2	43	14.44	.70	.10
N Lake Erie		2	10	11		23	14.39	.66	.14
W Lake Erie		3	28	14	1	46	14.28	.62	.09
Maumee		1	25	13		39	14.31	.52	.08
Lake Erie	1	3	12	7		23	14.09	.79	.17
SW Lake Erie		2	44	42	4	92	14.52	.62	.06
SE Lake Erie		1	7	6	3	17	14.65	.86	.21
St. Lawrence			14	12	3	29	14.62	.68	.13

Table 25. Frequency Distribution of Total Vertebrae in *Ammocrypta meridiana* and *Ammocrypta pellucida*.

Drainage	41	42	43	44	45	N	$\bar{X}$	SD	SE
A. meridiana									
Alabama	11	24	3			38	41.79	.58	.09
Tombigbee	5	21	4			30	41.97	.56	.10
A. pellucida									
Wabash		5	15	9		29	43.14	.69	.13
Green		1	4		1	6	43.17	.98	.40
Kentucky		15	13	3		31	42.61	.67	.12
Miami			5	7	1	13	43.69	.63	.17
Scioto		1	17	4		22	43.14	.47	.10
Ohio Proper		2	15	5		22	43.14	.56	.12
Sandy-Kanawha			12	4		16	43.25	.45	.11
Hocking			7	16	3	26	43.85	.61	.12
Muskingum		1	20	15		36	43.39	.55	.09
Upper Ohio			1	10	1	12	44.00	.43	.12
Maumee		1	23	9		33	43.24	.50	.09
Lake Erie		3	8		2	13	43.08	.95	.26
SW Lake Erie		4	11	2		17	42.88	.60	.15

Table 26. Frequency Distribution of Lateral Line Scales in *Ammocrypta meridiana* and *Ammocrypta pellucida*.

Drainage	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	N	$\bar{X}$	SD	SE
A. meridiana																										
Alabama	1	3	4	7	9	9	11	10	8	8	6	5	2										83	69.31	2.88	.32
Tombigbee	1	3	4	5	5	12	15	13	12	12	7	9	5	1	1		1						106	70.20	3.08	.30
A. pellucida																										
Cumberland											1												1	73.00	.00	.00
Wabash				1		2	4	6	7	11	17	19	21	9	10	6	3	2		1	1		120	74.11	2.88	.26
Green								3	1	1	2	3	3	2	2	3	2	1					23	74.96	3.05	.64
Rolling Fork				1	2			1	1														5	68.20	2.17	.97
Kentucky						2	3	1	3	3	6	7	3	2	2	3		1					36	73.42	2.97	.50
Maimi						1	1	1	2	2	2	1	2	1	1								14	72.57	2.65	.71
Licking						1	4	3	3	3	4	5	3	4	2	1	1						34	73.09	2.90	.50
Scioto					1	1	1	5	6	7	13	9	7	2	7	4	3	1	4			1	72	74.33	3.41	.40
Ohio Proper					1	1	3	4	4	3	3	5	3	1	2								30	72.20	2.64	.48
Sandy-Kanawha			1	1	2	4	2	4	3	4	3	2	2	1									29	70.55	3.11	.58
Hocking					2	3	3	3	4	6	5	3	3	2	1								35	71.77	2.66	.45
Muskingum							3	4	5	12	11	9	7	6	3	2	2	1	1				66	73.67	2.66	.33
Upper Ohio							1		1	1	2	3	1	2		1							12	73.75	2.42	.70
S Lake Huron			1	1	1	3	5	6	2	6	5	2											32	70.44	2.30	.41
Lake St. Clair			2	3	2	3	5	8	4	5	2	5	1	2		1							43	70.60	3.09	.47
N Lake Erie							2	3	2	2	4	4	4	1		1							23	72.87	2.36	.49
W Lake Erie								1	2	5	6	8	4	6	6	5	1	1	1				46	75.00	2.52	.37
Maumee			1	1	1	5	5	3	2	5	6	3	2	3	1	1							39	71.49	3.18	.51
Lake Erie				2	1	2	2	4	3	9	2	2	3	1									31	71.26	2.59	.47
SW Lake Erie					2	5	8	12	10	19	13	11	5	4	1	2	1						93	72.02	2.49	.26
SE Lake Erie							2	2	1	3	2	1	2	3	1								17	72.94	2.61	.63
St. Lawrence							1		1	2	5	5	5	5	3	2							29	74.52	2.10	.39

Table 27. Frequency Distribution of Scale Rows Above the Lateral Line in *Ammocrypta meridiana* and *Ammocrypta pellucida.*

Drainage	0	1	2	3	4	5	6	7	N	$\overline{X}$	SD	SE
A. meridiana												
Alabama			4	10	35	20	7		76	4.21	.97	.11
Tombigbee			1	11	40	43	5	1	101	4.43	.83	.08
A. pellucida												
Cumberland		1							1	1.00	.00	.00
Wabash		3	10	25	41	30	4	1	114	3.89	1.16	.11
Green			3	5	9	2			19	3.53	.90	.21
Rolling Fork				2	3				5	3.60	.55	.24
Kentucky	5	11	10	6	1				33	1.61	1.06	.18
Miami	1	2	6	5					14	2.07	.92	.25
Licking	1	12	10	7	3				33	1.97	1.05	.18
Scioto		5	2	10	14	6	2		39	3.51	1.34	.21
Ohio Proper		6	10	12	2				30	2.33	.88	.16
Sandy-Kanakha		19	5	4					28	1.46	.74	.14
Hocking		5	11	11	7	1			35	2.66	1.06	.18
Muskingum		2	1	11	30	20	2		66	4.08	.97	.12
Upper Ohio		5	3	1					9	1.56	.73	.24
S Lake Huron		7	12	8	2	3			32	2.44	1.19	.19
Lake St. Clair		14	13	11	4	1			43	2.19	1.07	.16
N Lake Erie	3	7	8	3	1	1			23	1.78	1.24	.26
W Lake Erie	2	10	10	15	6	2	1		46	2.50	1.33	.20
Maumee	1		4	14	13	8			40	3.55	1.08	.17
Lake Erie	5	14	7	2	3				31	1.48	1.15	.21
SW Lake Erie	10	12	10	16	22	17	6		93	3.11	1.78	.18
SE Lake Erie		3	9	2	3				17	2.29	.99	.24
St. Lawrence	1	6	10	7	5				29	2.31	1.11	.21

Table 28. Frequency Distribution of Scale Rows Below the Lateral Line in *Ammocrypta meridiana* and *Ammocrypta pellucida.*

Drainage	2	3	4	5	6	7	8	9	10	11	N	$\overline{X}$	SD	SE
A. meridiana														
Alabama				3	2	5	25	29	10	1	75	8.38	1.33	.15
Tombigbee						4	43	42	12		101	8.61	.75	.07
A. pellucida														
Cumberland			1								1	4.00	.00	.00
Wabash			4	30	42	24	10	4			114	6.16	1.13	.11
Green	1	2	7	5	3	1					19	4.53	1.22	.28
Rolling Fork				1	3		1				5	6.20	1.10	.49
Kentucky		1	9	11	9	3					33	5.12	1.02	.18
Miami			3	5	2	2	2				14	5.64	1.39	.37
Licking		3	12	10	7	2					34	4.79	1.07	.18
Scioto			6	11	11	9	2				39	5.74	1.14	.18
Ohio Proper			2	6	9	8	5				30	6.27	1.17	.21
Sandy-Kanawha			11	10	6	1					28	4.89	.88	.17
Hocking			1	20	11	3					35	5.46	.70	.12
Muskingum			1	9	17	15	17	6	1		66	6.91	1.31	.16
Upper Ohio		2	5	3							10	4.10	.74	.23
S Lake Huron		1	1	14	11	5					32	5.56	.91	.16
Lake St. Clair			1	4	15	17	6				43	5.53	.93	.14
N Lake Erie		1	9	3	3	4					20	5.00	1.30	.29
W Lake Erie			3	16	17	8					46	5.78	.96	.14
Maumee				3	20	6	6	4			39	6.69	1.15	.18
Lake Erie		3	11	11	3						28	4.50	.84	.16
SW Lake Erie		4	12	13	19	24	11	2			85	6.04	1.48	.16
SE Lake Erie		4	7	3	3						17	4.29	1.05	.25
St. Lawrence		1	5	10	9	2	1				28	5.32	1.09	.21

Table 29. Frequency Distribution of Transverse Scale Rows in *Ammocrypta meridiana* and *Ammocrypta pellucida*.

Drainage	6	7	8	9	10	11	12	13	14	15	16	17	18	19	N	$\overline{X}$	SD	SE
A. meridiana																		
Alabama					1	2	3	4	13	26	18	6	1	1	76	14.80	1.85	.21
Tombigbee								10	17	38	23	10	3		101	15.15	1.20	.12
A. pellucida																		
Cumberland				1											1	9.00	.00	.00
Wabash				2	1	9	17	29	36	14	6				114	13.32	1.42	.13
Green			1	2	2	2	6	5	2						20	11.65	1.69	.38
Rolling Fork							2	2	1						5	12.80	.84	.37
Kentucky	1	2	2	6	7	6	5	4							33	10.24	1.84	.32
Miami		1		2	3	2	2	2	2						14	11.07	2.06	.55
Licking	1	2	2	4	7	11	5	1	1						34	10.29	1.73	.30
Scioto			1	2	3	5	8	11	5	3	1				39	12.33	1.78	.29
Ohio Proper			3	2	5	5	6	4	4	1					30	11.40	1.94	.35
Sandy-Kanawha			4	7	7	5	3	1	1						28	10.11	1.55	.29
Hocking			1	2	6	8	11	5	2						35	11.40	1.40	.24
Muskingum				1	1	7	10	21	17	9					66	13.06	1.33	.16
Upper Ohio	1		3	2	2	3	1								12	9.42	1.73	.50
S Lake Huron			1		3	8	9	7	2	2					32	11.97	1.49	.26
Lake St. Clair		1	1	6	11	11	9	3	1						43	10.72	1.44	.22
N Lake Erie		1	2	2	4	4	3	2	2						20	10.75	1.97	.44
W Lake Erie			1	3	2	11	9	10	9	1					46	12.07	1.61	.24
Maumee					1	2	10	12	7	6	1				39	13.13	1.32	.21
Lake Erie		3	6	7	5	2	4	1							28	9.46	1.69	.32
SW Lake Erie		1	4	6	7	12	12	16	11	15	2				86	12.30	2.18	.23
SE Lake Erie		1	2	3	3	3	2	2	1						17	10.41	1.97	.48
St. Lawrence	1	1		1	7	9	4	4	1						28	10.89	1.73	.33

Table 30. Frequency Distribution of Dorsal Spines in *Ammocrypta vivax*.

Drainage	8	9	10	11	12	13	14	N	$\overline{X}$	SD	SE
Pascagoula			4	24	19	2		49	11.39	.70	.10
Pearl			7	39	32	3	1	82	11.41	.75	.08
Bayou Pierre		1	1	7	8	1		18	11.39	.92	.22
Big Black-Yazoo				3	2			5	11.40	.55	.24
Hatchie				3	4	2		9	11.89	.78	.26
St. Francis	1	5	22	24	9			61	10.57	.90	.12
White			23	21	6			50	10.66	.69	.10
Arkansas			1	7	1			9	11.00	.50	.17
Ouachita		1	11	37	24	8		81	11.33	.88	.10
Lower Red			3	8	2	1		14	11.07	.83	.22
Upper Red		1	3	15	12			31	11.23	.76	.14
Calcasieu			1	21	13	6		41	11.59	.77	.12
Sabine		3	4	45	34	6	1	93	11.42	.85	.09
Neches			6	36	32	6	1	81	11.51	.79	.09
Trinity				3	1			4	11.25	.50	.25
San Jacinto			11	32	16	2		61	11.51	.75	.10

Table 31. Frequency Distribution of Dorsal Rays in *Ammocrypta vivax*.

Drainage	9	10	11	12	N	$\overline{X}$	SD	SE
Pascagoula	19	25	5		49	9.71	.65	.09
Pearl	43	38	1		82	9.41	.53	.06
Bayou Pierre		11	7		18	10.39	.50	.12
Big Black-Yazoo	1	3	1		5	10.00	.71	.32
Hatchie		2	5	2	9	11.00	.71	.24
St. Francis	4	34	23		61	10.31	.59	.08
White	2	35	12	1	50	10.24	.56	.08
Arkansas		6	3		9	10.33	.50	.17
Ouachita	10	50	20	1	81	10.15	.63	.07
Lower Red	6	6	2		14	9.71	.73	.19
Upper Red	7	21	3		31	9.87	.56	.10
Calcasieu		27	14		41	10.34	.48	.07
Sabine	10	61	21		92	10.12	.57	.06
Neches	12	57	12		81	10.00	.55	.06
Trinity	1	3			4	9.75	.50	.25
San Jacinto	9	37	14	1	61	10.11	.66	.08

Table 32. Frequency Distribution of Anal Rays in *Ammocrypta vivax*.

Drainage	7	8	9	10	N	$\overline{X}$	SD	SE
Pascagoula		7	31	11	49	9.08	.61	.09
Pearl		19	59	4	82	8.82	.50	.06
Bayou Pierre		1	16	1	18	9.00	.34	.08
Big Black-Yazoo			4	1	5	9.20	.45	.20
Hatchie		1	5	3	9	9.22	.67	.22
St. Francis		10	42	9	61	8.98	.56	.07
White		8	39	3	50	8.90	.46	.07
Arkansas		2	7		9	8.78	.44	.15
Ouachita		9	59	13	81	9.05	.52	.06
Lower Red		2	12		14	8.86	.36	.10
Upper Red		6	23	2	31	8.87	.50	.09
Calcasieu		12	29		41	8.71	.46	.07
Sabine		15	70	8	93	8.92	.49	.05
Neches	1	24	55	1	81	8.69	.52	.06
Trinity		2	2		4	8.50	.58	.29
San Jacinto	1	17	40	3	61	8.74	.57	.07

Table 33. Frequency Distribution of Left Pectoral Rays in *Ammocrypta vivax*.

Drainage	13	14	15	16	17	N	$\overline{X}$	SD	SE
Pascagoula	2	28	19			49	14.35	.56	.08
Pearl	5	42	35			82	14.37	.60	.07
Bayou Pierre		9	8	1		18	14.56	.62	.15
Big Black-Yazoo		1	2	2		5	15.20	.84	.37
Hatchie		1	5	3		9	15.22	.67	.22
St. Francis	2	9	44	5	1	61	14.90	.65	.08
White		15	30	5		50	14.80	.61	.09
Arkansas		4	5			9	14.56	.53	.18
Ouachita	2	10	60	9		81	14.94	.58	.06
Lower Red	1	12	1			14	14.00	.39	.10
Upper Red	1	17	13			31	14.39	.56	.10
Calcasieu		20	19	2		41	14.56	.59	.09
Sabine	4	48	39	2		93	14.42	.61	.06
Neches		35	42	4		81	14.62	.58	.06
Trinity		4				4	14.00	.00	.00
San Jacinto	4	41	16			61	14.20	.54	.07

Table 34. Frequency Distribution of Total Vertebrate in *Ammocrypta vivax*.

Drainage	41	42	43	N	$\overline{X}$	SD	SE
Pascagoula	3	22	9	34	42.18	.58	.10
Pearl	8	28	4	40	41.90	.55	.09
Bayou Pierre	2	8	3	13	42.08	.64	.18
Big Black	2	1	1	4	41.75	.96	.48
St. Francis	6	24	3	33	41.91	.52	.09
White			6	6	43.00	.00	.00
Ouachita	7	20	3	30	41.87	.57	.10
Lower Red	5	8		13	41.62	.51	.14
Upper Red	1	14	3	18	42.11	.47	.11
Calcasieu	2	19	1	22	41.95	.37	.08
Sabine	4	25	1	30	41.90	.40	.07
Neches	9	13	5	27	41.85	.72	.14
Trinity		3		3	42.00	.00	.00
San Jacinto	7	14	2	23	41.78	.60	.12

Table 35. Frequency Distribution of Lateral Line Scales in *Ammocrypta vivax*.

Drainage	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	N	$\overline{X}$	SD	SE
Pascagoula			1	2	3	5	6	9	7	6	5	3	1	1									49	65.39	2.45	.35
Pearl	1	2	5	5	9	9	10	13	8	7	8	3	1	1									82	64.39	2.18	.31
Bayou Pierre										1	1	4	3	4	2	1	1						17	70.35	1.80	.44
Big Black-Yazoo					1							1	1	1			1						5	69.20	4.44	1.98
Hatchie							1	2	1	2	1	1	1										9	66.78	1.99	.66
St. Francis								1	2	3	5	7	7	8	9	6	5	3	1	2		1	60	71.15	2.91	.38
White							1	1	1	1	2	3	3	5	8	7	7	7	2	2			50	72.12	2.96	.42
Arkansas									1		1	1	2	2	2								9	69.89	1.96	.65
Ouachita				1	3	4	7	9	10	14	13	13	9	5	3	1							92	67.23	2.60	.27
Lower Red	1		1	1		2	3	3	1	1	1												14	63.79	2.69	.72
Upper Red							1	1	1	1		3	3	5	7	3	3	2	1				31	71.13	2.85	.51
Calcasieu			1	2	2	1	3	4	6	7	6	3	2	1	2	1							41	66.56	3.03	.47
Sabine		1	2	2	3	5	8	8	11	16	12	7	8	4	3	2	1						93	66.78	3.08	.32
Neches			2	2	2	6	7	9	10	9	14	8	5	3	2	1	1						81	66.64	2.93	.33
Trinity							1					2		1									4	68.25	2.99	1.49
San Jacinto				1	2	4	5	5	6	11	10	9	4	2	2								61	66.92	2.53	.32

Table 36. Frequency Distribution of Scale Rows Above the Lateral Line in *Ammocrypta vivax*.

Drainage	1	2	3	4	5	6	7	N	$\bar{X}$	SD	SE
Pascagoula		3	4	13	12	3	1	36	4.31	1.14	.19
Pearl			2	31	30	11		74	4.68	.76	.09
Bayou Pierre					11	7		18	5.39	.50	.12
Big Black-Yazoo					4	1		5	5.20	.45	.20
Hatchie				4	3	2		9	4.78	.83	.28
St. Francis			1	5	14	35	6	61	4.66	.83	.11
White				10	28	10		48	5.00	.65	.09
Arkansas				4	3	1	1	9	4.89	1.05	.35
Ouachita			1	15	52	21		89	5.04	.67	.07
Lower Red				5	9			14	4.64	.50	.13
Upper Red	1	2	3	5	11	3		25	4.28	1.31	.26
Calcasieu			7	19	10	4		40	4.27	.88	.14
Sabine				17	51	20	2	90	5.08	.71	.07
Neches				10	47	19	1	77	5.14	.64	.07
Trinity				2	2			4	4.50	.58	.29
San Jacinto			3	15	38	5		61	4.74	.68	.09

Table 37. Frequency Distribution of Scale Rows Below the Lateral Line in *Ammocrypta vivax*.

Drainage	6	7	8	9	10	11	12	N	$\bar{X}$	SD	SE
Pascagoula	2	3	4	17	9	1		36	8.86	1.15	.19
Pearl		2	15	39	18			74	8.99	.75	.09
Bayou Pierre		1	3	9	5			18	9.00	.84	.20
Big Black-Yazoo			1	3	1			5	9.00	.71	.32
Hatchie			1	2	5	1		9	8.67	.87	.29
St. Francis	3	17	32	8	1			61	7.79	.80	.10
White	1	10	21	14	2			48	8.13	.87	.13
Arkansas			4	4	1			9	8.67	.71	.24
Ouachita			12	43	27	7		89	9.33	.81	.09
Lower Red			2	2	7	3		14	9.79	.97	.26
Upper Red			2	8	13	2		25	9.60	.76	.15
Calcasieu			8	21	7	3	1	40	9.20	.94	.15
Sabine			8	29	40	13		90	9.64	.84	.09
Neches			3	25	35	12	3	78	9.83	.87	.10
Trinity				2	2			4	9.50	.58	.29
San Jacinto			1	17	22	16	5	61	10.11	.97	.12

Table 38. Frequency Distribution of Transverse Scale Rows in *Ammocrypta vivax*.

Drainage	10	11	12	13	14	15	16	17	18	N	$\bar{X}$	SD	SE
Pascagoula	2	1		2	9	14	7	1		36	14.50	1.56	.26
Pearl			2	11	26	29	10			78	14.44	.97	.11
Bayou Pierre				1	4	9	3	1		18	14.94	.94	.22
Big Black-Yazoo					2	1	1	1		5	15.20	1.30	.58
Hatchie			1	2	3	2	1			9	14.00	1.22	.41
St. Francis			8	20	28	5				61	13.49	.83	.11
White				9	18	18	3			48	14.31	.85	.12
Arkansas				1	3	4	1			9	14.56	.88	.29
Ouachita				5	24	36	19	4		88	14.92	.95	.10
Lower Red				1	2	7	4			14	15.00	.88	.23
Upper Red				1	6	10	7	1		25	15.04	.93	.19
Calcasieu				1	7	18	10	4	1	41	15.29	1.03	.16
Sabine					7	36	34	11	1	89	15.58	.85	.09
Neches					12	26	25	13	2	78	15.58	1.03	.12
Trinity						2	1	1		4	15.75	.96	.48
San Jacinto					1	21	23	14	2	61	15.92	.88	.11