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Noturus albater, new species, a female paratype, 63 mm. in standard length; UMMZ 102781, Missouri. (Courtesy Museum of Zoology, University of Michigan.)

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A Revision of the Catfish Genus Noturus Rafinesque, With an Analysis of Higher Groups in the Ictaluridae

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A Revision of the Catfish Genus Noturus Rafinesque, With an Analysis of Higher Groups in the Ictaluridae

Introduction

This study of the small North American catfishes in the genus *Noturus* was undertaken to analyze the species and to determine their relationships. It is based on critical examination of most of the many thousand specimens of *Noturus* now in museums, upon several hundred skeletonized or cleared and stained specimens of catfishes, and upon comparison with most of the other species in the family Ictaluridae.

The species in the family Ictaluridae appear to constitute six genera, forming three major natural groups. Each group includes one monotypic genus that is blind, unpigmented, and of restricted subterranean range, and one genus with species that are eyed, pigmented, and of widespread distribution in surface waters. The divisions are: (1) an *Ictalurus* group including the genus *Ictalurus* Rafinesque and the blind *Trogloglanis pattersoni* Eigenmann, (2) a *Noturus* group containing that genus and *Prietella phreatophila* Carranza, and (3) the *Pylodictis* group consisting of the large *Pylodictis olivaris* (Rafinesque) and the eyeless *Satan eurystomus* Hubbs and Bailey.

The 23 species of *Noturus* include one subspecies and ten species that are described here as new. They are arranged in three subgenera: *Rabida* Jordan and Evermann, *Noturus* Rafinesque, and *Schilbeodes* Bleeker. With *Prietella*, several of their characters are intermediate between those of the *Ictalurus* group and those of the *Pylodictis* group. In certain characters they appear to be the most primitive, but they have specialized in several directions, exemplified by loss, reduction, or fusion of some structures and by increase in others.

Hubbs and Raney (1944) studied much of the available material of *Noturus exilis*, *Noturus insignis*, and *Noturus gilberti*, giving some characters and mapping distributions. However, they incorrectly changed the names of *exilis*, *insignis*, and *gyrinus* to *insignis*, *marginatus*, and *mollis*, respectively, in the then recognized genus *Schilbeodes*. Otherwise, no study of the genus *Noturus* utilizing the existing material has been made since Jordan (1877d) and Swain and Kalb (1883).

The species of *Noturus* are mainly active at night, hiding in cavities or beneath objects during daylight. Consequently, they are often most readily collected by using chemicals, direct current electricity, or by seining after dusk. Some of the species appear to be very spottily distributed and are thus infrequently obtained except in intensive survey work. One, *Noturus flavipinnis* has not been collected since 1893. The known localities from which it was obtained are now ecologically unsuitable for its existence and it may be extinct. Although not often encountered, the members of the genus become rather widely known because of the painful "sting" produced by their pectoral spines.

The study of the variation and distribution of populations in *Noturus* has revealed several interesting patterns and presented problems of interpretation. Some wide ranging species, particularly *miurus* and *insignis*, show relatively little structural change geographically, but several structures in *Noturus gyrinus* gradually increase in length and number from north to south. Similarly a west to east increase is apparent in pectoral rays of *Noturus leptacanthus* and in anal rays of *Noturus funebris*. The presence of highly variant populations of *Noturus nocturnus* in the Red River system, which is in the middle of its range, is puzzling. In a number of species, localized and relatively minor variation is noted.

Three clusters of species, each with closely related allopatric representatives, are recognized as species groups; other species groups are suggested but the relationship of the species is not as clear. These allopatric populations are recognized as species because they show a relative morphological uniformity, with consistent divergence from related populations; trends or gradation of characters from one population toward the other do not exist and intermediates or intergrades are lacking.

Natural hybrids between species of *Noturus* are described but hybridization is rare. Sexual dimorphism in the family, once thought to be important in the interpretation of species of *Noturus*, has been exaggerated; instead differential morphological change, accompanying growth and sexual maturity, has resulted in several unnecessary names in *Ictalurus*, complicating its nomenclature.

Acknowledgments

A great many individuals have contributed importantly to this study in many ways, especially by the loan of specimens or making them available for study, provision of laboratory space, aid in collecting specimens, or have given freely information about specimens, notes on specimens in their care, or data from writings unavailable to me. To each I am greatly indebted and I sincerely trust that no one has been overlooked: Reeve M. Bailey, Marie-Louise Bauchot, Norman Benson, the late Leon Bertin, Albert P. Blair, James E. Böhlke, E. Milby Burton, Robert S. Campbell, Jorge Carranza, William M. Clay, Robert E. Cleary, Bruce B. Collette, the late

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I appreciate the permission of Carl L. Hubbs to include the descriptions of *Noturus albater* and *Noturus flavater*. These species were discovered and their previously unpublished names were coined many years ago by Dr. Hubbs. The frontispiece, depicting *Noturus albater* as drawn by the late Grace Eager for Dr. Hubbs, is reproduced here by permission of the Museum of Zoology, University of Michigan.

The photographs of *Noturus lachneri*, *N. hildebrandi lautus*, *N. baileyi*, and *N. elegans* from the Duck River system were made by William F. Smith-Vaniz; the others by the University of Michigan Photographic Services.

The drawings of the premaxillary teeth, and of the pectoral spines of *Noturus lachneri*, *N. hildebrandi lautus*, *N. baileyi*, and *N. elegans* from the Duck River system were made by Dorothea Schultz; all others were rendered by William L. Brudon.

William F. Smith-Vaniz and Fanny Phillips both greatly aided me in the preparation of the charts and maps.

The following individuals have read the manuscript or portions of it at some stage in its preparation, and provided helpful criticisms; I gratefully acknowledge their services: Reeve M. Bailey, Claude W. Hibbard, Carl L. Hubbs, Karl F. Lagler, Robert R. Miller, George A. Moore, and Milton B. Trautman.

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Source of Material

Representatives of the genus *Noturus* from the following collections have been studied. The abbreviations are those used throughout the text in referring to the material. If not included here, further data pertaining to specimens in the collections indicated by an asterisk may often be found in Taylor (1955).

AF	Mississippi State Game and Fish Commission, Jackson, Mississippi*
ANSP	Academy of Natural Sciences of Philadelphia*
BMNH	British Museum (Natural History)
CM	Charleston Museum*
CNHM	Field Museum (formerly Chicago Natural History Museum)*
CU	Cornell University*
DBUF	University of Florida*
FSU	Florida State University
INHS	Illinois Natural History Survey*
IU	Indiana University (Note: Gerking (1945) listed his collection of Indiana fishes now at Indiana University. An older collection, formerly at Indiana University, has been partially transferred to the University of Michigan. It bears the abbreviation IU, in parentheses after the abbreviation UMMZ, since it has not been fully cataloged into the Michigan collection.)
KU	Museum of Natural History, University of Kansas*
MCZ	Museum of Comparative Zoology, Harvard University
MNHN	Museum National d'Histoire Naturelle, Paris
NCSM	North Carolina State Museum, Raleigh
OAM	Oklahoma State University*
OSU	Ohio State Museum (chiefly the former Franz Theodore Stone Laboratory collection), Ohio State University*
OU	Museum of Zoology, University of Oklahoma*
SMF	Senckenbergische Naturforschende Gesellschaft, Frankfort am Main
SU	Division of Systematic Biology, Stanford University*
TNHC	University of Texas*
TU	Tulane University
Tulsa U	Tulsa University*
UGa	University of Georgia
UL	University of Louisville
UMinn	University of Minnesota
UMML	University of Miami, Institute of Marine Science
UMMZ	Museum of Zoology, University of Michigan*
UMoMZ	University of Missouri Museum of Zoology
USNM	United States National Museum
Vanderbilt U	Vanderbilt University

Specimens of the blind catfishes, in addition to those in Tulane University and the United States National Museum, were loaned by the Witte (now Texas) Memorial Museum, San Antonio, Texas, and the Instituto Mexicano de Recursos Naturales Renovables, Mexico, D.F., Mexico.

Methods

Descriptions of most of the counts and measurements used in this study can be found in Hubbs and Lagler (1947, pp. 8–15 and later editions). The counts of caudal rays and pores in the sensory canal system and some measurements are especially applicable to these fishes. They are not generally used or have been employed in this group for the first time.

Counts

Anal fin rays.—All rudimentary rays at the anterior end of the fin were counted. These simple rays decrease somewhat in number with age, i.e., some become branched rays. The number of anal rays was usually determined by making an incision above the anterior end of the fin, along the side of the body, then pulling the skin down to expose the minute rays, and counting them with the aid of strong transmitted light. A few counts were obtained by use of soft x-rays (see caudal fin rays). The full number of anal rays is present and countable at a very early age.

Dorsal fin rays.—Except in *Prietella* a prominent long hard spine is always present at the anterior end of the dorsal fin and is preceded by a short plate-like spine; neither is usually indicated, because the variation is in the number of soft rays. The full complement of dorsal fin rays is present in the yolk sac stage.

Pelvic and pectoral fin rays.—A hard spine always precedes the soft rays of the pectoral fin, but it is also usually excluded from the tabulations. The outer pelvic ray is typically simple, but on occasion may be branched; the frequency of occurrence of its branching was not determined. A minute ray-like structure, separate from and lateral to the base of the outer pelvic ray, was observed in *Ictalurus* and *Pylodictis* after clearing and staining. This structure has apparently degenerated into a small round ball or disappeared in *Noturus*. Shelden (1937) did not mention the element; if it is a degenerated ray or an accessory structure is not known. It is not included in the fin ray counts.

Enumerations from both the right and left fins are tabulated. In the genus *Noturus*, nothing is gained by adding the counts from the two sides. Individual asymmetry is frequent, but no population was found to be predominately asymmetrical. A slight suggestion of correlation in the increase in numbers of both pelvic and pectoral fin rays was noted in several species, particularly in *N. flavus*, *N. albater*, *N. eleutherus*, *N. miurus*, *N. gyrinus*, *N. nocturnus*, *N. gilberti*, *N. phaeus*, and *N. funebris*. In them, a high number of pectoral rays is frequently accompanied by an increase in number of rays in the pelvic fin. In

N. gyrinus this correlation also appears to correspond roughly with an increase in the number of preoperculomandibular pores, forming parallel geographic gradients. A prominent geographic increase in number of pectoral rays, but not in pelvic rays, is found in *Noturus leptacanthus*. The full complement of paired fin rays is probably present in the yolk sac stage; the normal complement was counted in specimens that had just lost the sac.

Caudal fin rays.—The full complement of caudal rays is apparently attained early in the first year of life after the yolk sac is lost (fig. 1 and, see p. 32, description of the young of *Noturus miurus*). In old specimens, there may be degeneration of one or two rays at the anterior end of the fin. This is suggested by occasional short rays (counted) that are neither attached at their base nor continue into the body. The number of branched rays in *Ictalurus* and *Pylodictis* is nearly constant, and they are differentiated at an early age, but in *Noturus* some of the simple caudal rays apparently become branched with age. The variation in number of branched rays is probably because of a continuation of the branching process, in the long rays, throughout life.

That the total number of caudal rays does not change after early in the first year of life is evidenced by general observation, by plotting the number of rays according to standard length in several species (see figs. 1 and 4), and from the fact that the rays, once developed, are distinct and do not grade imperceptibly into the surrounding tissues. The anterior rays often lie rather loosely inside the fin membrane. The number of rays in each "half" of the fin also remains constant.

Enumeration of caudal rays in the species of *Noturus*, especially in large individuals, is difficult and tedious. A few tabulations were from cleared and stained specimens. Others were made by the use of soft x-rays; in this method, fins were taped closely to the film holder, containing high contrast film, and exposed at 22KV, 150 MAS, with the x-ray unit about 20 inches from the subject.

The method most frequently used in determining the number of caudal rays is as follows: the mucus is cleaned from both sides of the fin by scraping with a dull knife; the fin is then rinsed and pressed flat against the glass stage of the microscope in a small pool of liquid; strong light is projected through the fin and a count made; the fish is then turned over to check the enumeration.

The caudal fin can be conveniently divided into the following parts:

Upper simple caudal rays: All unbranched rays in upper part of fin.
Lower simple caudal rays: All unbranched rays in lower part of fin.
Branched caudal rays: All branched rays in the fin.

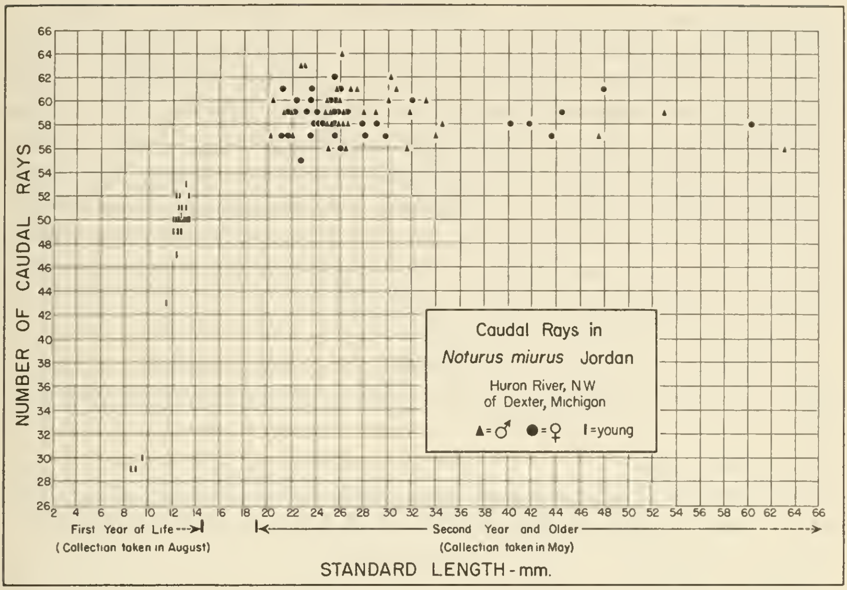

FIGURE 1.—Chart showing, by sex and size, the number of caudal rays in *Noturus miurus*. All specimens are from an area 2 or 3 miles northwest of Dexter, Michigan. Those collected in August were young that had not left the nest (see p. 30). Specimens above 20 mm., which were collected in the spring, had a full complement of caudal rays. No sexual difference in number of rays is evident. In the yearlings and older specimens the rays are distinct and stand out from the surrounding tissue. In the young, counts were made after staining with alizarin red S. Without this preparation the rays graded imperceptibly into the primordial fin tissue.

Upper-half caudal rays: Approximately one-half of the caudal fin is above a rather broad gap between the rays that extend from beneath the end of the axial streak (the line formed by the junction of the epaxial and hypaxial muscles). This displacement of the rays, near the middle of the fin, results from their attachment above and below a wide gap between the three lower and three or four upper hypurals. All rays, both simple and branched, that are above this gap are included in the upper half of the fin.

Lower-half caudal rays: All rays below the above mentioned gap.

Total caudal rays: All rays in the caudal fin.

Branched rays in the upper half of the caudal fin (upper lobe rays): All branched rays in the upper half of the fin.

Branched rays in the lower half of the caudal fin (lower lobe rays): All branched rays in the lower half of the fin.

Caudal fin-ray data where indicated in descriptions, include in order: upper simple rays, upper lobe branched rays, lower lobe branched rays, and lower simple rays, equaling total caudal rays.

Sensory canal system.—Variation was found in the number of pores in the preoperculomandibular canal and in the region of the anterior naris. Counts of both sides are tabulated individually. The internasal pores are the openings in the area between the anterior naris and the nasal barbel. If the count is given as one, the infraorbital and supraorbital canals are interpreted as fused anteriorly (pl. 1, fig. 1); if two, the canals are apparently not connected in this region (pl. 1, fig. 2). The variant count of three indicates the unfused condition and an extra pore mediad to the supraorbital canal. If the most anterior preoperculomandibular pore is common to both sides, it is included in both counts (as in *Pylodictis*).

Branchiostegal rays.—Counts of both sides, including all rudiments, are tabulated individually. Nearly all are from cleared and stained specimens; otherwise the rays usually cannot be counted accurately.

Gill rakers.—Counts are of the total number, including rudiments, on each anterior gill arch. Ranges given in the descriptions of *Noturus* are based on five or more specimens.

Ribs.—Data, from both sides, were taken only from cleared and stained specimens. All rudiments are included.

Vertebrae.—Tabulations do not include elements in the vertebral complex (of which there are five fused vertebrae, see p. 31); all other vertebrae, including one terminal vertebra with attached hypurals, were counted. Caudal vertebrae are those beginning with the first hemal arch with a single spine and include the terminal vertebra. Precaudal vertebrae are those anterior to the first vertebra bearing a hemal spine (excepting elements in the vertebral complex). Vertebrae anterior to the origin of the anal fin are the precaudal vertebrae plus those with hemal spines preceding the first pterygiophore of the anal fin.

Hypurals.—The hypurals are enumerated from below upward. Thus, hypurals 2–3 refers to the second and third hypurals as counted from below. They are frequently fused along their adjoining surfaces, except a broad gap exists between the lower three and the upper three or four. Hypural 1 has a hemal arch and has been termed a (the last) hemal spine in several recent papers.

Measurements

The measurements given are mostly self explanatory, and are described, with the exception of the points noted below, in Bailey and Taylor (1950, p. 33); most are in Hubbs and Lagler (1947, pp. 13–15). The lengths of dorsal and pectoral spines, barbels, and fins, and the depth of the head become relatively lessened with age; other parts seem to remain quite constant. Ranges of eye size, in the descriptions of *Noturus*, are based on five or more specimens.

Adipose notch or posterior end of adipose fin.—This point is variable. If the adipose fin forms a free flap at its posterior end, measurement is to the tip of the flap; if only a notch exists near the junction of the adipose and caudal fins, measurement is to the lowest point in the concavity; if the fin is separated from the caudal fin, the measurement is to the rear end of the adipose tissue.

Caudal peduncle depth.—The least depth of the caudal peduncle below the adipose fin.

Caudal peduncle length.—The measurement is from the base of the last anal ray to the midbase of the caudal fin.

Dorsal origin.—The dorsal origin is regarded as the apex of the notch in the imbedded, plate-like spine preceding the dorsal spine.

Dorsal spine length.—Measurement is from the dorsal origin to the tip of the long spine.

Pectoral spine to humeral process tip.—The distance is from the anterior base of the erected pectoral spine to the free end of the posterior process (spine) of the cleithrum (humeral process).

Predorsal length.—This length is from the dorsal origin to the tip of the snout.

Snout to anal fin.—Measurement is from the tip of the snout to the origin of the anal fin.

Snout to pelvic fin.—The distance is from the tip of the snout to the insertion of the outer pelvic ray.

The Family Ictaluridae

Members of the family Ictaluridae are found in the fresh waters of eastern North America, from the Hudson Bay and Saint Lawrence drainages of Canada southward through most Atlantic Ocean tributaries to the Usumacinta River, Guatemala; in Mexico, they occur in some of the streams flowing into the Pacific Ocean. Several of the economically important species have been introduced into waters in temperate countries throughout the world.

Although China was once included in the range of the family, no recent worker on the ichthyological fauna of China has reported any species referable to the Ictaluridae. These old reports probably stem from erroneous labels or misidentifications.

The Siluriformes or Nematognathi, to which the Ictaluridae belong, is characterized by the absence of parietal and opisthotic bones as well as the subopercle (unless the large, broad upper branchiostegal ray represents the subopercle). In most catfishes, the maxilla is greatly reduced; a vestige of this element remains as a small, rod-like structure that projects into the base of the maxillary barbel in the Ictaluridae.

A synopsis of certain characters of the Ictaluridae follows: body lacking scales but covered with thick skin; form moderately elongate; branchiostegal membranes forming a fold across the isthmus; dorsal fin anterior, with a hard spine (except *Prietella*) and usually with six soft, segmented rays; adipose fin present and of variable length; anterior and posterior nares relatively far apart; jaws toothed except in *Trogloglanis;* palate toothless; villiform teeth, similar to those of the jaws, in small patches on upper and lower rear pharyngeal arches; upper pharyngeal tooth patch obovate; lower pharyngeal arch S-shaped and bearing a diamond-shaped patch of teeth; palatine rod-shaped; hyomandibular heavy and with a broad head that fits into a groove in the pterotic and sphenotic; post-temporal present, absent, or vestigial; pectoral arch with two ossified radials (actinosts; Starks, 1930, p. 178), which are either separate or fused; entopterygoid (Kindred, 1919, p. 92, pl. 6, fig. 16) or pterygoid (Regan, 1911, p. 562) greatly reduced or absent; ectopterygoid (mesopterygoid of Regan, 1911, p. 562; Starks, 1926, p. 186) variously reduced, below and partially medial to the palatine (in *Noturus* much reduced in relative size); anterior vertebral complex containing five fused vertebral elements; jaws nonprotractile; eye lacking ossicles; gill rakers present anteriorly on all five arches and posteriorly on the third and fourth arches; rear faces of first and second arches smooth, and the fifth bound posteriorly by a membrane; the four pairs of barbels, include two which are mental, one is maxillary, and one is associated with the posterior nares.

The pelvic fin in ictalurids has eight, nine, or sometimes ten rays. The pelvic rays are attached to the pelvic girdle; there are no free radials. The pectoral fin possesses a hard spine, as does the dorsal fin, but the number of soft, segmented rays (5 to 12) varies with the species or species group.

The anatomy of *Amiurus* [=*Ictalurus*] has been described by Macallum (1884), McKenzie (1884), McMurrich (1884), and R. R. Wright (1884a–c). Kindred (1919) described the developing skull and Starks (1926, pp. 185–186) reviewed its ethmoid region. Examination of cleared and stained specimens of representative ictalurids indicates that the ossified structures are much alike in the species of the family and are essentially as described by Kindred and McMurrich. The differences observed in this study are regarded as primarily of generic or specific significance. Regan (1911) listed some of the major ones, indicating that *Noturus* differs from other ictalurids in the absence of the post-temporal and in the shortened lower limb of the cleithrum. These structures are reduced in *Noturus* and *Prietella*, and it is probable that they may also be reduced in the other blind species.

An air bladder is present in all ictalurids except *Satan* and *Trogloglanis*. It is attached to the vertebral complex by connective tissue but is never encased in bone. The testes of *Noturus* and *Pylodictis* are grossly similar in shape to those of *Ictalurus*, as described by Sneed and Clemens (1963).

The larger species of *Ictalurus* and *Pylodictis* are of considerable economic importance, both in sport and commercial fisheries. Small catfishes are sometimes used for bait, presumably because of their relative hardiness.

The young of *Ictalurus* and members of the genus *Noturus* are generally reputed to be venomous (Reed, 1907 and 1924b), introducing a poison with their sharp spines. The nature and source of the presumed poison should be carefully investigated. A gland, reputedly the poison gland, is situated just beneath the skin, immediately below the humeral process (posterior extension of the cleithrum) and opens directly to the surface through a large pore. It contains an amber colored, jelly-like material. The pore is reduced in size or closes with age in the larger ictalurids but remains open in *Noturus*. It is remote from the erect pectoral spine but the spine may closely approximate the pore when folded against the body. Flaky material surrounding the spines and imbedded in their grooves should also be investigated for possible toxicity.

Fossil representatives of *Ictalurus* are known from various Tertiary deposits—at least the Lower Pliocene (Hubbs and Hibbard, 1951)—indicating that the genus has had a long history, and *Pylodictis* has been recorded from the Pleistocene (Uyeno and Miller, 1962). Although fossils of other groups in the family are yet to be found or recorded, it is presumed that their history has been lengthy.

The members of this family are most active at night. The madtoms and stonecats are especially nocturnal in habits; they are seldom seen and infrequently captured by ordinary collecting methods in the daytime. At night they may literally swarm over the area where they appeared to be uncommon in the daytime. These observations point to the cryptic habits of many of the species and to their occasional great abundance in favored habitats. Hooper (1949 and 1951) has indicated something of the abundance of one species in Demming Lake, Minnesota. He estimated at least 8,600 individuals (88 pounds) of *Noturus gyrinus* in a lake of 12.5 acres.

The Sensory Canal System

PLATE 1

The sensory canal system provides important indications of interrelationships in fishes. A short article by Collinge (1895) compared the canals in certain Old World catfishes; Pollard (1892) gave comparative

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information on several forms; and brief descriptions of the system have appeared in anatomical discussions of certain species. In this study of the Ictaluridae, reference has been to R. R. Wright (1884b), Herrick (1901, pp. 230–231), and Kindred (1919). On certain details of structure their findings are not in agreement with my data.

In this family the canals are simple tubes. At intervals along their course these give off short lateral branches that extend to the surface and open through pores. The canal system is either imbedded in the large bones or retains cylinders or ringlets of bone (see also McMurrich, 1884, p. 279) for support. The ossified ringlets probably continue posteriorly to the end of the functional lateral line in the Ictaluridae. Stained specimens show that the infraorbital canal and short sections of the canals extending between the large bones are enclosed in these ringlets. Those stained without removing the skin exhibit the ringlets along the side of the body, where they extend to the end of the lateral line.

The canal system consists of the preoperculomandibular canal, the infraorbital canal, the supraorbital canal, the lateral cephalic canal, and the lateral body (line) canal (pl. 1). In disagreement with R. R. Wright (1884b, pp. 264–265), I count more pores in the preoperculomandibular canal and find that this tube is not isolated but connects with the lateral cephalic canal; however, in *Prietella* only a short section connects with the lateral canal as the preoperculomandibular canal is interrupted. Also I find no evidence of an occipital commissure.

The preoperculomandibular system traverses the lower jaw and preopercular bones, usually connecting with the lateral cephalic canal by one or more short ossified tubules or ringlets. Along its course it opens to the outside from 10, 11, or 12 pores, the number depending upon the species (tables 1 and 22). Of these pores, the first two to five open below the lower jaw in front of the mental barbels. In *Pylodictis* and *Satan* the first pore is median and a common outlet for the preoperculomandibular canals of both sides of the head. In other genera, the distance between the anterior pores is considerably greater, varying from a moderate separation in *Noturus*, *Prietella*, *Trogloglanis*, and in certain species of *Ictalurus* to a rather wide separation in other forms of *Ictalurus*.

Variations in number of pores in the preoperculomandibular canal seem to be of considerable significance, but the relative spacing is in part an expression of the development of the encasing dermal bones. The canal in *Pylodictis* and *Satan* has five pores (counting the median pore) in front of the posterior base of the outer mental barbel and seven posterior to that element. In *Noturus*, *Prietella*, and *Trogloglanis* there are usually only four anterior pores, but the posterior portion of the system varies with the species, usually having seven openings; there are six in each of four species. A further lateral shift of the anterior pores takes place in *Ictalurus* so that anterior to the outer mental barbel there are at most only four pores, in some forms three or even two. This shift leaves six to eight pores posterior to the outer mental barbel, as there are typically ten outlets from the canal (not eight or nine as reported in the literature).

Posterior to the outer mental barbel, six to eight pores from the preoperculomandibular system open below the lower jaw and over the opercle. The most posterior of these emerges at about the middle of the upper edge of the opercle and the next to the last typically opens over the midopercle, directly anterior to the pectoral fin. In *Prietella*, however, the last two pores are nearer the upper edge of the opercle, while the ninth pore is approximately in front of the pectoral spine. In this species the canal is interrupted between the most posterior pores. These adjacent pores probably result from the division of one pore; consequently, although *Prietella* now normally has eleven pores, it likely has been derived from a ten-pored ancestor.

The infraorbital canal is rather simple. Anteriorly, it opens by a pore (L1) posterior to or mediad of the anterior naris. The next pore (L2) opens lateral to these and above the maxilla. Posteriorly there are typically five (six in *Prietella* and one of two specimens of *Trogloglanis* has six) other openings along its course before it joins the supraorbital canal to form the lateral canal. The entire canal in *Prietella* typically has eight pores, the last two being isolated by interruption of the canal from the anterior section. Here again, probable disruption of the canal at a pore resulted in an extra pore. Anteriorly the canal passes through the first suborbital, also called the lacrymal bone, hence the symbolic terminology used for the first two pores. Posteriorly, the canal is supported by simple tubes of bone and all other pores arise from centers between these. In passing about the eye posteriorly, the canal swings almost directly upward in *Ictalurus*, *Trogloglanis*, *Prietella*, and *Noturus*; in *Pylodictis* and *Satan* the canal passes diagonally backward. It joins the supraorbital and lateral canals in the frontal.

The supraorbital and lateral cephalic canals form a simple straight tube which contains five pores. There is no connection between the two sides of the head. Of the pores, the first three exit from the tube traversing the nasal bone and the posterior two from the frontal. In *Pylodictis*, the anteriormost of the nasal pores (N1) is relatively small and far ahead of the anterior naris, near the upper lip, and the second (N2) or midnasal pore opens mediad or anterior to that structure. The anterior nasal pore (N1) in *Satan* is about midway between the edge of the upper lip and the naris; in the other genera of the family

Ictaluridae, pore N1 is close to the anterior naris and the midnasal (N2) is in a slightly posteromedial position. Connection of this system anteriorly with the infraorbital system is infrequent. However, in three species of *Noturus* (*lachneri*, *exilis*, and *miurus*) and in *Satan eurystomus* the connection is typical. In these, the midnasal (N2) and "mediad lacrymal" (L1) pores fuse to form an "internasal pore" (pl. 1, fig. 1); i.e., topographically the pores involved in fusion lie between the anterior and posterior nares.

Posteriorly the lateral cephalic canal connects with the lateral body canal after passing through the upper end of the supracleithrum. The posterior extent of the lateral line varies considerably between species. It ends just behind the head in *Noturus*, beneath the dorsal fin in some *Ictalurus*, and extends to the base of the caudal fin in other *Ictalurus*.

Relationships of the Genera of the Ictaluridae

During the course of the revision of *Noturus* an examination was made of most of the recognized species of Ictaluridae, consisting of *Pylodictis olivaris* (Rafinesque), *Satan eurystomus* Hubbs and Bailey, *Prietella phreatophila* Carranza, *Trogloglanis pattersoni* Eigenmann, as well as over a dozen species of *Ictalurus* and the members of the genus *Noturus* described below. Most were represented by ample material, but only three specimens of *Satan eurystomus* and two of *Trogloglanis pattersoni* were available, having been described previously by Hubbs and Bailey (1947) and Suttkus (1961). Skeletonized preparations of *Pylodictis*, *Prietella*, most species of *Noturus*, and over half the species of *Ictalurus* were studied.

The family comprises three relatively wide-ranging genera, and three genera that are known only from localized underground waters. The genera from underground waters show similarities to one each of the wide ranging genera: *Prietella* Carranza to *Noturus* Rafinesque, *Satan* Hubbs and Bailey to *Pylodictis* Rafinesque, and *Trogloglanis* Eigenmann to *Ictalurus* Rafinesque. The six genera can be arranged conveniently into three major groups, which are here termed the *Noturus* group, the *Pylodictis* group, and the *Ictalurus* group. No taxonomic name is assigned to them, however, because the suggested relationship requires further study. A comparison of the genera and indication of their relationship is presented in table 1.

Certain characters (not listed in table 1), long used as the bases for genera, appear to have value chiefly in delimitation of species. Of these, the shape of the group of teeth on the premaxillary bone and the shape of the caudal fin have been extensively used. *Trogloglanis pattersoni* has no teeth on the lower jaw or the premaxilla. The premaxillary teeth in the other genera are arranged in a transverse rectangular patch. Its width and lateral edges are rather variable, and various posterior extensions of the patch may invade the rear surface of the premaxilla which is variously extended backward. The variable posterior extension may be short and scarcely evident, moderate and from the posterior edge of the premaxilla (*Ictalurus balsanus*), long, narrow, and from near the posterior corner (*Noturus flavus;* pl. 2, fig. 3), or broad, long, and from the posterior edge (*Pylodictis olivaris*).

The shape of the caudal fin varies from species to species. Variations in the posterior fin margin are: rounded to deeply forked in *Ictalurus;* slightly emarginate in *Prietella, Trogloglanis,* and *Satan;* truncate or rounded to pointed in *Noturus;* and emarginate to rounded in *Pylodictis.* The degree of development and shape of serrae on the spines varies greatly throughout the species of catfishes. The skeleton is well ossified and the bones are heavy in species that attain a large or relatively large size, particularly *Pylodictis olivaris, Noturus flavus,* and the forms of *Ictalurus.* The bones are somewhat thinner in small species.

The ectopterygoid, broad in both *Ictalurus* and *Pylodictis,* is somewhat reduced in breadth in *Prietella* and is narrow in the species of *Noturus.* Similarly, the post-temporal bone is present in *Ictalurus* and *Pylodictis,* but is absent or vestigial in both *Prietella* and *Noturus.* Since the bones of both *Satan eurystomus* and *Trogloglanis pattersoni* are thin, both of these elements (not examined) could be expected to be reduced. The width of the opercle varies considerably; it is broad in most forms, but narrow in *Noturus.* The bone is relatively little narrowed in *Prietella.*

One epural is typically present in most species, but occasional specimens have two. Both *Pylodictis* and *Ictalurus* appear to have seven hypurals, with only infrequent reduction to six. Of these, three (1–3) support the lower lobe of the caudal fin and four (4–7) support the upper lobe. Three species of *Noturus,* subgenus *Schilbeodes,* possess a modal number of seven (1–3 + 4–7) hypurals. All others normally have six (1–3 + 4–6). Fusion of the hypurals in the specimens of *Prietella* studied prevents their enumeration.

The variation in branchiostegal rays in the family is 8 to 13. Two branchiostegals are typically associated with the epihyal; a third is sometimes at the junction of the epihyal and ceratohyal so that it could be included in the count for the epihyal; all other branchiostegals are associated with the ceratohyal. *Pylodictis* is the only species that normally has twelve branchiostegals. Two specimens of *Satan* have eleven, but the type-specimen has ten. In *Noturus* and *Prietella,* the variation is eight to twelve with modes from nine to eleven. The limited data from *Ictalurus* and *Trogloglanis* indicate a range of eight to eleven branchiostegal rays with modes eight to ten.

The anterior position of the first nasal pore (N1) is unique in *Pylodictis*, but its anterior position is approached in *Satan*. The number of sensory canal pores anterior to the outer mental barbel (see p.12) appears to be of some evolutionary significance. Another kind of pore, "the venom pore," located immediately below the posterior process of the cleithrum is large in most species of *Noturus* and in young of *Ictalurus* and *Pylodictis;* in *Prietella* and large individuals of the previous genera it is greatly restricted in size, but it appears to be absent in *Satan* and *Trogloglanis*.

Ictalurus group.—The species in the genus *Ictalurus* are a cluster of divergent forms having the following characters in common: ten preoperculomandibular pores, eight pelvic rays, and an extremely shortened, high adipose fin which is free from the back posteriorly and remote from the caudal fin. The bullheads, *Ameiurus* [=*Amiurus*] are regarded as members of the genus *Ictalurus* because there is gradation without a significant break from them through several intermediates to the most divergent *Ictalurus* such as *I. punctatus*. In young *Ictalurus* the body may be light grayish blue with black vertical fin margins, mottled, spotted with light or with dark, or brown or blackish above and lighter below. With age and development of breeding characteristics these fish assume a color that is almost uniformly dark, especially on the dorsal and lateral surfaces. In some forms the skull is greatly arched, especially in the young; in a few it is flattened or depressed, and in others it is variously intermediate in shape. With the development of the breeding characters, the skulls broaden and become more depressed. Thus the high arched heads are transformed into shallowly rounded structures and the flattened heads are even broader and more depressed by the change in bone relationships as well as the proliferation of muscle masses laterally and occipitally. Consequently, a breeding adult may show little resemblance to its young but instead may resemble the young of another species.

The shape of the caudal fin also varies or grades from rounded posteriorly through emarginate, notched, shallowly forked, and deeply forked among the species. The depth of the fork is extensively reduced with age and breeding condition so that species with deeply forked tails as young have only a deeply notched or very shallowly forked tail when older, again often resembling the young of another species. Only two of the species, *Ictalurus furcatus* and *I. punctatus*, have a continuous bony bridge from the supraoccipital to a small bone extending forward from the base of the dorsal fin. The supraoccipital ("occipital") process in others is variously developed, from an elongated shelf that is widely separated from the dorsal fin and lacks connecting elements, to a near union with the process from the dorsal fin base. Two of the species, *Ictalurus furcatus* and *I. balsanus*, have an additional posterior chamber to the air bladder; the latter has a moderate backward extension of the patch of teeth on the premaxilla. Their relationship to each other and to the genus *Ictalurus* should receive further study. Tentatively *Istlarius balsanus* Jordan and Snyder is included in *Ictalurus* because of its resemblance to that group and its probable affinity with *Ictalurus furcatus*.

The two syntypes (ANSP 22082–3) of *Gronias nigrolabris* Cope (1864) were examined in the course of this study. They do not represent a distinct genus, but are specimens of *Ictalurus nebulosus* (LeSueur) as maintained by Hubbs and Bailey (1947, p. 12). Fowler (1915a, p. 208) regarded them as a distinct species of *Ameiurus* [=*Ictalurus*]. Both have eight rays in each pelvic fin; the anal fins have 19 and 20 rays; the pectoral spines are long and serrated posteriorly. Contrary to report the eyes are present, but are asymmetrically developed—undoubtedly a teratological condition.

The relationship of *Trogloglanis pattersoni* Eigenmann to the *Ictalurus* group is suggested by several characters. In some respects it resembles the species of *Ictalurus* which have high arched skulls, a relatively shortened head, a long occipital process, and many gill rakers (table 1). Also, like those species, the mouth is constricted and inferior, but lacks teeth, the dorsal fin is slightly pointed, and the lateral line is long. Otherwise, the presence of eight pelvic rays (the specimen TU 10808 appears to have nine—perhaps an exception—rather than the eight reported) is certainly suggestive of relationship with *Ictalurus*. The posterior flap on the anterior naris is extreme but an elevation of the posterior rim of the naris is evident in several *Ictalurus*, especially *Ictalurus punctatus* in which the condition approaches *Trogloglanis*.

Eigenmann (1919) thought *Trogloglanis* related to the genus *Schilbeodes* [=*Noturus*] and Hubbs and Bailey (1947) regarded it as more closely related to *Ameiurus* [=*Ictalurus*]. Although *Trogloglanis* has undoubtedly diverged considerably from its ancestral ictalurid stock, it has few resemblances to *Noturus* or to *Pylodictis*, and it is quite distinct from the other species of blind catfishes. Eigenmann was undoubtedly impressed with the elongated adipose fin (which was once thought to be unique to *Noturus*), but the more recently discovered blind species also have a similar fin. Indeed, the morphology of the specimens does not suggest derivation from any of these stocks, or from the bullheads (*Ameiurus* auct) as postulated by Hubbs and Bailey (1947). The few similarities to *Ictalurus*, sensu strictu, which are listed above suggest derivation from a form not greatly unlike *I. punctatus*.

Noturus group.—*Prietella phreatophila* Carranza is similar in many characters to the genus *Noturus*. Several features of the two genera align them together and separate them from both the *Ictalurus* and *Pylodictis* groups although they appear to occupy an intermediate phylogenetic position (table 1). Among the many characters in common are the reduced occipital process, the long adipose fin, the general similarity in head and body shape, divergence from a normal mode of 15 branched caudal rays, a shortened air bladder, an obsolete post-temporal bone, a slightly reduced ectopterygoid, rather widely separated anterior ends of the preoperculomandibular canals, similarly shaped infraorbital canals, a short lateral line, and relatively few vertebrae. Yet they seem to be distinct units. *Prietella* differs from *Noturus* especially in the primitiveness or lack of ossification of the first dorsal ray, the degeneration of ossified tissue at the anterior base of the dorsal fin, especially the absence of the plate-like spine, and in features resulting from subterranean life: depigmentation, eyelessness, and interruption of the infraorbital and preoperculomandibular canals. The anterior fontanelle is a small round opening in contrast to the elongate slit or opening in all other ictalurids (see Suttkus, 1961, fig. 5).

The short, blunt, nonserrated, ungrooved condition of the pectoral spine and eight pelvic rays are duplicated or approached in few kinds of *Noturus*. Although *Pylodictis* and *Ictalurus* have a range that overlaps their apparent underground relatives, which occur in central Texas, *Noturus* and *Prietella* are geographically isolated; *Prietella* is known only from one locality in the Rio Grande drainage of Mexico, whereas *Noturus* ranges no farther southwestward than the Nueces River, Texas. They are regarded as distinct genera, but are thought to be related; there is no suggestion that *Prietella* is related to any of the other recognized groups of ictalurids. Indeed, the superficial similarity of *Prietella* and certain forms in the subgenus *Schilbeodes* of *Noturus* is striking.

Due to the similarity of *Noturus* and *Prietella*, the following description of *Prietella phreatophila* Carranza (based on thirteen specimens of which three were cleared and stained) is included (see also Carranza, 1954): standard length 34.0 to 52.8 mm.; anal rays 12 (in 1), 13 (1), 14 (6), and 15 (5); pelvic rays 8 (26 sides); soft pectoral rays 8 (7 sides) or 9 (19); dorsal rays 6 (2) or 7 (11), see p. 19; internasal pores 2 (24 sides); preoperculomandibular pores 10 (1), 11 (21), and 12 (2); gill rakers 10 (2 sides), 11 (4), 12 (7), 13 (10), and 14 (1); ribs 5 (5 sides) or 6 (1); precaudal vertebrae 7 (1), 8 (1), or 9 (1); caudal vertebrae 21 (1), 23 (1), or 24 (1); vertebrae anterior to anal fin origin 11 (1) or 12 (2); total vertebrae 29 (1), 31 (1), or 32 (1); branchiostegal rays 8 (2 sides) or 9(4). Caudal rays: upper simple rays 12 (1), 13 (3), or 14 (9); upper lobe branched rays 6 (13); lower lobe branched rays 6 (1) or 7 (12); lower simple rays 12 (1), 13 (0), 14 (7), 15 (4), or 16 (1); lower-half rays 19 (1), 20 (0), 21 (8), 22 (3), or 23 (1); total rays 37 (1), 38 (0), 39 (0), 40 (2), 41 (7), 42 (2), and 43 (1).

Other characteristics are (see also table 1): lower jaw included, almost subterminal; infraorbital and preoperculomandibular canals interrupted, apparently resulting in an extra pore in each; no dorsal spine, instead first dorsal ray segmented and flexible distally but without distinct segments basally; basal half better ossified than in other dorsal rays and the base expanded laterally; no imbedded plate-like spine at anterior end of dorsal fin but the pterygiophore that supports the plate-like spine in other species is present and with distal end broad; cleithrum relatively narrow; posterior process of cleithrum curved inward; pectoral spine present, short, relatively flexible, smooth along all edges, without obvious grooves, its end blunt and continuous with soft tissue which is segmented; one epural; number of hypurals unknown, almost solidly fused, either as a broad plate, or as two plates separated near the middle of the fin base; caudal fin truncate or slightly emarginate; lateral line short, ending just back of head; premaxillary tooth patch very wide and short, without visible posterior extensions; air bladder normal, short, no longer than wide, about as in *Noturus*.

Pylodictis group.—*Pylodictis olivaris* (Rafinesque) and *Satan eurystomus* Hubbs and Bailey are morphologically similar and closely related, but constitute separate genera. *Satan* differs from *Pylodictis* chiefly in the absence of eyes, the obsolescence of the air bladder, the lack of pigmentation, absence of backward extensions of the premaxillary tooth band, the excessive elongation of the adipose fin, and in divergences of the sensory canal system, especially the enlarged pores and the single internasal pore. The twelve preoperculomandibular pores in *Pylodictis* are approached in *Satan*. In *Satan* the type-specimen has 12 pores on each side counting the anterior median pore. As noted by Suttkus (1961, p. 57) two additional specimens appear to have 11 pores on each side. However, the preoperculomandibular canal is not continuous with the lateral cephalic canal posteriorly, possibly resulting in an extra pore (not counted by Suttkus) on each side, opening from the short canal connecting with the lateral cephalic canal. Thus the basic number of pores may be either 11 or 12. Of these pores, five are anterior to the outer mental barbel. Also the body form, the rather greatly depressed head, the wide mouth, the backward swing of the infraorbital canal, the terminal or subterminal lower jaw, the proximity of the anterior ends of the preoperculomandibular canals, and the presence of nine or more rays in each pelvic fin (the specimen of *Satan*, USNM 195830, has 9 rays instead of 10 as reported) suggest their phylogenetic relationship (compare, table 1), in agreement with Hubbs and Bailey (1947). As noted by Suttkus (1961) the dermethmoid (supraethmoid, Kindred, 1919) is broadly forked in both *Satan* and *Pylodictis* further suggesting close relationship.

Uyeno and Miller (1962) indicated other osteological differences of *Pylodictis* from both *Ictalurus* and *Noturus*.

Genus *Noturus* Rafinesque

Noturus Rafinesque, 1818a, p. 41 (original description; type-species, *Noturus flavus* Rafinesque, by monotypy); 1820a, p. 48 (comparison).

Pimelodon Vaillant.—LeSueur, 1819, p. 155 (probably vernacular and used with the French *livrée*, thus nonbinominal).—Vaillant, 1896a, p. 28; 1896b, p. 14, pl. 24 (name first available, from LeSueur; type-species, *Pimelodon insignarius* Vaillant [=*Noturus insignis* (Richardson)], by monotypy).

Pimelode.—LeSueur, 1820, p. 44 (vernacular; used with the French *livrée*).

Schilbeodes Bleeker, 1858, pp. 36, 249, 258 (original description; type-species, *Silurus gyrinus* Mitchill, by monotypy).—Jordan and Gilbert, 1877b, p. 93 (misspelled as *Schilbeoides*).

Rabida Jordan and Evermann, 1896a, pp. 144–146 (original description in key; *furiosus*, in parentheses, presumably intended as type-species).—Jordan, 1920, pp. 473, 566 (misspelled as *Rabidus;* type-species designated: *Noturus furiosus* Jordan and Meek); 1923, p. 147 (misspelled as *Rabidus*).

The name *Pimelodon* predates the name *Schilbeodes* if *Pimelodon* can be credited to LeSueur as a scientific name. After his description of six species of the genus *Pimelodus* LeSueur (1819, p. 155) inserted a description, perhaps as an afterthought, of another beginning as follows: "J'indique ici sous le nom de Pimelodon *livrée*. . . ." In an abstract of this paper LeSueur (1820, p. 44) italicized both parts of the name, shortening Pimelodon to the well-known vernacular "*Pimelode*," a name commonly used for *Pimelodus;* he did not mention Pimelodon in the abstract. The names of the six species of *Pimelodus* were consistently italicized in both papers as was the French name *livrée*. Pimelodon and most, but not all, of the other vernacular names were not italicized. It is thus apparent that LeSueur coined the word Pimelodon from *Pimelodus* and intended it only as a temporary vernacular name. Subsequent writers did not mention Pimelodon nor list it as a genus name until Vaillant (1896a,b) published a synonymy and LeSueur's drawing of *Noturus insignis* under the name *Pimelodon insignarius*. Because it appears that *Pimelodon* was originally pubished as a vernacular name by LeSueur, it is here accepted as first available nomenclatorially in 1896. The meaning and origin of the word *Pimelodon* is otherwise unknown.

Gill (1876, p. 410) used the name Noturi to include the genus *Noturus*.

Noturus is compared with the other genera of the family Ictaluridae in table 1. The characters of the genus are: eyes present; body and fins variously pigmented, never entirely unpigmented; dorsal and pectoral fins always with a hard spine at anterior end; adipose fin long, its posterior end adnate to the back, sometimes forming a short free flap, and variously connected to, or separated from the upper caudal fin by at most a small notch; caudal fin truncate, rounded, or pointed behind; procurrent caudal rays covered by a thin membrane; number of branched (and simple) caudal rays extremely variable; lateral line short; skull arched to greatly depressed; skeleton rather poorly ossified, bones thin; post-temporal bone absent, or reduced and nonfunctional; ectopterygoid narrow, reduced in size; opercle narrow, much longer than broad; teeth present on lower jaw and premaxilla; occipital process very short and narrow, projecting little beyond skull; ossified pectoral radials fused or unfused; pelvic rays usually 8 or 9; gill rakers on the first arch 3 to 10; preoperculomandibular pores usually 10 or 11; branchiostegal rays 8 to 12, usually 8 to 11; vertebrae variable, 30 to 42; soft dorsal rays 5 or usually 6; soft pectoral rays 5 to 11, usually 6 to 10; sensory canal system continuous on each side, not interrupted; preoperculomandibular canal with four pores anterior to outer mental barbel, its anterior end usually widely separated from the canal of the opposite side; infraorbital canal bending upward and slightly anteriorly behind eye (pl. 1, fig. 1), with seven pores; first pore of supraorbital canal in front of and adjacent to anterior naris; air bladder always present, moderately long to little longer than broad, never with a posterior chamber; epurals typically one, sometimes two; hypurals normally six (1–3 below + 4–6 above), but modally seven (1–3 below + 4–7 above) in three species. Other skull and skeletal characters are much like those of *Ictalurus* which has been described by Kindred (1919) and McMurrich (1884).

The principal reviews of the genus are by Jordan (1877d) containing a moderately good summary of the recognized forms and characters, which is most useful in identifying the newly described species; Swain and Kalb (1883), giving some new information but introducing confusion; and Jordan and Evermann (1896a), employing a nomenclature that for the most part still holds today. Characters and distributions were presented for some species by Hubbs and Raney (1944), but these authors made unnecessary changes in nomenclature.

Information on the natural history and morphology of the species of *Noturus* is sketchy. Some of the principal, yet often brief, contributions deal with: food habits (Curd, 1960; Forbes, 1880b, 1888a, 1888b; Langlois, 1954; Pearse, 1915, 1918, 1921); spines, poison, and poison glands (Birkhead, 1967; Reed, 1900, 1907, 1924a, 1924b); parasites (Anthony, 1963; Bangham, 1941a, 1941b, 1946; Bangham and Hunter, 1939; Bangham and Venard, 1942; Fischthal, 1947, 1950, 1953, 1956; Larson, 1966; Van Cleave and Mueller, 1934); reproduction (R. M. Bailey, 1938; Fowler, 1917b; Greeley, 1929, 1934; Hankinson, 1908; Langlois, 1954); distribution (Hubbs and Lagler, 1958; Hubbs and Raney, 1944; Jordan and Evermann, 1896a; Trautman, 1959); age and growth (Hooper, 1949); development (Fish, 1932; Ryder, 1886, 1887; Sumner, 1899); morphology (Chranilov, 1929; Herrick, 1901; Regan, 1911; Suttkus, 1961). The ecology of most of the species has been briefly discussed by many authors. Several aspects of the life history of *Noturus insignis* (Richardson) were described by Clugston and Cooper (1960) and a population of *Noturus funebris* Gilbert and Swain was studied by Thomerson (1966).

As indicated by Hubbs and Raney (1944), I feel that there is no very sharp break between the subgenus *Schilbeodes* and the species forming *Rabida*. There are probably even fewer important differences between the subgenera *Schilbeodes* and *Noturus*. Thus, the species formerly assigned to these three "genera" are combined as *Noturus*. However, certain resemblances among the species make it practicable to retain three subgeneric groups.

Noturus flavus, the largest and one of the most widespread species, is the type-species of *Noturus*, long recognized as a monotypic genus. *N. flavus* differs from all other species in the unfused condition of the pectoral radials, but some forms, chiefly *N. stigmosus*, vary in that direction. The pattern of teeth on the premaxilla, long employed as a generic character, is regarded as of little more than specific importance; the shape of the band varies considerably among the species of *Noturus* and simply reaches an extreme development in *flavus;* it does not conform to the shape of the premaxilla (pl. 2). *N. flavus* is not consistently distinguishable from other species in the numbers of pectoral and pelvic rays or of vertebrae. Superficially, *N. flavus* is most similar to *N. gilberti*, and their true relationship may be rather close. The present arrangement of subgenera differs from past classifications chiefly in that *Noturus* is monotypic, *Rabida* includes only the mottled forms, a very distinctive group of species, and *Schilbeodes* contains the remaining, more somberly colored species.

Three names that have been used to indicate members of this genus were not accompanied by descriptions. They are:

Noturus liacanthus.—Jordan (1877c, p. 50). The name is now unidentifiable. Jordan included it in a list of fishes of the Ohio Valley that were not noticed by Rafinesque.

Noturus latifrons.—Jordan (1885, p. 802). Gilbert and Swain probably intended to use this name for *Noturus eleutherus* (see p. 165).

Schilbeodes punctatus.—Mitchell (1904, p. 154). According to Mitchell (1904, p. 405) this is a lapsus for *Schilbeodes gyrinus* (Mitchell).

Key to the Subgenera of *Noturus*

1. Pectoral spine usually curved, scimitar-like, with both anterior and posterior serrae; anterior serrae small, numerous, sometimes barely visible; posterior serrae larger and their tips (except 1 to 3 near spine base) uniformly recurved toward spine base; color pattern usually of dark blotches or saddles on back, over lighter background; ossified pectoral radials typically fused; premaxillary tooth patch rectangular with posterior corners rounded or obtusely angulate . . . . Subgenus **Rabida**

   Pectoral spine nearly straight to moderately curved, without anterior serrae; anterior edge of spine often with recurved hooks or step-like processes; posterior edge of spine smooth or with serrae which are not regularly turned toward spine base; color pattern typically dark, without prominent darker blotches or saddles on body 2
2. Premaxillary tooth patch rectangular with distinct, long, usually narrow, projections from the posterior corners; ossified pectoral radials never fused. Subgenus **Noturus**

   Premaxillary tooth patch rectangular, with posterior corners rounded or acute to obtusely angulate; ossified pectoral radials typically fused. Subgenus **Schilbeodes**

History

The early naturalists first discovered members of the genus *Noturus* in the fresh waters of North America about 1817. Within three years, three of the common species, *Silurus gyrinus* Mitchill, *Noturus flavus* Rafinesque, and "Pimelodon *livrée*" LeSueur [=*Noturus insignis* (Richardson)] had been recognized and partially described. LeSueur, however, applied a vernacular name to his fish. At this time, also, Rafinesque proposed the generic name *Noturus* for *flavus*.

During the next 40 years no new species were recognized but two new names were based on the description by LeSueur. There was considerable speculation at this time as to whether the description of *Noturus flavus* was based on a young or adult specimen since a continuous adipose fin was regarded as a character of larvae or young individuals.

Bleeker (1858), believing that Mitchill's *Silurus gyrinus* lacked an adipose fin proposed the generic name *Schilbeodes* for this species. He later placed *Schilbeodes* in the synonymy of *Noturus* when informed by Gill that all of the North American catfishes have an adipose fin.

The common name stonecat, sometimes used for all species of *Noturus*, stems from Baird (1860, pp. 420–421) who wrote: "The genus *Noturus*, known provincially as Stone-Cat-fish embraces few species, . . ." The species on which this name was based or the locality of origin was not given. Baird had collected *Noturus gyrinus*, *Noturus exilis*, and *Noturus insignis* by this time. Of these, it is most likely that the name was based on the specimens of *N. insignis* from Carlisle, Pennsylvania, which became the types of *Noturus marginatus*.

From 1875 through 1891, Nelson described *Noturus exilis*, and Jordan and his co-workers described most of the remaining known species. The generic names *Rabida* and *Pimelodon* were established in 1896. Since then only two valid species have been named.

The common name madtom also originated locally. Jordan (1889, p. 353; 1890, pp. 101, 122) found the name to be in use in Virginia for *Noturus insignis* and possibly for *Noturus gilberti*. He said (1890, p. 101) of *insignis:* "Well known . . . here [Luray, Virginia localities] as elsewhere in Virginia, by the appropriate name of Mad-Tom."

Zoogeography

Noturus belongs to the large fish fauna of eastern North America. There, its species are found in tributaries to the Atlantic Ocean from the Nueces River, Texas, to the Hudson River, New York, and have spread into the Saint Lawrence and Hudson Bay drainages. Representatives have been introduced into Germany (unsuccessfully), into the Snake River of Idaho and Oregon, and into several New England streams. The discovery of *Prietella*, an apparent relative of *Noturus*, in northeastern Mexico suggests a more widespread distribution of the ancestral *Noturus*, possibly throughout eastern North America into Mexico.

Two ecological factors seem to contribute importantly to the present distribution of *Noturus:* water sufficiently warm for reproduction and a good supply of oxygen. Avoidance of cold water is indicated by the few species living in northern regions and by the infrequent occurrence of any species with cold water inhabiting trout. Of these, *Noturus insignis* is most commonly reported from trout streams—perhaps submarginal trout streams. Other evidence of a requirement for warm water are late season breeding in the north and general disappearance, after one or two years, from and below the area of large impoundments that release cold water.

Although one species seems to prefer lowland areas and water with little or no current the remainder appear characteristic of moderate to rapidly flowing streams. In the latter they are most often found on or just below riffles, where there is an abundance of cover for hiding and the water is well oxygenated. Although wet specimens will often survive for several hours in air, deficient oxygen appears to be a critical factor in controlling distribution. This is most noticeable in late summer and fall when species become almost entirely restricted to a riffle where there is deficient oxygen in the adjacent pools.

The present centers of greatest number of species of *Noturus*, and perhaps of their evolution, lie in the upland regions of the east central United States, roughly in a band from Arkansas and Missouri through

Kentucky and Tennessee to Virginia and North Carolina. All three subgenera have representatives entering portions of the region, and a number of endemics are found there.

The greatest number of species, twelve, are included in the fauna of Tennessee, followed by Kentucky with nine and thence by Alabama, Arkansas, Mississippi, and perhaps Missouri, with eight; away from this area, the number of species gradually decreases. Nine species are included in the faunas of the Ohio and Tennessee Rivers, decreasing to six known from the Cumberland, White, Arkansas, Ouachita, and lower Mississippi Rivers.

Because of the favorable ecological habitat available, this general region was probably a refuge for several northern species during Pleistocene glaciation as well as retaining its native fauna. Subsequently several species dispersed northward, some farther than others. The relatively northern *Noturus flavus* was undoubtedly pushed southward by glaciation but it has been able to move into nearly all the upper tributaries of the Mississippi River; it crossed (when or where is not clear) into the Arkansas drainage and utilized post glacial stream changes to enter the Great Lakes at a number of points. The members of the subgenus *Rabida* were perhaps more eastern and southern in distribution and consequently unable to move into the Mississippi drainage above the Ohio River. For some reason, perhaps because of the sediment load carried by the Mississippi, they have not entered any uppei portion of that system except for a simple crossover of *Noturus miurus* from the Wabash drainage to the Kaskaskia drainage in Illinois. This crossover may not have persisted.

Otherwise two species of *Rabida*, that were probably pushed southward during glaciation, traversed the Wabash River and entered the lower Great Lakes by way of the outlet of glacial Lake Maumee. Aside from *Noturus gyrinus*, the species of the subgenus *Schilbeodes* have entered only the lower portions of the Ohio (except apparent recent entrances by *N. insignis*) and Missouri River systems and only one (*N. exilis*) has moved extensively into the upper Mississippi River drainage. Thus it seems that the major distribution of the species of *Schilbeodes* was southward and eastward as today and most were not materially affected by glaciation. *Noturus insignis*, along the Piedmont, was probably restricted southward but it has successfully moved northward again; it has entered the Mississippi and Great Lakes drainages by relatively recent stream changes or human introduction.

Noturus gyrinus occupies the lowlands fringing the eastern uplands, ranging in waters varying from strongly acid to alkaline and into slightly brackish water. Because it lives successfully in quiet, standing waters it has been able to enter the Great Lakes drainage at a number of points and is the only *Noturus* that has gotten into the Hudson Bay drainage.

An indication of a similar, but more southern, distribution is shown by the ranges of the four species of the *furiosus* species group in the subgenus *Rabida*. In this group *Noturus furiosus* is the sole species of the subgenus that is found in Atlantic coast streams; *Noturus munitus* ranges farther east along the Gulf coast than do others; these combined with the species in the Ohio and Arkansas drainages point to an ancestor that was widely distributed around, but that did not extensively enter, the eastern upland region. *Noturus gilberti* in Virginia, and *Noturus albater* in the Ozarks are relicts without apparent close relatives elsewhere.

Sexual Dimorphism

Breeding ictalurid catfishes may temporarily show marked sexual differences, but young and immature individuals of both sexes are essentially alike in color and gross morphology. Ripe females are heavy with eggs and, if young adults, may lack the excessive development of head musculature and dark color displayed by nest-guarding males. With age, the female's musculature and color progressively resemble those of the mature male. Spawning males thus are commonly darker or more drab than spawning females. In some forms the external genitalia are useful in distinguishing the sexes, at least at the time of maximum gonad development. Some of these evidences of sexual dimorphism have played an important part in the interpretation of species of catfishes, especially in *Ictalurus*, and led to identification of two species of *Noturus* as one. Prominent, permanent, external, sexual differences have not been found in *Noturus*, and aside from the genitalia, may not exist in the other genera. There is some evidence suggesting slight external sexual differences in all groups. The only reliable way that was found to determine sex in *Noturus* was by examination of the gonads, as attempts to sort various species by sex on the basis of external morphology and genitalia met with failure.

A few years ago several workers accepted the suggestion that gross sexual dimorphism is a common permanent phenomemon in catfishes and is involved in the proper delineation of species. This belief was largely based on statements by Hubbs (1940, pp. 209–211) and Hubbs and Allen (1944, p. 118) and complicated by the frequent observation of a young appearing female, which often more or less resembles the immature young male, spawning with a more fully developed, dark, puffy cheeked male. These developmental changes have confused the nomenclature of several of the species of *Ictalurus* with excess names based on immature and adult stages. Ontogenetic change is minor and has not complicated nomenclature in *Noturus.*

Although Hubbs (1930, p. 432) had once recognized both *Noturus eleutherus* and *N. furiosus* from the Ohio Valley, these were later regarded as conspecific, the result of sexual dimorphism (Hubbs and Lagler, 1941, p. 65; Bailey and Taylor, 1950, p. 31).

A re-examination has been made of all Ohio drainage and Great Lakes material previously identified as *Schilbeodes furiosus* or *Schilbeodes eleutherus.* Many collections from the Ohio Valley were found to contain two distinct morphological types. It was also noted that samples from the Huron River, Michigan, consisted of only one of the kinds, and collections from the upper Tennessee Valley, the other. Examination of the gonads of these two forms indicated that each contained both males and females, although one sex often predominated in a collection. Combination of several random samples of either kind, however, suggested approximately a 50–50 ratio of males and females in nature. Since no intermediates between the two forms were present and since both males and females were represented in each morphological type, the occurrence of two sympatric species in the Ohio Valley is indicated. One of these, *Noturus stigmosus* (formerly aligned with *Schilbeodes furiosus*), in contrast to the other, *N. eleutherus*, is characterized by more caudal and anal rays, a longer and more extensively serrated pectoral spine, a longer posterior process of the cleithrum and dorsal spine, a deeper caudal peduncle, usually by 11 preoperculomandibular pores (10 in *eleutherus*), and by several distinctive features of pigmentation. The difference in number of caudal rays in Ohio Valley specimens of the two species is indicated in figure 4; no prominent sexual difference is apparent in either species.

In summary, external sexual differences, except perhaps in large breeding ictalurids (which are not well known), are slight. They do not constitute a complicating factor in the recognition of species. Much of the confusion has arisen from lack of knowledge of changes due to growth and sexual maturity. Plots of the number of serrae of the pectoral spine in *Noturus stigmosus* (fig. 2) and in several other species, suggest a slight sexual difference, the female perhaps averaging more. No sexual difference in numbers of fin rays is evident (e.g., figs. 1 and 4).

Reproduction

Little published observational work has been done on life histories of the species of *Noturus.* Hankinson (1908) and R. M. Bailey (1938) gave information on *Noturus gyrinus;* Fish (1932), Greeley (1929 and 1934), and Langlois (1954) recorded time of spawning, observa-

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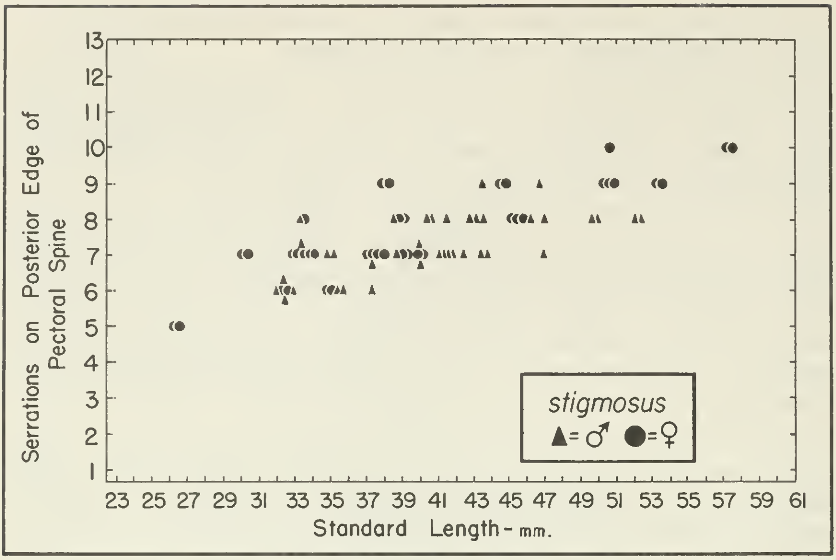

FIGURE 2.—Size change in the number of serrations of the posterior edge of the pectoral spine in *Noturus stigmosus*. *Noturus eleutherus* differs little from *stigmosus* in the number of serrae. In most other species of the subgenus *Rabida*, it is not possible to distinguish species on numbers of serrae as the overlap is great. There is some suggestion (in the several species plotted) that females average more serrae than do males.

tions of young, and egg counts for *Noturus flavus;* Fowler (1917b) and Clugston and Cooper (1960) reported on *Noturus insignis*, and Thomerson (1966) gave data on *Noturus funebris*. Species of *Noturus* lay comparatively few eggs, undoubtedly the joint result of small body size and large egg size. *N. flavus*, according to published accounts, lays more than others, probably averaging between 500 and 1000. The madtoms lay few eggs, many species perhaps less than 100 at a time.

Spawning occurs in middle or late summer in the north. Since the species are characteristic of warm water, this is to be expected. Probably the late spawning and warm water environment contribute importantly to the relative geographic constancy in fin ray counts of most species. The time of spawning in the south has not been reported, but it probably begins in early spring and extends well into the fall. Hellier (1967) reported young (size not given) of *Noturus gyrinus* collected in the Santa Fe River, Florida, from April to September. Thomerson (1966) was unable to determine the age of a sample of *Noturus funebris* from Florida, but based its age interpretation on the length frequency distribution of the sample, assuming late season spawning. If the spawning season does begin earlier and extends later into the year than in the north, his two smallest groups could easily have hatched the previous year rather than only one group resulting from the previous years spawning activity.

The species are nocturnal and all probably spawn in at least relative darkness, under objects or in cavities. All are probably solitary spawners as only one male and one female seem to occupy a nest.

The male fertilizes the eggs and then takes over their care and guarding, probably remaining with them and the young until the yolk sac is absorbed and the young are able to fend for themselves. The male, especially, is characterized during the breeding season by swollen areas on the head and upper surfaces, and by a drab color. The apparent ripe female seems to be somewhat less differentiated from nonspawning stages.

REPRODUCTION IN *Noturus miurus*.—Some information was gained on the reproduction and the young of *Noturus miurus* in the Huron River, 1.7 miles above Dexter, Michigan, in 1951. The river near the shore where the current was slow, had a bottom of silt and mud. In this area were scattered *Chara*, *Potamogeton*, and *Sagittaria*, numerous tin cans, a fallen tree, tree roots, some brush, boards, much debris, and a sunken boat. In the middle of the stream, where the current was somewhat faster, there was submerged vegetation on a bottom of gravel, sand, rubble, marl, and scattered mollusk shells. The water temperature on August 10 was 78°F.

On August 8 and 10 brooding specimens of *Noturus miurus* were found here in abundance by picking up the sunken tin cans, a relatively high proportion of which contained two adults or one adult with young or eggs. Beer cans which had round openings approximately ¾ to 1 inch in diameter were most often inhabited. The inhabited cans were free of detritus and most often had the open end downstream. They may have been cleaned by the male which guarded the nest. The area was revisited on July 27, 1952, when *N. miurus* was again found brooding eggs.

A sample of 10 nesting individuals, either with eggs or young, was retained. All were males. They ranged in standard length from 51 to 71 mm.; four were less than 60 mm. long and five were between 60 and 70 mm. Some data were obtained on the relation of size of the male guardian and the number of eggs or young as follows: 55 mm. (34 eggs); 55.5 mm. (28 young, brood incomplete); 56 mm. (34 young, brood incomplete); 64 mm. (35 eggs); 67 mm. (38 young, brood incomplete); 68 mm. (46 eggs). The eggs were large and amber in color. All those in a nest adhered together in an irregular mass until hatched. One guarding male swallowed his eggs after placement in a clear glass jar.

Nest-guarding males were rather characteristic. The black of the saddles and the top of the head had changed to intermediate grayish and tended to diffuse indistinctly into the general mottlings of the side. The head became especially broadened, and apparently flattened. The mouth appeared to have enlarged. Several muscle masses became swollen: one was located on the back just anterior to the dorsal fin; another on the top of the head and behind the eye was separated from the swollen mass of the opposite side only by a median depression, and continued indistinctly to below the eye, where it appeared as another enlarged mass on the cheek; the lips and an area around the base of the maxillary barbel were also swollen. The appearance of post-spawning females was not learned, since they did not occupy nests.

In a night collection of 99 specimens taken mostly from a *Chara* bed on August 10, 1951, 44 were males, 55 were females. Twelve of the males resembled nesting individuals. Three of the females lacked the general diffusion of pigment and the swollen muscles that characterized breeding males, but had large eggs; they possibly would still have spawned that summer. No post-spawning females were collected; the remaining 52 females were immature and contained tiny undeveloped eggs.

Reproduction in *Noturus stigmosus*.—In the Huron River Michigan, reproduction in *N. stigmosus* seems to occur a little earlier than in *N. miurus*, and more eggs are laid. The Museum of Zoology, University of Michigan, has two egg masses that were collected July 27, 1932, in which the embryos are well advanced in development. Another lot collected July 27, 1952, was guarded by a male 90 mm. in standard length; it contained 89 eggs. Still another lot taken the same day consisted of an incomplete brood of 61 young; it was also guarded by a male 90 mm. long. A male 67 mm. long, collected on July 19, 1953, was guarding 141 eggs.

One of the first two egg masses was reported to have come from gravel under a stone. The others came from cans which had fairly large openings. It is likely that any small cavity of about the size of a Number-2 can or larger with a large open end may serve as a nest. Other adults were found in assorted cans, milk bottles, a coffee can, and sunken boxes. As in *N. miurus*, occupied cans were free of detritus. The nest-guarding male had the same features: broadening and apparent flattening of the head; swellings of the lips, cheeks, back of head, and predorsal region; and the general diffusion of pigments from the constrasting or sharp markings of younger individuals, that are also characteristic of brooding males of *miurus*.

Early Development

Four sac fry from a brood of *Noturus miurus* that was hatched the night of August 10, 1951, were preserved the afternoon of August 14, 1951, and were stained with alizarin red S to determine ossified structures. They range from 9.5 to 11.0 mm. (mean 10.3 mm.) in total length or 8.0 to 9.5 mm. (mean 8.8 mm.) in standard length. At this stage, there are no pigment cells, the yolk sac is large, and considerable ossification has taken place. The top of the skull is unossified but the opercle and the jaws are well ossified. The rod-like basioccipital is prominent; back of it, the vertebral column is well developed. Pectoral and pelvic fins are present, with distinct fin rays; however, the number of rays was not determined because of their mangled condition. The pectoral fin has a poorly ossified spine that has no serrae; the dorsal fin has six soft dorsal rays (at least in three specimens), a well-developed but rather poorly ossified spine, and a short plate-like spine in front. No pectoral radials are visible.

The caudal fin at this stage has only 29, 29, and 30 rays, approximately one-half the adult complement; there are no branched rays. There are 14 or 15 (mean 14.8 in 4) anal rays, approximating the number (mean 15.2, see p. 198) in the adults at this locality. The branchiostegal ray complement does not seem to have been attained; there are six to eight rays present.

In the vertebral column, it can be seen that five vertebrae make up the anterior vertebral complex (Regan, 1911, pp. 553–554), which also were observed in tiny *Noturus gyrinus*. The most anterior centrum is longitudinally constricted and becomes a relatively free, flat disk; the next two are somewhat restricted in length; the fourth bears a parapophysis (or transverse process), one arm of which is directed forward at about a 45° angle. Its end turns slightly downward and is attached to the cleithrum. The fifth and successive vertebrae have transverse processes that are directed outward at an angle of about 90° to the vertebral axis. In the next larger size examined (see below), it can be seen that the sixth vertebra is the first that bears ribs. It is also the first free vertebra, as the centra of vertebrae 2–5 are nearly fused. This confirms R. R. Wright's (1884a, p. 249 and 1884c, p. 376) and McMurrich's (1884, pp. 294–295) observations. The dorsal spine is supported by a heavy strut extending diagonally backward from the fifth vertebra; the plate-like spine in front connects through a large strut to the fourth vertebra and its transverse process. Posteriorly, two small centra are present in the upturned caudal lobe; however, whether two, or three, or more are fused into the urostyle could not be determined.

Two other lots of 10 and 11 specimens of *Noturus miurus* were stained. The first is a brood at least 12 days old, with a range of from 14.7 to 16.0 mm. in total length and from 12.0 to 12.8 mm. (mean 12.5 mm.) in standard length. The 11 fish in the second brood died at various times, from three to five weeks after collection. They range from 14 to 17 mm. in total length and from 11.5 to 13.4 mm.

(mean 12.8 mm.) in standard length. The body form is like that of the adult; the yolk sac has degenerated and pigmentation is well advanced. The full complement of soft dorsal, soft pectoral, and pelvic rays is present (i.e., 6, 8, and 9 in each fin, respectively). There are nine branchiostegal rays in several. The anterior pectoral-spine serrae are present; there are two posterior serrae on each side in all specimens. The pectoral radials are ossified and distinct with one exception; those of the left side of an individual 12.8 mm. long have the ends fused.

The skull is poorly ossified. There are no definite bones in the infraorbital canal system or along the lateral line. The supraorbital, lateral, and preoperculomandibular canals are encased in tubes of bone that almost exceed in diameter the remainder of the bony elements through which the canals pass. The humeral process is long; the maxilla is scarcely visible.

Even at these sizes, the anal fin is virtually complete and the caudal fin has over 80 percent of its rays present (i.e., that take up the alizarin stain). The middle rays of the fin are beginning to branch. The following summary gives the range and mean for data from: (a) the first group, averaging 12.5 mm. in standard length, (b) the second averaging 12.8 mm., and (c) large specimens and adults from the same locality. Upper-half caudal rays: (a) 26–28 (27.1), (b) 23–29 (27.1), (c) 30–35 (32.5). Lower-half caudal rays: (a) 22–24 (23.0), (b) 20–24 (22.7), (c) 24–29 (26.4). Total caudal rays (fig. 1): (a) 49–52 (50.1), (b) 43–53 (49.8), (c) 55–64 (58.9). Anal rays: (a) 14–15 (14.6), (b) 14–16 (15.1), (c) 14–17 (15.2).

Subgenus *Schilbeodes* Bleeker

Schilbeodes contains all of the dark, nearly uniform colored species of *Noturus* except *flavus*. The nine included species show a diversity of characters that precludes an adequate phylogenetic arrangement of the species and may indicate that this grouping is polyphyletic.

In addition to the dark color pattern, there are usually 8 or 9 pelvic rays, 6 to 10 soft pectoral rays, and 10 or 11 preoperculomandibular pores. The pectoral spine (pl. 3, figs. 1–9) varies from short and blunt to long and relatively straight; it is deeply grooved in *N. gyrinus* to very shallowly grooved in *N. leptacanthus*; there are no anterior serrae, but the anterior edge may have recurved hooks or step-like processes; the posterior edge is variably serrate or smooth; the developed serrae are of variable shape or nearly straight, their tips never uniformly turned toward spine base; the mouth is terminal or inferior; the premaxillary tooth patch is a short, rectangular band without prominent posterior projections. The branchiostegal rays vary from 8 to 12; vertebrae anterior to the first pterygiophore of the anal fin

10 to 15, most frequently 11 to 14; precaudal vertebrae 7 to 11, usually 8 to 10; ribs 5 to 9, usually 6 to 8; caudal vertebrae showing much variation. The total number of vertebrae often averages higher than in most species of the subgenus *Rabida*, ranging from 32 to 42. Three species have a modal number of seven (3+4) hypurals; the remainder have six (3+3), as is typical of the other subgenera. The hypurals show various degrees of fusion. The ossified pectoral radials of each side of the pectoral girdle are typically fused; the anal fin is short to relatively long, containing 12 to 27 rays. The number of branched caudal rays is extremely variable; there are usually 16 or more, except in *N. leptacanthus*, ranging from 14 to 40. The body varies from short to moderately elongate. The species are of variable size: *N. leptacanthus* appears to be a small species; *N. insignis*, *N. nocturnus*, *N. phaeus*, and *N. funebris* attain a relatively large size for members of the genus.

The forms are found both in the lowlands and the mountains of the southern and eastern United States, with *gyrinus* having the greatest range—into southern Canada and south central Texas. This points to a southeastern origin. At least three of the species, *N. exilis*, *N. insignis*, and *N. gilberti* reach their greatest abundance in uplands. Aside from *N. gyrinus*, all are typical of graded streams and riffles. *N. exilis*, *N. phaeus*, and *N. funebris*, and possibly *N. leptacanthus*, appear to prefer small streams.

The earliest known species were placed in the genera *Silurus* Linnaeus or *Pimelodus* Lacépède. The name *Pimelodon* Vaillant was probably derived from the word *Pimelodus* and was based on *Pimelodon insignarius* Vaillant equals *Noturus insignis* (Richardson); otherwise it has not been in accepted usage. In later years, most authors have included the species as a unit, together with the species of the subgenus *Rabida*, in *Schilbeodes*, or all with *flavus* in *Noturus*. A few that have recognized *Rabida* as a genus, unnaturally included one or more of the species with pectoral spine serrae in that genus and generally restricted *Schilbeodes* to include only *leptacanthus*, *nocturnus*, and *gyrinus*, all of which lack prominent pectoral spine serrae.

Aside from *Noturus lachneri*, which is intermediate in several characters between *Noturus exilis* and *Noturus gyrinus*, *Schilbeodes* would be satisfactorily monotypic, with *Pimelodon* including the remainder of the species. The gradations of characters do not suggest the desirability of recognition of one group with a terminal mouth and ten preoperculomandibular pores and another with an inferior mouth.

Schilbeodes is formed from *Schilbe*, a genus of fishes lacking an adipose fin, and *odes* (Greek), meaning likeness. This name was proposed by Bleeker in the belief that the type-species, *Silurus gyrinus* Mitchill, lacked an adipose fin.

Key to the Species of the Subgenus *Schilbeodes*

1. Mouth terminal, jaws about equal; typically 10 preoperculomandibular pores, but 11 in some populations of *Noturus gyrinus* 2

   Mouth inferior, lower jaw included; preoperculomandibular pores normally 11, but 10 in some populations, especially *Noturus nocturnus* 4

2. Infraorbital and supraorbital canals typically joined anteriorly (1 internasal pore); head length in standard length 3.6 to 4.4 times; anal rays 16 to 22; vertebrae 36 to 41 3

   Infraorbital and supraorbital canals typically separated anteriorly (2 internasal pores); head length in standard length 3.0 to 3.8 times; anal rays 12 to 18; vertebrae 32 to 37; pectoral spine lacking serrae . . **Noturus gyrinus**

3. Pectoral spine lacking serrae; fins nearly unicolor; caudal rays 56 to 61; distance from rear end of adipose fin to tip of caudal fin stepped 1.2 to 1.6 times in distance from origin of dorsal fin to rear end of adipose fin . . . . **Noturus lachneri,** new species

   Pectoral spine with prominent, well-developed serrae; fin margins often black; caudal rays 44 to 57, usually 47 to 54; distance from rear end of adipose fin to tip of caudal fin stepped 1.6 to 2.5 times in distance from origin of dorsal fin to rear end of adipose fin . . . . . . **Noturus exilis**

4. Pelvic rays normally 8; pectoral spine nearly smooth behind; body and fins often with numerous clusters of darker chromatophores or freckles. **Noturus leptacanthus**

   Pelvic rays normally 9 or more; pectoral spine nearly smooth, rough, or serrate behind; no prominent clusters of chromatophores scattered over body and fins 5

5. Entire abdomen and lower surface of head usually well pigmented, covered with large, discrete chromatophores; anal base long, with 18 or more, usually 20 or more rays, and separated from caudal fin by only a narrow space; dorsal spine slender and flexible in young and juveniles, becoming stout with age 6

   Abdomen and lower surface of head mostly unpigmented, but pigment often on chin and in a narrow cross band anterior to pelvic fins (very large or old specimens, typically above 80 mm. standard length, often with a diffuse, dark pigment covering the lower surface); anal base shorter, of 21 or fewer rays; dorsal spine stout, stiff at all sizes 7

6. Several prominent, distinct, sharp serrae along posterior edge of pectoral spine; anal rays 18 to 25, usually 20 to 22; soft pectoral rays typically 8 or 9 . . . . **Noturus phaeus,** new species

   Pectoral spine without distinct serrae, or occasionally with one to three irregular size serrae in young, the posterior edge usually only roughened; anal rays 20 to 27, usually 21 to 24; soft pectoral rays typically 9. **Noturus funebris**

7. Vertical fins with broad light borders; abdomen and lower surface of head immaculate; caudal rays 46 to 54; upper-half caudal rays 22 to 27; spines very short . . . . **Noturus gilberti**

   Vertical fins dark or dusky, or occasionally with very narrow light margins; chin and area in front of pelvic fins usually with pigment; caudal rays 54 to 67, typically 56 or more; upper-half caudal rays 27 to 35, usually 29 or more 8

8. Pectoral spine with discrete serrae which often become irregular or reduced in size with age; vertical fins frequently with jet black margins; preoper-

culomandibular pores nearly always 11; anal rays 15 to 21, usually 17 to 19; vertebrae 37 to 42, usually 38 to 40; body relatively slender; head depressed . . . . **Noturus insignis**

Pectoral spine rarely with distinct serrae, its posterior edge usually only roughened; vertical fins usually uniformly dusky, but sometimes light edged and frequently with a submarginal dark brown band; preoperculomandibular pores either 10 or 11; anal rays 15 to 20, typically 16 to 18; vertebrae 35 to 38; body heavier; head rounded above . . . . **Noturus nocturnus**

Noturus gyrinus (Mitchill)

TADPOLE MADTOM

PLATES 2 (FIG. 1), 3 (FIG. 1), 5 (FIG. 1); MAP 1

Silurus gyrinus Mitchill, 1817, p. 289; reprinted *in* Jordan and Evermann, 1896a, p. 281 (original description; Wallkill [R.]).—Mitchill, 1818, pp. 241, 322–323 (description; Wallkill R.).—Rafinesque, 1819, p. 422; 1820b, p. 68; 1820c, p. 362; reprinted *in* Jordan, 1877c, p. 41, and *in* Call, 1899, p. 128 (believed to belong to . . . *Noturus*).—De Kay, 1842, pp. 185–186 (description; New York).—Bleeker, 1858, pp. 249, 258 (relationship; description; type-species of *Schilbeodes*).—Günther, 1864, p. 104 (New York).—Gill, 1876, pp. 422, 423 (correctly referred to *Noturus* by Rafinesque; Bleeker's 1858 description reprinted).—Jordan, 1919, p. 279 (orthotype of *Schilbeodes*).

Schilbeodes gyrinus (Mitchill).—Bleeker, 1858, p. 258 (North America).—Eigenmann and Beeson, 1894a, pp. 81–82; 1894b, p. 45 [and 1905, p. 121] (Indiana records: Kankakee R., Riverside;* Trail Cr., near Michigan City;* others compiled).—Cox, 1896, pp. 608, 612 (Minnesota records).—Evermann and Cox, 1896, pp. 375–426 (distribution; description; Missouri basin records, including Norfolk Cr.,* Norfolk Junction, Nebr.).—Eigenmann, 1896, p. 253 (Indiana records: String L.* [outlet]; Turkey L.,* channel,* and Turkey Cr.* [Syracuse]).—Jordan and Evermann, 1896a, pp. 144–146; 1896b, p. 234.—E. Smith, 1897, pp. 11–21 (Greenwood and Wawayanda Lakes, and Ramapo and Hackensack* Rivers, near New York City).—Cox, 1897, pp. 19–20, 78 (compiled).—Jordan and Evermann, 1898, p. 2790 (anal fin length).—Osburn and Williamson, 1898, pp. 11, 19 (Big Darby Cr. and Masons Run,* Franklin Co., Ohio).—Evermann, 1899, p. 306 (Black Bayou, Miss.; L. Lapourde, La.).—Reed, 1900, pp. 232–233 (poison glands).—Evermann and Kendall, 1900, p. 51 (Florida records).—Blatchley and Ashley, 1901, p. 176 (compiled).—Ramsey, 1901, p. 211 (Winona L.,* Ind.).—Blatchley, 1901, p. 252 (L. Maxinkuckee*).—Evermann and Kendall, 1901, p. 480 [and 1902, p. 210] (New York records).—Evermann, 1901, p. 338 (Wallkill R., N.Y.; economics).—Osburn, 1901, pp. 27–28 (ecology; Ohio records including [E. end] Sandusky Bay*).—Blatchley, 1902, p. 184 (compiled).—Evermann, 1902, p. 95.—Bean, 1903, pp. 93–94, 739 (Passaic R., N.Y.).—Large, 1903, pp. 9–10 [and 1905, pp. 56–57] (ecology; Illinois distribution).—Fowler, 1906a, pp. 171–173 (associations; Crosswicks Cr. and tribs. of Delaware R., "in or above tidewater," New Jersey); 1906b, p. 596 (Mill Cr., near Bristol,* Pa.).—Michael, 1906, p. 9.—Fowler, 1907a, p. 14 (Penn-

*Material designated by an asterisk has been re-examined.

sylvania records [in part]: Delaware R., Holmesburg;* Mill Cr., Bristol* and Tullytown); 1907b, p. 279 (specimen, Pennypack Cr., Holmesburg, Pa., figured; affluent of Crosswicks Cr., near Trenton,* N.J.; Mantua Cr., N.J.).—Reed, 1907, pp. 555–564, figs. 3–5 (poison apparatus).—Hankinson, 1908, pp. 188–249, pl. 59 (Walnut L.,* Mich.; ecology; food; reproduction; egg mass described and figured).—Wagner, 1908, p. 32 (L. Pepin, Wis.).—Meek, 1908, p. 141.—Fowler, 1908, pp. 151–152 (Pennsauken Cr., near Pennsauken,* N.J.).—C.W. Nash, 1908, pp. 24–25.—Reed and Wright, 1909, p. 393 (Cayuga L.,* N.Y.).—Forbes and Richardson, 1909 [and 1920, pp. lxx iii-cxv], pp. lxxiii-cix, 176–201, fig. 49 [not caption, 1st ed.], color plate, map 58 (ecology; comparison; range [in error]; Illinois distribution [see p. 44; one exception noted]).—Forbes, 1909, pp. 387–427, map 58 (Illinois ecology and distribution [one exception]).—Meek and Hildebrand, 1910, pp. 245–246 (Illinois records including: lagoon, Jackson Park, Chicago;* Des Plaines R., Berwyn;* and Indiana records).—Fowler, 1911a, p. 602 (Maurice R. basin [Muddy Cr.], near Elmer;* L. Hopatcong, in Hurd Cove,* N.J.); 1911b, pp. 4, 9 (Delaware*).—Leathers, 1911, pp. 246, 249 (at Rush L.,* and pond, Sand Point,* Huron Co., Mich.).—Bean and Weed, 1911, p. 172 (Little Beaver Dam Br.,* D.C.).—Hankinson, 1911, p. 203 (rush zone, Walnut L.,* Mich.).—Fowler, 1912a, pp. 241, 327 (Notch Cr., Brookdale; Muddy Cr., Elmer,* N.J.).—Wilson and Clark, 1912a, p. 15 (Indiana record); 1912b, p. 40 (Indiana records).—Richardson, 1913, p. 411 (Quiver L.,* Ill.).—Shelford, 1913, pp. 85–142 (ecology; L. Michigan, to 25 m. depth; Dead R., N. of Chicago).—Hankinson, 1913, pp. 108, 112 (Kaskaskia R. system, Ill.).—Halkett, 1913, pp. 17, 58 (Canada; hypothetical, Ontario).—Nichols, 1913, p. 92.—Fowler, 1913, p. 92 (Pennsylvania records compiled [in part only]).—Forbes, 1914, p. 18, fig. 14a, map 58 (Illinois distribution [one exception]; teeth figured).—Fowler, 1914a, p. 346 (Delaware R.); 1914b, p. 940 (near Penn's Manor,* Pa.).—Pearse, 1915, pp. 7–20 (food; ecology; Six Mile Cr., trib., L. Mendota, Wis.).—Fowler, 1915a, p. 208 (New Jersey records: [dam at] Pitman;* [West Br., Rancocas Cr.], Newton's Bridge;* [trib. Delaware R.], Florence.* Recorded from: Edison?, Pa.; Minneapolis,* Minn.; Brook R.,* Iowa; Miami,* Fla.; other records relisted [in part only]); 1915b, p. 5; 1916a, p. 12 (Alloway Cr., Alloway,* N.J.); 1916b, p. 41 (New Jersey record).—Adams and Hankinson, 1916, p. 168 (Oneida L. and tribs., N.Y.).—?Fowler, 1917a, p. 117 (Pennsylvania record).—Wells, 1918, pp. 570–571 (high resistance to adverse conditions in comparison with other fishes; negative to CO_2).—Fowler, 1918a, p. 4 (New Jersey records).—A. H. Wright, 1918, pp. 540–542 (in 5 Monroe Co., N.Y. streams).—Pearse, 1918, pp. 274–289 (food; Six Mile Cr. and L. Mendota, Wis.).—Nichols, 1918, pp. 38, 103.—Evermann, 1918, pp. 335, 366 (compiled).—Adams, Hankinson, and Kendall, 1919, p. 201 (New York record).—Fowler, 1919, p. 57 (Delaware basin in Bucks, Philadelphia, and ?Lehigh Counties, Pa., only).—Evermann and Clark, 1920, pp. 331–332, pl. 5 (reproduction; ecology; food; L. Maxinkuckee,* in main and small lake).—Wilson, 1920, p. 294 (food; ecology).—T. Surber, 1920, pp. 20–21 (figured; records compiled).—Hankinson, 1920, p. 134 (nests in natural cavities or depressions).—Fowler, 1920b, p. 150 (New Jersey records).—Conger, 1920, p. 11.—Lamont, 1921, p. 3

*Material designated by an asterisk has been re-examined.

(parasite, *Plagiorchis corti*, from intestine; L. Mendota, Wis.).—Fowler, 1921a, pp. 389, 398 (Delaware records); 1921b, p. 63 (Bucks Co., Pennsylvania records: Delaware R.;* Neshaminy?; Scott Cr.; others relisted).—Osburn, 1921, p. 6 (Portage L., Ohio).—Pearse, 1921, pp. 10–51 (food; L. Pepin, Wis.).—Palmer and Wright, 1922, pp. 356–361 (Okefinokee Swamp;* others compiled).—Dymond, 1922, p. 62.—Pratt, 1923 [and 1935, p. 89], pp. 95–96, figs. 41b–42 ([caption to figure transposed in first edition]; description; range).—Fowler, 1923, p. 28 (relisted).—Hankinson, 1923, p. 32 (New York records).—Wilson, 1923, pp. 253–254 (insect food).—Pearse, 1924, p. 148 (parasites).—Reed, 1924a, pp. 431–451, figs. 2–8 (structure and development of spine); 1924b, pp. 232–256, pl. 8, figs. 7–9, 12; pl. 9, figs. 18–21; pl. 10, figs. 22, 24; pl. 11, fig. 26; pl. 13, fig. 28; pl. 15, fig. 30 (description of pectoral spine and glands).—Hankinson, 1924, pp. 82, 86 (New York records).—Brimley and Mabee, 1925, p. 15 (North Carolina records including Little R., near Wendell*).—A. H. Wright, 1926, p. 81 (Okefinokee Swamp*).—Hubbs, 1926, p. 51.—Cahn, 1927, p. 42 (Oconomowoc R., Stonebank [USNM 87590, Waukesha Co.,* Wis., A. R. Cahn]; food; ?ecology).—Greene, 1927, p. 306.—Greeley, 1927, pp. 49, 57 (not taken in Genesee basin, New York [only]).—Fowler, 1928, p. 225 (relisted).—Potter and Jones, 1928, p. 355 (compiled).—Adams and Hankinson, 1928, pp. 384–385 (life history; ecology; food; effects of poison; Oneida L., New York localities).—Greeley, 1928, pp. 87–107 (food; ecology; New York records).—Eaton, 1928, p. 42.—Hubbs, 1928, p. 250 ("unusual habitat ascribed. . . ." by Cahn).—Hubbs and Greene, 1928, p. 390.—Wiebe, 1928, p. 161 (Mississippi R., Minneapolis,* Minn.).—Hildebrand and Towers, 1928, p. 122 (borrow pit, about 6 mi. SW. Greenwood,* Miss.).—Bajkov, 1928, p. 97 (compiled: Hudson Bay drainage).—Dymond, Hart, and Pritchard, 1929, pp. 4, 24 (Canada records).—Hankinson, 1929, p. 452 (North Dakota records [see p. 45]).—Greeley, 1929, pp. 155–174 (ecology; New York records).—Jordan, 1929, p. 94.—Truitt, Bean, and Fowler, 1929, p. 36 (?Baltimore Co., Md.).—Mueller, 1930, pp. 174–177 (parasites).—Osburn, Wickliff, and Trautman, 1930, p. 174 (Ohio).—Jordan, Evermann, and Clark, 1930, p. 155.—Thompson and Hunt, 1930, pp. 27–64, map 33 (Champaign Co., Ill., distribution; Salt Fork system only; ecology).—Cole and Allison, 1931, pp. 119–124 (decreased reaction time from increased hydrogen ions).—Greeley and Bishop, 1932, pp. 76, 87 (ecology; New York records and distribution).—Odell, 1932, pp. 117, 119 (New York records).—Sibley, 1932, pp. 129–130 (food; Black L. and Black R., N.Y.).—Shurrager, 1932, pp. 386–409 (arm of Margaret's Cr., Athens Twp., Ohio).—Greeley and Bishop, 1933, pp. 88–98, color pl. 8 (ecology; records Hudson R. system; adult male figured).—R. A. Moore, 1933, p. 17 (description kidneys).—Luce, 1933, p. 118 (near mouth Kaskaskia R., Illinois).—Gowanloch, 1933, pp. 85, 87 (Louisiana).—Friedrich, 1933, p. 29 (Minnesota record).—Churchill and Over, 1933, pp. 9, 60, fig. 48 (South Dakota distribution).—Hankinson, 1933, pp. 563, 568 ("Vegetal Shallows of Michigan inland lakes").—Roach and Wickliff, 1934, p. 374 (killed by oxygen reduction, Buckeye L.,* Ohio).—Van Cleave and Mueller, 1934, pp. 170–322 (parasites, Oneida L., N.Y.).—Jackson, 1934, p. 4 (Manitoba and prairie provinces, Canada).—Wallace, 1935, pp. 143–164 (parasites).—Greeley, 1935, pp. 86, 96 (ecology; New York records).—

*Material designated by an asterisk has been re-examined.

Odell, 1935, p. 132.—Fowler, 1935a, pp. 7, 19, fig. 36 (6 mi. NW. of Bennettsville,* S.C.).—Greene, 1935, pp. 144–145, map 60 (ecology; Wisconsin distribution [one exception]).—O'Donnell, 1935, p. 484 (ecology; Illinois distribution).—Ewers and Boesel, 1935, pp. 58, 63 (food; Buckeye L., Ohio).—Aitken, 1936, p. 33 (Iowa).—Fowler, 1936b, p. 150 (Florida records).—Hoover, 1936, p. 239 (Merrimack R.* and Penacook L., near Concord, N.H.).—Greeley, 1937, pp. 87, 97 (ecology; New York records).—Odell and Senning, 1937, p. 108 (New York records).—Carr, 1937, p. 81.—Toner, 1937, p. 14 (Belleville, Ontario).—Murray, 1938, p. 84 (in Indiana trout streams).—Blatchley, 1938, pp. 66–67.—R. M. Bailey, 1938, pp. 151–182 (ecology; reproduction; introduced, Merrimack Co., N.H.: Penacook L.,* 2.5 mi. WNW. Concord; Merrimack R., 1.25 mi. SE.* Concord and 2 mi. SSE.* Concord).—Schrenkeisen, 1938, p. 166.—Baker and Parker, 1938, p. 161 (Reelfoot L.,* Tenn.).—Bailey and Oliver, 1939, p. 152 (compiled).—Hubbs and Lagler, 1939, p. 26 (comparison; Great Lakes basin).—Trautman, 1939, pp. 279, 287 (Ohio records).—Dymond, 1939, pp. 27–28 (Ontario ecology and records).—Bangham and Hunter, 1939, pp. 401–434 (parasites, W. Lake Erie).—Kuhne, 1939, p. 68, fig. 43.—Baker, 1939a, p. 21 (Reelfoot L., Tenn.*); 1939b, p. 44 (comparison; Reelfoot L.*).—Raney, 1939b, pp. 675, 677 (associations; Cayuga L., Ithaca,* N.Y.).—Fowler, 1940b, p. 8 (Pennsylvania records relisted [in part only]).—Hubbs and Lagler, 1941, pp. 63–64, fig. 83 (comparison; range; ecology).—Bangham, 1941a, pp. 296, 302–305 (parasites; Hardee? Co., Fla.); 1941b, p. 445 (parasites; Buckeye L., Ohio).—Harkness and Pierce, 1941, p. 112 (L. Mize, Fla.).—Aitken, 1941, p. 389 (Iowa).—Driver, 1942, p. 254 [and 1950, p. 262].—Bangham and Venard, 1942, p. 29 (parasites, Reelfoot L.).—Eddy and Surber, 1943, pp. 151–162, fig. 29 (comparison; ecology; Minnesota distribution and records: St. Louis R. [system], trib. to L. Superior; L. Itasca; others compiled).—Bennett, 1943, p. 365 (population size estimated, artificial lake, Ill.).—Hubbs and Lagler, 1943, p. 80 (Foots Pond,* Ind.).—Haas, 1943, p. 163 (Fox and Rock R. systems, Ill.).—Hinks, 1943, pp. 58, 61 (figured; Red and Assiniboine R. systems, Manitoba).—Toole, 1943, p. 12 (ecology; Texas).—Smith and Moyle, 1944, p. 115 (relisted).—Radforth, 1944, pp. 6–62, figs. 22–23 (ecology; Ontario and L. Erie distribution; distribution compared with isotherms).—Goin, 1944, p. 146 (near Gainesville, Fla.; about hyacinth roots).—Fowler, 1945, pp. 32–271, fig. 164 (synonymy, distribution, and records, SE. U.S.).—Bangham, 1946, pp. 294, 302 (parasites, Lake-du-Bay, Wis.).—Cuerrier, Fry, and Prefontaine, 1946, p. 26 (St. Lawrence R., near Montreal).—Mélancon, 1946, p. 130.—Brimley, 1946, p. 15 (North Carolina records).—Marshall, 1947, p. 71 (Blue Springs, Fla.).—Baughman, 1950, p. 131 (Texas).—Neil, 1951, p. 765 (in crayfish burrows, Emanuel Co., Ga.).—?Fowler, 1951a, p. 91 (Lancaster Co., Pennsylvania records).—Hunt, 1953, p. 15 (Tamiami Canal, Fla.).—Hubbs, 1957, p. 98 (Texas distribution).—Keleher and Kooyman, 1957, pp. 106, 110 (Manitoba distribution; north to central L. Winnipeg).—G. Moore, 1957, pp. 142–144, figs. 2–77b, 2–79F, 2–80.—Hubbs and Lagler, 1957, p. 5; 1958, pp. 89, 91, fig. 175.—C. Hubbs, 1958, p. 8 (Texas distribution).—Slastenenko, 1958a, p. 7 (Canadian distribution); 1958b, pp. 248, 353, fig. 102 (compiled).—W. B. Scott, 1958, p. 19 (Canadian distribution).—Lambou, 1959b, p. 192 (in

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*Material designated by an asterisk has been re-examined.

Louisiana impoundments).—Becker, 1959, p. 97 (ecology; central Wisconsin distribution).—Boudreaux, Strawn, and Callas, 1959, p. 10 (Texas record).—Symington, 1959, p. 8 (Souris R., Saskatchewan).—Lambou, 1961, p. 57 (Louisiana lakes).—Anthony, 1963, p. 87 (parasites, McDill Pond, Wis.).—Eddy, Moyle, and Underhill, 1963, pp. 113, 115 (Mississippi R., above and below St. Anthony Falls, Minn.).—Birkhead, 1967, pp. 101–109 (compiled).

Noturus gyrinus (Mitchill).—Gill, 1861a, p. 45 (synonymy).—Abbott, 1871, p. 718 (Stony Brook, near Princeton, N.J.).—Jordan, 1876b, pp. 303–304 (description; Wallkill R., N.Y.).—Jordan and Copeland, 1876, p. 160 (E. Pennsylvania [based on *N. insignis*?] and SE. New York).—[Klippart], 1877, p. 153 (Indiana).—Jordan, 1877b, pp. 352, 371 (comparison; range [in error]); 1877d, pp. 71–120, pl. 42, fig. 66–67, pl. 43, fig. 69b–69c (comparison; range and synonymy [in part]; relationship; specimen from Hudson R. figured; Orange, Rockland, and ?Chemung Counties, N.Y.); 1877e, p. 611.—Jordan and Brayton, 1878, p. 93 (relationship).—Jordan, 1878d, p. 337 (description; range [in error]); 1878e, p. 414 (range [in error]).—Bean, 1880, p. 112 (near Piermont,* N.Y.).—Hay, 1881, pp. 514–515 (Mississippi record).— Jordan and Gilbert, 1883, p. 98.—Swain and Kalb, 1883, pp. 639–644 (synonymy; range [in error]; description; Illinois R.*).—Hay, 1883, p. 74 (Tombigbee, Chickasawha, and upper Mississippi R. systems).—Jordan and Meek, 1885, p. 8 (Chariton R., Chariton,* Iowa).—Graham, 1885b, p. 71 (synonymy; ?Kansas).—Forbes, 1885a, p. 84 [and 1900, p. 76] (ecology; "throughout Illinois").—Jordan, 1885, p. 802.—Eigenmann and Fordice, 1886, p. 410 (Bean Blossom Cr.,* Ind.).—Jordan and Gilbert, 1886, p. 6 (comparison).—Forbes, 1888a, pp. 455–473 (ecology; food; Pekin,* Peoria,* and Fox R.,* McHenry Co., Ill.; Clear L.* [East Cairo], Ky.).—Forbes, 1888b, pp. 514–536 (food).—Evermann and Jenkins, 1888, pp. 44, 52 (Indiana records).—Garman, 1889, p. 80 (Harkness Slough;* Dead Man's Slough; Willow L.;* Lily L.;* Broad L.;* Wood Slough,* all near Quincy, Ill.).—Henshall, 1889, p. 124 (Ross L., Ohio).—Meek, 1889a, p. 301 (New York records: Cayuga L.;* stream near Montezuma); 1889b, p. 168 (Iowa).—Jordan, 1890, pp. 158–165 (Indiana records: L. Maxinkuckee;* Big Cr., Posey Co.*).—J. Nelson, 1890, p. 671 (lake region, New York; doubted in New Jersey).—McCormick, 1890, p. 126 (Lorain Co., Ohio).—Bean, 1892, p. 20 (description only).—R. R. Wright, 1892, p. 443 (Great Lakes region).—McCormick, 1892, p. 13 (Lower parts streams entering the lake, Lorain Co., Ohio).—Woolman, 1892a, pp. 253–287 (Kentucky records); 1892b, p. 301 (Florida records).—Meek, 1892a, p. 12 (Iowa); 1892b, pp. 221–246 (Iowa records including Mississippi R., Muscatine;* Cedar R., Waverly* and West Liberty;* West Br. Cedar R., Dumont;* Indian Cr.* [Marion]; Big Sioux R., ?Sioux Falls or Sioux City*); 1892c, p. 108 (Cedar R. basin, Iowa).—Call, 1892, p. 46 (ecology; records relisted).—Meek, 1893, p. 229 (Arkansas [compiled in error?]).—Hay, 1894, pp. 172, 173 (compiled).—Abbott, 1894, p. 479 (compiled).—Kirsch, 1894, p. 87 [and vol. 14, p. 36]; 1896a, p. 48 (weedy bottom in upper Blue R.,* Indiana).—Meek, 1894b, p. 135 (Platte R., Fremont,* Nebr.; Floyd R., Lemars* and Sioux City,* Iowa; Storm L.,* Iowa).—Lönnberg, 1894, p. 113 (Florida records).— Garman, 1894, p. 56 (compiled).—Kirsch, 1895, pp. 323–335 (records include Tiffin R., Manitou Beach,* Michigan; Maumee R.,* Fort Wayne, Ind.;

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Fish Cr., Hamilton,* Ind.).—Woolman, 1896, pp. 356, 369 (Minnesota records: Pomme de Terre R., Appleton;* Chippewa R., Montevideo.* North Dakota records including Goose R.,* Hillsboro).—Meek, 1896, pp. 345–349 (Arkansas records: Old R., near Greenway [CNHM 1559,* either Marked Tree or ?Greenway]; St. Francis R.; Little and St. Francis Rivers, near Marked Tree;* Arkansas distribution [not W. Arkansas and Indian Territory]).—Hay, 1896, pp. 85, 89 (Water Valley,* Ind.; Kankakee R., Momence,* Ill.).—Call, 1896, p. 14 (ecology; Falls of the Ohio, Ky.).—Kirsch, 1986b, p. 105 (records relisted).—H. M. Smith, 1901, p. 134 (L. Mattamuskeet, N.C.).—Hay, 1902, p. 70.—Mitchell, 1904, pp. 154, 161, 405–406 (oral breathing valves described [confused and probably in part as *Schilbeodes punctatus*, a lapsus]).—Jordan, 1904, pp. 42, 351.—Fowler, 1906a, p. 173 (compiled, New Jersey).—Hahn, 1910, p. 175 (compiled).—Palmer and Wright, 1922, p. 356 (New R., Fla.).—Arnold and Ahl, 1936, p. 233 (figured; description; introduced as aquarium fish into Germany, 1895; failed to reproduce).—Bailey, Winn, and Smith, 1954, pp. 131–160 (records, lower Escambia R., Fla. [see p. 44]; fresh water; synonymy).—Taylor, 1954, p. 44 (synonymy; Michigan records [see p. 44]).—Slack, 1955, p. 40 (Indiana record).—Gerking, 1955, p. 76.—R. M. Bailey, 1955, p. 528 (Bass L., Michigan; heat mortality).—Harlan and Speaker, 1956, p. 114, pl. 21.—Cleary, 1956, map 64 (Iowa distribution).—R. M. Bailey, 1956, pp. 335, 364 (key).—Eddy, 1957, p. 152, fig. 382.—Taylor, 1957, p. 192.—Briggs, 1958, p. 260 (Florida, distribution).—Cross and Minckley, 1958, pp. 104, 106 (description; records, Osage R., Kansas).—Hancock and Sublette, 1958, p. 46 (Louisiana records, including Bayou Santabarb*).—Hallam, 1959, p. 158.—Stegman, 1959, p. 30 (Kinkaid Cr., Ill.).—Trautman, 1959, pp. 41, 43, 96, 432, 441–445, fig. 114, map 114 (synonymy, description, ecology, distribution, Ohio; range).—F. Cook, 1959, pp. 34, 135, 141, fig. 25D (Mississippi records).—Davis, 1960, p. 20 (Ouachita R., La.).—Behnke and Wetzel, 1960, p. 141.—Bonn and Holbert, 1961, p. 292 (L. Lavon, Tex.).—Schwartz, 1961, p. 25.—Patrick, 1961, p. 256 (in part; Ottawa and Potomac Rivers).—Suttkus, 1961, p. 63, fig. 5 (comparison; skull illustrated).—Deacon, 1961, pp. 395, 420–421 (Marais des Cygnes* R., Kans.).—Lambou, 1962a, p. 77; 1962b, pp. 197, 199 (Lake Bistineau,* La.).—Tabb and Manning, 1962a, p. 609 (Everglades National Park records); 1962b, p. 59 (records, zone of transition from marine to fresh water, Everglades National Park).—I. A. Carr, 1962, p. 6 (Saginaw Bay distribution).—Louder, 1962, pp. 69, 71 (North Carolina records).—Bailey and Allum, 1962, pp. 90, 118, 121 (characters, synonymy, distribution; South Dakota stations 8,* 15, 26c, 39, 44).—Collette, 1962, pp. 168, 169, 172 (in association with *Etheostoma*).—J. M. Walker, 1962, p. 38 (Louisiana parishes); 1963, p. 47 (Choudrant Bayou, La.).—P. W. Smith, 1963, pp. 254, 257–258 (records, Kaskaskia R., Ill.).—Feldmann, 1963, p. 17 (North Dakota records).—McNaught, 1963, pp. 43, 46 (L. Mendota).—Griswold, 1963, pp. 217, 220, fig. 3 (abundance and growth, Clear L., Iowa).—W. B. Scott, 1963, pp. 116, 123 (Ontario records; Canadian distribution).—Hanson and Campbell, 1963, p. 139 (Perche Cr., Mo.).—Larimore and Smith, 1963, pp. 324–345, fig. 47 (Champaign Co., Illinois records, ecology, distribution map).—Anderson, 1964, pp. 45, 51 (South Carolina records).—Keup and Bayless, 1964, p. 121 (Neuse basin,

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North Carolina; salinities 0 to 0.098).—Becker, 1964a, pp. 21, 25; 1964b, pp. 33–35, 46 (Wisconsin records).—B. T. Walker, 1965, pp. 106, 108 (Bayou D'Arbonne, station 16;* taken from bottles).—Burton and Douglas, 1965, pp. 93–94 (southern Bayou DeSiard, La.).—Suttkus and Taylor, 1965, p. 177.—H. H. Moore and Braem, 1965, pp. 2, 44 (records [stas. 155* and 156* re-examined] and distribution, Wisconsin tributaries of L. Superior).—Starrett and Fritz, 1965, p. 25 (L. Chautauqua, Illinois).—P. W. Smith, 1965, p. 9 (Illinois distribution).—Larson, 1966, pp. 99–100 (parasites, L. Itaska, Minn.).—Hellier, 1967, pp. 18–46 (parasites, ecology, distribution, Santa Fe R., Florida; young collected April to September).—Cross, 1967, pp. 197, 216 (figure, description, Kansas distribution).

Schilbeodes gyrinus gyrinus (Mitchill).—Greeley, 1936, pp. 77, 84 (ecology; New York: not in Susquehanna system; in Basher Kill system and Yankee L.).—Odell and Senning, 1936, pp. 93, 95.—Greeley, 1938, p. 69 (Cayuta L. and Cayuta Cr., N.Y.; ecology).—Odell and Senning, 1938, p. 99.

Noturus flavus Rafinesque [misidentifications].—De Kay, 1855, p. 66 (New York).—Baird, 1856, p. 26 (Hackensack R. [near Piermont*], N.Y.).—E. W. Nelson, 1876, p. 50 (Illinois, in part).—Jordan, 1876b, p. 303 (description; Ohio Valley, in part); 1877a, p. 46 (Indiana records [see Jordan, 1877d, p. 102]: Clear and Pine Lakes, Laporte Co.; St. Joseph R. system; White R. and tribs., near Indianapolis).—Garman, 1881, p. 89 (San Antonio, Texas*).—Eigenmann and Beeson, 1894a, p. 81; 1894b, p. 44 [and 1905, p. 120]; Hay, 1894, p. 175; Blatchley and Ashley, 1901, p. 288, and Blatchley, 1938, p. 66 (Jordan's Indiana records compiled).—Forbes and Richardson, 1909 [and 1920], p. 195 (Indiana distribution, in part).—Fowler, 1915a, p. 208 (Chariton,* Iowa [part is *Ictalurus melas*]).—?Bissett, 1927, p. 127 (Manitoba).—?Bajkov, 1928, p. 97 (Hudson Bay drainage, Canada).—?V. W. Jackson, 1934, p. 4 (Manitoba and prairie provinces).—Hinks, 1943, p. 62, and Dymond, 1947, p. 23 (Manitoba records need confirmation).—Gerking, 1945, map 62 (in part, compiled Indiana records).—Baughman, 1950, p. 131 (Texas compiled).—Rostlund, 1952, map 20 (distribution, in part).

Noturus sialis Jordan, 1877b, p. 377 (nomen nudum; White R. and small tribs., near Indianapolis, Indiana); 1877d, pp. 73–120, pl. 42, figs. 68, 69 (original description; type figured, and from White R., Indianapolis; about Falls of Ohio; range; synonymy); 1877e, pp. 611, 613 (range); 1878a, p. 119 (Ohio R.; White R.; Wabash R.; L. Michigan); 1878b, p. 68 (Illinois distribution; Wabash R.; Cache R.,* Johnson Co.; Illinois R., Pekin* and Cairo); 1878c, p. 368 (Indiana); 1878d and 1884, p. 337 (description; range [Kansas?]); 1878e, p. 414 (range).—Jordan and Brayton, 1878, pp. 87–95 (distribution; relationship).—Forbes, 1880b, pp. 74, 79 (food).—Jordan, 1882, pp. 745–801 (Ohio; description).

Schilbeodes gyrinus var. *sialis* (Jordan).—Jordan and Evermann, 1896a, p. 146; Truitt, Bean, and Fowler, 1929, p. 36 (Western specimens of *gyrinus* possibly distinguishable).

Schilbeodes gyrinus sialis (Jordan).—Greeley, 1936, p. 84 (probably valid form); 1940, p. 76 (ecology; 58 records [not listed], L. Ontario watershed, N.Y.).—Odell, 1940, p. 95 (records, L. Ontario drainage, New York).—Senning, 1940, pp. 104–105 (records, L. Ontario drainage, N.Y.).

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*Material designated by an asterisk has been re-examined.

Noturus nocturnus Jordan and Gilbert [misidentifications].—Jordan and Gilbert, 1886, p. 18 (Rio Lampasas, Belton,* Tex.).—Evermann and Kendall, 1894, pp. 80–96 (Texas distribution and records, in part: Lampasas R., Belton;* San Antonio Springs, San Antonio;* Hunter Cr., near Houston).

Schilbeodes nocturnus (Jordan and Gilbert) [misidentifications].—Forbes, 1909, p. 398 (Illinois distribution, in part).—Forbes and Richardson, 1909 [and 1920, pp. lxxviii–lxxxviii], pp. lxxiii–lxxxiii, 199 (range and Illinois distribution, in part [Camp Cr., Dallas City,* Henderson Co.]).—Eigenmann, 1919, pp. 398–399 (mouth of underground river, San Marcos, Tex.; "other places in Texas," in part).—O'Donnell, 1935, p. 484 (Camp Cr.,* Henderson Co., Ill.).

Ameiurus natalis (LeSueur) [misidentification].—Evermann and Kendall, 1894, pp. 78, 96 (Garman's record of *Noturus flavus* from San Antonio,* Tex.).

?*Schilbeodes punctatus*.—Mitchell, 1904, pp. 154, 405 (nomen nudum; lapsus; oral breathing valves described).

Schilbeodes mollis (Hermann) [misidentifications].—Hubbs and Raney, 1944, pp. 1–26 (synonymy, discussion, and description, in part).—Bailey and Harrison, 1945, p. 68 (ecology; Clear L., Iowa).—Gerking, 1945, pp. 13, 74, map 63 (ecology; Indiana distribution [see p. 44]).—Lagler and Salyer, 1945, p. 161 (in food of gartersnake, *Thamnophis s. sirtalis*).—Carpenter and Siegler, 1947, pp. 6, 53, fig. 45 (compiled).—Hubbs and Lagler, 1947 [and 1949], pp. 71–73, fig. 175 (ecology; comparison; specimen, Jackson Co., Michigan figured; range [Montana, dubious]).—Dymond, 1947, p. 23 (comparison; Canadian distribution).—Fischthal, 1947, pp. 162, 181 (parasites, Wisconsin localities).—Eddy and Surber, 1947, pp. 171–182, diag. 7E, fig. 29 (figured; teeth figured; range; description).—Carlander, 1948, p. 272 (Oak Island and at mouth of Rainy R., L. of Woods, Minnesota area).—Trautman, 1948, pp. 166–173, pl. 1, figs. 3, 6, and 9 (description; tribs. of L. Erie, Ohio; hybridizes with *Schilbeodes miurus*).—Hooper, 1949, pp. 34–38 (age of population by vertebrae; Demming L., Minn.).—Cooper and Washburn, 1949, pp. 27, 31 (Merkle L., Mich.; survived heavy winter kill).—[McCabe], 1949, pp. 41, 235 (Howe Pond,* Mass.).—Morgan, 1949, p. 96, fig. 60 (Howe Pond, Spencer, Mass.).—Leonard and Leonard, 1949, p. 304 (Birch Cr., Michigan).—Dickinson, 1949, p. 25 (near Gainesville, Florida).—Lincicome and Van Cleave, 1949, p. 426 (*Leptorhynchoides thecatus*, a parasite, in specimens from Minnesota, Ohio, and Wisconsin).—Harrison, 1949, p. 339 (Des Moines R. basin, Iowa).—C. B. Nash, 1950, p. 562 (ecology; L. Erie, Long Point, Ohio).—Moore and Cross, 1950, pp. 139–142 (ecology; description; Oklahoma and Swan Cr., Ohio specimens compared; Oklahoma records: [not in Illinois R.?]; oxbow lake,* Poteau; Clear Boggy R.,* Pontotoc Co.; slough along Little R., McCurtain Co.; Mountain Fork R., near confluence with Little R.*).—R. F. Smith, 1950, pp. 63–136, 172, fig. 29 and 1953, pp. 21–135, 183–184 (lake and pond records, New Jersey).—Moore and Paden, 1950, pp. 87, 93 (Oklahoma [not Illinois R.]).—Carlander, 1950, p. 109 (compiled).—Raney, 1950, pp. 170–190 (ecology; reproduction; coastal plain form; reported, James R. system, Va.).—Reid, 1950, pp. 177–178 (ecology; Orange L., Fla.).—Bailey, 1951, pp. 194, 224 and *in* reprint, 1951, pp. 194, 226 (comparison; Iowa).—Harlan and Speaker, 1951, p. 97, pl. 18 (Iowa; distribution; natural

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*Material designated by an asterisk has been re-examined.

history).—Legendre, 1951, p. 3 (Quebec).—Mansueti, 1951, p. 302 (Maryland, in associations).—Frey, 1951, pp. 8–39 (description; Lakes Jones, Salters,* Singletary, White, Black, and Waccamaw,* N.C.).—Howden and Mansueti, 1951, p. 95 (compiled).—Hall, 1951b, pp. 14, 17 (L. Murray, Carter* Co., Okla.).—Hooper, 1951, pp. 464–477 (Demming L., Minnesota; introduced in 1940; a great weight of specimens taken after poisoning).—Cross and Moore, 1952, p. 406 (Oklahoma; relisted).—Fowler, 1952, p. 108 (relisted).—G. Moore, 1952, p. [6] (Oklahoma).—Jurgens and Hubbs, 1953, p. [3] (Texas).—Keleher, 1953, pp. 171–172 (distribution; size; Manitoba records: junction of Red and Assiniboine Rivers, Winnipeg; L. Winnipeg, Black Bear Island, 51°46′ N. Lat.).—Freeman, 1953, p. 269 (Savannah R. basin, Aiken* and Barnwell* Counties, S.C.).—Mansueti and Elser, 1953, p. 118 (associations; Chamber's L., Federalsburg, Md.).—Legendre, 1953, pp. v, xi, 29, fig. 59 (synonymy; comparison; Québec, Canada).—Fischthal, 1953, p. 101 (parasites, Wisconsin).—Bick, Hornuff, and Lambremont, 1953, p. 230 (Louisiana record).—Knapp, 1953, pp. 77–78, fig. 107 (comparison; range).—Raney and Massmann, 1954, pp. 426–431 (throughout tidewater section, Pamunkey R., Va.; most abundant in coves).—Hall, 1954, pp. 61–62 (doubtful, Illinois R., Okla.).—W. B. Scott, 1954, p. 69 (figured; characters; size; food; distribution in E. Canada).—Langlois, 1954, pp. 208, 281 (food; Ohio records).—Cleary, 1954, p. 633 (Shellrock R. and Cedar R. basin, Iowa).—Harrington, 1954, p. 529 (death from carp egg diet).—Legendre, 1954, pp. 8, 14, 43, fig. 59 (key; Québec).—Freeman, 1954, pp. 138, 145, 147–151 (records, in part, Savannah R. drainage, South Carolina: stations 3,* 33,* 35,* 37,* 61*).—Harmic, 1954, p. 50 (Christina Cr., Del.).—Carr and Goin, 1955, pp. 21, 64, pl. 12 (Florida distribution).—Bond and Bisbee, 1955, p. 56 (Oregon and Idaho* records).—R. F. Smith, 1957, pp. 12–189, fig. 17 (lake and pond records, New Jersey; used for bass bait).—Anderson and Freeman, 1957, pp. 104, 109 (Congaree drainage records* [all re-examined]).—Crittenden, 1958, p. 218 (Bay Co., Fla. records).

Noturus mollis (Hermann) [misidentification].—Patrick, 1961, p. 256 (Escambia R.).

Schilbeodes leptacanthus (Jordan) [misidentifications].—Fowler, 1945, p. 271 (Murdock,* Fla.).—Freeman, 1954, pp. 138, 145 (Savannah drainage, S.C., station 50* only).

Noturus leptacanthus Jordan [misidentification].—?Gunter and Hall, 1965, pp. 23, 49, 57 (Caloosahatchee R., near Fort Myers, Fla.; salinity 0.22 ppt.).

Schilbeodes insignis (Richardson) [misidentifications].—Harrison and Speaker, 1954, p. 519 (compiled records: Big Sioux* and Floyd* Rivers; Little Sioux R.;* ?Boyer R., all Iowa).

Other material studied

UNITED STATES: Alabama: CU 15537, 19281 (Hurricane Cr., 5 mi. E. Holt, Tuscaloosa Co.); USNM 36713 (Black Warrior R., near Tuscaloosa), 200474 (Cahaba R., near Centreville, Bibb Co.); UMMZ 97800, 111204 (vicinity of Auburn); TU 2619, 19409 (Cahaba R., 8.5 mi. N. Centreville, Hwy. 27, Bibb Co.), 24553. Arkansas: UMMZ 128448, 128559; UMMZ (Delavan and Creaser no. 31–13); USNM 165847; TU 2226; CU 35675. District of Columbia: UMMZ (IU no. 6458); USNM 87491. Florida: UMMZ 86759 (Paradise Key, Dade Co.), 87896, 92158–9, 92162 thru 92164, 110471, 110669, 136506, 138453, 139232,

*Material designated by an asterisk has been re-examined.

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155060, 155499, 158178, 158549, 158638, 165062, 165113; UMMZ (Rogers coll., 2 lots); CU 3991, 12029, 12786, 15919 (Tamiami Canal, 40 mi. W. Miami), 16732; CNHM 11917; USNM 82246, 88590, 89360, 92909, 133250, 133366, 133390, 133417, 134065, 196731; UMML 4753, 5963, 11356, 13038, 13705, 14055, 16095 (pool, 5 mi. N. Coot Bay Pond, Everglades National Park). Georgia: UMMZ 88624, 88669, 134635, 138732, 138740; UMMZ (Fletcher nos. 16-Oconee R., Princeton, Clarke Co.; 31); Tulsa U 6; CU 214, 517, 15457, 17195, 17208, 17262; TU 12160 (Vidlery Cr., at Chattahoochee R., Roswell, Fulton Co.). Idaho: UMMZ 136204 (Snake R., Homedale bridge, Homedale, Owyhee Co.). Illinois: UMMZ 105921, 111669, 130053, 135599, 142024, 147029; UMMZ (G. V. Harry coll.; Bauman nos. 42, 68, 73, 75, 76, 77, 79; Mississippi River Survey colls., from Andalusia, Cordova, and Oquawka); CNHM 1380, 1470, 13911 thru 13918, 43268, 43298, 43317; INHS 51, 193, 211, 217, 1099, 2801, 5056, 5057, 5068, 7119, 11884, 13404, 13941, 24721, 24947, 24987, 24990, 24996, 24998, 26023, 26028, 26090, 26340, 26555, 26690, 26709, 27562, 27600, 27607, 27608, 27610, 27628, 27648, 27755, 28044, 28047, 28077, 28079, 28085, 28089, 28091 thru 28093, 28096, 28099, 28124, 28125, 28128, 28130, 28138, 28148, 28150, 28160, 28161, 28174, 28177, 28180, 28186, 28201, 28225, 28255, 28485, 28486, 28499; INHS (other nos. 484, 3090, 6233); UL 8430, 8991, 9065, 9074, 9102, 9124, 9146; USNM 15266, 201323. Indiana: USNM 64941, 64944, 66794 thru 66797, 67769, 68994, 120939, 196701, 196729, 199584; IU 15, 30, 36, 131, 138, 141, 154, 269, 305, 327, 357, 359, 362 thru 364, 366, 425, 446, 461; CNHM 2869, 6401, 7295, 10594, 16837 thru 16839, 42466; UMMZ 66620, 66965; UL 8092, 8104, 8295, 8852, 8873. Iowa: UMMZ 100895, 100942, 101083, 101382, 101553, 142414, 146013, 146839, 146887; UMMZ (Mississippi River Survey colls., from Sabula, Burlington, and near Dubuque); CNHM 1025, 1220, 2109; USNM 54986, 61937, 125567, 174928, 196733. Kansas: KU 3735, 3864, 3890 (Marais des Cygnes R., sec. 6, T. 17 S., R. 20 E., Franklin Co.). Kentucky: UMMZ 121614; UL 5072, 5274, 5495, 5610, 7048, 7118, 7905, 7931, 8770, 9615, 9862; USNM 199589. Louisiana: UMMZ 165879, 170525, 170837, 184286, 184291; UMMZ (Delavan and Creaser no. 31–53; Taylor nos. 54–3, 55–43, 55–46, 56–38, 56–42, and from L. Bruin, L. St. John, Buck Bayou–T. 9 S., R. 15 E.); USNM 172332, 172655, 172683, 172728, 172786, 172843, 172872, 172997, 173017, 173055; CU 13949; TU 1336, 3363, 3818, 4259, 4568, 5787, 6370, 7791, 11804, 13626. Maryland: USNM 30238, 61592, 68165, 74121, 85348, 85691, 89221, 90546, 100246, 100664–100665, 103863, 120967, 192647, 196682 thru 196690, 196730; CU 18697; UMMZ 89394, 136025, 137801; UMMZ (field no. H33–4). Massachusetts: CU 20590 (Sugden Reservoir, Spencer). Michigan: UMMZ 55242, 55388, 56041, 56262, 56611, 60014, 60025, 60270, 61742 (Otsego L., Otsego Co.), 61823 (Farm L., Au Sable R., Otsego Co.), 65668, 66664, 67447 (North Br. Devil R., Alpena Co.), 67486 (Snyder or Mindack L., Alpena Co.), 67516 (Zim L., W. of Alpena, Alpena Co.), 71627 (Devil L., Alpena Co.), 73308, 80674, 81832, 83310, 84845, 85353, 85368, 85395, 89932, 89994, 90127, 90247, 90986, 91003, 91010, 91030, 91067, 91146, 91235, 98003, 98024, 98084, 98131, 101894, 110253, 110327, 110366 (Bear L., Manistee Co.), 110373 (Lemon L., Manistee Co.), 111313, 113160, 116236, 116312, 116339, 116361, 116945, 117019, 117163, 117181, 129157, 129184, 133563, 133582, 136740, 136765, 136807, 136972, 136993, 137013, 137035, 137176, 137188, 137216, 137252, 137271, 137654, 137705, 137737, 137750, 138002, 138056, 138125, 138852, 138863, 139806, 139819, 140157, 140186, 145086, 164283, 164426, 165856 thru 165858, 165861 thru 165864, 165867 thru 165869; UMMZ (Kalamazoo River Survey nos. KA10, KA11, KA19, KA26, KA28, KA29, KA30, KA37, KA39, KA45; field no. S–1–Hart L., Calhoun Co.; Peterson coll.-Homer Mill Pond, Calhoun Co.; Crowe coll.-L. St. Clair, Bouvier Bay, St. Clair Co.; Hankinson nos. 9379J, 9410J, 9414S); USNM 68774, 174905, 193202. MINNESOTA: USNM 86555; UMMZ 80081 (Cloquet R., near mouth, St. Louis Co.), 94835 (Mississippi R., between Cass L. and Bemidji, Beltrami Co.), 97260. MISSISSIPPI: UMMZ 113452, 113878, 113894 (Luxapalilla Cr., 5 mi. N. Columbus, Loundes Co.), 157740 (Tombigbee R., 2.5 mi. N. of Amory, Monroe Co.), 163716; UMMZ (Delavan and Creaser no. 31–74, trib., Noxubee R., 2 mi. E. Macon, Noxubee Co.; Hutchins coll., Bluff L., near State College; Walker nos. 39–31, 39–32, 39–41, 39–46; Stickel coll.); AF 3332 (Leaf R., Scott Co.), 5354 (Trim Cane Cr., Oktibbeha Co.); USNM 165965, 165983, 175384 (Wheeler Cr., N. of Baldwyn, Prentiss Co.), 175385, 175386, 175387 (creek, 0.5 mi. E. Smithville, Monroe Co.); TU 3042, 3756, 4763, 14102; Mississippi Game and Fish Commission (Enid Reservoir, Yalobusha Co.; Lake Beulah, Bolivar Co.). MISSOURI: UMMZ 147169, 148328, 148683, 148732, 148805, 149015, 149050, 149430, 149436, 149456, 149902, 149935, 150199, 150277, 150588, 152504, 152619, 152638, 152953, 152975, 152992, 153086, 153108, 153129, 153152, 153196, 153234, 153250, 153272, 164825 (Missouri R., near St. Joseph, Buchanan Co.); CNHM 754. NEBRASKA: UMMZ 133947, 134152 (Cedar R., 1 mi. SE. Erickson, Wheeler Co.), 134711, 134746, 134910 (South Fk. Nemaha R., 1 mi. E. and 1 mi. S. Humboldt, Richardson Co.), 135292 (Elkhorn R., 5 mi. W. Stuart, Holt Co.), 135747 (Cache Cr., SW. of Ewing, Holt Co.). NEW JERSEY: UMMZ 99214, 109536, 109803, 111095, 114839; CU 5345, 5355, 7406. NEW YORK: CU 2100, 2334, 2349, 3580 (Oneida L., near Fredericks Cr., Oswego Co.), 5230 (Glenmere L., Orange Co.), 5429, 5493 (Greenwood L., Orange Co.), 5892, 6070 (lagoon of Fall Cr., Ithaca, Tompkins Co.), 6115 (Duck L., Oswego Co.), 9867, 14343, 18356, 20398 (trib. of barge canal, New London, Oneida Co.); USNM 64300 through 64303, 196732; UMMZ 99092, 99202, 114199 (Hackensack R., 3 mi. SW. Nyack, Rockland Co.), 114331 (Rutgers Cr., 0.5 mi. NW. Westtown, Orange Co.). NORTH CAROLINA: UMMZ 156984; USNM 94236, 118950, 191016, 191038, 191090; CU 4008, 9880, 9888, 11512, 11582, 11688, 14106, 16810, 17011, 19565, 19582, 19853, 41801; UMML 21264. NORTH DAKOTA: UMMZ (Hankinson nos. 9960–Pembina R., Pembina, Pembina Co.; 9961–Red R., Pembina, Pembina Co.; 9964–Red R., Grand Forks, Grand Forks Co.); USNM 1508 (Maple R., of North Red R., near Lat. 47° N.), 69295 (Sheyenne R.). OHIO: UMMZ 87461 (Pymatuning Cr., S. Vernon Twp., Trumbull Co.), 87465 (Pymatuning Cr., SE. Wayne Twp., Ashtabula Co.), 107717 (trib., Little Salt Cr., Liberty Twp., Jackson Co.), 109283 (Sunfish Cr., Newton Twp., Pike Co.), 118150, 118159, 118324, 118329, 118499, 121822; SU 932; USNM 58726, 62852. OKLAHOMA: UMMZ 167196 (Bois d'Arc Cr., S. of Ada, Pontotoc Co.); Tulsa U (slough along Little R., U.S. Hwy. 70, between Idabel and Broken Bow, McCurtain Co.); KU 2405 (Lake Murray, Carter Co.). PENNSYLVANIA: ANSP 47354, 48486 thru 48488; USNM 58728 (Erie, Erie Co.). SOUTH CAROLINA: CU 15159, 15218, 15319, 15381, 15389, 15712; CM 33.257.3, 33.309.12; USNM 25614, 92204, 162523, 162562, 192682 thru 192734, 200477; UMMZ 143192, 143199. SOUTH DAKOTA: SU 4525 and USNM 76122 (Mitchell, Davison Co.); SU 34889. TENNESSEE: UMMZ 105398; UMMZ (Delavan and Creaser no. 31–11). TEXAS: UMMZ 110562, 110588, 111008, 120150 (White Rock L., Dallas), 120261, 129782, 129982, 162070, 162084 (Lake Corpus Christi State Park, near Mathis, San Patricio Co.), 166017, 166041, 167220, 170031, 170319, 170395, 170465; UMMZ (Bonham coll.); TNHC 517, 1196, 1580; USNM 166089, 166166, 196670; TU 2980, 14019, 14062, 14084, 21378, 21979, 24591 (Nueces R., 11 mi. W. Batesville, Hwy. 76, Zavala Co.); KU 3609 (near Henrietta, Clay Co.). VIRGINIA: CU 14403, 14431, 16750, 16886; USNM 85595, 85697; UMMZ 102333.

WISCONSIN: UMMZ 64512, 64531, 64649, 64898, 72379, 73568, 73644, 73702, 73717, 73803, 74209, 74347, 74778 (outlet Mary L., Marinette Co.), 74836 (outlet Nocquebay L., SW. of Crivitz, Marinette Co.), 76164, 76691, 77058, 77142, 77630, 77773, 77789, 77875, 78096, 78126, 78210, 78257, 78297, 78310, 78353, 78395, 78448, 78461, 95976, 95984, 96005, 96078, 96175, 96214, 96263; SU 14985; CNHM 35648–9.

CANADA: MANITOBA: UMMZ 180538 (Millers Cr., sec. 34, T. 30, R. 5 E. Prin. mer.). ONTARIO: UMMZ 130869, 130915, 130939, 130980. QUEBEC: UMMZ 136396 (L. St. Louis of St. Lawrence R., at Maple Grove, near Lariviere dock, Montreal).

TYPE.—*Silurus gyrinus* was described from the Wallkill River. Jordan (1877d, p. 71) did not list the type-specimen among those that he examined, and it is presumably not extant.

DIAGNOSIS.—*Noturus gyrinus*, as well as *N. exilis* and *N. lachneri*, in the subgenus *Schilbeodes* has a terminal mouth (jaws subequal) and typically ten preoperculomandibular pores over much of its range. In contrast to *N. exilis* the pectoral spine is deeply grooved and nonserrated, and there are modally eight pelvic rays, except in the central Gulf drainage. From *N. lachneri*, *gyrinus* is characterized by the separation of the anterior ends of the infraorbital and supraorbital canals (2 internasal pores) and fewer fin rays and vertebrae. Also characteristic are the high procurrent caudal rays, many of which may be branched and a low (1.5, usually 1.2 or less) ratio of the distance from the end of the adipose fin to the tip of the caudal fin stepped into the distance from the origin of the dorsal fin to the end of the adipose fin. Except for the lower, more lightly pigmented surfaces, the body and fins are nearly uniformly colored.

DESCRIPTION.—Other counts and measurements are given in tables 17 to 26. Body shape somewhat variable, usually short and chubby, deepest at or in front of dorsal fin, but some individuals, especially in the southern states, are very elongate; head rather deep; skull arched and rounded above; lower jaw terminal; premaxillary tooth patch with lateral edges and posterior corners rounded (not angulate), the overall lateral dimension of the band of teeth notably greater than in other species of *Noturus*, about 3 or 4 times the anterior-posterior measurement; humeral process distinct, about as long as the width of the shaft of the pectoral spine, its tip usually turned slightly inward; eye very small, 3.5 to 5.0 times in snout; pectoral spine without serrae, but frequently with some smooth bumps on its posterior edge near base; the spine angulate in cross section, very deeply grooved, their depth nearly that of the spine, their length variable, but along most of the spine; imbedded in these grooves and surrounding the spine is a mass of grayish white, flaky material; dorsal spine stout; adipose fin high, widely united to the long procurrent caudal rays, many of which may be branched; caudal fin sometimes truncate behind, frequently rounded, but usually ending in an obtuse point, formed by the extreme elongation of the middle caudal rays.

The numerous branched caudal rays are very characteristic of this species. Their large number results from splitting or branching of the ends of the long procurrent and principal rays. The number of branched rays in 143 specimens from throughout the range varies from 15 to 40; there seems to be no definite geographic trend. Specimens from Michigan average 30.4 branched rays, some from New Jersey 23.8, Indiana specimens 21.7, and samples from Missouri, Texas, Alabama, Florida, and North Carolina average between 27.5 and 31.3. Branched rays in the lower lobe of the caudal fin similarly are low in number in the samples from New Jersey, Maryland, and New Hampshire, averaging 11.1; other samples, as indicated above, average from 12.5 to 13.9; the total mean is 13.3, and the range 9 to 17. Branched rays in the upper lobe of the fin are a little more variable, with means as follows: New Jersey, Maryland, and New Hampshire, 12.3; Great Lakes basin, 16.6; Indiana, 9.4; North Carolina, 16.0; Missouri, 13.6; Texas, 16.8; Alabama, 17.5; Florida, 17.1. The total range is 6 to 23 and the mean 14.3.

As a result of the excessive branching of the long rays, the number of simple rays is reduced. The upper simple rays vary from 8 to 26; they may be fewer in number northward; the overall average is 16.9. The lower simple rays seem to increase slightly in number southward. They range from 8 to 13 in Michigan (mean 9.8), 10 to 15 in Indiana (mean 12.6), 9 to 15 in Missouri (mean 12.3), 10 to 16 in Texas (mean 12.2), and 12 to 17 in Florida (mean 14.5); the extremes of all samples tabulated are 8 and 18, and the mean is 12.7.

The soft dorsal rays vary geographically; they range from four to seven. Skeletons and cleared and stained specimens from the Great Lakes basin, Louisiana, and North Carolina indicate that the ossified pectoral radials (actinosts) are fused (in 30 specimens) on each side; one specimen has ten vertebrae anterior to the anal fin origin and ten have eleven. There are usually ten or fewer gill rakers on the first arch; they range from five to ten in Florida and from seven to nine in Michigan. The largest specimen examined is 105 mm. in standard length. In the same series of 17, USNM 199589, from Goose Creek, near Louisville, Kentucky, are four others ranging from 91 to 98 mm. in standard length. Otherwise, specimens rarely attain lengths of 90 mm.

The color in life varies from a dull golden yellow to olive gray. Preserved specimens are usually gray or brown; some are nearly black. The fins, barbels, and upper body surfaces are nearly uniformly pigmented, but the barbels and fins may be darker or lighter than the general tone of the body. A dark gray axial streak is present; the lower body surface is variously unpigmented in young, lightly or irregularly pigmented in older specimens.

VARIATION.—The division of this species into eastern and western subspecies or species as postulated by some authors (see synonymy), does not appear to have foundation. It is a wide ranging species that has some local differentiation, but which shows strong north to south gradients. Some of these variations have been mentioned above.

Localized variation in the number of dorsal rays exists; gradients in caudal, pelvic, pectoral, and possibly anal rays and preoperculomandibular pores are evident. Specimens from northern glaciated areas are heavy bodied and have relatively short spines; those from more southern waters are emaciated and have long hard parts. No trend in internasal pores is evident.

The following summarizes in order the number of tabulations, range (in parentheses), and mean for combined samples from (a) Michigan, (b) New Jersey and New Hampshire, (c) North Carolina, (d) Indiana, (e) southeastern Missouri, (f) Texas, (g) Black Warrior River, (h) Florida, and (i) the total for all specimens.

Lower-half caudal rays: (a) 34 (22–25) 23.76; (b) 20 (22–28) 25.20; (c) 4 (24–28) 26.00; (d) 29 (23–27) 25.03; (e) 30 (24–28) 26.20; (f) 25 (23–29) 26.00; (g) 4 (26–29) 27.50; (h) 99 (25–32) 28.25; (i) 247 (22–32) 26.50.

Upper-half caudal rays: (a) 34 (27–31) 29.44; (b) 21 (27–32) 29.67; (c) 4 (28–31) 29.75; (d) 29 (28–34) 30.93; (e) 30 (28–34) 31.00; (f) 26 (30–36) 32.15; (g) 4 (31–33) 32.25; (h) 100 (30–36) 32.75; (i) 250 (27–36) 31.48.

Anal rays: Lake Huron drainage 52 (13–16) 14.65; Lake Erie drainage 13 (14–16) 14.85; Lake Michigan drainage in lower Michigan 12 (13–16) 14.75; Michigan total 77 (13–16) 14.70; New Jersey 19 (15–17) 15.68; North Carolina 4 (16–17) 16.25; Indiana 30 (13–16) 14.73; Missouri 30 (12–16) 14.63; Texas 26 (13–17) 15.04; Florida Parishes, Louisiana 2 (17–18) 17.50; Tombigbee River 14 (15–18) 16.36; peninsular Florida 103 (13–18) 15.50; and total 310 (12–18) 15.17. The other small samples fall in these ranges.

Preoperculomandibular pores: Lake Huron drainage 136 (9–12) 10.23; Lake Erie drainage 48 (9–12) 10.42; Lake Michigan drainage in lower Michigan 36 (10–11) 10.47; Michigan total 220 (9–12) 10.31; New Jersey 38 (8–11) 9.79; North Carolina 8 (10) 10.00; Georgia 4 (10) 10.00; Indiana 62 (9–12) 10.21; Illinois 32 (10) 10.00; Missouri 60 (10–11) 10.10; Oklahoma 34 (9–11) 10.03; Texas 108 (9–11) 10.04; Florida Parishes, Louisiana 4 (11) 11.00; other Louisiana 20 (9–11) 10.00; Mississippi drainage, Mississippi 12 (10–11) 10.17;

Pascagoula River 18 (10–11) 10.94; Biloxi Bay drainage 18 (9–11) 10.56; Bay St. Louis drainage 4 (10) 10.00; Tombigbee River 54 (9–12) 10.91; peninsular Florida 206 (8–12) 10.04; Escambia River 66 (10–11) 10.06; and total 976 (8–12) 10.19.

Soft dorsal rays: Most Michigan specimens and a sample from the Ohio River, Indiana, have five rays more frequently than six; two from New Hampshire and six of fourteen from Illinois have five rays; otherwise the samples tend strongly toward six soft dorsal rays. The following summarizes most of the data: Lake Huron drainage 111 (4–6) 5.32; Lake Erie drainage 47 (5–6) 5.40; Upper Peninsula, Michigan 8 (5–6) 5.13; Lake Michigan drainage, Lower Peninsula, Michigan 44 (4–7) 5.61; Michigan total 210 (4–7) 5.40; Indiana 31 (5–6) 5.48; New Jersey 16 (6) 6.00; North Carolina 4 (5–6) 5.75; Missouri 30 (5–6) 5.87; Oklahoma 10 (5–6) 5.70; Texas 49 (5–7) 5.98; Louisiana 12 (6) 6.00; Biloxi Bay drainage 9 (6) 6.00; Tombigbee River 20 (6–7) 6.05; peninsular Florida 102 (5–7) 5.97; Marianna, Florida 6 (6) 6.00; and total 521 (4–7) 5.69.

Vertebrae: No prominent variational trend in vertebrae is suggested; however, the higher number in the central Gulf drainage specimens seems to correspond with an increase in numbers of other parts. Summaries by areas: Great Lakes basin 27 (33–36) 34.33; New Jersey 13 (35–36) 35.46; Nebraska 6 (32–34) 33.33; Indiana 31 (33–36) 34.19; Missouri 27 (33–35) 33.63; North Carolina 34 (34–36) 34.71; Texas 26 (33–35) 34.15; lower Mississippi drainage 2 (33–34) 33.50; Florida Parishes, Louisiana 2 (36–37) 36.50; Tombigbee River 5 (36–37) 36.60; Cahaba R., Alabama 2 (36–37) 36.50; peninsular Florida 19 (32–35) 33.37; and total 194 (32–37) 34.30.

The geographic variation in caudal, pelvic, and pectoral rays is shown in tables 2 and 3. Gradients in these and in the general morphology follow the geographic trend suggested by Hubbs (1940, p. 209).

Summarizing the data, Atlantic coastal populations of *gyrinus* appear to be much like those from the Mississippi Valley from approximately the same latitude, as there seems to be a gradient in most characters from north to south in both areas. The number of soft dorsal rays is reduced in the Great Lakes basin, but six, the normal for *Noturus* is usually attained elsewhere. There are fewer pelvic, soft pectoral, and caudal rays and fewer preoperculomandibular pores in the north; all of these increase in number southward, but the greatest increase appears to be in the central Gulf drainage, notably the Mobile Bay drainage, Alabama. This is unexplained. The Mobile drainage population does not appear to be isolated. The increase, therefore, may result from recent genetic fusion within the drainage of populations invading from the east and west. There seems to be no important geographic trend in color; some specimens are nearly black, but in preservative most are slate gray.

A rather obvious trend in the relative lengths of spines and robustness of the body exists. Most specimens from the glaciated area of the north central states are plump or fat and have very short spines. Their digestive tracts are literally stuffed with insects. Specimens from Houston, Texas, are slender and emaciated; they have a narrow caudal peduncle and very long spines. Their digestive tracts are empty. Most other long spined individuals from the lower Mississippi Valley and Florida that were examined contain little food. Occasional fat, short spined individuals from the same regions are greatly distended by food, chiefly insects. It is believed that the amount of available food directly controls the relative growth of the framework parts. Where little food is available, the hard skeletal parts grow at the expense of the soft tissues; where much food is available, all parts grow uniformly.

No quantitative study of the amount of food utilized is available, but comparative growth rates of parts on different quantities of food should be determined. As an indication of the variation, the following stepped proportions are given (number, range, and mean in sequence) from: (a) New Jersey, (b) Michigan, (c) Missouri, (d) Texas, and (e) Florida.

Least peduncle depth in predorsal length: (a) 15 (2.1–3.0) 2.6; (b) 15 (2.3–2.7) 2.5; (c) 15 (2.4–3.0) 2.7; (d) 20 (2.5–3.0) 2.7; (e) 21 (2.6–3.1) 2.9.

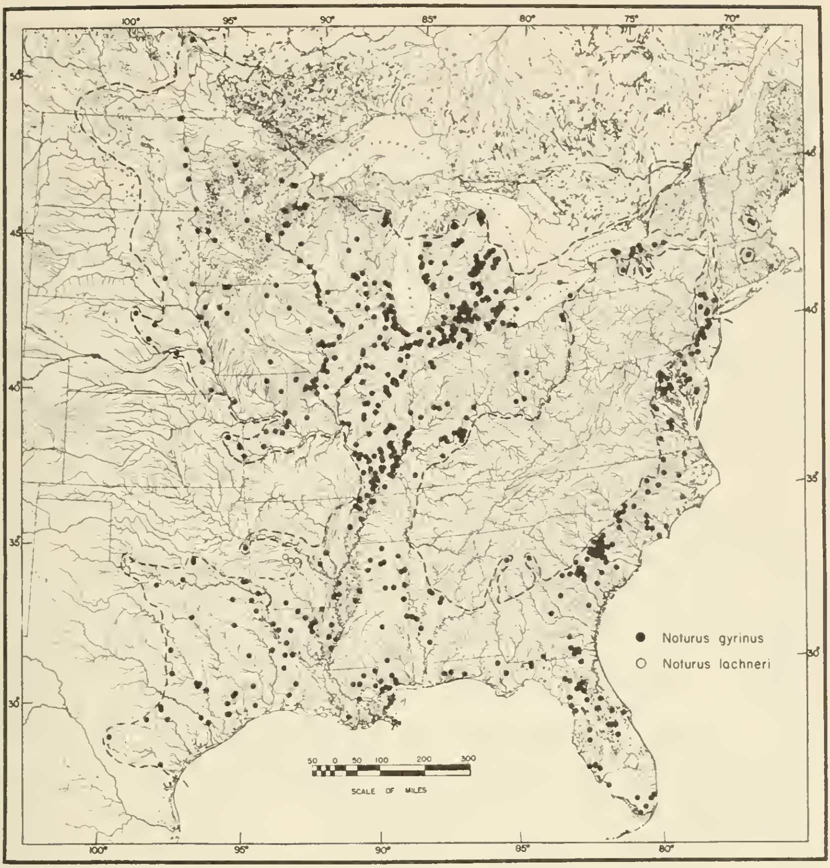
Pectoral spine length in predorsal length: (a) 24 (2.4–3.7) 3.0; (b) 26 (2.4–3.3) 2.9; (c) 30 (1.9–2.6) 2.3; (d) 39 (1.6–2.5) 2.1; (e) 41 (2.0–2.8) 2.3.

Pectoral spine length in peduncle depth: (a) 24 (0.8–1.7) 1.2; (b) 26 (0.8–1.5) 1.2; (c) 30 (0.7–1.0) 0.8; (d) 39 (0.5–0.9) 0.7; (e) 40 (0.6–1.0) 0.8.

Dorsal spine length in predorsal length: (a) 14 (3.2–4.5) 3.9; (b) 15 (2.9–4.5) 3.5; (c) 14 (2.2–3.4) 2.8; (d) 20 (2.0–3.0) 2.6; (e) 20 (2.3–3.5) 2.7.

Standard lengths (mm.): (a) 15 (24–60) 39.4; (b) 15 (32–60) 44.5; (c) 15 (33–47) 38.4; (d) 20 (38–50) 44.1; (e) 20 (35–60) 42.5.

Distribution.—*Noturus gyrinus* (map 1) is found from Saskatchewan, Manitoba, the Dakotas, Nebraska, Kansas, Oklahoma, and Texas eastward to the Atlantic coast, New York, and the Saint Lawrence River system. It has been introduced elsewhere. It avoids the uplands of the Ouachita Mountains of Arkansas, the Ozark Plateau of Arkansas and Missouri, the Appalachian Highlands, and the Piedmont Plateau. On the Atlantic coast it occurs chiefly below the Fall Line (approximately the line indicated on map 1) and ranges



MAP 1.—Distribution of *Noturus gyrinus* (Mitchill) and *Noturus lachneri*, new species. The symbols represent localities from which specimens have been examined. The dashed lines outline the known and hypothetical range of *Noturus gyrinus.* One line, extending from Texas to Saskatchewan eastward to Quebec and New York, bounds its general range. A second line surrounds the upland region of the eastern United States, an area from which the *gyrinus* is not known. All unverified literature records that seem to be based on *gyrinus* are from localities within the range as outlined. *N. gyrinus* has been introduced into at least two places in New England (shown here), into the Snake River basin of Idaho and Oregon, and into Europe.

from the Hudson River, New York, to the tip of peninsular Florida. On the Gulf coast, it is found mostly below a similar line and ranges westward to the Balcones Escarpment and the Nueces River, Texas. *N. gyrinus* is found throughout much of the lower Red River system, upstream at least to Lake Altus, southwestern Oklahoma (personal communication from Dr. George A. Moore). The single specimen from a lake near Poteau, Oklahoma, in the Arkansas basin, may be the result of an introduction. From the lower Mississippi Valley, *N. gyrinus* funnels northward through the lowlands into much of the northern Ohio and upper Mississippi Valleys, and into the Missouri system, where it occurs throughout northern Missouri. It reaches a westward limit in eastern Kansas, Nebraska, and South Dakota. *N. gyrinus* is distributed in the Hudson Bay drainage from the Red River of the North in the Dakotas at least to Black Bear Island in Lake Winnipeg, Manitoba (Keleher, 1953), and has been reported from the Rainy River (Carlander, 1948; W. B. Scott, 1963) and the Souris River, Saskatchewan (Symington, 1959). In the upper Great Lakes basin, *N. gyrinus* is known from the Saint Louis River system and tributaries to western Lake Superior, from the Lake Michigan basin in the Menominee River system, and occurs southward throughout most of the Lake Michigan and Lake Huron drainages of the Lower Peninsula of Michigan. It apparently avoids the northern part of the Lower Peninsula. It occurs in the drainages of the lower Great Lakes to Montreal, Canada, and has occupied the Mohawk and upper Hudson River systems of New York.

Elsewhere, *N. gyrinus* has been introduced into the Merrimack River of New Hampshire, into the Connecticut River system of Massachusetts, and into the Snake River of Idaho and Oregon. Probably there were many introductions of this species along with bullheads (*Ictalurus*) into other bodies of water. Arnold and Ahl (1936) indicated that *N. gyrinus* was once introduced as an aquarium fish into Germany, but that it did not reproduce.

Specimens of *N. nocturnus*, *N. insignis*, *N. flavus*, and, probably *N. exilis* have been reported as this species.

Nomenclature.—Contrary to the opinion of Hubbs and Raney (1944), I do not think that Hermann's (1804, p. 309) description of *Silurus mollis* (reprinted in C. L. Hubbs, 1936, p. 125, and in Hubbs and Raney, 1944, p. 25) can be shown to apply to this species. Hence, their action in changing its name from *Silurus gyrinis* Mitchill is regarded as invalid. The description is so incomplete that *Silurus mollis* will probably forever remain a nomen dubium. Some information bearing on the understanding of the description (Hermann, 1804, p. 309) of *Silurus mollis* follows:

1. "Observationes Zoologicae . . ." was edited and published in 1804 after Hermann's death; thus the original description may not convey the meaning intended by Hermann.

2. This work has not been entirely overlooked. Several of the catalogs of the British Museum cite it in their bibliographies, but they rarely list or assign its new names. It may be that the descriptions are too incomplete or indefinite to identify.

3. Hermann was a member of the faculty of the University of Strasbourg. According to Dr. Francois Gouin (personal communication)

he left no figure or specimen of *Silurus mollis* in the Strasbourg collection, and may never have handled the specimen.

4. The "Musei Humphrediani" was "A [sale] Catalogue of the Large and Valuable Museum of Mr. George Humphrey. . . ." It is dated 1779, and item 33 on page 131 reads "a globe fish, another American fish, and a snake, in three bottles." [Copy seen in the British Museum of Natural History.] Lists of European natural history collections do not indicate the disposition of this collection, nor its present location, and I have failed to locate Hermann's specimen. Humphrey apparently was not the collector of the fish; he was primarily a dealer in shells.

5. The meaningful characters in the description are: the name *Silurus*, a posterior dorsal fin that is adipose, twelve anal rays, and a very soft and flabby belly. In themselves, these are not diagnostic. In addition, it is stated that there are four cirri of the upper jaw and that the specimen came from America. America could mean either North or South America. The meaning of the four cirri of the upper jaw is uncertain, as no lower barbels are indicated for the specimen. The body of the description "radio primo . . . mollibus candidis," is confused and apparently cannot be meaningfully translated. It indicates among other things something that is soft and (?) white and that a spine is associated with the head, neither character applying to *Noturus gyrinus*.

To summarize, the description of *Silurus mollis* is indefinite; it may not apply to an ictalurid; and the specimen from which the description was made may be lost forever. Thus, until shown to be otherwise, I agree with Fowler (1945, p. 123) that the name is unidentifiable; it should be removed from association with *Noturus gyrinus*.

The original description of *Silurus gyrinus* as published by Mitchill (1817, p. 289) is perhaps inadequate, and led to some confusion among early workers. The later and more complete description given by Mitchill (1818, pp. 241, 322–323) unquestionably identifies his material with this long known form. Characteristic are the locality, the pectoral formula, the pectoral spine, the tail, and the easily overlooked adipose fin.

The type of *Noturus sialis* Jordan has not been located and probably was destroyed by fire at Indiana University. The name, however, has long been correctly placed in the synonymy of *Noturus gyrinus* as confirmed by the descriptions and by Jordan's action.

According to Mitchell (1904), the name *Schilbeodes punctatus* is a lapsus for *Schilbeodes gyrinus*.

Etymology.—The name *gyrinus* (Greek) means tadpole, in allusion to its resemblance to a larval salientian.

Relationship.—Among the species of *Noturus*, *N. gyrinus* appears to be more closely related to *N. lachneri* than to any other. Both have a relatively low number of paired fin rays, a uniformly dark color pattern, and the pectoral spines lack developed serrae. As a group, with *N. gyrinus* at one extreme and *N. exilis* at the other, the three have in common a terminal or virtually terminal mouth and ten preoperculomandibular pores.

Ecological consideration.—*N. gyrinus* is typically a species inhabiting quiet or slow running waters, being especially abundant in lakes and their outlets, sloughs, ponds, quiet backwaters, and in the oxbows and base-level mouths of streams. It prefers a soft muddy bottom with extensive vegetation and, according to Hankinson (1908), nests in cavities.

It has been taken in collections with the following species of *Noturus: leptacanthus, nocturnus, funebris, phaeus, insignis, exilis, flavus, eleutherus, stigmosus, furiosus,* and *miurus.*

Remarks.—Two specimens in the Tulane University collection are identified as *Noturus gyrinus*, with some doubt. They are TU 3818, Big Branch of Hog Branch (Tickfaw drainage), 2.8 mi. west of Holden, U.S. Hwy. 190, Livingston Parish, Louisiana, and TU 11084, oxbow of West Pearl River, 0.5 mi. north of Yellow Lake Bayou, St. Tammany Parish, Louisiana. Counts from the specimens are included in the summaries of variational data, usually listed as Florida Parishes, Louisiana, and these are included in the tables comparing the species of *Noturus*. Also included in the summaries are the caudal ray counts of 22+8+13+17=60 for the first, and 20+13+15+16=64 for the latter specimen. The two localities are plotted on the map showing the distribution of *gyrinus*.

Both specimens have a slightly included lower jaw. Otherwise the color pattern, body shape, wide caudal fin, short adipose fin, and spines seem typical of *gyrinus*. The number of fin rays, vertebrae, and preoperculomandibular pores is as high or higher than data obtained for *gyrinus* from other portions of its range. The position of the lower jaw and the high counts suggest that the specimens may possibly be hybrids. If so, they may be crosses of *Noturus gyrinus* and *Noturus nocturnus*. Discounting the position of the lower jaw, they seem otherwise to be fairly typical *gyrinus*, but having a high average number of meristic characters.

***Noturus lachneri*, new species**

OUACHITA MADTOM

Plates 3 (fig. 2), 5 (fig. 2); Map 1

Type.—USNM 201592 (holotype), collected from the Middle Fork of the Saline River at Arkansas Highway 7 crossing, 11.2 miles north of Mountain Valley, Garland County, Arkansas, May 27, 1967, by Leslie and Betty Knapp.

PARATYPES.—ARKANSAS: TU 7074 (1 specimen) and TU 7077 (2), South Fork Saline R., 3 mi. SE. U.S. Hwy. 70 or 7.7 mi. SSW. Owensville, Garland Co., Aug. 7, 1953, E. Liner. USNM 165901 (5) and UMMZ 187095 (2), trib. of Saline R. [presumably Salt Cr., sec. 34, T. 1 S., R. 15 W.], just off U.S. Hwy. 70, about 1 mi. NW. Benton, Saline Co., Apr. 22, 1952, E. A. Lachner, F. J. Schwartz, and W. T. Leapley.

DIAGNOSIS.—*Noturus lachneri* is one of the three species of the subgenus *Schilbeodes* that are characterized by a terminal mouth, subterminal lower jaw, and ten preoperculomandibular pores. It is distinguished from *Noturus gyrinus* by the single internasal pore and a short head which is projected 3.7 to 4.2 times in the standard length. *N. gyrinus* seldom has more than 36 vertebrae or 17 anal rays but *lachneri* has 37 or 38 vertebrae and 16 to 19 anal rays. From the other species, *Noturus exilis*, *N. lachneri* is distinguished by lack of serrations of the pectoral spine, more caudal rays, and typically eight rather than nine pectoral rays.

DESCRIPTION.—Other counts and measurements are given in tables 17 to 26. Body moderately elongate, about as deep posteriorly as anteriorly; head relatively flattened above, somewhat depressed; jaws about equal, mouth terminal; premaxillary teeth in a transverse band which is about 3.5 times as wide as long, its posterior corners rounded; dorsal spine stout, about half length of longest dorsal ray; pectoral spine nearly straight to very slightly curved, with moderate grooves, devoid of serrae anteriorly and posteriorly; adipose fin relatively short and of moderate height, without a free posterior flap, broadly connected to the procurrent caudal fin; a very shallow indentation at the junction of the two fins; procurrent caudal rays of moderate length, the posterior fin margin broadly rounded; eye small, 2.3 to 2.9 in snout; gill rakers on first arch seven to nine; posterior process of cleithrum (humeral process) nearly straight, slightly shorter than diameter of pectoral spine. The largest specimen, a male, is 69.5 mm. in standard length.

All of the specimens have six soft dorsal rays. In the caudal fin, eight of the specimens have eight branched rays in the upper lobe, a count similar to that of *Noturus exilis;* these same specimens have 23 to 25 upper simple rays; the other specimens have 13, 20, and 22 rays with slight to deep branching in the upper lobe, and 18, 12, and 9, respectively, upper simple rays, a condition suggestive of the excessive branching in *Noturus gyrinus*. In the lower lobe there are 11 to 14, mean 12.6 branched rays and 11 to 15, mean 13.6, simple rays.

In a specimen cleared and stained there is one epural; twelve vertebrae are anterior to the anal fin origin; hypurals 1–3 (those supporting the lower caudal lobe) are fused, and hypurals 4–5 (in upper caudal lobe) are fused. The pectoral radials are fused on both sides.

The color in life of the holotype was reported to be dark brown; when in the water it resembled a darkly colored young bullhead. No bright colors were present.

The Tulane specimens are nearly transparent—evidently because of faulty preservation—and have virtually no pigment. The holotype, in preservation, is dark grayish brown above, grading to slightly lighter on lower side, and pale whitish below. Widely scattered chromatophores cover the entire lower surface of the head, an area about the base of the pelvic fins, and the side of the abdomen; the middle of the abdomen is immaculate. Heavy dark pigment is on the chin in front of the mental barbels; a small unpigmented area surrounds the vent. The vertical fins are similar in color to the upper body surface; the paired fins and barbels are similarly pigmented but lighter. The remaining paratypes are yellowish brown, and presumably extensively faded as the upper chromatophores are not prominent and the abdomen and lower surface of the head are devoid of distinct pigment cells.

Type.—The holotype of *Noturus lachneri* is an immature female, 40.0 mm. in standard length. It has 17 anal rays, 6 soft dorsal rays, 37 vertebrae (of which, judged from a radiograph, 8 are precaudal, 29 are caudal, and 12 are anterior to the anal fin origin), and 25+8+13+14=60 caudal rays. On each side there are 8 pelvic rays, 8 soft pectoral rays, 10 preoperculomandibular pores, and a single internasal pore. There also appear to be six hypurals, of which the lower three (1–3) are fused, and one epural. The head length is stepped 3.9 times in the standard length and the distance from the rear end of the adipose fin to the tip of the caudal fin is stepped 1.35 times in the distance from the dorsal origin to the posterior end of the adipose fin. There appear to be eleven branchiostegal rays on the right side, in agreement with counts obtained from a cleared and stained paratype. Measurements are given in table 27.

Distribution.—*Noturus lachneri* is known only from three localities in the Saline River system, Arkansas, a tributary to the Ouachita River.

Relationship.—The ten preoperculomandibular pores and terminal mouth suggest a relationship closest to *Noturus exilis* and *Noturus gyrinus*. In several characters including number of vertebrae, anal rays, and pectoral rays it is intermediate between the two species. The dark, nearly uniform color, lack of pectoral spine serrae, modal number of eight pelvic rays, and large number of caudal rays are characters similar to those of *N. gyrinus*, but the fusion of the anterior ends of the infraorbital and supraorbital canals, the short flattened head, rather elongate body, and relatively short grooves of the pectoral spine show similarities to *N. exilis*.

Etymology.—*Noturus lachneri* is named after Dr. Ernest A. Lachner in recognition of his outstanding work and interest in North American ichthyology.

Ecology.—Little information regarding the habitat of this species is available. The holotype was collected from a stream 30 to 50 feet wide with alternating pools and riffles. The specimen was observed, in daylight, swimming near the edge of a pool in about one inch of water. At this point there was no appreciable current and the bottom was covered with small rocks of a few inches in diameter. During the attempt to capture the specimen it swam beneath several rocks, before it could be finally uncovered and scooped into a net. The series, USNM 165901, came from a small stream that was in flood following a heavy rain. The bottom is described as consisting of gravel, rubble, and sand.

Noturus exilis Nelson

SLENDER MADTOM

Plates 1 (fig. 1), 2 (fig. 2), 3 (fig. 3), 6 (fig. 1); Map 2

Noturus exilis E. W. Nelson, 1876, pp. 33, 51 (original description; types from McLean Co., Ill. [probably Mackinaw Cr.]).—Jordan and Copeland, 1876, p. 160 (Illinois and Wisconsin*).—Jordan, 1877b, pp. 371–372 (comparison; Illinois and Wisconsin*); 1877c, p. 50 (S. Illinois;* not noticed by Rafinesque); 1877d, pp. 73–119, pl. 38, figs. 58–59b (comparison; relationship; range; a type from Illinois R. figured [An error in locality is evident for the other two figures, as the captions are given, page 119, as "Illinois River" and under the figures as "Root R., Wis.," the latter an improbable locality.]); 1877e, p. 611 (relationship).—Jordan and Gilbert, 1877a, p. 2; [Klippart], 1877, p. 153, and Jordan, 1878c, p. 368 (hypothetical for Indiana; range [in error]).—Jordan and Brayton, 1878, pp. 87, 93 (relationship; range [in error]).—Jordan, 1878a, p. 118 (Illinois R. [system] only); 1878b, p. 67 (McLean Co., Ill., and [Marais des Cygnes R.], Kansas* [Root R., Wis., compiled in error?, see above]); 1878d [and 1884], pp. 335–336 (description; range); 1878e, p.414.—Bean, 1880, p.112 (South Grand R.,* Mo.).—Jordan, 1882, pp. 745–800 (synonymy; description; hypothetical for Ohio; range [in error]).—Swain and Kalb, 1883, pp. 640–644 (identical to *Noturus insignis*).—Jordan and Gilbert, 1883, p. 100 (description; range).—Hoy, 1883, p. 434 (Wisconsin; ?Fox R.).—Jordan, 1885, p. 802.—Forbes, 1885a, p. 84 [and 1900, p. 76] (besides the types, found in creeks in ?DeKalb, [Kappa] Woodford,* and Union* Counties, Ill.).—Cragin, 1885, p. 107 (Kansas).—?Graham, 1885a, no. 30, p. [2] (Neosho R., Kans. [probably a misidentification of *Noturus flavus* or *nocturnus*]); 1885b, p. 71 (Osage R., Kans. [Neosho R. a misidentification?]).—Call, 1887, p. 79 (Hinkson Cr., near Columbia,* Mo.).—Jordan, 1889, p. 353.—Meek, 1889b, p. 168 (Iowa; comparison; range); 1891, pp. 117–141 (description; Missouri records: Little Dry Fork, near Rolla;* Jones Cr., Dixon;* Little Piney R., Newburg* and

*Material indicated by an asterisk has been re-examined.

Arlington; Niangua R., Marshfield;* Spring Br. of Hickory Cr., Neosho;* James R., near Springfield;* Bear and Hinkson Creeks, near Columbia*).—Gilbert, 1891, pp. 146, 152 (Richland Cr., Pulaski, Tenn.;* Cypress Cr., Florence, Ala.).—Call, 1892, p. 46 (Iowa record).—Meek, 1892a, p. 12 (Ames, Iowa); 1892b, pp. 223, 225 (Iowa records); 1892c, p. 108 (Iowa distribution).—Hay, 1894, pp. 172, 174 (description and range [not Indiana]).—Meek, 1894a, pp. 75–92 (Arkansas records: Middle Fork of White R., Fayetteville* and Illinois R., Ladd's Mill,* Washington Co.).—??Kirsch, 1895, pp. 327–335 (Tiffin R., Manitou Beach, Mich. [probably a misidentification of *Noturus flavus* or *gyrinus*; subsequent efforts to check or duplicate the record have proven fruitless, and *exilis* is known neither from the drainage basin nor from a region close to this locality]).—Evermann and Kendall, 1895, pp. 469–470 (Indian Cr., S. of Neosho and Spring Br.,*at Neosho Hatchery, Mo.).—Hay, 1902, p. 71 (range [not Indiana]).—Jordan, 1904, pp. 42, 351 (description, range, synonymy).—Cleary, 1956, map 65 (Iowa distribution [but probably not Taylor Co. locality]).—Harlan and Speaker, 1956, p. 113, pl. 21 (figured; description, in error; Iowa distribution [but probably not Lake of Three Fires, Taylor Co.]).—Bailey, 1956, pp. 335, 364 (Iowa; key).—Taylor, 1957, p. 192.—Eddy, 1957, p. 153, fig. 386.—Clarke, Breukelman, and Andrews, 1958, p. 168 (Lyon Co., Kans.).—S.W. Jackson, 1958, p. 236 (Oklahoma records).—Trautman, 1959, p. 30 (not in Ohio).—Metcalf, 1959, p. 393 (Spring R. drainage, Kans.).—Eddy and Underhill, 1959, p. 342 (Otter Cr.,* Minn.).—Stegman and Minckley, 1959, p. 341 (in gravel, Hutchins Cr., Ill.).—Deacon and Metcalf, 1961, pp. 317–321 (Washington* and Mill* Creeks, Kans.).—Deacon, 1961, pp. 396, 420–423 (Marais des Cygnes R., Kans.).—Larimore and Smith, 1963, pp. 324–333 (compiled).—P. W. Smith, 1965, p. 8 (Illinois distribution).—Bunting and Irwin, 1965, pp. 294–304 (Tyler Cr., Okla.; as test animal).—Metcalf, 1966, pp. 34–35, 80, 150–151, 167, map 40 (distribution, ecology, history, Kansas R. system; Missouri and Kansas records, including Mill Cr.,* Washington Cr.,* and Indian Cr.,* Kans.).—Cross, 1967, pp. 197, 219, fig. 18B (figure, description, Kansas distribution).—Branson, 1967, pp. 137, 151 (Oklahoma records).

Schilbeodes exilis (Nelson).—Jordan and Evermann, 1896a, pp. 145, 147 (description; synonymy; range); 1896b, p. 234.—Evermann and Cox, 1896, pp. 365–426 (Missouri and Kansas records compiled [page 388, a Meek record erroneously listed as Little Piney R., Cabool, Mo.]).—?Cox, 1896, p. 608 (Blue Earth R., Mankato, Minn.).—?Cox, 1897, pp. 19–20, 78 (description; Blue Earth R., Mankato, Minn.).—Jordan and Evermann, 1900, pl. 28, fig. 65 (USNM 36261, Osage Fork, Gasconade R., Marshfield,* Mo.).—??Evermann, 1902, p. 95 (Great Lakes basin [compiled and probably in error]).—Large, 1903, pp. 9–10 [and 1905, pp. 56–57] (comparison; Illinois records: Cane Cr., Freeport;* South Henderson? and Honey* Creeks, Henderson Co.; Iroquois R., near Watseka?; creeks in Union Co.*).—??Michael, 1906, p. 9 (spelled *exiles;* range, Michigan record, and inclusion in "Great Lakes" compiled [all probably in error]).—Goldsborough and Clark, 1908, p. 33 (one specimen, Guyandotte R.,* W. Va. [USNM 56615, August 15, 1900, W. P. Hay; locality doubtful]).—Forbes, 1909, pp. 387–404 (range and Illinois distribution [in error]).—Forbes and Richardson, 1909 [and 1920, pp. lxxviii–xciv], pp. lxxiii–lxxxix, 196–200 (range [in error]; description; figured; Illinois records: Illinois R.* [system]; the Pecatonica [Cane Cr.*], Freeport,

*Material designated by an asterisk has been re-examined.

Stephenson Co.; Du Page R., Will Co.;* Honey Cr. [Stronghurst*], Henderson Co.; two? creeks in Union Co. [Cave Spring Br., Jonesboro;* Dutch Cr., SW. of Jonesboro;* Clear* Cr.; Big Cr., 6 mi. S. of Anna*]).—Meek and Hildebrand, 1910, pp. 245–246, fig. 21 (description; range [in error]; Illinois record).—Shelford, 1913, p. 95 (ecology, positively rheotactic).—Hankinson, 1913, p. 109 (Kaskaskia R., Ill.).—Fowler, 1915a, p. 209 (Brook R., Iowa).—?T. Surber, 1920, p. 21 (compiled, Minnesota).—Conger, 1920, p. 11.—H. S. Pratt, 1923, p. 96.—C. L. Hubbs, 1926, pp. 51–52 (remarks concerning record from Tiffin R., Manitou Beach, Mich.).—Cahn, 1927, p. 42 (Oconomowoc R., Stonebank and ?Mukwonago R., Wis.).—Greene, 1927, p. 306.—??Hubbs and Greene, 1928, p. 390 (Great Lakes basin [compiled and in error?]).—Potter and Jones, 1928, p. 355 (compiled).—Hubbs and Brown, 1929, p. 3 (unknown in lower Great Lakes).—Thompson and Hunt, 1930, pp. 27, 44 (habitat; ?Champaign Co., Ill.).—Greene, 1935, pp. 145–146 (L. Erie trib. [in error?]; Cahn's records of *Schilbeodes miurus* possibly *S. exilis;* Illinois and Wisconsin records [?Mukwonago R.]; recent origin in Wisconsin).—Aitken, 1936, p. 33 (Iowa).—Schrenkeisen, 1938, p. 167.—??Hubbs and Lagler, 1939, p. 26 (Great Lakes basin [compiled and in error?]).—Kuhne, 1939, p. 68 (Tennessee).—Breukelman, 1940b, p. 381 (Osage R.* system, Kans.).—Hubbs and Lagler, 1941, pp. 63, 65 (range [but, not in Kanawha R. system; recorded from Great Lakes, in error?]; comparison; [not] "a complex of subspecies referable to *S. insignis*").—Aitken, 1941, p. 389 (Iowa).—Jennings, 1942, p. 365 (Kansas record).—Eddy and Surber, 1943, pp. 151–163 (comparison; Minnesota record doubted).—C. L. Hubbs, 1946, p. 38 (Oklahoma).—G. A. Moore, 1952, p. [6] (Oklahoma).—Hall, 1954, p. 57 (Oklahoma records); 1955, pp. 37, 38 (population reduced, impoundment, Illinois R., Okla.).—G. A. Moore, 1957, pp. 143, 144, figs. 2–76, 2–79D (description; range, in error).—Hubbs and Lagler, 1957, p. 5 (questionable, Great Lakes); 1958, pp. 89, 91, fig. 178 (key; range, in error).—Curd, 1960, pp. 26–29 (food, Tyner Cr. and Illinois R., Okla.).—Birkhead, 1967, pp. 101–110 (comparative toxicity of venoms).

Rabida exilis (Nelson).—Jordan, 1929, p. 93.—Jordan, Evermann, and Clark, 1930, p. 156.—Luce, 1933, p. 119 (Illinois record).—O'Donnell, 1935, p. 484 (Illinois records).—H. S. Pratt, 1935, p. 90.—Blatchley, 1938, p. 67 (range and description [in error; not Indiana]).—Driver, 1942, p. 254 [and 1950, p. 262].

Noturus elassochir Swain and Kalb, 1883, pp. 638–644 (original description; type,* USNM 29677, collected by Dr. E. R. Copeland from Illinois R., Napierville, Ill.).—Jordan, 1885, p. 802 ("identical with *Noturus exilis*, Nelson").—Hubbs and Raney, 1944, p. 20 (type-locality: "presumably Napierville on West Branch of Du Page R., tributary to the Illinois River," Ill.).

Noturus insignis (Richardson) [misidentification].—Swain and Kalb, 1883, pp. 640–641 (synonymy and range, in part).—Gerking, 1955, p. 51 (not in Indiana).

Schilbeodes insignis (Richardson) [misidentifications].—Fowler, 1915a, pp. 208–209 (Carthage, Mo.* only).—Hubbs and Raney, 1944, pp. 1–23, map 1 (synonymy, description, distribution, all in part).—Fowler, 1945, p. 32 (Tennessee R. basin).—?Eddy and Surber, 1947, pp. 171, 182 (comparison; description; Minnesota record compiled).—?Hubbs and Lagler, 1947 [and 1949], pp. 71, 73, fig. 178 (comparison; specimen, Washington Co., Ark. figured; range, in part; Wisconsin and Michigan records doubted).—Har-

*Material indicated by an asterisk has been re-examined.

rison, 1949, p. 338 (Iowa record).—Moore and Paden, 1950, pp. 87, 89 (associations; natural history; Oklahoma records).—Harlan and Speaker, 1951, p. 97, pl. 19 (description).—Bailey, 1951, pp. 194, 224 and *in* reprint, 1951, pp. 194, 226 (comparison; Iowa).—Hall, 1951a, pp. 38–39 (Grand L., Okla.); 1951b, p. 17 (L. Carleton, Okla.).—Cross and Moore, 1952, p. 407 (records, Poteau R., Okla.).—Lewis and Elder, 1953, pp. 193, 202 (Illinois record).—Martin and Campbell, 1954, pp. 47–53 (riffles of Black R., Mo.).—Cleary, 1954, p. 633 (distribution, Cedar R., Iowa).—?Schelske, 1957, p. 38 (Verdigris R., Kans. record [doubtful]).

Noturus flavus Rafinesque [misidentifications].—?Jordan and Gilbert, 1886, p. 7 (tribs. to Poteau R. [Poteau R., W. of Hackett,* Indian Territory], near Fort Smith and Lee Cr., above Van Buren, Ark.).—?Meek, 1893, p. 229 (Arkansas records: Fort Smith; Illinois R., Prairie Grove* and Ladd's Mill;* Jordan's Cr. and Barren Fork, Dutch Mills).—?Meek, 1894a, pp. 90, 92 (Fort Smith, Ark.).—Large, 1903, p. 10 [and 1905, p. 57] (Kaskaskia R., Douglas Co.,* Ill.).—Forbes, 1909, pp. 397–417, map 57, and 1914, p. 18, map 57; Forbes and Richardson, 1909 [and 1920, pp. lxxxviii—cv], pp. lxxxiii–c, 195, map 57 (Illinois records [Lake Fork, Douglas Co.;* Buck Cr., McClean Co.*]).—?Hubbs and Ortenburger, 1929, p. 96 (compiled).—Luce, 1933, p. 118 (Kaskaskia R. system,* Ill.).—O'Donnell, 1935, p. 484 (Douglas Co.,* Ill.).—?Moore and Paden, 1950, p. 87 (Meek's records for Illinois R. and Barren Fork).—?Rostlund, 1952, p. 274 (Arkansas records of Meek).—?Cross and Moore, 1952, p. 406 (Poteau R., Okla.).

Noturus gyrinus (Mitchill) [misidentifications].—?Meek, 1894a, pp. 75, 92 ([confused] ?Flat and Machine Creeks, at Smithville, Ark., and [by drainage as] Illinois R. system).

Schilbeodes mollis (Hermann) [misidentification.—?Moore and Cross, 1950, p. 141 and ?Moore and Paden, 1950, pp. 87, 93 (reference to Meek's record: Illinois R., Ark.).

Schilbeodes nocturnus (Jordan and Gilbert) [misidentification].—Cross and Moore, 1952, p. 406 (Poteau R., Okla. records: Fourche Maline,* sec. 11–12, T. 5 N., R. 19 E., Latimer Co., in part; Poteau R.,* sec. 29, T. 5 N., R. 27 E., Le Flore Co., in part).

Other material studied

UNITED STATES: Alabama: UMMZ 96452, 113927 (Cedar Cr., 3 mi. S. Russellville, Franklin Co.), 165876; UMMZ (TVA nos. 2, 4B, 10, 14, 16-Clark Spring Br., trib. Flint Cr., 0.5 mi. from Austinville, Morgan Co.; Delavan and Creaser nos. 31–75, 31–77-stream, 6 mi. SW. Huntsville, Madison Co.); USNM 190722. Arkansas: UMMZ 97214 (trib. to Little Buffalo R., near Diamond Cave, 3.5 mi. W. Jasper, Newton Co.), 102823, 116376 (trib. to South Spring R., about 5 mi. NW. Ravenden, Sharp Co.), 123437, 128295, 128312, 128377, 128697, 169894, 170899, 170921; CU 9836 (stream, 10 mi. W. Little Rock, Pulaski Co.); CNHM 1624; SU 32234; Tulsa U (Lee Cr. at Oklahoma line); USNM 165883 (McHenry Cr., sec. 28 and 33, T. 1 N., R. 13 W., Pulaski Co.), 201395, 202485 (Wagon Wheel Cr., N. Alonzo, Independence Co.), 202486 (Choctaw Cr., Hwy. 65, S. Choctaw, Van Buren Co.). Illinois: UMMZ 114911, 135611 (Hutchins Cr., E. of Wolf Lake, Union Co.); CU 3474 (stream, E. of Anna, Union Co.); USNM 1498, 24841 (Rocky Brook, Union Co.), 29677 (holotype, *Noturus elassochir*, Illinois R., Napierville); CNHM 42141, 42177, 42207, 42239; CNHM (Hickory Cr., Sta. 5 and Morley Cr., Sta. 7, Will Co.). Iowa: UMMZ 146788

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*Material designated by an asterisk has been re-examined.

(Cedar Cr., about 4.5 mi. W. Churden, Greene Co.), 146862 (East Buttrick Cr., Greene Co.), 159766 (East Br. Otter Cr., Linn Co.); USNM 174929 (Iowa City). KANSAS: UMMZ 120598 (Marais des Cygnes R., 5 mi. N. Lebo, Coffey Co.), 122201, 126827, 126851 (Salt Cr., 1 mi. S. Osage City, Osage Co.), 155189, 160355, 160373, 160394 (Spring Cr., 5.5 mi. E. Baxter Springs, Cherokee Co.), 160531 (South Fork of Pottawatomie Cr., 1.5 mi. S. Garnett, Anderson Co.), 160546, 160877; KU 655 (Pottawatomie Cr., near Glenlock, Anderson Co.), 1516, 4335 (Indian Cr., sec. 10, T. 13 S., R. 25 E., Johnson Co.), 4672, 4675 (Washington Cr., 0.5 mi. below Lone Star Lake, Douglas Co.), 8117, 8263 (Mill Cr., sec. 11, T. 12 S., R. 10 E., Wabaunsee Co.); KU (Big Bull Cr., 1 mi. NW. Paola, Miami Co.; Long Cr., Osage Co.; stream 3 mi. S. Louisburg, Miami Co.); USNM 172051 (Spring R., Hwy. 96, Cherokee Co.), 174904, 174907. KENTUCKY: UL 6038, 6048 (Whipporwill Cr., U.S. Hwy. 79, Logan Co.), 6826. MINNESOTA: UMinn 18150 (Otter Cr., trib. Red Cedar R., Mower Co.). MISSOURI: UMMZ 102517, 102535, 102580 (Barren Fork, trib. to Eleven Point R., 2 mi. SE. Thomasville, Oregon Co.), 102730, 103054, 103209, 111376, 111413, 111419, 111441, 113626, 113642, 113643, 113663, 120045, 142116, 142220, 142249, 148002, 148304 (Elk Fork of Salt R., 2 mi. S. Paris, Monroe Co.), 148425, 148460, 149134, 149342, 149529, 150050, 150090, 150100, 150201, 150275, 150301, 150334, 150350, 150391, 150468, 150519, 150771, 150802, 150866, 150882, 150921, 150943, 150964, 150995, 151056, 151077, 151093, 151127, 151206, 151265, 151321, 151428, 151452, 151479, 151502, 151571, 151604, 151632, 151651, 151670, 151691, 151713, 151735, 151755, 151810, 151890, 151912, 151933, 151949, 151971, 152010, 152062, 152090, 152115, 152237, 152338, 152360, 152443, 152473, 152673 (North Moreau Cr., 8 mi. SW. Jefferson City, Cole Co.), 152698, 152841, 152868, 152926 (Bois Brule Cr., 3 mi. S. Carnegie, Cole Co.), 153298 (Driskin Cr., trib. of Indian Cr., Oriole, Cape Girardeau Co.), 162602 (Little Bonne Femme Cr., 6 mi. S. Columbia, Boone Co.); UMMZ (Buffalo Cr., Tiff City, McDonald Co.; Creaser and Clanton nos. 24, 25, 28, 32, 33, 35, 45-Caster R., 8 mi. E. Fredericktown, Hwy. 61, Madison Co., 47, 48, 49, 53-Charles Cr., 2 mi. SW. Farmington, St. Francois Co.); CU 10787; USNM 36246, 36292, 171994, 201394; SU 2566; INHS (Niangua R., Bennett Spring Park, Dallas Co.; Salt R., NE. of Shelbina, Shelby Co.; Gasconade R., 4 mi. S. Jerome, Phelps Co.; Sac R., N. of Stockton, Cedar Co.; Meramec R., 10 mi. NE. Salem, Dent Co.; Pomme de Terre R., 2 mi. SW. Hermitage, Hickory Co.). OKLAHOMA: UMMZ 103134, 103153, 103178, 108408, 109472 (Bandy Cr., 1 mi. S. Wilburton, Latimer Co.), 110093 (Cunnee Tubby Cr., 2.25 mi. N. Wilburton, Latimer Co.), 110872 (Brushy Cr., near NW. end Rich Mountain, Le Flore Co.), 110873 (Shaunty Cr., 2 or 3 mi. SW. Stapp, Le Flore Co.), 110953 (Spring Cr., Camp Garland, Mayes Co.), 116439, 116654 (Spavinaw Cr., below dam at Spavinaw, Mayes Co.), 116777, 127173, 127308, 137863, 137941 (Illinois R., near Gore, Sequoyah Co.), 167213; UMMZ (field nos. C–4–39, C–5–39, MM25, Sc 4–40; Delavan and Creaser no. 31–34); USNM 165820; CU 17885; Tulsa U (Illinois R., Hwy. 59, Adair Co.); TU 4137. TENNESSEE: TU 19471; UMMZ 96392, 105051, 105296, 120169, 120938 (McBride Br., SW. of Beech Grove, Coffee Co.), 168491, 174459 (trib. to Turnbull Cr., 2 mi. W. Kingston Springs, Cheatham Co.); USNM 190822, 193478, 196800, 197397; UMML 10672; CU 22164 (Sulphur Cr., Hwy. 76, 5 mi. S. Adams, Robertson Co.), 37252, 42033 (Duck R., U.S. Hwy. 41, 1.4 mi. NW. Manchester, Coffee Co.), 47850 (Elk Cr., Stewart Co.), 48238 (trib., U.S. Hwy. 64, 7 mi. E. Pulaski, Giles Co.); Vanderbilt U (Turnbull Cr., Dickson Co.; Hurricane Cr., McEwen-Bold Springs road, Humphreys Co.); ANSP 83004 (Brimstone Cr., 2.75 mi. S. New River, Scott Co.). WISCONSIN: USNM 1412 (Oconomowoc R., Lac la Belle); INHS (Cahn coll.–Honey Cr., trib. Rock R., Watertown).

Type.—The types of *Noturus exilis* Nelson have not been located. They may have been destroyed in the Indiana University fire of 1883. The type-locality is in McLean County, Illinois.

Diagnosis.—*Noturus exilis* is the only member of the subgenus *Schilboedes* typically having the combination: mouth terminal or subterminal, jaws about equal, a single internasal pore, nine pelvic rays, and ten preoperculomandibular pores. It has 17 to 22 anal rays; 8 to 10, usually 9 pelvic rays; 8 to 10, frequently 8, but mostly 9 soft pectoral rays; and 44 to 57 caudal rays. The vertical fin borders are often black or darkened, and the posterior edge of the pectoral spine always has distinct serrae.

The shortened caudal fin distinguishes *Noturus exilis* from *N. insignis* and *N. nocturnus* and the ten preoperculomandibular pores segregate it from other species of the subgenus except *gyrinus*, *lachneri*, *nocturnus*, and *gilberti*. In contrast to *gilberti*, the vertical fins have dark borders, some of the abdomen and lower head has pigment, and the spines are longer. In contrast to *gyrinus* and *lachneri*, there are more pelvic rays.

Description.—Other counts and measurements are given in tables 17 to 26. Head decidedly depressed, rather elongate, especially in front of eyes, by elongation of the mesethmoid; lower jaw terminal or subterminal; eye small, 2.5 to 3.5 times in snout; humeral process obscure in some populations, usually shorter than the width of the pectoral spine exclusive of serrae; dorsal spine stout; pectoral spine short, straight, with five to eight, occasionally as many as ten serrae which are long, prominent, and usually straight, but sometimes bent outward or inward or fused at the base; anterior serrae never present on spine, instead there may be retrorse hooks or progressive offsetting of the edge (pl. 3, fig. 3); adipose fin long and low, closely united to the anterior caudal rays, without a notch; caudal fin slightly rounded behind; posterior corners of the premaxillary tooth patch rounded, truncate, or projecting slightly backward.

The soft dorsal fin has five (in 1), six (189), or seven (4) rays. Of 187 individuals from over the range the caudal fin usually has 16 to 20 (mean 18.39) upper simple rays, 17 to 20 (mean 19.11) branched rays of which 8 are in the upper lobe (mean 8.02) and 10 to 12 (mean 11.09) are in the lower lobe, and 11 to 15 (mean 13.16) lower simple rays.

In the skeletons and stained specimens examined: vertebrae anterior to the anal fin origin 12 (in 1), 13 (12), 14 (1), or 15 (1); ossified pectoral radials fused (in 49 sides examined). The five or six hypurals, at least in the specimens examined, are seldom fused; hypurals 1–3 were fused (in 1 specimen), 2–3 (in 3), and no fusion observed (in 13). There are five to eight gill rakers on the first arch.

The largest specimen known, an unusually large individual, was retained in an aquarium at the Museum of Zoology, University of Michigan, for one and one-half years, at which time it had attained 113 mm. in standard length. The color of its sides, dorsal surface, and pectoral fins is a slate-gray; the pelvic fins and lower surface are darkly pigmented but somewhat lighter than the sides. Other specimens are less than 100 mm., rarely more than 90 mm., in standard length and lack the darkened undersurface.

General color in life yellowish brown to gray-black. In preserved material: ventral surface much lighter than side or upper surface; top of head, upper barbels, back, and most of side nearly uniformly grayish; an obovate, light yellow spot extends backward from the base of the last two or three dorsal rays; side lightly but uniformly pigmented; mental barbels and lower surface of head and belly light, but all under surfaces becoming darker with age; ventral surface immaculate (individuals to about 90 mm. in standard length); old specimens nearly unicolored and only slightly lighter below; a band of pigment crosses the chin in front of barbels and a faint one lies just in front of the pelvic fins; all median fins lightly pigmented with gray; dorsal, caudal, and anal fins often with black borders; the fins unicolor in some populations; pelvic and pectoral fins of small individuals unpigmented, but becoming darker with age; tips of pectoral rays unpigmented.

Variation.—There is considerable variation in *Noturus exilis*, as noted by Hubbs and Raney (1944, p. 21). The degree of pigmentation of the fins varies from place to place. They have very dark margins in the White River system and are often unicolor in many other areas. Also in the White River, *exilis* is more elongate.

Average meristic differences among samples from the Arkansas River system, White River system, and Missouri River system can be demonstrated. Subspecific separation, however, probably is not warranted. In fin ray counts, specimens from Tennessee, Illinois, and Iowa appear to be much like those of the Missouri basin. The data are listed as follows: number of tabulations, range (in parentheses), and mean in samples from (a) Arkansas River system, Arkansas, Missouri, and Oklahoma, (b) White River system, Missouri and Arkansas, (c) Missouri River basin, (d) Tennessee, Minnesota, Iowa, Illinois, and the Meramec River, Missouri, and (e) total. Data for the specimen, USNM 56615, reputedly from Guyandotte River, West Virginia, are omitted here, but included in tables 17 and 19 comparing the species of *Noturus*.

Pelvic rays: (a) 126 (8–10) 9.02; (b) 68 (9–10) 9.06; (c) 100 (8–10) 9.03; (d) 100 (8–10) 9.15; (e) 394 (8–10) 9.06.

Soft pectoral rays: (a) 126 (8–9) 8.62; (b) 68 (8–10) 8.97; (c) 102 (8–10) 8.74; (d) 94 (8–9) 8.89; (e) 390 (8–10) 8.78.

Lower-half caudal rays: (a) 63 (21–26) 23.48; (b) 34 (22–26) 24.74; (c) 52 (22–27) 24.48; (d) 47 (21–26) 24.23; (e) 196 (21–27) 24.14.

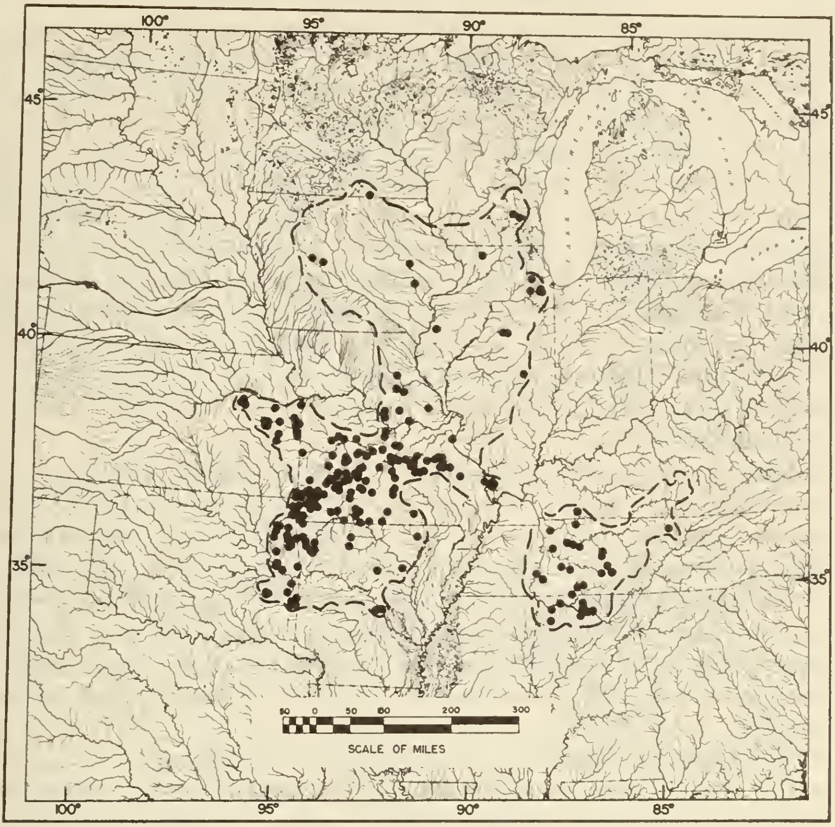
Upper-half caudal rays: (a) 63 (22–28) 24.81; (b) 34 (25–29) 26.50; (c) 52 (24–31) 27.52; (d) 47 (25–28) 26.91; (e) 196 (22–31) 26.33.

Vertebrae seem to decrease in number northward. The upper Mississippi and Missouri basin samples are low in number. The counts from the White River system are highest: Iowa, Wisconsin, and Illinois River, Illinois 8 (36–38) 37.13; Missouri River drainage, Missouri and Kansas 36 (36–39) 38.11; Arkansas River drainage, Oklahoma and Arkansas 32 (38–40) 38.88; White River system 24 (39–41) 40.13; Tennessee River system 13 (39–40) 39.38; total 113 (36–41) 38.83.

Internasal pores: A sample from Hickory Creek, Illinois has 9 of 70 circumorbital canals unconnected anteriorly (two internasal pores); the other 61 are connected. Otherwise the species throughout its range has a single internasal pore. This characteristic was utilized as one of the identification checks for nearly all the lots examined. Of the samples tabulated at random from areas other than Hickory Creek, 466 of 471 canals have a single internasal pore. This variation is not reflected in the number of preoperculomandibular pores (table 22).

Variations in caudal ray and anal ray counts are given in tables 4 and 5. Note especially the greater number of anal rays in the White River population, and the low number of caudal rays in the Arkansas River system.

Distribution.—The range (map 2) of *Noturus exilis*, a creek species, may have been broken very recently into two or more populations, one in the Ozarks and northward and one in the Tennessee and Cumberland River basins. It was recorded by Goldsborough and Clark (1908, p. 33) from the Guyandotte River, West Virginia [USNM 56615], on the basis of a single specimen, likely the result of a transposition of locality data. Dr. Frank J. Schwartz has failed to find additional specimens in his survey of West Virginia fishes. Thus the locality is now doubted, and not shown on the distribution map, since other records (two from Indiana) from the Ohio drainage have been re-identified as *Noturus flavus*, and presence in the Green River, Kentucky (Charles, 1967, pp. 386–389) is doubtful and probably also based on misidentifications of juvenile *N. flavus*. It does not seem likely that *N. exilis* has occurred in the Ohio basin within historical times.



Map 2.—Distribution of *Noturus exilis* Nelson. Circles represent localities whence I have examined specimens. The dashed line indicates the known range. This line is not connected from the region of the lower Tennessee basin to southeastern Missouri because the two populations may be isolated by lowlands. The locality of a single specimen from West Virginia is not shown; it is thought to be the result of a transposition of locality information, and thus in error. Other literature records from outside the indicated range are either known misidentifications or of dubious reliability.

The report of *exilis* from Root River, Wisconsin, in the Great Lakes basin, by Jordan (1877d), is also doubted. As noted in the synonymy, Illinois River, Illinois, and Root River, Wisconsin, are both given as the locality for the specimen Jordan illustrated. The Illinois River locality coincides with the range as presently known. However, two specimens of a *Noturus* are listed as *Noturus exilis* in the United States National Museum catalog books. These specimens (USNM 1420) were collected by S. F. Baird from Root River, Racine, Wisconsin, in July 1853 and entered in the catalog book in February 1859. They may have been sent to Agassiz in March 1859 and not returned, for the specimens have not recently been found. Thus it is possible that an original misidentification was made and that Jordan never actually saw the specimens. Other Wisconsin material was available to Jordan, as two or three specimens (USNM 1412) were collected by Baird in July 1853 from Lac la Belle. The remarks column of the catalog book bears the notation "Jordan ident" for USNM 1412, meaning that Jordan examined the specimens and [correctly] identified them. No such notation is entered for USNM 1420 which appears on the same page. It now seems likely that Jordan copied or was informed of the Root River locality without examining the specimens, and that he or someone else added that locality to the figure captions without closely checking the specimen data or "List of Illustrations." Subsequently the range of *N. exilis* has been stated to include "Lake Michigan" and "the lake," both based on the Root River material.

The record from the Tiffin River, Manitou Beach, Michigan, has not been re-examined or duplicated. It seems likely that Kirsch misidentified a specimen of *Noturus gyrinus* or *Noturus flavus*. Since this specimen does not appear to exist, since extensive collecting at the locality has failed to yield further specimens, and since the nearest positive records come from drainages many miles away, it is thought best to regard it as a probable error in identification. Thus, there is no present admissible evidence that *exilis* occurs in the Great Lakes basin.

In Tennessee, Kentucky, and Alabama, the records of *exilis* are based on many specimens from the Duck River, the Cumberland River, and the lower Tennessee River basins upstream to the bend in Alabama. *N. exilis* is not present in the upper Tennessee basin.

Noturus exilis is abundant in many of the Ozark and sub-Ozarkian streams of Arkansas, Kansas, Missouri, and Oklahoma. In the Arkansas drainage, it occurs in tributaries to the Neosho River arising in the Ozarks, in most streams east of the lower Arkansas River in Oklahoma, in the Poteau River, and in many tributaries of the Arkansas River in Arkansas. In Arkansas and Missouri, it is found in much of the upper White River system. In Kansas and Missouri, the species is found throughout the Osage River system. It is confined in the Missouri River drainage of Missouri to the Osage and the lower tributaries of the Missouri, but in Kansas at least three populations exist in southern tributaries to the Kansas and Missouri Rivers, either as remnants of a wider distribution or as crossovers from the adjacent Osage system. In the upper Mississippi drainage, it is found in several Mississippi tributaries in Illinois, Wisconsin, Missouri, Iowa, and Minnesota.

Although recently collected in southern Minnesota (Eddy and Underhill, 1959) the record of Cox (1896) from Blue Earth River, Minnesota, is still doubted. Another dubious record, the sole one in the Missouri River drainage, Iowa, was recorded by Cleary (1956, map 65) as Lake of Three Fires, Taylor County. Subsequent efforts to re-examine the specimen have been fruitless, as the specimen was presumably discarded in the field (personal communication from Robert E. Cleary).

Specimens of *Noturus flavus* and of *Noturus nocturnus* have been identified as this species; *Noturus insignis* has been confused with it. Table 9 is intended to facilitate the identification of young individuals of *exilis* and similar species.

Nomenclature.—As indicated under *Noturus insignis*, the action of Hubbs and Raney (1944) in transferring the name *Pimelodus insigne* Richardson to the identity of *Noturus exilis* is invalid. That name belongs to the eastern species, here called *Noturus insignis*. As shown in the above synonymy, the first available name for the present species is *Noturus exilis* Nelson.

The original description of *Noturus exilis* was supplemented by Jordan (1877b, p. 372) who gave diagnostic characters from the types. Some of these are: "Pectoral spines very strongly serrated behind . . . with five or more prominent recurved hooks . . . , jaws nearly equal . . . color nearly uniform; tip of dorsal blackish." In addition, his figure (1877d, pl. 38, fig. 59b) of one of the types confirms the presence of a subterminal lower jaw and the serrated pectoral spine. There can remain little doubt about the application of the name *Noturus exilis*.

The holotype (USNM 29677) of *Noturus elassochir* from Napierville, Illinois, which was described later by Swain and Kalb (1883), also belongs to this species. It is a large individual, 117 mm. in total length or 99.8 mm. in standard length, and the body form, subterminal jaws, spines, and premaxillary tooth band are typical. On each side there are: one internasal pore, ten preoperculomandibular pores, nine soft pectoral rays, and ten pelvic rays. The anal fin has 19 rays, the caudal fin has $19+9+12+11=51$ rays, and there are 38 vertebrae.

Etymology.—The name *exilis* (Latin) means slender, referring to the slim body.

Relationship.—*Noturus exilis* has previously been confused with and considered an intimate relative of *Noturus insignis*, chiefly on the basis of a relatively long body and anal fin and a similarity in color pattern. These characters are misleading, however, as important differences between the two are to be found in the structure of the pectoral spine, the form of the caudal fin and number of hypurals, the shape of the skull, the difference in position of the mouth, and in the structure of the sensory canal system of the head. Instead, it seems that *N. insignis* and *N. nocturnus* are more closely related; that *N. exilis* has an affinity with *Noturus lachneri* and through that species with *Noturus gyrinus*. This cluster of species has in common a terminal mouth and similar pore counts. Divergence in the group was probably early as judged by the increase in anal and paired fin rays, reduction in number of caudal rays, and well-developed pectoral spine serrae in *N. exilis*.

ECOLOGY.—*N. exilis* lives entirely in streams of small or medium size in moderate or fast current. It occurs on riffles composed of coarse gravel, rubble, or loose slab rock.

Noturus exilis has been taken in collections with *gyrinus*, *nocturnus*, *flavus*, *albater*, *placidus*, *flavater*, *miurus*, *elegans*, and the specimen referred to *elegans* from Piney Creek, Alabama.

***Noturus leptacanthus* Jordan**

SPECKLED MADTOM

PLATES 3 (FIG. 4), 8 (FIG. 2); MAP 3

Noturus leptacanthus Jordan.—Jordan and Copeland, 1876, p. 160 (nomen nudum; Alabama R.).—Jordan, 1877b, pp. 352–372 (original description; the single specimen from Silver Cr., 1 mi. above its junction with the Etowah R.); 1877d, pp. 73–102, pl. 41, figs. 64–65 (description; synonymy; type figured).—Jordan and Brayton, 1878, pp. 44–87 (description; Chattahoochee R., near Gainesville, Georgia; record relisted).—Jordan, 1878a, p. 119; 1878d [and 1884], p. 336; 1878e, p. 414.—Swain and Kalb, 1883, pp. 639–644 (description; range [except Enterprise, Miss.]).—Jordan and Gilbert, 1883, pp. 98–99 (description; range [in error]).—Jordan, 1885, p. 802.—Jordan and Gilbert, 1886, p. 7 (comparison).—Jordan, 1889, p. 353 (relationship).—Gilbert, 1890, p. 226 (Georgia record); 1891, pp. 153–157 (Alabama records: Choccolo Cr.,* Oxford; Cahawba R., Helena;* Little Escambia R.,* Pollard; Hawkins Cr., Greenville;* Sand(y) Cr.,* Evergreen).—Woolman, 1892b, p. 301 (description; Florida record).—Palmer and Wright, 1922, p. 356 (compiled).—Bailey, Winn, and Smith, 1954, pp. 114–160 (fresh water; range; synonymy; records, Escambia R.,* Alabama and Florida [all were examined]).—Eddy, 1957, p. 152, fig. 383.—Taylor, 1957, p. 192.—Briggs, 1958, p. 260 (SE. United States to Lake Co., Fla.).—Cook, 1959, pp. 34, 135, 141 (description; Mississippi records).—Parsons and Crittenden, 1959, p. 191 (Chipola R., Florida).—Suttkus, 1961, p. 63, fig. 5 (comparison; skull illustrated).—Patrick, 1961, p. 256 (Escambia and Flint Rivers).—Boschung, 1961, pp. 275, 282 (compiled).—Collette and Yerger, 1962, p. 225 (ecology; Okaloosa and Walton Counties, Fla.).—Anderson, 1964, pp. 45, 51 (South Carolina records).—Suttkus and Taylor, 1965, p. 177 (associations).—Richards, 1966, p. 829 (associations with *Etheostoma inscriptum*).—Hellier, 1967, pp. 18–46 (parasites, ecology, distribution, Santa Fe R., Fla.).—Suttkus and Ramsey, 1967, p. 140 (associations with *Percina aurolineata*, Cahaba R., Ala.).

Schilbeodes leptacanthus (Jordan).—Jordan and Evermann, 1896a, pp. 145–146 (description; range); 1896b, p. 234.—Evermann and Kendall, 1900, p. 51

*Material indicated by an asterisk has been re-examined.

(compiled).—Reed, 1907, pp. 562–564 (axillary glands and probably spine glands present).—Palmer and Wright, 1922, pp. 356–361 (New R., Fla.; hypothetical, Okefinokee Swamp).—H. S. Pratt, 1923, pp. 95–97.—A. H. Wright, 1926, pp. 80–81.—Viosca, 1936, pp. 42–43 (Little Bogue Falia Cr., La., in association with *Ambloplites ariommus*); 1937, p. 136 (in association with *Necturus beyeri*).—A. Carr, 1937, p. 81 (comparison; Florida).—Schrenkeisen, 1938, p. 167.—Hubbs and Raney, 1944, pp. 3, 9, 26 (comparison; anal fin length).—?Fowler, 1945, pp. 32, 271, 351 (synonymy; description; range [except Mississippi R. system]; ?Florida records, in part only: Wekiwa R.; L. Fairview; Palm Springs. Alabama records).—D. C. Scott, 1951, p. 37 (Coosa R.,* near Childersburg, Ala.).—Freeman, 1953, p. 269 (Savannah R. basin, in Aiken* and Barnwell* Counties, S.C.); 1954, pp. 138, 145–146, 151 (Savannah drainage, South Carolina records, in part: stations 3,* 13, 18,* 24,* 33,* 49, 60,* 90*).—Carr and Goin, 1955, pp. 21, 65 (description; Florida distribution).—G. A. Moore, 1957, pp. 143–144.—Crittenden, 1958, p. 218 (Bay Co., Florida record).—Birkhead, 1967, pp. 101–110 (comparative toxicity of venoms).

Rabida leptacantha (Jordan).—Jordan, Evermann, and Clark, 1930, p. 155.—Harper, 1930, p. 152 (Collins Mill Cr., about 7 mi. NE. of Cuthbert,* Ga.).—Fowler, 1935b, p. 73 (Georgia record).—H. S. Pratt, 1935, p. 90 (description?; range).—??Fowler, 1936b, p. 150 (Crystal R., Citrus Co., Fla.).—Driver, 1942, p. 254 [and 1950, p. 262].

Rabida gilberti (Jordan and Evermann) [misidentifications].—Fowler, 1935a, p. 19, fig. 37 (Great Cypress Swamp,* S.C., in part; "South Carolina"*).

Schilbeodes marginatus marginatus (Baird) [misidentifications].—Hubbs and Raney, 1944, pp. 8, 24 (synonymy, in part; records: "South Carolina";* Great Cypress Swamp,* in part).—Fowler, 1945, p. 81 (synonymy, in part).

Schilbeodes mollis (Hermann) [misidentification].—Freeman, 1954, pp. 138, 146 (Savannah R. drainage, S.C., station 21* only).

Other material studied

UNITED STATES: Alabama: Tulsa U 8; CU 11827, 13786, 14019, 15994, 16105, 16213, 17167, 17488, 17671, 19272; USNM 36827, 162336, 162345, 166024, 166035, 199552, 201248; UGa 139; TU 1130, 1644, 2616, 7476, 14144, 15267, 19072; UMMZ 113911, 123970, 123974, 124133, 128749, 155516, 163545, 166385, 168745. Florida: UMMZ 87895 (Santa Fe R., Poe Springs, Alachua Co.), 110481, 110487, 110975, 134570, 155496, 161759, 163320 (trib. of Suwannee R., SE. Genoa, Hamilton Co.), 163326 (Juniper Springs, head of Juniper Cr., Ocala National Forest, Marion Co.), 163495, 163522, 166167, 166186, 166193, 166216, 166295; CU 3126 (Black Cr., near Green Cove Springs, Clay Co.), 12024 (stream, 1.5 mi. W. Cassia, Lake Co.), 12128, 12140, 12499, 12604, 16678, 16691, 16700, 19164; TU 80, 223, 5049, 8552, 21223, 24638, 24667, 24676, 24711, 24754, 24769; UMML 11384. Georgia: Tulsa U 5; UMMZ 88389, 88519, 88672, 134636, 157885, 163942, 163965, 164067, 164079, 165878, 168818; UMMZ (Fletcher nos. 6, 23, 45, 77, 78); CU 4044, 15429, 15762, 15806, 15964, 17195, 17216, 17239, 17258, 17299, 17323, 17371, 17456, 17498, 17629, 17650, 17781; CU (Raney no. 1574); USNM 162364, 162453, 162466, 162469, 168042, 168054; TU 14189; UGa 443, 445, 538, 542. Louisiana: USNM 163979; UMMZ (Delavan and Creaser no. 31–59, stream, 0.5 mi. N. Ethel, East Feliciana Parish); UMMZ 165880 (Chefuncte R., Hwy. 35, 10.5 mi. SW. Franklinton, Tangipahoa-Washington Parish line), 166149; TU 1218 (trib. Tangipahoa R., 1.5 mi. W. Bolivar, Tangi-

*Material indicated by an asterisk has been re-examined.

pahoa Parish), 6153 (Richland Cr., 7 mi. NE. Norwood, East Feliciana Parish), 14072 (stream, Hwy. 10, 1.4 mi. W. Darlington, Saint Helena Parish), 14076 (stream, U.S. Hwy. 51, 1.4 mi. N. Kentwood, Tangipahoa Parish). Mississippi: CU 11619, 11851, 12580, 15627, 15656, 15677, 16245, 16612; USNM 129409, 175388, 201247, 201249; TU 820, 1618, 14086 (stream, U.S. Hwy. 51, 2.4 mi. S. Magnolia, Pike Co.), 14158, 14164, 17731, 19798, 23416, 23456, 23744; TU (McGee Cr., Hwy. 98, Tylertown, Walthall Co.; Copiah Cr., Hwy. 27, 2.4 mi. S. Georgetown, Copiah Co.); AF 3443, 4150 (trib. of Tangipahoa R., Pike Co.), 6271; UMMZ 113778 (trib. of Bogue Chitto R., 3 mi. N. Summit, Pike Co.), 146610 (creek, 1 mi., 1.5 mi., and 2 mi. S. Centreville, Wilkinson Co.), 155381, 155442, 157790, 157812, 161158 (Little Bahala Cr., U.S. Hwy. 51, 3.5 mi. N. Brookhaven, Lincoln Co.), 161182 (Big Cr., U.S. Hwy. 51, 0.5 mi. N. Bogue Chitto, Lincoln Co.), 161191 (stream, U.S. Hwy. 51, 2.5 mi. N. Bogue Chitto, Lincoln Co.), 163715, 166120; UMMZ (Walker nos. 39–31, 39–32, 39–33, 39–37, 39–38, 39–49). South Carolina: CU (Suttkus no. 1210, trib. of Broad R., 5.1 mi. S. Allendale, Allendale Co.); CU 15151, 15315 (trib. of Jackson Br., Hwy. 5, 1.8 mi. S. Sycamore, Allendale Co.), 19081 (trib., North Fk. Edisto R., Hwy. 178, 11.5 mi. NW. Orangeburg, Orangeburg Co.), 19655 (Little R., Hwy. 22, 5.6 mi. E. Calhoun Falls, Abbeville Co.); USNM 162350 (trib., South Fk. Edisto R., U.S. Hwy. 1, about 10 mi. NNE. Aiken, Aiken Co.), 162522, 162555, 162574, 168117 (Keowee R., Hwy. 183, 14 mi. E. Walhalla, Oconee Co.), 192667 thru 192670, 192671 (Goodbys Cr., U.S. Hwy. 176, 2 mi. S. U.S. Hwy. 301, Orangeburg Co.), 192672 thru 192674, 192675 (Edisto R., 2.75 mi. SSE. Branchville, Bamberg Co.), 192676 thru 192681, 200481; TU 14190 (Seneca R., U.S. Hwy. 76, 8.4 mi. SE. Pendleton, Anderson Co.).

Type.—This species was originally described from a single specimen which was probably destroyed in the Indiana University fire of 1883. The type-locality is Silver Creek, one mile above its junction with the Etowah River, Georgia.

Diagnosis.—*Noturus leptacanthus* is the only member of the subgenus *Schilbeodes* that typically has eight pelvic rays and an included lower jaw. The pectoral spine is short, weakly if at all grooved, and devoid of serrae, usually not even roughened on the posterior edge. There are extremely large chromatophores (obscured in old individuals) scattered over the body and fins. The adipose and caudal fins are united. There are 47 to 58 caudal rays, 14 to 19 anal rays, 7 to 10, usually 8 or 9 soft pectoral rays, 2 internasal pores, and normally 11 preoperculomandibular pores.

Description.—Other counts and measurements are given in tables 17 to 26. The body is moderately elongate, little deeper forward than behind; head rounded above, slightly arched, depressed between the eyes; eye small, 2.0 to 2.7 times in snout; lower jaw included; premaxillary tooth patch with rounded posterior corners; humeral process moderate, usually a little longer than the diameter of the pectoral spine; pectoral spine relatively short, with very shallow grooves and without a trace of serrae; dorsal spine stout; adipose fin always well connected to the caudal fin, but a shallow, broad notch is formed at their juncture; upper procurrent caudal rays moderate in length; caudal fin truncate or slightly rounded behind.

There are usually 6 soft dorsal rays; in 111 specimens, there are five (in 2), six (108), and seven (1). There are five to eight gill rakers on the first arch. The largest specimen examined is 78.7 mm. in standard length. There are (extremes in parentheses): (17) 17 to 20 (23), mean 19.2, upper simple caudal rays; (14) 15 to 18 (19), mean 16.7, branched caudal rays, of which 7 are usually in the upper one-half of the fin and 9 or 10 are most frequent in the lower one-half; and (12) 14 to 17 (20), mean 15.6, lower simple caudal rays.

In 13 stained specimens vertebrae anterior to the origin of the anal fin eleven (in 7), twelve (5), and one not counted; ossified pectoral radials fused on all 26 sides.

The general life color is reddish brown or a dark yellowish brown. The pigmentation in preserved material is as follows: top of head dark brown; side of body and dorsal surface uniform with slight darkening at the base of the dorsal and adipose fins; area over air bladder frequently dark gray; lower cheek and side of head pale yellowish; upper barbels light tipped, mostly pigmented only at their base; anterior naris pale; lower surface of head, abdomen, and pelvic fin creamy white, almost immaculate, but each with scattered pigment, especially concentrated in front of mental barbels; anal and dorsal fins light with moderate, scattered pigment; pectoral fin with pigment concentrated near base, scattered elsewhere; caudal and adipose fins sometimes with a light margin, darkly blotched with large gray-black chromatophores which often diffuse throughout the fins; large brownish chromatophores scattered over fins, head, and side; mental barbels usually immaculate except at base.

Variation.—Table 7 gives variation in the number of pelvic and soft pectoral rays. Counts from one or more, usually several, collections from each river system are combined; enumerations were usually made of rays of both fin pairs of the same specimens, and both sides are tabulated individually. The pelvic rays are rather uniformly eight, but there is a strong increase in pectoral rays from west to east. No correlation between pelvic and pectoral ray counts is indicated. The increase in pectoral rays is a moderately uniform gradient, but certain modes are evident. West of the Pascagoula River system, the modal number of rays is eight. From the Tombigbee and Alabama River systems eastward, the mode is nine.

There are normally eleven preoperculomandibular pores throughout most or the range. However, 19 of 22 canals tabulated from the Comite River system (the western edge of the known range), southwestern Mississippi, have ten pores, and only three sides have eleven (mean 10.14). Pore counts of 192 canals from other areas show no trend; the range is ten to twelve, and the average is 10.96.

The number of vertebrae appear to be lowest in the west, especially the Comite and Chefuncte drainages of Mississippi and Louisiana. In this area the modes are 33 or 34 vertebrae. Elsewhere the modes in the counts obtained are 35. The following summary lists in order the number of specimens, range, and mean number of vertebrae for each river system: Comite 11 (32–35) 33.6; Chefuncte 9 (33–35) 34.0; Pascagoula 8 (34–35) 34.6; Tombigbee 21 (35–37) 35.4; Alabama 15 (34–35) 34.7; Apalachicola 9 (34–36) 35.1; Savannah 20 (35–37) 35.3; Combahee 3 (35) 35.0; Edisto 3 (35–36) 35.3.

The color pattern and body form are relatively uniform, and no geographic trend is evident in the other tabulations. The number of counts, the range (in parentheses), and the mean are given in sequence for grouped samples from the following areas: (a) Lake Pontchartrain drainage, (b) Pearl River drainage, (c) the area from the Pascagoula River to the Tombigbee River, (d) Pensacola Bay drainage, (e) the Apalachicola River to the Ochlockonee River, (f) Suwannee River drainage, (g) the area east of the Satilla River, including the Great Cypress Swamp, and (h) the total.

Anal rays: (a) 19 (16–17) 16.47; (b) 10 (15–16) 15.80; (c) 6 (15–16) 15.67; (d) 40 (15–18) 15.93; (e) 20 (14–17) 16.00; (f) 15 (14–17) 15.60; (g) 13 (15–19) 16.62; (h) 124 (14–19) 16.04.

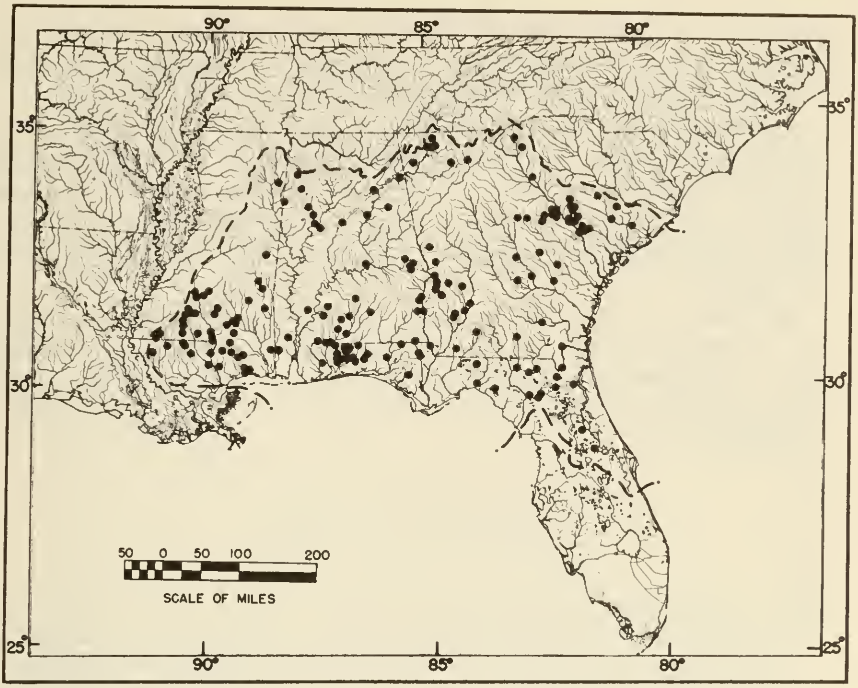
Lower-half caudal rays: (a) 11 (24–27) 24.91; (b) 10 (24–26) 25.30; (c) 6 (23–27) 24.83; (d) 40 (23–28) 25.35; (e) 21 (22–28) 25.05; (f) 15 (24–27) 25.00; (g) 13 (23–27) 24.69; (h) 116 (22–28) 25.10.

Upper-half caudal rays: (a) 11 (24–28) 25.64; (b) 10 (25–28) 26.80; (c) 6 (23–26) 25.50; (d) 40 (24–30) 26.30; (e) 21 (24–29) 26.38; (f) 15 (25–29) 26.53; (g) 13 (24–27) 25.62; (h) 116 (23–30) 26.21.

Total caudal rays: (a) 20 (48–57) 51.10; (b) 10 (50–54) 52.10; (c) 6 (47–56) 50.33; (d) 40 (48–58) 51.65; (e) 21 (47–57) 51.43; (f) 15 (50–54) 51.53; (g) 13 (48–53) 50.31; (h) 125 (47–58) 51.34.

DISTRIBUTION.—*Noturus leptacanthus* (map 3) occurs in both the Atlantic and Gulf coastal drainages. It is found in most streams from the Amite and Comite Rivers system of Louisiana and southwestern Mississippi eastward to both the Great Cypress Swamp and Edisto River, South Carolina. The Florida distribution, however, is poorly known. Aside from a few uncertain records (included in the above synonymy, but which perhaps refer to *Noturus gyrinus*), this species is known to extend no farther into peninsular Florida than the Suwannee River system on the west and the Saint Johns basin in the east.

The distribution of *N. leptacanthus* is strikingly similar to that of *Percina nigrofasciata* as worked out by Crawford (1956, map 1). The



MAP 3.—Distribution of *Noturus leptacanthus* Jordan. The circles represent localities from which I have examined specimens. The dashed line outlines the range, which includes those literature records th.t appear to be correct.

distribution maps of the two species show identical ranges except that Crawford plotted a single record from the Mississippi River basin, and he showed no record from Great Cypress Swamp, South Carolina.

Some specimens referable to *Noturus nocturnus* have been reported as *Noturus leptacanthus*.

NOMENCLATURE.—The original description of *Noturus leptacanthus* Jordan (1877b, p. 352) unquestionably applies to the species considered here. The diagnostic characters include the color "pale reddish yellow, slightly blotched," the small anal fin, the eight soft rays of the pectoral fin, the "small and slender dorsal and pectoral spines which are devoid of internal serratures," and the "upper jaw much the longer."

ETYMOLOGY.—The name *leptacanthus* (from Greek) means [small or] slender spined. It was presumably used in reference to the absence of the roughenings on the pectoral spine.

RELATIONSHIPS.—The large chromatophores and smooth slender spines are exceptional in *Noturus*. The general morphology, however, points to a relationship with the species in the subgenus *Schilbeodes*, with an early divergence from most members of that group. Its relationship with any other species does not appear to be intimate.

ECOLOGY.—*Noturus leptacanthus* is most frequently taken from small to moderate size streams, and appears to be chiefly a creek species. It prefers moderate to fast current, living on riffles of coarse sand or large gravel. Other species of *Noturus* that have been collected with *leptacanthus* are *gyrinus*, *nocturnus*, *funebris*, *insignis*, and *munitus*.

In addition to the similar range, *Percina nigrofasciata* appears to be a common darter associate of *N. leptacanthus*. Although *leptacanthus* is not collected as frequently as *nigrofasciata*, because of its cryptic habits, the number of collections in which the two are taken together is striking.

Noturus nocturnus Jordan and Gilbert

FRECKLED MADTOM

PLATES 3 (FIG. 5), 8 (FIG. 1); MAP 4

Noturus leptacanthus Jordan [misidentifications].—Hay, 1881, pp. 514, 515, and Swain and Kalb, 1883, p. 642 (description; Chickasawha R., Enterprise,* Mississippi).—Hay, 1883, pp. 73–74 (distribution; Enterprise,* Mississippi; Big Black R., near Edwards [probably, USNM 32301,* Mississippi?, 1882, O. P. Hay], Mississippi).

Noturus nocturnus Jordan and Gilbert.—Jordan, 1885, p. 802 (nomen nudun; range).—Graham, 1885b, p. 77 (nomen nudum; Arkansas R. or branches near Fort Smith; hypothetical in Kansas).—Jordan and Gilbert, 1886, pp. 6–17 (original description; best specimens, USNM 36461, from Saline R., Benton,* Ark.; other records: Poteau R.,* Okla.; Washita R., about 0.5 mi. above Arkadelphia,* Ark.; Sabine R., 5 mi. S. of Longview,* Tex.; Trinity R., Dallas,* Tex. [others are *Noturus gyrinus*]).—Jordan, 1889, p. 353 (relationship); 1890, pp. 161, 165 (description; Big [Pigeon R.] Cr., Evansville,* Ind.).—Meek, 1891, p. 138 (Ouachita R., near Crystal Springs* and [West Fork] Saline R., about 24 mi. E. of Hot Springs, Ark.); 1893, p. 229 (range; compiled records from Arkansas only); 1894a, pp. 90–92 (Arkansas records compiled).—Evermann and Kendall, 1894, pp. 80–96, pl. 11 (type ascribed in error to Sabine R., Belton [for Saline R.,* Benton], Ark.; type figured; type-locality also indicated as Poteau R., near Fort Smith, Ark.; records compiled).—Hay, 1894, p. 172.—Meek, 1896, pp. 342, 346 (Walnut Cr., Kiamichi [Okla.]; Little and St. Francis Rivers, near Marked Tree [now recorded: CNHM 1581, Marked Tree,* Ark., S. E. Meek and CNHM 764, St. Francis R., Greenway,* Ark., S. E. Meek], Ark.).—Hay, 1902, p. 70 (compiled).—Parks and Cory, 1938, p. 21 (compiled).—Böhlke, 1953, p. 43 (syntypes, SU 562,* SU 564,* and USNM 36461*).—Gerking, 1955, pp. 51, 76 (Indiana records; key).—Bailey, 1956, p. 338 (hypothetical, Iowa).—Eddy, 1957, p. 152, fig. 384 (key; range).—Taylor, 1957, p. 192.—Clarke, Breukelman, and Andrews, 1958, p. 168 (Lyon Co., Kans.).—Hancock and Sublette, 1958, p. 46 (Louisiana: stations 4,* 5,* 12, 13*).—Cook, 1959, pp. 34, 135,

*Material indicated by an asterisk has been re-examined.

142, fig. 25E (description; Mississippi records).—Minckley and Deacon, 1959, pp. 348, 349 (in food *Pylodictis*, Neosho R.).—Metcalf, 1959, pp. 383, 393 (distribution and records, Kansas and Oklahoma).—Deacon, 1961, pp. 395, 421–422 (Neosho R., Kans., distribution).—J. M. Walker, 1962, p. 38 (Lincoln Parish, La.).—Larimore and Smith, 1963, pp. 324–330 (record, Champaign Co., Ill.).—P. W. Smith, 1965, p. 9 (Illinois distribution).—Norden, 1965, p. 102 (records, Little R., La.).—B. T. Walker, 1965, p. 108 (Bayou D'Arbonne, La., station 16*).—Grosvenor, 1965, p. 273 (color photograph).—Suttkus and Taylor, 1965, p. 177 (associations).—Cross, 1967, pp. 197, 218 (figure, description, Kansas distribution).—?Charles, 1967, pp. 385–396 (Green R., Ky. [some or all may be *Noturus gyrinus*]).—Branson, 1967, p. 146 (Oklahoma and Kansas records).

Schilbeodes nocturnus (Jordan and Gilbert).—Eigenmann and Beeson, 1894a, p. 82; 1894b, p. 45 [and 1905, p. 121] (compiled).—Eigenmann, 1896, p. 253 (Indiana).—Jordan and Evermann, 1896a, pp. 145–146 (comparison; range; type-locality, Saline R., Benton, Ark.; types,* USNM 36461); 1896b, p. 234 (range; type-locality indicated); 1900, p. 3236, pl. 27, fig. 64 (type, USNM 36461, from Sabine [for Saline] R.).—Large, 1903, pp. 9–10 [and 1905, pp. 56–57] (comparison; 10 Illinois records: 2, Havana;* 3, near Lincoln [Salt Cr.*]; 3, Kaskaskia R. system [Lanx Ford,* ?Clinton Co.; Shelbyville,* Shelby Co.; Crab Apple Cr.,* Moultrie Co.]; Spoon R., near Lewistown;* South Fork Saline R.,* Saline Co.).—Jordan, 1904, p. 351.—Reed, 1907, pp. 555–564 (description of poison glands).—Meek, 1908, p. 141 (range; compiled record).—Forbes and Richardson, 1909 [and 1920, pp. lxxviii–ciii], pp. lxxiii–xcviii, 196–199 (Illinois distribution and range [in error, see Large, 1903, pp. 9–10]; description; figures; synonymy).—Forbes, 1909, pp. 387–415 (range and Illinois distribution [in error]).—Hankinson, 1913, p. 109 (Kickapoo Cr.;* Kaskaskia R.* [Cooks Mills]; Flat Branch, all near Charleston, Ill.).—Eigenmann, 1919, pp. 398–399 ("other places in Texas" [partly *N. gyrinus*]).—H. S. Pratt, 1923, pp. 95, 97 [and 1935, p. 89].—Reed, 1924b, pp. 232, 256 (spine glands).—Greene, 1927, p. 309 (Illinois; hypothetical, Wisconsin).—Jordan, 1929, p. 94.—Luce, 1933, p. 118 ([2 mi. below] Vandalia,* Keyesport, and Venedy Station, on Kaskaskia R., Ill.; ecology).—O'Donnell, 1935, p. 484 (compiled).—Greene, 1935, p. 219.—Schrenkeisen, 1938, p. 167.—Kuhne, 1939, p. 68 (Tennessee).—Hubbs and Lagler, 1939, p. 26 (key only).—Lamb, 1941, p. 44 (records, San Jacinto R. system, Tex., include Winters Bayou* [6 mi. N. of river]).—Aitken, 1941, p. 390 (hypothetical, Iowa).—Hubbs and Lagler, 1941, pp. 63–64 (comparison; range; ecology; "possibly divisible into at least 3 subspecies or species" [but not in Great Lakes]).—Toole, 1943, p. 12 (figured; description; Texas).—Gerking, 1945, pp. 74–75 (Big Pigeon Cr., Evansville,* Ind., only).—Hubbs, 1946, p. 38 (Oklahoma).—Higginbotham, 1947, pp. 462–464 (greatest oxygen consumption in late afternoon).—Hubbs and Lagler, 1947 [and 1949], pp. 71, 73, fig. 176 (comparison; range [not Great Lakes]; specimen figured, Dunklin Co., Mo.).—Trautman, 1948, pp. 166–171 (description; Great Lakes basin record a hybrid; Oklahoma and Missouri).—Moore and Paden, 1950, p. 87 (ecology; Illinois R., Oklahoma records: Stations 6,* 7,* and 8*).—Baughman, 1950, p. 131 (Texas).—Bailey, 1951, p. 196 (hypothetical, SE. Iowa; recorded, NE. Missouri).—Cross and Moore, 1952, pp. 406–407 (type-locality indicated; Poteau R., Oklahoma records: Stations 7,* in part, 15,* 22, 24,* in part, 25, 28, M2,* M3,* Miz,* 29, 33,* M_1*).—

*Material indicated by an asterisk has been re-examined.

G. A. Moore, 1952, p. [6] (Oklahoma).—Jurgens and Hubbs, 1953, p. [3] (Texas).—Moore and Buck, 1953, p. 24 (description; Oklahoma records).—Knapp, 1953, pp. 77–78, fig. 108.—Hall, 1954, p. 59 (Oklahoma records including Grand R. [about 4 mi. E. of]* Choteau, Mayes Co.).—Cross, 1954, p. 311 (riffle, South Fork Cottonwood R., Chase Co., Kans.); 1955, pp. 475–476 (description; ecology; Chikaskia R.; Kansas records: Neosho R. in Coffey, Labette, and Lyon Counties; trib. to Four-Mile Cr.,* Sedgwick Co.).—Hall, 1955, p. 36 (reservoir population reduced, Illinois R., Okla.).—G. A. Moore, 1957, pp. 143, 144, fig. 2–79E (description; range).—Hubbs, 1957, p. 96 (Texas distribution).—Schelske, 1957, pp. 32–47 (occurrence, Verdigris R. system, Kans.).—Hubbs and Lagler, 1958, p. 91, fig. 176 (not in Great Lakes).—C. Hubbs, 1958, p. 8 (Texas distribution).—Lambou, 1959a, pp. 49–52 (Louisiana records).—Birkhead, 1967, pp. 101–110 (comparative toxicity of venoms).

Rabida nocturna (Jordan and Gilbert).—Jordan, Evermann, and Clark, 1930, p. 156.—Blatchley, 1938, p. 67 (compiled).—Driver, 1942, p. 254 (comparison; range [in error]); 1950, p. 262.

Noturus flavus Rafinesque [misidentifications].—Forbes, 1909 and 1914, map 57, and Forbes and Richardson, 1909 [and 1920], map 57 (Illinois distribution, in part [Havana;* Crooked Cr., Ripley;* "north line",* Brown Co.]).

Schilbeodes gyrinus (Mitchill) [misidentification].—Forbes, 1909 and 1914, and Forbes and Richardson, 1909 [and 1920], map 58 ([Mackinaw Cr.,* Tazewell Co., Illinois]).

Schilbeodes insignis (Richardson) [misidentification].—Hubbs and Raney, 1944, map 1 ([Sanbois R., 7 mi. S. of Stigler,* Haskell Co., Okla.]).

Type-specimens.—USNM 36461 (lectotype) and USNM 201388 (2 paralectotypes), Saline River, near Benton railroad bridge, Arkansas, 1884, David Starr Jordan and C. H. Gilbert. SU 562 (4 paralectotypes) and USNM 36383 (28 paralectotypes), Poteau R., Slate Ford, W. of Hackett, Oklahoma, 1884, Jordan and Gilbert. SU 564 (2 paralectotypes) and USNM 36426 (15 paralectotypes), Washita [Ouachita] R., about 0.5 mi. above Arkadelphia, Arkansas, 1884, Jordan and Gilbert.

Other material studied

UNITED STATES: Alabama: UMMZ 167361 (Alabama R., Camden, Wilcox Co.); USNM 200440 (trib., Uphapee Cr., 7.0 mi. SW. Auburn, Lee Co.), 200475 (Cahaba R., Harrisburg bridge, near Centreville, Bibb Co.), 201241 (Tensaw R., Stockton, Baldwin Co.). Arkansas: Tulsa U (Lee Cr., at Arkansas-Oklahoma line); UMMZ 167217, 167219, 167305, 169947, 169995; UMMZ (Burnett Springs, 2 mi. N. of Paragould, Greene Co.); TU 10351, 12292, 15594; USNM 172406; CU 42244. Illinois: UMMZ 105762, 165883; UMMZ (Bauman nos. 45, 68, 75, 76–77). Indiana: UMMZ 113553 (White R., Hindustan Falls, near Shoals). Kansas: UMMZ 111483; KU 2351 (trib., Four Mile Cr., sec. 36, T. 27 S., R. 2 E., Sedgwick Co.); USNM 172048, 200781. Kentucky: UMMZ 126943 (Laurel Cr., near mouth, trib. to Little Sandy R.); USNM 63809; UL 8674 (Rough R., 5.5 mi. N. and 3 mi. W. Leitchfield). Louisiana: UMMZ 113722, 165881, 184025; UMMZ (Taylor coll.: La. nos. 55–21c, 55–33, 55–43, 55–46; Comite R., about 1.5 mi. NE. Olive Branch, East Feliciana Parish);

*Material indicated by an asterisk has been re-examined.

CU 15525; TU 765, 882, 1335, 2068, 3932, 4258, 4875, 6252, 6265, 13248, 13347, 13625, 13680, 13714, 14089, 14833, 15844, 16795, 20908; TU (Big Cr., Pollock, Grant Parish); USNM 163119, 172110, 172333, 172528, 172550, 172638, 172654, 172670, 172682, 172716, 172808, 172873, 172884, 172926, 172962, 172980, 172998, 173056, 173100, 173118, 173143, 173169, 173282. Mississippi: UMMZ 163717; UMMZ (Walker no. 39–32; Sandy Cr., 15 mi. N. of Iuka, 1 mi. W. of Hwy. 25); AF 3255 (Okahatta Cr., trib. to Chunky Cr., Newton Co.); TU 6255, 14941, 15184, 17729, 19786, 23514. Missouri: UMMZ 139501, 139569, 139585, 139649, 139723, 142185, 142203, 148564, 149251, 149739, 149994 (Mississippi R., Canton, Lewis Co.), 150225 (Osage R., 5 mi. SE. of Amoret or 5 mi. NW. of Foster, Bates Co.), 152749, 153130, 153151, 164582; INHS (lower St. Francis R., Butler and Dunklin Counties; Osage R., N. of Schell City, Vernon and Bates Counties; Meramec R., 2 mi. SE. of St. Clair, Franklin Co.; Salt R., 6 mi. N. of Center, Ralls Co.); UMoMZ (A.C. Bauman nos. 50, 54; C.B. Obrecht no. 41–29, Current R., 7 mi. N. Doniphan, Ripley Co.). Oklahoma: UMMZ 156771, 167176, 167177, 167178, 167182 (Chikaskia R., below L. Blackwell, Kay Co.), 167184 (trib. to Washita R., Dougherty bridge, Murray Co.), 167195, 167201 (Shoofly Cr., at bridge N. of Braman, Hwy. 177, Kay Co.), 167214; OAM 4112; Tulsa U (Grand R., at Earbob Cr., Mayes-Wagoner Co. line; creek, 0.5 mi. N. of Okay; Big Skin Bayou, U. S. Hwy. 64; Brushy Cr., 2 mi. S. of Choteau, Mayes Co.; Bird Cr., Avant, Osage Co.; creek, 10.5 mi. S. Antlers, Choctaw Co.; California Cr., 2 mi. S. Delaware; Poteau R., 4 mi. SE. Heavener, Le Flore Co.; Pryor Cr., 1.5 mi. S. Pryor; Caney R., Hulah Dam, Osage Co.; Little Beaver Cr., 1 mi. W. Hardy, Kay Co.; Bird Cr., 1.5 mi. NW. Catoosa; Verdigris R., 1 mi. N. of U. S. Hwy. 66, Rogers Co.; Big Lee Cr., 2 mi. E. Nicut); TU 13776 (Chikaskia R., 5.4 mi. NW. Braman, below Lake Blackwell); USNM 165779, 165796; CU 14134. Tennessee: UMMZ 168328; USNM 193480, 193481 (Rose Cr., 2 mi. above mouth, Hardeman Co.); Tennessee Game and Fish Comm. (Cumberland R., mi. 232, Old Hickory Reservoir). Texas: UMMZ 161774; UMMZ (Delavan and Creaser no. 31–39, White Rock Cr., Preston Road, 12 mi. N. of Dallas); TNHC 1046, 1196 (trib. of Peach Cr., Hwy. 105, 15 mi. E. of Conroe, Montgomery Co.), 1388 (West Fk. San Jacinto R., 3 mi. W. of Conroe, Montgomery Co.), 1439 (trib. to Long Cr., 2 mi. N. of Goodrich, Hwy. 59, Polk Co.); TU 3384, 3415, 3477, 3505, 3791 (trib., Trinity R., Hwy. 294, 3.7 mi. W. Elkhart, Anderson Co.), 3853, 14042, 14044, 14063 (stream, Hwy. 105, 8.1 mi. E. Conroe, Montgomery Co.), 14066, 14323, 14346, 21679, 21734, 21797, 21910.

Diagnosis.—*Noturus nocturnus*, subgenus *Schilbeodes*, has 55 to 64 caudal rays; 15 to 20, seldom more than 18 anal rays; 8 to 10, typically 9 pelvic rays; 7 to 11, modally 9 or 10 soft pectoral rays; 2 internasal pores; and normally either 10 or 11 preoperculomandibular pores. The lower jaw is included. The pectoral spine is roughened behind; there are seldom distinct serrae. The vertical fins frequently have narrow, dark submarginal bands and very narrow, clear margins; the dorsal and lateral surface of the body and the vertical fins otherwise are nearly unicolor.

N. nocturnus is superficially similar to *N. insignis*, *N. funebris*, and *N. phaeus*; it is easily segregated from the other species of *Schilbeodes* by several of the above characters. Distinguishing it from *insignis* are the more rounded head, shorter body, and the usual absence of serrae on the posterior edge of the pectoral spine. The poorly pigmented lower surface of the head and abdomen, the normally stiff dorsal spine, and the shorter anal fin distinguish it from *funebris* and *phaeus*.

Description.—Counts and measurements are given in tables 17 to 26. Body only moderately elongate; caudal peduncle tapering posteriorly, slightly narrower than head depth; eye small, 2.0 to 3.5 times in snout; gill rakers on first arch 5 to 7; largest specimen, an exceptionally large individual from Missouri, 121.5 mm. in standard length; most are under 100 mm. in standard length.

Head rounded above, slightly depressed forward; lower jaw included; premaxillary tooth band with posterior corners rounded or, sometimes, obtusely angulate; dorsal spine relatively short, stout, its thickness about as in most *Noturus*; pectoral spine moderate in length and relatively straight, without anterior serrae; its posterior edge irregularly roughened or sometimes with as many as four irregularly developed serrae; posterior process of cleithrum short, its length about equal to the diameter of the pectoral spine; adipose fin broadly connected with the high procurrent caudal rays, without a distinct notch; caudal fin rounded or slightly pointed behind.

In cleared and stained specimens: vertebrae anterior to origin of anal fin 11 (in 2), 12 (7), or 13 (7); hypurals all separate distally in 20 specimens or hypurals 2–3 fused in 4 specimens; ossified pectoral radials tightly fused on 27 sides or incompletely fused on 5 sides.

Soft dorsal rays in 131 specimens: 5 (in 3), 6 (126), or 7(2). The caudal fin has 19 to 26, mean 23.02 upper simple rays; 17 to 23, usually 18 to 21, mean 19.6 branched rays of which usually 8, less frequently 7 (in specimens above 40 mm. in standard length), are in the upper-half and 10 to 13 are in the lower-half of the fin; and 13 to 19, mean 16.3 lower simple rays.

Body color yellowish brown to dark brown, lighter below, and yellowish white on abdomen. Side and upper surface of body and head uniformly pigmented, without blotches or light markings; upper barbels dark; anterior edge and sometimes all of lower barbels pigmented; lips dark; abdomen pale and immaculate or sometimes with a few scattered chromatophores, becoming covered with a diffuse, dusky pigment with age; a moderate band of pigment across abdomen in front of pelvic fins; branchiostegal membrane pale, sometimes flecked with a few melanophores; chin anterior to mental barbels heavily pigmented; dorsal, anal, adipose, pectoral, and pelvic fins heavily flecked with pigment near their bases, becoming more diffuse outward, with the margins to outer half often immaculate; anal fin often with a marginal to submarginal dark or dusky band and the edge clear; caudal fin typically darker than other fins, usually uniformly dusky. Large specimens, above 90 mm., almost uniformly and heavily pigmented over upper part of body, fins, and abdomen.

Type.—Jordan and Gilbert (1886) listed *Noturus nocturnus* from six localities in Oklahoma, Arkansas, and Texas, but based their description on the specimens from Oklahoma and Arkansas. Their specimens from the Rio Lampasas, Texas, are not *nocturnus* but are *Noturus gyrinus*. Two of the localities have been variously listed (see synonymy) as the type-locality, beginning with Evermann and Kendall (1894). Evermann and Kendall were the first to publish a figure of *nocturnus*, based on a specimen from the Saline River, Benton, Arkansas. This figure was reprinted by Jordan and Evermann (1900, p. 3236, pl. 27, fig. 64) and stated to be from the type, USNM 36461, essentially designating a lectotype.

When examined by me, USNM 36461 contained three specimens in agreement with the original catalog record. The largest of the three is herein selected as the lectotype because it most closely approaches the length of 2.3 inches noted on the drawing and is unique in having a dark longitudinal line near the middle of the caudal fin, as shown on the original drawing and many of the published illustrations. The lectotype retains the number USNM 36461.

The lectotype is a male, 48.5 mm. in standard length. It has 18 anal rays, 26+8+11+17=62 caudal rays, and 6 soft dorsal rays. On each side there are nine pelvic rays, nine soft pectoral rays, two internasal pores, and eleven preoperculomandibular pores. The posterior edge of the pectoral spine is roughened, without serrae. The head length is stepped into the standard length 3.8 times and the distance from the adipose notch to the tip of the caudal fin is stepped into the distance from the origin of the dorsal fin to the adipose notch 1.55 times.

Variation.—*Noturus nocturnus* is a variable species and appears to form distinctive localized populations. The most noteworthy of these is one in the Red River system. There, specimens are often light gray to yellowish and sometimes have extremely short spines. In this system the preoperculomandibular pores are often ten instead of eleven. Some Texas specimens are extremely elongate, but show no increase in meristic characters. The single specimen from the Tennessee basin in Mississippi has 20 anal rays, an unusually high number. Color variations are a prominent brownish band near the edge of the anal fin and a rather broad white posterior margin of the caudal fin, but there is no definite geographic trend. The specimens from the Alabama River have a high number of soft pectoral rays, modally ten; other specimens from eastern Gulf tributaries tend to have a higher number of pectoral rays than elsewhere.

Aside from the peculiar pore counts of populations in the Red River system, the gradients in meristic characters appear to be slight. The following data are arranged in the sequence: number of tabulations, range (in parentheses), and mean by drainage.

Vertebrae: San Jacinto R., Texas 8 (35–37) 35.75; Neches R., Texas 2 (37) 37.00; Red R., Oklahoma and Louisiana 24 (35–38) 37.04; Ouachita R., Louisiana 16 (36–38) 36.56; Arkansas R., Oklahoma 11 (35–37) 36.09; Black R., Missouri 1 (38) 38.00; Cache R., Illinois 14 (36–37) 36.57; Alabama R., Alabama 7 (36–37) 36.86; total 83 (35–38) 36.61.

The following data, in the same sequence, are combined from broad geographic areas: (a) Texas, (b) Red River system, Oklahoma, (c) Red River system, Louisiana, (d) Arkansas River system, Oklahoma and Kansas, (e) Ouachita River system, (f) Mississippi River drainage above Arkansas River, (g) tributaries to Gulf of Mexico between Mississippi and Mobile Rivers, (h) Mobile River drainage, (i) total.

Pelvic rays: (a) 56 (8–10) 9.02; (b) 30 (8–9) 8.93; (c) 24 (9–10) 9.13; (d) 46 (9–10) 9.17; (e) 44 (9–10) 9.05; (f) 62 (8–10) 8.98; (g) 44 (8–10) 9.00; (h) 20 (9–10) 9.15; (i) 326 (8–10) 9.04.

Soft pectoral rays: (a) 54 (8–10) 9.06; (b) 30 (8–10) 9.23; (c) 22 (9–10) 9.23; (d) 46 (9–10) 9.30; (e) 44 (9–10) 9.11; (f) 63 (7–10) 8.98; (g) 42 (9–10) 9.43; (h) 20 (9–11) 9.85; (i) 321 (7–11) 9.21.

Anal rays: (a) 22 (16–18) 16.95; (b) 19 (15–18) 16.68; (c) 12 (17–19) 18.00; (d) 12 (15–18) 16.50; (e) 24 (15–18) 17.13; (f) 32 (15–20) 16.97; (g) 24 (16–19) 17.33; (h) 10 (16–18) 16.70; (i) 155 (15–20) 17.04.

Lower-half caudal rays: (a) 22 (27–31) 28.50; (b) 14 (26–30) 27.64; (c) 12 (28–31) 29.08; (d) 12 (27–30) 28.00; (e) 21 (26–29) 27.82; (f) 29 (26–30) 27.66; (g) 5 (28–30) 29.00; (h) 8 (27–29) 27.75; (i) 123 (26–31) 28.07.

Upper-half caudal rays: (a) 22 (29–33) 31.00; (b) 14 (29–33) 31.00; (c) 12 (31–34) 32.25; (d) 12 (28–33) 30.33; (e) 21 (29–33) 30.91; (f) 29 (29–34) 30.59; (g) 5 (30–33) 31.20; (h) 8 (29–32) 30.38; (i) 123 (28–34) 30.89.

Total caudal rays: (a) 22 (56–64) 59.50; (b) 19 (55–62) 58.68; (c) 12 (59–64) 61.33; (d) 12 (56–62) 58.33; (e) 21 (56–62) 58.73; (f) 30 (55–63) 58.23; (g) 5 (58–63) 60.20; (h) 8 (56–60) 58.13; (i) 129 (55–64) 58.94.

Preoperculomandibular pores: (a) 64 (10–11) 10.89; (b) 225 (9–12) 10.26; (c) 114 (9–11) 10.27; (d) 180 (9–12) 10.86; (e) 203 (9–12) 10.94; (f) 54 (10–12) 10.80; (g) 52 (10–12) 10.92; (h) 20 (10–11) 10.95; (i) 916 (9–12) 10.66, including Calcasieu River, Louisiana 4 (11) 11.00.

Preoperculomandibular pores in streams of Red River system: Clear Boggy River, Oklahoma 63 (9–11) 10.30; Kiamichi River, Oklahoma 12 (10–12) 10.33; Little River, Oklahoma 146 (9–11)

10.23; Washita River, Oklahoma 4 (10–11) 10.25. The modal number for each population in the Red River system, Oklahoma, is strongly ten; the mode for nearly all the other samples outside the Red River system is eleven.

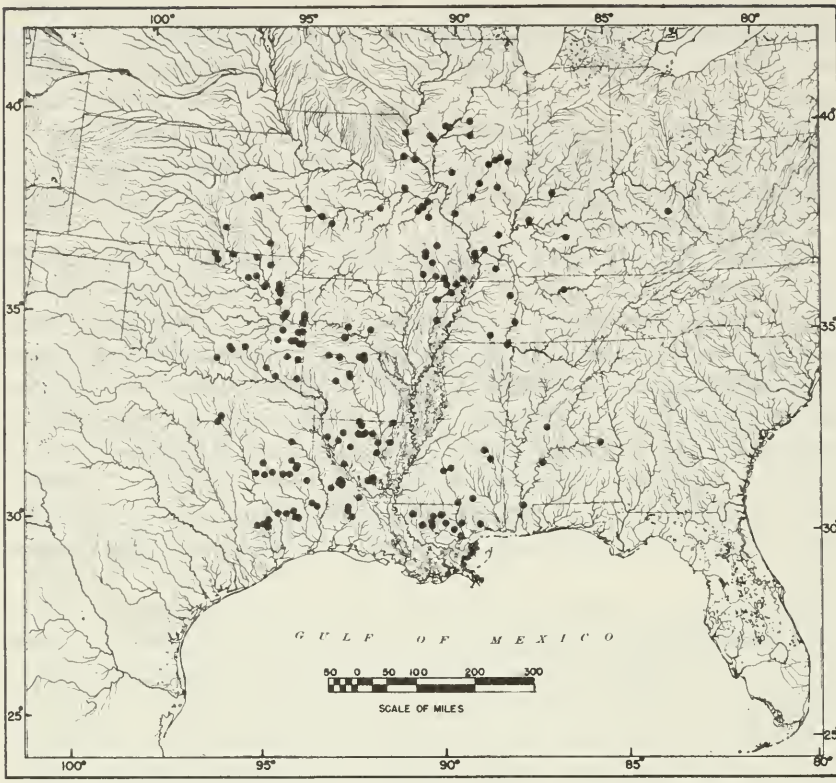
In northwestern Louisiana, specimens from Saline and Kisatchie Bayous have strong modes of ten; other populations in the Red River system, Louisiana, may have modes of ten or eleven but I have been unable to establish trends.

The Red River populations are confusing because of the shift in pore count inside the range of the species. I do not know if this character is a geographic variation of *nocturnus* confined to the Red River drainage, or if two very similar species are involved. As noted previously, some populations with the low pore count have relatively short spines and light color; others do not. Since there appear to be no other distinguishing characters I have been unable to identify populations or specimens consistently without counting pores, and in the lower portions of the drainage the pores may grade from ten to eleven. No samples have been observed containing two distinct morphological types.

Distribution.—*Noturus nocturnus* (map 4) is found in the lower and central Mississippi drainage and in other tributaries to the Gulf of Mexico in Alabama, Mississippi, Louisiana, and Texas. Base-level streams and brackish water are probably avoided; otherwise *nocturnus* occurs throughout the lower Mississippi River system from and below the following: the bend of the Tennessee River in Mississippi, tributaries to the Ohio River in Indiana and Kentucky, tributaries to the upper Mississippi River in Missouri, the Illinois River in Illinois, the Osage River in Kansas and western Missouri, the Arkansas River system in Kansas and Oklahoma, and the Red River system in Texas and Oklahoma. It ranges eastward in most Gulf of Mexico tributaries to the Mobile River system, Alabama. Westward from the Mississippi drainage, *nocturnus* is found in many larger tributaries to the Gulf of Mexico, to the San Jacinto River in Texas.

N. nocturnus is notably absent from the Ozark upland (upper White River system) and probably is sparsely distributed in the small eastern tributaries to the Mississippi River from Kentucky to Louisiana. The fauna of the latter region, however, has not been collected as extensively as that of the Ozarks; the predominance of shifting sand streams probably limits the favored habitat here. The reason for the absence in the Ozark streams is unknown. In contrast, *nocturnus* ranges throughout much of the Ouachita upland.

The hybrid *Noturus gyrinus* × *Noturus miurus*, and the following species of *Noturus* have been incorrectly recorded as *nocturnus: gyrinus*, *exilis*, *flavus*, and *albater*.



Map 4.—Distribution of *Noturus nocturnus* Jordan and Gilbert. The circles represent localities from which I have examined specimens. All unverified literature records are from well within the area of the figures shown.

Relationships.—*Noturus nocturnus* appears to be most closely related to *Noturus insignis*, from which it differs in the fewer hypurals, the shorter anal fin, the poorly serrated pectoral spine, the poor development of black margins on the vertical fins, the relatively short chunky body, and the rounded head. These characters, however, are subject to considerable variation from population to population in both species. The two species are strikingly similar in structure of the pectoral spine, the number of fin rays, the tendency to have dark marginal or submarginal bands on the vertical fins, the sensory canal system, and show resemblances in ecology. They seem to form a compact and closely related group allied to *Noturus funebris* and *Noturus phaeus*.

Ecology.—This species lives in moderate size to large streams in riffles or in areas of moderate to fast current over a gravel and boulder bottom. It is seldom found in streams with shifting sand bottoms. The water is frequently turbid or slightly turbid, but it probably prefers clear water. It has been taken in collections with *gyrinus*, *leptacanthus*, *exilis*, *phaeus*, *flavus*, *eleutherus*, *placidus*, *munitus*, and *miurus*.

ETYMOLOGY.—The name *nocturnus* (Latin), meaning nocturnal, alludes to the dark color of this species.

Noturus insignis (Richardson)

MARGINED MADTOM

PLATES 3 (FIG. 6), 6 (FIG. 2); MAP 5

Pimelodon *livrée* [French vernacular].—LeSueur, 1819, pp. 155–156 (description; no locality); 1820, p. 44 (as *Pimelode livrée;* abstract of description; no locality).—Vaillant, 1896a, p. 28 and 1896b, p. 14 (synonymy).—Bertin and Estève, 1950, p. 25 (synonymy; specimen, MNHN 3053, from Philadelphia, United States).

Pimelodus insigne Richardson, 1836, p. 132 (named as follows: "The following species have been detected in the United States. . . . *Pimelodus catus* . . . and *insigne* (*livrée*, LeSueur).").

Noturus insignis (Richardson).—Jordan, 1877d, pp. 72–119, pl. 36, fig. 56, pl. 37, figs. 57–57c (synonymy; range; relationship; comparison; Pennsylvania specimens figured); 1877e, p. 611 (relationship); 1878a, p. 118 (Susquehanna R., Pa.; synonymy); 1878c, p. 368 (upper Ohio R. [not Indiana]); 1878d [and 1884], p. 335 (description; range; synonymy); 1878e, p. 414 (range; synonymy).—Jordan and Brayton, 1878, pp. 29, 87, 93 (range; Reedy R.,* Greenville Court-House, S.C.).—Bean, 1880, p. 112 (James R.,* Va.; [Conoy Cr.* and Susquehanna R.*], Bainbridge, Pa.; Potomac R.*).—Cope, 1881, p. 77 (description; range; synonymy; tribs. of Susquehanna R.,* Pa.).—Jordan and Gilbert, 1883, p. 100 (range; description; synonymy).—Swain and Kalb, 1883, pp. 638–644 (range and synonymy [in error]; description; Susquehanna R.*).—True, 1883, p. 258 (South Carolina).—Jordan, 1885, p. 802.—Jordan and Gilbert, 1886, p. 6 (comparison).—Jordan, 1889, pp. 352–353 (comparison and associations); 1890, pp. 101–136 (description, ecology, and associations; Virginia records including Shenandoah R.,* 5 mi. NW. of Luray; Buffalo Cr.,* Buffalo Mills; Blackwater R., Zuni;* Roanoke R., Salem* and Roanoke.* North Carolina records including Tar R., 2 mi. below Rocky Mount;* Little R., Goldsboro;* Neuse R.,* Millburnie; South Buffalo Cr., 5 mi. SE. of Greensboro;* Reedy Fork,* Haw R., Fulks Mill; Little Yadkin R.,* Lindsays Mills; ?Second Cr., trib. to Little R.; ?Jumping Run, 6 mi. N. of Salisbury; Catawba R., near Marion;* Bucks Cr., Pleasant Garden;* Johns R., near Morgantown*).—Bean, 1892, pp. 19–20, pl. 19, fig. 26 (description; synonymy; Susquehanna and Delaware drainages, Pa.; not viviparous).—Evermann and Cox, 1895, pp. 304–309 (compiled).—Jordan, 1904, pp. 42, 351 (description; range).—Taylor, 1957, p. 192.—Eddy, 1957, p. 153, fig. 387.—Clugston and Cooper, 1960, p. 9 (age, growth, maturity, sex ratios, Bald Eagle Cr., Centre Co., Pa.).—Beyerle and Cooper, 1960, p. 256 (common, Kettle Cr., Pa., with trout).—Patrick, 1961, p. 256 (North Anna R.).—Schwartz, 1961, p. 25 (probable bait introduction into Deep Creek L.,* Md. and Ohio R. tributaries,* W. Va.).—McFadden and Cooper, 1962, pp. 54, 56 (Kettle and Shaver Creeks, Pa., with trout).—Tenney and Woolcott, 1964, pp. 17–20 (response to toxin).—Richards, 1966,

*Material indicated by an asterisk has been re-examined.

p. 829 (associations with *Etheostoma*).—New, 1966, p. 23 (eggs on undersurface of rocks?).

Schilbeodes insignis (Richardson).—Jordan and Evermann, 1896a, pp. 145, 147 (description; range; synonymy); 1896b, p. 234.—Smith and Bean, 1899, p. 181 (vicinity of Washington, D.C.).—Jordan and Evermann, 1900, pl. 28, fig. 66 (Consy [Conoy] Cr.,* Bainbridge, Pa.).—W. F. Ross, 1902, pp. 112–120 (Bald Eagle Cr., Pa.; reproduction; ecology; food habits).—Bean, 1903, pp. 95–96, 740 (synonymy; description; Delaware and Susquehanna systems, New York).—Fowler, 1906a, pp. 171–173, pl. 15 (description; associations; Crosswicks Cr., N.J.); 1906b, p. 595 (Susquehanna tribs., Cameron Co., Pa. only).—McConnell, 1906, p. 174 (Marsh Run of Bald Eagle Cr., Pa.).—Reed, 1907, pp. 555–564 (poison apparatus described).—H. M. Smith, 1907, p. 70 (synonymy; description; range; North Carolina distribution).—Fowler, 1907a, p. 14 (Pennsylvania records: Delaware R. basin, in the Schuylkill* and [Delaware R.], Holmesburg;* Susquehanna basin, Carlisle;* Conestoga Cr.* and Paradise,* Lancaster Co.); 1910, p. 927 (outlet, Lakemont Park L., Altoona,* Pa.); 1912b, p. 54 (Conowingo Cr., near Conowingo,* Md.).—Nichols, 1913, p. 92 (near New York City).—Fowler, 1913, p. 92 (Pennsylvania records, in part; Cambria Co. [error for Blair Co.; Port Allegany in error]); 1914a, p. 357 (Deer Cr., Md.); 1915a, pp. 208–209 (in part; Assanpink Cr.,* Trenton, N.J.; Gynn Oak,* Md.; Pennsylvania records: [Delaware R.], Milanville;* Dingmans Ferry;* Delaware Water Gap;* Lopez.;* others relisted).—McAtee and Weed, 1915, pp. 5–10 (Maryland records: Rock Run;* Cabin John Run;* the Canal; Potomac R.;* Sycamore Cove).—Fowler, 1915b, p. 1 (hypothetical, Delaware Co., Pa.).—?Welsh, 1916, p. 54 (Little Peedee R., S.C.).—Radcliffe and Welsh, 1916, pp. 40–41 (Maryland records: Tenmile Cr., near Boyds;* Chesapeake and Ohio Canal, below Buzzards Hole*).—Fowler, 1917a, pp. 110, 117 (Harihokake Cr., near French Town,* N.J.; Pennsylvania records include Saucon Cr.,* Lanark; Martins Cr., near Bangor*); 1917b, pp. 34–36, plate (reproduction; nest figured; Middle Fork Tohickon Cr., Pa.); 1918c, p. 90 (Pennsylvania records).—Nichols, 1918, pp. 38, 103 (description; near New York City).—Fowler, 1919, p. 57 (Pennsylvania records including Jordan Cr., near Helfrichs Spring,* Lehigh Co.); 1920a, p. 299 (Paupack L. outlet, Pike Co., Pa.); 1920b, p. 150 (New Jersey counties); 1921a, p. 387 (Pennsylvania); 1921b, p. 63 (Bucks Co., Pennsylvania records including Haycock Cr.*); 1922, p. 16 (Depot Br., Greenville Co., S.C.).—Breder and Crawford, 1922, p. 322 (as *insignia;* Oxon Run, District of Columbia).—H. S. Pratt, 1923, p. 96.—Fowler, 1923, pp. 9, 16 (Virginia records); 1924, p. 269 (Susquehanna R., near Towanda, Pa.; used for bait); 1925, p. 24 (Big Conewago Cr., Pa.).—Brimley and Mabee, 1925, p. 15 (Boones Pond, N.C.).—Coker, 1925, p. 59 (Paddys Cr., trib. to Catawba R., N.C.; ecology); 1926, p. 108 (associations; Paddys Cr., N.C.).—Fowler, 1927, p. 191 (Pine Cr., Galeton,* Pa.).—Fowler and Carlson, 1927, p. 66 (Pennsylvania records).—Hubbs and Greene, 1928, p. 390 (L. Ontario drainage).—Pickens, 1928, p. 30 (South Carolina).—Eaton, 1928, pp. 41–42 (Keuka L., N.Y.).—Greeley, 1928, pp. 87–105 (ecology; economics; New York records).—Hubbs and Brown, 1929, p. 4 (not in Great Lakes W. of Niagara Falls).—Truitt, Bean, and Fowler, 1929, pp. 36–37, fig. 6 (range; description; synonymy; Maryland counties).—Hildebrand, 1932, p. 53 (description; North Carolina record).—Greeley, 1934, p. 108, pl. 9 (colored figure, adult male, Catatonk Cr., N.Y.).—Stewart, 1935, p. 85 (region of

*Material indicated by an asterisk has been re-examined.

Lewisburg, Pa.).—Greeley, 1935, pp. 86, 96 (ecology; records, Mohawk R. system, N.Y.).—Odell, 1935, p. 132.—Greeley, 1936, pp. 46–85 (ecology; associations; reproduction; habits; economics; distribution and abundance, Delaware and Susquehanna systems, N.Y.; records).—Odell and Senning, 1936, pp. 93, 95 (New York records).—Hoover, 1936, p. 239 (Merrimack R., near Concord, N.H.).—Greeley, 1937, pp. 87, 97 (ecology; Wallkill and Rondout systems, N.Y.; Rondout R., Mill Hook); 1938, p. 69 (Chemung and Cohocton Rivers, N.Y.).—Odell and Senning, 1938, p. 99 (Waneta L.).—Bailey, 1938, pp. 151–182 (comparison; ecology; New Hampshire records: Soucook R., Loudon;* Merrimack R., Merrimack Co.; Pemigewasset R.,* 2 mi. S. Bristol).—Schrenkeisen, 1938, pp. 166–167.—Bailey and Oliver, 1939, p. 152 (only in Merrimack drainage of New Hampshire).—Hubbs and Lagler, 1939, p. 26 (comparison; Great Lakes basin).—E. W. Surber, 1939, p. 331 (bait fish; Shenandoah and Potomac River systems).—Koster, 1939, p. 201 (associations; Danby Cr., N.Y.).—Van Duzer, 1939, p. 65 (associations; near Ithaca, N.Y.).—Fowler, 1940a, p. 11 (South Br. Rariton R., N.J.); 1940b, pp. 8–9 (Pennsylvania records).—Hubbs and Lagler, 1941, pp. 63–64 (comparison; range; ecology).—Fowler, [1944], p. 52 (Tobyhanna Cr., Pa.).—Hubbs and Raney, 1944, pp. 18–24 (synonymy, in part, including references to basis of the name *insignis*).—E. W. Surber, 1946, pp. 183–191 (effects of DDT).—Brimley, 1946, p. 15 (comparison; North Carolina distribution; Little R., near Bunnlevel).—Bertin and Estève, 1950, p. 25 (synonymy).—R. F. Smith, 1950, pp. 58–59, 172 (Farrington L., N.J.; bass bait).—Cheng and James, 1960, p. 164 (new species Cestode from specimens, Sinking Cr., Va.).

Rabida insignis (Richardson).—Jordan, 1929, p. 93.—Jordan, Evermann, and Clark, 1930, p. 156 (range; synonymy).—Fowler, 1933, p. 8 (Maryland records including Winters Run,* Harford Co.); 1935a, pp. 6–20 (range; South Carolina records: North Saluda R.* and Middle Saluda R.,* Greenville Co.; Turkey Cr.,* Edgefield Co.; Thompson Cr.,* Chesterfield Co.; 6 mi. NW. of Bennettsville* [Hwy. 9], Marlboro Co.).—H. S. Pratt, 1935, p. 90.—Fowler, 1936c, p. 193 (as *insigne;* Mill Cr., Old Fort, *N.C.); 1938, p. 103 (Pennsylvania records); 1939, p. 60 (New Jersey record).—Driver, 1942, pp. 252, 254 [and 1950, pp. 262–263].

Schilbeodes insignis insignis (Richardson).—Hubbs and Lagler, 1957, p. 5; 1958, pp. 89, 91, fig. 177.

Noturus insignis insignis (Richardson).—R. D. Ross, 1959b, p. 4 (key; Shenandoah R. system).—Flemer and Woolcott, 1966, pp. 78, 87 (distribution and food, Tuckahoe Cr., Va.).

Pimelodus lemniscatus Valenciennes, *in* Cuvier and Valenciennes, 1840, pp. 144–145 (original description; specimen received with LeSueur's drawing and indicated by him, "Mem. du Mus. d'hist. natur. de Paris, t. V, p. 155," under the name "*Pimelode livrée*").—De Kay, 1842, p. 187 (description; Southern States).—Storer, 1846, p. 405 [and *in* reprint, 1846, p. 153] (description; synonymy; range).—Bleeker, 1858, pp. 192, 206 (United States).—Girard, 1859, pp. 158–159 (LeSueur's specimen believed from Pennsylvania).—Bertin and Estève, 1950, p. 25 (synonymy; holotype, MNHN 3053, Philadelphia, United States).

Noturus lemniscatus (Valenciennes).—Girard, 1859, pp. 158–159 (incorrectly assigned to *Pimelodus*).—Gill, 1861a, p. 45 (synonymy).—Günther, 1864, p. 104 (synonymy; description; North America).—Jordan and Copeland, 1876,

*Material indicated by an asterisk has been re-examined.

p. 160 (Southern States).—Jordan, 1876b, p. 303 (description; range); 1877c, p. 50 (present in the [upper] Ohio; not seen by Rafinesque in Ohio Valley).

Noturus marginatus Baird.—[Kennicott], 1861, p. 23 (nomen nudum; Carlisle,* Pa.).—Baird, *in* Cope, 1869, pp. 237, 241 (original description; Sinking Cr.* of the Kanawha; head of James R.; the Susquehanna*).—Cope, 1870 [and *in* reprint, 1877], pp. 484, 495 (Catawba* and Yadkin* Rivers, N.C.).—Jordan, 1876b, p. 303, and Jordan and Copeland, 1876, p. 160 (range [in error]).—?Jordan and Gilbert, 1877a, p. 2 (Ohio Valley [not Indiana]).—Jordan, 1877b, pp. 371–372 (range [in error]; synonymy).—[Klippart], 1877, p. 153 (upper Ohio R.; not seen in Indiana).—Jordan and Evermann, 1896a, p. 147 (type-locality indicated as Pennsylvania, based on USNM 1571).—Fowler, 1915a, pp. 208–209 (cotypes,* ANSP 8431–2).

Schilbeodes marginatus (Baird).—Hubbs and Raney, 1944, pp. 3–26, map 1 and legend (distribution; description; type-locality restricted to Carlisle, Pa.; synonymy).—Burton and Odum, 1945, pp. 187, 191 (Virginia records).—Bailey and Taylor, 1950, p. 31 (two subspecies).—Fowler, 1951a, p. 91 (Lancaster Co., Pa., records); 1951b, p. 101 (Chester Co., Pa., records); 1952, p. 109 (synonymy; New Jersey records).—Robins and Deubler, 1955, pp. 14, 16 (Tioughnioga R., N.Y.; associations with *Lota*).—G. A. Moore, 1957, pp. 143, 145.

Schilbeodes marginatus marginatus (Baird).—Hubbs and Raney, 1944, pp. 1–24, map 1 (synonymy, in part; distribution; description; locality records; Great Cypress Swamp* [complex]; [not "South Carolina"]).—Fowler, 1945, pp. 32, 81, 123, 172, fig. 163 (specimen figured, Assanpink Cr.,* Trenton, N.J.; distribution; synonymy, in part; records including Glade Cr.,*Roanoke, Va.; Mill Cr., Old Fort,* N.C.; specimen, Edisto R., Sandy Island Bridge, S.C., described).—Raney and Lachner, 1946a, p. 675 (in associations).—Hubbs and Lagler, 1947 [and 1949], pp. 71, 73, fig. 177 (comparison; range; ecology; Broome Co., N.Y.).—Carpenter and Siegler, 1947, pp. 6, 54, fig. 46 (comparison; New Hampshire rivers).—Raney, 1950, pp. 170–188 (ecology; synonymy; distribution, James R. basin, Va.).—Fowler, 1950a, p. 100 (Pennsylvania record); 1950b, p. 104 (Berks Co., Pennsylvania record).—Howden and Mansueti, 1951, p. 95 (Northwest Br., Anacostia R. system, Md.).—Freeman, 1952, p. 36 (South Carolina records); 1953, p. 269 (Savannah R. basin, Aiken* and Barnwell* Counties, S.C.).—Raney and Massmann, 1954, pp. 426–428 (Lester Manor, and at or above Fall Line, Pamunkey R., Va.).—Harmic, 1954, pp. 25, 45 (Delaware records).—Freeman, 1954, pp. 138, 145, 147, 151 (Savannah drainage, S.C., stations 33* and 40*).—Fischthal, 1956, p. 230 (New York records; list and incidence of parasites).—Anderson and Freeman, 1957, p. 104 (Congaree drainage, South Carolina records* [all reexamined]).—Ross, 1959a, pp. 6–20 (records, Potomac and Shenandoah drainages).

Noturus occidentalis Gill [misidentification].—Günther, 1864, p. 105 (description, in part; young presented by Smithsonian Institution;* "intermaxillary teeth" figured).—Jordan, 1877b, p. 372 (of Günther, probably *Noturus marginatus*).—Swain and Kalb, 1883, p. 640 (of Günther, equals *Noturus insignis* [but not Platte R.]).

Noturus flavus Rafinesque [misidentifications].—Cope, 1865, p. 277 (Susquehanna R.).—Uhler and Lugger, 1876, p. 151 (description [in error]; Maryland records).—Jordan, 1877d, p. 99, and 1878a, p. 118 (Potomac R.).—Swain and Kalb, 1883, p. 639 (Potomac and Patapsco).—?J. Nelson, 1890, p. 671

*Material indicated by an asterisk has been re-examined.

(New Jersey [but not range, description, or synonymy]).—Truitt, Bean, and Fowler, 1929, p. 37 (Maryland records of Uhler and Lugger are likely *Schilbeodes insignis*).—Fowler, 1945, p. 123 (Maryland records of Uhler and Lugger [probably incorrectly] ascribed to *Schilbeodes gyrinus*).

Noturus gyrinus (Mitchill) [misidentifications].—Cope, 1869, p. 237 (Delaware Water Gap,* Pa.); 1881, p. 77 (description; range, in part; trib. to the Delaware R. in Pennsylvania).—Bean, 1892, p. 20 (Pennsylvania distribution, in part).—Patrick, 1961, p. 256 (White Clay R., only).

Schilbeodes gyrinus (Mitchill) [misidentifications].—Fowler, 1907a, p. 14 (Pennsylvania records, in part: Delaware Water Gap,* Monroe Co.; Dingmans Ferry,* Pike Co.; Loyalsock Cr.,* near Lopez, Sullivan Co.); 1912b, pp. 47, 54 (Gynn Falls,* near Baltimore, Md.; Big Neshaminy Cr., Etterton,* and ? near Long Pond, Bucks Co., Pa.); 1913, p. 92 (Pennsylvania records relisted); 1914a, p. 351 (?Delaware R., Torresdale; Lime Kiln Run,* Lehigh Co., Pa.).—?Fowler, 1915a, p. 208 (Torresdale, Pa.).

Pimelodon insignarius Vaillant, 1896a, p. 28 (synonymy; name inscribed on LeSueur's drawing of *Pimelodon livrée*); 1896b, p. 14, pl. 24 (synonymy; name on LeSueur's colored drawing; drawing first published).—Jordan, Evermann, and Clark, 1930, p. 155 (synonymy; basis of name *Pimelodon*).

Rabida gilberti (Jordan and Evermann) [misidentification].—Fowler, 1935a, p. 19 (Great Cypress Swamp,* S.C., in part).

Schilbeodes exilis (Nelson) [misidentification].—Hubbs and Lagler, 1941, p. 65 (Kanawha R. system).

Schilbeodes marginatus atrorus Hubbs and Raney, 1944, pp. 1–25, pl. 1, map 1 (original description; distribution; synonymy and included records; ecology; holotype,* UMMZ 139452, and 8 paratypes,* UMMZ 139453, Wolf Cr., U.S. Hwy. 52, between Bastian and Novis, Bland Co., Va.; figured; other paratypes* and nontypes* listed).—Fowler, 1945, p. 32 (distribution).—Raney and Lachner, 1946b, p. 226 (ecology; Anglin Cr., Patrick Co., Va.;* in association with *Thoburnia hamiltoni*).—Raney, 1950, p. 187 (N. limit of range in Roanoke or Chowan systems).

Schilbeodes insignis atrorus Hubbs and Raney.—Hubbs and Lagler, 1958, p. 91 (range).

Noturus insignis atrorus (Hubbs and Raney).—R. D. Ross, 1959c, pp. 8, 24 (key; New R. system).—Ross and Perkins, 1959, pp. 13–33 (records, New R., Va.).—Ross and Carico, 1963, pp. 9, 16 (records, North Fk. Holston R., Va.; entered from New R. by stream piracy or introduced by human agency).

TYPE.—MNHN 3053 (holotype), Philadelphia, U.S.A., C. A. LeSueur.

OTHER MATERIAL STUDIED

UNITED STATES: DISTRICT OF COLUMBIA: USNM 43605, 85712, 85725. GEORGIA: CU 17373 (Brushy Cr., 0.9 mi. S. Wrens, Hwy. 1, Jefferson Co.); USNM 162467, 162468 (Reedy Cr., 3.9 mi. NE. Wrens, Jefferson Co.); UMMZ 94576, 94582 (Athens Cr., N. of Talmo); UMMZ (Fletcher nos. 6, 29—Barber Cr., about 2 mi. S. of Athens, Clarke Co., 51, 82). MARYLAND: USNM 64426, 66333, 67043, 67073, 70279, 70415–6, 70448, 73287, 73389, 73890, 74776, 75031, 76743, 84052, 85736, 85797, 89012, 103136, 120968, 131769, 131782, 131795, 131814, 157360, 170970 (Deep Creek L., Garrett Co.), 196692 thru 196697; CU 2029, 9249, 13069; UMMZ 66860, 89343. NEW JERSEY: UMMZ 109804, 109820; CU 5333, 5346, 9827. NEW YORK: UMMZ 89165, 94468, 109631, 109656,

*Material indicated by an asterisk has been re-examined.

114318; UMMZ (Hankinson no. 272); USNM 166441; CU 283, 834, 2952, 3694, 4120, 5758, 7411, 7736, 7873, 8894 (Keuka L.), 9312 (Keuka L.), 11485, 11486 (Catherine Cr., Schuyler Co.), 18719, 18739, 18755, 18781, 18800, 18810, 18982, 19040, 19051, 19102, 19115, 20119, 20139, 20152, 20196, 20233, 20240, 20278, 20382. North Carolina: Tulsa U 3; USNM 20322, 40443, 67931, 74813, 92529, 162249, 162890, 162934 thru 162936, 190983, 191000, 191015, 191046, 191058, 191072, 191091, 192755, 192762, 192764, 192787 thru 192796, 200476; CU 4015, 8534, 8540, 9369, 9631, 9654, 9734, 9749, 9776, 9797, 9846, 9857, 10069, 11093, 11096, 11263, 11336, 11426, 11431, 11526, 11591, 11664, 11893, 14080, 14107, 15611, 16809, 16847, 16903, 18392, 19075, 19230, 19241, 19310, 19334, 19404, 19438, 19494, 19513, 19528, 19556, 19581, 19763, 37833; CU (Raney no. 1533); UMMZ 94531, 94542, 94656, 126268, 132788, 138481, 139439, 145270, 147569, 147590, 147611, 156664, 165615; UMMZ (White coll.—Morgan Cr., Orange Co.); NCSM 1482 (Watauga R., Hwy. 105, Watauga Co.), 1489 (Laurel Cr., U.S. Hwy. 321, Watauga Co.), 1501 (Watauga R., county road 1200, Watauga Co.), 2356 (Cove Cr., 2.25 mi. SW. Sugar Grove, Watauga Co.). Pennsylvania: UMMZ 94482, 94486, 138221 (1 syntype, *Noturus marginatus*, Carlisle); ANSP 8431–2 (2 syntypes, *Noturus marginatus*, Carlisle), 8519, 48178, 48543; ANSP (Peters Cr., Lancaster Co.; Briar Cr., Columbia Co.); CU 10358, 16380, 16457, 16506, 18820, 18858, 18878, 18913, 19058, 20463; USNM 1571 (9 syntypes, *Noturus marginatus*, Carlisle), 67539, 70378, 74847–8, 161756, 161774, 192651 (Mill Cr., 2 mi. W. Elliottsville, Fayette Co.), 196691; MNHN 340 and 341 (2 syntypes, *Noturus marginatus*, Carlisle); MCZ 35955 (1 syntype, *Noturus marginatus*, Carlisle). South Carolina: CU 15183, 15380, 15481, 15632, 19068, 19597, 19680, 19736; USNM 23447, 31078, 40600, 162946, 168128, 192735 thru 192754, 192756 thru 192761, 192763, 192765 thru 192786, 192797 thru 192801; UMMZ 94565, 143200, 143203–4. Virginia: CU 8322, 8336, 8365, 8423, 9415, 9688, 10055, 10083, 10503, 10520, 11214, 11370, 11456, 11642, 11656, 11724, 11747, 11774, 11885, 11916, 11948, 12229, 13115, 14554, 16837, 16869, 16900, 17002, 19612, 20301, 20316, 20685 (North Fk. Holston R., Hwy. 91, 2.3 mi. SW. Broadford, Smyth Co.), 20706, 20721, 20730; USNM 1470, 40194, 44396, 64443, 93285, 100182, 100192, 100212, 100234, 101323, 101345, 102404, 103410, 104077, 104091 (2 paratypes, *Schilbeodes marginatus atrorus*, Sinking Cr., 3 mi. above mouth, New R. system, Giles Co.), 104096, 104110, 107454 thru 107456, 107722, 125670, 132068, 162001 thru 162006, 162150 thru 162152, 162195 (trib. of Reed Cr., 3.1 mi. N. Max Meadows, Wythe Co.), 162851 thru 162853, 168150, 177279, 190965 (North Fk. Holston R., just above Saltville, Smyth Co.), 201244–5; UMMZ 94522, 95089, 95151, 95190, 95323, 95346, 95401, 95408, 95423, 126243, 135411, 136151, 138523 (5 paratypes, *Schilbeodes marginatus atrorus*, Reed Cr., Hwy. 21, 1 mi. SW. Wytheville, Wythe Co.), 139452 (holotype, *Schilbeodes marginatus atrorus*, Wolf Cr., U.S. Hwy. 52, between Bastian and Novis, Bland Co.), 139453 (8 paratypes, *Schilbeodes marginatus atrorus*, taken with holotype); ANSP 8435 (1 syntype?, *Noturus marginatus*, Sinking Cr. of Kanawha). West Virginia: UMMZ 136859; CU 4922, 11140 thru 11142, 11181, 13759; USNM 192652 (Big Sandy Cr., Clifton Mills, Preston Co.).

Diagnosis.—*Noturus insignis* is separated from most species of the subgenus *Schilbeodes* by a combination of characters: 54 to 67, usually 56 or more caudal rays, normally 9 pelvic rays, usually 9 soft pectoral rays, 15 to 21 anal rays, distinct posterior serrae of the pectoral spine, which may become reduced in size with age, an included lower jaw, typically 11 preoperculomandibular pores, and 2 internasal pores. The ventral surface of the head, except the lower lip, and the abdomen, except a narrow band just anterior to the pelvic fins, are usually unpigmented. The vertical fins of many specimens have a black margin.

It is distinguished from *Noturus exilis*, with which it has been associated, by the longer caudal fin, the included lower jaw, and the greater number of preoperculomandibular and nasal pores; from *Noturus nocturnus*, an apparent close relative, by the more depressed skull, better developed pectoral spine serrae, and usually 38 or more vertebrae; and from *Noturus funebris* and *N. phaeus* by a shorter anal fin and a poorly pigmented ventral surface.

Description.—Other counts and measurements are given in tables 17 to 26. Body elongate; caudal peduncle deep, both anteriorly and posteriorly, deeper than head depth; head depressed; lower jaw included; premaxillary tooth band usually obtusely angulate at corners; dorsal spine moderate in length, stiff; pectoral spine long, slightly curved, without anterior serrae, but with numerous distinct posterior serrae, which may become irregularly fused in old specimens; humeral process about equal in length to the diameter of the pectoral spine; adipose fin broadly united to the moderately high procurrent caudal fin; caudal fin truncate or rounded behind; eye moderate, 1.9 to 2.6 times in snout; gill rakers six to ten on first arch; size fairly large. Specimens over 100 mm. are frequently obtained; one of the largest is a Virginia specimen 126 mm. in standard length.

The caudal fin has (extremes in parentheses): (21) 23 to 26 (28), mean 24.3, upper simple rays; (15) 17 to 20 (22), mean 18.4, branched rays, of which there are nearly always 7 in the upper-half of the fin and most frequently 10 to 13 in the lower-half; (13) 16 to 20 (23), mean 18.3, lower simple rays. The soft dorsal rays are five (in 3), six (119), and seven (2). The posterior edge of the pectoral spine is serrated, with up to nine serrae.

In cleared and stained specimens for North Carolina, Virginia, and New York: vertebrae anterior to the anal fin origin 12 (11), 13 (23), 14 (2). In 82 of the 92 sides of the pectoral arches examined, the ossified radials are tightly fused; the other sides show partial fusion of the elements, perhaps because relatively small specimens were used. The hypurals are separate in 39 specimens; hypurals 2 and 3 fused (in 4), hypurals 4–5 fused (1), and hypurals 6–7 fused (3).

General color yellowish to slate-gray, lighter on ventral surfaces. Top and sides of body and head uniformly darkly pigmented; no blotches or light areas present; barbels usually with some chromatophores, those above dark, the barbels below light colored; chin in front of the mental barbels pigmented, and a narrow bridge of pigment crosses abdomen in front of pelvic fins; otherwise, abdomen and lower surface of head usually immaculate, but sometimes lightly pigmented in very large specimens; all fins lightly pigmented, especially near their bases, but pelvic fins relatively clear; margins of pectoral, anal, dorsal, and caudal fins frequently with a dark band or with concentrations of pigment that is usually darker than the basal areas of the fins, their extreme edges clear; adipose fin dusky near base, clear distally.

VARIATION.—Certain features of the variation in this species have been discussed by Hubbs and Raney (1944). They indicate that important average differences in the lengths of the dorsal and pectoral spines exist between populations and describe color variations. The data given by Hubbs and Raney (1944, pp. 8, 9, 10, 17) for several proportional measurements of Roanoke and Kanawha specimens are virtually overlapped by the data from other areas. *N. insignis* is, therefore, not unlike other species in the great variation in the length of the spines. As discussed under *Noturus gyrinus*, it appears that some nongenetic factors are operative in determining the development of hard parts, and that the relative lengths of the dorsal and pectoral spines are dependent upon these factors.

The black-bordered fins of Kanawha and Roanoke River specimens are distinctive, but there is a gradient of this character southward into North Carolina and scattered samples from New York, Pennsylvania, and Virginia have similar appearing specimens. The ecological distribution of black fin borders is apparently like that in *Noturus exilis*, which in cool, clear streams develops black-bordered fins, but in warm turbid streams lacks any trace of the dark borders. One small specimen of *insignis* from Georgia has clear white fin borders.

No important variations in meristic characters are apparent. The data (number of tabulations, range in parentheses, and mean) are summarized from the following areas: (a) Cape Fear River to Oconee River; (b) Neuse and Tar Rivers; (c) Roanoke, Chowan, and Kanawha Rivers; (d) James River to Potomac River; (e) the area north of the Potomac River to the Susquehanna River; (f) Holston River; (g) Watauga River; and (h) total.

Soft pectoral rays: (a) 46 (8–10) 9.07; (b) 40 (7–10) 8.90; (c) 62 (8–10) 9.02; (d) 12 (9) 9.00; (e) 95 (8–9) 8.83; (f) omitted; (g) 20 (9–10) 9.15; (h) 275 (7–10) 8.95.

Pelvic rays: (a) 46 (9–10) 9.04; (b) 40 (9–10) 9.30; (c) 62 (9–10) 9.06; (d) 12 (9–10) 9.17; (e) 96 (8–10) 9.02; (f) omitted; (g) 20 (9–10) 9.05; (h) 276 (8–10) 9.08.

Anal rays: (a) 23 (15–20) 18.00; (b) 22 (17–21) 18.45; (c) 31 (16–20) 18.48; (d) 6 (17–19) 18.00; (e) 49 (15–19) 17.29; (f) omitted; (g) 10 (17–21) 18.80; (h) 141 (15–21) 17.99.

Lower-half caudal rays: (a) 24 (27–33) 29.50; (b) 22 (28–33) 30.45; (c) 32 (26–32) 29.78; (d) 6 (30–31) 30.67; (e) 49 (28–33) 29.67; (f) 3 (28–30) 29.00; (g) 9 (26–31) 28.56; (h) 145 (26–33) 29.74.

Upper-half caudal rays: (a) 24 (29–33) 31.08; (b) 22 (29–34) 31.95; (c) 32 (29–33) 30.91; (d) 6 (33–34) 33.67; (e) 50 (29–35) 31.62; (f) 3 (29–30) 29.33; (g) 10 (27–32) 29.90; (h) 147 (27–35) 31.35.

Total caudal rays: (a) 24 (57–65) 60.58; (b) 22 (57–67) 62.41; (c) 32 (56–65) 60.69; (d) 6 (64–65) 64.33; (e) 49 (58–66) 61.31; (f) 3 (57–60) 58.33; (g) 9 (54–62) 58.33; (h) 145 (54–67) 61.10.

Vertebrae: In the counts obtained, the mode for each river system is 39, except the Merrimack. The data are summarized for the following river systems: Savannah 4 (38–39) 38.75; Wateree 24 (38–40) 38.88; Neuse 69 (37–42) 38.83; Tar 17 (38–41) 39.29; Roanoke 26 (37–40) 39.19; Holston 16 (38–40) 39.25; New 3 (38–39) 38.67; James 52 (37–40) 38.98; Monongahela 8 (38–39) 38.88; Potomac 34 (38–41) 38.97; Susquehanna 36 (37–40) 38.53; Merrimack 1 (38) 38.00; total 290 (37–42) 38.92.

Type.—A single specimen, MNHN 3053, is the basis of the description of Pimelodon *livrée,* hence the holotype of *Pimelodus insigne,* of *Pimelodus lemniscatus,* and of *Pimelodon insignarius.* Doctor Leon Bertin and Dr. Victor G. Springer (personal communications) have kindly provided certain critical information about this specimen as follows: The standard length is 74.8 mm. and the total length 88.4 mm.; the caudal fin has approximately 25+13+9+16=63 rays; there are 7 soft dorsal rays and 20 anal rays; on each side there are 2 internasal pores, 9 pelvic rays, and 9 soft pectoral rays. "Philadelphie (États-Unis)," is indicated as the type-locality by Bertin and Estève (1950, p. 25), but Bertin states in his letter that there could have been a transposition of specimens: "Provenance. Une erreur a pu se produire à l'origine entre deux spécimens: un *Pimelodus lemniscatus* (l'holotype) et un *Pimelodus nebulosus* dont les provenances sont Savannah et Philadelphie. Il est possible que Savannah s'applique au *P. lemniscatus* et Philadelphie au *P. nebulosus.*" However, the black fin margins shown in Vaillant's figure (1896b) of *Pimelodon insignarius* are not characteristic of southern specimens. A subsequent check on this confusion suggests that data from MNHN 3052 which is listed as *Pimelodus nebulosus* from Savannah was inadvertently copied on a label for MNHN 3053, and that Philadelphia is probably the correct locality.

Range.—*Noturus insignis* (map 5) has as an apparent native range part of the Lake Ontario drainage, most of the Atlantic coastal streams from New York to Georgia, where it is most frequently found at or above the Fall Line, and the upper New or Kanawha River system. It occurs in the Merrimack River of New Hampshire

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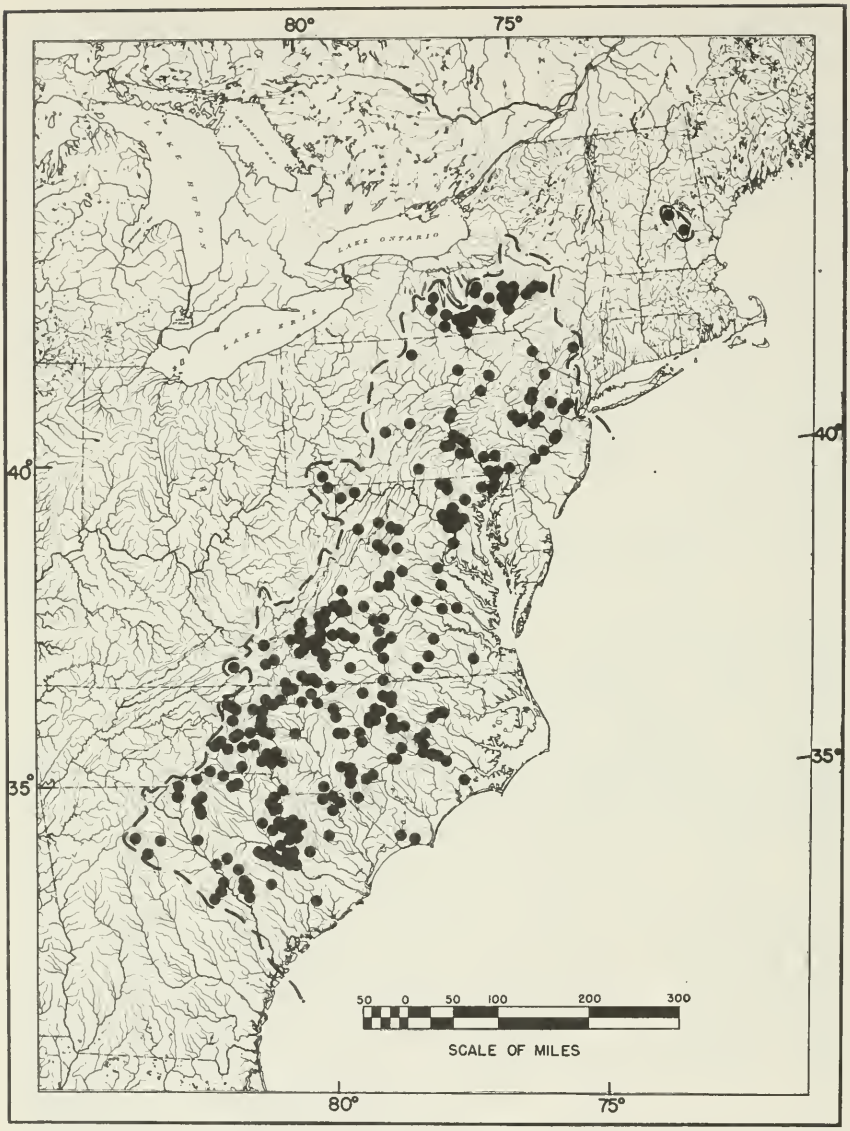


MAP 5.—Distribution of *Noturus insignis* (Richardson). Circles indicate the localities from which I have examined specimens. The dashed line outlines the known limit of distribution and surrounds localities for which there are unconfirmed literature records.

N. insignis is believed to be a native inhabitant of tributaries to the Atlantic Ocean from Georgia to New York and the upper Kanawha River system. It was probably introduced by man into New England and has crossed into the Lake Ontario drainage, the upper Tennessee River basin, and other tributaries of the Ohio River in Maryland, Pennsylvania, and West Virginia.

where it has presumably been introduced. In New York the records are from Keuka Lake, Catherine Creek, tributary to Seneca Lake, and a few other small tributaries in the Lake Ontario drainage, from the Mohawk and Hudson River systems, and from the Delaware and Susquehanna basins. In the New River, it is confined to the area above the falls in West Virginia, Virginia, and North Carolina. In Georgia it occurs in the Oconee and Savannah River systems.

In recent years specimens of *Noturus insignis* have been collected from other drainages in the upper Ohio River system and from the Tennessee system. The collections from the Tennessee system indicate that *insignis* is well established there, where it is known from several localities in the Watauga drainage in North Carolina and from the North Fork of the Holston River, Virginia. I and several other collectors have obtained specimens from the latter stream and found it abundant, at least locally. *N. insignis* has been collected from three localities in the Monongahela and Youghiogheny systems in West Virginia, Maryland, and Pennsylvania. Although few specimens have been collected, the geographic dispersal suggests that *insignis* is established in both streams.

The historical evidence points to the absence of *insignis* from the upper Ohio and Tennessee systems until recently, as many earlier collectors did not obtain specimens. Establishment could have been by any of at least three methods, but the first seems most likely: (a) Frequent references in the fishery literature indicate that madtoms are often used as bait for other fishes. They are very hardy and able to survive injury and extreme conditions. Dumping of a few unwanted bait specimens could easily start a new population in a favorable habitat. (b) Accidental dispersal when stocking game fishes. *Noturus gyrinus* has undoubtedly been introduced into several areas by this method. However, *insignis* is less likely to be an inhabitant of fish hatcheries and it is expected that it would rarely be captured and distributed along with game fishes. (c) Changes in drainage pattern may account for dispersal of *N. insignis* into the Holston drainage but they do not appear to be responsible for several of the introductions elsewhere.

An undoubted introduction by man was into Clark Lake, Gogebic County, Michigan (UMMZ 186551).

Noturus leptacanthus, *N. exilis*, *N. flavus*, and *N. miurus* have been reported under the name *Noturus insignis* or one of its synonyms.

Etymology.—The name *insignis* (Latin) means remarkable or extraordinary. The probable intention was to emphasize the color and the long adipose fin, features which were at one time considered unique.

Nomenclature.—The recent resurrection of *Noturus marginatus* Baird for this species and the transfer of *Pimelodus insigne* Richardson to the form herein called *Noturus exilis* (Hubbs and Raney, 1944) are invalid.

Noturus insignis was first described by LeSueur from material (probably a single specimen) that became the basis of five different names. Two of these, both accompanying LeSueur's descriptions, were vernacular. Richardson (1836, p. 132) named *Pimelodus insigne* on the basis of one of LeSueur's descriptions and vernacular names. Next, Valenciennes (Cuvier and Valenciennes, 1840, p. 144) described LeSueur's specimen anew, naming it *Pimelodus lemniscatus*. Finally Vaillant published a synonymy (1896a, b) and LeSueur's colored drawing (1896b) under the drawing's label *Pimelodon insignarius*. None of the descriptions indicated a type-locality.

Characters of the single specimen that serves as the type of these names are given above. LeSueur (1819, p. 155) indicated that the first dorsal, anal, caudal, and pectoral fins are bordered with a band of black, also shown in LeSueur's drawing, published by Vaillant (1896b). However, the 50 caudal rays noted by LeSueur must be interpreted as an estimation. Valenciennes (Cuvier and Valenciennes, 1840, p. 144) described the upper jaw as longer than the lower and the caudal fin with more than 60 rays, including the small ones above and below, in agreement with counts obtained by Bertin from the type. The locality indicated, the characters given, and the original descriptions when considered together leave no doubt of identity with the madtom here called *Noturus insignis;* the combination of characteristics (2 internasal pores, the high number of caudal rays, the included lower jaw, the color, and a locality in the eastern United States) refers to no other species.

Noturus marginatus was described by Baird (*in* Cope, 1869, pp. 237, 241). Localities listed are "Sinking Creek of the Kanawa," "head of James River," and "the Susquehanna." Jordan and Evermann (1896a, p. 147) listed USNM 1571, a collection containing at least nine specimens, as type. Hubbs and Raney (1944, p. 15) accepted Jordan and Evermann as having restricted the type and type-locality. No lectotype of *Noturus marginatus* has yet been selected. Baird's description was based, at least in part, upon specimens from the Susquehanna River at Carlisle, Pennsylvania (USNM 1571). It is uncertain if Baird based his description also on the Virginia specimens or if these were only listed by Cope after comparison with the Academy of Natural Science specimens provided by Baird. I have examined several of the syntypes of *marginatus* and find that they are all referable to *Noturus insignis*.

Schilbeodes marginatus atrorus, described by Hubbs and Raney (1944) from Wolf Creek, Bland County, Virginia, differs little from other material except in the intensity of the black on the fin borders.

Pimelodus insignis Schomburgk (1841, p. 180 and plate VI in the Natural History of the Fishes of [British] Guiana, vol. 1) is a primary homonym of *Pimelodus insigne* Richardson (1836, p. 132).

Ecological considerations.—As noted by examination of the distribution map (map 5) of this species, the records are chiefly from high-gradient streams above the Fall Line. Raney and Massman (1954) and Greeley (1928, 1935, 1936, and 1937) have discussed the ecology. *N. insignis* lives in clear or normally clear water in moderate to swift current, chiefly about riffles of rubble, boulders, or coarse gravel.

Noturus insignis has been taken in collections containing *Noturus gyrinus*, *N. leptacanthus*, *N. gilberti*, and *N. furiosus*.

The funebris Group

The *funebris* group, subgenus *Schilbeodes*, includes two allopatric species, *Noturus funebris* and *Noturus phaeus*. They are found in the lower Mississippi River system and other Gulf of Mexico tributaries from the Red River and Bayou Teche, Louisiana, to Econfina Creek in western Florida. Neither species is known from any of the streams between the Mississippi and Pearl River systems, in the Florida Parishes of Louisiana and southern Mississippi. It is in this region that intermediates between the two species would be expected, but extensive collections indicate their absence. Both are typical of permanent springs and small, clear streams; they are commonly found beneath submerged vegetation at the outlet and downstream from springs.

In contrast to other species of *Noturus* the anal fin is long with 18 to 27 rays (table 17) and the dorsal spine is slender and somewhat flexible, becoming stiff with age. The caudal fin has an intermediate number of rays. Like *Noturus insignis* the hypurals are modally seven (1–3+4–7) in both species. X-rays and skeletonized specimens indicate a rather prominent mode of eleven vertebrae anterior to the origin of the anal fin, suggesting that the anal fin is more anterior in position than in other species except *Noturus gyrinus* and *Noturus leptacanthus*. Unlike other *Noturus*, the flange or thin bone connecting the anterior and posterior rami of the transverse process of the fourth vertebra in the vertebral complex is very poorly developed or rudimentary. The lateral boundary of this ledge of bone is very deeply concave in contrast to that in other species where it is very shallowly concave to moderately convex or with a nearly straight margin parallel to the vertebral axis.

The two species are almost uniformly darkly colored, with occasional narrow darker bands near the margins of the dorsal, anal, and caudal fins. Especially characteristic of the *funebris* group are the dark, usually discrete, chromatophores that are uniformly distributed over the lower surface of the head and abdomen at all sizes, except large old adults. These freckles may become diffuse or lost near the midline of these surfaces in older specimens.

Noturus funebris Gilbert and Swain

BLACK MADTOM

PLATES 3 (FIG. 7), 7 (FIG. 1); MAP 6

Noturus funebris Gilbert and Swain.—Jordan, 1885, p. 802 (nomen nudum; "Northern Alabama").—Gilbert and Swain, *in* Gilbert, 1891, pp. 153, 157 (original description; types* from: "in a spring run tributary to North River near Tuscaloosa, Alabama").—Böhlke, 1953, p. 43 (holotype, USNM 36696* and paratype, SU 3952*).—Bailey, Winn, and Smith, 1954, pp. 131–155 (distribution; Escambia R. basin records*).—Eddy, 1957, p. 153, fig. 385 (key; range).—Taylor, 1957, p. 192.—Briggs, 1958, p. 260 (Florida distribution).—Cook, 1959, pp. 34, 135, 142, fig. 25F (description; Mississippi records).—?Suttkus, 1961, p. 63, fig. 5 (comparison; skull illustrated).—Suttkus and Taylor, 1965, p. 177 (associations).—Thomerson, 1966, p. 397 (length frequency distribution; sex ratio; egg counts; associations, Metts Cr., Fla.).

Schilbeodes funebris (Gilbert and Swain).—Jordan and Evermann, 1896a, pp. 145, 147 (description; Tuscaloosa,* Ala.); 1896b, p. 234.—Reed, 1907, p. 555 (not examined for poison glands).—Schrenkeisen, 1938, p. 167 (compiled).—Carr and Goin, 1955, pp. 21, 64 (description; Florida distribution).—G. A. Moore, 1957, pp. 143–144 (description).

Rabida funebris (Gilbert and Swain).—Jordan, Evermann, and Clark, 1930, p. 156.

TYPE-SPECIMENS.—USNM 36696 (lectotype), USNM 161732 (2 paralectotypes), and SU 3952 (1 paralectotype), from a spring run, tributary to North River, near Tuscaloosa, Alabama, summer of 1884, C. H. Gilbert and Joseph Swain.

OTHER MATERIAL STUDIED

UNITED STATES: ALABAMA: Escambia R. system: TU 3146, 14180, 16520; CU 11826; Tulsa U 8. Perdido R. system: TU 14184. Fish R. system: TU 3156, 14389. Tallapoosa R. system: USNM 201246; CU 14045; UMMZ 111195–6, 168676. Cahaba R. system: TU 14198. Black Warrior R. system: TU 14141; CU 19271. Tombigbee R. system: TU 24549; CU 16162. Other tribs. Mobile Bay: TU 3091; CU 12636; UMMZ 155463. FLORIDA: Econfina Cr. drainage: USNM 201242 (Cr., about 1000 yards W. U.S. Hwy. 231 on Jackson-Bay Co. line); DBUF (Cr., 0.5 mi. W. Econfina Cr. bridge, W. Bennett, Bay Co.). Choctawhatchee R. system: TU 1084, 1102, 20574, 21330. Alaqua Cr. drainage: DBUF (at Portland, Walton Co.). Yellow R. system: TU 23830, 24010, 24089, 24107, 24456, 24661, 24774. Blackwater R. sytsem: TU 20528; CU 16702; UMMZ 155498, 163521, 166192, 166215; DBUF 1457. Escambia R. system: UMMZ 165131. Escambia Co., unknown drainage: CU 13712. Perdido R. system: TU 1778; USNM 143049. LOUISIANA: Pearl R. system: TU 95, 739, 1666, 3598, 5756, 6238, 7352, 7590, 7826, 8245, 11477, 14266, 14394, 14548, 15549, 23093, 23383; USNM 152985. MISSISSIPPI: Pascagoula Bay drainage:

*Material designated by an asterisk has been re-examined.

TU 1127, 15442; UMMZ 155443, 155449; UMMZ (Walker no. 39–49). Biloxi Bay drainage: UMMZ (Walker nos. 39–34, 39–37). Bay Saint Louis drainage: TU 18599; UMMZ 163697; UMMZ (Walker no. 39–33). Pearl R. system: TU 72, 111, 826, 1730, 1795, 3879, 4870, 5814, 6253, 7223, 7276, 7301, 14162, 15099, 15202, 16141, 16729, 16743, 17578, 17658, 17949, 23433, 23610, 23716; CU 11860, 16616; AF 1718 (Old Brook, trib. Bogue Chitto R., Lincoln Co.); UMMZ 155371, 155382.

Diagnosis.—*Noturus funebris*, subgenus *Schilbeodes*, has 20 to 27, usually 21 or more anal rays; the anal fin separated from the lower procurrent caudal rays by a small notch; the dorsal spine rather slender and usually flexible (except large specimens); the ventral surface, including both the head and abdomen, profusely sprinkled with large discrete chromatophores; 8 to 11, usually 9 soft pectoral rays; 9 pelvic rays; 11 preoperculomandibular pores; 2 internasal pores; 50 to 58 caudal rays; and an included lower jaw. The body and fins are nearly unicolor, blackish or steel blue. In contrast to *Noturus phaeus* the pectoral spine serrae are absent or vestigial, irregular, and never strongly developed.

Description.—Other counts and measurements are given in tables 17 to 26. Head rounded above; lower jaw included; body heavy and elongate, not much deeper forward than behind; anal base long; dorsal spine slender, relatively flexible, only stiff in large specimens; dorsal fin usually slightly pointed, the first or second ray longest; adipose fin low, closely united to the procurrent caudal fin; pectoral spine short, stout, straight, without prominent uniformly developed posterior serrae; posterior edge of spine usually only roughened; a few distinct but irregularly developed sharp serrae may be present in young specimens; these become reduced to short blunt knobs or fuse into an irregular roughened mass with age; end of caudal fin rounded to truncate; posterior corners of premaxillary tooth band slightly rounded; eye small, 2.0 to 2.5 times in snout; posterior process of cleithrum short, definite, about equal in length to the width of the pectoral spine.

Gill rakers on the first arch five to eight. There are (extremes in parentheses): (18) 19 to 21 (22) upper simple caudal rays; (15) 16 to 18 (20) branched caudal rays, of which there are usually 7 in the upper half of the fin and 9 to 11 in the lower half; and (13) 15 to 18 (19) lower simple caudal rays. Of 83 specimens counted, all have 6 soft dorsal rays.

The stained and cleared specimens have relatively light, poorly ossified bones; particularly noticeable externally is the slender, flexible dorsal spine; vertebrae anterior to anal fin origin 10 (in 2) or 11 (1); pectoral radials fused on six sides; hypurals modally 7, all unfused in 27 specimens counted, mostly from x-rays, or fused as follows, numbers 2–3 (in 8), 4–5 (1), both 2–3 and 4–5 (2), and both 2–3 and 6–7 (1). This species reaches at least 119 mm. in standard length.

The general background color is dark brownish black or blue-black, usually a gun metal blue color. The upper surface, barbels, fins, and side are darkly pigmented. The ventral surface is somewhat lighter, but sprinkled with large chromatophores. These may become diffused with age, so that the midline of the abdomen appears to be immaculate. The fins are all heavily pigmented, but sometimes edged with white or cream color. A band of black pigment often crosses the outer ends of the rays of both the dorsal and anal fins and may outline the posterior margin of the caudal fin.

Type.—The lectotype of *Noturus funebris* (USNM 36696) herein selected shows evidence of having been dried at one time, but is the best of the three specimens that I found in USNM 36696. It is a female, 77.3 mm. in standard length or 95.5 mm. in total length. There are 6+17=23 anal rays, 21+7 (+28)=56 caudal rays, 6 soft dorsal rays, and 28 rays in both the upper half and the lower half of the caudal fin. On each side there are 9 pelvic rays, 10 soft pectoral rays, 6 gill rakers on the first arch, 2 internasal pores, 11 preoperculomandibular pores, and at least 10 branchiostegal rays. The posterior edges of the pectoral spines have a few irregular, very short, blunt, knob-like serrae or roughenings. The head length is stepped into the standard length 3.85 times. The barbels are moderately long; the dorsal spine is short but slender.

Variation.—*N. funebris* shows rather strong west to east gradients in number of anal rays and vertebrae (tables 6 and 8). On the basis of these structures two populations may be recognizable. Specimens from west of the Alabama system seem to have modal numbers of 35 or 36 vertebrae and usually 21 to 23 anal rays. Specimens from east of the Alabama system, chiefly western Florida, appear to have a modal number of 37 vertebrae and 23 to 27 anal rays.

The pore and paired fin ray counts show very strong modes with only occasional random variations within a sample. The variation in pectoral rays is given in table 8. The counts of pelvic rays, based on the same specimens, vary as follows: Pearl River 7 to 10, mean 8.94; Wolf River 9 to 10, mean 9.05; Blackwater River 9 to 10, mean 9.22; Yellow River 9 to 10, mean 9.20; Econfina Creek 9 to 10, mean 9.33; no variation from 9 rays is indicated in the counts from all other river systems.

Based on the relatively few specimens counted, no significant geographic variation in caudal rays is evident.

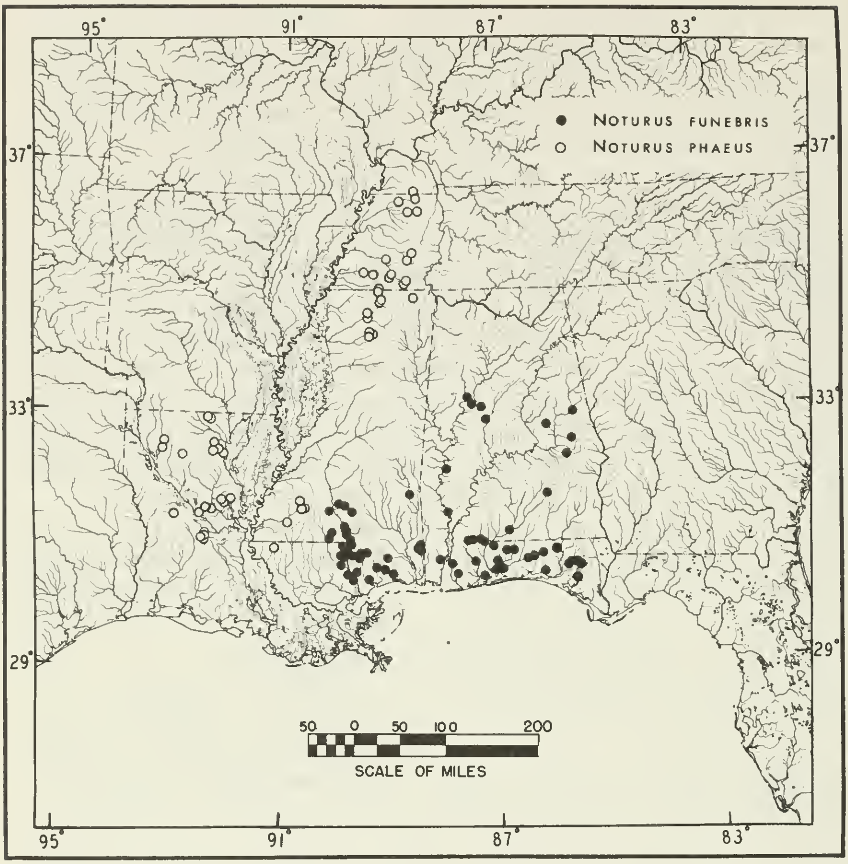
Distribution.—*Noturus funebris* (map 6), a small stream or creek species, is confined to eastern Gulf of Mexico tributaries. It ranges from the Pearl River system of Mississippi and Louisiana eastward to Econfina Creek, Florida. Although it lives well upstream in the Alabama and Tombigbee River systems, the centers of abundance appear to be in the lower portions of the stream systems.

Etymology.—The name *funebris* (Latin) means of or belonging to a funeral; the allusion is in reference to the dark color.

Relationship.—*Noturus funebris* and *Noturus phaeus* are recognized as forming the *funebris* species group because of their many similarities. Intimate relationship with other species of *Noturus* is not apparent. *Noturus funebris* and *Noturus nocturnus* are strikingly similar superficially, especially externally. Both species are similarly dark colored and lack pectoral spine serrae. The lower surfaces of *nocturnus* gradually darken with age and increase in size so that *nocturnus* is not readily distinguished from *funebris* except in number of anal rays and in the relative slenderness and flexibility of the dorsal spine. *Noturus nocturnus*, with its apparent relative *Noturus insignis*, thus may be moderately closely related to the *funebris* group.

Ecology.—Most records are from permanent springs, creeks, and small to moderate size streams. The species is often found under vegetation in moderate to fast clear water over a small gravel or coarse sand bottom. It has been taken in collections with *N. leptacanthus*, *N. gyrinus*, *N. munitus*, and probably with *N. miurus*.

Remarks.—Thomerson (1966) listed other fish associates and described aspects of the biology of a population of *funebris* from western Florida, based on formalin preserved specimens. He concluded that females did not reach maturity until approximately 100 mm. in standard length; three females, 104 to 119 mm. long, contained 114 to 192 ova. Because of long storage in formalin he was unable to determine the age of the specimens but concluded from a length frequency distribution that the sample, collected March 8, 1961, contained several year classes. The larger size specimens were poorly represented. I question his classes I–III, specimens 25 to 35 mm. in standard length, those 45 to 50 mm., and those 55 to 65 mm. especially. The growth rate of his first three classes is materially shorter than that obtained by Clugston and Cooper (1960) for *Noturus insignis*. They found an average annual increase of about 45 mm. total length in Pennsylvania. The season of growth is undoubtedly longer in Florida than in Pennsylvania, and the season of reproduction could likewise be prolonged. Thus, it seems logical to predict that Thomerson's classes I and II are actually year class I, with his year class II resulting from reproduction earlier in the year and year class I from late season broods. It is also possible that his year class III may actually be year class I. If this is true, his remaining year classes would require adjustment. As in other moderate size *Noturus*, *funebris* probably lives no longer than three or four years.



Map 6.—Distribution of *Noturus funebris* Gilbert and Swain and *Noturus phaeus*, new species. Symbols represent localities from which specimens have been examined.

Noturus phaeus, new species

BROWN MADTOM

Plates 3 (fig. 8), 7 (fig. 2); Map 6

Noturus funebris Gilbert and Swain [misidentifications].—Hancock and Sublette, 1958, p. 45 (Little Bayou Pierre,* La.).—Norden, 1965, p. 102 (records, Little R. system, La.).—?Raney and Suttkus, 1966, p. 102 (associations with *Etheostoma rubrum*, Bayou Pierre, Miss.).

Types.—USNM 202143 (holotype) and USNM 193471 (10 paratopotypes), collected from the North Fork of the Obion River, at state highway 69, Henry County, Tennessee, July 27, 1954, by C. E. Ruhr and party.

*Specimens re-examined.

OTHER PARATYPES.—The number of specimens, in parentheses, follows the museum number.

KENTUCKY: UL 5143 (1), Terrapin Cr., 3 mi. SW. Bell City, Graves Co., June 30, 1954, W. M. Clay and E. W. Distler. MISSISSIPPI: UMMZ 161058 (66), Mimosa Spa, 1.5 mi. N. of Waterford, or 8 mi. S. of Holly Springs, Marshall Co., April 2, 1949, W. R. Taylor, Norman Benson, and H. W. Harry. UMMZ 161066 (4), stream, 0.6 mi. S. of Waterford, Marshall Co., April 2, 1949, Taylor, Benson, and Harry. TU 3037 (5), trib. to Yocona R., 14.7 mi. E. Oxford, Lafayette Co., May 23, 1952, R. D. Suttkus. TU 3134 (4), trib. to Yocona R., Hwy. 6, 8 mi. E. Oxford, Lafayette Co., May 24, 1952, Suttkus. TU 3668 (3), trib. to Yocona R., old Hwy. 6, 7 mi. E. Oxford, Lafayette Co., May 24, 1952, Suttkus. TU 14014 (1), Yocona R., Hwy. 334, 7.9 mi. SE. Oxford, Lafayette Co., July 12, 1956, Penn and Black. TU 14024 (1), stream, U.S. Hwy. 45, 3 mi. N. Biggersville, Alcorn Co., July 12, 1956, Penn and Black. TU 14036 (2), stream, Hwy. 7, 0.3 mi. SW. Michigan City, Benton Co., July 11, 1956, Penn and Black. USNM 175389 (1), Shones L., E. of Holly Springs, Benton Co., June 9, 1952, Y. J. McGaha. USNM 175390 (2), Little Spring Cr., Hwy. 7, 2 mi. N. Little Tallahatchie R., Marshall Co., June 16, 1952, McGaha. USNM 175391 (2), Snow Cr., 5 mi. W. Ashland, Benton Co., May 12, 1951, William L. Hudspeth. TENNESSEE: USNM 190745 (2), Moss Cr., on Rose Creek road, 1.3 mi. N. of Hwy. 57 or about 2.5 mi. ENE. of Pocahontas, McNairy Co., August 31, 1959, W. R. Taylor and Robert Kanazawa. USNM 190777 (10), Spring Cr., Hwy. 125, 1.2 mi. S. of Bolivar, Hardeman Co., September 1, 1959, Taylor and Kanazawa. USNM 193465 (3), Moss Cr., about 4 mi. W. of Selmer, McNairy Co., August 18, 1954, C. E. Ruhr. USNM 193466 (1), Indian Cr., 3 mi. due S. of Grand Junction, Hardeman Co., August 6, 1954, Ruhr. USNM 193467 (13), Deer Cr., at Huron, Henderson Co., July 21, 1954, Ruhr. USNM 193468 (8), Loosahatchie R., Hwy. 76, due N. of Somerville, Fayette Co., August 31, 1954, Ruhr. USNM 193469 (1), Loosahatchie R., 5 mi. due N. of Oakland, Fayette Co., August 31, 1954, Ruhr. USNM 193473 (4), Spring Cr., about 4 mi. SSW. Bolivar, Hardeman Co., August 4, 1954, Ruhr. USNM 197401 (2), Middle Fk. Obion R., Hwy. 6, Gleason Crossing, Weakley Co., September 16, 1954, C. E. Farrell. KU 8958 (1), Middle Fk. Obion R., Hwy. 22, 4.3 mi. SE. intersection with Hwy. 54, Weakley Co., September 7, 1964, F. B. Cross and party. UMMZ 168521 (1), trib. to South Fork Forked Deer R., 2.6 mi. SE. Pinson, Chester Co., August 31, 1954, R. M. and D. M. Bailey; UMMZ 177681 (4), same locality, May 20, 1956, R. M. Bailey and W. L. Brudon. Vanderbilt U (no number) (4), North Fork Obion R., Campground Levee Crossing, Weakley Co., September 15, 1954, Farrell. Vanderbilt U (no number) (3), Big Black Cr., Madison Co., September 16, 1954, Farrell.

OTHER MATERIAL STUDIED

UNITED STATES: LOUISIANA: UMMZ 113740 (3 specimens), trib. to Little R., 0.25 mi. S. of Dry Prong, Grant Parish. UMMZ (Delavan and Creaser no. 31–57) (1), stream, at Jena, La Salle Parish. UMMZ (Delavan and Creaser no. 31–54) (4), trib. to Little R., Pollock, Grant Parish. UMMZ (Taylor no. La 55–24) (1), Choudrant Cr., sec. 16, T. 18 N., R. 1 E., Ouachita Parish. UMMZ (Taylor no. La 55–37) (5), stream, sec. 16–17, T. 16 N., R. 3 E., Ouachita Parish. USNM 172639 (20) and USNM 172981 (2), Brushy Cr., at Hwy. 7, 3.5 mi. S. Sibley, sec. 9, T. 17 N., R. 9 W., Webster Parish. USNM 172662 (6), Hairs Cr., just E. of Jena, sec. 7, T. 8 N., R. 4 E., La Salle Parish. USNM 172776 (4), Cheniere Cr., S. Cadeville, sec. 35, T. 17 N., R. 1 E., Ouachita Parish. USNM

172874 (2), Saline R., due E. Bienville, sec. 23, T. 16 N., R. 6 W., Bienville Parish. USNM 172895 (1), creek, sec. 27, T. 22 N., R. 1 E., Union Parish. USNM 172905 (6) and USNM 172944 (5), Meridian Cr., 1 mi. E. Conway, sec. 17, T. 22 N., R. 1 E., Union Parish. USNM 172915 (7), Clarks Cr., sec. 24, T. 17 N., R. 1 E., Ouachita Parish. TU 911 (153) and TU 6260 (159), Big Cr., at Pollock, Grant Parish. TU 1223 (1), trib., Red R., U.S. Hwy. 71, 10 mi. SE. Colfax, Grant Parish. TU 1343 (1), trib., Spring Cr., Hwy. 85, 5.1 mi. E. Hineston, Rapides Parish. TU 1361 (4), stream, 2 mi. N. Minden, Webster Parish. TU 2058 (17), Rocky Br., trib. to Spring Cr., Hwy. 85, 9.1 mi. E. Hineston, Rapides Parish. TU 3457 (68), trib., Bayou Cocodrie, Hwy. 85, Rapides Parish. TU 5234 (3), Corney Br. Beaver Cr., Hwy. 311, 4.4 mi. SW. Wilson, East Feliciana Parish. TU 5774 (1), Indian Cr., 3.1 mi. S. Woodworth, Rapides Parish. TU 5868 (6), Br. of Spring Cr., Hwy. 85, Melder, Rapides Parish. TU 13737 (1), Little Bayou Pierre, Mora Road, 8.5 mi. E. Kisatchie, Natchitoches Parish. TU 14173 (6), trib. to Bayou Teche, Hwy. 85, E. of Melder, Rapides Parish. TU 14330 (17), stream, Hwy. 8, 0.5 mi. SW. Manifest, Catahoula Parish. MISSISSIPPI: Tulsa U (uncataloged) (1), Brushy Cr., Homochitto, Amite Co. TU 2922 (6), TU 15121 (5), TU 19775 (1), TU 19850 (5), and TU 23964 (1), trib., Homochitto R., U.S. Hwy. 84, vicinity of Lucien, Franklin Co. TU 7203 (1), trib., McCall Cr., U.S. Hwy. 84, 13.2 mi. E. Bude, Franklin Co. TU 23892 (2), Homochitto R., Hwy. 550, 4.9 mi. E. Union Church, Lincoln Co.

DIAGNOSIS.—*Noturus phaeus*, subgenus *Schilbeodes*, has 18 to 25, usually 20 to 22 anal rays; the anal and caudal fins only slightly separated; the dorsal spine slender and usually flexible, but stiff in large specimens; the lower surfaces of the head and abdomen profusely sprinkled with large chromatophores; 7 to 10, usually 8 or 9 soft pectoral rays; typically 9 pelvic rays, 11 preoperculomandibular pores, and 2 internasal pores; 50 to 59 caudal rays; and the lower jaw is included. The body and fins are nearly unicolor, typically medium to dark brown. *N. phaeus* differs from *N. funebris*, its allopatric relative, in the constant presence of distinct, well-developed posterior serrae on the pectoral spine and averages fewer pectoral and anal rays over much of its range.

DESCRIPTION.—Other counts and measurements are given in tables 17 to 26. Head rounded above; lower jaw included; body heavy and moderately elongate, not much deeper anteriorly than posteriorly; dorsal spine slender, relatively flexible especially in young; dorsal fin pointed, the first or second ray longest; adipose fin relatively low, united to the procurrent caudal fin; pectoral spine short, stout, nearly straight, with three to eight, usually four to six distinct posterior serrae in juveniles to adults; serrae relatively uniformly developed, nearly straight to slightly curved, sharp, except in old specimens, their length greater than half the diameter of the spine shaft; end of caudal fin rounded to truncate; posterior corners of premaxillary tooth band slightly rounded; eye small, 2.1 to 2.6 times in snout; posterior process of cleithrum about equal in length to the width of the pectoral spine.

Gill rakers on the first arch six to nine. There are (extremes in parentheses): (17) 19 to 21 (23) upper simple caudal rays; (16) 17 or 18 (20) branched caudal rays, of which there are typically 7 in the upper half of the fin and 10 or 11 in the lower half; and (13) 15 to 18 (19) lower simple caudal rays. The soft dorsal rays are five (in 2) or six (148).

In five stained and cleared specimens there are eleven vertebrae anterior to the anal fin origin; the pectoral radials are fused on each side, except the fusion on one side is incomplete. As judged from x-rays and cleared specimens the hypurals are seldom fused; no fusion was observed in 34 specimens; hypurals 2–3 were fused in 7, and 6–7 in 2. The largest known specimen is 123 mm. in standard length.

The general background color is light or dark brown in life as well as in most preserved specimens. No bright colors are present. The upper surface, barbels, fins, and side are nearly uniformly brown; the lower surface may be somewhat lighter, but is sprinkled with large distinct, brown chromatophores. These may become diffused with age, so that some old specimens, noted especially in those from western Tennessee, appear to have the medial portion of the abdomen, as well as other parts of the body, unpigmented. The fins are all heavily pigmented, sometimes light edged. The dorsal and anal fins may have a distal dark band of pigment.

Type.—The holotype, USNM 202143, is a male, 94.6 mm. in standard length. It is light brown colored with narrow pale or whitish margins to the fins. There are 6 soft dorsal rays, 21 anal rays, 20+7+10+15=52 caudal rays, 1 epural, 6 (3+3) unfused hypurals, and 36 vertebrae. On each side there are nine pelvic rays, eight soft pectoral rays, eleven preoperculomandibular pores, two internasal pores, and eight serrae posteriorly on the pectoral spines. The serrae are sharp pointed, but two left serrae and one right serration have split distally so that they have two sharp points instead of one. The head length is stepped into the standard length 3.35 times and the distance from the rear end of the adipose fin to the tip of the caudal fin is contained 1.8 times in the distance from the origin of the dorsal fin to the rear end of the adipose fin. Measurements are given in table 27.

Variation.—*Noturus phaeus* apparently has relatively little geographic variation in most structures studied, but the variation in pectoral rays (table 8) is prominent. In specimens from Kentucky, Tennessee, and northern Mississippi the modal number of soft pectoral rays is eight and the mode in Louisiana and southern Mississippi is nine. This would point to a break, or shift, in characters in central Mississippi rather than a change across the Mississippi River lowlands. To the contrary, a break could be expected in the floodplain of the Mississippi River where little suitable habitat for *phaeus* is apparent, and is not expected across Mississippi where the distribution is probably continuous.

The variation in anal rays and vertebrae is included in tables 6 and 8. Variation from the strong modes is small in the pore counts and number of dorsal rays. The variation from nine pelvic rays is random and very similar to that of most other species of *Noturus*. The means for the same specimens as the pectoral ray counts range from 8.93 to 9.07, except the three specimens from Beaver Creek, Louisiana, with nine or ten pelvic rays, have a mean of 9.33.

Variations in caudal ray counts appear to be slightly irregular, but probably insignificant. The following data include number of counts, range (in parentheses), and mean for combined samples for each river system.

Caudal rays: Forked Deer River, Tennessee 13 (51–57) 53.92; Yazoo River, Mississippi 70 (50–58) 53.70; Little River, Louisiana 3 (55–57) 56.33; Brushy Creek, Louisiana 22 (53–59) 55.18; Beaver Creek, Louisiana 3 (51–54) 53.00.

Upper-half caudal rays: Forked Deer River 13 (27–31) 28.00; Yazoo River 70 (24–29) 26.50; Little River 3 (28–30) 29.33; Brushy Creek 22 (26–29) 27.82; Beaver Creek 3 (26–27) 26.67.

Lower-half caudal rays: Forked Deer River 13 (24–28) 25.92; Yazoo River 70 (24–30) 27.20; Little River 3 (27) 27.00; Brushy Creek 22 (26–30) 27.36; Beaver Creek 3 (25–27) 26.33.

Distribution.—*Noturus phaeus* (map 6) is confined to the lower Mississippi Valley and the headwaters of Bayou Teche, Louisiana. It occurs in most eastern tributaries to the Mississippi River from southwestern Kentucky to Louisiana, in the lower Ouachita drainage, and in the Red River system upstream to northwestern Louisiana. The population now in upper Bayou Teche is the result of recent diversion of streams from the Red River.

Etymology.—The name *phaeus* (Greek) meaning of the hue or color of twilight, dusky, brown, or grayish brown, refers to the color of this species.

Relationship.—*Noturus phaeus* is closely related to *Noturus funebris*. The somewhat similar *Noturus nocturnus* may be confused with *phaeus*, but the two differ in several characters, including number of anal rays and relative slenderness of the dorsal spine, in addition to other skeletal characters. *N. phaeus* has prominent pectoral spine serrae; *N. nocturnus* never has uniformly developed serrae—when present the serrae typically are few, relatively short, and of irregular sizes. Aside from *Noturus funebris*, *phaeus* is probably closest related to *insignis* and *nocturnus* among the species of *Noturus*.

Ecology.—*N. phaeus* is most commonly collected from permanent springs and small streams. It is frequently found under vegetation in moderate to fast clear water over small gravel or perhaps coarse sand. It has been taken in collections with the following species of *Noturus: gyrinus, nocturnus, hildebrandi, stigmosus,* and *miurus*. It is often collected with *Noturus nocturnus* in Louisiana and with *Noturus hildebrandi lautus* and *Noturus miurus* in western Tennessee.

Noturus gilberti Jordan and Evermann

ORANGEFIN MADTOM

Plates 3 (fig. 9), 9 (fig. 1); Map 7

Noturus gilberti Jordan and Evermann, *in* Jordan, 1889, pp. 351–353, pl. 43, figs. 2–2b (original description; Roanoke R., Roanoke,* Salem,* and Alleghany Springs, Va.; type, USNM 39931*).—Jordan, 1890, pp. 97, 122, pl. 13, figs. 2–2b (description; Roanoke R., Salem* and Roanoke,* Va.).—Böhlke, 1953, p. 43 ([in error]; lectoholotype, USNM 39931;* paralectotype, SU 1335,* Roanoke R., Roanoke, Va.).—Robins and Raney, 1956, p. 31 (Johns Cr.,* Newcastle, Va.; on moderately swift, cold water riffle; probably reached James R. by stream capture Roanoke tribs.).—Eddy, 1957, p. 154, fig. 388.—Taylor, 1957, p. 192.—Robins, 1961, p. 311 (remnant of older fauna).

Schilbeodes gilberti (Jordan and Evermann).—Jordan and Evermann, 1896a, pp. 145, 148 (description; range); 1896b, p. 234; 1900, p. 3236, pl. 28, figs. 67–67b (type, USNM 39931,* Roanoke R., Salem, Va.).—Jordan, 1904, p. 351.—H. S. Pratt, 1923, pp. 96–97.—Schrenkeisen, 1938, p. 167.—Hubbs and Raney, 1944, pp. 1, 24–25 (synonymy; range; comparison; Roanoke R., Glenvar,* Va.).—Fowler, 1945, p. 32 (Roanoke R. system only [not in Santee R. system]).—Raney and Lachner, 1946b, p. 220.—Raney, 1950, p. 187 ("known with certainty only from the Roanoke").—G. A. Moore, 1957, pp. 143, 145.

Rabida gilberti (Jordan and Evermann).—Jordan, 1929, p. 93.—Jordan, Evermann, and Clark, 1930, p. 156.—H. S. Pratt, 1935, p. 90.—Fowler, 1935a, pp. 6, 19 (Roanoke R., Va., only).—Driver, 1942, p. 254.

Type-specimens.—USNM 39931 (lectotype) and USNM 161733 (2 paralectotypes), Roanoke River, Salem, Virginia, 1888, David Starr Jordan and party. USNM 40219 (8 paralectotypes), MCZ 31994 (1 paralectotype), and SU 1335 (4 paralectotypes), Roanoke R., Roanoke, Virginia, summer 1888, Jordan.

Other material studied

UNITED STATES: Virginia: Roanoke R. and South Fork Roanoke R. at various points, from 0.25 mi. above Alleghany Springs, Montgomery Co. to 2.0 mi. W. of Salem, Roanoke Co.: CU 9417, 11548, 20298, 20314, 20702, 20767; UMMZ 138522, 165832; USNM 161960, 161961, 168151, 177259, 194752. Mayo R., U.S. Hwy. 58, 2 mi. NW. Stuart, Patrick Co.: USNM 162854. Johns Cr., New Castle, Craig Co.: CU 20353. Craig Cr., Hwy. 311, 2.2 mi. SW. New Castle, Craig Co.: USNM 194740. Craig Cr., Hwy. 616, 1.2 mi. NE. New Castle, Craig Co.: USNM 194753.

Diagnosis.—*Noturus gilberti* is the only species of the subgenus *Schilbeodes* with very short dorsal and pectoral spines, immaculate undersurfaces, and broad light margins of the vertical fins. The 46 to

*Material designated by an asterisk has been re-examined.

54 caudal rays, 9 or 10 pelvic rays, included lower jaw, and short anal fin in combination also distinguish it from other species of the subgenus.

Description.—Other counts and measurements are given in tables 17 to 26. Dorsal and ventral contours of body not noticeably tapering posteriorly; head slightly depressed; eye small, 2.5 to 3.3 times in snout; lower jaw included; posterior corners of premaxillary tooth band slightly rounded; branchiostegal membranes and lower surface of head covered with large papillae; spines very short, rather obtuse; serrae irregular, sometimes well developed on posterior edge of pectoral spine (pl. 3, fig. 9); posterior process of cleithrum short or obscure, its free length less than the diameter of the pectoral spine; adipose fin low, without free posterior end, but nearly free from the caudal fin which is truncate posteriorly.

In six stained specimens there are 14 or 15, modally 14, vertebrae anterior to the origin of the anal fin. This range is identical to the range obtained for *Noturus flavus*. The pectoral radials (actinosts) are fused on both sides in each specimen. Each has six hypurals and one epural. The hypurals are unfused in four specimens; hypurals 2 and 3 are fused in one and 5 and 6 in another.

There are seven to nine gill rakers on the first arch. The 47 individuals counted have 6 soft dorsal rays. In the caudal fin there are 15 to 20, usually 17 to 19 upper simple rays; 15 to 17, almost constantly 16 branched rays of which 7 are in the upper half and 9 in the lower half of the fin; and 14 to 18, usually 15 to 17 lower simple rays. The largest individual examined is the Mayo River specimen, 85 mm. in standard length.

Color was described from fresh material by Hubbs and Raney (1944, p. 25): "the first dorsal fin has a blackish base, but is otherwise pale . . .; the caudal fin has an orange border, which is broader above than below." In specimens collected August 31, 1958, the overall color of the upper body surface was dark grayish brown. The light parts of the fins varied in color from light yellow to bright yellow or orange as follows: pelvic and anal fins light to medium yellow; adipose fin and caudal fin border medium yellowish orange; pectoral and dorsal fins bright yellowish orange to orange.

In preserved material, the pelvic fins, mental barbels, anal fin; the lower surface of the head and abdomen, the adipose fin, about two-thirds of the dorsal fin, and a broad upper and lower margin and the tip of the caudal fin are immaculate. The side is brownish, only slightly lighter than the uniformly colored dorsal surface of the body which is dark brown or a gray-black; a black blotch on the middle caudal rays extends nearly to the margin of the fin; the pectoral fin is pigmented at the base and about the spine; its outer half is immaculate; the nasal barbels are black; the maxillary barbels are partially pigmented.

The large specimen from the Mayo River is similar in color to Roanoke and James specimens but a large, dusky brownish blotch, not prominent, occupies the middle half of the anal fin from the base almost to the margin. The base of the dorsal fin is dark brown, as in other specimens, but a band of the same color extends along the first two rays almost to the margin, thence backward across the third and fourth rays.

Type.—Jordan and Evermann (*in* Jordan, 1889, p. 352, pl. 43, figs. 2–2b) figured *Noturus gilberti* and listed USNM 39931 as the type. Jordan and Evermann (1900, p. 3236, pl. 28, figs. 67–67b) published the same figures and were the first to indicate that they were "from" the type, USNM 39931, essentially designating a lectotype. The original drawings, bearing this catalog number, indicate that a specimen 3.5 inches long from Roanoke River, Salem, Virginia was drawn.

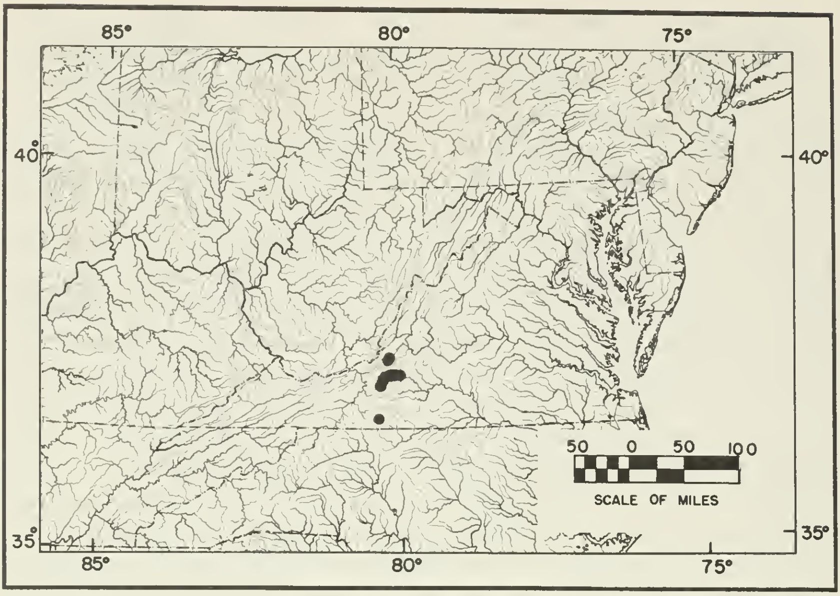
When examined by me, USNM 39931 contained four specimens, three of *N. gilberti* and one of *Noturus insignis*. The catalog book and original records indicate that four specimens were originally included. It is not now possible to be certain which specimen of *Noturus gilberti* was drawn, but the largest one, slightly less than 3.5 inches in total length, is selected as the lectotype, retaining USNM 39931. It is in good condition, but slightly brownish, perhaps due to becoming dry during the rendering of the illustrations. The other specimens, originally in this collection, showed no sign of having been dried.

The lectotype is a female, 73.0 mm. in standard length. It has 15 anal rays, $17+6+9+17=49$ caudal rays, 37 vertebrae, and 6 soft dorsal rays; on each side there are 9 pelvic rays, 9 soft pectoral rays, 10 preoperculomandibular pores, and 2 internasal pores. The pectoral spines are very short and broad. The head length is stepped into the standard length 4.3 times and the distance from the adipose notch to the tip of the caudal fin is contained 1.8 times in the distance from the origin of the dorsal fin to the adipose notch.

One specimen MNHN 89–312 and one BMNH 89.10.30.89, both collected by David Starr Jordan from Roanoke River, Roanoke, Virginia, are not listed as paratypes. Although they were evidently collected with the paratype series, USNM 40219, they apparently were separated from the original series and not studied by Jordan and Evermann (see comments under *Noturus furiosus*, p. 187).

Variation.—Specimens from the James and Roanoke River systems are similar. Counts from Roanoke River specimens broadly overlap those from the five James River specimens and the one from the Mayo River, except three from the James have 54 caudal rays whereas the highest number obtained from Roanoke specimens is 53.

Distribution.—*N. gilberti* (map 7) is confined to Virginia. Since the original description, it has been thought to be restricted to head-



MAP 7.—Distribution of *Noturus gilberti* Jordan and Evermann. So far as known this species is confined to the areas of Virginia indicated by the symbols.

waters of the Roanoke River, but in recent years specimens have been collected from the Mayo River and headwaters of the James River system adjacent to the Roanoke River. Specimens of *Noturus leptacanthus* and *N. insignis* have been reported as *gilberti*.

ETYMOLOGY.—*Noturus gilberti* was named for Charles Henry Gilbert, an outstanding American ichthyologist.

RELATIONSHIPS.—The species is very distinct and does not appear to be closely related to any other kind of *Noturus*. It is assigned to the subgenus *Schilbeodes* because of its common characters, but in some respects, chiefly color pattern, number of paired fin rays, and vertebral elements, it resembles *Noturus flavus*.

ECOLOGY.—Hubbs and Raney (1944, p. 24) indicate that *N. gilberti* was taken from a rubble riffle. Specimens seem to prefer to hide in relatively fast water riffle habitats, beneath large stones and debris that is not swept away by the current. *Noturus insignis* is a common associate of *gilberti*.

Subgenus *Noturus* Rafinesque

The subgenus *Noturus* contains only one species, *Noturus flavus* Rafinesque, the type-species of *Noturus*. *N. flavus* has been placed in *Noturus* since recognition, except for irregular inclusion in the genus

Pimelodus Lacépède. The genus *Noturus* has either been treated as monotypic or enlarged to include all the recognized species of *Noturus*.

The unfused pectoral radials, the specialization of the premaxillary tooth band, the greater numbers of pelvic and soft pectoral rays, an increase in the numbers of certain skeletal parts, and the relatively larger size attained are the chief characteristics of the subgenus. These characters, in view of the great variation of the same characters in other species of *Noturus*, are not worthy of use in the placement of *Noturus flavus* in a monotypic genus. Since *flavus* may be closely related to certain *Schilbeodes*, the discussion of characters is chiefly in relation to the members of that subgenus.

The moderately long, nearly straight, mostly unserrated pectoral spine (pl. 3, fig. 10) shows no important differences from *Schilbeodes;* indeed, the species of that subgenus have a wide range of variation in shape and serrations that would virtually include all structures found in *flavus*. There are no anterior serrae; the posterior serrae are irregularly developed, usually indistinct and never uniformly turned toward the spine base. The recurved anterior hooks or steps of the spine can almost be duplicated in many individuals of *N. insignis;* the short grooves are moderate in depth and mostly distal on the spine. The body is moderately elongate as is also true in several *Schilbeodes*. The numbers of soft pectoral (9 to 11, modally 10) and pelvic (8 to 10, modally 9) rays are higher in *flavus* than in any other group; however, the high mean number of pelvic rays of *flavus* is approached by *N. gilberti*. These two species are the only forms without pigment on the lower surface of the head and abdomen, and are superficially alike, after preservation, in having broad light (immaculate) margins of the vertical fins; otherwise *flavus* is yellowish, slate-gray, or olive green above; it resembles *exilis* in having a yellowish spot beneath the posterior end of the dorsal fin base; there are no prominent dark blotches as in *Rabida*.

The shape of the premaxillary tooth band appears to be of some importance. The posterior extensions constitute undoubted specializations, but the function is not yet known. Posterior extensions of a similar nature but of dissimilar shape and structure have appeared at least twice in other genera of the family. Undoubtedly all three were derived independently. In *N. flavus* (pl. 2, fig. 3) the extension is long and narrow and emerges from the lateral corner of the otherwise rectangular band; in *Pylodictis olivaris* (Rafinesque) the extension is broad and long and emerges from the posterior edge; in *Ictalurus balsanus* (Jordan and Snyder) the extension is from the posterior edge, but is short and broad. In the genus *Noturus*, there is considerable specific variation in the shape of the premaxillary tooth band. In *N. gyrinus*, the transverse extent is greater than in other species; in

Rabida and other *Schilbeodes*, the band of teeth is a short block, usually indented laterally; there is often a short extension posteriorly of the bone on each side. Sometimes these extensions bear short teeth that may be covered with flesh and visible only after the flesh is removed. This is true of large specimens of *Noturus exilis*.

After examining the species of the genus in which skeletons were available, it was found that *N. flavus* differs from the other species chiefly in the extreme degree of development of the backward toothed process. In adults, however, there is no overlap of this character between *flavus* and other species of the genus. The width of the band is about 1.5 to 2.5 times the least length.

Noturus flavus has two ossified pectoral radials on each side. In other species of the genus these fuse or tend to fuse at an early age but no tendency towards fusion has been noted in *flavus*. The lower jaw is included. The high number of caudal rays is interpreted as of no particular significance. There are usually eleven preoperculomandibular pores, the mode for the genus. The anal fin with 15 to 18, rarely 19 rays is of moderate length. The head is relatively large, and is projected 3.3 to 3.8 times in the standard length. The skeleton is well ossified, perhaps a factor associated with the greater size attained. The vertebral number averages higher than in other species of the genus, but is closely approximated by *N. exilis*, *N. gilberti*, and *N. insignis*. The origin of the anal fin is slightly farther back than in other species, with the exception of *N. gilberti*. In 14 specimens of *N. flavus* there are typically 14 or 15 vertebrae anterior to the end of the first pterygiophore of the anal fin. This high number is duplicated in *N. gilberti* and is approximated in *N. insignis* and *N. exilis*. The high number of precaudal vertebrae (11 or 12) is also overlapped slightly by *N. insignis* and *N. furiosus;* the number of caudal vertebrae overlaps those of many members of the other subgenera. *Noturus flavus*, however, is the only species of the genus that usually has nine ribs (range, 8 to 10); others typically have eight or fewer, seldom nine. There are ten branchiostegal rays as in many other *Noturus*. There is typically one epural. The six (3+3) or sometimes seven (3+4) hypurals are seldom fused, at least in small to medium size specimens.

In *Noturus flavus*, as in the subgenus *Schilbeodes*, the number of branched caudal rays is relatively high (16 to 22, usually 17 to 20), but the rays are only of moderate length. In species of *Schilbeodes* other than *N. gilberti* and *N. leptacanthus* the usual number is 17 or greater; species of *Rabida* usually have fewer branched rays.

N. flavus is relatively northern in distribution and extends farther westward than any other species of *Noturus*. It prefers fast water in large streams, and is commonly associated with a rocky bottom.

The name *Noturus* (Greek) is from *notos* (the back) and *oura* (the tail), referring to the connected caudal and adipose fins.

Noturus flavus Rafinesque

STONECAT

Plates 2 (fig. 3), 3 (fig. 10), 9 (fig. 2); Map 8

Noturus flavus Rafinesque, 1818a, p. 41 (original description; the Ohio); 1820b, p. 68; 1820c, p. 362 [and reprinted *in* Jordan, 1877c, p. 41, and *in* Call, 1899, pp. 128–129] (description; "common near the falls").—Kirtland, 1838, pp. 169, 195 (Mahoning R., Ohio; known as young catfish).—Storer, 1846, p. 406 [and *in* reprint, 1846, p. 154] (description copied; synonymy; Ohio; Mahoning R.; L. Erie).—Kirtland, 1847, pp. 336–343, pl. 26, fig. 2 (?description; synonymy; L. Erie; Mahoning R.; occasionally taken near Cleveland [The figure represents this form, but the counts given were either copied or the records are complex.]).—Gill, 1861a, p. 45 (synonymy); 1861b, p. 50; and Bleeker, 1862, p. 12, and 1863, p. 103 (type-species of *Noturus*).—Hayden, 1863, p. 178; and Girard, *in* Warren, 1875, p. 104 (Yellowstone R.*).—Günther, 1864, p. 104 (compiled).—Cope, 1865, p. 277 (description [complex]; Swartz Cr., Genesee Co.,* Mich.; Youghiogheny R.* [Pa.]).—J. G. Cooper, 1869, p. 297 ("The river at Fort Benton").—Cope, 1869, p. 237 (Miami R., Ind.;* Michigan;* Kiskiminitas R., W. Pa.); 1872, p. 442 ("From the waters of the Platte; identical with those from the Ohio").—Jordan, 1875, p. 225; 1878c, p. 368.—Jordan and Copeland, 1876, p. 160.—Gill, 1876, p. 423; and Jordan, 1876a, p. 96; and Jordan and Gilbert, 1877b, p. 85 (synonymy).—?Jordan, 1876b, p. 303 (description; synonymy; range [all complex]).—?E. W. Nelson, 1876, p. 50 (Illinois [complex]).—[Klippart], 1877, pp. 149, 153 (Ohio; Indiana).—Jordan and Gilbert, 1877a, p. 2 (Indiana; Ohio Valley).—?Jordan, 1877a, p. 46 (White R., Ind. [complex]).—Jordan, 1877b, pp. 352, 372, 377 (comparison; synonymy; White R. and tribs., Indianapolis, Ind. [complex]); 1877c, pp. 9–41 (synonymy; nominal species of Rafinesque reviewed); 1877d, pp. 71–119, pl. 36, figs. 54–55 (synonymy; range; general localities [complex]).—Jordan and Brayton, 1878, p. 87.—Jordan, 1878a, p. 118 (synonymy; distribution [complex]).—?Jordan, 1878b, p. 67 (Illinois distribution).—Jordan, 1878d [and 1884], p. 335 (description; range); 1878e, p. 414.—Forbes, 1880a, pp. 42–43 (in food of *Micropterus salmoides*).—Cope, 1881, p. 77 (range; description; tribs. of the Ohio, Pa.).—Jordan, 1882, pp. 739–800 (description; synonymy; range; Ohio; Ohio R.; White R., Indianapolis).—Jordan and Gilbert, 1883, pp. 100–101 (description; synonymy; range [complex]).—Swain and Kalb, 1883, pp. 638–644 (synonymy; distribution [in error]; description).—Bean, 1884, p. 491 (range [in error]; Madrid,* N. Y.).—Gilbert, 1884, p. 199 (Indiana records including [Bloomington*], Monroe Co.).—Graham, 1885a, no. 30; and Cragin, 1885, p. 107 (Rock Cr., Kans.).—Graham, 1885b, p. 71 (Kansas).—Jordan and Meek, 1885, pp. 2–16 (Des Moines R., Ottumwa,* Iowa; Hundred and Two R., near Bedford, Iowa* and Maryville,* Mo.; Blackwater Cr., Brownsville and Flat Cr., near Sedalia,* Mo.; Grand R., Clinton* and Tabo Cr., Calhoun,* Mo.).—Jordan, 1885, p. 802.—Forbes, 1885a, p. 84 [and 1900, p. 76]; 1885b, p. 108.—Jordan and Gilbert, 1886, p. 6 (comparison only).—Evermann and Bollman, 1886, p. 335 (Pigeon Cr., near Monongahela City,* Pa.).—Evermann, 1886, p. 3 (Indiana record).—Eigenmann and Fordice,

*The material indicated by an asterisk has been re-examined.

1886, p. 410 (Bean Blossom Cr.,* Monroe Co., Ind.).—Gilbert, 1886, p. 207 (Kansas records).—Hay, 1887, pp. 250–253 (Kansas records: North Fork Solomon R., Lenora;* Smoky Hill R., Wallace).—Forbes, 1888b, pp. 512, 515 (food relations).—Henshall, 1888, p. 77 (Ohio records).—Evermann and Jenkins, 1888, pp. 44–56 (Indiana records including Deer Cr., Camden*).—Gilbert, 1889, p. 40 (Kansas records).—Meek, 1889b, pp. 167–168 (Iowa; description).—Jordan, 1890, pp. 155–167 (Indiana records including Wabash R., Vincennes* and New Harmony;* West Fork White R., Spencer*).—Bollman, 1890, p. 221 (Kalamazoo R., Battle Creek,* Mich.).—McCormick, 1890, p. 126 (Lorain Co., Ohio).—J. Nelson, 1890, p. 671 (description; synonymy; range [not in New Jersey]).—Gilbert, 1891, pp. 146, 152 (Shoal Cr., Florence,* Ala.).—Bean, 1892, pp. 18–19 (description; range; ecology; economics; Pennsylvania).—McCormick, 1892, p. 13 (description; Lorain Co., Ohio distribution).—Woolman, 1892a, pp. 285, 287 (Kentucky record).—R. R. Wright, 1892, p. 443.—Call, 1892, p. 55.—Meek, 1892a, p. 12 (Iowa); 1892b, pp. 232–246 (misprinted *Nocturus flavus;* Iowa records: Cedar R., Cedar Rapids;* Missouri R., Sioux City,* near mouth Big Sioux R.; Big Sioux R., Sioux Falls and Sioux City*); 1892c, p. 108 (compiled); 1893, p. 229 (range [in error]).—Bean, 1893, pp. 27–28 (Iowa; range).—Kirsch, 1893, pp. 262–264 (Tennessee records).—Evermann, 1893, p. 77 (South Fork Cheyenne R., Cheyenne Falls; Belle Fourche R.,* Belle Fourche).—Eigenmann and Beeson, 1894a, p. 81; 1894b, p. 44 [and 1905, p. 120] (Indiana records, some compiled [some are *Noturus gyrinus*]).—Hay, 1894, pp. 172–175 (description; economics; "Great Lakes from shore to twenty fathoms"; other Indiana records compiled [some are *N. gyrinus*]).—Garman, 1894, p. 56 (Licking R., Ky.).—Eigenmann, 1894, pp. 107–132 (Missouri R., Craig, Montana;* "reported at Medicine Hat").—Kirsch, 1894, p. 87 [and vol. 14, p. 36] (Indiana records include Eel R. [Logansport*]).—Meek, 1894b, p. 135 (Salt Cr. [Havelock*], near Lincoln, Nebr.).—Kirsch, 1895, pp. 327–335 (records include: Maumee* R., Fort Wayne, Ind.; Maumee R., Defiance* and Grand Rapids,* Ohio; St. Marys R., Decatur,* Ind.; Auglaize R., Cloverdale* and Defiance,* Ohio; Blanchard R., Ottawa,* Ohio).—Call, 1896, p. 14 (Ohio basin; Falls of the Ohio; "occasionally seen in markets").—Jordan and Evermann, 1896a, pp. 143–144 (description; synonymy; range [in error]); 1896b, p. 233 (synonymy; range [in error]).—Eigenmann, 1896, pp. 252–253 (reproduction; Indiana record).—Kirsch, 1896a, p. 48 (Indiana record); 1896b, p. 105 (Maumee basin records repeated).—Cox, 1896, p. 608 (Minnesota record).—Evermann and Cox, 1896, pp. 334–426 (synonymy; Missouri R. basin; Nebraska records include: Beaver Cr., York;* Platte R., Grand Island.* South Dakota records include: Beaver Cr., Buffalo Gap;* Belle Fourche R., Belle Fourche.* Wyoming records include: Powder R., Arvada;* Platte R., Douglas.* Several records compiled [Missouri R., St. Joseph copied in error]).—Cox, 1897, pp. 16–78 (description; record compiled).—Osburn and Williamson, 1898, pp. 11, 19 (Franklin Co., Ohio records including Scioto R.*).—Parker, Williamson, and Osburn, 1899, pp. 22, 32 (Ohio record).—Jordan and Evermann, 1900, p. 3236, pl. 27, fig. 63 (L. Champlain, Westport,* N.Y.).—Herrick, 1901, pp. 230–231 (description head canals).—Evermann and Kendall, 1901, p. 480 [and 1902, p. 210] (Nine-mile Point,* L. Ontario, N. Y.).—Osburn, 1901, p. 26–27 (description; Ohio records [Little Darby Cr. listed in error?]).—Jordan and Snyder, 1901, p. 117 (scattered villi on skin of sides).—Evermann, 1902, p. 95.—Hay,

*The material indicated by an asterisk has been re-examined.

1902, pp. 70–71.—Bean, 1902, pp. 254, 277 (range; figure; Nine-Mile Point,* N.Y.); 1903, pp. 91–92, 739 (description; range [in error]; synonymy; economics; Nine-Mile Point,* N.Y.).—Large, 1903, pp. 9–10 [and 1905, pp. 56–57] (description; Illinois distribution; Mackinaw Cr.; [but not Kaskaskia R.]).—Jordan, 1904, pp. 41, 351.—Mitchell, 1904, p. 162 (description oral breathing valves).—Henshall, 1906, p. 3 (Missouri R., Craig,* Mont.).—Michael, 1906, p. 8 (range [in error]; Michigan records compiled).—Reed, 1907, pp. 556–564, fig. 1 (description poison apparatus).—Cockerell, 1908, p. 163 (comparison; Rocky Mountain distribution; Wyoming;* Platte R.;* Missouri R.,* Mont.).—C. W. Nash, 1908, pp. 23–25 (description; L. Erie and L. Ontario).—Meek, 1908, p. 140 (range [in error]; reproduction; Indiana).—Forbes, 1909, pp. 387–437 (range [in error]; Illinois distribution [Kaskaskia R. record is *N. exilis;* certain others are *N. nocturnus*]; ecology).—Forbes and Richardson, 1909 [and 1920, pp. lxxviii–cxv], pp. lxxiii–cix, 176–201, color plate, fig. 48, map 57 (Illinois distribution [see Forbes, 1909]; ecology; synonymy; description; range [in error]; figured; teeth figured [captions transposed in first edition]).—Meek and Hildebrand, 1910, pp. 244–245 (description; range [in error]; Illinois record).—Hahn, 1910, p. 175 (Bean Blossom Cr., Indiana).—Leathers, 1911, pp. 246–249 (Saginaw Bay, Michigan records).—Fowler, 1912b, p. 47 (Two Lick Cr.* and Cherry Run,* Indiana Co., Pa.).—Shelford, 1913, p. 119 (Illinois record).—Hankinson, 1913, p. 112 (not found around Charleston, Ill.).—C. W. Nash, 1913, p. 252 (streams near Toronto, Canada).—Fowler, 1913, p. 91 (Pennsylvania records including Erie,* Erie Co.).—Halkett, 1913, pp. 17, 57 (Ottawa R., Canada, at Ottawa Fish Hatchery; range [in error]).—Forbes, 1914, p. 18, fig. 14c, map 57 (Illinois distribution [in error]; teeth figured).—Fowler, 1915a, p. 208 (records re-examined and relisted, also Iowa: [one record only] Brook R.,* [location?]); 1918b, p. 7 (relisted).—Evermann, 1918, pp. 306–366 (synonymy; *luteus* spelled *lutius;* Kentucky and Tennessee records compiled [Tennessee R., Florence is probably error for Shoal Cr.*]).—A. H. Wright, 1918, p. 543 (Salmon Cr.,* Monroe Co., N.Y.).—Fowler, 1919, p. 57 (Pennsylvania records relisted).—T. Surber, 1920, p. 20 (description; presence in Blue Earth R., Mankato, Minn. questioned).—Conger, 1920, p. 10.—Dymond, 1922, pp. 59, 62 (L. Erie records).—Hankinson, 1923, p. 32; and 1924, pp. 84, 86 (New York record).—H. S. Pratt, 1923 [and 1935, p. 89], p. 95, fig. 41d (teeth figured [transposed name in first edition]; description; range [in error]).—Reed, 1924a, pp. 431–451, fig. 9 (comparison and description of spines).—C. L. Hubbs, 1926, pp. 49, 51 (Great Lakes basin; comparison).—Cahn, 1927, pp. 41–42 (Fox R., near Lannan and Oconomowoc R., Stonebank, Wis. [a specimen, USNM 87510, Wisconsin,* Oct. 16, 1925, A. R. Cahn]; food; ecology).—Fowler and Carlson, 1927, p. 66 (Pennsylvania records; habits).—Greene, 1927, p. 306 (Wisconsin*).—Greeley, 1927, pp. 49–57 (economics; New York distribution and records).—Potter and Jones, 1928, p. 355 (compiled).—Hubbs and Greene, 1928, p. 390.—Eaton, 1928, p. 42 (New York record).—Greeley, 1928, pp. 87–105 (New York records).—Hubbs and Brown, 1929, p. 42 (trib. of Kettle Cr.,* near Fultons Bridge, about 5 mi. from L. Erie, Ontario).—Dymond, Hart, and Pritchard, 1929, pp. 4, 24 (Credit R. and ?Burlington Bay, Ontario).—Greeley, 1929, pp. 155–174, color pl. 5 (male figured; reproduction; ecology; economics; New York distribution and records).—Sibley, 1929, p. 184 (food).—Jordan, 1929, pp. 92–93.—Hankinson, 1929, p. 452 (North Dakota records: Little

*The material indicated by an asterisk has been re-examined.

Missouri R.* [at Marmarth]; Cannon Ball R.* [just below Mott]; Heart R.* [about 10 mi. S. of Richardton, Stark Co.]).— Hubbs and Ortenburger, 1929, p. 96 (Elk R.,* 7 mi. N. of Grove, Delaware Co., Oklahoma only).— Jordan, Evermann, and Clark, 1930, p. 155 (range [in error]; synonymy).— Greeley, 1930, pp. 45–82 (New York record).—Thompson and Hunt, 1930, pp. 27–60, map 32 (ecology; Champaign Co., Illinois distribution).—Coker, 1930, p. 180 (lock gate,* Keokuk, Iowa).—Osburn, Wickliff, and Trautman, 1930, p. 174 (Ohio).—Greeley and Greene, 1931, pp. 54–89 (ecology; New York distribution and records).—Greeley and Bishop, 1932, pp. 76–87 (New York distribution and records).—Fish, 1932, p. 351, fig. 67 (L. Erie, along rocky shores; reproduction compiled; description and figure of 20 mm. individual).—R. A. Moore, 1933, p. 17 (description of kidneys).—Greeley and Bishop, 1933, pp. 89, 98 (ecological distribution; New York records).— E. Moore, 1933, p. 20; and Odell, 1933, p. 128 (Sacandaga Reservoir, N.Y.).— Pate, 1933, p. 153 (food; Sacandaga Reservoir distribution).—Churchill and Over, 1933, pp. 9–60, fig. 47 (South Dakota; description).—Greeley, 1934, pp. 96, 104 (reproduction; New York records).—Van Cleave and Mueller, 1934, pp. 170–322 (Oneida L., N.Y.; parasites).—Ricker, 1934, p. 107 (ecology?; mouth of Credit R., Ontario).—Greeley, 1935, pp. 86, 96 (ecology; "9 collections from Mohawk River or tributaries," N.Y.).—O'Donnell, 1935, p. 484 (Illinois ecology; distribution [in error]).—Greene, 1935, pp. 142–146, map 59 (Wisconsin distribution; ecology; range; dispersal routes; Cahn's record of *Schilbeodes miurus* from Wisconsin may be *flavus*).—?Ewers and Boesel, 1935, p. 66 (in food of *Aplites salmoides;* Buckeye L., Ohio).— Aitken, 1936, p. 33 (Iowa).—Toner, 1937, p. 14 (L. Ontario and St. Lawrence R.; spawning habits).—Greeley, 1938, p. 69 (economics; New York distribution).—Welter, 1938, p. 67 (Kentucky records).—Blatchley, 1938, p. 66 (description; Indiana distribution, in part: Walnut and Raccoon Creeks).— Schrenkeisen, 1938, pp. 165–167 (description; range [in error]).—Simon and Simon, 1939, pp. 52, 57 (comparison; Wyoming records: Big Horn R.;* Tongue R.; Belle Fourche R.;* Laramie R.).—Trautman, 1939, p. 281 (more numerous, 1895, in Maumee R. than subsequently).—Hubbs and Lagler, 1939, p. 26.—Raney and Lachner, 1939, pp. 158, 160 (in associations; nesting habits; Shenango R., near Delaware Grove* and French Cr., Mill Village,* Pa.).—Raney, 1939a, p. 275 (Ohio drainage of W. Pennsylvania).— Kuhne, 1939, pp. 62, 68 (comparison; Tennessee).—Bangham and Hunter, 1939, pp. 401–434 (parasites; W. Lake Erie).—Breukelman, 1940a, p. 372 (NW. Kansas distribution); 1940b, pp. 381, 383 (Kansas distribution: Neosho,* Spring,* Verdigris,* Osage,* Solomon,* and Smoky Hill* Rivers; Hackberry Cr.;* Smoky Hill R., Logan Co.*).—Fowler, 1940b, p. 8 (Pennsylvania records compiled).—Greeley, 1940, p. 76 (New York records).— Senning, 1940, pp. 104–108 (New York records).—Hubbs and Lagler, 1941, pp. 63–64, fig. 82 (comparison; range [except Texas]).—Shoup, Peyton, and Gentry, 1941, pp. 70, 73 (Tennessee records: Puncheon Camp Cr., Allred, Overton Co.;* Ashburn Cr., 1 mi. below Ashburn [Creek] Schoolhouse,* Clay [or Pickett] Co.; Sewell Cr., E. of Millers Chapel, Pickett Co.;* Town Br., N. of Byrdstown, Pickett Co.* and SW. of Livingston, Overton Co.;* Wolf R., NW. of Byrdstown, Pickett Co.;* Obey R., Eagle Creek Ford,* Pickett Co.; Franklin Cr., S. of Moodyville, Pickett Co.;* Blackmans Fork Roaring R., E. of Gainesboro, Jackson Co.;* Big Indian Cr., W. of Boatland Bridge [Jamestown], Fentress Co.*).—Aitken, 1941, p. 389 (Iowa).—Jen-

*The material indicated by an asterisk has been re-examined.

nings, 1942, p. 365 (Kansas record).—Simon and Simon, 1942, p. 53 (Wyoming records).—Shoemaker, 1942, p. 269.—Driver, 1942, p. 252 [and 1950, p. 262] (comparison; range [in error]).—Palay, 1943, pp. 247–274 (neurosecretory granules and neurosecretion).—Hinks, 1943, pp. 58, 62 (comparison only).—Haas, 1943, pp. 162–163 (Rock R. drainage, Ill.).—Eddy and Surber, 1943, pp. 151, 161 [and 1947, pp. 170, 180, diag. 7d] (comparison; ecology; range; Minnesota distribution and records).—Radforth, 1944, pp. 6–61, figs. 22–23 (Ontario and L. Erie distribution; comparison with isotherms; ecology; glacial distributions).—Hubbs and Raney, 1944, pp. 3, 6 (synonymy; classification).—Palay, 1945, pp. 129–143 (description of tractus preoptico-hypophysis).—Fowler, 1945, pp. 13, 32, 351, fig. 162 (distribution [Tennessee R. system only]; specimen from Clinton,* Mo., figured).—Gerking, 1945, pp. 16, 73–74, map 62 (ecology; Indiana distribution [but not some literature records; see also IU Material studied p. 118]).—Cuerrier, Fry, and Prefontaine, 1946, p. 26 (Chateauguay,* St. Francis, and Nicolet Rivers, near Montreal, Canada).—C. L. Hubbs, 1946, p. 38.—Simon, 1946, pp. 94–117, fig. 74 (description; range; Wyoming records).—Mélancon, 1946, p. 131.—Hubbs and Lagler, 1947 [and 1949], pp. 71–72, fig. 174 (comparison; ecology; range [in error]).—Raney and Roecker, 1947, p. 172 (eaten by gartersnake, New York).—Fischthal, 1947, pp. 162, 181 (parasites, Vermillion and Yellow Rivers, Wis.).—Dymond, 1947, pp. 22–23 (comparison; Canadian distribution [in part only]: upper St. Lawrence R., near Montreal; Great Lakes, N. to Bruce Peninsula).—Smith, Johnson, and Hiner, 1949, p. 208 (Root R. tribs., Minn.).—Lincicome and Van Cleave, 1949, p. 426 (records of *Leptorhynchoides thecatus*, a parasite, compiled).—Hooper, 1949, p. 35 (vertebrae used in age determination).—D. C. Scott, 1949, p. 177 (Indiana record).—Harrison, 1949, p. 338 (Des Moines basin, Iowa).—Moore and Paden, 1950, pp. 87, 90 (reference to Meek's records [which are probably *Noturus exilis*] from Illinois R. and Barren Fork; Illinois R. system, Oklahoma localities: Illinois R.,* near mouth of Flint Cr., Delaware Co.; Flint Cr.,* from its mouth to 1.5 mi. upstream, Delaware Co.; Illinois R., near Scraper,* Cherokee Co.; Illinois R., E. of Tahlequah,* Cherokee Co.; Illinois R., about 5 mi. NE. of Gore,* Sequoyah Co.; Illinois R., near mouth,* Sequoyah Co.; Illinois R., above Tenkillers Dam,* Sequoyah Co.).—Fischthal, 1950, p. 100 (parasites; Hay Cr., Wis.).—Lachner, Westlake, and Handwerk, 1950, p. 93 (associations; French Cr., Carlton,* Pa.).—Starrett, 1950, pp. 118, 126 (Boone Co., Iowa).—Penn, 1950, pp. 648, 651 (compiled).—Laakso, 1951, p. 100 (Montana record).—Legendre, 1951, p. 3 (Quebec).—Bailey, 1951, pp. 194, 224 [and *in* reprint, 1951, pp. 194, 226] (comparisons; Iowa).—Harlan and Speaker, 1951, p. 97, pl. 18 (ecology; Iowa distribution; description compiled).—Moore, 1952, p. [6] (Oklahoma).—Larimore, Pickering, and Durham, 1952, pp. 8–25 (ecology and distribution in Jordan Cr., Ill.).—Cleary, 1952, p. 439 (Wapsipinicon R., Iowa).—Rostlund, 1952, pp. 33, 274 (map of distribution [in error]; records: [St. Francis R. listed in error; Washington Co., Ark., records probably based on misidentifications of *Noturus exilis*]; Republican [Arikaree?] R., Nebr., near Colorado border; Maitland R., Huron Co. and Glengarry Co., Ontario; others compiled [some, as Manitoba, probably in error]).—Legendre, 1953, pp. xi, 29, fig. 58 (comparison; Quebec, Canada).—Beckman, 1953, pp. 69–70, 109 (figure; description; rare [or hypothetical] in E. Colorado bordering Nebraska; recorded, Republican R. near Colorado line).—Fischthal, 1953, p. 101 (parasites, Wisconsin).—

*The material indicated by an asterisk has been re-examined.

??Martin and Campbell, 1954, pp. 47–53 (Black R., Mo., on riffles [misidentifications; probably *Noturus nocturnus*]).—Cleary, 1954, p. 633 (distribution, Cedar and Iowa Rivers, Iowa).—W. B. Scott, 1954, p. 68 (characters; size; distribution in E. Canada; life history; food; figured).—Langlois, 1954, pp. 34–278 (food; reproduction and life history notes; Lake Erie distribution and records).—C. Hubbs, 1954, pp. 277, 285 (not in Texas).—Harrison and Speaker, 1954, p. 519 (Iowa distribution).—Cross, 1954, p. 311 (ecology; Kansas records).—Legendre, 1954, pp. 14, 43, fig. 58 (key; Quebec).—Liegey, Donahue, and Eaton, 1955, pp. 12–19 (Ischua Cr., N.Y.).—Hall, 1955, p. 36 (population reduced by reservoir, Illinois R., Okla.).—Gerking, 1955, pp. 51, 75 (Indiana records; key).—Personius and Eddy, 1955, p. 42 (compiled).—Cleary, 1956, p. 271, map 66 (Iowa distribution).—Harlan and Speaker, 1956, p. 113, pl. 21.—Bailey, 1956, pp. 335, 364 (key, Iowa).—Hubbs and Lagler, 1957, p. 5.—Taylor, 1957, p. 192.—?Paloumpis, 1957, p. 60 (oxbows, Squaw Cr., Boone Co., Iowa).—Eddy, 1957, p. 151, fig. 381 (key; range, in part).—G. A. Moore, 1957, pp. 141, 142, fig. 2–77d (description; range, in part).—Underhill, 1957, pp. 21, 27, 29, map 17 (Minnesota distribution; arrival post Lake Agassiz).—Schelske, 1957, pp. 40–46 (occurrence, Verdigris R. system, Kans.).—Slastenenko, 1958a, p. 7 (Canadian distribution); 1958b, pp. 246, 353, fig. 101 (compiled).—W. B. Scott, 1958, p. 19 (Canadian distribution; ?hypothetical southern Canadian Plains region).—Clarke, Breukelman, and Andrews, 1958, p. 168 (Lyon Co., Kans.).—Hubbs and Lagler, 1958, pp. 89, 90, fig. 174 (key; range, in part).—Minckley, 1959, pp. 428, 432–433 (ecology and records, Blue R. basin, Kans.).—Underhill, 1959, p. 101 (lower Vermillion R., S.D.).—Minckley and Deacon, 1959, p. 348 (in food *Pylodictis*, Blue R., Kans.).—Metcalf, 1959, p. 383 (southern Kansas records).—Lennon and Parker, 1959, p. 15 (lower Abrams Cr.,* Great Smoky Mountains National Park).—Trautman, 1959, pp. 96, 432–434, fig. 110, map 110 (description, ecology, Ohio distribution; range).—Ross, 1959c, pp. 8, 24 (key; hypothetical, New R. system).—Hallam, 1959, p. 159 (as *Notrus;* associations, Ontario; infrequently with trout; commonly in warmer streams).—Becker, 1959, p. 96 (central Wisconsin distribution; ecology).—Suttkus, 1961, p. 63, fig. 4 (comparison; skull illustrated).—Deacon, 1961, pp. 395, 404, 408–421 (sedentary; "lacks air bladder" [erroneous]; distribution and abundance Neosho and Marais des Cygnes Rivers, Kans.).—Deacon and Metcalf, 1961, p. 317 (Wakarusa R., Kans., records).—Bailey and Allum, 1962, pp. 90, 118–122 (characters; synonymy; South Dakota stations* [all their specimens examined]).—Carr, 1962, p. 6 (Saginaw Bay).—Lennon, 1962, p. 6 (rare, Abrams Cr.*).—Clay, 1962, p. 92, fig. 62.—Brown, 1963, p. 25 (Missouri and Yellowstone Rivers, Mont.).—Larimore and Smith, 1963, pp. 324–344, fig. 46 (Champaign Co., Ill., records; distribution map; ecology).—W. B. Scott, 1963, p. 123 (Ontario).—Eddy, Moyle, and Underhill, 1963, pp. 113, 115 (Minnesota distribution; not above St. Anthony Falls).—Nursall and Lewin, 1964, p. 128 (description; Milk R., Alberta record).—Paquet, 1964, pp. 95, 99 (Etchemin R., Quebec).—Walburg, 1964, pp. 4, 16, 27 (found Lewis and Clark Lake only first two years of impoundment).—Smith, 1965, p. 8 (Illinois distribution).—Fee and Drum, 1965, p. 321 (*Lernea* parasite, Des Moines R., Iowa).—Rock and Nelson, 1965, p. 138 (mortality from *Aeromonas*, Rock R., Ill.).—Johnson, 1965, pp. 350, 352 (Humber and Rouge R. systems, Ontario).—H. H. Moore and Braem, 1965, pp. 2, 44 (records and distribution, Lake Superior

*The material indicated by an asterisk has been re-examined.

tributaries, Wis., including Amnicon* and Nemadji* Rivers).—Metcalf, 1966, pp. 34, 43–44, 59–62, 80, 150, map 39 (records, ecology, distribution, history, Kansas R. system).—Cross, 1967, pp. 197, 221, fig. 18A (figure, description, Kansas distribution).—Branson, 1967, pp. 137, 151 (compiled).

Pimelodus flavus (Rafinesque).—De Kay, 1842, p. 187 (Ohio; "young catfish with rudiments of an adipose fin").—Bleeker, 1858, p. 210 (Ohio).

Noturus species.—Rafinesque, 1818b, p. 107 (one species inhabiting the Ohio).

Noturus luteus Rafinesque, 1819, pp. 421–422 (original description; no locality given other than interior of U.S.).—Gill, 1861a, p. 45 (equals *Noturus flavus*); 1876, p. 423 (original description reprinted; name of *Noturus flavus* changed by Rafinesque to *Noturus luteus*).—Jordan, 1882, p. 739 (Ohio).—Jordan and Evermann, 1896a, p. 144 (Ohio R. indicated as type-locality).

Noturus occidentalis Gill, 1861a, pp. 45–46 (original description; Platte R.).—Günther, 1864, p. 105 (Platte R.; description [but not records or figure of teeth]).—Jordan and Copeland, 1876, p. 160 (Platte R.).—Gill, 1876, pp. 423–424, pl. 8 (description; Platte R.).—Jordan, 1877b, p. 372 (equals *Noturus flavus*).

Noturus platycephalus [misidentifications] Günther, 1864, pp. 104–105 (original description; North America;* "intermaxillary" teeth figured).—Jordan and Copeland, 1876, p. 160 (North America).—Jordan, 1877b, p. 372 (equals *Noturus flavus*).

Noturus insignis (Richardson) [misidentification].—Swain and Kalb, 1883, pp. 640–641 (Nebraska and Platte R. only).

Schilbeodes insignis (Richardson) [misidentifications].—?Fowler, 1906b, p. 595 (Allegheny R., above Port Allegany, McKean Co., Pa.); 1913, p. 92 (records questioned, Port Allegany, Pa.).—Hubbs and Raney, 1944, pp. 12–20, map 1 (synonymy, in part and Indiana records).—Gerking, 1945, p. 75 (compiled Indiana records).

Noturus exilis Nelson [misidentifications].—Eigenmann and Fordice, 1886, p. 410 (Bean Blossom Cr., Monroe Co. [SU 3980, White R., Spencer*], Ind.).—Evermann and Jenkins, 1888, pp. 44–54 ([USNM 39600] Tippecanoe R.,* Ind.).—Hay, 1894, pp. 172, 174 (Indiana records compiled; description?); 1902, p. 71 (Indiana records compiled).—Hahn, 1910, p. 175 (taken, 1885, in Bean Blossom Cr., Indiana, by Eigenmann; not taken in 1904).—?Charles, 1967, pp. 386–389 (Green R., Ky.).

Schilbeodes exilis (Nelson) [misidentifications].—Eigenmann and Beeson, 1894a, p. 81; 1894b, p. 44 [and 1905, p. 120]; and Meek, 1908, p. 141 (Indiana records compiled).—Eigenmann, 1896, p. 253 (Indiana).

Rabida exilis (Nelson) [misidentifications].—Blatchley, 1938, p. 67 (Indiana records compiled).

Schilbeodes gyrinus (Mitchill) [misidentifications].—?Fowler, 1907a, p. 14; 1913, p. 92; 1919, p. 57; and 1940b, p. 8; and ?Greeley, 1927, p. 57 (Genesee R., below Gold, Potter Co., Pa.).—?Keim, 1915, p. 51 (headwaters of Genesee R., Potter Co., Pa.).—Greene, 1935, map 60 (Wisconsin record: [St. Croix R., 11 mi. N. of Danbury,* Burnett Co.]).

Stonecat.—?Eschmeyer, 1943, p. 47 (common name only; bay of Norris Reservoir, Tenn.).

Schilbeodes nocturnus (Jordan and Gilbert) [misidentifications].—Gerking, 1945, pp. 74–75 (in part; Indiana station nos. IU 183,* 186,* 225,* 233,* 253* [3 mi. NE. Osgood instead of 3 mi. NW. West Harrison], 254*).

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*The material indicated by an asterisk has been re-examined.

TYPE.—USNM 202494 (formerly UL 12460) (neotype of *Noturus flavus* Rafinesque, herein designated), collected from Eagle Creek (a tributary to the lower Kentucky River which is tributary to the Ohio River), from pool below bridge at state highway 36, 3.5 miles east of Jonesville in Grant County, Kentucky, August 11, 1959, by William R. Turner.

OTHER MATERIAL STUDIED.—No locality known: BMNH (two syntypes of *Noturus platycephalus*, "Old Collection"; no locality or catalog number with specimens).

UNITED STATES: ILLINOIS: INHS 14, 196, 7119, 24989, 26456, 26596, 26597, 26619, 26690, 26697, 27610, 27612, 27645, 27648, 27662, 27669, 27747, 28044, 28061, 28132, 28142, 28156, 28177, 28189, 28193, 28199, 28219, 28225, 28237, 28255; INHS (Salt Fork R., S. of Oakwood, Vermilion Co., and Rock R., near Como, Whiteside Co.; other nos. 834, 979, 980, 1146, 1149, 1158, 1177, 1193, 3093, 3113, 3117); CNHM 1379, 21834, 32738, 42206, 43381, 43402; CNHM (Hickory Cr., Will Co.); Cu 3400, 7450, 7547; UMMZ 169749; UMMZ (Bauman nos. 46, 50, 53); USNM 200479; UL 7791 (Ohio R., Lock 51, Golconda). INDIANA: USNM 36747, 40655, 66542 thru 66545, 66548, 67783, 69029–30, 121977; IU 29, 48, 102, 141, 157, 178, 184, 186, 208, 225, 253, 254, 255, 257, 258, 261, 262, 339, 340, 342, 345, 347, 350, 352, 448, 506; UMMZ 66638, 99924, 99956, 100866, 113555, 126474; UMMZ (IU nos. 2863, 3149, 8880, 9627). IOWA: USNM 61936, 174930; UMMZ 101098, 101271, 102260, 146789, 146827, 146831; TU 10199. KANSAS: KU 232.7, 255, 645, 646 (Drum Cr., Montgomery Co.), 647, 648, 650, 651, 652 (Hackberry Cr., Gove Co.), 1521; KU (Bourbon Co., and Solomon R., Cloud Co.); USNM 9428 (Fort Lyon, Kansas, Dr. E. Palmer; this is the same locality and collector as listed for the type of *Cliola camura* Jordan and Meek, and is in apparent error), 131673, 172064, 200678, 200681, 200682; UMMZ 97049, 97067, 97128, 111480 (Verdigris R., 7 mi. NE. of Independence, Montgomery Co.), 111724, 120488, 120679, 120773 (Verdigris R., 1 mi. E. of Madison, Greenwood Co.), 122202, 122203, 160331, 160339, 160457 (Rose Cr., 2 mi. W. and 2 mi. S. of Wallace, Wallace Co.), 160504; UMMZ (Vermillion R., N. of Wamego, Pottawatomie Co.). KENTUCKY: UMMZ 126944, 168014, 168038; UMMZ (Delavan and Creaser nos. 31–86, 31–87); CNHM 6567; CU 48609, 48610; UL 5356, 5635, 5658, 5679, 5680, 5776, 5828, 6822, 7688, 8039; USNM 202495 through 202498. MICHIGAN: USNM 10595, 174908, 193197, 193206; UMMZ 55182, 56575, 64222, 64974, 65856 (Au Sable R., below Foote Dam, Iosco Co.), 73219, 79862 (North Br. Chippewa R., sec. 15, T. 16 N., R. 7 W., Mecosta Co.), 81513, 83390 (Ferris Cr., sec. 2, T. 10 N., R. 5 W., Montcalm Co.), 83864, 83910, 92207, 95007, 100786, 101729 (Saginaw Bay, off Katechay Island), 101895, 111328, 116256, 116291, 116327, 116362, 116881 (shore, L. Huron, sec. 26, T. 11 N., R. 16 E., Sanilac Co.), 116964, 117032, 117052, 131864 (Little Rabbit R., sec. 21, T. 4 N., R. 13 W., Allegan Co.), 131894 (Big Rabbit R., sec. 26 and 35, T. 4 N., R. 13 W., Allegan Co.), 136805, 137158, 137215, 137294, 137653, 137674, 138083, 138105, 138142, 138776 (Green Lake Cr., sec. 19, T. 4 N., R. 11 W., Allegan Co.), 162969, 164302, 164313, 164323, 164332, 164355, 165833, 165842; UMMZ (Kalamazoo River Survey nos. KA19, KA21, KA43, KA45; Hankinson no. 9412S). MINNESOTA: UMMZ 156699 (Cottonwood R., sec. 22, T. 109 N., R. 33 W., Brown Co.). MISSOURI: USNM 36291 (Sac R., Greenfield, Dade Co.); INHS (Osage R., N. of Schell City; Niangua R., Bennett Spring Park, Dallas Co.; Salt R., N. of Shelbina, Shelby Co.; Grand

R., 2 mi. SW. Sumner, Chariton Co.; Gasconade R., 4 mi. S. Gerome, Phelps Co.; Pomme de Terre R., 2 mi. SW. Hermitage, Hickory Co.; South Grand R., 2.5 mi. S. Prettyman, Cass Co.); UMMZ 142209, 142234, 142260, 147054 (Mississippi R., Crystal City, about 1 mi. above mouth of Plattin Cr., Jefferson Co.), 148105, 148746, 148755, 148981, 148993, 148214, 149360, 149380, 149433, 150091 (Little Sac R., 0.5 mi. SW. Aldrich, Polk Co.), 150123, 150159, 150436 (Niangua R., 5 mi. SE. Buffalo, Dallas Co.), 150651, 150697, 150770, 150803 (Pomme de Terre R., 4 mi. SE. Eckton, Hickory Co.), 152547, 152621, 152639, 152674, 152750, 164577; UMoMZ (W. L. Pflieger coll.: From Missouri R.: P62–152, Rocheport; P63–48, Bonnots Mill; P63–119, at mouth; P63–130, Lexington. From Mississippi R.: P63–114, 2 mi. E. Fornfelt; P63–122, 3 mi. E. Winfield; P63–133, 2 mi. E. Illmo; P63–134, Neely's Landing; P63–137, West Quincy; P63–138, Canton; P66–41, Grand Tower Island. P63–117, Locust Cr., Sullivan Co.). MONTANA: USNM 1482 (Yellowstone R., Fort Sarpy), 37780 (Big Horn R.), 129629 (Missouri R., Judith Ferry), 143088 (Musselshell R.); UMMZ 94433 (Tongue R., Miles City, Custer Co.). NEBRASKA: USNM 76124 (Long Pine); UMMZ 134043, 134053, 134555, 134968, 135026, 135074, 135136 (Arikaree R., 1 mi. NW. of Haigler, Dundy Co.), 135286 (Minnechaduza Cr., 3 mi. W. of Valentine, Cherry Co.), 135362, 135367; KU 4160; UMoMZ 5320. NEW YORK: CU 2153, 2327, 2460, 2641, 3063, 3551, 4610 (Olean Cr., 0.5 mi. N. of North Olean, Cattaraugus Co.), 4653, 5266, 5271, 5443, 6144, 6145, 8150, 8389 (Genesee R., above Wellsville, Allegany Co.); USNM 70012, 70014, 161948. OHIO: USNM 1418, 11062, 62854, 62855, 69419, 69420, 69421, 118937, 161715; CNHM 6564, 9777, 9870–1; UMMZ 55669, 87714, 87738, 87795, 87806, 87816, 87835, 101635, 101651, 107566, 107669, 107760, 107782, 118354, 118406, 159834. OKLAHOMA: Tulsa U (Illinois R., below Tenkiller Dam, 6 mi. NE. of Gore, Sequoyah Co.; Illinois R., U.S. Hwy. 59, Adair Co.; Neosho R., at Earbob Cr., Mayes-Wagoner Co. line; Caney R., Hulah Dam, Osage Co.); UMMZ 164576; TU 15535 (Verdigris R., Hwy. 88, Rogers Co.). PENNSYLVANIA: CU 4188, 5597, 6717, 9423, 9435, 10718 (Allegheny R., 1.5 mi. E. of Port Alleghany, McKean Co.); UMMZ 102376, 102942; USNM 161750 thru 161755; UL 9287, 9325, 9353. SOUTH DAKOTA: USNM 76125 (White R., Chamberlain). TENNESSEE: USNM 24839 (near Knoxville), 118938 (Rock Island); UMMZ 125706, 157444 (Roan Cr., 2.5 mi. ESE. of Doeville, Johnson Co.), 157576 (South Holston R.' 0.25 mi. above South Holston Dam, Sullivan Co.), 168261; Vanderbilt U (Turnbull Cr., Dickson Co.; Turnbull Cr., Cheatham Co.); TU 19491. VIRGINIA: USNM 190943 (South Fk. Holston R., Hwy. 91, 5.8 mi. SW. Lodi, Washington Co.). WEST VIRGINIA: CU 4537, 5734, 13434; USNM 192648 (Shavers Fk., 0.7 mi. NE. Turkey Knob bridge, Randolph Co.), 192649 (Shavers Fk., 3 mi. SW. Parsons, Tucker Co.), 192650. WISCONSIN: UMMZ 64640 (Milwaukee R., Waubeka, Ozaukee Co.), 64836 (Milwaukee R., 1.5 mi. W. Newburg, Washington Co.), 64882 (br. Cedar Cr., 1 mi. W. Jackson, Washington Co.), 73660, 74118 (South Br. Little Wolf R., 11 mi. NW. Waupaca, Waupaca Co.), 76911, 76926, 76959, 77029, 77045, 77055, 77108, 77561, 78807 (Black R., 2 mi. N. Wither, Clark Co.); TU 15746 (Milwaukee R., West Bend, Washington Co.), 15762 (Newburg, Washington Co.). WYOMING: UMMZ 113443 (Wind R., Riverton, Fremont Co.), 159939 (Big Horn R., Basin, Big Horn Co.), 161890 (Piney Cr., 6 mi. W. of Ucross, Sheridan Co.), 161903 (Belle Fourche R., U.S. Hwy. 14, 2 mi. W. Carlile Junction, Crook Co.), 162440 (Little Goose Cr., 2 mi. S. Sheridan, Sheridan Co.); USNM 174932.

CANADA: QUEBEC: UMMZ 136395 (Chateauguay R., first rapid above dam, near Montreal).

DIAGNOSIS.—*Noturus flavus*, the only member of the subgenus *Noturus*, differs from other species of the genus in the increased number of paired fin rays (usually 9 or 10 pelvic and 9 to 11, more often 10, soft pectoral rays), in the backward projections of the lateral edges of the premaxillary tooth band, in the relatively larger size attained, and in always having two free pectoral radials on each side. There are 54 to 67 caudal rays.

It is distinguished from members of the subgenus *Rabida* by the reduced serrations of the pectoral spine and by the absence of a mottled pattern, from the subgenus *Schilbeodes* (except *N. gilberti*) by the relatively broad cream colored margin of the caudal fin and the immaculate lower surface of the head and abdomen. It differs from *N. gilberti* in size, in the premaxillary tooth pattern, in the increased number of caudal rays, and in the longer spines.

DESCRIPTION.—Counts and measurements are given in tables 17 to 26. Head depressed; lower jaw included; eye small, 2.5 to 4.7 times in snout; humeral process distinct, shorter than width of pectoral spine; pectoral spine of moderate length, roughened or sometimes with a few serrae behind; shallowly beveled or with recurved hooks along the anterior edge, but without anterior dentations as found in *Rabida;* dorsal spine stout; adipose fin continuous with caudal fin; caudal fin truncate or slightly rounded behind; premaxillary band of teeth with distinct posterior extensions which vary from a shallow V-shape to long, narrow trailing bands that may be nearly as long as the overall breadth of the premaxillary; lower lip and median under surfaces of head covered with coarse papillae.

In both skeletons and cleared and stained specimens of *Noturus flavus:* ossified pectoral radials always two and unfused (48 sides); vertebrae anterior to anal origin 14 (in 10) or 15 (4).

The soft dorsal rays are five (in 2), six (109), and seven (6). In the caudal fin there are (extremes in parentheses): (20) 22 to 26 (29), mean 23.9, upper simple rays; (15) 16 to 20 (22), mean 18.2, branched rays of which 7, frequently 8, are in the upper half and 9 to 12 are most usual in the lower half of the fin; (14) 16 to 21 (24), mean 18.1, lower simple rays. There are usually six or seven gill rakers.

The size probably exceeds 250 mm. in standard length. Specimens ranging from 175 to 200 mm. are common in collections; many are above 200 mm. The Museum of Zoology has a specimen that is 240 mm. in standard length.

General color in life yellowish, slate-gray, or olive green along sides and on dorsal surfaces. In preservative, top of head, areas about dorsal fin base, and between dorsal and adipose fins dark gray; ventral surface immaculate, including mental barbels, lower side of head, abdomen, pelvic fin, lower edge of caudal peduncle, lower and upper margin and sometimes end of caudal fin, and edge of adipose fin. A gray blotch extends well into the adipose fin, the anterior end of which is immaculate; an irregular dark gray blotch covers most of middle of caudal fin and extends variably to the edge; sides of body yellowish gray; anal fin very lightly pigmented; dorsal fin with a light margin, a distal dark gray band, and an intermediate light gray area that grades into the dark gray base; pectoral fins dark gray except margin; upper edge of pectoral spine dark gray, front edge white; upper barbels gray; a light yellow elliptical or ovate spot at posterior end of dorsal fin. With age, lower surfaces become grayed with a diffuse dark pigment.

TYPE.—As is well known and was documented by Call (1899, p. 29), Rafinesque did not retain the specimens on which his descriptions were based and I have found none nor a reference that any of his specimens are extant. Because no type-specimen of *Noturus flavus* Rafinesque exists, a neotype of it is selected in order to fix that name to the species for which it has been in long and continued use. As discussed under Nomenclature (p. 127) several characters in the original and later descriptions suggest the possibility that Rafinesque may have described a composite of *Noturus gyrinus* and *Noturus flavus*—at least his counts of fin rays fit precisely the counts listed herein for *gyrinus* and most are outside the range of those obtained for *flavus*. Further, although the present Ohio River is unlike the river in the early nineteenth century, having been modified considerably by man, *Noturus flavus* is apparently rare below Pennsylvania, but *Noturus gyrinus* is moderately common (personal communication from Dr. William M. Clay, based on the extensive survey of the Ohio River Valley Water Sanitation Commission). Aside from *flavus* collected from the river bordering Illinois, I have been unable to examine material from this lower section of the stream.

In his original description of *flavus*, Rafinesque indicated the locality as the Ohio. Later papers list the Falls of the Ohio as the only definite locality, and it is probable that his specimens were obtained there—hence I assume that to be the type-locality. The specimen selected as the neotype is the best that has become available from near this locality. It is typical of *flavus* in fin ray counts, number of vertebral elements, shape of the premaxillary tooth band, body shape, and color pattern as described and illustrated herein. Aside from the higher fin ray counts, a slightly smaller size, and Rafinesque's color description, it corresponds well with his original account. It was collected with one other specimen of *flavus*, USNM 202495.

The neotype is a male 114.2 mm. in standard length. The following data from it are not included in other summaries in this paper: I,6 dorsal rays; 6+12=18 anal rays; 24+8+12+18=62 caudal rays; 1 epural; 3+3=6 hypurals, all free distally; 39 vertebrae of which 14 are anterior to the origin of the anal fin; 10 soft pectoral rays on the left side and 11, including a tiny inner ray, on the right side. On each side there are 10 pelvic rays, 2 internasal pores, and 11 preoperculomandibular pores. The head length is stepped into the standard length 3.7 times, the eye into the snout 3.2 times, and the distance from the rear end of the adipose fin to the tip of the caudal fin into the distance from the origin of the dorsal fin to the rear end of the adipose fin 1.8 times. Further measurements are given in table 27.

Variation.—The following summary of the data obtained on this species is the result of combining several samples from various geographic areas. It indicates relatively little geographic variation. The data listed consist of the number of counts, range (in parentheses), and the mean for, in sequence: (a) Missouri River, South Dakota and Nebraska, (b) Neosho and Illinois Rivers of Kansas and Oklahoma, (c) Osage River system, Missouri, (d) Missouri and Mississippi Rivers, Missouri, (e) Ohio and Cumberland Valleys, (f) Great Lakes basin, chiefly Huron River, Michigan, and (g) totals.

Soft pectoral rays: (a) 68 (9–11) 9.68; (b) 40 (9–11) 9.98; (c) 5 (9–10) 9.60; (d) 52 (9–11) 9.62; (e) 40 (9–11) 9.80; (f) 79 (9–11) 9.85; (g) 284 (9–11) 9.77.

Pelvic rays: (a) 68 (8–10) 9.29; (b) 40 (9–10) 9.18; (c) 9 (9–10) 9.11; (d) 51 (8–10) 9.31; (e) 40 (8–10) 9.40; (f) 80 (8–10) 9.25; (g) 288 (8–10) 9.28.

Anal rays: (a) 28 (15–18) 16.18; (b) 17 (15–17) 15.88; (c) 5 (16–17) 16.60; (d) 26 (15–18) 16.38; (e) 19 (15–19) 17.11; (f) 37 (16–18) 17.27; (g) 132 (15–19) 16.64.

Lower-half caudal rays: (a) 19 (26–30) 28.16; (b) 20 (28–32) 29.75; (c) 5 (27–30) 28.60; (d) 26 (27–33) 30.08; (e) 18 (27–31) 29.28; (f) 36 (26–32) 28.67; (g) 124 (26–33) 29.15.

Upper-half caudal rays: (a) 19 (29–36) 31.89; (b) 20 (30–33) 31.00; (c) 5 (30–33) 31.40; (d) 26 (27–34) 31.81; (e) 18 (29–32) 30.78; (f) 36 (28–33) 30.75; (g) 124 (27–36) 31.11.

Total caudal rays: (a) 19 (55–66) 60.05; (b) 20 (58–64) 60.75; (c) 3 (60–63) 61.33; (d) 26 (55–67) 61.38; (e) 18 (57–63) 60.06; (f) 37 (54–64) 59.27; (g) 123 (54–67) 60.24.

Vertebrae: Specimens from the southwestern portion of the range, lower Missouri and Arkansas River drainages, appear to have fewer vertebrae with modal numbers of 38 or 39; those from the upper Missouri have slightly more, and those from elsewhere the most, modally 39 or 40; French Cr., Pennsylvania 16 (38–40) 39.38; Tennessee R. system 25 (38–41) 39.80; Great Lakes drainage 44 (38–41)

39.48; upper Missouri R., Nebraska to Montana 15 (37–40) 38.93; Smoky Hill R., Kansas 5 (38) 38.00; Neosho R., Kansas 4 (38–40) 38.75; Missouri and Mississippi Rivers, Missouri 24 (37–40) 38.50; total 133 (37–41) 39.21.

Specimens collected from the channels of the Missouri River throughout Missouri and the Mississippi River below the mouth of the Missouri River generally have smaller eyes than specimens from elsewhere. Although a few small eyed individuals have been obtained from the mouths of tributary streams, the small eye size seems to be restricted to the area of these highly turbid big rivers. Specimens from the Mississippi River above the mouth of the Missouri River have normal size eyes.

The eye size is variable, but the eyes are usually obviously small. Occasional individuals in a sample have relatively large eyes, and in these samples a few appear to have eyes of intermediate size. The eye of *flavus* from the upper Mississippi River and other clear streams is usually stepped into the snout length 2.5 to 3.4 times. In 15 of the Missouri and Mississippi River specimens the eye is stepped into the snout 2.5 to 4.7, mean 3.6 times.

Because the eyes of these specimens show considerable size variation, especially within a small sample, from tiny to almost normal size, and because the specimens appear otherwise typical of *flavus* I am inclined to believe that the eye size is simply a response to the muddy, turbid river waters. Degeneration or loss of eyes within a few years has been observed in bullhead populations that have been subjected to reduced light or darkness.

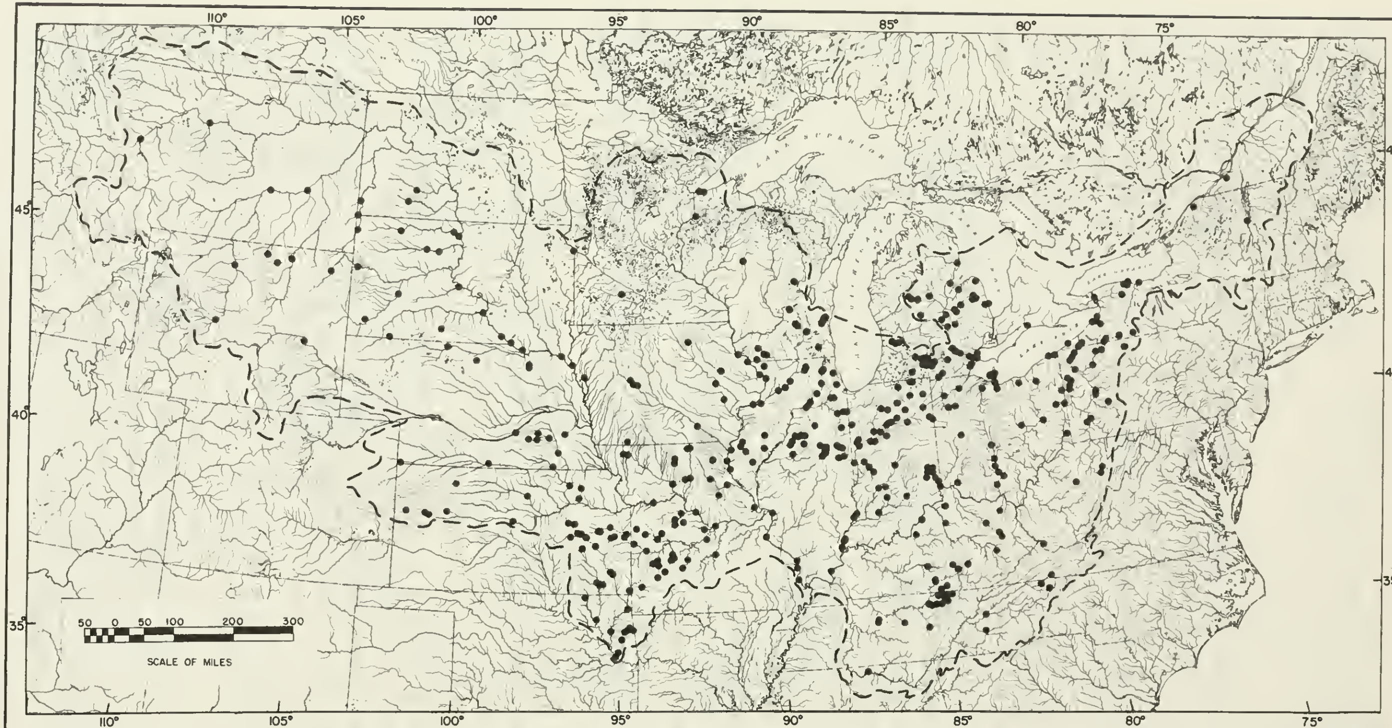
Further study of these or similar specimens should be made to compare the structure of the eye in detail with that of other specimens.

Aside from the eye size these specimens do not appear to differ from other populations of *flavus* in their morphology. Their color is drab, usually medium gray in preservation, but the distribution of pigment does not differ from that of other *flavus*.

Distribution.—*Noturus flavus* (map 8) occurs in the Mississippi River system, in the Mohawk and Hudson River systems, and in the Great Lakes-Saint Lawrence River drainage.

It has entered the Mohawk and upper Hudson River systems (Greeley and Bishop, 1933, pp. 89, 98; and Greeley, 1935, pp. 86, 96) from the Great Lakes, presumably as a canal immigrant. After the recession of Wisconsin ice, several entrances were made from the Mississippi drainage into the Great Lakes basin; one was undoubtedly into the Lake Michigan basin, another into the Lake Erie basin, and one was into the Lake Superior tributaries. In the Lake Michigan basin, *flavus* is confined to the area south of the Kalamazoo River in Michigan and to the southern half of Wisconsin and southward.

298-943 O—69——9



Map 8.—Distribution of *Noturus flavus* Rafinesque. Circles represent stations whence specimens have been examined. The dashed line surrounds the known and hypothetical range. Unverified but presumably authentic literature records fall within this area and include several from the Hudson River drainage and from the western plains states. Records from outside the indicated range are either known or believed to be based on misidentifications.

From the Lake Erie basin, *flavus* has spread northward into Lake Huron to the Bruce Peninsula, Canada, and the Au Sable River, Michigan. It has become distributed throughout the Lake Erie and Ontario basins and is known to range eastward to Lake Champlain, tributaries of the Saint Lawrence River, near Montreal, and has been reported from the Etchemin River, Quebec (Paquet, 1964).

N. flavus is found in western tributaries to Lake Superior (H. H. Moore and Braem, 1965), undoubtedly arriving from the St. Croix River, a tributary of the Mississippi River. Its spread eastward into Lake Superior is probably limited by cold water. Eddy, Moyle, and Underhill (1963) state that *N. flavus* is absent from the upper Mississippi River, Minnesota, above St. Anthony Falls, which is an apparent effective barrier to distribution.

In the Mississippi River basin, *flavus* is found throughout most of the Ohio, Cumberland, Tennessee, upper Mississippi, and nearly the entire Missouri River systems. It has crossed from the Missouri, by way of the Osage or Kansas Rivers, into the Arkansas River system. It avoids streams of low gradient and is notably absent, for example, from southern Illinois and other areas of slow runoff. *N. flavus* has not yet been recorded from the South Platte River and apparently avoids much of the rest of the Platte; otherwise it is known from many of the upper Missouri River tributaries. In the Arkansas drainage, *flavus* is known from the Illinois, Neosho, and Verdigris River systems. Records of *flavus* from elsewhere are apparently based on misidentifications. The following is a discussion of the more important of these.

The inclusion of Texas in the range of *flavus* by Baughman (1950, p. 131) and by other recent writers in general references is an error initiated by S. Garman (1881, p. 89). His material, from San Antonio, Texas, was re-identified by Evermann and Kendall (1894, pp. 78, 96) as *Ameiurus* [= *Ictalurus*] *natalis*. A small specimen of *Noturus gyrinus* in the Museum of Comparative Zoology (MCZ 24900), collected by Edward Palmer in 1880 from San Antonio, Texas, misidentified as *Noturus flavus*, was examined by me and is undoubtedly the basis of Garman's report. No specimen or record of *Ameiurus* [*Ictalurus*] *natalis* obtained by Palmer from San Antonio has been found in that collection, suggesting that Evermann and Kendall did not examine Garman's material.

Records of *Noturus flavus* by Jordan and Gilbert (1886, p. 7) for Lee's Creek and the Poteau River, near Fort Smith, Arkansas, are probably based on *Noturus exilis*. These authors did not list *exilis*, a species that is now known from Lee's Creek and was recorded as *Schilbeodes insignis* by Cross and Moore (1952, p. 407) from many stations in the Poteau River, Oklahoma. In addition, a collection of Jordan and Gilbert's paratypes of *Noturus nocturnus* from the Poteau

River contained a specimen of *exilis*. Similarly, Meek's (1893, p. 229) records of *Noturus flavus* from Arkansas are probably referable to *Noturus exilis*. It is noted, for example, that Meek initially listed *flavus* but not *exilis* from the Illinois River. Later, without comment, he listed *exilis* but not *flavus* from this system. This identification has been confirmed by examination of some of his material. Examination of the record (Forbes and Richardson, 1909, map 57) from the Kaskaskia River, Illinois, reveals that it, too, is *Noturus exilis*.

The record from the Black River, Missouri (Martin and Campbell, 1954), is doubted, as the specimens on which the report was based cannot be found. Extensive surveys of Missouri and Arkansas fishes have not otherwise yielded specimens from any of the following rivers: Black, Current, White, and St. Francis. The Meramec River, Missouri, is included hypothetically in the range of *flavus;* there are no records.

References to *Noturus flavus* from Manitoba by Bissett (1927, p. 127) and from the Hudson Bay drainage by Bajkov (1928, p. 97) and later compilations of these reports are listed here in the synonymy of *Noturus gyrinus*. Both reports were based on original material, but neither gave a description or listed specific localities, and presumably their material was not retained. It is of further interest that only Bajkov listed *gyrinus*, this on the basis of previous references. While there are many records of *gyrinus*, there are no other records of *flavus* from the drainage, and it is most probable that both are misidentifications of *gyrinus*. This is in agreement with many recent writers who have questioned the authenticity of the records and conforms to an opinion expressed to me by Dr. W. B. Scott in a letter in which he outlined the Canadian distribution of this species.

In addition to *Noturus exilis* and *N. gyrinus*, some records of *Noturus insignis* and *N. nocturnus* have been listed as *Noturus flavus* or one of its synonyms. Young specimens are most frequently misidentified. A comparison of the young of several similar forms appears in table 9.

NOMENCLATURE.—Rafinesque apparently gave two names to this species. They are: *Noturus flavus*, described from the Ohio (1818a, p. 41), and *Noturus luteus*, described later without statement of locality (1819, pp. 421–422). It appears that they were based on the same material; the descriptions, aside from being in different languages and having a few minor differences, are very similar and give the impression that only one kind of animal is described. Evidence that Rafinesque knew only one species is that he recognized only *Noturus flavus* in later papers. The viewpoint that the names are based on the same animals agrees with Gill's (1861a, p. 45; 1876, p. 423), and the type-localities are here assumed to be the same. Because his types were not preserved, the application of these names may have been subject to some uncertainty. Several species of *Noturus*, besides the one described here, occur at or near the Falls of the Ohio (Jordan, 1877d, p. 99; and Call, 1896, p. 14). Among them is *Noturus gyrinus*, which may have been part of the material on which the name *Noturus flavus* was based. The other species of the genus that are known from the Ohio Valley seem to be eliminated from consideration in this question on the basis of Rafinesque's descriptions. Confusion arises when it is realized that Rafinesque gave paired fin-ray counts that fit *Noturus gyrinus* precisely and not *flavus*. Further, he described the color as entirely of a rufous yellow (1818a, p. 41) or as entirely yellowish (1819, p. 422), a character that could be assumed to be more applicable to *gyrinus*. Other parts of the description, however, better fit the form known under Rafinesque's name. Characters that he listed which apply only to *flavus* as known and not to *gyrinus* are: the large size indicated (described simply as small in 1819, presumably in comparison with the larger ictalurids), the truncate tail, and the upper jaw longer. Although it is impossible to know whether he had some specimens of *gyrinus* mixed with *flavus*, or simply made errors in determining the fin formulas (his fin-ray counts for some other species of catfishes are inaccurate), it appears that the description better applies to the form long known as *Noturus flavus*, and that the name must be restricted to that species on the basis of the characters listed above. This viewpoint is confirmed by an examination of Rafinesque's unpublished drawing (notebook in the Smithsonian Institution) of *Noturus luteus* (= *Noturus flavus*), that illustrates a long, slender fish resembling either *Noturus insignis* or *Noturus flavus* but which on the basis of the described color could only be the form considered here as *Noturus flavus*.

Gill (1861a, pp. 45–46) named this species *Noturus occidentalis* on the basis of specimens from the Platte River, Nebraska, the identification of which is confirmed by his descriptions and figures (1876, pp. 423–424, pl. 8). I have been unable to locate any type-specimen of *Noturus occidentalis*.

Günther (1864, pp. 104–105) named the species anew, as confirmed by his figure of the "intermaxillary teeth," after receiving specimens of another species that he thought to be the *Noturus occidentalis* of Gill. Günther's two syntypes of *Noturus platycephalus* in the British Museum are labled "Old Collection"; his description indicates only the locality, "North America." They are typical of *N. flavus*.

Etymology.—The name *flavus* (Latin), yellow, was given in reference to the general yellow color of Ohio specimens.

Relationship.—The relationships of *Noturus flavus* and the other species of *Noturus* are intimate. *Noturus* is recognized as a monotypic subgenus closest to some of the elongate forms in the subgenus *Schilbeodes*, particularly *N. gilberti*, *N. insignis*, and *N. nocturnus*.

ECOLOGICAL CONSIDERATIONS.—It is generally recognized that the distribution of *flavus* is controlled by stream gradient (for example it is absent from southern Illinois, map 8); it prefers riffles or rapids of moderate or large streams which usually have many large loose rocks. It is also known to be common in Lake Erie and Saginaw Bay where there may be a minimum of current, but much wave action. In feeding, it may work into quiet water. Although it prefers large streams I have taken large *flavus* in the High Plains from loose submerged limestone rocks in the outlet of a spring that was no more than five feet wide and remote from any large stream. *Noturus flavus* has been taken in collections with *gyrinus*, *nocturnus*, *exilis*, *eleutherus*, *placidus*, *stigmosus*, and *miurus*.

The populations of *Noturus flavus*, particularly, are reduced in size or eliminated in sections of streams where large reservoirs have been constructed. Presumably this is because of loss of riffle habitat plus lowered water temperature. Although *flavus* is a relatively northern species of *Noturus*, it is very infrequently found in water cold enough to maintain salmonids.

Subgenus *Rabida* Jordan and Evermann

The subgenus *Rabida*, a very distinctive group, contains the species of *Noturus* with serrae (dentations) on both the anterior and the posterior edges of the pectoral spine (pl. 4). The anterior serrae are fine, numerous, and usually distinct in all but old specimens. Those of the posterior edge are large and distinctly curved; their tips, except the 1 to 3 basal serrae, are regularly turned toward the base of the spine. The pectoral spine may be short to very long and is usually curved backward, scimitar-like. The grooves of the spine are shallow to moderate in depth and short, mostly occupying the distal half of the spine.

Other characteristics of *Rabida* are: body relatively short and usually chunky; lower jaw included; anal fin with 12 to 19 rays; head relatively large; vertebrae 30 to 39, usually 31 to 37; normally 11 preoperculomandibular pores in most species, but 10 in *eleutherus* and *hildebrandi lautus;* 9 pelvic rays except 8 in the *hildebrandi* group; usually 8 soft pectoral rays but 9 in *albater* and *hildebrandi;* caudal rays relatively short to moderate in length, the branched rays (12 to 24, usually 15 to 19) commonly less numerous than in *Schilbeodes* or *Noturus;* usually 12 or 13 vertebrae anterior to the first pterygiophore of the anal fin; precaudal vertebrae variable, mostly 7 to 10; caudal vertebrae extremely variable in number; 5 to 8 ribs on each side; branchiostegal rays typically 9 or 10 on each side; the ossified pectoral radials usually fused, but some species, chiefly *Noturus stigmosus*, vary in the amount of union of the two elements; all species typically have one epural and 3+3 hypurals, with variable fusion in each set of hypurals. The skeleton is not well ossified, perhaps because of the small size attained. The premaxillary teeth (pl. 2, fig. 4) occupy a short rectangular area which is about 1.5 to 2.5 times as broad as long, with rounded to obtusely angulate posterior corners. All the species are mottled or covered with irregular dark blotches or saddles. In young or small specimens the adipose fin is distinctively translucent or clear. The background color of the body may be pinkish, yellowish, or brownish, becoming darker with age.

The included species have been uniformly listed as a unit in either the genus *Noturus*, or *Rabida*, or *Schilbeodes;* they have never been split into separate genera. However, when *Rabida* has been recognized, authors have tended to include in it one or more of the species in the subgenus *Schilbeodes* that have posterior serrations on the spine. *Schilbeodes* has thus been split unnaturally into two or more groups.

With the exception of one that is found in Atlantic coastal streams of North Carolina, the species are restricted to tributaries of the Gulf of Mexico or have invaded the lower Great Lakes after recession of the Wisconsin ice. Most species, except *Noturus miurus*, seem to require a considerable stream gradient and are found at or near riffles.

Noturus furiosus, the North Carolina representative, appears to be a segment of a once wide-ranging species which may have occurred in most preglacial rivers of eastern North America. *N. stigmosus* and *N. miurus* have crossed into the Great Lakes basin, probably by way of the Maumee outlet. *N. munitus* and *N. miurus* are perhaps recent invaders of Gulf tributaries lying to the east of the Mississippi River. Invasion of this area by *N. miurus* probably was a simple matter, because of its tendency to enter small and quiet waters. However, invasion by *N. munitus* (a river species) probably called for large quantities of flowing, fresh water such as a major shift in river drainage, overflow by an overburdened Mississippi River, or by a freshwater concentration in what is now the Gulf of Mexico adjacent to the mouths of the Mississippi and Mobile Rivers. Another possibility is that *munitus* has remained as a remnant of the former more widely distributed ancestor of the *furiosus* group.

With these exceptions the species are confined to the Ohio, the Tennessee, the lower Mississippi, and the Red River drainages. *N. miurus* has crossed over into the upper Kaskaskia River, Illinois; otherwise no member of the subgenus has entered the upper Mississippi or the Missouri River systems. The forms are especially characteristic of upland or high-gradient streams where as many as three or possibly four species may occur together.

The name *Rabida*, from *rabidus* (Latin), means mad, fierce, or furious.

Key to the Species of the Subgenus *Rabida*

1. Pelvic rays typically 8; posterior process of cleithrum (humeral process) shorter than diameter of pectoral spine shaft 2
   Pelvic rays typically 9; humeral process length variable, short or longer. 3
2. Soft pectoral rays 7 to 10, most frequently 9 but often 8; anal rays 12 to 17, usually 13 or more; preoperculomandibular pores normally 10 or 11; mouth inferior, lower jaw included . . . . **Noturus hildebrandi**
   Soft pectoral rays 7 or 8; anal rays 12 or 13; preoperculomandibular pores 11; mouth approximately subterminal, lower jaw only slightly included. **Noturus baileyi,** new species
3. Preoperculomandibular pores typically 10; adipose fin nearly separated from caudal fin and forming a free posterior flap; caudal rays 39 to 52, usually fewer than 49; blotch on adipose fin low, confined to its basal half; no midcaudal crescent of dark pigment; soft pectoral rays typically 8; humeral process intermediate, longer than width of pectoral spine shaft, but never longer than shaft plus serrae . . . . **Noturus eleutherus**
   Preoperculomandibular pores typically 11 4
4. Posterior process of cleithrum typically shorter than diameter of pectoral spine shaft, always shorter than shaft plus serrae; predorsal length stepped 1.4 to 2.1, usually more than 1.5 times in distance from dorsal origin to rear end of adipose fin; adipose and caudal fins moderately to broadly united, the adipose fin not developing a free posterior flap 5
   Posterior process of cleithrum (humeral process) typically longer than diameter of pectoral spine including its serrae; predorsal length stepped 1.1 to 1.6, usually 1.2 to 1.5 times in distance from origin of dorsal fin to rear end of adipose fin 7
5. Soft pectoral rays most frequently 9; a prominent broad dark bar at caudal peduncle base and distinct white areas usually on procurrent caudal rays; rear process of cleithrum very short or obscure; anterior dentations of pectoral spine poorly developed or nearly obscure; anal rays 13 to 16, usually 14 or 15 . . . . **Noturus albater,** new species
   Soft pectoral rays 8 but frequently 9; bar, if present, on caudal peduncle no more prominent than medial bands on caudal fin which is without large white areas; rear process of cleithrum present or obscure; anterior dentations of pectoral spine moderately or poorly developed 6
6. Posterior process of cleithrum present, acute, distinct; anal rays 14 to 19, usually 15 or more; vertebrae 34 to 37; dark saddles on back broad and prominent; pectoral fin pigmented only near base and about spine; adipose fin with a dark bar . . . . **Noturus elegans,** new species
   Cleithrum only roughened posteriorly, without a process; anal rays 13 to 16, usually 14; vertebrae 32 to 34; dark saddles on back narrow and not prominent; pectoral fin well pigmented; adipose fin yellowish, without a bar . . . . **Noturus trautmani,** new species
7. A midcaudal crescentic dark brown bar in addition to a dark brown submarginal caudal band; dorsal fin with a brown but never with a jet black blotch and caudal peduncle without a jet black bar; dark bar on adipose

fin not extending to the margin, or if to the margin the caudal rays are 52 or fewer (the *furiosus* species group) 8

A submarginal dark caudal band but no midcaudal crescentic bar, or if a bar is present, a more prominent dark bar crosses caudal peduncle; dark bar on adipose fin always extending to margin; dorsal fin with a distal black blotch (except *flavipinnis*); caudal rays 51, typically 53 or more (the *miurus* species group) 11

8. Adipose blotch dusky, entering only basal half of fin; caudal rays 50 to 59, usually 52 to 58; no distinctive, discrete, round, brownish chromatophores on abdomen; anterior serrae of pectoral spines poorly developed, or reduced and irregular. . . . . **Noturus placidus**, new species

Adipose blotch dark brown, entering upper half of fin in juveniles and adults; anterior serrae of pectoral spine prominent, sharp, and well developed . 9

9. Adipose blotch extending to fin margin; caudal rays 45 to 52, usually 46 to 50; vertebrae 30 to 33, usually 31 or 32; lower head, abdomen, and lower base of pelvic fins sprinkled with numerous small, rounded, discrete, brown chromatophores; head length stepped 2.7 to 3.3 times in standard length . . . . **Noturus munitus**

Adipose blotch not reaching fin margin; caudal rays 47 to 60, usually 49 to 58; vertebrae 31 to 36, usually 33 to 35; head length stepped 3.1 to 3.8 times in standard length 10

10. Caudal rays usually 49 to 53; only anterior part of abdomen with distinct, round, brownish chromatophores in smaller individuals, these often obscured in large individuals; a pair of large light spots, typically enclosed in dark saddle, just anterior to dorsal fin base. **Noturus stigmosus**, new species

Caudal rays usually 53 to 58; no distinctive round, brownish chromatophores on abdomen; dark saddle at dorsal fin nearly uniform anterior to dorsal fin base, without a pair of light spots . . . . **Noturus furiosus**

11. Anterior ends of infraorbital and supraorbital canals typically connected (1 internasal pore); a jet black blotch distally on first 3 or 4 dorsal rays; adipose and caudal fins moderately connected; basicaudal bar seldom prominent on caudal peduncle, usually confined to posterior edge of peduncle and base of caudal rays . . . . **Noturus miurus**

Anterior ends of infraorbital and supraorbital canals typically distinct (2 internasal pores); basicaudal bar extending rather broadly across caudal peduncle 12

12. Dorsal fin mostly yellowish, with faint brown pigment, without a prominent black blotch; adipose and caudal fins moderately connected; basicaudal brownish bar extending broadly across caudal peduncle where it widens into a blotch . . . . **Noturus flavipinnis**, new species

A jet black blotch distally on dorsal rays; adipose fin nearly free from caudal fin; basicaudal bar jet black, of subuniform width, broadly crossing caudal peduncle . . . . **Noturus flavater**, new species

The HILDEBRANDI Group

Noturus hildebrandi (Bailey and Taylor)

LEAST MADTOM

PLATES 4 (FIGS. 1–2), 10; MAP 9

DIAGNOSIS.—*Noturus* (*Rabida*) *hildebrandi* with typically eight pelvic rays, a short caudal fin, and reduced anterior serrae of the pectoral spine plus a very short posterior process of the cleithrum (humeral process) is associated with *Noturus baileyi* in the *hildebrandi* species group. Both are readily distinguished from other species of the subgenus *Rabida* by the presence of only eight pelvic rays. In contrast to *Noturus baileyi,* there are typically eight or nine, more often nine, instead of seven or eight soft pectoral rays, more anal rays (usually 13 to 15), and the lower jaw is definitely included instead of being almost subterminal. The internasal pores are typically two on each side but the preoperculomandibular pores, normally ten or eleven, vary geographically.

Description.—Counts and measurements are given in tables 17 to 26. Head depressed; lower jaw prominently included; lip rather thick; eye moderate, about 1.4 to 2.5 times in snout; posterior process of cleithrum very short or obscure, blunt to sharp pointed; pectoral spine small, relatively straight (pl. 4, figs. 1, 2); its anterior serrae small or obscure; its posterior serrae, except the proximal one or two, recurved toward the spine base; dorsal spine small and stiff; adipose fin of moderate height and length, without a free posterior flap, broadly connected with the rather short procurrent caudal rays; caudal fin truncate or with a slightly rounded posterior margin; posterior corners of premaxillary tooth patch obtuse. The largest specimen examined is one typical of the southern subspecies, from the Homochitto River, 53 mm. in standard length. Typical specimens of the northern subspecies reach 48 mm. in standard length.

The soft dorsal rays are five (in 4), six (156), or seven (2). The caudal fin has (extremes in parentheses): (14) 16 to 18 (20) upper simple rays; (13) 15 or 16 (17) branched rays of which (5) 7 (9) are in the upper half of the fin and (6) 8 or 9 (10) are in the lower half; and (11) 13 to 15 (17) lower simple rays. There are four to eight gill rakers on the first arch.

In six cleared and stained specimens, 12 (in 5) or 13 (1) vertebrae are anterior to the origin of the anal fin; the ossified pectoral radials are fused; and the six hypurals show variable fusion distally; hypurals 2–3 were fused in four specimens from the Homochitto drainage; hypurals 2–3 and 4–5 were fused in two from western Tennessee. The number of caudal vertebrae may also vary as follows: Homochitto drainage 25 (2), 26 (1), or 27 (1); western Tennessee 28 (2).

Relationship.—The characters listed in the diagnosis are regarded as indicating, at least tentatively, the relationship of *Noturus hildebrandi* and *Noturus baileyi* in the *hildebrandi* species group.

Discussion.—A study of the geographic distribution and characteristics of populations of *Noturus hildebrandi* has revealed a situation that appears to be unique among North American fishes. No other eastern North American fish is known that has its range confined to the relatively small eastern tributaries to the Mississippi River in Mississippi, Tennessee, and probably Kentucky.

Two rather uniform subspecies are recongized. They are most readily distinguished by color pattern and number of preoperculomandibular pores. An apparent change in a number of other characters from north to south points to a cline, but because of a prominent shift, in northern Mississippi and southwestern Tennessee, in pore counts and color pattern, with relative uniformity of populations elsewhere, subspecies are recognized.

The synonymy and discussion pertaining to the subspecies will be found with the descriptions of the two forms. The geographic variation of *Noturus hildebrandi* is discussed separately to facilitate comparison.

Geographic Variation.—No specimens are known from the Big Black River system, Mississippi, and, aside from the Coldwater River specimens, only five relatively small poor specimens are available from the Yazoo system. Otherwise samples are generally adequate to indicate variational trends.

No significant variation in the number of caudal rays, branched and simple caudal rays, dorsal rays, or internasal pores has been noted in any population.

Pelvic rays: The pelvic rays appear to be almost constantly eight in all populations. Very few counts of nine rays on one or both sides of a specimen were obtained; they appear randomly throughout the range.

The variation in vertebrae, preoperculomandibular pores, and anal rays is shown in tables 10 to 12. The preoperculomandibular pores in table 11 are the sum of the counts obtained from the two sides of each specimen.

In the following summaries the data presented include number of specimens, range (in parentheses), and mean for (a) Homochitto River system, (b) Bayou Pierre, (c) Yalobusha system, (d) Yocona system, (e) Tallahatchie system, (f) Coldwater River, (g) Loosahatchie River, (h) Hatchie system, (i) South Forked Deer system, and (j) Obion system.

Preoperculomandibular pores: (a) 129 (10–12) 10.87; (b) 50 (10–12) 10.84; (c) 2 (11) 11.00; (d) 2 (11) 11.00; (e) 6 (10–11) 10.67; (f) 18 (9–11) 9.67; (g) 4 (9–10) 9.50; (h) 48 (9–11) 10.06; (i) 4 (10) 10.00; (j) 58 (9–11) 9.84.

Upper-half caudal rays: (a) 65 (22–27) 24.11; (b) 25 (21–24) 23.04; (c) 1 (24) 24.00; (d) 1 (24) 24.00; (e) 3 (23–25) 24.00; (f) 9 (21–26) 23.56; (g) 2 (22–23) 22.50; (h) 25 (22–26) 24.00; (i) 2 (24–26) 25.00; (j) 29 (21–26) 23.76.

Lower-half caudal rays: (a) 65 (20–24) 22.03; (b) 25 (21–24) 22.40; (c) 1 (23) 23.00; (d) 1 (22) 22.00; (e) 3 (22–23) 22.33; (f) 9 (19–23)

21.22; (g) 2 (19–22) 20.50; (h) 25 (20–25) 22.20; (i) 2 (23–24) 23.50; (j) 29 (20–25) 22.52.

Total caudal rays: (a) 65 (44–51) 46.14; (b) 25 (43–48) 45.44; (c) 1 (47) 47.00; (d) 1 (46) 46.00; (e) 3 (46–47) 46.33; (f) 9 (40–48) 44.78; (g) 2 (41–45) 43.00; (h) 25 (43–50) 46.20; (i) 2 (47–50) 48.50; (j) 29 (42–50) 46.28.

Head length (expressed as thousandths of standard length): (a) 40 (281–333) 306.4; (b) 11 (268–305) 287.0; (c) 1 (279) 279.0; (d) 1 (305) 305.0; (e) 2 (279, 304) 291.5; (f) 9 (294–340) 309.1; (g) 2 (275, 293) 284.0; (h) 7 (260–277) 271.0; (i) 2 (264, 277) 270.5; (j) 28 (245–293) 264.2.

Soft pectoral rays: (a) 129 (8–10) 8.69; (b) 49 (8–9) 8.76; (c) 2 (8) 8.00; (d) 2 (9) 9.00; (e) 4 (9–10) 9.50; (f) 18 (8–9) 8.39; (g) 4 (8–9) 8.75; (h) 50 (8–10) 8.96; (i) 4 (8–9) 8.50; (j) 58 (7–9) 8.40.

Head length: Typical *hildebrandi* have a relatively large head and the populations from Tennessee have a smaller head. The variation in head size is irregular and difficult to evaluate since the head length appears to be slightly greater in relation to standard length in juveniles. The head lengths plotted against standard lengths (fig. 3) indicate a merging of individuals smaller than 30 mm. in standard length in all populations. Above this size, all specimens from Tennessee show no overlap with those from the Homochitto and Coldwater Rivers. Specimens from Bayou Pierre are somewhat intermediate with a few individuals falling within the plotted area of the Tennessee specimens. The specimen from the Yalobusha system falls within the area of the

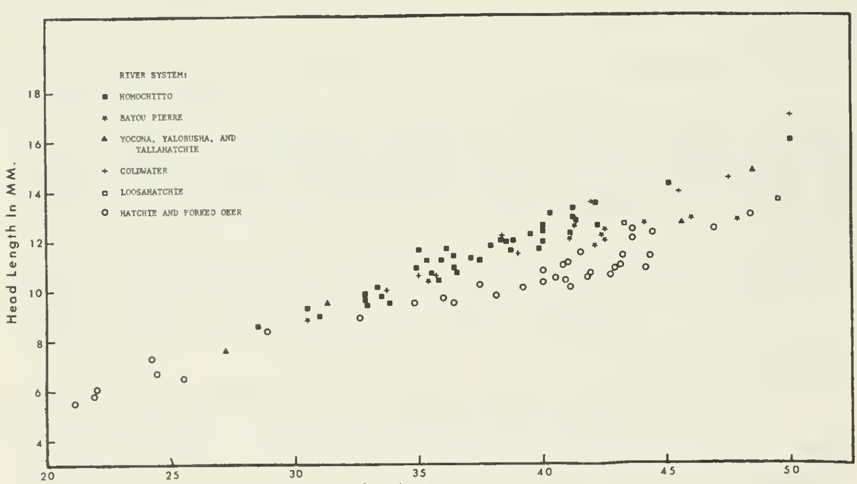


FIGURE 3.—Head length plotted against standard length, as a comparison of populations of *Noturus hildebrandi*.

Tennessee specimens; all others from the Yazoo are outside this range. Thus, aside from the Bayou Pierre specimens and one from the Yalobusha there is no overlap in head length plotted against standard length in larger individuals.

Color pattern: All Mississippi specimens have a pigmentation pattern on the body and head generally similar to the typical *hildebrandi* in the Homochitto system. It consists of prominent dorsal saddles, and extension of the pigment to the lower side of the body. In the Homochitto and Bayou Pierre specimens a blotch or bar extends well into the adipose fin, usually to the margin in larger individuals. In Tennessee specimens, the blotches or saddles are not prominent; the adipose fin is yellowish without a blotch but often with small, scattered chromatophores; heavy pigment is confined to the very base of the fin. Also in Tennessee specimens the lower side of the body is immaculate or with a few large, scattered chromatophores. Specimens from the Loosahatchie River and, less so in the Hatchie system, show more pigment on the lower side than do specimens from the Forked Deer system, yet they are very similar in color pattern to those from the Forked Deer system. The Shones Lake specimen is small with little pigment ventrolaterally and a short blotch extending into the otherwise clear adipose fin. Specimens from the Coldwater River, Mississippi, strongly resemble those from the Homochitto system in boldness of the blotching and darkness of pigmentation, but the lower side is not as well pigmented; the adipose fin is yellowish without a blotch except two individuals have a very low intrusion of pigment into the fin. The other four specimens from the Yazoo have a body pattern resembling typical *hildebrandi* but there is little pigment in the adipose fin except in the Yalobusha specimen which has a short blotch.

Intergrades.—The following material is regarded as intermediate between *Noturus hildebrandi hildebrandi* and *Noturus hildebrandi lautus*.

UNITED STATES: Mississippi: Yazoo River system: USNM 175392 (1 specimen, 48 mm. standard length), creek, 1 mi. S. Coffeeville, Yalobusha Co. USNM 175393 (1, 50), Pumpkin Cr., 6 mi. SE. Oxford, old Hwy. 6, Lafayette Co. USNM 175394 (1, 30) and University of Mississippi (1, 46), trib., Puss Cuss Cr., 12 mi. NE. Oxford, just N. Hwy. 30, Lafayette Co. USNM 175395 (1, 33), Shones Lake (Snow Cr.), E. Holly Springs or about 4 mi. W. Ashland, Hwy. 4, Benton Co. CU 42162 (9, 34–50), Coldwater R., U.S. Hwy. 78, 5.5 mi. SE. Olive Branch, DeSoto Co. Tennessee: Loosahatchie River system: USNM 197399 (1, 49) and USNM 193476 (1, 43), Loosahatchie R., Hwy. 76, due N. Somerville, Fayette Co.

The short, heavy bodied specimens from the Coldwater River in extreme northern Mississippi are most intermediate with preoperculomandibular pore counts of *lautus* but head lengths agreeing with *hildebrandi*. The numbers of vertebrae and anal rays are also suggestive of *hildebrandi* but the color pattern includes some characters of both forms. The two slender bodied specimens from the Loosahatchie River, Tennessee, tend strongly toward typical *lautus* in most characters but are considered intermediate because of the presence of a short blotch on the adipose fin and considerable extension of pigment onto the lower side. The remaining five specimens from the Yazoo system, Mississippi, are relatively short bodied with head lengths, pore counts, and pigmentation patterns intermediate or tending strongly toward *hildebrandi* but the anal ray count is relatively high as in *lautus*. Thus, aside from the Coldwater River specimens, the characters of the few known individuals from the Loosahatchie and Yazoo systems rather closely approach those of the adjacent subspecies.

Noturus hildebrandi hildebrandi (Bailey and Taylor)

Plates 4 (fig. 1), 10 (fig. 1); Map 9

Schilbeodes hildebrandi Bailey and Taylor, 1950, pp. 31–38, pls. 1–2, figs. E–F (original description; Brushy Cr., Amite Co., Miss.; ecology).—Cook, 1953, pp. 192, 195 (Mississippi).—G. A. Moore, 1957, pp. 143, 145, figs. 2–79C, 2–81 (description; range).

Noturus hildebrandi (Bailey and Taylor).—Eddy, 1957, p. 154 (key; range).—Taylor, 1957, p. 192.—Cook, 1959, pp. 34, 37, 135, 143, figs. 25A–B (description; Mississippi records).—Suttkus, 1961, p. 63, fig. 5 (comparison; skull illustrated).—Suttkus and Taylor, 1965, pp. 171, 175 (comparison).—Raney and Suttkus, 1966, p. 101 (associations with *Etheostoma rubrum*, Bayou Pierre, Miss.).

Type-specimens.—UMMZ 157620 (holotype), UMMZ 155338 (21 paratopotypes), and USNM 112066 (4 paratopotypes), collected from Brushy Creek, 1 mi. above its mouth in Homochitto River, at village of Homochitto, 4 mi. NE. of Coles, sec. 14, T. 4 N., R. 2 E., Amite Co., Mississippi, April 1, 1948, by Reeve M. and Marian K. Bailey.

Other material studied

UNITED STATES: Mississippi: Homochitto River system: USNM 172031 (16 specimens, 29–45 mm. standard length), Brushy Cr., Homochitto, Amite Co. TU 2915 (13, 29–51), TU 11990 (4, 41–45), TU 19774 (7, 40–52), TU 19846 (2, 46–49), trib., Homochitto R., Lucien, U.S. Hwy. 84, Franklin Co. TU 19995 (1, 28), Homochitto R., 3.6 mi. SE. Meadville, Hwy. 98, Franklin Co. TU 23897 (23, 31–49), Homochitto R., 4.9 mi. E. Union Church, Hwy. 550, Lincoln Co. TU 23961 (14, 39–53), Homochitto R., 0.4 mi. E. Lucien, U.S. Hwy. 84, Franklin Co. Bayou Pierre system: USNM 200380 (11, 31–47), Bayou Pierre, about 5 mi. SW. Utica Institute, Hwy. 18, Copiah Co. FSU 9226 (6, 23–28), Bakers Cr., 2.2 mi. SE. Port Gibson, Hwy. 547, Claiborne Co. FSU 9265 (8, 22–40), Bayou Pierre, 8.7 mi. SW. Utica, Hwy. 18, Copiah Co.

Diagnosis.—*Noturus hildebrandi hildebrandi* differs prominently from *Noturus hildebrandi lautus* in having a larger head stepped 3.0 to 3.7, usually 3.1 to 3.5 times in standard length; modally eleven preoperculomandibular pores; and a prominently blotched color pattern with the pigment extending across the lower side of the body almost to the ventral surface.

Description.—Typical specimens are short and chunky, the abdominal region and head being relatively large and heavy. In contrast to *lautus* the caudal region may be short (note the 25 to 27 caudal vertebrae in cleared and stained specimens) and the numbers of vertebrae and anal rays average fewer (tables 10 and 12).

General background coloration yellowish or straw color; side and dorsal surface with dark brown chromatophores forming rather prominent saddle-like blotches, alternating with lighter obovate areas on the back and upper side; midside of body rather densely pigmented; pigment on lower sides slightly lighter and less dense or lower side strongly variegated; first dorsal saddle beginning just before the dorsal fin and extending backward to the third dorsal ray; a second, about as long, lies midway between the dorsal and adipose fins; a third slightly longer, at the middle of the adipose fin extends variably, usually to the margin in adults, onto that fin, which is otherwise nearly immaculate; an irregular bar crosses the upper and lower procurrent rays and the rear portion of the caudal peduncle.

Caudal fin dusky, without obvious light areas except rear margin; submarginal dark brown caudal band broad, becoming diffuse anteriorly; also present, a short medial, narrow vertical crescent of dark brown pigment or intermediate band; soft dorsal fin immaculate except a few scattered chromatophores distally and dark brown basally; membrane over dorsal spine heavily pigmented, the heavy dark brown pigment extending from near the spine tip diagonally downward to the base of the third soft ray; bases of rear dorsal rays with little pigment. A few irregularly placed chromatophores distally on longer anal rays and scattered over the pectoral fin, usually on the longer rays, but covering the pectoral spine; pelvic fins immaculate; undersurface of head (except lightly pigmented area in front of barbels), abdomen, and inner mental barbels unpigmented; outer mental barbels sometimes with a few brown chromatophores; upper barbels with dense dark brown pigment; top of head dark brown; a dark bar crosses the back of the head, extending onto the operculum and upper branchiostegal membrane; another, below the eye, extends forward to the nares; a light area behind the eye has fine chromatophores; the cheek has relatively little pigment.

Type.—The holotype, UMMZ 157620, a female, is 41.3 mm. in standard length. It has 13 anal rays, 17+7+9+12=45 caudal rays, and 6 soft dorsal rays. On each side there are eight pelvic rays, nine soft pectoral rays, five serrae on the posterior edge of the pectoral spine, two internasal pores, eleven preoperculomandibular pores, and six gill rakers. The head length is stepped into the standard length 3.25 times and the distance from the adipose notch to the tip of the caudal fin is stepped into the distance from the dorsal origin to the adipose notch 1.8 times. Table 28 gives further measurements.

Etymology.—This subspecies was named *hildebrandi* in honor of the late Dr. Samuel F. Hildebrand, an outstanding American ichthyologist.

Distribution.—*Noturus h. hildebrandi* ranges from the Homochitto River system northward in Mississippi. It intergrades with *Noturus hildebrandi lautus* in northern Mississippi and southwestern Tennessee. The populations in the Homochitto and Bayou Pierre are relatively uniform and are regarded as typical. Intergrades from the Yazoo drainage in northern Mississippi vary toward *Noturus hildebrandi lautus*, but those from the southern portion of the system closely approach typical *hildebrandi* morphologically.

Ecology.—In southern Mississippi *Noturus hildebrandi hildebrandi* is typically found in relatively shallow, clear, gravelly or small pebble-bottomed riffles with moderate to swift current. It has been collected frequently with *Noturus miurus*.

Noturus hildebrandi lautus, new subspecies

Plates 4 (fig. 2), 10 (fig. 2); Map 9

Types.—USNM 201665 (holotype), USNM 193470 (16) and UMMZ 187093 (4) (totaling 20 paratopotypes, 36–47 mm. standard length), collected from North Fork of Obion River, at Tennessee Highway 69, Henry County, Tennessee, July 27, 1954, by C. E. Ruhr and party.

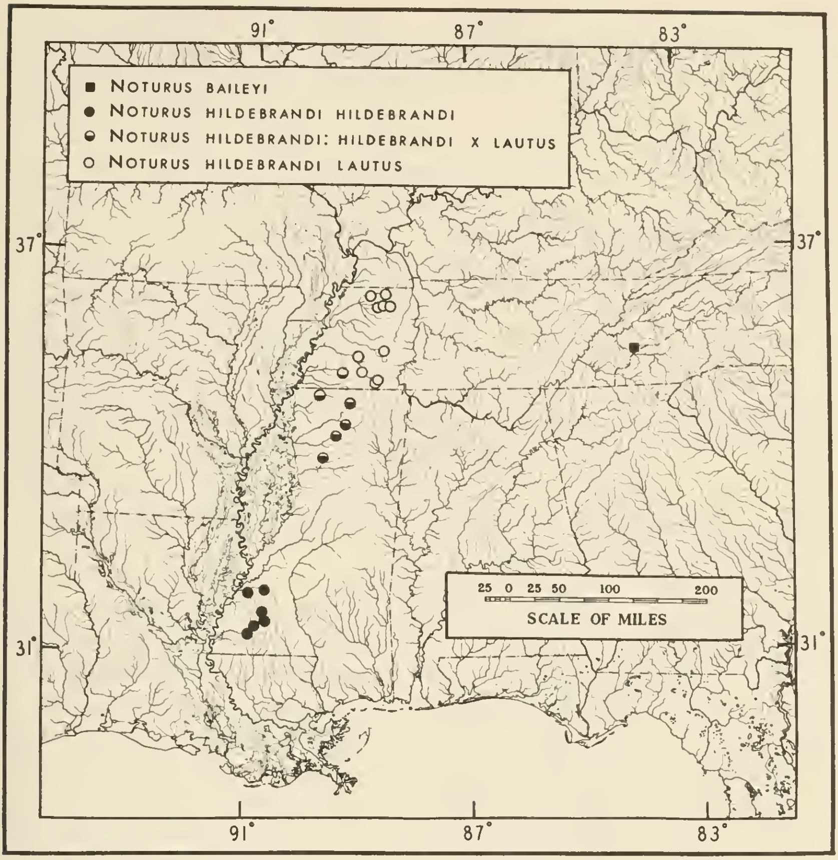
Other paratypes

UNITED STATES: Tennessee: Forked Deer River system; Obion drainage: USNM 197395 (4, 24–44), North Fork Obion R., Campground Levee Crossing, Weakley Co., September 15, 1954, C. E. Farrell. USNM 197402 (2) and UMMZ 187092 (2) (totaling 4, 35–48), Middle Fork Obion R., Hwy. 6, Gleason Crossing, Weakley Co., September 16, 1954, C. E. Farrell. KU 9751 (2), Middle Fork Obion R., 4.5 mi. W., 1 mi. S. Paris, Henry Co., April 5, 1965, F. B. Cross. KU 10036 (3), Middle Fork Obion R., Hwy. 22, Weakley Co., September 7, 1964, Cross.

Other material studied

UNITED STATES: Tennessee: Hatchie River system: USNM 190746 (18, 18–44), Moss Cr., on Rose Creek Road, 1.3 mi. N. Hwy. 57 or about 2.5 mi. ENE. Pocahontas, McNairy Co. USNM 190775 (6, 15–42), Spring Cr., 1.2 mi. S. Bolivar, Hwy. 125, Hardeman Co. USNM 193464 (1, 40), Moss Cr., about 4 mi. W. Selmer, McNairy Co. Vanderbilt U (1, 32), Big Black Cr., Madison Co. South Forked Deer River system: USNM 193479 (2, 42–44), Deer Cr., Huron, Henderson Co.

Diagnosis.—*Noturus hildebrandi lautus* differs from *Noturus hildebrandi hildebrandi* in having a relatively short head stepped 3.4 to 4.1, usually 3.6 to 3.9 times in standard length; modally ten preoper-



Map 9.—Distribution of members of the *hildebrandi* species group of the subgenus *Rabida*. The symbols represent material examined.

culomandibular pores; and the lower side of the body is cream colored, with little pigment.

Description.—Although the head of *lautus* is proportionately short, the body is relatively elongate and slender. The elongation seems to be caudad, as noted in the presence of 28 caudal vertebrae in two cleared specimens, and is reflected in the slight increase in number of anal rays and vertebrae (tables 10 and 12).

General background color yellowish with reddish brown superimposed. Blotches or saddles on back often not prominent, separated by rounded lighter areas; midside of body, down to approximately the axial streak, densely reddish brown; lower side at or from just below axial streak rather abruptly yellowish with only scattered or no brown pigment except a small area just behind pectoral fin and at rear end of caudal peduncle. The general location of the dorsal saddles

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and the distribution of pigment in the dorsal fin of *hildebrandi* and *lautus* are similar, except that the saddle-like blotch below the adipose fin does not enter that fin in *lautus*; the adipose fin is yellowish and immaculate or sometimes with small brown chromatophores scattered throughout; bar at rear end of caudal peduncle similar in shape to that of *hildebrandi* but ending near bases of the upper and lower procurrent caudal rays—these rays mostly immaculate distally; caudal fin yellowish with one or two narrow, short, brown bars distally and a wider brown bar near base; much of the upper and lower portions of the fin often immaculate; anal fin immaculate or with a few chromatophores distally on posterior long rays; pelvic fins, lower barbels, abdomen, and lower surface of head immaculate; pectoral spine brown with some pigment on adjacent soft rays; head dark reddish brown above with a bar across its rear end to the lower margin of the opercle; a similar band extending forward from beneath the eye to the nares; a small round yellowish spot usually present behind the eye; cheek yellowish; upper barbels heavily pigmented.

Holotype.—The holotype (pl. 10, fig. 2) is a female, 40.3 mm. in standard length. It has 15 anal rays, 16+7+8+15=46 caudal rays, and 6 soft dorsal rays. The left pectoral fin has eight soft rays and the right has nine including a tiny basal splint. On each side there are eight pelvic rays, ten preoperculomandibular pores, two internasal pores, and seven recurved serrae on the posterior edge of the pectoral spine. The anterior edge of the pectoral spine is roughened; the serrae are greatly reduced in size and indistinct. The head length is projected into the standard length 3.8 times, and the distance from the rear end of the adipose fin to the tip of the caudal fin into the distance from the dorsal origin to the rear end of the adipose fin 2.0 times. Further measurements are given in table 28.

Distribution.—*Noturus hildebrandi lautus* is known only from western Tennessee but it may range into southwestern Kentucky and into northern Mississippi in the Hatchie River system. It intergrades with *Noturus hildebrandi hildebrandi* in southwestern Tennessee and northern Mississippi.

Etymology.—The name *lautus* (Latin) meaning washed or clean and neat refers to the trim, neat, and pleasing color pattern of this subspecies.

Ecology.—In the Obion River, Tennessee, *lautus* was taken in water 12 to 18 inches deep, over a bottom of shifting sand with some gravel up to one inch in diameter. In the Hatchie system it lives in highly turbid, but perhaps seasonally clear, moderately deep streams with slow to moderate current. Where collected in this system little riffle habitat was available; the bottom consisted of shifting sand and debris with occasional gravel or of mud, sand, and silt with considerable debris such as sunken logs and brush. It has been collected frequently with *Noturus phaeus* and *Noturus miurus*, and sometimes with *Noturus stigmosus*.

Noturus baileyi, new species

SMOKY MADTOM

PLATES 4 (FIG. 3), 11 (FIG. 1); MAP 9

Schilbeodes miurus (Jordan) [misidentification].—Lennon and Parker, 1959, pp. 3, 15 (lower Abrams Cr., Great Smoky Mountains National Park by poisoning, June 6 to 9, 1957; used in toxicity test).

Noturus miurus Jordan [misidentification].—Lennon, 1962, p. 6 (rare, Abrams Cr.).

TYPE-SPECIMENS.—USNM 201602 (holotype), USNM 201601 (3 paratopotypes), and UMMZ 187096 (1 paratopotype), collected from the lower portion of Abrams Creek, Great Smoky Mountains National Park, June 8, 1957, by Eugene W. Whitney and party.

DIAGNOSIS.—*Noturus* (*Rabida*) *baileyi* is a member of the *hildebrandi* species group, which is characterized by typically eight pelvic rays, a short caudal fin, short to almost obscure anterior serrae of the pectoral spine, and a very short posterior process of the cleithrum (humeral process). The color pattern of *baileyi*, in preservation, is somber, more so than in any other species of *Rabida*. The back and side of the head and body are almost uniformly pigmented, without blotching and the dorsal saddles are small. Like the typical southern subspecies of *Noturus hildebrandi* there are 11 preoperculomandibular pores and the head is large but generally unlike *hildebrandi*, the anal fin is very short with 12 or 13 rays and there are only 7 or 8, modally 8, soft pectoral rays.

DESCRIPTION.—Counts and measurements are given in tables 17 to 23 and 25 to 26. Head relatively large, rounded above, only slightly deeper than caudal peduncle; greatest body depth beneath dorsal fin; caudal peduncle tapering slightly posteriorly, not prominently constricted; mouth subterminal, with lower jaw only slightly included, less so than in any other species of *Rabida;* eye moderate, 1.8 to 2.1 times in snout; pectoral spine only slightly curved, relatively straight for a *Rabida;* anterior serrae fine, numerous; posterior serrae moderately large, recurved toward spine base, four or five in all specimens; dorsal spine stout, relatively short, about 2/5 length of longest dorsal ray; posterior process of cleithrum short, acute, its length less than half diameter of pectoral spine shaft; premaxillary teeth in a small rectangular cross band with posterior corners smoothly rounded; adipose fin higher than the short anterior upper procurrent caudal rays, without a notch between them; caudal fin of moderate length, nearly truncate posteriorly; barbels all very short.

The soft dorsal rays are six in all specimens. The caudal fins of these specimens all have 15 branched rays with 7 rays in the upper half and 8 in the lower half. The upper simple caudal rays are 16 (in 3), 17 (1), or 18 (1) and the lower simple caudal rays are 13 (3) or 14 (2). The following branchiostegal counts from the right side of specimens were made without staining or dissection of the elements and thus may be low: 9 (in 1) or 10 (2); the gill rakers on the first arch range from 5 to 8; as judged from x-rays the 6 hypurals are variably fused or lack fusion distally. The individuals range from 42.7 to 49.4 mm. in standard length.

The specimens are all of a medium brown color (perhaps faded) and without prominent saddles or blotches but moderate blotches as follows: top of head along midline and an area bounded by the posterior margins of the eyes and anterior nares darker brown; a narrow dark saddle, about as wide as eye length, extending from just anterior to dorsal spine back to the third or fourth dorsal ray; another about as wide, but lighter, extends from the dorsal fin to the adipose fin; and a very narrow dark saddle at the base of the adipose fin projects as a faint dark area into the adipose fin, perhaps to the margin; faint yellowish areas on back at rear base of dorsal fin, and at both the anterior and posterior bases of the adipose fin. Body and head otherwise appearing medium brown, lower surfaces lighter. The medium brown effect resulting from numerous rather large brown chromatophores over a yellowish background; large prominent dark brown or black chromatophores scattered on side of head and cheek; abdomen, lower head, and pelvic fins yellowish, immaculate. Faint brown pigment on rays, at least distally, of dorsal fin, anal fin, and upper side of pectoral fins; dorsal and pectoral spines and dorsal rays, near base, rather heavily pigmented; caudal fin almost uniform light brownish, or perhaps with a slight darkening near ends of rays; aside from the faint blotch, adipose fin yellowish; lower barbels immaculate; upper barbels, brownish.

Type.—The holotype (pl. 11, fig. 1), USNM 201602, is a male 45.8 mm. in standard length. It has 6 soft dorsal rays, $4+9=13$ anal rays, and $18+7+8+14=47$ caudal rays. On each side there are eight pelvic rays, eight soft pectoral rays, one internasal pore (abnormal), and eleven preoperculomandibular pores. The head length is stepped into the standard length 3.45 times and the distance from the rear end of the adipose fin to the tip of the caudal fin is stepped into the distance from the dorsal origin to the rear end of the adipose fin 2.0 times. There are four posterior serrae on the left pectoral spine and five on the right. Measurements are given in table 28.

Distribution.—*Noturus baileyi* (map 9) is known only from Abrams Creek, Great Smoky Mountains National Park, a tributary to the Little Tennessee River, Tennessee.

Relationship.—*Noturus baileyi* and *Noturus hildebrandi* are tentatively associated in the *hildebrandi* species group because of their similar numbers of pelvic and caudal rays as well as the general reduction of anterior serrae of the pectoral spine and the reduced posterior process of the cleithrum in both.

Etymology.—*Noturus baileyi* is named in honor of Dr. Reeve M. Bailey, under whom this study was made.

Ecology.—The lower section of Abrams Creek is a stream of 14.6 miles, between the Little Tennessee River and a 25 foot waterfall. Approximately 2.5 miles of the lower part of this stream are now part of Chilhowee Lake, created by construction of a dam on the Little Tennessee River at Chilhowee, Tennessee. The specimens were collected during a reclamation of Abrams Creek, to increase its sport fishery, prior to closure of the dam at Chilhowee. The locality of capture is not now known but would appear to be above the area of present impoundment if the date of capture, June 8, 1957, is correct. Although the reclamation eliminated the fish fauna (Lennon and Parker, 1959) from lower Abrams Creek, subsequent collecting indicates that many of the fish species, reported by them, have returned but no species of Ictaluridae have been taken.

The middle section of lower Abrams Creek consists of alternating series of long pools and moderate riffles. The current is moderate in the pools to swift on the riffles. The bottom consists mostly of various size rocks, varying from pea gravel to boulders. Lennon and Parker (1959, p. 12) gave further data regarding Abrams Creek: "The stream below Abrams Falls is characterized by short cascades and very long, deep pools. Most of it cannot be waded . . . . At the campground, the stream averages 63 feet in width at the normal discharge rate of 90 cfs. The gradient is approximately 44 feet per mile. The water is clear, slightly brown, and soft." *Noturus baileyi* was collected with *Noturus flavus*.

Remarks.—A possible source of future confusion concerning the origin of the specimens of *Noturus baileyi* requires comment. The lot of mixed specimens containing the *Noturus baileyi*, when received at the U.S. National Museum, included three other species of *Noturus*: *N. exilis* (USNM 201603, 1 specimen), *N. flavus* (USNM 201604, 7 specimens), and *N. elegans* (USNM 201600, 4 specimens). The published list of species collected in the Abrams Creek survey included only *Noturus flavus* and *Noturus miurus*. The specimens of *Noturus baileyi*, although not prominently marked with a bold pattern, as is typical *N. miurus*, are thought to be the basis of the listing of *miurus*.

The specimens of *N. exilis* and *N. elegans* are regarded as incorrectly included in the fauna of Abrams Creek for the following reasons: (1) The specimens of *N. elegans* and *N. exilis* are similarly preserved and those of *N. baileyi* and *N. flavus* have another preservation, indicating that the *elegans* and *exilis* were not fixed with the *flavus* and *baileyi*. All were evidently mixed at a later time. (2) *N. elegans* is known to occur in the Green River system, Kentucky and the Duck River system, Tennessee. The Duck River population is boldly marked, much more so than any examined from the Green system. The specimens in question, of *N. elegans*, USNM 201600 (pl. 12, fig. 2), are identical in color pattern and general morphology to others from the Duck system. (3) *N. exilis* is known to have been collected with *N. elegans* in the Duck system, and is fairly common in the lower Tennessee drainage, ranging upstream as far as Alabama. Both *exilis* and typical *elegans* are unknown from the upper Tennessee drainage.

Thus, the available evidence points to the specimens of *N. flavus* and *N. baileyi* having been collected from Abrams Creek, in the upper Tennessee drainage and suggests that those of *N. exilis* and *N. elegans* were collected in the lower Tennessee drainage, probably in the Duck River system.

***Noturus albater*, new species**

OZARK MADTOM

Frontispiece; Plates 4 (fig. 4), 11 (fig. 2); Map 10

Noturus nocturnus Jordan and Gilbert [misidentifications].—Meek, 1893, p. 229 (Arkansas records, in part: Spring R., Black Rock;* Middle Fork White R., Fayetteville;* White R., Oxford Bend); 1894a, pp. 75, 92 (Spring R., Black Rock,* Ark.).

Noturus miurus Jordan [misidentifications].—Meek, 1894a, pp. 75, 92 (description; Arkansas records: Middle Fork White R.* and Main Fork White R.,* Fayetteville; White R., Oxford Bend).

Schilbeodes miurus (Jordan) [misidentification].—Hubbs and Ortenburger, 1929, pp. 96–97 (reference to previous Arkansas records, in part).

Type-specimens.—UMMZ 151171 (holotype) and UMMZ 167236 (1 paratopotype), from the White River, at Forsyth, on Hwy. M80, Taney Co., Missouri, collected August 4, 1940, by G. V. Harry and Mitro Pellock.

Other paratypes.—The number of specimens, in parentheses, follows the museum number.

UNITED STATES: Arkansas: Middle Fork White R., N. of Carter, Washington Co., UMMZ 128311 (37), July 15, 1939, J. D. Black and Henry Mills. Buffalo R., 5 mi. SE. Saint Joe, U.S. Hwy. 65, 2.5 mi. above Gilbert, Searcy Co., UMMZ 169910 (1), August 17, 1940, R. M. Bailey and M. E. Davis. Little Red R., U.S. Hwy. 65, 1.5 mi. SE. Leslie, Searcy Co., UMMZ 169928 (2), August 17, 1940, Bailey and Davis. West Fork of White R., 4 mi. S. West Fork, Washington Co., UMMZ 170900 (3), September 14, 1940, Bailey and Davis. White R., Fayetteville, CNHM 1623 (4), S. E. Meek. Main Fork White R.,

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*Material indicated by an asterisk has been re-examined.

Fayetteville, USNM 59132 (5), Meek. Spring R., Black Rock, USNM 73569 (3), ANSP 81482 (1), and SU 1170 (3), Meek. Middle Fork White R., Fayetteville, USNM 116375 (32), 1893, Meek. Big Buffalo R., Hwy. 21, 15.8 mi. W. Jasper, Newton Co., TU 10180 (1), April 30, 1955, R. D. Suttkus and party. West Fork White R., U.S. Hwy. 71, 6.1 mi. S. Fayetteville, Washington Co., TU 12240 (15), September 2, 1955, Suttkus. White R., Hwy. 68, 8 mi. E. Springdale, Washington Co., TU 12258 (85), September 3, 1955, Suttkus; TU 16553 (35), October 4, 1957, Suttkus; TU 16575 (12), October 5, 1957, Suttkus. War Eagle Cr., Hwy. 23, 5.4 mi. N. Huntsville, Madison Co., TU 22401 (7), October 25, 1959, Suttkus and party. Buffalo Fork White R., Hwy. 74, 15.5 mi. W. of Jasper, Newton Co., TU 22504 (37) and TU 22514 (2), October 25, 1959, Suttkus and party. Devils Fork Little Red R., between Stark and Edgemont, Cleburne Co., TU 22709 (9), October 23, 1959, Suttkus and party. West Fork White R., U.S. Hwy. 71, 1 mi. S. Greenland, Washington Co., KU 4542 (4), April 26, 1959, D. A. Distler, C. F. Cole, and A. L. Metcalf. Richland Cr., Hwy. 45, at Goshen, Washington Co., KU 6311 (1), April 22, 1961, F. B. Cross and B. A. Simco. West Fork White R., at West Fork, Washington Co., KU 6338 (2), April 23, 1961, Distler. Big Cr., Hwy. 14, Searcy Co., KU 6615 (1), September 2, 1960, Distler and W. N. Berg. Middle Fork Little Red R., U.S. Hwy. 65, S. of Leslie, Searcy Co., KU 6625 (3), September 2, 1960, Distler and Berg. Kings R., Hwy. 74, 2 mi. W. Kingston, Madison Co., KU 6674 (3), September 3, 1960, Distler and Berg. Buffalo R., Buffalo River State Park, Marion Co., KU 8020 (2), April 4, 1964, Cross; KU 9866 (6), April 7, 1965, Cross. West Fork White R., U.S. Hwy. 71, 5 mi. S. Fayetteville, Washington Co., CU 34246 (1), August 19, 1959, R. J., R. V., and J. J. Miller. West Fork White R., U.S. Hwy. 71, 1 mi. S. Greenland, Washington Co., CU 35390 (24), April 11, 1959, C. F. Cole. War Eagle Cr., ford, 5 mi. NNW. Huntsville, Madison Co., CU 35633 (1), October 9, 1958, Cole, C. Cleland, and J. Preston. Trib. of East Fork White R., 2.9 mi. NW. Combs, Madison Co., CU 35803 (2), October 10, 1958, Cole, Cleland, and Preston. Richland Cr., Hwy. 45, 10 mi. E. Fayetteville, Washington Co., CU 36427 (1), September 16, 1958, Duane Rorie and Cole. Bear Cr., U.S. Hwy. 65, 6.0 mi. W. Marshall, Searcy Co., CU 36547 (1), April 7, 1958, Cole and S. L. Finkelstein. West Fork White R., Greenland, Washington Co., CU 37441 (9), March 29, 1961, L. W. Knapp and party. Devils Fork Red R., 1.9 mi. N. jct. county road and Hwy. 92, Cleburne Co., CU 41964 (6), April 26, 1962, Knapp and Miller. Fayetteville, BMNH 98.12.29.178 (1), Meek. MISSOURI: James R., 1 mi. S. Galloway, U.S. Hwy. 65, Greene Co., UMMZ 102781–2 (2), August 22, 1930, E. P. Creaser and E. B. Williamson. Big Brushy Cr. and Middle Fork Black R., near Black, sec. 27, T. 33 N., R. 1 E., Reynolds Co., UMMZ 139531 (1), July 2, 1941, Aden C. Bauman. Black R. and mouth of Markham Spring Cr., Hwy. A, near Williamsville, sec. 23, T. 27 N., R. 4 E., Wayne Co., UMMZ 139690 (2), August 15, 1941, Bauman. Finley Cr. of James R., UMMZ 142217 (1), July 14, 1942, Missouri Conservation Dept. Finley Cr. of James R., at Hawkins Bridge, UMMZ 142274 (1), July 17, 1942, Mo. Cons. Dep. Flat Cr. of James R., Barry Co., UMMZ 142303 (1), July 13, 1942, Mo. Cons. Dep. James R., 7.5 mi. E. Springfield, Greene Co., UMMZ 150996 (1), August 1, 1940, G. V. Harry and Mitro Pellock. Beaver Cr., Hwy. M125, Bradleyville, Taney Co., UMMZ 151086 (7), August 2, 1940, Harry and Pellock. Beaver Cr., Hwy. M80, Kissee Mills, Taney Co., UMMZ 151126 (2), August 3, 1940, Harry and Pellock. James R., Hwy. M13, Galena, Stone Co., UMMZ 151287 (6), August 6, 1940, Harry and Pellock. White R., Hwy. M86, 3 mi. S. of Shell Knob, Barry Co., UMMZ 151345 (4), August 7, 1940, Harry and Pellock. Flat Cr., 0.5 mi. S. McDowell, Barry Co., UMMZ 151407 (2), August 8, 1940, Harry and Pellock. James R., County Road

A, 6 mi. S. Marshfield, Webster Co., UMMZ 152013 (3), August 20, 1940, Harry and Pellock. Jacks Fork Current R., Alley Spring State Park, Shannon Co., UMMZ 164823 (1), April 27, 1946, Stanton Hudson. James R., 1 mi. S. Galloway, Greene Co., UMMZ 167170 (13), June 29, 1931, John Delavan and Creaser. Current R. and Spring Br., Blue Spring, near Eminence, Shannon Co., UMMZ (no. C41–16) (1), June 27, 1941, C. B. Obrecht. Current R., at Cave Spring, near Hunter, Carter Co., UMMZ (no. C41–21) (1), July 31, 1941, Obrecht. Eleven Point R., Turner Mill Spring, Oregon Co., UMMZ (no. C41–41) (2), August 25, 1941, Obrecht. Marble Cr., near French Mills, Madison Co., UMMZ (no. CC21) (1), October 12, 1933, Creaser and W. Clanton. Eleven Point R., sec. 11–12, T. 24 N., R. 3 W., 1 mi. below Turners Mill, UMMZ (no. 3) (1), June 20, 1938, A. Hugh Denny. Current R., sec. 5, T. 23 N., R. 2 E., UMMZ (no. 20) (1), July 27, 1938, Denny. Black R., Lesterville, Reynolds Co., INHS (uncataloged) (3), October 12–15, 1948, Lowry. Current R., Hwy. 14, 0.7 mi. W. Doniphan, Ripley Co., CU 24243 (2), August 13, 1953, C. R. Robins and W. S. Woolcott. Eleven Point R., Hwy. 14, 25.4 mi. W. Current R., Oregon Co., CU 24266 (5) and CU 24267 (15), August 13, 1953, Robins and Woolcott. Little Black R., Hwy. 14, 2.4 mi. E. Fairdealing, Butler Co., CU 24281 (2), August 13, 1953, Robins and Woolcott. Long Cr., Oasis, Taney Co., CU 32834 (5), November 10, 1956, L. W. Knapp and J. P. Henley. White R., Hwy. 86, near Shell Knob, Barry Co., CU 32861 (15), November 9, 1956, Knapp and Henley; CU 32864 (8), February 23, 1957, Knapp and Henley; CU 32935 (3), July 4, 1957, Knapp and M. Bowman. Finley Cr., U.S. Hwy. 160, S. of Nixa, Christian Co., CU 37453 (6), March 29, 1961, Knapp and party. Finley Cr., at crossing, 5 mi. E. of Sparta, Christian Co., CU 37718 (2), August 28, 1957, Knapp and R. Myers. Flat Cr., at second crossing above James R., Stone Co., CU 38052 (2), September 12, 1957, Knapp and party. James R., at Finley Cr., Stone Co., CU 38433 (1), May 18, 1958, L. and B. Knapp. James R., Road A, Webster Co., KU 5550 (1), June 5, 1960, D. A. Distler and A. L. Metcalf. Current R., Round Springs State Park, sec. 20, T. 30 N., R. 4 W., Shannon Co., KU 7645 (18), April 7, 1963, F. B. Cross and M. L. Wiley. Current R., Owls Bend, Hwy. 106, Shannon Co., KU 7679 (1), April 8, 1963, Cross and Wiley. James R., Road D, W. of Turner, Greene Co., KU 7853 (1), May 11, 1963, Cross. James R., Hwy. M125, 6 mi. S. Strafford, Greene Co., KU 7882 (1), May 11, 1963, Cross. Saint Francis R., Sam A. Baker State Park, sec. 32–33, T. 30 N., R. 5 E., Wayne Co., UMoMZ 7261 (4), September 20, 1949, Perry Robinson. Sinking Cr., Hwy. K, 9.2 mi. from junction Hwy. K with Hwy. 21, Reynolds Co., USNM 202484 (9), June 29, 1964, Leslie W. Knapp. Black R., Hwy. A, 3 mi. W. Williamsville, Wayne Co., USNM 202487 (11), June 29, 1964, Knapp. Bryants Cr., Hwy. 14, 14 mi. E. Ava, Douglas Co., USNM 202488 (2), May 21, 1965, Knapp.

DIAGNOSIS.—*Noturus* (*Rabida*) *albater*, aside from *Noturus hildebrandi* which has eight pelvic rays throughout its range, is the only species of the subgenus with typically nine soft pectoral rays. In contrast to other species of the subgenus the body is elongate with more vertebrae and the head is proportionately small. The head length in the standard length goes 3.7 times or more, distinguishing *albater* from other *Rabida*, except *N. elegans* and *N. hildebrandi lautus*. From the members of the *elegans* group, *albater* is distinguished by pigmentation, especially the large dark adipose bar, the basicaudal bar, and the creamy white area on the upper procurrent caudal rays.

In *N. albater* there are 45 to 54 caudal rays, usually 9 pelvic rays, normally 2 internasal and 11 preoperculomandibular pores, and 13 to 16 anal rays. The posterior process of the cleithrum is very short or obscure and the anterior serrae of the pectoral spine are nearly obscure.

Description.—Other counts and measurements are given in tables 17 to 26. Body rather elongate for a *Rabida*, the greatest depth under the dorsal fin; caudal peduncle slightly tapering posteriorly, as deep as the head back of the eyes; eye 1.5 to 2.4 times in snout; head rounded or somewhat flattened above, little depressed; snout slightly depressed; lower jaw included; premaxillary tooth band with posterior corners rounded or obtusely angulate; pectoral spine (pl. 4, fig. 4) relatively short, rather slender, and nearly straight, with the anterior serrae weak or almost obscure; serrae of the posterior edge rather numerous and with tips curved toward spine base (except 1 to 3 proximal serrae); humeral process blunt, poorly developed or nearly obscure, seldom as long as the width of the shaft of the pectoral spine; dorsal spine moderately slender; adipose fin high, with a rounded upper edge, no free posterior flap, and united to the moderately long procurrent caudal rays; posterior end of caudal fin rounded or truncate; gill rakers six to eight on the first arch.

In 91 specimens, 90 have 6 soft dorsal rays, 1 has 5. In 87 specimens (extremes in parentheses): upper simple caudal rays (15) 17 to 19 (21), mean 18.02; branched caudal rays (one aberrant count of 12), otherwise (15) 16 (17), mean 15.9, of which 7 are usually in the upper part of the fin and 9 in the lower half; lower simple caudal rays (13) 14 to 17 (18), mean 15.5. There are three to eleven posterior serrae of the pectoral spine. The largest specimen measures 89 mm. in standard length; most are under 60 mm.

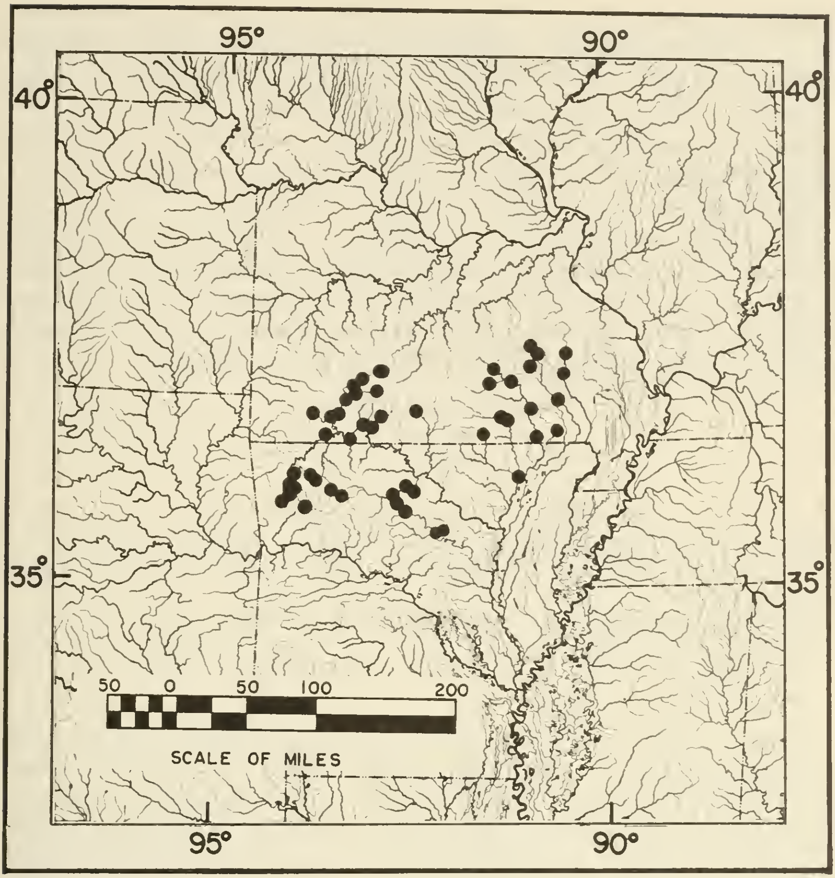
In a stained specimen the ossified pectoral radials are tightly fused on each side and there are 13 vertebrae anterior to the origin of the anal fin.

Body color yellowish with prominent black or brown blotches. In preservation, yellowish or brown with contrasting dark brown or black markings; top of head dark brown with a posterior bar that extends to the branchiostegal membrane and onto the operculum; a dark band extends from the snout around the eye, backward to meet the first, outlining a light postorbital spot; anterior nares pale, but usually with some pigment; upper barbels pigmented; lips pale, with some pigment in front of and occasionally on mental barbels; a light band (not prominent) of pigment anterior to pelvics; remainder of lower head, abdomen, and pelvic fins immaculate; anal fin often with a few brownish blotches; pectoral fin and membrane over spine heavily pigmented, its edge immaculate; dorsal spine and proximal part of dorsal fin brownish; remainder of dorsal fin often with brown pigment distally on rays or some specimens with a dark brown submarginal blotch or band; adipose fin whitish, the base anteriorly with scattered brown pigment and the middle with a dark brown or blackish blotch or bar which usually extends to the margin in adults; this blotch confined to the upper body surface and discrete from the other black saddles; another saddle extends from the front of the adipose fin to a yellowish, obovate area at the base of the last dorsal rays; a lightly pigmented area before the dorsal fin; a squarish anterior saddle beginning just before the dorsal fin may extend to or below the lateral line and backward to the third or fourth dorsal ray; a yellowish white blotch on the upper and usually the lower procurrent caudal rays, their base brown; a black or dark brown vertical bar extends through the caudal peduncle to both margins of the caudal fin; branched caudal rays and adjacent simple rays brownish or yellowish brown with dark brown concentric bands at or near end of rays.

Type.—The holotype (UMMZ 151171) is an adult male, 61.2 mm. in standard length and 73.5 mm. in total length. It has $5+9=14$ anal rays, $17+6+10+14=47$ caudal rays, 37 vertebrae, and 6 soft dorsal rays. The pectoral fins and internasal pores are atypical, the pectoral having eight soft rays on the left and nine (counting a small splint) rays on the right; there is one internasal pore on the left and two on the right side. On each side there are nine pelvic rays, seven recurved serrations on the posterior edge of the pectoral spine, and eleven preoperculomandibular pores. The head length stepped into the standard length is 3.75 and the distance from the adipose notch to the tip of the caudal fin stepped into the distance from the origin of the dorsal fin to the adipose notch is 2.35 .The humeral process and the anterior serrae of the pectoral spine are short or even obscure. Plate 11, figure 2 shows the body form and pigmentation of this specimen; table 28 gives further measurements.

Distribution (map 10).—*Noturus albater* is known only from the upper White and Saint Francis River systems of Arkansas and Missouri. It occurs in the two main branches of the White, the Black and the White Rivers and their tributaries. Two records are known from the upper Saint Francis River, Missouri.

Variation.—The meristic data taken from seven to ten specimens from the Black River system are overlapped (one exception) by the combined counts on 58 to 88 specimens from the upper White River system. Means for the samples from (a) the White River, (b) the Black River, and (c) the combined population follow in order: pelvic rays (a) 9.04, (b) 8.95, (c) 9.03; soft pectoral rays (a) 8.94, (b) 8.85,



Map 10.—The distribution of *Noturus albater*, new species. Circles represent material examined. Unverified records which appear to be based on *N. albater* lie well within the indicated range.

(c) 8.94; preoperculomandibular pores (a) 10.93, (b) 10.90, (c) 10.92; anal rays (a) 14.50, (b) 14.90, (c) 14.54; lower-half caudal rays (a) 24.25, (b) 24.30, (c) 24.26; upper-half caudal rays (range: (a) 23 to 28; (b) 22 to 26) (a) 25.13, (b) 24.20, (c) 25.03; total caudal rays (a) 49.35, (b) 48.50, (c) 49.27; vertebrae (a) 36.78, (b) 37.00, (c) 36.80. Only pectoral and pelvic rays were counted from four Saint Francis River specimens. These coincide with counts from White River specimens. Considering the small size of the Black River sample, no important differences are evident.

Relationships.—*Noturus albater* is a distinctive species without close affinity to any other species of the subgenus *Rabida*. The increased number of pectoral rays and the shortening of the anterior pectoral serrae and posterior process of the cleithrum, as well as some similarity in color pattern suggest a remote relationship with typical *Noturus hildebrandi.* Otherwise the elongate body form and small head indicate some relationship to members of the *elegans* group.

ETYMOLOGY.—The name *albater* (Latin), *albus* (white) and *ater* (black), meaning white and black, refers to the contrasting light areas of the caudal fin and the dark saddles.

ECOLOGICAL CONSIDERATIONS.—Records are from clear or normally clear, moderate or large size streams, having a bottom of sand, gravel, rubble, and large rock. The species lives in moderate to swift current, primarily on the shallower riffles. *Noturus albater* has been taken in collections with *Noturus exilis, N. flavater,* and *N. miurus.*

The ELEGANS Group

Noturus elegans, new species

ELEGANT MADTOM

PLATES 4 (FIGS. 5–6), 12; MAP 11

Noturus miurus Jordan [misidentifications].—?Woolman, 1892a, p. 256 (records, in part, Green R. system, Ky.).—?Garman, 1894, p. 56 (compiled from Woolman).

Schilbeodes miurus (Jordan) [misidentification].—?Evermann, 1918, p. 335 (compiled from Woolman).

Noturus species.—Murphy, 1964, p. 71 (Green R., Ky.).—Charles, 1967, pp. 385–394 (Green R., Ky.).

TYPE-SPECIMENS.—UMMZ 167597 (holotype) and UMMZ 155526 (30 paratopotypes), from Fallen Timber Creek, at Hwy. 90, 8 mi. SE. of Glasgow, Barren Co., Kentucky, collected April 7, 1948, by Reeve M. and Marian K. Bailey. UMMZ 154650 (11 paratopotypes) and USNM 174903 (4 paratopotypes), same locality, April 10, 1947, R. M. Bailey and N. J. Wilimovsky.

OTHER PARATYPES.—The number of specimens, in parentheses, follows the catalog number.

UNITED STATES: KENTUCKY: UMMZ 88038 (1), Harrison Cr., 8 mi. S. Glasgow, Barren Co., August 28, 1929, E. P. Creaser and H. R. Becker. UMMZ 154676 (1), Bays Fork of Barren R., U.S. Hwy. 31 E., 2 mi. NE. Scottsville, Allen Co., April 11, 1947, R. M. Bailey and N. J. Wilimovsky. UMMZ 165258 (3), Green R., Hwy. 198, Yosemite, Casey Co., April 5, 1953, R. M. Bailey, D. M. Bailey, H. E. Winn, and J. J. Keleher. UMMZ 165293 (43) and USNM 174902 (5), Green R., Greensburg, Green Co., April 5, 1953, R. M. Bailey and party. UMMZ 165340 (13), East Fork Barren R., Hwy. 63, 5 mi. NW. Tompkinsville, Monroe Co., April 6, 1953, R. M. Bailey and party. UMMZ 165395 (18), Fallen Timber Cr., Hwy. 63, 6 mi. SE. Glasgow, Barren Co., April 7, 1953, R. M. Bailey and party. UMMZ 168229 (7), Russell R., Hwy. 206, 1 mi. E. Columbia, Adair Co., August 24, 1954, R. M. Bailey and family. USNM 163065 (9), trib., Green R., Hwy. 35, 4.5 mi. SSW. Liberty, Casey Co., April 25, 1952, F. B. Schwartz, E. A. Lachner, and W. T. Leapley. USNM 163066 (2), trib., Green R., Hwy. 35, 6 mi. NE. Liberty, Casey Co., April 25, 1952, Schwartz, Lachner, and Leapley. USNM 163090 (17), trib., Russell R., Hwy. 80, 7 mi. NE.

Edmonton, Metcalfe Co., April 25, 1952, Schwartz, Lachner, and Leapley. USNM 163091 (2), trib., Green R., Hwy. 80, at Edmonton, Metcalfe Co., April 24, 1952, Schwartz, Lachner, and Leapley. USNM 163092 (2), trib., Green R., Hwy. 35, 0.2 mi. E. Dunnville, Casey Co., April 25, 1952, Schwartz, Lachner, and Leapley. USNM 163093 (2), Russell R., Hwy. 80, about 1 mi. SE. Columbia, Adair Co., April 25, 1952, Schwartz, Lachner, and Leapley. USNM 200480 (3), Trammel Cr., 1.5 mi. above mouth, Warren Co., Peter A. Hackney. USNM 201396 (3), Knob Lick Cr., Hwy. 198, just N. Yosemite, Casey Co., June 12, 1965, Schwartz and R. V. Miller. CU 37616 (1), Calhoun Cr., Hwy. 35, 5 mi. S. Liberty, Casey Co., March 25, 1961, Neal R. Foster and party. CU 45997 (1), Trammel Cr., 3.4 mi. SW. jct. U.S. Hwy. 231 and Hwy. 100, at U.S. Hwy. 231, Allen Co., August 1963, T. Zorach and party. KU 7078 (1), stream, Hwy. 80, 4 mi. W. Russell Springs, Adair Co., June 8, 1960, A. L. Metcalf. TU 19390 (12), Green River, Hwy. 88, 3.8 mi. ENE. Donansburg, Green Co., September 7, 1958, R. D. Suttkus and party. TU 19460 (16), trib. to Barren R., U.S. Hwy. 31 E., 2.6 mi. SW. Lucas, Barren Co., September 7, 1958, Suttkus and party. UL 5185 (1), Bays Fork, U.S. Hwy. 31 E., 1.5 mi. NE. Scottsville, Allen Co., July 8, 1954, W. M. Clay and E. W. Whitney. UL 5581 (42), Salt Lick Cr., 0.75 mi. S. and 1 mi. E. Akersville, Monroe Co., October 29, 1955, Charles and party. UL 5728 (22), Russell R., Hwy. 80, 2 mi. E. Columbia, Adair Co., August 10, 1955, D. Distler and Clay. UL 5746 (2), Goose Creek, Casey Co., May 5, 1955. UL 6155 (9), Long Cr., 2 mi. E. Mt. Union or 4 mi. E. and 7 mi. S. Scottsville, Allen Co., June 8, 1956, Clay and Bernard Carter. UL 7915 (1), Green R., below first bridge on Hwy. 35, S. of Liberty, Casey Co., June 28, 1955, Charles and party. TENNESSEE: UMMZ 181071 (1), Trace Cr., Hermitage Springs, Clay Co., April 30, 1954, H. E. Winn and Norman Benson.

OTHER MATERIAL STUDIED

UNITED STATES: KENTUCKY: USNM 199585 (1 specimen), locality unknown. TENNESSEE: USNM 197396 (2 specimens), Hurricane Cr., S. of McEwen, Humphreys Co.; USNM 197398 (2), Bigby Cr., near Mount Pleasant, Maury Co.; USNM 197400 (1), Tumbling Cr., Humphreys Co.; USNM 201387 (5), Beaver Dam Cr., Hwy. 50, E. edge Coble, Hickman Co.; USNM 201600 (4), locality unknown; mixed with specimens reputed to have been collected in Abrams Creek, Great Smoky Mountains National Park, but instead probably from Duck River system, Tennessee; see remarks under *Noturus baileyi*.

DIAGNOSIS.—*Noturus* (*Rabida*) *elegans* is characterized by an elongate anal fin with 14 to 19 rays, small spines with short anterior serrae, a short posterior process of the cleithrum, and typically 9 pelvic rays.

It has 46 to 55 caudal rays; 8, sometimes 9, soft pectoral rays; normally 11 preoperculomandibular pores; and 2, infrequently 1, internasal pores. The body is moderately elongate; the caudal and adipose fins are united, but the fins are low at the junction; the soft dorsal rays, except near the dorsal fin base, are without dark pigment.

It is distinguished from members of the *miurus* and *furiosus* species groups by color pattern, shorter spines and posterior process of the cleithrum, and the connection of the adipose and caudal fins; from *Noturus eleutherus* by small spines, wide union of the caudal and adipose fins, and eleven rather than ten preoperculomandibular pores;

from the probable *hildebrandi* species group by color pattern and nine rather than eight pelvic rays; from *Noturus albater* by generally fewer pectoral rays and color pattern; from *Noturus trautmani* by better developed anterior serrae of the pectoral spine, a bolder color pattern in preservation, a longer posterior process of the cleithrum, a lower adipose and upper caudal fin, a longer anal base, and more vertebrae.

Description.—Counts and measurements are given in tables 17 to 26. Head somewhat depressed; lower jaw included; eye moderate, about 1.5 to 1.8 times in snout; posterior process of cleithrum short but distinct, about equal in length to the width of the pectoral spine including the anterior but not the posterior serrae; pectoral spine relatively short, slightly curved, with recurved posterior serrae and very fine, yet distinct anterior serrae; dorsal spine stout; adipose fin moderately low and relatively long, without a free posterior margin, united to the caudal fin; procurrent caudal rays of moderate length; tail slightly rounded posteriorly, middle rays longest; body elongate, dorsal and ventral surfaces only slightly tapering posteriorly; posterior corners of premaxillary tooth band rounded. The largest specimen is 64 mm. in standard length.

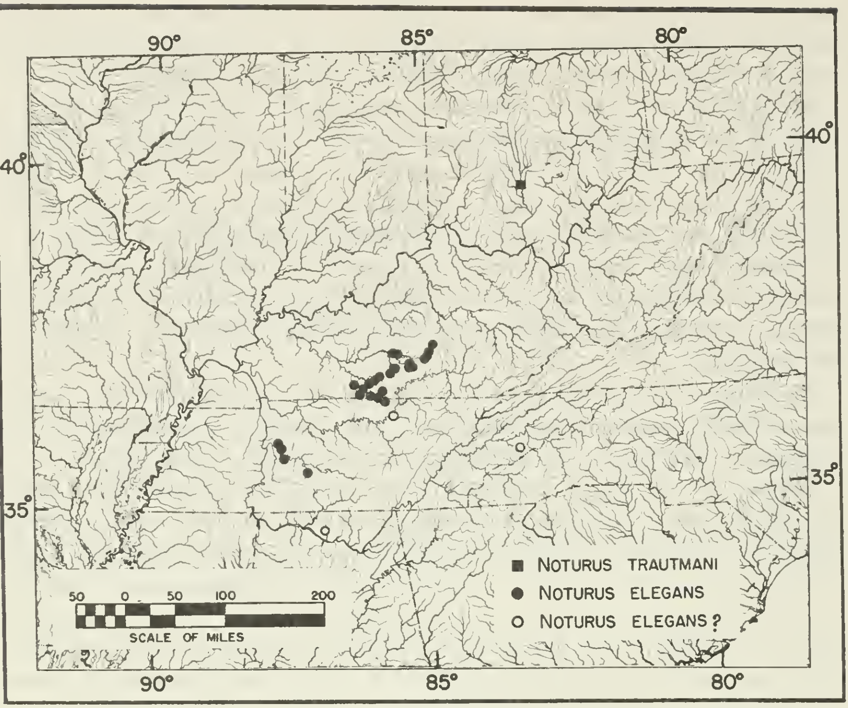
The caudal fin has (extremes in parentheses): (16) 17 to 20 (22) upper simple rays; (13) 15 to 18 (19) branched rays of which there are modally 7, often 8, in the upper half and 8 to 10 in the lower half of the fin; and (11) 13 to 17 (18) lower simple rays. There are six to eight gill rakers on the first arch; the pectoral spines bear five to nine recurved serrae; and there are typically six soft dorsal rays. Five cleared and stained specimens from the Green River system have the pectoral radials fused and twelve vertebrae anterior to the anal origin.

Background color in aquarium specimens from the Green River system yellowish gray, lightly diffused with pink. In preservation golden yellow or light yellow, dark brown on dorsum and side in one example, with numerous minute chromatophores completely covering the side and upper surface. Pelvic fin and ventral surface of head and abdomen immaculate, except a light band of pigment often on the chin in front of mental barbels; mental barbels immaculate or sometimes with scattered pigment; a dark brown bar on posterior end of head passes downward over the operculum and a branch follows the lateral line to below the dorsal fin; a similar colored band extends forward from below the eye onto the snout, through the nares; upper barbels well pigmented; lower cheek light, with moderate chromatophores; top of head dark; dorsal fin immaculate except dark brown at base of first three rays and over dorsal spine; a dark brown saddle, beginning just anterior to base of dorsal spine, extends to the third dorsal ray and midside; another lies between the adipose and dorsal fins; a third, at base of adipose fin, variously extends into the basal half or more of fin and to the distal margin in adults; a very light bar of brown pigment crosses the caudal peduncle, extending onto the upper procurrent caudal rays; three light ellipses separate the four dark dorsal saddles or blotches; a quadrate-shaped light area lies between the first saddle and head; caudal fin usually with two or more concentric brown bands covering most of fin, one of which is submarginal; anal fin usually immaculate, infrequently with scattered pigment; pectoral spine covered with brown chromatophores, the pectoral rays moderately pigmented near spine and toward base.

Specimens from the Green River system (pl. 12, fig. 1) usually are somberly colored, lacking bold dark saddles, in contrast to the prominent patterns of Duck River specimens (pl. 12, fig. 2).

Type (pl. 12, fig. 1).—The holotype (UMMZ 167597) is a male, 44.1 mm. in standard length. It has $6+11=17$ anal rays; on each side there are eight soft pectoral rays, nine pelvic rays, eleven preoperculomandibular pores, two internasal pores, and seven serrae on the posterior edge of the pectoral spine; the dorsal fin has five soft rays and the caudal fin has $19+7+9+14=49$ rays. The head length is stepped into the standard length 3.85 times and the distance from the adipose notch to the tip of the caudal fin is stepped into the distance from the dorsal fin origin to the adipose notch 2.05 times. Other measurements are given in table 28.

Variation.—Vertebrae in 28 specimens from the Green, 42 from the Barren, and 14 from the Duck River systems are 34 to 36, mean 35.07; 34 to 37, mean 35.83; and 34 to 36, mean 35.29, respectively. The combined mean is 35.49. Other mean variational data are listed, in order, for (a)48 Green River specimens, (b)48 from the Barren River system, (c)14 from the Duck River system, and (d) the combined samples; the ranges of variation are given in parentheses but omitted if identical: internasal pores (a)1.92, (b)1.86, (c)1.96, (d)1.90; preoperculomandibular pores (a)(10–12) 10.98, (b) (10–12) 11.04, (c)(10–11) 10.82, (d)(10–12) 10.99; soft pectoral rays (a)8.22, (b)8.23, (c)8.25, (d)8.23; pelvic rays (a)(8–10) 9.06, (b)(8–10) 9.02, (c)(9–10) 9.11, (d)(8–10) 9.05; anal rays (a)(49 specimens; 14–18) 15.73, (b) (14–18) 15.81, (c)(16–19) 17.29, (d)(14–19) 15.96; soft dorsal rays (a)(5–6) 5.94, (b)(6) 6.00, (c)(5–6) 5.86, (d)(5–6) 5.95; upper-half caudal rays (a)(23–29) 25.92, (b)(24–29) 25.92, (c)(25–28) 26.21, (d)(23–29) 25.95; lower-half caudal rays (a)(21–26) 24.06, (b)(20–26) 23.63, (c)(23–26) 24.00, (d)(20–26) 23.86; total caudal rays (a)(46–54) 49.98, (b)(46–55) 49.54, (c)(48–54) 50.21, (d)(46–55) 49.82. The anal fin thus appears to be slightly longer and the color pattern is bolder in



MAP 11.—The distribution of members of the probable *elegans* species group of the subgenus *Rabida*. *Noturus trautmani*, new species, is known only from Big Darby Creek, Ohio. *Noturus elegans*, new species, is common in the Green River system, with a boldly colored form in the Duck River system. The two localities in the Tennessee River basin and one in the Cumberland basin represent material tentatively referred to *N. elegans*, under which it is discussed.

Duck River specimens. The data for other characters do not indicate significant differences between populations.

DISTRIBUTION.—*N. elegans* (map 11) is found in the Green River system of Kentucky and the Duck River system, Tennessee. One lot from the Cumberland drainage and two from the Tennessee basin are only tentatively referred to *N. elegans* (see p. 155). In the Green River system, *elegans* occurs in the upper parts of both the Barren and Green Rivers and their tributaries.

ETYMOLOGY.—The name *elegans* (Latin) refers to the neat or handsome color pattern.

RELATIONSHIP.—The rather long slender body, short spines and posterior process of cleithrum, and the continuous adipose and caudal fins align *Noturus elegans* with *Noturus trautmani*. Despite prominent differences in color, head, body, and fin shape, and anal and pectoral ray counts, it is similar to species of the probable *hildebrandi* group and to *Noturus albater*. Because of these several dissimilarities, *elegans* is tentatively associated here with *trautmani* as the *elegans* group.

Ecology.—*Noturus elegans* is frequently taken with *Noturus miurus*. A single specimen of *Noturus stigmosus* was secured in a collection with *elegans* and *miurus* at Greensburg, Kentucky. *Noturus eleutherus* and presumably *Noturus flavus* have also been taken from the Green River near this locality. *Noturus exilis* was collected with *elegans* in the Duck River system.

N. elegans appears to prefer moderate to swift riffles of clear, gravelly, or rubble-bottomed streams, living in both small creeks and moderate size rivers.

Remarks.—Several other specimens are only tentatively identified as *Noturus elegans* (map 11). They show certain structural similarities to *elegans* but differ from the typical populations of *elegans*, as found in the Duck and Green systems, and from *Noturus trautmani* sufficiently to leave doubt of their identification. The data for these specimens are: Alabama: UMMZ 165877 (1 specimen), Piney Cr. [Fork], 0.5 mi. above bridge at Anderson Plantation, sec. 12, T. 4 S., R. 4 W., Limestone Co., June 9, 1941, C. M. Tarzwell. Tennessee: UMMZ 131386 (1 specimen), Dunn Cr., Jones Cove (at mouth of Yellow Breeches Cr.), Sevier Co., June 26, 1940, Carl L. Hubbs; UMMZ 168262 (4 specimens), Roaring R., 2 mi. above mouth and 2 mi. E. of Gainesboro, on road about 1 mi. from Hwy. 53, Jackson Co., August 25, 1954, R. M. Bailey.

The Dunn Creek specimen (pl. 13, fig. 2), a male, is elongate, 51.2 mm. in standard length. It has a relatively long anal fin (6+11=17 rays), very little pigment in the outer three-fourths of the dorsal fin, the adipose fin well united with the procurrent caudal fin, a relatively small pectoral spine, and a short humeral process. It differs prominently from typical *elegans* in having very large brownish chromatophores on the cheek below and behind the eye, and in fewer caudal rays (15+7+9+13=44). On each side it has eleven preoperculomandibular pores, two internasal pores, and eight soft pectoral rays. There are six soft dorsal rays. The pelvic fin has nine rays on the left side and eight on the right. The left pectoral spine has five recurved serrae and its anterior edge is lined with moderate serrae. There are 34 vertebrae.

The Piney Creek specimen (pl. 13, fig. 3) was taken in a collection containing *Noturus exilis*. This specimen, a male, is 32 mm. in standard length; its body is short and chunky. Each side has eleven preoperculomandibular pores, eight soft pectoral rays, nine pelvic rays, and two internasal pores. There are 20+7+10+17=54 caudal rays, 5+11=16 anal rays, and six soft dorsal rays; the spines are relatively short, with poorly developed anterior serrae, but normal and recurved posterior

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serrae. The humeral process is of moderate length; the adipose and caudal fins are rather well connected; the caudal fin is nearly uniformly colored; the adipose and dorsal fins have no pigment; and there are 35 vertebrae. It differs from typical *elegans* especially in the very short, chunky body.

The Roaring River specimens appear to be juveniles, ranging from 27.0 to 30.5 mm. in standard length. The anal fin is short with 14 (in 3) or 15 (1) rays, all pectoral fins have 9 soft rays, and the vertebrae are 34 (3) or 35 (1), all characters that differ modally from typical *elegans*. In the four specimens the soft dorsal rays are six and there are on each side nine pelvic rays, two internasal pores, and eleven preoperculomandibular pores. Each pectoral spine has moderate anterior serrae and five to six recurved posterior serrae. The caudal fins have 24 (1), 25 (1), or 27 (2) upper-half rays and 24 (2) or 25 (2) lower-half rays, totaling 48 (1), 49 (1), or 52 (2) rays.

Noturus trautmani, new species

SCIOTO MADTOM

PLATES 4 (FIG. 7), 13 (FIG. 1); MAP 11

TYPE.—UMMZ 187098 (holotype), collected from Big Darby Creek, 1 mile south of Fox, southeastern Jackson Township, Pickaway County, Ohio, November 4, 1943, by Milton B. Trautman and Walter Cunningham.

PARATOPOTYPES (all same locality as holotype).—OSU 5914 (1 specimen), collected with the holotype. OSU 5988 (1), December 30, 1943, M. B. and Mrs. M. A. Trautman. OSU 6621 (1), November 16, 1945, Trautman and Owen Weeks. OSU 9570 (1), September 26, 1957, Trautman and Donald I. Mount. OSU 9571 (1), October 3, 1957, Trautman and Mount. OSU 9572 (2), October 9, 1957, Mount. OSU 9573 (2), October 13, 1957, Mount. OSU 9574 (1), October 22, 1957, Trautman and Mount. USNM 202493 (6), November 16 or 17, 1957, Trautman and Mount.

DIAGNOSIS.—*Noturus* (*Rabida*) *trautmani*, with typically 9 pelvic rays, 8 or sometimes 9 soft pectoral rays, 45 to 51 caudal rays, 11 preoperculomandibular pores, 2 internasal pores, and reduction of the anterior pectoral spine serrae plus the very short or obscure posterior process of the cleithrum, shows the greatest similarity to *Noturus elegans*. The somewhat similar *Noturus albater* has a bolder and different color pattern, more vertebrae, and modally nine soft pectoral rays rather than eight. Other species of the subgenus *Rabida* differ in one or more of the following characters: number of pelvic rays, number of preoperculomandibular pores, or they are relatively short and heavy bodied with large anterior spine serrae and extreme development of the posterior process of the cleithrum.

Noturus trautmani differs from *Noturus elegans* in having fewer vertebrae (32 to 34) and a shorter anal fin (13 to 16, modally 14 rays); the relatively high adipose fin lacks a blotch or bar; the anterior serrae of the pectoral spine are very short to obscure and the posterior process of the cleithrum is absent or very poorly developed. The body and head are relatively uniformly grayish brown on upper and lateral surfaces, lacking prominent saddles or blotches; large brownish chromatophores are scattered over the cheek and operculum.

Description.—The 17 specimens, although collected over a period of 14 years, are very similar in their morphology. Counts and measurements are given in tables 17 to 26. Head rounded, slightly flattened above; lower jaw included; eye large, 1.4 to 1.8 times in snout; barbels short and thickish; posterior process of cleithrum short or obscure; pectoral spine rather short, nearly straight, with distinct, recurved posterior serrae, but with very small or obscure anterior serrae; dorsal spine stout; dorsal rays about equal in length, the posterior rays when depressed extending far backward of the anterior rays; adipose fin high, widely connected to the caudal fin, and without a posterior free margin; caudal fin rounded or nearly truncate posteriorly, the middle rays slightly the longest; caudal peduncle about as deep as head; posterior corners of premaxillary tooth band slightly rounded.

The caudal fins have 17 to 20, mean 18.44 upper simple rays; 14 to 18, mean 16.06 branched rays, of which 7 (in 15) or 8 (1) are in the upper half of the fin, and 7 to 11, usually 9, mean 9.00 are in the lower half; and 12 to 16, usually 14 or 15, mean 14.47 lower simple rays. All specimens have six soft dorsal rays. The pectoral spines have five to seven posterior serrae, and there are five or six gill rakers on the first arch. The specimens range in standard length from 23.2 to 44.1 mm.

In a small specimen, 27 mm. in standard length, that was cleared and stained, the ossified pectoral radials are separate on the right side; on the left side the ends are fused. The six hypurals are separate distally and there are twelve vertebrae anterior to the first pterygiophore of the anal fin.

In preserved specimens, caudal fin dusky (a triangular dusky area on the branched rays in small specimens), with a slight suggestion of concentric rings or bars that lie parallel to the margin and that may pass through the end of the caudal peduncle; anal fin yellowish, some rays with a few chromatophores distally; adipose fin yellow, sometimes with a few brownish chromatophores near base; pelvic fins mostly yellowish but with some scattered pigment; pectoral spines covered with dense brown pigment; pectoral rays usually heavily dusted with brown except at tips; mental barbels and lower surface of head immaculate; maxillary barbels lightly dusted with brown pigment; nasal barbels dark brown; a patch, large as pupil, of brown chromatophores on abdomen just anterior to each pelvic fin and sometimes a narrow gray area just behind the isthmus; otherwise abdomen and lower head immaculate; lower surface adjacent to anterior one-fourth of anal fin, forward to pelvic fins yellowish, mostly immaculate, or with a narrow cross-band of dark brown pigment just behind vent; dorsal fin white or translucent, with a few scattered, brownish chromatophores distally on rays; dorsal spine and base of dorsal fin dark grayish brown; top of head dark grayish brown; upper lip pale yellowish; a dark band extends forward from beneath the eye to below the anterior naris; lower cheek yellowish; large, scattered, brown chromatophores on cheek and lower half of operculum; a dark band of pigment crosses back of head and extends downward to the brachiostegal membrane and operculum; area over air bladder dark gray; upper side of body nearly uniformly dark grayish brown; lower side more variegated with grayish brown and yellowish white; a light tan area extends backward, dorsally, from head nearly to the dorsal fin; a narrow dark grayish brown blotch surrounds the dorsal fin base; two other narrow dark saddles, also with their greatest dimensions lengthwise of the body, lie between the dorsal and adipose fins and at the base of the adipose fin. A rounded light yellowish area, size of eye, occupies the upper anterior procurrent caudal rays, and the caudal peduncle beneath the rear part of the adipose fin and the procurrent rays; another of similar size is centered above the base of the posterior anal ray.

The following is an extract of color notes, provided by Dr. Trautman, from specimens 23 to 30 mm. long, collected September 26 to October 9, 1957. Eye blue-black, pupil with a walleye cast; top of head dusky olive, occipital region darkest; cheeks lighter, heavily speckled with large melanophores; lower surface of head and upper lip milky white, unspotted; the four upper barbels pale, with a line of melanophores along their posterior edges; lower barbels without chromatophores; dorsal half of body heavily speckled, dusky olive; sides lighter, more blotched; belly, from vent forward, white except chromatophores at bases of pelvic fins; a band of chromatophores extends from the vent to the anal fin and, as a line, along each side almost to that fin's posterior end; dark saddles at occiput, dorsal fin base, between dorsal and adipose fins, and beneath center of adipose fin; caudal fin with about three dusky crescentic bands; dorsal and anal fins transparent.

TYPE.—The holotype (pl. 13, fig. 1), UMMZ 187098, is a male, 44.1 mm. in standard length. It has 5+11=16 anal rays, 18+8+10 +14=50 caudal rays, 33 vertebrae, and 6 soft dorsal rays. Paired structures in order from left to right are: 9–9 pelvic rays, 9–8 soft pectoral rays, 2–2 internasal pores, 11–12 preoperculomandibular pores, and 5–6 recurved serrae on the posterior edge of the pectoral spine. The posterior process of the cleithrum is obscure; a few anterior serrae are present on the pectoral spine but are too poorly developed to enumerate. The head length is stepped into the standard length 3.55 times and the distance from the rear end of the adipose fin to the tip of the caudal fin is stepped into the distance from the dorsal origin to the rear end of the adipose fin 2.0 times. Table 28 gives further measurements.

Distribution.—*Noturus trautmani* is known only from one locality in Big Darby Creek, a tributary of the Scioto River, Ohio.

Etymology.—This species is named for Dr. Milton B. Trautman, an outstanding ichthyologist and Ohio naturalist, who collected the types and has studied the fish fauna of Big Darby Creek intensively.

Relationship.—*Noturus trautmani* is a species of *Rabida* that appears to be most closely related to *Noturus elegans* of the Green and Duck River systems. Both have similar paired fin ray counts, an obscure or moderately short rear process of the cleithrum, weak anterior pectoral spine serrae, the adipose and caudal fins rather broadly united, moderately long upper procurrent caudal rays, relatively few caudal rays, little or no pigment on the dorsal fin soft rays, and a relatively elongated body shape. They tentatively form the *elegans* species group.

Remarks.—Dr. Trautman has made repeated attempts in recent years to collect this species from the only known locality, the Big Darby Creek riffle, one mile south of Fox, Ohio, but his success has been limited. All specimens were collected in the fall and early winter, eight (two not seen by me) being the largest number obtained at any one time. Most have been collected at times when large numbers of *Etheostoma tippecanoe* were also present on the riffle.

The riffle is described in Trautman's notes as riffle three above the bridge. It has a bottom of gravel, sand, silt, and boulders. Some vegetation is listed as present and the current where the specimens were taken is described as moderate to fast. Big Darby Creek, in this region, varies from about 40 to 150 feet wide. The well defined, moderate depth riffles alternate with deep pools.

The fish fauna of the riffle and adjacent pools is known to include 82 or more species (personal communication from Trautman). In addition to *Noturus trautmani, Noturus flavus* and *Noturus miurus* are known from Big Darby Creek, and *Noturus stigmosus* was collected with *trautmani. Noturus eleutherus* lives close by in the Scioto River.

The paucity of specimens of *trautmani*, especially from a stream as well known ichthyologically as Big Darby Creek, Ohio, is puzzling.

It has been noted that the collections were made over a period of several different years. This suggests that *trautmani* is very secretive and consequently difficult to obtain or that it typically lives in another habitat.

Noturus eleutherus Jordan

MOUNTAIN MADTOM

PLATES 4 (FIG. 8), 14; MAP 12

Noturus miurus Jordan [misidentifications].—Jordan and Copeland, 1876, p. 160 (nomen nudum; French Broad R.).—Jordan, 1885, p. 802 ("*Noturus eleutherus* seems inseparable from *Noturus miurus*").—Jordan and Gilbert, 1886, p. 10 (Washita [Ouachita] R., about 0.5 mi. above Arkadelphia,* and Saline R., Benton,* Ark. [both complex]).—Eigenmann and Fordice, 1886, p. 410 (Bean Blossom Cr., Monroe Co.,* Ind. [complex]).—Jordan, 1890, pp. 158–162 (Indiana records: Tippecanoe R., Marshland* [complex]; Wabash R., New Harmony;* Wabash R., Vincennes* [complex]).—Woolman, 1892a, pp. 276–278 (Horse Cr., Garratsville? and Middle Fork Kentucky R., 4 mi. N. of Hyden [5 specimens, UMMZ (IU 4828), labeled Big Cr., Hyden,* Ky. are *eleutherus*]).—Meek, 1893, p. 229; and 1894a, pp. 90–92 (in part; compiled).—Garman, 1894, p. 56 (compiled).—Hay, 1894, pp. 173–174 (in part; compiled).—Hahn, 1910, p. 175 (in part; compiled).

Schibeodes miurus (Jordan) [misidentifications].—Eigenmann and Beeson, 1894a, p. 81; 1894b, p. 44 [and 1905, pp. 120–121] (in part; compiled).—Forbes, 1909 and 1914, map 59; and Forbes and Richardson, 1909 [and 1920], map 59 (in part; Illinois [INHS 5060, Wabash R.,* Mount Carmel Rapids]).—?Evermann, 1918, p. 335 (in part; compiled).—Hubbs and Ortenburger, 1929, pp. 96–97 (in part; reference to Arkansas records).—Gerking, 1945, map 64 (in part; some compiled records).

Rabida miura (Jordan) [misidentification].—Fowler, 1936a, p. 111 (Holston R., 6–7 mi. above Bluff City,* Tenn.).

Noturus eleutherus Jordan, 1877b, pp. 370–372 (original description; type from French Broad R.,* Tenn.); 1877d, pp. 73–120, pl. 40, figs. 62–63[a] (in part; description; type* figured; French Broad R., Tenn. only).—Jordan and Brayton, 1878, pp. 56–94 (in part; type-locality restated as Big Pigeon R., Cocke Co., Tenn., near its junction with the French Broad; relationship; Tennessee R. system only).—Jordan, 1878d [and 1884], p. 336 (description; range [in error]); 1878e, p. 414 (French Broad R. only).—Jordan and Gilbert, 1883, pp. 99–100 (description, in part; Tennessee only).—True, 1883, p. 258.—Swain and Kalb, 1883, pp. 638–644 (type,* USNM 29678, "Big Pigeon River at Clifton [error?] Tennessee," described; synonymy).—Jordan, 1889, p. 352 (comparison only); 1890, pp. 125, 151 (comparison; French Broad R. [Spring Cr.], Hot Springs,* N.C.).—Woolman, 1892a, pp. 256, 287 (bayou of Green R., Greensburg,* Ky.).—Garman, 1894, p. 56 (compiled).—Hay, 1894, pp. 171–172 (description and comparison [in error]; Gosport,* Ind., only [White R., Indianapolis, error in compilation]); 1902, p. 70 (comparison, in part; record compiled).—Jordan, 1904, pp. 42, 351 (description; "three specimens known"; White R.,* Ind. and French Broad R.*).—Evermann, 1918, pp. 319–320 (Hines Cr., Clinton,* Tenn.; others compiled).—Gerking, 1955, p. 76 (key, in part).—Lachner, 1956, p. 68 (ecology, upper Allegheny system).—Eddy,

*Material indicated by an asterisk has been re-examined.

1957, p. 154, fig. 389 (key; range, in part).—Taylor, 1957, p. 192.—Trautman 1959, pp. 43, 97, 435–442, fig. 111, map 111 (synonymy; description; Ohio distribution and ecology; range).—R. D. Ross, 1959c, pp. 8, 24 (key; hypothetical New R. system).—Conant, 1960, p. 31, fig. 10 (map of disjunct distribution).—P. W. Smith, 1965, p. 8 (Illinois distribution).—Suttkus and Taylor, 1965, pp. 171, 175 (comparison).—Charles, 1967, pp. 387, 389 (Green R., Ky.).

Schilbeodes eleutherus (Jordan).—Eigenmann and Beeson, 1894a, p. 81; and 1905, p. 121 (Indiana records: West Fork White R., Gosport* and ?Shriner L., Columbia City only); 1894b, p. 45 (in part; West Fork White R., Gosport,* Ind.).—Eigenmann, 1896, p. 253 (Indiana).—Jordan and Evermann, 1896a, pp. 145–148 (in part; description; synonymy; records compiled); 1896b, p. 234 (range; synonymy).—??Large, 1903, pp. 9–10 [and 1905, pp. 56–57] (in part; description; [records, undoubtedly errors in identification; some may be *Noturus miurus*]).—H. M. Smith, 1907, p. 70 (comparison; record compiled).—Meek, 1908, p. 141 (White R., Ind., only).—Evermann and Hildebrand, 1916, p. 442 (Clinch R., Walkers Ford, 12 mi. SW. Tazewell, Tenn.).—Evermann, 1918, pp. 315–366 (records relisted; synonymy; type* stated to be from Big Pigeon R., Newport, Cocke Co., Tenn.; [Clinton Co., Ky., an error]).—H. S. Pratt, 1923, pp. 96–97.—Hubbs and Ortenburger, 1929, p. 97 (in part; Indiana).—Osburn, Wickliff, and Trautman, 1930, p. 174 (Ohio).—C. L. Hubbs, 1930, p. 432 (comparison).—Shurrager, 1932, pp. 386–409 (ecology; Hocking R.,* 400 yards below Guysville Dam, Athens Co., Ohio).—Schrenkeisen, 1938, p. 167.—Raney, 1939a, p. 275 (in part; Ohio drainage, W. Pennsylvania).—Raney and Lachner, 1939, p. 160 (in associations; French Cr., Mill Village, Erie Co.,* Pa.).—Kuhne, 1939, p. 68, fig. 42 (Tennessee).—Fowler, 1940b, p. 9 (in part; compiled).—Hubbs and Lagler, 1941, p. 65 (range [in error]).—Shoup, Peyton, and Gentry, 1941, pp. 70, 73 (Tennessee records: Obey R.,* above mouth of Iron Cr., Clay Co.; Obey R., Eagle Creek Ford [between Livingston and Byrdstown],* Pickett Co.).—Aitken, 1941, p. 390 (hypothetical, Iowa).—Gerking, 1945, pp. 16, 76, map 65 (in part; ecology and Indiana distribution [including station nos. IU 179,* in part; 225;* 339,* in part; 448;* station no. 690;* probably all White R. records and, in part, the Tippecanoe R. records, but not the small tributaries of middle Wabash R. nor the Whitewater R.]).—Fowler, 1945, p. 32 ([Alabama written in error?] Mississippi R. system only).—Brimley, 1946, p. 15 (compiled).—Hubbs and Lagler, 1947 [and 1949], p. 73 (range [in error]).—?D. C. Scott, 1949, p. 178 (Tippecanoe R., Tippecanoe River State Park, Ind.).—Lachner, Westlake, and Handwerk, 1950, p. 93 (ecology, French Cr., Carlton,* Pa.).—Bailey and Taylor, 1950, pp. 31–38, pl. 2, figs. C–D (description; synonymy; range [in error]; records; spine figured).—G. A. Moore, 1952, p. [6] (Oklahoma).—Hall, 1954, p. 61 (Mountain Fork R., Oklahoma).—G. A. Moore, 1957, p. 145, fig. 2–79A (description; range, in part).—Hubbs and Lagler, 1958, p. 91 (not in Great Lakes).

Rabida eleuthera (Jordan).—Jordan, 1929, p. 93 (as *eleutherus*; description; range [in error]).—Jordan, Evermann, and Clark, 1930, p. 156 (in part; synonymy; records relisted).—H. S. Pratt, 1935, p. 90.—Blatchley, 1938, pp. 67–68 (in part; description; Indiana records compiled).—Driver, 1942, p. 254 [and 1950, p. 262] (comparison; range [in error]).

Noturus latifrons.—Jordan, 1885, p. 802 (nomen nudum; White R., Ind.; credited to Gilbert and Swain, Proc. U.S. Nat. Mus., 1885).

*Material indicated by an asterisk has been re-examined.

Schilbeodes gallowayi Fowler, 1945, pp. 2, 32, 122, figs. 155–157 (original description; type,* ANSP 54723, Holston R., above Bluff City, Tenn.).—Bailey and Taylor, 1950, pp. 31–38.

Type.—USNM 29678 (holotype), Big Pigeon River, tributary to [and near its junction with] the French Broad River, at Clifton [probably an error for near Newport, Cocke County], Tennessee, "taken alive from mouth of watersnake," by David Starr Jordan and C. H. Gilbert.

Other material studied

UNITED STATES: Arkansas: Caddo R.: UMMZ 169997. Georgia: Chickamauga Cr.: USNM 161724. Illinois: Wabash R.: UMMZ (Bauman nos. 46, 49, 50, 53). Indiana: Wabash R. system: USNM 40862, 121971, 121973, 121974; UMMZ 66597, 66624, 90376, 113554, 164578. Kentucky: Green R.: UMMZ 88000, UMMZ 167258. Ohio R.: UL 7206, 7223. Kentucky R.: USNM 199586. Levisa Fork: UL 6656. Ohio: Muskingum R. system: OSU 843, 868, 973, 1009; OSU (no. F409). Scioto R.: UMMZ 87736; OSU 821, 1684, 1694, 2540; OSU (nos. F471, 3–38, 3–74). Other Ohio R. tribs.: UMMZ 86039; OSU 5157; OSU (no. F55). Oklahoma: Red R. drainage: Tulsa U (Little R., Cerrogordo); UMMZ 155828 and OU (OAM no. 2863) (Mountain Fork R., near mouth, sec. 10, T.7S., R.26E.). Pennsylvania: French Cr.: USNM 161782. Tennessee: Tennessee R. system: UMMZ 103673, 112333, 129323, 154552, 157575, 158375, 159008; USNM 24840, 125474; CU 23454, 38189, 40113, 48608; ANSP 54723 (holotype of *Schilbeodes gallowayi*, Holston R., above Bluff City, Tennessee, collected June 30, 1930 by J. Gordon Carlson). Cumberland R. system: CU 48613; USNM 161725.

Diagnosis.—*Noturus* (*Rabida*) *eleutherus* has a short caudal fin with 39 to 52, usually 43 to 49 rays; typically 9 pelvic and 8 soft pectoral rays; 12 to 16 anal rays; and normally 2 internasal and 10 preoperculomandibular pores. The humeral process is of moderate length; the adipose fin is nearly free posteriorly; the coloration is rather somber; and the blotch of the adipose fin extends only into its basal half.

In the subgenus *Rabida*, only *eleutherus* and *Noturus hildebrandi lautus* have ten preoperculomandibular pores but *N. hildebrandi* has eight pelvic rays. Unlike the *miurus* and most forms of the *furiosus* groups, *eleutherus* has few caudal rays and a relatively short humeral process; it lacks the midcaudal crescent present in members of the *furiosus* group. From the *hildebrandi* and *elegans* groups, *eleutherus* is distinguished by color pattern, a shorter, more chunky body, the relatively free posterior end of the adipose fin, and the longer pectoral spines.

Description.—Counts and measurements are given in tables 17 to 26. Body rather short, heaviest forward; caudal peduncle moderately narrow, a little deeper than snout; head slightly depressed, especially before eyes; lower jaw included; premaxillary tooth band

*Material indicated by an asterisk has been re-examined.

with obtusely angulate or rounded posterior corners; humeral process about equal to or longer than diameter of spine, not equal to width of spine and its serrae; pectoral spine moderately long, with posterior serrae recurved toward base and anterior serrae rather well developed; dorsal spine stout; adipose fin high, its posterior end developing into a free flap and nearly free from the short procurrent caudal fin; caudal fin truncate or slightly rounded behind; eye 1.8 to 2.7 times in snout; gill rakers 3 to 6 on first arch; the largest specimen examined is 73 mm. in standard length, but few specimens exceed 60 mm.

The caudal fin has (extremes in parentheses): (14) 15 to 18 (20), mean 16.5 upper simple rays; (14) 15 or 16 (18), mean 15.6 branched rays, of which 7 are most frequent in the upper half and 8 or 9 are usually in the lower half of the fin; and (10) 13 to 15 (17), mean 13.8 lower simple rays. Soft dorsal rays in 133 counts are five (in 2), six (130), and seven (1). The pectoral spine has four to eleven, usually from five to eight posterior serrae.

Five stained specimens have 11 (in 1), 12 (2), or 13 (2) vertebrae anterior to the origin of the anal fin. The ossified pectoral radials of both sides are fused in each specimen.

Color a rather dull brown, varying from dark brown to yellowish brown; side of body mottled; a dark brown bar crosses base of caudal peduncle (obscure in pale specimens); area over air bladder dark; a dark brown saddle begins at the front of the dorsal spine, extending backward through the base of the third dorsal ray and downward to below the lateral line; a narrow saddle just behind the dorsal fin contacts the anterior part of the adipose fin; another narrow dark blotch projects broadly into the base of the adipose fin; the basicaudal bar extends to the extremities of the upper procurrent rays and variously, sometimes not at all, onto the lower procurrent rays; caudal fin variously mottled, without a midcaudal bar, but a subterminal dark brown band is separated from a brownish blotch on basal half of longest caudal rays by a narrow light area; tips of caudal rays immaculate; adipose fin pale, unpigmented except at base; membrane of dorsal spine and base of dorsal rays moderately pigmented; a brown band crosses the otherwise immaculate dorsal fin about three-fourths of the distance from the base; pelvic fin immaculate, rarely with a few brown blotches; pectoral fin and spine blotched, ends of rays pale; undersurface of head and abdomen with very few brown chromatophores; a dusky band usually bridges the abdomen in front of pelvics and another crosses the chin; lower barbels weakly pigmented; upper barbels rather heavily pigmented; top of head dark; a light spot usually present behind the eye and another on cheek below eye; a band crossing the back of the head extends to the branchiostegal membrane and operculum, its lower end meeting one extending diagonally downward from the eye and forward below the nares to the snout; anterior naris pale.

TYPE.—The holotype of *Noturus eleutherus* (USNM 29678) is in extremely poor condition. It has little color left and is somewhat distorted. According to Jordan (1877b, p. 370) it was taken alive from the mouth of a watersnake. The specimen is 62 mm. in standard length and apparently a male; the premaxillary tooth patch is rectangular, and without backward extensions. There are 14 anal rays, approximately 43 (with a possible error of ± 2 or 3) caudal rays, 24 rays in the upper half of the caudal fin, 9 rays in the right pelvic fin and probably 9 in the left, 6 soft dorsal rays, 4 or 5 gill rakers on the first arch, and 2 internasal and 10 preoperculomandibular pores on each side. There are 8 recurved serrae on the posterior edge of the left pectoral spine and weak anterior serrae. The adipose blotch is very low on the fin; the head length stepped into the standard length is 3.45, and the humeral process is moderate in length. Measurements are given in table 28.

VARIATION.—The general similarity of populations of *eleutherus* suggest geographic continuity; the color pattern, body form, and meristic characters are relatively uniform. The few specimens from the Red and Ouachita River systems look like other material, and differ at most by a minor shift in averages.

The numbers of meristic counts, their range (in parentheses), and means are as follows: (a) Tennessee and Cumberland River systems, (b) Ohio Valley proper, (c) Ouachita and Red River systems, and (d) total.

Anal rays: (a) 32 (12–15) 13.63; (b) 94 (12–16) 13.87; (c) 6 (13–14) 13.50; (d) 132 (12–16) 13.80.

Lower-half caudal rays: (a) 31 (20–26) 22.29; (b) 94 (20–25) 22.56; (c) 4 (22–23) 22.50; (d) 129 (20–26) 22.50.

Upper-half caudal rays: (a) 32 (21–25) 22.84; (b) 95 (21–27) 23.57; (c) 4 (24–26) 24.75; (d) 131 (21–27) 23.43.

Vertebrae: Upper Tennessee R. 35 (32–35) 33.11; Obey R., Tennessee 1 (34) 34.00; Scioto R., Ohio 28 (31–33) 32.39; Kentucky R. 2 (32–33) 32.50; Wabash R. 18 (32–34) 32.33; Ouachita R. 3 (31–32) 31.33; total 87 (31–35) 32.66.

Caudal rays: Holston River 12 (42–47) 45.17; Clinch River 17 (42–47) 44.41; Cumberland River 2 (50–51) 50.50; Green River 2 (43–44) 43.50; Wabash River 22 (44–52) 46.86; Miami River 19 (43–51) 46.05; Scioto River 28 (42–50) 46.14; Shade Creek, Hocking and Muskingum Rivers 20 (39–49) 45.35; French Creek 5 (43–51) 46.80; Ouachita River 1 (47) 47.00; Little River 3 (46–49) 47.33; total 131 (39–52) 45.90.

Pelvic ray counts in samples from Tennessee, Kentucky, Arkansas, Oklahoma, the Miami River, Ohio, and the Wabash River have means of 9.00, 8 French Creek specimens a mean of 9.38, 40 specimens from Shade Creek, the Hocking and Muskingum Rivers a mean of 9.23, and 56 specimens from the Scioto River a mean of 9.21; the samples with high means have 9 or 10 pelvic rays.

There are usually eight soft pectoral rays. The means for the same geographic areas as the pelvic rays are usually 7.97 to 8.03, but the Scioto River population has a mean of 8.16 and the combined samples for Shade Creek and the Muskingum and Hocking Rivers has a mean of 8.10.

NOMENCLATURE.—The holotype of *Noturus eleutherus* Jordan is briefly described above. The name applies only to the species currently recognized. Fowler (1945) described *Schilbeodes gallowayi* from the same region. The type (ANSP 54723) came from the Holston River, above Bluff City, Tennessee. It is a male, 55.5 mm. in standard length, with 14 anal rays, 16+7+10+12=45 caudal rays, and 6 soft dorsal rays. On each side there are nine pelvic rays, eight soft pectoral rays, six recurved serrae on the posterior edge of the pectoral spine, and two internasal pores. There are 25 moderate dentations on the anterior edge of the left pectoral spine and 23 on the right; 10 preoperculomandibular pores on the left and 9 on the right; and 3 gill rakers on the left front arch and 4 on the right. The head length is stepped 3.5 times in the standard length and the distance from the end of the adipose fin to the tip of the caudal fin stepped into the distance from the origin of the dorsal fin to the end of the adipose fin is 2.1. The color pattern and the above listed characters are typical of *Noturus eleutherus.*

Jordan (1885, p. 802) listed: "*Noturus latifrons* Gilbert and Swain, Proc. U. S. Nat. Mus., 1885. White River, Indiana." This appears to be a nomen nudum, as no description has been found. A specimen of *Noturus eleutherus* (USNM 39519 or 36653) is labeled W. White River, Gosport, Indiana, and has a printed label indicating that it is USNM 36653, the type of *Noturus latifrons* Gilbert and Swain.

DISTRIBUTION.—*Noturus eleutherus* (map 12) seems to be a river species. It occurs in the Ohio River and its various tributaries from French Creek, Pennsylvania, through Ohio and Kentucky to the Wabash River, Indiana, and the Cumberland River, Tennessee. In the upper Tennessee River system it is known from North Carolina, Tennessee, and Georgia. The distribution is apparently discontinuous since *eleutherus* occurs also in the Ouachita River system of Arkansas and the Red (Mountain Fork) River system of Oklahoma and Arkansas. This seeming discontinuity, however, may not be real since the big river faunas are little known.

The hybrid, *Noturus exilis* × *Noturus miurus*, and specimens of *N. placidus*, *N. stigmosus*, *N. furiosus*, *N. flavater*, and *N. miurus* have been improperly recorded as *eleutherus*.

MAP 12.—Distribution of *Noturus eleutherus* Jordan. The verified localities are indicated on the map. Many other records are considered doubtful. I suspect that this species is found also in the lower sections of the rivers from which it is known and that there is no significant distributional gap between Arkansas and the Ohio drainage.

ECOLOGICAL CONSIDERATION.—A survey of the field records for *eleutherus* suggests that it is chiefly a resident of large or fairly large, moderate or swift-flowing streams or rivers. It has been taken principally in streams containing moderate or large stones, rubble, gravel, and sand, and usually lives in clear water. Dr. George A. Moore has informed me that in the Mountain Fork River, the species came almost exclusively from a heavily vegetated, gravel riffle with gentle flow. Species of *Noturus* that have been collected with *eleutherus* are: *gyrinus, nocturnus, flavus, stigmosus, miurus,* and *flavipinnis.*

REMARKS.—The name *eleutherus* (Greek) means not bound, or free; it refers to the relatively free posterior flap of the adipose fin.

Although both sexes are present in each species, *Noturus eleutherus* has been regarded by some workers as the male and *Noturus stigmosus* as the female. This has led to lumping populations containing both species under the name *Schilbeodes eleutherus.* A comparison of the two forms is given in table 13. Figure 4 compares their caudal ray counts.

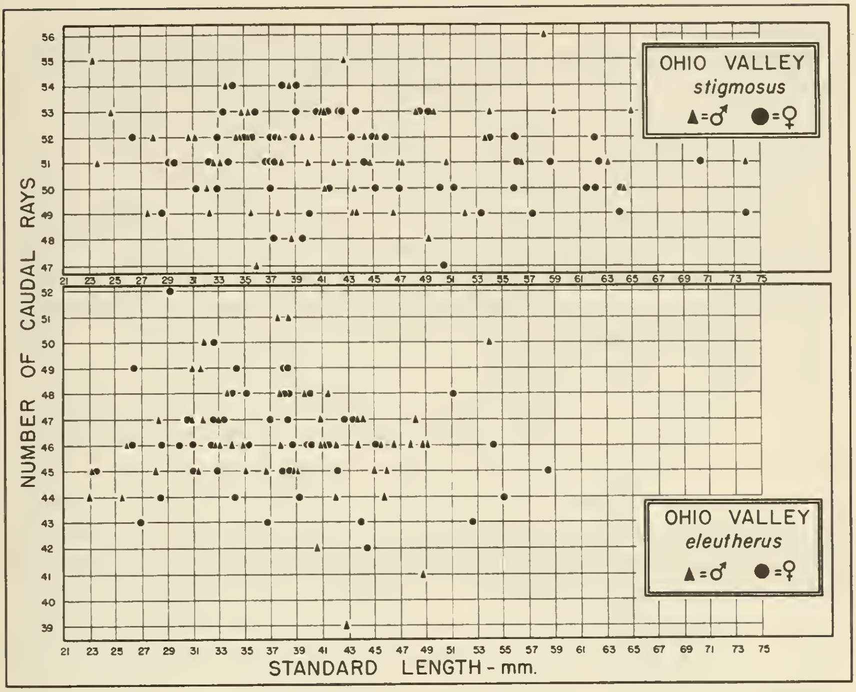

FIGURE 4.—Comparison of the number of caudal rays in *Noturus eleutherus* and *Noturus stigmosus*. The data are from specimens taken in the Ohio drainage basin, including several lots in which the species were associated. No change in number with age is indicated nor is a sexual difference evident. An overlap exists between 47 and 52 caudal rays, but only an occasional specimen of *N. eleutherus* has more than 49 rays and few examples of *N. stigmosus* have less.

The FURIOSUS Group

The *furiosus* group consists of four widely separated allopatric stocks (map 13), a geographic situation without known parallel among eastern North American fishes. These populations are named *Noturus furiosus*, *Noturus stigmosus*, *Noturus munitus*, and *Noturus placidus*. All are characterized by a long, strong, relatively well-serrated pectoral spine; a long humeral process and dorsal spine; a dark, lunate or crescent-shaped midcaudal band; whitish tips of the anterior dorsal rays; a relatively free posterior margin of the adipose fin; and an intermediate number of caudal rays.

The four disjunct populations differ in certain characters (table 14) which point to the desirability of nomenclatorial recognition. Because these morphological differences, although not strikingly prominent, permit identification of all well-preserved specimens, the four populations are recognized as species. The geographic segregation, however, may raise questions as to the proper systematic level (species or subspecies?). No intergradation or significant geographic gradients are known and the hiatus in ranges is probably real. The criterion of interbreeding cannot be applied because the forms are found in three completely isolated watersheds. The two forms (*N. placidus* and *N. stigmosus*) that occur in the Mississippi drainage are apparently not only segregated geographically, but separated ecologically by a barrier (the lower Arkansas and Mississippi Rivers) of highly turbid waters and shifting sand; morphologically they are quite dissimilar. *Noturus stigmosus* appears to be more closely related to *N. munitus* than to the other species, suggesting relatively recent isolation of the two forms.

In comparison with other *Noturus*, only *N. gyrinus* occupies as extensive a range as does the *furiosus* group. The species of the group are all characteristic of lowland streams, chiefly large streams and rivers; thus simple headwater crossovers between streams probably did not take place. Instead, relict populations of a more widely distributed ancestor remain today, or the forms attained their present distribution through changed drainage of major streams. No direct method of getting into the eastern Carolina streams from the Ohio Valley or Gulf coastal region is evident, thus the geographic pattern suggests a more widespread previous distribution. *Noturus munitus*, however, due to closer similarity to *N. stigmosus* than to the other forms, may have become established relatively recently, perhaps during some excessive overflow of glacial meltwaters from an overburdened Mississippi River, or during a concentration of these fresh waters in the Gulf of Mexico between the mouths of the Mississippi and Alabama Rivers. Because other large-river fishes are known to range eastward from the Mississippi River into other Gulf coastal streams, a major change in the course of a stream may be indicated. Invasion of the Lake Erie drainage by *N. stigmosus* has been recent as indicated by the similarity of the Huron River and Ohio Valley populations, and by their distribution. It undoubtedly took place in post-Wisconsin time through the Maumee glacial outlet.

***Noturus placidus*, new species**

NEOSHO MADTOM

PLATES 4 (FIG. 9), 15 (FIG. 2), 17 (FIG. 2); MAP 13

Noturus miurus Jordan [misidentification].—?Gilbert, 1886, p. 207 (Neosho R., Emporia, Kans.).

Schilbeodes miurus (Jordan) [misidentifications].—Breukelman, 1940b, p. 381 (Neosho R. system,* Kans.).—Moore and Paden, 1950, p. 87 (Illinois R., about 5 mi. NE. of Gore,* Okla.).

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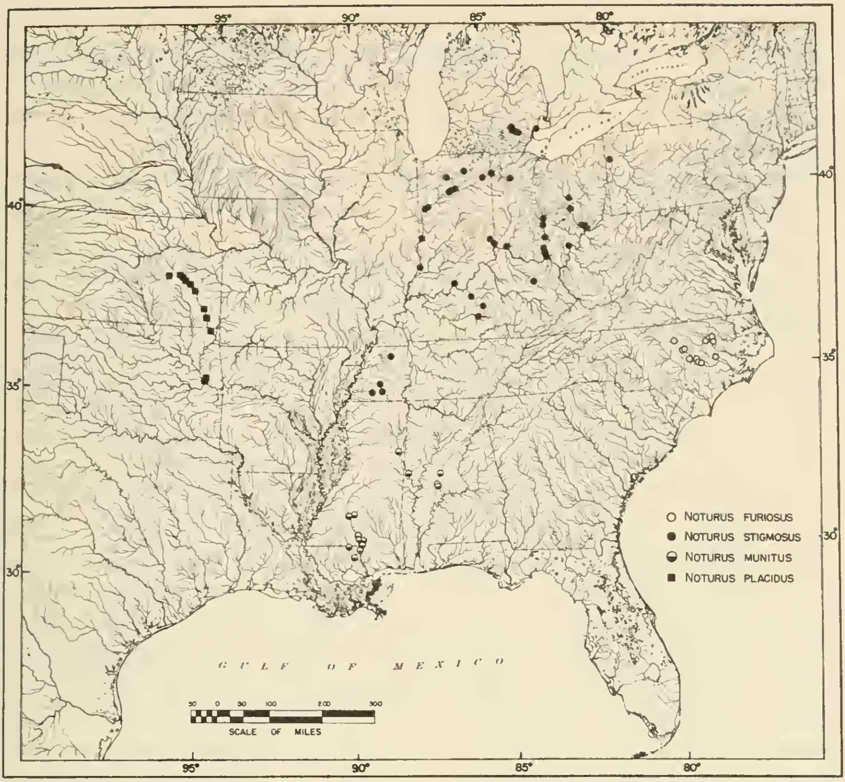
*Material indicated by an asterisk has been re-examined.



MAP 13.—Distribution of the four species of the *furiosus* group. The symbols represent material examined.

Schilbeodes eleutherus (Jordan) [misidentifications].—Hubbs and Lagler, 1941, p. 65; and 1947 [and 1949], p. 73 (Kansas).—Moore and Paden, 1950, p. 87 (Illinois R. records: near mouth* and near Gore,* Sequoyah Co., Okla.).—Bailey and Taylor, 1950, pp. 31, 38 (parts of Arkansas R. system).

Noturus eleutherus Jordan [misidentification].—Eddy, 1957, p. 154 (range, in part).

Schilbeodes species.—G. A. Moore, 1952, p. [6] (Oklahoma).—Hall, 1954, p. 61 (Illinois R., Okla.).—Cross, 1954, p. 311 (synonymy; riffles of Cottonwood R.,* at mouth of South Fork Cottonwood R., Chase Co., Kans.).

Noturus species.—Clarke, Breukelman, and Andrews, 1958, p. 168 (riffles, Lyon Co., Kans.).—Deacon, 1961, pp. 396, 404, 419–424 (habitat, abundance, distribution, Neosho R., Kans.; in moderate to large streams).—Cross, 1967, pp. 197, 222 (figure, description, Kansas distribution).—Branson, 1967, p. 146 (Neosho R., Kans.).

TYPE-SPECIMENS.—UMMZ 167653 (holotype), UMMZ 167654 (27 paratopotypes), and KU 2517 (82 paratopotypes), from the Neosho

*Material indicated by an asterisk has been re-examined.

River, just S. of U.S. Hwy. 50, near Emporia, sec. 7, T. 19 S., R. 12 E., Lyon Co., Kansas, collected July 11, 1952, by W. R. Taylor and F. B. Cross. USNM 200679 (8 paratopotypes), same locality, collected August 13, 1965, by W. R. and Brian Taylor, Cross, and Ron S. Nolan.

Other paratypes.—The catalog number is followed by the number of specimens in parentheses.

UNITED STATES: Kansas: UMMZ 97126–7 (4), Neosho R., 12 mi. NE. of Parsons, Neosho Co., September 22, 1930, J. Clark Salyer II. KU 1757 (2), Neosho R., Coffey Co., University of Kansas Biological Survey. KU 2518 (42) and UMMZ 167655 (15), Neosho R., Neosho Rapids, sec. 29, T. 19 S., R. 13 E., Lyon Co., July 11, 1952, W. R. Taylor and F. B. Cross. KU 2519 (2), Neosho R., Hartford, sec. 10 and 15, T. 20 S., R. 13 E., Lyon Co., July 12, 1952, Taylor and Cross. KU 2520 (6) and UMMZ 167657 (2), Neosho R., Burlington, sec. 26, T. 21 S., R. 15 E., Coffey Co., July 12, 1952, Taylor and Cross. KU 2521 (12) and UMMZ 167656 (4), Neosho R., Neosho Falls, sec. 28 and 33, T. 23 S., R. 17 E., Woodson Co., July 12, 1952, Taylor and Cross. KU 2693 (68), Cottonwood R., sec. 25, T. 19 S., R. 8 E., Chase Co., August 14, 1952, Cross and R. L. Carpenter. KU 2915 (5), Neosho R., sec. 16, T. 32 S., R. 21 E., Labette Co., May 9, 1953, Cross. KU 7769 (24), Neosho R., 1 mi. S. and 0.5 mi. E. Montana, Labette Co., April 11, 1963, Martin L. Wiley. KU 8462 (29), Neosho R., 2.5 mi. W. and 0.5 mi. N. St. Paul, sec. 16, T. 29 S., R. 20 E., Neosho Co., August 27, 1959, James Deacon. USNM 200677 (38), Cottonwood R., at mouth of South Fk. Cottonwood R., sec. 25, T. 19 S., R. 8 E., Chase Co., August 13, 1965, W. R. and Brian Taylor, Cross, and Ron S. Nolan. Oklahoma: KU 2403 (1), Illinois R., near mouth, Sequoyah Co., August 24, 1946, J. M. Paden. UMMZ 156772 (2), mouth of Illinois R., sec. 20–21, T. 12 N., R. 21 E., Sequoyah Co., August 24, 1946, G. A. Moore. UMMZ 156774 (1), Illinois R., about 5 mi. NE. of Gore, sec. 22–23, and 27, T. 13 N., R. 21 E., August 23–27, 1946, Moore. Tulsa U (no number) (2), Illinois R., Gore, Sequoyah Co., August 27, 1948 and October 7, 1950, A. P. Blair. Tulsa U (no number) (1), Neosho R., 4 mi. NW. of Miami, Ottawa Co., September 29, 1951, Blair.

Diagnosis.—*Noturus* (*Rabida*) *placidus* has a moderately long humeral process, rather weak dentations of the anterior edge of the pectoral spine, a somber color pattern, 50 to 59 caudal rays, 13 to 16 anal rays, 11 preoperculomandibular pores, 2 internasal pores, 9 pelvic rays, and 8 soft pectoral rays. It is a member of the *furiosus* group, which is characterized by having a midcaudal brownish crescent of pigment, a relatively deep, chunky body, and tending to have typical saddle marks, of which the first bears two very faint, light, predorsal spots; but the adipose fin is relatively well connected with the caudal, the humeral process and the serrations of the pectoral spine are somewhat reduced, the blotch of the adipose fin is dusky and enters only its base, the lower procurrent caudal rays are usually unpigmented, and the belly generally lacks chromatophores.

Description.—Other counts and measurements are given in tables 17 to 26. Body heavy, deepest below the dorsal fin; caudal peduncle moderately deep and heavy; head shallowly rounded above or slightly depressed; lower jaw included; eye large, 1.7 to 2.3 times in snout; premaxillary tooth patch with posterior corners rounded or obtusely angulate; humeral process subequal to or a little longer than width of the pectoral spine and its serrae; pectoral spine moderately long and curved backwards, anterior dentations definite, numerous but short, posterior serrae as in others of the subgenus, relatively few in number, and with the tips recurved; dorsal spine long; adipose fin of moderate height and length, connected to the short procurrent caudal rays, but tending to form a small, free, posterior flap; caudal fin truncate or slightly rounded behind; gill rakers five to seven on the first arch. The largest specimen examined measures 57.1 mm. in standard length.

One stained specimen has single pectoral radials (2 elements fused), and twelve vertebrae anterior to the origin of the anal fin.

Posterior serrae of the pectoral spine in 58 fins, 6 to 8, usually 6 or 7; soft dorsal rays in 89 specimens, 6 (in 79), 7 (9), or 8 (1). Upper simple caudal rays in the same specimens (extremes in parentheses) are (19) 20 to 22 (24), mean 21.1; branched caudal rays (15) 16 or 17 (19), mean 16.3, with usually 7 rays in the upper half and 9 or 10 in the lower half; lower simple caudal rays (15) 16 to 18 (20), mean 16.9.

Body moderately mottled, but somber, generally without the prominent dark blotches of related species; color in life light yellowish pink mottled with brown. Head moderately dark above; a dark band on back of head extends onto the branchiostegal membrane and operculum; another passes just below the eye backward to the first and forward onto the snout; cheek, anterior naris, and postorbital spot pale; upper barbels heavily pigmented; outer mental barbel with scattered pigment; inner mental barbel, lower lip, and lower surface of head usually immaculate; abdomen usually immaculate, but sometimes with a few irregularly shaped chromatophores, rarely with round brown spots; these most prominent in young below 21 mm. in standard length; pelvic fin pigmented near the base on upper surface, otherwise immaculate, or with one or more large irregular blotches; pectoral fin blotched, with an immaculate margin; anal fin with some scattered pigment, a submarginal dark brown band, and an immaculate edge, sometimes also with a short, medial dark brown band; dorsal fin with the basal saddle or blotch extending posteriorly to base of second ray; dorsal spine yellowish white at tip, otherwise dusky as is the fin base; the dusky base followed outward by a scarcely pigmented, clear area, a broad dark brown distal band, and an immaculate margin; caudal fin with two crescentic brown bands, one subterminal which connects with a median band above and below; lower limb of bands usually not extending forward to procurrent rays, which are im-

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maculate; upper limb extends onto upper procurrent rays and downward, indistinctly, into base of caudal peduncle; adipose fin mostly immaculate, its broad, dusky blotch extending into only the basal one-half of fin; below, the blotch grades into the mottled side; a dark or dusky blotch is between the dorsal and adipose fins; the first dark saddle extends from the dorsal fin to below the lateral line, backward to the second dorsal ray, and forward as a narrow blotch along the midline to a point midway between the dorsal spine and head; it may enclose two small, faintly developed, predorsal light spots; membrane over air bladder grayish.

Type.—The holotype (UMMZ 167653) is a male, 43.0 mm. in standard length. It has 4+10=14 anal rays, 20+8+9+17=54 caudal rays, and 6 soft dorsal rays. On both sides there are: nine pelvic rays, eight soft pectoral rays, six serrae from posterior edge of pectoral spine, two internasal pores, and eleven preoperculomandibular pores. The head length is stepped into the standard length 3.35 times and the distance from the end of the adipose fin to the tip of the caudal fin is stepped into the distance from the origin of the dorsal fin to the end of the adipose fin 1.55 times. Other measurements are given in table 28,

Range.—Map 13 shows the distribution of this species. It occurs in the Cottonwood River, throughout the Neosho River below Emporia, Kansas, and in the lower few miles of the Illinois River, Oklahoma. Cross (1967, p. 223) recorded specimens from the Spring River, Kansas, a tributary of the Neosho River.

Variation.—Other than the specimen with 13 anal rays, counts obtained from the Neosho River population overlap broadly those from 5 Illinois River specimens. Probably there are no significant differences in the structures studied between Illinois and Neosho River specimens, and none is evident in pigmentation. Illinois River fish are heavier bodied.

Etymology.—The name *placidus* (Latin) means mild, quiet, or gentle. It is used in allusion to the relatively poorly armed pectoral spine in contrast with other members of this species group.

Relationship.—Although the adipose blotch is poorly developed and extends only into the basal portion of the fin, and the humeral process is hardly longer than in *Noturus eleutherus*, the number of preoperculomandibular pores, the pigmentation, especially the tendency to form predorsal light spots in the saddle about the dorsal fin, and the midcaudal crescentic bar, align this species with the *furiosus* species group.

Ecological considerations.—*Noturus placidus* has been taken in collections containing *N. nocturnus*, *N. exilis*, and *N. flavus*. In the Illinois River, Oklahoma, it was taken close to a locality whence *N. miurus* was obtained.

N. placidus is a riffle fish, living under rocks, in large gravel, or in cavities; it probably prefers clear water. It was taken easily in the upper Neosho River by literally shoveling gravel out of a riffle onto the bank and removing the catfish from the substratum. Mr. J. Clark Salyer collected the species by turning stones and seining with a heavily weighted seine up the riffle from which the stones had just been removed. It is of interest to note that Salyer collected his specimens from beneath large stones, I have collected them chiefly from gravel, and Dr. George A. Moore reports that in the Illinois River he found them over a fine sand bottom with mud and decaying matter, but which was barren of plants.

N. placidus seems to be confined to riffles in the main channels of the larger rivers. No specimens have been obtained from creeks or the small to moderate size tributaries of the Neosho or Illinois Rivers.

***Noturus stigmosus*, new species**

NORTHERN MADTOM

PLATES 2 (FIG. 4), 4 (FIG. 11), 16 (FIG. 1), 18 (FIG. 1); MAP 13

Noturus miurus Jordan [misidentifications].—Jordan, 1890, pp. 158–162 (description; Indiana records: Tippecanoe R., Marshland,* in part; Wabash R., Vincennes,* in part).—Woolman, 1892a, p. 251 (Kentucky records: Rolling Fork of Salt R., 1.25 mi. E. of Booth,* in part and New Market,* in part).—Hay, 1894, pp. 173–174 (in part; compiled).—Kirsch, 1895, pp. 327–335 (Maumee R., Antwerp,* Ohio and Fort Wayne,* Indiana, both in part; Blanchard R., Ottawa,* Ohio); 1896b, p. 105 (in part; records repeated).

Schilbeodes miurus (Jordan) [misidentifications].—Eigenmann and Beeson, 1894a, p. 81; 1894b, p. 44 [and 1905, pp. 120–121] (in part; Indiana records compiled).—Osburn, 1901, p. 29 (in part; compiled).—Evermann, 1918, p. 335 (in part; compiled).—Gerking, 1945, map 64 (compiled Indiana records, in part).

Noturus eleutherus Jordan [misidentifications].—Kirsch, 1894, p. 87 [and vol. 14, p. 36] (middle course of Eel R., Ind.*).—Hay, 1894, p. 172; and 1902, p. 70 (compiled).—Kirsch, 1896a, p. 53 (relisted; hypothetical, Whitley Co., Ind.).—Gerking, 1955, p. 76 (key, in part).—Eddy, 1957, p. 154 (range, in part).

Schilbeodes eleutherus (Jordan) [misidentifications].—Eigenmann and Beeson, 1894a, p. 81; 1894b, p. 45 [and 1905, p. 121] (in part; compiled).— Osburn and Williamson, 1898, pp. 12, 19 (description; Big Walnut Cr., Franklin Co.,* Ohio).—Osburn, 1901, pp. 27, 28 (description; record relisted).—Meek, 1908, p. 141 (Eel R., Ind.).—Hubbs and Ortenburger, 1929, p. 97 (Indiana, in part).—Raney, 1939a, p. 275 (Ohio drainage of W. Pennsylvania, in part).—Raney and Lachner, 1939, p. 158 (associations; Shenango R., near Delaware Grove,* Mercer Co., Pa.).—Hubbs and Lagler, 1939, p. 27 (comparisons; Great Lakes basin).—Fowler, 1940b, p. 9 (in part; compiled).—Hubbs and Lagler, 1941, pp. 63, 65 (in part; comparison; ecology; range, including head of Detroit R.,* L. Erie drainage of Michigan and W. Ohio, and part of Ohio R. tribs.).—Gerking, 1945, pp. 16, 76, map 65 (ecology; Indiana

*Material indicated by an asterisk has been re-examined.

distribution, in part [including station nos. IU 179,* in part, 254,* and 339,* in part; probably also the Eel R. and Tippecanoe R. records, in part]).—Hubbs and Lagler, 1947 [and 1949], pp. 72–73, fig. 180 (comparison; range, in part; specimen Washtenaw Co., Michigan figured).—Bailey and Taylor, 1950, pp. 31, 38 (range, in part; Ohio R. drainage and Huron R., Mich.).—W. B. Scott, 1954, p. 69 (Detroit R.).—G. A. Moore, 1957, p. 145 (range, in part).

Rabida eleuthera (Jordan) [misidentification].—Blatchley, 1938, pp. 67–68 (Eel R., Ind., only).

Schilbeodes furiosus (Jordan and Meek) [misidentifications].—Hubbs and Brown, 1929, pp. 2–43 (hypothetical, Ontario; Huron R., Ann Arbor,* Mich.; range). —Osburn, Wickliff, and Trautman, 1930, pp. 170–174 (range, in part, including Indiana and Michigan; Ohio records: Shade Cr., Meigs Co.;* lower reaches of the Scioto* and Muskingum* Rivers).—Hubbs, 1930, p. 432 (description; Indiana, Ohio, and Huron R., Ann Arbor,* Mich., only).—Hubbs and Lagler, 1957, p. 5 (Great Lakes region); 1958, pp. 89, 91, fig. 180 (key; range).

Noturus furiosus Jordan and Meek [misidentifications].—Trautman, 1959, pp. 41, 43, 97, 435–443, fig. 112, map 112 (synonymy; description; range; Ohio distribution and ecology).—Charles, 1967, pp. 385, 387 (Green R., Ky.).

Noturus stigmosus Taylor.—Taylor, 1957, p. 192 [reprint, p. 151] (nomen nudum).

Noturus species.—P. W. Smith, 1965, p. 9 (Illinois distribution: lower Vermilion and Wabash Rivers).

Type-specimens.—UMMZ 165843 (holotype) and UMMZ 165844 (7 paratopotypes), from the Huron River, just south of pool, below North Territorial Road, north of Dexter, sec. 13, T. 1 S., R. 4 E., Washtenaw Co., Michigan, collected September 3, 1951, by F. B. Cross, R. M. Bailey, and W. R. Taylor.

Other paratopotypes

UNITED STATES: Michigan: Huron R., just S. of North Territorial Road, N. of Dexter, sec. 13, T. 1 S., R. 4 E., Washtenaw Co., UMMZ 165846 (22 specimens), May 13, 1952, C. L. Smith, G. C. Rinker, and W. R. Taylor; UMMZ 165849 (5), July 19, 1953, Taylor and Smith; TU 19217 (4), August 31, 1958, R. D. Suttkus, Carter Gilbert, and William Davis; TU 19246 (6), September 3, 1958, R. D. Suttkus, Myrna Anderson, and Tom Poulson.

Other paratypes

UNITED STATES: Michigan: Huron R., 2 mi. above Dexter, Washtenaw Co., UMMZ 64223 (3 specimens), July 27, 1932, S. N. Jones; UMMZ 92137 (1), May 19, 1931, Henry van der Schalie; UMMZ 108063 (5), May 23, 1931, Carl L. Hubbs and van der Schalie. Huron R., 3 mi. NW. of Dexter, Washtenaw Co., UMMZ 95005 (1), November 27, 1931, E. P. Creaser; UMMZ 106881 (3), January 4, 1932, Creaser and Kuhne. Huron R., at Delhi Rapids, 4 mi. above Ann Arbor, Washtenaw Co., UMMZ 109530 (1), May 24, 1935, R. M. Bailey; UMMZ 181035 (1), October 30, 1937, Bailey and Lloyd Smith. Huron R., above mouth of Mill Cr., Washtenaw Co., UMMZ 111327 (2), June 10, 1936, M. B. Trautman and C. M. Tarzwell. Huron R., Ann Arbor, Washtenaw Co., UMMZ 126218 (1), October 29, 1903, Charles C. Adams. Junction of L. St. Clair and Detroit R., at

*Material indicated by an asterisk has been re-examined.

Alter Road, opposite Marine Hospital, Wayne Co., UMMZ 132009 (1), March 21, 1937, I. G. and J. L. Crawford. Huron R., 1.75 mi. NW. of Dexter, Washtenaw Co., UMMZ 165835 (2), August 8, 1951, W. R. Taylor, L. W. Lowe, and C. L. Smith; USNM 174906 (1) and UMMZ 165837–165838 (5), August 10, 1951, Bailey, Taylor, Lowe, and Smith; UMMZ 165841 (13), August 10, 1951, Taylor, Bailey, Smith, and Lowe; UMMZ 165847 (2), July 27, 1952, R. M. Bailey and family, and Taylor. Huron R., at and above outlet of Portage L., Washtenaw Co., UMMZ 165848 (2 adults and 61 young), July 27, 1952, Bailey and family, and Taylor. Huron R., sec. 12, T. 1 S., R. 4 E., Washtenaw Co., UMMZ 167301 (10), June 8, 1954, G. P. Cooper. INDIANA: Maumee R. [at Fort Wayne], UMMZ (IU no. 8970) (1), P. S. Kirsch. OHIO: Blanchard R., Ottawa, Putnam Co., OSU 9347 (1), P. S. Kirsch. Maumee R., Antwerp, Paulding Co., UMMZ (IU no. 6651) (5), Kirsch.

OTHER MATERIAL STUDIED

UNITED STATES: INDIANA: Wabash R., Independence, Warren Co., IU 179 (5 specimens). Whitewater R., Cedar Grove, Franklin Co., IU 254 (1specimen). Wabash R., Attica, Warren Co., IU 339 (3 specimens). Eel R., 1892, P. S. Kirsch, CU 41757; USNM 66697. Eel R., Mexico, Miami Co., USNM 66690. Wabash R., Terre Haute, Vigo Co., USNM 66692, 161719. Tippecanoe R., Marshland, Fulton Co., USNM 66699, 66847, 161718, 161722. Eel R., Adamsboro, Cass Co., USNM 66701. Eel R., Logansport, Cass Co., USNM 121972. Wabash R., Durkee's Ferry, Terre Haute, USNM 121975. Wabash R., Vincennes, Knox Co., USNM 161721. Tippecanoe R., below Tippecanoe L., Kosciusko Co., UMMZ 164579. Logansport, Cass Co., UMMZ (IU no. 9604). Ohio R., Lock 44, mi. 663.1, Leavenworth, UL 8954. KENTUCKY: Rolling Fork Salt R., New Market, USNM 161716. Rolling Fork Salt R., Booth, USNM 161727; UMMZ (IU no. 8663). Green R., Greensburg, Green Co., UMMZ 165294. Licking R., Hwy. 801, about 4 mi. S. Farmers, USNM 199587. OHIO: Big Darby Cr., S. of Fox, SE. Jackson Twp. Pickaway Co., OSU (no number). Muskingum R., Dam 2, west-central Muskingum Twp., Washington Co., UMMZ 107888. Shade Cr., Chester Twp., Meigs Co., OSU (no. F55); UMMZ 164580. Scioto R., Clay Twp., Scioto Co., OSU (nos. F359, 3–74). Muskingum R., Dam 3, Lowell, Washington Co., OSU (no. F409). Scioto R., SW. Scioto Twp., Pike Co., OSU (no. F471); UMMZ 87735. Muskingum R., Muskingum Twp., Washington Co., OSU (nos. F541 or 542); OSU 843. Big Walnut Cr., Lockbourne, Franklin Co., OSU (no. F627). Scioto R., Morgan Twp., near mouth of Bear Cr., Scioto Co., OSU (no. 3–38). Scioto R., at Lucasville, Rush and Valley Townships, Scioto Co., OSU 821. Muskingum R., Adams Twp., Washington Co., OSU 868. Muskingum R., Ellis Dam, Washington Twp., Muskingum Co., OSU 938. Walhonding R., Bethlehem Twp., Coshocton Co., OSU 973. Scioto R., Rush Twp., Scioto Co., OSU 21112. Muskingum R., below Dam 3, Adams Twp., Washington Co., OSU 2879. Little Miami R., Red Bank, Columbia Twp., Hamilton Co., OSU 5157. Paint Cr., NE. Huntington Twp., Ross Co., OSU 6509. Whitewater R., at Indiana line, OSU 6974. PENNSYLVANIA: Shenango R., near Delaware Grove, N. of Mercer, Mercer Co., CU 3730, 6418, 8202, 8216; UMMZ 102894. Shenango R., N. of Mercer, Mercer Co., CU 4167. Shenango R., at Delaware Grove, 6 mi. N. of Mercer, Mercer Co., UMMZ 75487, 110744. Shenango R., Mercer Co., UMMZ 106834. Shenango R., UMMZ 110755. Shenango R., 6 mi. N. of Mercer, Mercer Co., UMMZ 110765. TENNESSEE: Middle Fork Obion R., at Hwy. 22, about 5 mi. SE. intersection with Hwy. 54, Weakley Co., CU 48614; KU 8959. Spring Cr., Hwy. 125, 1.2 mi. S. Bolivar, Hardeman Co., USNM 190776. Big Black Cr., Madison Co., Vanderbilt

U (no number). Loosahatchie R., Hwy. 76, N. of Somerville, Fayette Co., USNM 193463.

DIAGNOSIS.—*Noturus* (*Rabida*) *stigmosus* of the *furisous* species group has 47 to 56, usually 49 to 53 caudal rays; 13 to 16 anal rays; 8 to 10, normally 9 pelvic rays; 7 to 9, often 7, but more frequently 8 soft pectoral rays; and typically 2 internasal and 11 preoperculomandibular pores. The posterior process of the cleithrum and spines are long; the adipose fin is of moderate height. Other characters contrasting it with members of the *furiosus* group are: the blotch of the adipose fin extends one-half to four-fifths the distance from the base to the margin but not to the margin; the anterior abdominal surface (except in large specimens) has many discrete chromatophores; the anterior serrae of the pectoral spine are prominent; the adipose and caudal fins are nearly free from each other; and the midcaudal crescent typically extends across both the upper and lower procurrent caudal rays to the caudal peduncle.

The midcaudal crescent of pigment, the nearly separated caudal and adipose fins, the eleven preoperculomandibular pores, and the moderate number of caudal rays distinguish *stigmosus* from all *Noturus* except species of the *furiosus* group. For further comparison with members of the *furiosus* group, see table 14.

DESCRIPTION.—Other counts and measurements are given in tables 17 to 26. Body chunky, deepest below the dorsal fin; caudal peduncle deep; head arched, slightly flattened above; lower jaw included; eye large, 1.7 to 2.4 times in snout; premaxillary tooth patch with rounded or obtuse posterior corners; humeral process longer than the width of pectoral spine and its serrae; pectoral spine long, curved backward, with numerous, prominent dentations on the anterior edge, and several on the posterior edge; posterior serrae, except for the basal 1 to 3, with tips recurved toward spine base; dorsal spine long, considerably longer than in *Noturus eleutherus*; adipose fin of medium height, with a free posterior flap, and weakly united at base to the short procurrent caudal rays; caudal fin truncate behind, with rounded corners; gill rakers four to seven on first arch. The largest specimen examined is 100.5 mm. in standard length. Many others are greater than 80 mm.

Soft dorsal rays are five (in 5), six (129), and seven (11). Caudal rays in Ohio Valley and Michigan specimens are (extremes in parentheses): (17) 18 to 20 (24), mean 19.8 upper simple rays; (14) 15 to 17 (19), mean 16.2 branched rays, of which (6) 7 (9) are in the upper half and (7) 9 or 10 (11) are in the lower half of the fin; and (13) 14 to 16 (18), mean 15.1 lower simple rays; counts from western Tennessee specimens fall within these ranges. Serrae on the posterior edge of pectoral spine mostly 5 to 10, ranging up to 14.

In cleared and stained specimens from Indiana, Ohio, Pennsylvania, and Michigan: vertebrae anterior to the anal origin 12 (12) or 13 (2); ossified pectoral radials tightly fused (9 sides) or variously joined or separate (25 sides). The partially fused radials may have the two ends fused but the middle parts unjoined and separated by a space, or have one or both ends of each radial free from the other element.

In life, body pinkish, yellowish, or medium tan with markings varying from brown to dark gray, or black. In preservation, body yellowish or pinkish; side usually mottled with light brown, heavily pigmented; head dark brown above, with a dark bar crossing back of head to operculum and branchiostegal membrane; another brown band extending from the snout backward passes beneath the eye, below a light brown spot back of eye, and to the bar on the operculum; anterior naris and cheek pale; upper barbels heavily pigmented with brown; mental barbels and lower lip with scattered dark pigment; lower surface of the head immaculate only at midline, otherwise with scattered brown pigment; abdomen immaculate except for a bridge of brown pigment just in front of pelvic fins and round brown chromatophores in the area back of isthmus and between pectoral fins; pelvic fin with some pigment below, mottled with brown above, especially near base; pectoral fin blotched, with an immaculate edge; front edge of pectoral spine whitish; anal fin dusky gray near base, with scattered brown pigment outward, a single submarginal brown band, margin unpigmented; tip of dorsal spine creamy white, spine otherwise dark brown; dorsal fin with a basal dusky gray area, then a clear area, a subterminal dark brown band, and a white edge; caudal fin yellowish white with two distinct crescentic brown bands (the inner obscured in some Ohio specimens by a dusky basicaudal blotch) which bend forward, the subterminal band uniting with the midcaudal band and passing onto the procurrent caudal rays and thence to the caudal peduncle; tip of fin and area between bands and peduncle yellowish white; band (bar) on caudal peduncle indistinct; adipose fin becoming dusky with age, especially near base, margin whitish; blackish adipose blotch extends from base one-half to four-fifths of the distance across fin; base of the blotch extending posteriorly and connected on the side, anteriorly, with a dark saddle between the dorsal and adipose fins, the connection outlining a yellowish area at anterior end of adipose fin; anterior brown saddle extending to below the lateral line, forward to midway between the dorsal spine and head, enclosing a pair of light yellowish white spots, and backward to the third dorsal ray; the light spots are variable in size, but are seldom indistinct; predorsal area light grayish brown; area over air bladder grayish.

Type.—The holotype (UMMZ 165843) is a male, 66.9 mm. in standard length. It has 5+9=14 anal rays, 20+7+9+14=50 caudal rays, and six soft dorsal rays. There are ten pelvic rays on the left and nine on the right side. On each side there are eight soft pectoral rays, two internasal pores, eleven preoperculomandibular pores, and seven serrae on the posterior edge of the pectoral spine. The anterior serrae of the pectoral spine are prominent and numerous. The humeral process is long. The body form and pattern are shown in the figures (pl. 16, fig. 1; pl. 18, fig. 1). The head length is stepped into the standard length 3.35 times; the distance from the adipose notch to the tip of the caudal fin is stepped into the distance from the dorsal origin to the adipose notch 1.95 times. Other measurements are given in table 28.

Distribution.—*Noturus stigmosus* (map 13) is found in the tributaries to the Mississippi River in western Tennessee and in the Ohio River system from the Shenango River, Pennsylvania, through Ohio to the Wabash River, Indiana, and the Green River, Kentucky. It is not known from either the Tennessee or Cumberland River systems. After the Wisconsin glaciation, it undoubtedly used the Maumee outlet to gain access to the western part of the Lake Erie basin, where it occurs in the Detroit, Huron, and Maumee Rivers. It is typically found in large streams or rivers.

Variation.—A study of data obtained from *Noturus stigmosus* throughout its range reveals no geographic trends; specimens from the Great Lakes basin appear not to differ materially from Ohio Valley or western Tennessee fish.

The following summarized data includes number of tabulations, range of variation (in parentheses), and mean; several samples have been grouped as follows: (a) Shenango River, Pennsylvania, (b) Muskingum River, Ohio, (c) Shade Creek and Scioto River, Ohio, (d) Miami and Whitewater Rivers, Ohio, (e) Salt River, Kentucky, (f) Wabash River, Indiana, (g) Great Lakes basin, (h) western Tennessee, and (i) total.

Preoperculomandibular pores: (a) 68 (9–12) 10.84; (b) 121 (8–12) 10.94; (c) 72 (9–12) 10.93; (d) 6 (10–11) 10.83; (e) 10 (10–11) 10.80; (f) 12 (9–12) 10.75; (g) 38 (10–12) 10.79; (h) 14 (10–11) 10.93; (i) 341 (8–12) 10.89.

Pelvic rays: (a) 70 (8–10) 9.23; (b) 122 (8–10) 9.08; (c) 22 (9–10) 9.14; (d) 6 (9–10) 9.33; (e) 6 (9–10) 9.17; (f) 12 (9–10) 9.08; (g) 58 (9–10) 9.14; (h) 14 (9–10) 9.21; (i) 310 (8–10) 9.14.

Soft pectoral rays: (a) 68 (7–8) 7.94; (b) 122 (7–8) 7.65; (c) 22 (7–8) 7.95; (d) 6 (8) 8.00; (e) 6 (7–9) 7.83; (f) 12 (7–8) 7.42; (g) 38 (7–8) 7.63; (h) 14 (8–9) 8.07; (i) 288 (7–9) 7.76.

Anal rays: (a) 35 (13–16) 14.49; (b) 61 (13–16) 14.34; (c) 11 (13–15) 14.09; (d) 3 (15–16) 15.67; (e) 3 (13–15) 14.00; (f) 6 (13–15) 14.17; (g) 27 (13–16) 14.44; (h) 7 (13–15) 14.00; (i) 153 (13–16) 14.37.

Lower-half caudal rays: (a) 35 (22–26) 24.03; (b) 60 (23–26) 24.62; (c) 11 (23–26) 24.27; (d) 3 (25) 25.00; (e) 3 (23–25) 24.00; (f) 6 (24–25) 24.83; (g) 18 (22–25) 23.50; (h) 7 (23–25) 24.43; (i) 143 (22–26) 24.30.

Upper-half caudal rays: (a) 35 (25–30) 27.23; (b) 61 (24–29) 26.39; (c) 11 (24–29) 27.18; (d) 3 (26–27) 26.33; (e) 3 (24–27) 25.67; (f) 6 (26–31) 28.00; (g) 18 (25–28) 26.67; (h) 7 (25–28) 26.71; (i) 144 (24–31) 26.76.

Total caudal rays: (a) 35 (49–55) 51.26; (b) 60 (47–54) 51.03; (c) 11 (47–55) 51.55; (d) 3 (51–52) 51.33; (e) 3 (47–51) 49.67; (f) 6 (50–56) 52.83; (g) 28 (47–55) 50.29; (h) 7 (49–53) 51.14; (i) 153 (47–56) 51.04.

Vertebrae: Shenango R., Pennsylvania 26 (33–35) 33.77; Muskingum R., Ohio 5 (33–34) 33.60; Scioto R., Ohio 9 (32–35) 33.56; Huron R., Michigan 31 (31–35) 33.58; Licking R., Kentucky 1 (34) 34.00; Wabash R., Indiana 11 (32–34) 33.45; western Tennessee 7 (33–34) 33.57; total 90 (31–35) 33.62.

Etymology.—The name *stigmosus* (Latin adjective) means marked or branded and is used in reference to the color pattern, especially the two light spots which are usually present immediately anterior to the dorsal fin, and the brownish chromatophores found anteriorly on the abdomen.

Remarks.—This species has been confused with and identified as *Noturus eleutherus* because of the presumed sexual dimorphism. A comparison of characteristics of these species is given in table 13. The differences in caudal rays in *stigmosus* and *eleutherus* are shown in figure 4.

Relationships.—The morphology and color pattern indicate this to be a member of the *furiosus* species group. In that group it is closest to *Noturus munitus* Suttkus and Taylor in its geographic distribution and general morphology. The two exhibit considerable similarity in color pattern and in body shape. *N. stigmosus* differs consistantly from *N. munitus,* in each river system from which it is known, in higher average numbers of vertebrae, anal rays, caudal rays, especially the upper simple and branched caudals, in distribution of pigment, in having a generally smaller head, and in apparently attaining a larger size.

Ecology.—*Noturus stigmosus* occupies small rivers and creeks in western Tennessee. In this area the bottom consists of sand, often shifting sand, and mud, and the water varies from clear to turbid, with moderate current. There is little cover aside from tree limbs, fallen logs, and occasional drifts of miscellaneous debris. The few specimens, all large, that have been collected suggest lack of congregation of individuals, as they have been found scattered over considerable distances in a stream.

In the Ohio Valley and Michigan, *N. stigmosus* usually inhabits large streams and rivers. There, it probably avoids extremely silty rivers with shifting bottom and it is not normally a resident of small streams or creek-like habitats. In the Huron River, Michigan, scattered specimens were found in clear water in an area of moderate to fast current over mixed gravel, sand, and marl and some vegetation, but they were most numerous and apparently concentrated on a riffle (the type-locality) of large, irregular stones over which a swift current flowed. At this riffle, they were commonly taken with *Noturus flavus*.

Noturus stigmosus has been taken in collections containing the following *Noturus: gyrinus*, *phaeus*, *flavus*, *hildebrandi lautus*, *elegans*, *trautmani*, *eleutherus*, and *miurus*.

***Noturus munitus* Suttkus and Taylor**

FRECKLEBELLY MADTOM

PLATES 4 (FIG. 10), 16 (FIG. 2), 18 (FIG. 2); MAP 13

Noturus munitus Suttkus and Taylor, 1965, pp. 169–178, figs. 1–3 (original description; ecology; localities in Pearl, Tombigbee, and Cahaba Rivers).—Suttkus and Ramsey, 1967, p. 140 (in associations with *Percina aurolineata*, three Cahaba R., Alabama localities).

TYPE-SPECIMENS.—TU 26250 (holotype), TU 11311 (196 paratypes), ANSP 102047 (10 paratypes), BMNH 1964.12.24.1–10 (10 paratypes), CNHM 72742 (10 paratypes), CU 47676 (25 paratypes), MCZ 43090 (10 paratypes), MNHN 1964–584 (5 paratypes), SMF 7580–7584 (5 paratypes), SU 62400 (5 paratypes), UMMZ 181771 (25 paratypes), USNM 198208 (25 paratypes), Pearl R., 2.6 mi. E. Sandy Hook, Marion Co., Mississippi, November 14, 1955, Royal D. Suttkus and Kristin T. Nielsen.

OTHER PARATYPES.—All Pearl River system; see original description for data.

UNITED STATES: LOUISIANA: TU 7369, 10462, 11588, 15073, 15465, 17472, 19825, 19880, 23310, 23351, 28429, 29942, 29962, 29975, 29989, 30010, 30025, 30040. MISSISSIPPI: USNM 197708; TU 3557, 3627, 3951, 4872, 8886, 9709, 13954, 14930, 14938, 15171, 16148, 17721, 17951, 18739, 18963, 19781, 22824, 23127, 23518, 23701, 23869, 26657, 26695, 26759, 26878, 27137, 27172, 27299, 28034, 28272, 28303, 28316, 28345, 28373, 28391, 28403, 28534, 28719, 28768, 28820, 30149.

OTHER MATERIAL STUDIED

UNITED STATES: ALABAMA: Cahaba R.: USNM 200473. Tombigbee R.: USNM 200379 (about 1 mi. below mouth Sipsey R., at Greene-Sumter Co. line). MISSISSIPPI: Tombigbee R.: USNM 198188.

DIAGNOSIS.—*Noturus* (*Rabida*) *munitus*, a member of the *furiosus* group, has the posterior margin of the adipose fin nearly free from the caudal fin, a short anal fin with 12 to 14, exceptionally 15 rays, an abbreviated caudal fin with 45 to 52 rays, and typically 9 pelvic rays, 8 soft pectoral rays, 11 preoperculomandibular pores, and 2 internasal pores. It has a relatively short chunky body, a slender caudal peduncle, and proportionately large spines and head. No other species of *Rabida* has the entire abdomen and the base of the pelvic fins sprinkled with brownish chromatophores. As in others of the *furiosus* group, the posterior process of the cleithrum (humeral process) is long, and a lunate midcaudal bar is present, but the dark blotch of the short and high adipose fin extends to its margin or virtually so.

Description.—Other counts and measurements are given in tables 17 to 26. Body short and heavy, deepest below or before dorsal fin; caudal peduncle relatively narrow, somewhat constricted below posterior part of adipose fin; head moderately depressed; lower jaw included; eye large, 1.6 to 2.4 times in snout; premaxillary tooth patch with posterior corners rounded or obtusely angulate; posterior process of cleithrum longer than diameter of pectoral spine including its serrae; pectoral spine very long and curved backward; anterior dentations of spine prominent and numerous; posterior serrae about as in other species of *Rabida*, relatively few in number, well developed, and with the tips recurved; dorsal spine long and stiff; adipose fin short, but high, with upper margin convex and forming a free posterior flap, poorly connected to the short procurrent caudal rays; caudal fin truncate behind; gill rakers on first arch five to seven. The largest specimen examined is 78 mm. in standard length.

In 132 specimens, there are (extremes in parentheses): (16) 17 to 18 (20), mean 17.7 upper simple caudal rays; (13) 15 (16), mean 15.1 branched caudal rays, of these, 6 or usually 7, mean 6.8 are upper branched caudal rays and (7) 8 (9), mean 8.3 are lower branched caudal rays; (13) 14 to 16 (17), mean 14.8 are lower simple caudal rays. The soft dorsal rays are 5 in 9 and 6 in 138 counts. There are 4 to 8 (mean 6.5) serrae on the posterior edge of the pectoral spine in specimens 22 to 46 mm. in standard length.

Aside from the count of eight left and nine right branchiostegal rays given in the original description, the counts on two other specimens that were cleared and stained are nine on both sides. In the two cleared specimens, there are twelve preanal vertebrae and the pectoral radials are solidly fused on three sides. On one side the ends of the radials are united, but a very narrow medial separation exists.

Body heavily mottled with dark brown; side well pigmented, light to medium brown; head dark brown above; a dark bar across the back of the head extends through the operculum and branchiostegal membrane to lower surface of the head; another band passes backward from the snout through the eye to the posterior cephalic band on the operculum; postorbital area light; cheek lightly pigmented; upper barbels heavily pigmented; lower barbels, lower lip, and side of lower surface of head with scattered pigment; midline of lower surface of head usually immaculate; abdomen and base of pelvic fin with numerous, round brownish chromatophores; a faint brown bridge of pigment crosses abdomen just anterior to pelvic fins; blotches of brown pigment sometimes present on pelvic fin in addition to the brown chromatophores; pectoral fin rather heavily mottled, some blotches present, margin of rays pale, yellowish to whitish; anal fin pigmented at base and sometimes with distal and medial dark brown bands, its edge whitish; basal saddle of dorsal fin extending posteriorly to third ray; lower one-half of fin dusted with small chromatophores, followed distally by a relatively clear area, a broad dark brown distal band extending from spine to last dorsal ray, and finally with white tips to dorsal spine and soft rays; spine heavily pigmented, dark brown; caudal fin with two broad dark crescents, one subterminal and one medial, both somewhat connected across upper and lower procurrent rays and tending to form a basicaudal bar; adipose fin dusky anteriorly, with a clear free flap; adipose blotch, with few exceptions, extending to fin margin; base of dark blotch or saddle at adipose fin not, or but weakly, connected with other blotches; a rectangular dark saddle, nearly confined to dorsal surface, lies between the dorsal and adipose fins; anterior saddle extending to below lateral line, anteriorly to about midway between the dorsal spine and head, and posteriorly to third dorsal ray; saddle encloses or tends to enclose two rather large, light predorsal spots; area over air bladder dark gray.

In life the bright colors consist mostly of yellow or shades of gold that vary considerably in intensity. The light pigmented areas of the body, except the abdomen, may be covered with a golden or yellowish sheen. The abdomen is apparently whitish in life.

Holotype.—The holotype is a male, 50.5 mm. in standard length. It has 6 soft dorsal rays, $17+7+9+14=47$ caudal rays, and 13 anal rays. On each side there are nine pelvic rays, eight soft pectoral rays, eleven preoperculomandibular pores, eight posterior serrae on the pectoral spine, and two pores between the nares indicating that the supraorbital and infraorbital canals are separate anteriorly. The head length is stepped 2.9 times in the standard length. The distance from the rear end of the adipose fin to the tip of the caudal fin is stepped 1.75 times in the distance from the origin of the dorsal fin to the rear tip of the adipose fin. Further measurements are given in table 28.

Variation.—Additional specimens that have become available since the original description of *N. munitus* have permitted a comparison of populations in the three main river systems from which it is known. In a few specimens from the Tombigbee River the adipose blotch is submarginal, rather than extending to the extreme margin. Otherwise the color patterns in each river system are very similar.

The following summaries of the data include the number of counts, range (in parentheses), and means for (a) Pearl River system, (b) Tombigbee River, and (c) Cahaba River.

Vertebrae: (a) 65 (30–33) 31.20; (b) 60 (30–33) 31.72; (c) 13 (30–32) 30.92.

Anal rays: (a) 74 (12–14) 12.88; (b) 60 (12–15) 13.47; (c) 13 (12–14) 13.23.

Upper-half caudal rays: (a) 74 (23–26) 24.34; (b) 60 (23–27) 24.85; (c) 13 (23–27) 24.69.

Lower-half caudal rays: (a) 74 (21–26) 22.95; (b) 60 (22–24) 23.07; (c) 13 (22–25) 23.54.

Total caudal rays: (a) 74 (45–52) 47.28; (b) 60 (45–51) 47.92; (c) 13 (46–52) 48.23.

Soft pectoral rays: (a) 148 (7–9) 7.93; (b) 120 (7–8) 7.93; (c) 26 (7–8) 7.81.

Preoperculomandibular pores: (a) 142 (9–12) 10.95; (b) 120 (9–12) 10.89; (c) 26 (10–12) 10.77.

Although the Pearl River specimens generally have lower mean numbers of anal and caudal rays than do the populations in the Tombigbee and Alabama River systems, the differences do not seem to indicate a significant divergence in any of the river systems.

DISTRIBUTION (map 13).—*Noturus munitus* ranges from the Pearl River in Louisiana and Mississippi eastward to the Cahaba River, a tributary to the Alabama River, Alabama. It seems to be confined to the lower portion of the Pearl River and its larger tributaries. In the Mobile Bay drainage *munitus* is probably found throughout most of the Tombigbee River and likely will be found to have a more extensive range in the Alabama River system.

ETYMOLOGY.—The name *munitus* (Latin), means armed or protected, and is used in allusion to the excessively large spines and serrae.

RELATIONSHIPS.—Features of pigmentation, expecially the dark adipose blotch and the two crescentic caudal bars, in addition to the body shape, the long posterior process of the cleithrum, and the relatively free posterior edge of the adipose fin indicate a relationship with the other species of the *furiosus* group.

ECOLOGY.—*Noturus munitus* is found chiefly on riffles and in rapids of rivers and their larger tributaries. It apparently avoids small streams and still-water habitats. Species that have been collected with it are *Noturus miurus*, *Noturus leptacanthus*, *Noturus nocturnus*, and *Noturus funebris*.

Noturus furiosus Jordan and Meek

CAROLINA MADTOM

PLATES 4 (FIG. 12), 15 (FIG. 1), 17 (FIG. 1); MAP 13

Noturus eleutherus Jordan [misidentifications].—Jordan, 1877d, pp. 101–120, pl. 40, fig. 63b, pl. 41, fig. 63c (in part; description; specimen figured, USNM 20926, from Tar R., Tarboro, N.C.* [indicated, in error, as types]).—Jordan and Brayton, 1878, pp. 70–94 (in part; North Carolina only; Tar R.;* Neuse R., Goldsboro; relationship).—Jordan, 1878d [and 1884], p. 336 (description and range, in part); 1878e, p. 414 (Tar R. only).—Jordan and Gilbert, 1879, p. 368 (relisted); 1883, pp. 99–100 (description, in part; North Carolina only).—Evermann and Cox, 1895, p. 307 (Neuse R. basin).

Schilbeodes eleutherus (Jordan) [misidentification].—Hubbs and Lagler, 1941, p. 65 (Neuse, Tar, and Little Rivers, N.C., only).

Noturus miurus Jordan [misidentifications].—Swain and Kalb, 1883, pp. 638–643 (comparison; synonymy, in part; Tar and Neuse Rivers, N.C.; measurements).

Schilbeodes miurus (Jordan) [misidentification].—Jordan and Evermann, 1900, p. 3237, pl. 29, fig. 68 (USNM 20926, Tar R.,* N.C.).

Noturus furiosus Jordan and Meek, *in* Jordan, 1889, pp. 351–352, pl. 43, figs. 1–1b (original description; type, USNM 39932;* synonymy; North Carolina records: Neuse R., Millburnie, near Raleigh;* Little R., Goldsboro;* Tar R., [2 mi. below] Rocky Mount;* Tar R., near Tarboro*).—Jordan, 1890, pp. 97–127, pl. 13, figs. 1–1b (comparison; synonymy; types from Neuse R., Millburnie, near Raleigh;* other records relisted).—Evermann and Cox, 1895, pp. 307–309 (compiled).—Jordan, 1920, p. 473 (orthotype of "*Rabidus*" Jordan and Evermann).—Jordan, Evermann, and Clark, 1930, p. 155 (genotype of *Rabida*).—Fowler, 1945, p. 122 (comparison).—Böhlke, 1953, p. 43 (syntypes, SU 1380* and USNM 39932;* the latter, the lectotype series by action of Jordan and Evermann).—Eddy, 1957, p. 155, fig. 391.—Taylor, 1957, p. 192.—Suttkus and Taylor, 1965, pp. 171–178 (relationship).

Schilbeodes furiosus (Jordan and Meek).—Jordan and Evermann, 1896a, pp. 144–149 (description; synonymy; range); 1896b, p. 234; 1900, p. 3237, pl. 29, figs. 69–69b (type, USNM 39932*).—H. M. Smith, 1907, pp. 20–21, 71, fig. 20 (description).—J. H. Pratt, 1907, p. 177.—H. S. Pratt, 1923, p. 96.—Osburn, Wickliff, and Trautman, 1930, p. 174 (range, in part).—Hubbs, 1930, p. 432 (description and range, in part).—Hubbs and Raney, 1944, p. 3 (relationship).—Fowler, 1945, pp. 32, 121 (synonymy; distribution; record relisted).—Brimley, 1946, p. 15 (comparison; local names; North Carolina records: tribs. to Neuse R. [Crabtree Cr.*], Raleigh and compiled records*).--Bailey and Taylor, 1950, p. 31 (range; possible relationships).—G. A. Moore, 1957, pp. 143, 145.

Rabida furiosa (Jordan and Meek).—Jordan, Evermann, and Clark, 1930, pp. 155–156.—Driver, 1942, p. 254 [and 1950, p. 262].

Schilbeodes miurus furiosus (Jordan and Meek).—Schrenkeisen, 1938, p. 167.

TYPE-SPECIMENS.—USNM 39932 (lectotype), USNM 164109 (2 paralectotypes), SU 1380 (2 paralectotypes), Neuse River, at Millburnie, near Raleigh, North Carolina, summer 1888, David Starr Jordan.

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*Material indicated by an asterisk has been re-examined.

Other paralectotypes.—Number of specimens, in parentheses, follows the catalog number.

UNITED STATES: North Carolina: ANSP 71335 (1), USNM 20926 (6), UMMZ (IU no. 7246) (1), UMMZ 167076 (1), SU 3435 (2), Tar R., near Tarboro, Edgecombe Co., J. W. Milner. USNM 40398 (1), Tar R., 2 mi. below Rocky Mount, 1888, D. S. Jordan. USNM 40572 (1), Little R., near Goldsboro, 1888, Jordan. USNM 67937 (1), Neuse R., Raleigh, August 27, 1888, Jenkins and Meek.

Other material studied

UNITED STATES: North Carolina: USNM 48475 (Crabtree Cr., Raleigh), 191057 (Tar R., at railroad bridge, Rocky Mount), 191071 and 191110 (Fishing Cr., below County Hwy. 1500, 5.5 mi. NNE. Tarboro, Edgecombe Co.), 191099 (Swift Cr., above Hwy. 95, W. of Leggett, Edgecombe Co.); UMMZ 165884 (Neuse R., Wake Co.), 165885 (Raleigh); NCSM 243 (Neuse R., near Raleigh), 485 and 486 (Beaverdam Cr., 0.5 mi. upstream from Neuse R., Wayne Co.), 632 (Middle Cr., Hwy. 210, Johnston Co.), 758 (Little Contentnea Cr., Hwy. 102, Pitt Co.), 1242 and 2715 (Neuse R., below Quaker Neck Dam, Goldsboro, Wayne Co.), 1794 (Little R., 1 mi. W. Raines Crossroads, Johnston Co.), 1930 (Eno R., County Hwy. 1004 bridge, Durham Co.), 2209 (Little R., Hwy. 581, 1 mi. W. Goldsboro, Wayne Co.).

Diagnosis.—*Noturus* (*Rabida*) *furiosus*, is a member of the *furiosus* group which is characterized by a relatively short chunky body, long spines and posterior processes of the cleithra, and a midcaudal crescent of brownish pigment. The anal fin averages more rays than in the other species of the group and the high number of caudal rays, 51 to 60, usually 53 to 58, is closely approached only by *N. placidus*. The lower surface of the head and abdomen are immaculate or with occasional blotchings in contrast to *N. munitus* and juvenile *N. stigmosus* which have numerous small chromatophores sprinkled over these surfaces. Unlike *N. placidus* but similar to *N. munitus* and *N. stigmosus* the color pattern is bold and the bar of the adipose fin extends well into the upper half of the fin (extending at least three-fourths the distance from the fin base in *furiosus*).

Description.—Other counts and measurements are given in tables 17 to 26. Body heavy, deepest below dorsal fin; caudal peduncle deep; head rounded above, little depressed; lower jaw included; eye large, 1.8 to 2.6 times in snout; premaxillary tooth patch with posterior corners obtusely pointed or rounded; humeral process longer than the width of pectoral spine and its serrae; spine long, strong, curved backwards, anterior dentations numerous, prominent, and strongly developed, posterior serrae recurved and relatively few in number; dorsal spine long and stiff; adipose fin rather high, relatively short, and with a convex upper edge; its posterior margin forming a free flap, and base only weakly united to the short procurrent caudal rays; caudal fin truncate or slightly rounded behind; gill rakers on first arch five to seven; a species of moderately large size, the largest specimen is 100 mm. in standard length. Upper simple caudal rays 20 to 26, mean 22.2; branched caudal rays 14 to 19, mean 16.9, of which 6 to 8, usually 7 or 8, mean 7.3 are in the upper half and 7 to 11, usually 9 or 10, mean 9.6 are in the lower half of the fin; lower simple caudal rays 13 to 19, mean 16.4. Soft dorsal rays 6 (in 112) or 7 (1). Anterior serrae of pectoral spine large, numerous, often 30 or more; posterior serrae 6 to 12, usually 9 or 10, mean 9.12. Ossified pectoral radials solidly fused on eleven sides in seven specimens cleared and stained; three sides have them variously fused. Vertebrae anterior to the anal fin 12 (in 2) or 13 (5).

Body color variegated; side rather plain, only moderately well pigmented; head dark above; a dark band on the back of the head extends onto the branchiostegal membrane and operculum; another, under the eye, extends backward below the light postorbital spot to the first on the operculum and forward to the snout; cheek pale; upper barbels heavily pigmented; mental barbels and lower lip with scattered pigment; lower surface of head immaculate; abdomen immaculate except for a poorly developed bridge of pigment just anterior to the pelvic fins; no obvious round, brown chromatophores on abdomen; pelvic fin blotched in large specimens, pigmented above and below near base; pectoral fin blotched, edge immaculate; base of anal fin dusky; anal fin frequently with two dark brown bands variously well developed, one median, the other subterminal, edge immaculate.

Behind a light grayish predorsal area, the basidorsal blotch or saddle extends backward almost to the third dorsal ray, forward to midway between the dorsal fin and head, and to below the lateral line, its anterior edge irregular; predorsal light spots, such as are found in *stigmosus*, are seldom present in the basidorsal saddle; the dorsal fin with a dusky base, then some sparse pigment, an immaculate area, and a subterminal dark brownish band, followed by a clear light edge; membrane of dorsal spine, except over the tip, pigmented; caudal fin with two distinct but rather narrow crescentic bands, the subterminal band joining the median band above and below, and passing as one onto the upper and lower procurrent rays, thence across the caudal peduncle as a distinct broadened bar, rest of fin pale; adipose fin moderately clear except for a broad, blackish blotch extending at least three-fourths the distance to the fin margin and turning slightly backward; the blotch expands on the back near the base of the adipose fin but does not contact the other blackish saddles; another blackish blotch or saddle confined to the dorsal surface between the adipose and dorsal fins; membrane over air bladder grayish.

Type.—Jordan and Meek (*in* Jordan, 1889, p. 351) listed USNM 39932 as type of *Noturus furiosus*. The catalog book indicates that five specimens were originally included in this lot. Jordan and Evermann (1900, p. 3237, pl. 29, figs. 69–69b) republished Jordan and Meek's original figures and first indicated that they were from the type, USNM 39932, effectively designating a lectotype. The drawings, on file in the Division of Fishes, United States National Museum, indicate that a specimen 3.6 inches long was illustrated. Two small specimens formerly included in USNM 39932 are now SU 1380. When examined by me, USNM 39932 contained only the three largest specimens. I have selected the largest of these, a specimen 73 mm. in standard length as the lectotype retaining USNM 39932. It is only slightly shorter than the indicated length of the specimen drawn, and although in good condition, it shows some evidence of having been partially dried at one time.

The lectotype is a male. It has 15 anal rays, 6 soft dorsal rays, 23+8+9+18=58 caudal rays, and 35 vertebrae. On each side there are eight soft pectoral rays, nine pelvic rays, two internasal pores, and eleven preoperculomandibular pores. The pectoral spines from left to right have eight and nine posterior recurved serrae, and 33 and 34 distinct anterior serrae. The head length is stepped into the standard length 3.3 times; the distance from the adipose fin to the end of the caudal fin stepped into the distance from the dorsal origin to the posterior end of the adipose fin is 1.9. The posterior process of the cleithrum is very long. There are no abdominal chromatophores. The pigmentation is much like that shown in the original figure, the adipose blotch extending to or nearly to the edge of the fin. A bar crosses the caudal peduncle, and the saddle beneath the dorsal fin extends considerably forward of the dorsal spine, but is not broken up with light spots like those of *munitus* and *stigmosus*. Measurements are given in table 28.

Remarks.—One specimen MNHN 89–313 and one BMNH 89.10.30.86, both collected by David Starr Jordan from Little River, Goldsboro, North Carolina, are not listed as paratypes. Although they were evidently collected with USNM 40572, which is considered a paratype, the original description indicates that Jordan and Meek knew of only one specimen from Goldsboro.

Range.—Map 13 shows the known distribution. The records are from the Neuse and Tar River systems of North Carolina. Some recent writers have referred to *Noturus stigmosus*, the Ohio Valley relative, under the name *furiosus*.

Variation.—The Neuse and Tar River populations of *N. furiosus* are relatively similar, showing no important differences. The following summary lists in order, the number of tabulations, range (in parentheses), and mean for the Neuse and Tar systems and their combined total in sequence. Vertebrae: 27 (34–36) 35.04, 93 (33–36) 34.57, 120

298–943 O—69——13

(33–36) 34.68; anal rays: 28 (14–17) 15.11, 85 (14–17) 15.42, 113 (14–17) 15.35; upper-half caudal rays: 28 (27–32) 29.61, 84 (27–33) 29.39, 112 (27–33) 29.45; lower-half caudal rays: 28 (25–28) 26.68, 84 (23–28) 25.82, 112 (23–28) 26.04; total caudal rays: 28 (53–60) 56.29, 84 (51–59) 55.21, 112 (51–60) 55.48.

Etymology.—The name *furiosus* (from Latin, *furios*) meaning furious, raging, or to drive mad, was proposed in allusion to the long, strongly serrated pectoral spines.

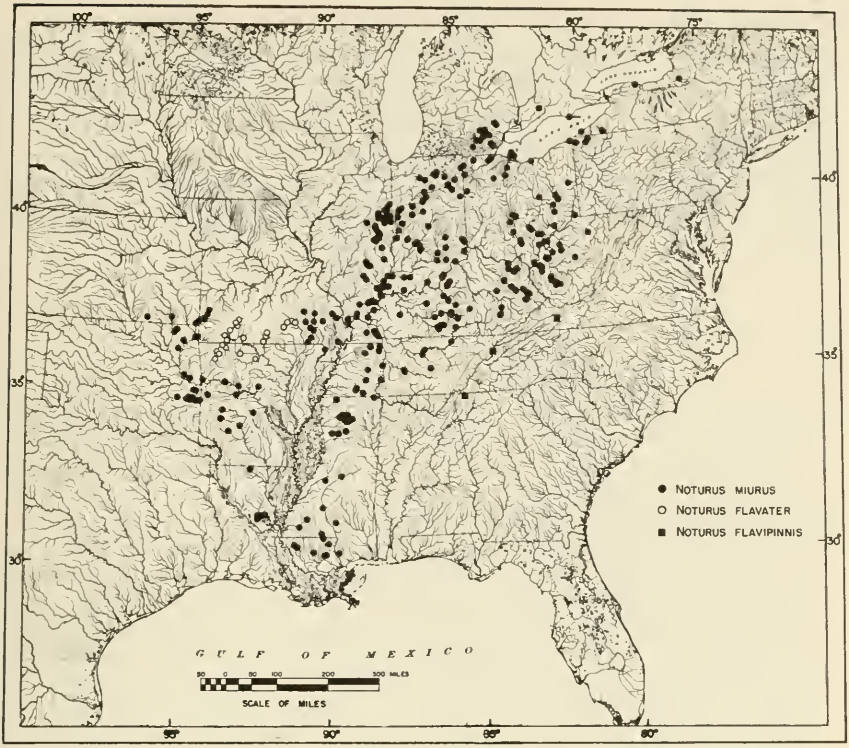
Relationships.—The body shape, the color pattern, especially the two caudal crescents, and the relatively free posterior margin of the adipose fin indicate that the species is related to the three other species included in the *furiosus* species group.

Ecology.—*Noturus furiosus* seems to occupy a variety of habitats. As judged from the old collections it would appear that it is confined to the area at and just below the Fall Line in North Carolina. A few specimens from the Neuse River system, however, suggest that there may be slight penetration onto the Piedmont. Specimens collected by me were all from clear or relatively clear water in large creeks and small rivers. The largest individuals were collected on a rather swift riffle in shaded water about three feet deep over a bottom of gravel, large rocks, and rubble near the Fall Line. The species appears to be most abundant, however, on the Coastal Plain where it is frequently found in very shallow water with little or no current, over a fine to coarse sand bottom with little gravel. Here it was observed to be hiding in bright sunlight beneath mussel shells and debris, the head projecting from the hiding place just enough to permit observations of the surroundings. It has been taken in collections with *Noturus gyrinus* and *Noturus insignis*.

The miurus Group

The *miurus* group contains three apparently allopatric representatives known as *Noturus miurus*, *Noturus flavipinnis*, and *Noturus flavater*. They are characterized by a long, strong, well-serrated pectoral spine; a long humeral process and dorsal spine; a dark band or blotch which extends to the margin of the adipose fin; a many rayed caudal fin; and the absence of a prominent midcaudal concentration of pigment.

Origin of the group probably was in the Mississippi drainage, perhaps its central portion, as each of the species are found there today (map 14). Only one, *N. miurus*, has entered other river systems, undoubtedly as a crossover from the Mississippi River drainage. The other two are known only from the uplands of the central portion of the Mississippi Valley, *N. flavipinnis* from the upper Tennessee River system and *N. flavater* from the Ozarks of Missouri and Arkansas. *N.*



MAP 14.—Distribution of the three species of the *miurus* group. The localities whence I have examined specimens are shown by the symbols indicated. Many unverified literature records of *Noturus miurus* or *Schilbeodes miurus* cannot be assigned with certainty to any member of this group. Those reports for which a presumptive identification is possible fall within the ranges indicated by the specimens examined.

Noturus flavipinnis, new species, is known only from the upper Tennessee River system. *Noturus miurus* Jordan occurs in the Great Lakes, the Ohio Valley, the lower Mississippi Valley, and eastward to the Pearl River of Mississippi. *Noturus flavater*, new species, of the Ozark upland, approximates *N. miurus* geographically, but the known ranges of the two species do not overlap.

miurus is found throughout the Ohio drainage, and in the lower parts of the Tennessee and Mississippi Valleys. It has crossed over into parts of the lower Great Lakes drainage and into various Gulf coastal streams lying to the eastward of the lower Mississippi River, to the Pearl River, Mississippi. Records of *miurus* from the upper Mississippi Valley except a simple crossover into the Kaskaskia River, Illinois, are without foundation. Dispersal in *N. miurus* has probably been rather easily attained since it readily enters relatively small streams with little current.

Although regarded as allopatric species, the actual range of *N. flavater* closely approximates that of *N. miurus* in southeastern Missouri and Arkansas, and the hiatus in distribution, as based on the few records from the upper Tennessee River, between *N. flavipinnis* and *N. miurus* may not be real. Thus, although they may be ecologically segregated, distributions could easily overlap. They are regarded as full species because the morphological differences separating them are rather prominent and remain quite constant, permitting identification of all individuals. There is no indication that intergradation occurs.

Noturus miurus Jordan

BRINDLED MADTOM

PLATES 4 (FIG. 13), 19 (FIGS. 1, 2); MAP 14

Noturus marginatus Baird [misidentifications].—E. W. Nelson, 1876, p. 50 (Wabash Valley and S. in Illinois).—Jordan, 1876b, p. 303 (description; range [complex]).—?Jordan and Copeland, 1876, p. 160 (range [complex]).—Jordan and Gilbert, 1877a, p. 2 (Ohio Valley [complex]; Indiana).

Noturus miurus Jordan, 1877a, p. 46 (nomen nudum; Indiana records: Maumee R. basin; lower Wabash R. basin; White R., near Indianapolis); 1877b, pp. 370–377 (original description; Ohio Valley* and SW.; immediate neighborhood of Indianapolis, Ind., in White R.* and small tribs.); 1877c, p. 50 (present but not noticed by Rafinesque in Ohio Valley); 1877d, pp. 73–120, pl. 39, figs. 60–61b (comparison; synonymy [in error]; range [L. Michigan and Wisconsin erroneous]; relationship; Falls of the Ohio; type from White R., Ind. and specimen from Ohio R., W. Va., figured).—[Klippart], 1877, p. 153 (compiled).—Jordan, 1877e, p. 613 (range); 1878a, p. 119 (range; Tangipahoa [error for Natalbany?*] R.); 1878b, p. 68 (synonymy; Illinois distribution, including Wabash R. and Cache R., Johnson Co.); 1878c, p. 368 (compiled).—Jordan and Brayton, 1878, pp. 87–95 (distribution [but not in Illinois R. basin]; relationship).—Jordan, 1878d [and 1884], p. 336 (description; range [Iowa erroneous]); 1878e, p. 414 (range); 1882, pp. 745–801 (synonymy [in error]; description; Ohio distribution; records complied).—Jordan and Gilbert, 1883, p. 99 (description; range [but not in Minnesota]).—Swain and Kalb, 1883, pp. 638–644 (comparison, synonymy, and range [in error]; compiled records; Blue R.).—Gilbert, 1884, p. 199 (Indiana records including Salt Cr. [Bloomington*], Monroe Co.).—Jordan, 1885, p. 802 (general range, but not footnote).—Graham, 1885b, p. 71 (branches of Missouri R., Kansas [erroneous]).—Forbes, 1885a, p. 84 (Cache* and Wabash Rivers, Ill.).—Jordan and Gilbert, 1886, pp. 6, 10 (Poteau R.,* Indian Territory; Lees Cr.,* Ark.; Saline R., Benton,* and ?Washita [Ouachita] R., Ark. [both complex]).—Eigenmann and Fordice, 1886, p. 410 (Bean Blossom Cr., Ind.* [complex]).—Jenkins, 1887, p. 94 (streams, Vigo Co., Ind.).—Evermann and Jenkins, 1888, pp. 44–56 (Indiana records).—Jordan, 1889, pp. 351–352 (comparison).—Henshall, 1889, p. 124 (Ohio record).—Jordan, 1890, pp. 125–127, 158–166 (Indiana records [in part] including West Fork White R., Spencer*).—Linton, 1891, p. 359 (no parasites; Black R., Ohio).—?Gilbert, 1891, pp. 146, 152 (Duck R., Columbia City, Tenn.; Cypress Cr., Florence, Ala. [possibly both are in error]).—McCormick, 1892, p. 13 (Ohio records).—Woolman, 1892a, pp. 251–287 (Kentucky records: Rolling Fork of Salt R., at Booth,*

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*Material indicated by an asterisk has been re-examined.

and at New Market* [both complex], and ?New Haven; Rough Cr., Hartford? [UMMZ (IU 8686), is *Ictalurus punctatus*]; Big Barren R., Bowling Green?; Little Barren R., Osceola?; Pittman Cr.,* 3 mi. W. of Greensburg; Mayfield Cr., Hickory Grove;* Blain Cr., Catalpa [described]; Little Sandy R.?; distribution [The Kentucky R. system records probably are *Noturus eleutherus*, and some of the Green R. system records may be *Noturus elegans*.]). —Meek, 1892a, p. 12 (Iowa, compiled [in error]); 1892c, p. 108 ([erroneously] recorded from Minnesota; not known from Iowa); 1893, p. 229 (Arkansas records compiled [some complex]; range [in error]).—Garman, 1894, p. 56 (Kentucky distribution compiled [most records not assignable]: ?Ohio R.; ?Big Sandy R.; ?Green R. [some may be *N. elegans*]).—Meek, 1894a, pp. 75–92 (comparison; compiled Arkansas records only: Fort Smith; ?Arkadelphia [part is *N. eleutherus*]).—Kirsch, 1894, p. 87 [and vol. 14, p. 36] (middle course of Eel R.* and Meredith Cr., Ind.).—Hay, 1894, pp. 172–174 (description; range and compiled Indiana records [both in part]).—Kirsch, 1895, pp. 327–335 (Maumee R.* [in part], St. Joseph R., and St. Marys R., Fort Wayne, Ind.; Maumee R., Antwerp,* Ohio [in part]; St. Joseph R., Edgerton,* Ohio; Fish Cr., Hamilton, Ind.; Cedar Cr., Waterloo, Ind.; St. Marys R., Rockford,* Ohio and Decatur, Ind.; Tiffin R., Manitou Beach* and Hudson, Michigan, and West Unity* and Brunnersburg, Ohio; Auglaise R., Cloverdale, Oakwood, and Defiance, Ohio; Sugar Cr., Cloverdale, Ohio; Blanchard R., Findlay, Ohio;* Hoaglin Cr., near Oakland, Ohio); 1896a, p. 48 (relisted); 1896b, p. 105 (Maumee R. records repeated [in part only]).—Forbes, 1900, p. 76 (as *minurus;* only S. Illinois in Cache* and Wabash systems).—Hay, 1902, p. 70 (relationship; Indiana distribution).—Jordan, 1904, pp. 42, 351 (description; range [in error]; synonymy).—Mitchell, 1904, pp. 161, 406 (oral breathing valves described).—Hahn, 1910, p. 175 (Bean Blossom Cr., Ind.).—Hubbs and Raney, 1944, p. 6 (synonymy).—Bertin and Estève, 1950, p. 25 ("paratype" [wrongly] ascribed to Etowah R., Ga.).—Gerking, 1955, p. 76 (key).—Bailey, 1955, p. 528 (Bass L., Mich., heat mortality).—Eddy, 1957, p. 154, fig. 390.—Taylor, 1957, p. 192.—Eddy and Underhill, 1959, p. 343 (not in Minnesota).—Metcalf, 1959, p. 393 (Kansas range).—Trautman, 1959, pp. 41–43, 97, 435–442, fig. 113, map 113 (synonymy, description, ecology, distribution, Ohio; range).—Cook, 1959, pp. 34, 136, 143, fig. 25C (description; Mississippi distribution).—Ross, 1959c, pp. 8, 24 (key; New R. system).—Suttkus, 1961, p. 63, fig. 5 (comparison; skull illustrated).— J. M. Walker, 1962, p. 38 (Jackson Parish, La.).—Greeson, 1963, p. 25 (Dix R., Ky.).—Larimore and Smith, 1963, pp. 324–344, fig. 48 (records, ecology, distribution map, Champaign Co., Ill.).—W. B. Scott, 1963, p. 123 (Ontario). —Murphy, 1964, p. 71 (Green R., Kentucky).—P. W. Smith, 1965, p. 9 (Illinois distribution).—B. T. Walker, 1965, pp. 108–109 (partly as *Noturus minurus;* Louisiana record).—Norden, 1965, p. 102 (Louisiana record).—Suttkus and Taylor, 1965, pp. 171—177 (comparison; associations).—Raney and Suttkus, 1966, p. 102 (associations with *Etheostoma rubrum*, Bayou Pierre, Miss.).—Cross, 1967, pp. 197, 224 (figure, description, Kansas distribution).—Charles, 1967, pp. 385–395 (Green R., Ky.).—Branson, 1967, p. 146 (Oklahoma and Kansas records).

Schilbeodes miurus (Jordan).—Eigenmann and Beeson, 1894a, p. 81; 1894b, p. 44 [and 1905, pp. 120–121] (Indiana records: Flat Rock Cr., Decatur Co.;* Clear Cr.,* Bloomington; Terre Haute; West Fork White R., Gosport;* others compiled [L. Maxinkuckee error in compilation?; several complex or

*Material indicated by an asterisk has been re-examined.

misidentified]).—Moenkhaus, 1896, p. 160 (Patoka R., near Huntingburg,* Ind.).—Evermann and Cox, 1896, pp. 365–426 (compiled [erroneous]).—Jordan and Evermann, 1896a, pp. 145–149 (description; range [in error]); 1896b, p. 234 (range [in error]).—Eigenmann, 1896, p. 253 (Indiana).—Osburn and Williamson, 1898, pp. 12, 19 (Franklin Co., Ohio localities including Big Walnut Cr.*).—Osburn, 1901, pp. 27–29 (Ohio records [some in error]).—Evermann and Goldsborough, 1901, p. 360; and 1902, p. 171 (L. Chautauqua,* N. Y.).—Evermann and Kendall, 1901, p. 480 [and 1902, p. 210] (New York record).—Evermann, 1902, p. 95.—Bean, 1903, pp. 96–97, 740 (compiled).—Large, 1903, pp. 9–10 [and 1905, pp. 56–57] (description; Wabash and Cache R. basins, Illinois [specimen from creek near Pontiac, Ill., now unidentifiable; in error]).—McConnell, 1906, p. 179 (Pennsylvania record).—Michael, 1906, p. 9 (compiled).—Reed, 1907, pp. 555–564, fig. 2 (glands and pectoral spine described).—Hankinson, 1908, p. 199 (Orchard L.,* Mich.).—Meek, 1908, p. 141.—Forbes and Richardson, 1909 [and 1920, pp. lxxviii-cxv], pp. lxxiii-cix, 176–201, map 59 (ecology; range [in error]; Illinois distribution [see INHS material, p.194; one Wabash R. collection complex; not in Illinois R. basin]; description; figured).—Forbes, 1909, pp. 387–427 (range [in error]; Illinois distribution, in part; ecology).—Hankinson, 1910, p. 26 (as *miurrus;* Kickapoo Cr., near Charleston,* Ill.).—Meek and Hildebrand, 1910, pp. 245, 247, fig. 22 (description; range [in error; undoubtedly ascribed to Chicago area on basis of erroneous L. Michigan report]).—Ward, 1912, p. 226 (free of parasites).—Hankinson, 1913, pp. 104–112 (ecology; Embarrass R. system, Ill.).—Fowler, 1913, p. 92 (compiled).—Forbes, 1914, p. 17, fig. 26, map 59 (in part, Illinois distribution).—F. C. Baker, 1916, p. 177 (food; Oneida L., N. Y.).—Adams and Hankinson, 1916, p. 168 (relisted).—Evermann, 1918, pp. 325–366 (in part; compiled).—Wright, 1918, p. 543 (Salmon Cr.,* N. Y.).—Fowler, 1919, p. 57 (compiled).—? T. Surber, 1920, p. 21 (Red Cedar R., St. Anagar, Iowa, and Austin and Ramsey, Minn. [misidentifications]).—Conger, 1920, p. 11.—Dymond, 1922, p. 62 (Sandusky Bay, L. Erie).—H. S. Pratt, 1923, p. 96.—Reed, 1924a, p. 445, fig. 12 (spine described).—Hubbs, 1926, pp. 51–52.—Greene, 1927, pp. 308–309 (hypothetical, Wisconsin; range [in error]).—Cahn, 1927, p. 42 (Wisconsin records [not now identifiable; erroneous]: Menomonee R., and Fox R., near Lannan).—Adams and Hankinson, 1928, pp. 385–386 (ecology; food; comparisons; Oneida L., N. Y., records).—Potter and Jones, 1928, p. 355 (not in Iowa).—Hubbs and Greene, 1928, p. 390.—Greeley, 1928, pp. 87–105 (Oneida L., N. Y.).—Hubbs and Ortenburger, 1929, pp. 96–97 (Little Petit Jean R., 13 mi. NW. Waldron,* Ark.; like Indiana examples; previous records, Oklahoma and Arkansas [in part]).—Greeley, 1929, pp. 165, 174 (Sandusky Bay, L. Erie).—Hubbs and Brown, 1929, pp. 2–42 (distribution; Ontario records: Sydenham R.,* 23 mi. E. Sarnia, below Strathroy; Dedricks Cr.,* 1 mi. W. Port Rowan).—Thompson and Hunt, 1930, pp. 27–65, map 34 (ecology; Salt Fork system, Champaign Co., Ill.).—Osburn, Wickliff, and Trautman, 1930, p. 174 (Ohio).—Hubbs, 1930, p. 432 (comparison).—Shurrager, 1932, pp. 386, 404–409, tables 1–4, 6–8 (ecology and distribution; Hocking R. system, Ohio [table 1 confused; see also UMMZ material, p.195]).—R. A. Moore, 1933, p. 17 (kidneys described).—V. Bailey, 1933, p. 584 [and *in* separate, p. 202] (Green R.,* Ky., near Mammoth Cave).—Hankinson, 1933, p. 568 (open or barren shallows of Michigan inland lakes).—Van Cleave and Mueller,

*Material indicated by an asterisk has been re-examined.

1934, pp. 167–321 (parasites; Oneida L., N. Y.).—Greene, 1935, pp. 146, 218, 220 (Wisconsin records of Cahn questioned).—Aitken, 1936, p. 33 (doubtful in Iowa).—Greeley, 1938, p. 69 (New York records, including Chautauqua L.*).—Welter, 1938, p. 67 (Licking R. system, Ky.).—Schrenkeisen, 1938, p. 167.—Trautman, 1939, p. 281 (abundance in Maumee R.).—Hubbs and Lagler, 1939, p. 27 (comparison; Great Lakes basin).—Raney, 1939a, p. 275 (Ohio drainage, W. Pennsylvania).—Kuhne, 1939, p. 68, fig. 41 (Tennessee).—Dymond, 1939, p. 27 (Ontario).—Bangham and Hunter, 1939, pp. 401–434 (parasites, W. Lake Erie).—Fowler, 1940b, p. 9 (compiled).—Greeley, 1940, p. 76 (records, L. Ontario watershed, New York including Salmon Cr.,* Monroe Co.).—Breukelman, 1940b, p. 381 (Spring* and Verdigris* R. systems, Kans.).—Lagler and Hubbs, 1940, p. 239 (in food of gar, Michigan).—Hubbs and Lagler, 1941, pp. 63, 65, fig. 84 (comparison; range [in error]; ecology).—Aitken, 1941, p. 389.—Shoup, Peyton, and Gentry, 1941, pp. 70, 73 (Cumberland R.,* at mouth of Hamilton Br., Jackson Co., Tenn.).—Allen and Clark, 1943, p. 29 (ecology; NE. Kentucky).—Eddy and Surber, 1943, pp. 151, 163 [and 1947, pp. 171, 182] (description; occurrence in Minnesota doubted; range and Iowa record [in error]).—Radforth, 1944, pp. 6, 50, figs. 20–21 (distribution [in error]; ecology; Ontario records).—Addair, 1945, p. 13 (lower Kanawha basin, W. Va.).—Gerking, 1945, pp. 13, 75–76, map 64 (ecology; Indiana distribution [compiled records in part, some in error; see also IU material, p. 194).—Fowler, 1945, p. 32 (Mississippi R. basin).—Hubbs, 1946, p. 38 (Oklahoma).—Dymond, 1947, p. 23 (Ontario distribution).—Hubbs and Lagler, 1947 [and 1949], pp. 72–73, fig. 179 (comparison; range; ecology).—Trautman, 1948, pp. 166–173, pl. 1, figs. 1, 4, 7 (description; comparisons; hybridizes with *Schilbeodes mollis* [equals *N. gyrinus*]; L. Erie basin).—Shockley, 1949, pp. 254, 269 (Indiana record).—D.C. Scott, 1949, pp. 178–179 (Indiana record).—C. B. Nash, 1950, p. 562 (Ohio record).—Moore and Paden, 1950, p. 87 (Illinois R. and Swimmers Br.,* 5 mi. NE. of Gore, Okla.).—Bailey and Taylor, 1950, pp. 31–38, pl. 2, figs. A–B (comparison; range; data; UMMZ 155337, Brushy Cr.,* Amite Co., Miss.).—Bailey, 1951, p. 189 (deleted from Iowa list; supposed occurrence in Minnesota erroneous).—Cross and Moore, 1952, p. 407 (synonymy; Poteau R., Okla., localities).—G. A. Moore, 1952, p. [6] (Oklahoma).—Larimore, Pickering, and Durham, 1952, pp. 8–25 (ecology and distribution, Jordan Cr., Ill.).—Langlois, 1954, p. 207 ([2 mi. SE. of] Niagara Reef,* Lake Erie; Sandusky R., Ohio).—W. B. Scott, 1954, pp. 69–70 (Canadian distribution; characters; size).—Hall, 1954, p. 57 (Oklahoma record).—Martin and Campbell, 1954, pp. 47–53 (riffles of Black R., Missouri [part may be *Noturus albater*]).—Hall, 1955, p. 36 (Illinois R., Okla.).—Schwartz, 1956, p. 250 (*Clinostomum* parasite, Conneaut Cr., Pa.).—Schelske, 1957, pp. 40, 41, 47 (occurrence, Verdigris R., Kans.).—Carter, 1957, p. 257 (Dewey L., Kentucky).—Lewis, 1957, p. 28 (Big Cr., Ill.).—Hubbs and Lagler, 1957, p. 5.—G. A. Moore, 1957, pp. 144, 145, fig. 2–79B.—Slastenenko, 1958a, p. 7 (Canadian distribution); 1958b, pp. 250, 353 (compiled).—W. B. Scott, 1958, p. 19 (Canadian distribution).—Hubbs and Lagler, 1958, pp. 89, 91, fig. 179.

Rabida miura (Jordan).—Jordan, 1929, p. 93 (as *miurus;* comparison; range [in error]).—Jordan, Evermann, and Clark, 1930, p. 156 (synonymy; range [in error]).—Luce, 1933, p. 119 (as *miurus*; headwaters, Kaskaskia R.,* Ill.).—O'Donnell, 1935, p. 484 (as *miurus;* Illinois distribution and ecology).—H.S.

*Material indicated by an asterisk has been re-examined.

Pratt, 1935, p. 90.—Blatchley, 1938, p. 67 (Indiana distribution and records: Walnut Cr.* [outlet of Eagle L., Warsaw]; noted in the Raccoon; others compiled).—Driver, 1942, p. 254 [and 1950, p. 262] (comparison; range [in error]).

Noturus.—Bean, 1882, p. 206 (Natalbany R., near Tickfaw,* La.).

Noturus eleutherus Jordan [misidentification].—?Hay, 1894, p. 172 (White R., Indianapolis, Ind. [compiled in error]).

Schilbeodes eleutherus (Jordan) [misidentifications].—?Large, 1903, pp. 9–10 [and 1905, pp. 56–57] (headwaters of Kaskaskia and Embarrass Rivers in Douglas* and Piatt* Counties, Ill.).—Gerking, 1945, p. 16, map 65 ("some smaller streams"; Indiana distribution, in part: [IU 182,* Coal Cr., Fountain Co.; IU 193,* Raccoon Cr., Parke Co.]).

Type-specimens.—MNHN A1308 (lectotype), White River, Indianapolis, Indiana, collected by David Starr Jordan. BMNH 80.1.21.17 (1 paralectotype), Ohio River, collected by David Starr Jordan.

Other material studied

UNITED STATES: Arkansas: UMMZ 167216 (Wolf Cr., 1.25 mi. S. Antoine), 169948, 169972, 169996; UMMZ (Delavan and Creaser no. 31–28; Chaney coll.-Petit Jean Cr., 3 mi. N. of Ola, Yell Co.); CNHM 734; TU 12303 (Ouachita R., 6 mi. NW. Mount Ida), 15592; KU 6931 (South Fork Caddo R., 4 mi. W. Hopper, Montgomery Co.). Illinois: INHS 5056, 5058, 5060, 5064, 24996, 24997, 24998, 26006 thru 26009, 26012, 28063, 28064, 28068, 28084, 28086, 28088, 28100, 28102, 28123, 28180, 28181, 28255, 28490, 28496 (Lake Fork Cr., Piatt Co.); INHS (East Br. Salt Fork Cr., 1.5 mi. N. St. Joseph, Champaign Co.; Salt Fork Cr., S. of Oakwood, Vermilion Co.); UMMZ 144520, 165882; UMMZ (Hankinson coll.-Embarrass R., Crawford Co.; Hankinson nos. 5221, 7716, 9094, 9099; Bauman nos. 45, 48, 52, 72, 75, 76–77, 79); UL 9072, 9114. Indiana: UMMZ 66623, 81351, 81395, 99941, 126473, 139939, 160268; UMMZ (IU no. 7287–White R., Indianapolis); INHS 27527 (Indianapolis); IU 20, 106, 149, 151, 160, 179, 186, 188, 204, 216, 223, 225, 244, 253, 254, 320, 336, 339, 347, 438, 446, 448, 456; USNM 66687, 66688, 66689, 66691, 66693, 66695, 66700, 66702, 66703, 67768, 69774, 199588; UL 8091, 8337, 8872. Kansas: KU 653, 654 (Drum Cr., Montgomery Co.), 7236 (Otter Cr., sec. 26, T. 33 S., R. 9 E., Chautauqua Co.); KU (Brush Cr., Hwy. 66, 1 mi. W. Riverton, Cherokee Co.). Kentucky: UMMZ 88023, 88037, 104294, 118284, 154684, 154719, 155525, 165259, 165295, 165396, 167277, 168230, 168354, 168881; UMMZ (TVA nos. 42S5, 42S6); UL 4842, 4953, 5050, 5266, 5424, 5637, 5658, 5675, 5681, 5699, 5732, 5771, 6746, 6993, 7075, 7617, 7906, 7912, 7930, 8039, 8680, 10082. Louisiana: CU 16325; UMMZ (Comite R., 1.5 mi. NE. Olive Branch, East Feliciana Parish; Delavan and Creaser nos. 31–54-stream at Pollock, Grant Parish; 31–57-stream at Jena, La Salle Parish); TU 970, 1264, 4675, 9810, 19879; USNM 172549, 172681, 173170. Michigan: UMMZ 55208, 55428, 56574, 60256, 73327 (Union L., Oakland Co.), 86252, 95006, 97249, 108064, 112430, 137315, 138980, 141964, 165834, 165836, 165845. Mississippi: UMMZ 113459, 155355 (Bogue Chitto R., Hwy. 48, 7 mi. W. Tylertown, Walthall Co.), 161400, 166121 (East Br. Hobolochitto R., Hwy. 11, 0.9 mi. N. Picayune, Pearl River Co.); UMMZ (Dolley coll.-roadside canal, 1.75 mi. E. Kendrick, Tishomingo Co.); USNM 129282 (borrow pits and creeks, Carthage, Leake Co.), 129399, 175374 thru 175383, 196639, 196640, 200478, 201243; TU 808 (near Bassfield, Jefferson Davis Co.), 3044, 3671, 5106 (Hobolochitto R., Hwy. 11, 0.6 mi. N. Picayune, Pearl

*Material indicated by an asterisk has been re-examined.

River Co.), 7217; TU (Copiah Cr., Hwy. 27, 2.4 mi. S. Georgetown, Copiah Co.). Missouri: INHS (Black R., Lesterville, Reynolds Co.); UMMZ 102654, 139502 (St. Francis R., at mouth of Twelve Mile Cr., near Saco, Madison Co.), 139577 (Black R., at mouth Logan Cr., Reynolds Co.), 139627, 139691 (Black R. and mouth Markham Spring Cr., near Williamsville, Wayne Co.), 151811 (North Fork Spring R., 5 mi. S. Lamar, Barton Co.), 151837, 151868, 152976, 153153; UMoMZ (A. C. Bauman nos. 40; 53-Black R., sec. 10, T. 26 N., R. 5 E., Butler Co.; 55. C. B. Obrecht nos. 41–34–Little Black R., at Beaver Dam Cr., Butler Co.; 41–35–Little Black R., at Logan Cr., Ripley Co.). New York: CU 478, 2327, 2962–3 (Salmon Cr., Hilton, Monroe Co.), 3790 (Frederick Cr., 2 mi. above Constantia, Oswego Co.), 18346. Ohio: OSU 3072, 4265, 6645, 7748, 7757, 8624, 8840; OSU (Big Darby Cr., between Harrisburg and Darbyville, Pickaway Co.); USNM 1445, 62850, 62853; CNHM 6565, 6569, 6570; UMMZ 86024, 87510, 87518, 87638, 87697, 87700, 87705, 87706, 87779, 87843, 107695, 107716, 107738, 107765, 118328, 118372, 118517, 159879, 169168, 169170; UMMZ (Shurrager nos. 28, 29, 40, 44). Oklahoma: UMMZ 103177, 109055 (Big Cr., 7 mi. SW. Centralia, Nowata Co.), 116757, 127254, 137902, 167180, 167181, 167193, 167194, 167203, 167204, 167205, 167206; UMMZ (field no. SC 4–40–Elk R., Camp Kemp, Delaware Co.); OAM 773 (Fourche Maline R., sec. 11–12, T. 5 N., R. 19 E., Latimer Co.), 993; OAM (field no. C–8–1950–Sallisaw Cr., McKey's Store, Sequoyah Co.); Tulsa U (Big Cabin Cr., 1 mi. W. Pyramia, Craig Co.); USNM 36389; TU 15540. Pennsylvania: CU 5511 (L. LeBoeuf, Waterford, Erie Co.), 6892 (French Cr., Mill Village, Erie Co.); USNM 58722, 192653. Tennessee: UMMZ 88094 (Stone R., Hwy. 1, Murfreesboro, Rutherford Co.), 116001 (Duck R., above dam at Kettle Mills, Maury Co.), 116017, 168439, 168520; USNM 36131, 190744, 190778, 193472, 193474, 193475, 193477 (Turnbo Cr., 3 mi. NW. Bath Springs, Decatur Co.), 193482, 193483, 197403; Tennessee Game and Fish Comm. (Cumberland R., mi. 232, Old Hickory Reservoir). West Virginia: CU 4479, 4769, 14790, 14804 (Elk Cr., Romines Mill, Harrison Co.), 20830, 20834, 20848, 20856, 20861, 20873, 21025; UMMZ 118583, 119448; USNM 192654 thru 192666; UL 9768.

Diagnosis.—*Noturus* (*Rabida*) *miurus*, of the *miurus* species group, has 54 to 65, usually 57 or more caudal rays; 13 to 17 anal rays; and typically 9 pelvic rays, 8 soft pectoral rays, 11 preoperculomandibular pores, and a single internasal pore. A black blotch extends to the margin of the adipose fin and another is present on the extremity of the anterior dorsal rays, but the band of pigment on the procurrent caudal rays extends little onto the caudal peduncle. The caudal and adipose fins are broadly connected, and the spines and humeral process are long.

In combination, the more numerous caudal rays, the black tipped dorsal fin, and the adipose blotch distinguish *miurus* from all but species of the *miurus* group. The single internasal pore usually distinguishes it from all species of *Rabida*; the absence of a black bar crossing the caudal peduncle distinguishes it from others of the *miurus* group; and black in the dorsal fin segregates it from *flavipinnis*.

Description.—Other counts and measurements are given in tables 17 to 26. Body heaviest just in front of dorsal spine; caudal peduncle tapers backward; eye large, 1.1 to 1.8 in snout; head rounded above, only slightly depressed; lower jaw included; premaxillary tooth patch with sharp or slightly rounded corners; humeral process about as long as or longer than width of pectoral spine including serrae; pectoral spine long, curved (pl. 4, fig. 13), with large, recurved posterior serrae and rather long, distinct anterior serrae; dorsal spine stout; adipose fin widely connected to caudal fin, with only a moderate notch and no prominent flap at free edge; caudal fin rounded or pointed behind; six or seven gill rakers on the first arch. A Michigan specimen, the largest examined, measures 88 mm. in standard length.

In 28 skeletonized and stained specimens, the ossified pectoral radials are fused on 51 sides; 5 sides have them partially joined. The young at about 12 mm. in standard length have two distinct ossified radials at the base of each fin. Vertebrae anterior to the anal fin origin are 12 (in 9) or 13 (10).

The caudal fin has (extremes in parentheses): (20) 23 to 27 (29), mean 25.4 upper simple rays; (14) 16 to 19 (24), mean 17.5 branched rays, of which there are usually 7 or 8 in the upper half and 8 to 11 in the lower half of fin; and (11) 15 to 18 (20), mean 16.5 lower simple rays. The pectoral spine has as many as eleven posterior serrae. In 195 specimens, the dorsal soft rays are five (in 2), six (192), and seven (1).

General life color yellowish, brownish, light reddish orange, or pinkish. In preservation, side lightly and irregular mottled; four dark saddles on back; one, with a nearly straight anterior margin about midway between dorsal fin and head, extends laterally onto side to below lateral line and backward to second dorsal ray; another blotch between adipose and dorsal fins, a third, which is black, at middle of adipose fin extends to its margin; another, a continuation of the submarginal black caudal band extends downward through the procurrent caudal rays onto the edge of the caudal peduncle, passing chiefly around the margin of the peduncle and across lower procurrent rays, connecting again with the black submarginal caudal band; caudal fin generally grayish, frequently with an immaculate tip; adipose fin otherwise variably pigmented or translucent with a few scattered chromatophores; anal fin dusky near base, usually with a submarginal dark band, and irregularly pigmented on extremity of rays; pectoral fin moderately well pigmented near base and about spine, especially on upper surface; pelvic fin with chromatophores on upper surface near base; dorsal fin with dark gray pigment about base of first two rays and along spine, a few scattered chromatophores extend along rays to middle of fin, tip of dorsal spine and first three to five dorsal rays covered with a jet black blotch, and margin of fin nearly immaculate, whitish; top of head dark; a light circular area back of eye; another on cheek below eye; a rectangular light brown area posterior to head on dorsal surface; a dark brown bar extends across the back of the head to the branchiostegal membrane and onto the operculum, giving off a posterior branch that follows the lateral line backward to meet the first dorsal saddle on the side; another band extends downward and backward from the eye, joining the band of pigment on the operculum and passing forward just under the eye and nares to the snout; upper barbels well pigmented; lower barbels covered with scattered fine chromatophores; upper lip weakly pigmented; under surfaces of head and abdomen with only a few scattered chromatophores, otherwise white, but a bridge of pigment crosses abdomen in front of pelvic fins and one covers the chin in front of mental barbels.

Type.—I have succeeded in locating only two of Jordan's numerous original specimens, one in the British Museum and the other in the Museum National d'Histoire Naturelle, Paris. The latter, MNHN A1308, is selected as the lectotype because it shows the better preservation and because it is from the White River at Indianapolis, Indiana. This locality has been consistently stated to be the type-locality. Although Jordan referred to Ohio Valley specimens, presumably meaning Ohio River, no definite locality was given. The British Museum specimen bears no locality data other than Ohio River.

Bertin and Estève (1950, p. 25) erroneously listed MNHN A1308 as a paratype from the Etowah River, Georgia. A subsequent study of the records for this specimen indicates that the locality error was made when the specimen was recataloged in recent years. The specimen was received from David Starr Jordan in 1879. Further, listing the specimen as a paratype was also in apparent error as no specimen is known to have been designated as the holotype by Jordan, and no lectotype was selected.

The lectotype is a male, 59.5 mm. in standard length. Although rather pale, it shows virtually all of the color pattern that is so characteristic of this species. It has 6 soft dorsal rays, 15 anal rays, $24+7+12+11=54$ caudal rays, and 35 vertebrae. The count of eleven lower simple caudal rays is low, perhaps due to an injury, later healed, that malformed the anterior part of the lower fin. There are two internasal pores on the left and one on the right. Each pectoral spine has prominent fine serrae anteriorly and seven recurved serrae posteriorly. Each pelvic fin has one simple ray and eight branched rays and each pectoral fin has eight soft rays. The preoperculomandibular pores are eleven on the left side and ten on the right. The head length is stepped 3.4 times in the standard length and the distance from the rear end of the adipose fin to the tip of the caudal fin (ends of rays broken) is stepped into the distance from the origin of the dorsal fin to the rear end of the adipose fin about 1.6 times. Further measurements are given in table 28.

Variation.—*N. miurus* shows remarkable uniformity of characters, considering its wide latitudinal range. The chief geographic differences noted are the paler and more emaciated condition of southern specimens; those from clear northern streams (Tippecanoe and Huron Rivers) are darker and fatter. The basic color pattern is the same throughout the range. A very slight increase in fin rays from north to south is suggested by certain of the caudal ray counts. Pearl River specimens do not appear to be differentiated.

The following summarized data lists, in order, the number of counts, the range (in parentheses), and the mean:

Vertebrae: Homochitto River, Mississippi 15 (34–37) 35.13; Corney Bayou, Louisiana 7 (34–36) 35.14; Hatchie River, Tennessee 31 (35–37) 36.03; Poteau River, Oklahoma 9 (34–35) 34.56; southern Illinois and southeastern Missouri 14 (35–36) 35.29; Ohio River, Indiana 4 (34–37) 35.25; Coal River, West Virginia 28 (34–37) 35.79; Huron River, Michigan 103 (32–36) 34.50; all specimens 212 (32–37) 35.03.

The ensuing data are listed in the following sequence: (a) chiefly Mississippi drainage, Louisiana and Mississippi, (b) Arkansas River system of Missouri, Kansas, and Oklahoma, (c) southeastern Missouri, (d) Kentucky and Tennessee, (e) Wabash and Ohio drainages, Indiana, (f) Muskingum River system, Ohio, (g) Huron River, Michigan, and (h) total, all specimens.

Internasal pores: (a) 228 (1–2) 1.02; (b) 82 (1–2) 1.06; (c) 48 (1–2) 1.06; (d) 78 (1–2) 1.05; (e) 52 (1–2) 1.29; (f, including Lake Erie specimens) 66 (1–2) 1.05; (g) 146 (1–2) 1.01; (h) 701 (1–2) 1.05.

Soft pectoral rays: (a) 40 (7–9) 7.83; (b) 57 (7–9) 8.12; (c) 34 (8–9) 8.24; (d) 30 (7–8) 7.80; (e) 50 (7–9) 7.92; (f) 28 (8–9) 8.07; (g) 144 (7–9) 7.92; (h) 383 (7–9) 7.97.

Anal rays: (a) 21 (14–16) 15.14; (b) 28 (13–16) 14.54; (c, including southern Illinois) 18 (14–16) 15.22; (d) 15 (13–17) 14.67; (e) 25 (14–17) 15.28; (f) 13 (14–16) 15.08; (g) 77 (14–17) 15.16; (h) 197 (13–17) 15.05.

Lower-half caudal rays: (a) 21 (24–29) 26.14; (b) 32 (23–29) 26.63; (c) 17 (25–29) 27.47; (d) 14 (24–28) 26.43; (e) 25 (23–29) 26.36; (f) 14 (25–28) 26.57; (g) 71 (24–29) 26.42; (h) 194 (23–29) 26.52.

Upper-half caudal rays: (a) 21 (32–37) 34.14; (b) 33 (31–34) 32.70; (c) 17 (31–35) 32.82; (d) 15 (31–36) 33.33; (e) 25 (31–35) 33.08; (f) 14 (31–36) 33.29; (g) 72 (30–35) 32.49; (h) 197 (30–37) 32.92.

Total caudal rays: (a) 21 (57–65) 60.29; (b) 32 (54–62) 59.28; (c) 18 (57–63) 60.33; (d) 14 (56–64) 59.79; (e) 25 (54–63) 59.44; (f) 14 (57–62) 59.86; (g) 80 (55–64) 58.93; (h) 204 (54–65) 59.43.

Distribution.—*Noturus miurus* (map 14) is known from the Great Lakes basin, the Mississippi River system, the Pearl River system, and one or more streams between the Pearl and Mississippi Rivers. Access to the Great Lakes was probably by way of the Maumee outlet in post-Wisconsin times. However, more than one invasion route into Lake Erie may have been followed. In the Great Lakes, *miurus* apparently has not entered the Lake Huron drainage, but is known from tributaries to Lake Saint Clair in Ontario, from Lake Erie and many of its tributaries, and from Lake Ontario and its tributaries in New York, occurring as far eastward as Oneida Lake. Although recorded from Lake Michigan, specimens which were the basis of this record are not extant, and have not been duplicated; the record is probably either based on a misidentification or hypothetical.

N. miurus occurs throughout most of the Ohio Valley, but usually avoids the uplands or high-gradient streams. Addair (1945, p. 13) found *miurus* only in the lower part of the Kanawha River system, and it is found only in the lower Tennessee River basin. The species has crossed over from the Wabash system into the headwaters of the Kaskaskia River, Piatt County, Illinois (material re-examined by author). Aside from the single Kaskaskia River record, *N. miurus* is confined in the Mississippi River basin to the Ohio system and to tributaries of the Mississippi adjacent to and below the mouth of the Ohio.

Indeed, there is no reason to believe that any member of the subgenus *Rabida* occurs in the upper Mississippi or Missouri drainages. However, some erroneous reports exist. The specimens which provided the basis for these reports are not available. Forbes and Richardson (1909) overlooked or re-identified Large's (1903, pp. 9–10) record of *miurus* from Pontiac, Illinois; Jordan's (1877d) records from Lake Michigan and Wisconsin have not been duplicated and are generally viewed with skepticism; they are probably hypothetical; Iowa (Jordan, 1878d, p. 336) and Minnesota (Jordan and Gilbert, 1883, p. 99) were apparently listed on hypothetical grounds, and the errors perpetuated by compilers; "Branches of the Missouri River," Kansas (Graham, 1885b, p. 71) is either based on a transposition of locality information and a misidentification or a statement of hypothetical range; Iowa and Minnesota records (T. Surber, 1920, p. 21) are lost, have not been duplicated, and are doubted by Dr. Samuel Eddy (personal communication); and Wisconsin records (Cahn, 1927, p. 42) are not available, were not confirmed by Greene (1935), and also seem to have no validity.

N. miurus is found in many of the lowland streams of the lower Mississippi Valley, but seems to avoid the Red River system. In the Arkansas system it has extended upstream to the Spring, Verdigris, Poteau, and other rivers in Kansas, Oklahoma, and western Missouri.

N. miurus has crossed from the Mississippi Valley into the Pearl River system of Mississippi and Louisiana, and has been recorded from the Tangipahoa River, an apparent error for the Natalbany River, Louisiana.

Many literature records of *miurus* cannot be assigned to any species with assurance; they are listed without comment in the synonymy of *miurus*.

REMARKS.—There has long been doubt concerning the identity of the specimens that formed the basis of the name *Notorus miurus* Jordan. Most members of the subgenus *Rabida* have at one time or another been identified as *miurus* by Jordan and others, and the types have not been seen or studied by recent workers. Some confusion has arisen because two other species of the subgenus *Rabida* also occur in Indiana near the type-locality. Both of them, *Noturus eleutherus* and *Noturus stigmosus,* could easily have been included in the type-material.

Diagnostic characters from Jordan's (1877b, pp. 370–377) original description that point to the correctness of the lectotype selection are: pectoral spines strongly serrated, extremely strong and curved, the upper jaw longest, the "adipose fin continuous . . . interrupted by a notch which does not quite break its continuity . . . much mottled blackish and yellowish; margins of dorsal, anal and caudal fins, and a broad patch in the middle of the adipose fin, definitely black." These characters taken in combination with the locality (White River, Indiana) indicate the species herein called *Noturus miurus* and eliminate others. The figures of the types given by Jordan (1877d, pl. 39) have little value; that in Jordan and Evermann (1900, pl. 29, fig. 68) illustrates, instead, a specimen of *Noturus furiosus;* the figure of *Schilbeodes miurus* in Forbes and Richardson (1909) is the first to represent adequately the species recently generally identified as *miurus* and which as concluded here must bear that name.

ETYMOLOGY.—The name *miurus* (Greek) is defined as meaning curtailed, and presumably refers to the general shortened appearance of some specimens.

RELATIONSHIP.—The strong resemblance of this species to *flavater* and *flavipinnis* and their structural similarities are sufficient to justify their association as the *miurus* species group.

ECOLOGICAL CONSIDERATIONS.—The geographic distribution of *miurus* is a clue to its requirements. It seems to avoid clear, cold, fast waters; at least it is not present in the cool upper waters of the White River in Missouri and Arkansas in association with *flavater,* and it has not penetrated into the colder upper Great Lakes. It lives in lowland or base-level streams which have some current, in many streams (chiefly pools below riffles) with moderate current, and in lakes. It mostly avoids rock and gravel riffles, especially those with fast water;

instead it lives in areas of deposition, chiefly over a soft bottom. For example, in the Huron River, Michigan, in riffles where *N. stigmosus* and *N. flavus* are most common, there are no residual *miurus*, but that species occupies the same section of stream and the habitats overlap below these riffles. Dr. George Moore states that in Oklahoma *miurus* also lives in quiet pools with a mud bottom and an abundance of detritus, such as leaves and twigs. *Noturus miurus* has been taken in association with the following species of *Noturus*: *gyrinus*, *nocturnus*, *phaeus*, *exilis*, *flavus*, *hildebrandi*, *albater*, *elegans*, *eleutherus*, *munitus*, and *stigmosus*.

Noturus flavipinnis, new species

YELLOWFIN MADTOM

PLATES 4 (FIG. 14), 20 (FIG. 1); MAP 14

Noturus miurus Jordan [misidentifications].—Jordan, 1890, p. 143 (description; North Fork Holston R., Saltville,* Va.).—Evermann, 1918, p. 320 (Clinch R. [Hines Cr.*], Clinton, Tenn.).

Schilbeodes miurus (Jordan) [misidentifications].—Evermann and Hildebrand, 1916, p. 442 (Clinch R., Walkers Ford, 12 mi. SW. of Tazewell, Tenn.; Tennessee R., near mouth of Lyon Cr., 5 mi. W. of Knoxville, Tenn.; Chickamauga Cr.,* Lee and Gordon's Mill, 3 mi. from Crawfish Springs, Georgia).—Evermann, 1918, pp. 323–366 (compiled; in part only).

TYPES.—USNM 163801 (holotype), USNM 36820 (3 paratopotypes), and UMMZ 167862 (1 paratopotype), Hines Creek, Clinton, Tennessee, [1884], C. H. Gilbert and Joseph Swain.

OTHER PARATYPES.—The catalog number is followed by the number of specimens in parentheses. USNM 125417 (1), Chickamauga Cr. [at Lee and Gordon's Mill], east Tennessee [Georgia], October 1893, R. R. Gurley. USNM 40455 (1), [above the ford], North Fork of Holston R., Saltville, Virginia, [August 9] 1888, David Starr Jordan. SU 2326, 3575, 4073, and 4605 (6), no known locality; from a lot mixed with other specimens during the 1906 California earthquake; four locality labels are included with the material, but none is believed to be correct.

DIAGNOSIS.—*Noturus* (*Rabida*) *flavipinnis* of the *miurus* species group has 54 to 62 caudal rays; 14 to 16 anal rays; and typically 2 internasal pores, 11 preoperculomandibular pores, 8 soft pectoral rays, and 9 pelvic rays. The yellowish dorsal fin has a submedial band of brownish pigment, but no black; a brown band crosses the caudal peduncle; and the blotch of the adipose fin extends to the margin. The spines, their serrae, and the humeral process are moderately long. The adipose and caudal fins are united. No midcaudal crescent is evident.

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*Material indicated by an asterisk has been re-examined.

N. flavipinnis is the only *Rabida* with the combination: a light tipped dorsal fin, a black blotch extending to the margin of the adipose fin, 54 or more caudal rays, and the adipose and caudal fins distinctly connected. Unlike others of the *miurus* group, it lacks black on the dorsal fin, and the basicaudal bar is distinct but not prominent; like *flavater*, but unlike *miurus*, the infraorbital and supraorbital canals do not unite anteriorly (2 internasal pores).

Description.—The only descriptive information on this species was given by Jordan (1890, p. 143), who said "Not rare in the weeds above the ford [North Fork of Holston River, north of Saltville, Virginia]. The specimens are quite large and the color is rather pale. In general they agree with Indiana examples." He described the stream as "moderately swift, not very clear, the water warm."

Other counts and measurements are given in tables 17 to 23 and 26. Body heaviest forward, deepest at or before dorsal spine; caudal peduncle tapering backward; eye large, 1.2 to 1.8 times in snout; head moderately rounded above, but flattened before eyes; lower jaw included, but mouth nearly subterminal; premaxillary tooth patch with acute or rounded posterior corners; humeral process as long as or longer than width of pectoral spine including anterior and posterior serrae; pectoral spine long (pl. 4, fig. 14) with four to ten large recurved posterior serrae and prominent anterior serrae; dorsal spine stout; adipose fin with a moderate notch between it and caudal fin, but distinctly connected at their base; posterior free end of adipose fin sometimes extended into a flap; caudal fin rounded or pointed behind; five to eight gill rakers on the first arch. The largest specimen is 86.9 mm. in standard length.

The 13 specimens all have 6 soft dorsal rays. The caudal fin has 22 to 26, mean 23.4 upper simple rays; 17 to 22, usually 17 branched rays (with typically 7 in the upper part of the fin and 10 below); and 14 to 17, usually 15 lower simple rays.

Due to long preservation of the specimens, little can be determined about details of original pigmentation. The pale color, accentuated by fading with age, leaves little pattern of prominence other than the saddles. Side of body nearly uniform, except where covered by four dorsal saddles, with various size chromatophores; one saddle (obscured in large specimens) below the dorsal fin, extends to below the lateral line, forward about half the distance from the dorsal spine to the head, apparently surrounding a predorsal light spot on each side, and backward to the second dorsal ray; second blotch is between the adipose and dorsal fins; a black blotch at the middle of the adipose fin extends to its margin; a prominent, brownish, obovate patch on the end of the caudal peduncle extends narrowly onto the procurrent caudal rays. Caudal fin yellowish, lightly pigmented, but with broad crescentic bands near margin; adipose fin yellowish, with some scattered chromatophores outside of the saddle; anal fin mottled near base (a dark brown spot at middle of anal base and on peduncle in one specimen), with scattered melanophores distally on the fin rays; pectoral fins with light tips and inner margins, otherwise moderately well pigmented; pectoral spine pigmented; pelvic rays pigmented only about base; dorsal fin well pigmented about base of fin rays, its spine pigmented approximately to tip, and one or two narrow brownish bands extend across the middle of the fin; distal one-fourth of dorsal rays and the tip of the spine yellowish, with no black pigment. Top of head dark; a light spot back of eye; cheek mottled; a dark brown bar crosses posterior end of head, extending onto the operculum and branchiostegal membrane; another extends diagonally backward from the eye onto the operculum; forward, it passes just under the eye and nares onto the snout; upper barbels brown; anterior nares pale; maxillary barbels and upper lip weakly pigmented; lower barbels, especially the outer ones, somewhat pigmented; undersurface of head unpigmented; abdomen with a bridge of dark pigment in front of pelvics and a few scattered melanophores, otherwise yellowish.

Type (pl. 20, fig. 1).—The holotype (USNM 163801) is a female, 65.2 mm. in standard length or 79 mm. in total length. It has 4+11=15 anal rays, 22+7+10+15=54 caudal rays, 34 vertebrae, and 6 soft dorsal rays. On each side there are nine pelvic rays, eight soft pectoral rays, eight recurved serrae on the posterior edge of the pectoral spine, six gill rakers, and two internasal pores. The left side has eleven and the right has ten openings to the preoperculomandibular canal. The anterior pectoral spine serrae are numerous and of moderate length. The humeral process is long. The black adipose blotch extends to the margin; there is no black pigment near the tips of the dorsal rays; the the basicaudal bar is present, though faint. Pigmentation about the base of the dorsal fin cannot be ascertained. The preservation is good. The head length stepped into the standard length is 3.55; the distance from the adipose notch to the tip of the caudal fin stepped into the distance from the dorsal origin to the adipose notch is 1.65. Table 28 gives further measurements.

Variation.—No geographic trend is evident in the available material. The single specimen with the infraorbital and supraorbital canals connected anteriorly is from Hines Creek, Tennessee.

Range.—*N. flavipinnis* (map 14) appears to be confined to the upper Tennessee River basin, where it is known from tributaries in Georgia, Tennessee, and Virginia.

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REMARKS.—The adjectival name *flavipinnis* (Latin), from *flavus* (yellow), *pinna* (fin), and the suffix *is* refers to the general yellow color of the dorsal fin.

RELATIONSHIPS.—The pointed or slightly rounded caudal fin with its numerous rays, the blotch that extends to the margin of the adipose fin, and the general body shape suggest that this species is a relative of *N. miurus* and *N. flavater;* together they form the *miurus* group.

ECOLOGICAL INFORMATION.—The habitat of this species was described by Jordan (see p. 202). I have segregated *flavipinnis* from collections containing *Noturus eleutherus*.

DISCUSSION.—It is of interest to note that *Noturus flavipinnis* has not been collected since 1893, and possibly is extinct. It was not included in the collections made in the surveys of the Tennessee River system just prior to establishing the large impoundments, and it has not been taken by numerous collectors that subsequently have visited the region.

The three localities from which specimens are known were visited in August 1959, but specimens were not obtained. The North Fork of the Holston River, just above Saltville, Virginia, seems to be relatively undisturbed, but a large population of *Noturus insignis has* become established there. It is possible that *insignis* and *flavipinnis* cannot occupy the same area.

The Clinch River and the mouth of Hines Creek both are subject to periodic fluctuation of water level by control at Norris Dam. Here, the Clinch River was shallow and clear, averaging about 6 inches deep with only a few pools about 4 feet deep. It had a temperature of 62° F, presumably after considerable warming. A few hours later the shallow area was covered with about 4 feet of cold turbid water. It is likely that the temperature of the Clinch River is constantly too low to permit reproduction. Chickamauga Creek, at Lee and Gordon's Mill, was found to be seriously polluted by waste from upstream and supported very few fishes.

***Noturus flavater*, new species**

CHECKERED MADTOM

PLATES 4 (FIG. 15), 20 (FIG. 2); MAP 14

Noturus miurus Jordan [misidentifications].—Jordan and Gilbert, 1886, p. 2 (White R., Eureka Springs,* Ark.).—Meek, 1893, p. 229 (compiled); 1894a, pp. 90–92 (compiled: Eureka Springs,* Ark., only).

Schilbeodes miurus (Jordan) [misidentification].—Hubbs and Ortenburger, 1929, pp. 96–97 (previous Arkansas records).

Noturus eleutherus Jordan [misidentifications].—Meek, 1894a, pp. 75–92 (description; Main Fork of White R., Fayetteville, Ark., and Sallisaw R., near Makey's Store* [McKey's Store], Okla. [the latter locality an obvious error]).

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*Material indicated by an asterisk has been re-examined.

Schilbeodes eleutherus (Jordan) [misidentifications].—Jordan and Evermann, 1896a, p. 148 (compiled: White R., Fayetteville, Ark.; Sallisaw R.,* Indian Territory [in error]).—Hubbs and Ortenburger, 1929, pp. 47, 97 (E. Oklahoma [in error] and Arkansas).—Hubbs and Lagler, 1941, p. 65 (Arkansas R. system in Oklahoma [in error]).—Hubbs, 1946, p. 38; and Hubbs and Lagler, 1947 [and 1949], p. 73 (Oklahoma, in part [in error]).—Moore and Paden, 1950, p. 87 (reference to literature record from Oklahoma [in error]).—Bailey and Taylor, 1950, pp. 31, 38 (parts of Arkansas R. system [in error]).

Rabida eleuthera (Jordan) [misidentifications].—Jordan, 1929, p. 93 (as *eleutherus;* Oklahoma [in error]).—Jordan, Evermann, and Clark, 1930, p. 156 (White R., Fayetteville, Ark.; Sallisaw R.,* Indian Territory, Okla. [in error]).

Type-specimens.—UMMZ 151322 (holotype) and UMMZ 151323 (8 paratopotypes), collected from Flat Creek, at Hwy. M39, 12 mi. NE. of Cassville, Barry Co., Missouri, August 6, 1940, by George V. Harry and Mitro Pellock.

Other paratypes.—The number of specimens, in parentheses, follows the catalog number.

UNITED STATES: Arkansas: Crooked Cr., 1 mi. SW. of Harrison, Boone Co., UMMZ 169893 (1), August 16, 1940, R. M. Bailey and M. E. Davis. White R., Eureka Springs, UMMZ (IU no. 5370) (1), D. S. Jordan; USNM 36330 (1), Jordan and Gilbert. Richland Cr., Washington Co., UMMZ 167218 (1), October 4, 1950, C. E. Hoffman. War Eagle Cr., Madison Co., CU 35818 (3), September 25, 1958, C. F. Cole. Kings R., U.S. Hwy. 62, 4.8 mi. W. Berryville, Carroll Co., CU 41184 (1), April 7, 1958, Cole and S. Finkelstein. Buffalo R., Buffalo River State Park, Marion Co., KU 8011 (17), April 4, 1964, F. B. Cross; KU 9867 (2), April 7, 1965, Cross. Missouri: Crane Cr. of James R., Stone Co., UMMZ 142121 (3), July 13, 1942, Missouri Conservation Department. North Fork White R., at mouth of Spring Cr., near Twin Bridges, sec. 34, T. 25 N., R. 11 W., Douglas Co., UMMZ 142150 (1), June 23, 1942, Mo. Cons. Dept. North Fork White R., Blue Springs, at Hammonds Mill, near Dora, Ozark Co., UMMZ 142254 (2), June 29, 1942, Mo. Cons. Dept. Finley Cr. of James R., Hawkins Bridge, UMMZ 142275 (1), July 17, 1942, Mo. Cons. Dept. Flat Cr. of James R., Barry Co., UMMZ 142302 (1), July 13, 1942, Mo. Cons. Dept. James R., Hwy. 123, near Christian-Greene Co. line, UMMZ 142308 (1), July 9, 1942, Mo. Cons. Dept. Beaver Cr., trib. to White R., Kissee Mills, Hwy. M80, Taney Co., UMMZ 151128 (2), August 3, 1940, George V. Harry and Mitro Pellock. White R., 3 mi. S. Shell Knob, Hwy. M86, Barry Co., UMMZ 151346 (1), August 7, 1940, Harry and Pellock. North Fork White R., Tecumseh, Hwy. M30, Ozark Co., UMMZ 152091 (1), August 22, 1940, Harry and Pellock. Jacks Fork of Current R., Alley Spring State Park, Shannon Co., UMMZ 164824 (1), April 27, 1946, Stanton Hudson. Current R. and spring branch, at Blue Spring, near Eminence, Shannon Co., UMMZ (no. C41:16) (1), September 10, 1941, Obrecht. Ebb and Flow Spring, 7 mi. NE. Montier, Shannon Co., CNHM 43154 (1), August 26, 1939, Loren P. Woods. Middle Current R., OAM 3243 (1), July 1–4, 1949, Perry Robinson. North Fork White R., near Tecumseh, USNM 163546 (2), August 1944, A. C. Bauman. Jacks Fork of Current R., Hwy. 17, Alley Spring, USNM 163547 (1), October 9, 1945, Funk and Bauman. White R., Hwy. 86, between Shell Knob and Viola, Barry Co., CU 32863 (3), February 23, 1957, L. W. Knapp and J. P. Henley; CU 32871 (2), September 11, 1956, Knapp and

*Material designated by an asterisk has been re-examined.

Henley; CU 32936 (1), July 4, 1957, Knapp and M. Bowman. James R., sec. 30, T. 29 N., R. 20 W., Greene Co., KU 3378 (1), 1954, Perry Robinson. Current R., Hwy. 106, Owls Bend, Shannon Co., KU 5624 (3), June 6, 1960, D. A. Distler and A. L. Metcalf; KU 7682 (1), April 8, 1963, F. B. Cross and M. L. Wiley. OKLAHOMA [in error]: Sallisaw R., Indian Territory, USNM 73592 (1), S. E. Meek.

DIAGNOSIS.—*Noturus* (*Rabida*) *flavater* of the *miurus* species group has 51 to 60 caudal rays; 14 to 17 anal rays; and typically 2 internasal pores, 11 preoperculomandibular pores, 8 soft pectoral rays, and 9 pelvic rays. It is the only species in the genus *Noturus* having both a broad, black vertical bar at the base of the caudal fin and a large black blotch on the outer one-third of the dorsal fin; a broad, black bar extends to the margin of the adipose fin. The spines, their serrae, and the posterior process of the cleithrum are long.

It differs from species other than of the *furiosus* group in having both a relatively free posterior end of the adipose fin and more than 51 caudal rays; from the *furiosus* group by the extension of the black bar at the middle of the adipose to its margin (*N. munitus* has a blotch extending to the margin, but usually has fewer caudal rays), the absence of the prominent midcaudal crescent, and other features of pigmentation. The two internasal pores distinguish it from *miurus;* the broad, dark blotches, the relatively free posterior margin of the adipose fin, and the larger size distinguish it from both *flavipinnis* and *miurus.*

DESCRIPTION.—Other counts and measurements are given in tables 17 to 26. Body moderately short and chunky, deepest in front of dorsal fin; caudal peduncle relatively deep; head rounded, arched, only slightly depressed in front of eyes; lower jaw included; posterior corners of premaxillary tooth patch obtuse or angulate; eye moderately large, 1.6 to 2.5 in snout; humeral process long, as long as or longer than width of pectoral spine and its serrae; pectoral spine (pl. 4, fig. 15) long, curved, deeply grooved near its tip, with prominent, long anterior serrae which turn outward distally and inward near the base, and with several large uniformly recurved posterior serrae; dorsal spine stout; adipose fin high, with a free posterior flap, virtually free from the short procurrent caudal rays; caudal fin almost truncate, usually rounded behind; gill rakers on first arch six to ten. The largest specimen is 114 mm. in standard length; several are over 100 mm.

In one cleared and stained specimen there are 13 vertebrae anterior to the origin of the anal fin. One set of pectoral actinosts is tightly fused; the other lacks fusion at the middle but the ends are united.

Soft dorsal rays in 41 specimens constantly 6; pectoral spine serrae, in specimens both over and under 100 mm. in standard length, 6 to 13, mean 10.0; upper simple caudal rays 19 to 24, mean 21.5; branched caudal rays 16 to 20, mean 17.9; usually 8, infrequently 7, upper branched caudal rays, mean 7.8; 9 to 12, mean 10.2, lower branched caudal rays; 14 to 19, mean 16.2, lower simple caudal rays.

General color yellowish brown, with dark brown or purplish black saddles and blotches. Side lightly mottled; abdomen and lower surface of head behind mental barbels usually unpigmented or with a few large round chromatophores near isthmus, uniformly yellowish or white; mental barbels and chin in front of them lightly pigmented; lower surface of pelvic fins occasionally with scattered pigment and the upper with diffuse pigment concentrated on outer rays, frequently forming a dark brown blotch; a small black spot on lower side of caudal peduncle extends into middle of anal base; anal fin with scattered brown chromatophores, especially near base, and a variable black submarginal band, otherwise yellowish white; pectoral fin with tip and inner margin immaculate, otherwise base and most of fin mottled with dark brown pigment; dorsal fin yellowish brown near base and along spine, middle clear yellowish white, tip of spine and distal one-third of first four or five rays covered with a black blotch, extreme tip of rays transluscent, whitish; adipose fin dark yellowish brown anteriorly; a broad black saddle extends from the midside through the middle of the adipose fin to its margin and turns backward along the upper edge, extending almost to the posterior end of the free flap in large specimens; free flap translucent, yellowish white; anterior procurrent caudal rays translucent or white; a broad jet black vertical bar of subuniform width extends from the lower to the upper margins of caudal fin and broadly crosses the caudal peduncle; in large specimens, it extends backward along the upper and lower margins of the caudal fin to meet the broad, subterminal, black caudal bar; a variable, usually narrow, vertical bar in the middle of the caudal fin does not continue to the margins; remainder of fin mottled or plain yellowish, margin clear white; a broad, dark brown or black saddle rests between the dorsal and adipose fins; a narrow one extends from in front of the dorsal spine to the second or third dorsal ray and downward to the midside. Head dark brown, darkest along midline and at posterior end where a dark bar passes downward from the occipital region to the upper branchiostegal membrane and operculum; a transverse dark brown bar passes backward and downward from the eye to the operculum and forward through the eye to below the nares and onto the snout; upper barbels heavily mottled.

Type.—The holotype (UMMZ 151322) is a male, 102.9 mm. in standard length. It has 3+12=15 anal rays, 21+9+11+17=58 caudal rays, 35 vertebrae, and 6 soft dorsal rays. On each side there are nine pelvic rays, nine (atypical) soft pectoral rays, two internasal pores, and eleven preoperculomandibular pores. There are eleven recurved serrae on the left and twelve on the right on the posterior edge of the pectoral spine, and many well-developed but smaller serrae on the anterior edge. The body form and pattern of pigmentation of this specimen is shown in plate 20, figure 2. The head length is stepped into the standard length 3.4 times. The distance from the adipose notch to the tip of the caudal fin is stepped into the distance from the dorsal origin to the adipose notch 1.65 times. Other measurements are given in table 28.

Variation.—*N. flavater* in the Current River closely approaches geographically localities from which *N. miurus* has been collected in the Little Black and Black Rivers, Missouri. In these areas there is a sharp break in characters between the two species and no interbreeding of the populations is indicated.

Populations of *flavater* from the White and Current Rivers, although presumably rather widely separated appear to be identical.

Total caudal rays in 36 specimens from the upper White River are 51 to 59, and in five from the Current River 54 to 60; rays in the upper half of the caudal fin are 26 to 31 in the White and 29 to 32 in the Current; soft pectoral rays are 7 to 9, usually 8 in the White River system, but there are 7 rays in 3 fins and 8 rays in 6 from the Current River system. Other data from the upper White River specimens overlap those from the Current. No significant variational trend is known to exist.

Distribution.—*Noturus flavater* (map 14) is confined to the upper White River system in Arkansas and Missouri. It is found in the upper Current River; the adjacent Black River contains *Noturus miurus*. From the Current it ranges southwesterly through most of the Ozark streams to the headwaters of the White River.

The record (Meek, 1894a) from Sallisaw River near Makey's [McKey's] Store, Oklahoma, is undoubtedly based upon transposed data. Dr. George A. Moore has loaned a specimen of *Noturus miurus* that he took from this locality.

Etymology.—The name *flavater* (Latin) is from *flavus* (yellow) and *ater* (black), and refers to the black and yellow colors.

Relationship.—*Noturus flavater* is obviously an allopatric representative of *N. miurus* and *N. flavipinnis*. The general similarity of color pattern, the morphology, and especially the numerous caudal rays align *flavater* with the *miurus* group.

Ecology.—*N. flavater* lives in clear, possibly cool, water of moderate to rapid current, flowing over a gravel, rubble, and boulder bottom. It seems to prefer the deeper portions of streams or pools rather than the shallow riffles. Specimens have been taken in collections with *exilis* and *albater*.

Hybridization

Natural hybrids between species of the family Ictaluridae appear to be rare. The few specimens that are recognized as hybrids are offspring of species exhibiting extremes of morphology. If closely related species interbreed, the resulting hybrids may not be recognized because of the extensive overlap in characters differentiating the parents.

The hybrids are not accidental, as in many cyprinids, but their scarcity probably results from a rather rigid system of mating and occupation of territory by the breeding pair. The available evidence indicates that pairs spawn alone, in cavities or beneath objects. Natural hybrids would thus appear to result from occasional breakdown of psychological barriers in mating.

Numerous hybrids of *Ictalurus furcatus* (LeSueur) and *Ictalurus punctatus* (Rafinesque) have been obtained experimentally after administration of gonadotropin and isolation of pairs in pens or aquaria (Giudice, 1966). Evidence presented suggests that most of the resulting eggs were viable, and indicates that offspring are vigorous growers and variously intermediate morphologically between the parent species. Conclusions could not be reached regarding the possible sterility of the F_1 hybrids. However, the gonads of several natural hybrids in *Noturus* appear, from gross observation, capable of producing viable eggs and sperm.

The effect of hybridization on evolution in the family cannot be postulated. The scarcity of natural hybrids in collections would suggest that hybridization has little effect. Although the fertilized eggs of crosses of any two species, or genera, may be viable, crosses between the most divergent forms such as between members of the genera *Ictalurus* and *Pylodictis* are doubted on morphological grounds. Offspring from hybrid parents have not been recognized, if indeed they exist.

The belief of Trautman (1948) that *Noturus* hybrids are the result of a breakdown of ecological barriers is also doubted for the following reasons. Most of the species of *Noturus* (few exceptions) have been collected with one or more other species at some part of the range (see discussions of species). Three to five species are commonly taken from small sections of streams in the Ohio and Mississippi drainage as well as elsewhere. These individuals of different species are often found hiding and nesting within a few feet of each other in apparent normal environments. Thus, if the barriers to hybridization are ecological, I would expect hybrids to be common rather than rare. Such is not the case.

It is also doubted that overcrowding is of any significance in ictalurid hybridization. Rather the opposite may be true—inability of a species to find a mate of its own kind in the breeding season. This is suggested by the observation that, with the exception of the Indiana specimen, the hybrid *Noturus* are from near the edge of the range of one of the parents, where its distribution interfingers into that of the other species. For example, one of the parent species of the Oklahoma hybrid is rare at the hybrid locality, as determined from extensive collections made at the locality.

The following is a summary of hybrids in the family Ictaluridae: O'Donnell (1935, p. 483) and Thompson (1935, p. 492) recorded three or four specimens from the Rock River, at Rockford and Sterling, Illinois, "which appear to be hybrids" between *Ictalurus punctatus* (Rafinesque) and *Opladelus* [*Pylodictis*] *olivaris* (Rafinesque). These fish were not described or illustrated, notes concerning them were not made, and the specimens can no longer be found. Although both species are known to occur together, because of the apparent distant relationship of *Ictalurus* and *Pylodictis* the identification of these individuals as hybrids is subject to considerable doubt.

Six specimens have been recognized as hybrids between species of *Noturus*. The most noticeable characteristics of these hybrids are the abnormal pectoral spine and peculiar coloration. Two other specimens of uncertain identity that may be hybrids are discussed under *Noturus gyrinus*.

Noturus gyrinus (Mitchill) × *Noturus miurus* Jordan

PLATES 3 (FIG. 12), 21 (FIG. 2)

Schilbeodes nocturnus (Jordan and Gilbert) [misidentifications].—Osburn, Wickliff, and Trautman, 1930, pp. 170, 174 (near mouth of Portage R., Ottawa Co., Ohio; one specimen).—Hubbs and Lagler, 1939, p. 26 (Great Lakes basin); 1941, pp. 63–64; and Gerking, 1945, pp. 74–75 (L. Erie basin).—Hubbs and Lagler, 1947 [and 1949], pp. 71, 73 (possibly the L. Erie basin record is a hybrid).—Trautman, 1959, pp. 31, 43, 442.

Rabida nocturna (Jordan and Gilbert) [misidentification].—Driver, 1942, p. 254 (Great Lakes basin).

Schilbeodes miurus (Jordan) × *Schilbeodes mollis* (Hermann).—Trautman, 1948, pp. 166–173, pl. 1, figs. 2, 5, 8 (description and comparisons; S. shore of L. Erie, 2 mi. E. of Port Clinton, Ohio).—Slastenenko, 1960, p. 74 (compiled).

MATERIAL STUDIED

UNITED STATES: INDIANA: USNM 199583 (1 specimen), Laughery Cr. [near mouth], near Aurora, August 13, 1957; collected with 4 *N. miurus* and 31 *N. gyrinus*. MICHIGAN: UMMZ 157214 (1 specimen), Huron R., N. of Milford, sec. 13, T. 2 N., R. 7 E., Oakland Co., May 23, 1949. UMMZ 167302 (1 specimen), Huron R., just below Kent Lake Dam, sec. 1, T. 1 N., R. 6 E., Livingston Co., June 8, 1954, reportedly collected with both parent species. NEW YORK: CU 42514 (1 specimen), dredged channel just below lake road, Cayuga Lake, Seneca Co., July 24, 1960.

Description.—Comparison of the hybrids with specimens of *Noturus gyrinus* and *Noturus miurus* is given in table 15. A fifth hybrid of this combination, from the western end of Lake Erie, was described by Trautman (1948). In the hybrids examined, body moderately short, little deeper forward than through caudal peduncle, deepest below dorsal spine; head broad, generally flat above, rather deep; skull somewhat arched; upper jaw usually slightly longest; lower jaw ending at about middle of upper lip in three specimens; jaws virtually equal in Indiana specimen; barbels rather short; posterior process of cleithrum prominent, a little longer than maximum diameter of pectoral spine; pectoral spine (pl. 3, fig. 12) slightly curved, without anterior serrae, prominent deep grooves present only in small specimens; posterior serrations present, but short and irregularly spaced or fused; dorsal spine stout; adipose fin broadly connected to the rather high upper procurrent caudal fin, with a very shallow indentation at junction; caudal fin almost truncate behind, with a rounded posterior margin; premaxillary tooth patch rather broad, the width of the band about 4 times its length; posterior corners of the band rounded.

Additional data are given in sequence for the specimens as follows: UMMZ 157214, UMMZ 167302, CU 42514, and USNM 199583. Standard length (in mm.) and sex: 108.8, probably female; 67.9, female with large eggs; 55.0, sex omitted; 33.0, sex uncertain. Anal rays: 17, 15, 15, 15. Upper branched caudal rays: 21, 17, 17, 7. Lower branched caudal rays: 13, 14, 13, 10. All have six soft dorsal rays.

The following stepped measurements of the two Michigan specimens and the New York specimen fall within the range obtained from Michigan *N. gyrinus* and *N. miurus:* Head length in standard length 3.2 to 3.45 times; predorsal length in distance dorsal fin origin to adipose notch 1.3 to 1.4; distance from adipose notch to tip of caudal fin in distance dorsal fin origin to adipose notch 1.2 to 1.5. In two specimens, the length of the dorsal spine in the predorsal length (2.6 to 2.65) and the length of the pectoral spines in the predorsal length (2.1 to 2.3) fall within the range obtained from Michigan *N. miurus*, but not Michigan *N. gyrinus;* these measurements do, however, fall within the range obtained for all specimens of *N. gyrinus* measured. In the three specimens, the caudal peduncle shows intermediacy, its depth in the predorsal length (2.7 to 2.75) overlaps slightly the same measurement obtained from Michigan *N. gyrinus* but is outside the range obtained for all specimens of *N. miurus* measured.

In the largest specimen there are 35 vertebrae. Its pectoral and dorsal spines are broken. There are no anterior serrae, but the posterior serrae of the pectoral spine are extremely irregular (pl. 3, fig. 12). The eye is stepped 2.6 times in the snout, and there are nine gill rakers on the left arch and eight on the right. The general color of this specimen is a mottled brown. When first preserved, the individual was light reddish orange with dark mottling and was tentatively identified as *Noturus miurus*.

In the largest specimen, side of body and peduncle mottled medium brown, darkest below dorsal fin and over air bladder; upper surface of head and upper barbels mottled dark brown, side of head lighter; lower surface of head and abdomen pale yellowish with numerous small chromatophores which are most concentrated just in front of pelvic fins and on the chin in front of barbels; lips and lower barbels dusky; pelvic fin pale yellowish, upper and lower surfaces with scattered chromatophores which are most concentrated near the base; pectoral fin dusky, especially near the spine, edge pale; dorsal fin with outer parts of rays brownish black, suggesting the black blotch of *N. miurus*, middle of fin yellowish, base dusky; a semblance of a basidorsal dark spot, and an obovate round yellowish spot at the base of the last three dorsal rays; anterior and posterior end of adipose fin yellowish, with a wide, medial, dark brown blotch that extends to margin; area between dorsal and adipose fin dark brown; caudal fin grayish brown, margin of rays yellowish, and a submarginal brownish black band encircling the fin; anal fin yellowish brown with a dark band on the ends of rays of anterior three-fourths of fin.

In the smaller Michigan specimen, belly and lower surface pale, with little scattered pigment; upper side and dorsal surface dark gray; lower half of caudal peduncle light gray; caudal fin with a moderately dark submarginal band; anterior lower procurrent caudal rays pale; anal fin with a prominent dark gray submarginal band; adipose fin dark gray, with a darker, definite obtuse blotch; dorsal fin gray, with tips of the first rays blackened; pectoral fins with blackish distal blotches.

The Indiana specimen (USNM 199583) has 34 vertebrae of which 12 are anterior to the anal fin, 7 hypurals without fusion, and 1 epural. There are about two small, short serrae near the posterior base of the pectoral spine. Its color is generally brownish, with darker traces of the *miurus* pattern superimposed, most prominent of which is the dark gray adipose blotch of *miurus*. The New York specimen is also brownish in color with *miurus* blotching.

Discussion.—That these specimens are correctly identified as hybrids between *Noturus gyrinus* and *Noturus miurus* is indicated by their color pattern and general intermediate morphology. The blotches of the dorsal surface although nearly obscured, and the darkened fin margins when present suggest a form of the subgenus *Rabida*; the general darkening of the body suggests one of the nearly unicolored species of *Noturus*.

The tendency toward many branched caudal rays, the tall upper procurrent caudal rays, the subterminal to almost terminal lower jaw, and the broad band of premaxillary teeth favor *N. gyrinus.*

N. miurus, as one parent, could contribute the irregular serrae (in combination with *gyrinus*), the blotched appearance, and the single internasal pore on each side. As in the hybrids, *N. miurus* has eleven preoperculomandibular pores and would be expected (in combination with a parent having a terminal jaw) to produce a subterminal jaw. The brownish black area near the tip of the dorsal fin and one which extends to the margin of the adipose fin are features of *miurus.* The same areas in *N. miurus* are black and diagnostic of that species. A darkened band on the anal fin probably comes from *N. miurus.* Several of the relatively low proportional measurements are also characteristic of both parents.

Hybrid vigor is indicated in the large individual as its extremely large size has not been attained, rarely approached, by any specimen of the parent species that has been examined. Compared to the hybrid (108.8 mm.), *N. gyrinus* seldom reaches 90 mm., and *N. miurus* attains 88 mm. in standard length. It is possible ecologically for the two species to hybridize. Neither is a typical riffle fish. Instead, *N. gyrinus* seems to prefer slow current or standing water; *N. miurus* prefers slow or moderate current. Both are found over mud or detritus bottoms. *N. miurus* nests in cavities, and according to Hankinson (1908, p. 208), *N. gyrinus* was found nesting in "an old tin can," on June 26, in Walnut Lake, Michigan. While it is possible that June may be a little early in Michigan for *miurus* to spawn (they were found spawning in late July and August in the Huron River), indications are that the breeding seasons of the species of *Noturus* may overlap considerably. *N. gyrinus* is probably common in the regions whence the hybrids were taken and *miurus* is probably uncommon.

I have not examined the only other known hybrid of this combination, described by Trautman (1948), but believe that his interpretation is correct. His figure and data suggest an individual that is intermediate in most respects (a hybrid) between *Noturus gyrinus* and *Noturus miurus.*

The ecological distribution of the two species in northern Ohio is discussed by Trautman (1948, pp. 171–173). He found them spawning close together under objects or in various types of cavities in southwestern Lake Erie, and feels that this is a breakdown rather than an overlap of the ecological distribution. I interpret the distribution of the species as broadly interfingering, and have examined several samples from throughout the overlapping ranges of the two species where both have been secured in the same collection. It appears most probable that hybrids, in such circumstances of ecological overlap, are the result of the breakdown of isolating mechanisms that exist between the two parents, especially where the population size of one species is very small. It seems improbable that such hybrids, although rare, result from accidental fertilization between species that are solitary or nearly solitary in their nesting habits.

Noturus exilis Nelson × *Noturus miurus* Jordan

PLATES 3 (FIG. 11), 21 (FIG. 1)

Schilbeodes eleutherus (Jordan) [misidentifications].—C. L. Hubbs, 1946, p. 38; and Hubbs and Lagler, 1947 [and 1949], p. 73 (Oklahoma, in part).—Moore and Paden, 1950, p. 87 (Poteau R., Slate Ford, Okla. [erroneously credited to Jordan and Gilbert]).—Bailey and Taylor, 1950, pp. 31, 38 (in part; Arkansas R. system).—Cross and Moore, 1952, p. 407 (Poteau R., Slate Ford, Okla.).

Schilbeodes miurus (Jordan) × *Schilbeodes nocturnus* (Jordan and Gilbert) [misidentification].—Taylor, *in* Cross and Moore, 1952, p. 407 (UMMZ 137904, Poteau R., Slate Ford, Okla.).—Slastenenko, 1960, p. 75 (compiled).

MATERIAL STUDIED

UNITED STATES: OKLAHOMA: UMMZ 137904 (1 specimen), Poteau R., Slate Ford, near Shady Point, Le Flore Co., April 12, 1941.

DESCRIPTION.—Reconsideration of this specimen, identified by me as a hybrid between *Schilbeodes miurus* and *Schilbeodes nocturnus* (see synonymy), leads me to the firm belief that *Noturus exilis* rather than *Noturus nocturnus* was one of the parents. There is no question that *Noturus miurus* was the other parent. The single specimen is from the Poteau River, a tributary of the Arkansas River in eastern Oklahoma. It is compared with *Noturus miurus*, *N. exilis*, and *N. nocturnus* in table 16.

Body rather short, heaviest forward; caudal peduncle tapering posteriorly; head broad, prominently depressed; lower jaw virtually terminal; premaxillary tooth patch with angulate posterior corners; eye 2.3 times in snout; humeral process prominent, a little longer than width of pectoral spine; pectoral spine (pl. 3, fig. 11) rather short, curved backward; its anterior edge with irregularities or roughenings suggesting vestigial serrae; posterior serrae prominent and regularly arranged but short in relation to diameter of spine; dorsal spine stout; adipose fin moderately long and high, broadly united to the moderately tall procurrent caudal fin; caudal fin tapers backward toward a point, middle rays very long, with a rounded posterior margin.

The individual is a male, 51.1 mm. in standard length. There are 5 + 10 = 15 anal rays, 24 + 7 + 10 + 15 = 56 caudal rays, 6 soft dorsal rays, 36 vertebrae, 7 distinct posterior pectoral spine serrae on the left side and 8 on the right. On each side there are nine pelvic rays, nine soft pectoral rays, ten preoperculomandibular pores, a single internasal pore, and six gill rakers. The least depth of the caudal peduncle is stepped 3.3 times in the predorsal length; the pectoral spines are stepped an average of 0.75 times in the peduncle depth or 3.75 times in the distance from the dorsal origin to the adipose notch. The specimen gives an impression of having been partially dried, as do other *Noturus* (*miurus* and *nocturnus*) with which it was collected.

Body color light brown; anal fin with a dark brown submarginal band; otherwise anal, pelvic, and pectoral fins with little pigment except near bases; caudal fin light yellowish brown, with a yellowish brown edge and a broad submarginal dark brown or black band; adipose fin with a yellowish, translucent margin and an irregular blotch extending about half way into fin; dorsal fin with a dark brown or black band through ends of rays, its base heavily pigmented, but midsection relatively poorly pigmented; membrane of dorsal spine (at least basal section) pigmented; lips and lower barbels yellowish, poorly pigmented; lower lip with a suggestion of washed out pigment, but bridge of pigment before pelvic fins a little heavier; otherwise lower surface without pigment; head dark brown above and along side, with large brown chromatophores on cheek and side; remnants of dorsal blotches present but not obvious; one about anterior base of dorsal fin, another between dorsal and adipose fins, and a third about base of adipose fin but not extending to margin of that fin; the dark brown or blackish band on caudal fin continues downward through the upper procurrent caudal rays and up through the lower procurrent caudal rays to caudal peduncle where it diffuses or becomes indistinct.

Discussion.—As judged from the several collections examined, *N. exilis* appears to be rare at the locality of capture of the hybrid; one specimen was taken but not recorded by Jordan and Gilbert; Cross and Moore (1952) did not list *exilis* from Stations 28 or M3 (the hybrid locality), but an earlier collection (Station Miz) contained the species. Elsewhere, in the Poteau River, *N. exilis* appears to be more common; Cross and Moore recorded it from 13 collections as *Schilbeodes insignis* (Richardson). *N. nocturnus* and *N. miurus* are common at this locality and throughout the Poteau River. Both were taken in the collection with the hybrid (Station M3), although *miurus* was not so indicated by Cross and Moore (1952, p. 407).

The hybrid unquestionably involves *Noturus miurus* as one parent; the recurved posterior serrae, the slight indication of anterior serrae, the suggestion of brown saddles on the dorsal surface and the bands of pigmentation on the procurrent caudal rays all indicate the subgenus *Rabida*. Of this group, only *N. miurus* is found in the stream. The other species of *Rabida* in the drainage (*N. placidus*) has neither a long pointed caudal fin with a broad subterminal blackish band, nor the pigmentation of the lower procurrent caudal rays. The low adipose blotch and the somber color probably were the basis for the initial identification as *Schilbeodes eleutherus* (see synonymy), but both *N. eleutherus* and *N. placidus* differ in the above listed characters and do not have the broad, dark brown or black blotch that is present on the dorsal fin of the hybrid. The pectoral spine (pl. 3, fig. 11) is rather unlike that of any species of *Rabida*, nor can the greatly depressed head be duplicated in any species of the subgenus.

Noturus exilis seems to be the other parent. It provides the source of the almost terminal lower jaw, the greatly depressed head, and reinforces the broad dark brown or black margins of the dorsal and caudal fins. *N. nocturnus*, in contrast, has an included lower jaw as does *miurus* and neither of these has the skull depressed. If the hybrid involves *N. nocturnus*, one might expect more caudal rays since both that species and *N. miurus* have notably high counts, whereas that in *N. exilis* is low. The serrations of the posterior edge of the pectoral spine in *N. miurus* are prominent and uniformly recurved, much as in the hybrid; those of *exilis* are prominent, but relatively straight (pl. 3, fig. 3); those of *N. nocturnus* are rarely developed and distinct, they are usually represented by a roughened edge (pl. 3, fig. 5). If the hybrid involved *N. miurus* and *N. exilis*, the prominent serrae would presumably be maintained, as in the hybrid. If *N. miurus* and *N, nocturnus* were jointly involved, the serrae would probably be reduced and irregular, about as in the hybrid *N. gyrinus*×*N. miurus* (pl. 3, fig. 12), an intermediate situation. The nine soft pectoral rays are obtained from one of the dark species, as *N. miurus* and most kinds of *Rabida* typically have eight. The single internasal pore is present in *lachneri*, *exilis*, and *miurus* among the species of *Noturus*. The preoperculomandibular pores number ten as in *exilis*, and are usually eleven in *miurus*. In *nocturnus* there are typically eleven preoperculomandibular pores in the Arkansas River drainage, but ten pores in the adjacent Red River drainage. Thus, the listed characters point to a hybrid involving *Noturus exilis* and *Noturus miurus*. In this case, the ecological distributions of the two parent species slightly overlap or interfinger; one species (*N. exilis*) is rare at the particular locality, and at the time of the breeding season, isolating mechanisms have broken down.

Phylogeny

The North American catfishes, family Ictaluridae, have been regarded by some workers as representative bagrids and a few writers, even in recent years, have placed them in the Old World family Bagridae. An evolutionary relationship is possible and seems probable but no critical study, involving comparison of fossils, of the divergent Asiatic forms, and of the American species, has been made. Because of several prominent differences, however, it is likely that the current separation of the North American species as a family will hold. Study of the ictalurids indicates a lack of diverse modification in most organ systems and suggests a monophyletic origin. The principal differences in groups and species result from loss or accentuation of parts.

A comparison of the genera of the family Ictaluridae is presented in table 1. The genera seem to fall into three major divisions: the *Pylodictis* group containing that genus and *Satan;* the *Noturus* group, encompassing also *Prietella;* and the *Ictalurus* group, including *Ictalurus* and *Trogloglanis*. That the genera in each group are related is evidenced by their structural similarity. Adaptation to underground life, eyelessness, depigmentation, and absence of the air bladder are regarded as extreme specializations in *Satan* and *Trogloglanis*. In the latter, the backward extension of the supraoccipital process is extreme and is equaled only in a few highly modified species of *Ictalurus;* the loss of teeth on the jaws is unique in the family. *Noturus* and *Prietella* are similar in many characters but dissimilar in others suggesting early divergence from a common ancestor. *Prietella* has apparently adopted a subterranean life, with loss of eyes and pigment, and reduction of the skeleton. Yet in the retention of a poorly ossified, mostly segmented, first long dorsal ray it is much more primitive than *Noturus*. As judged from the sensory canal system and the number of pelvic rays, the *Noturus* group is intermediate between the *Ictalurus* and *Pylodictis* groups. In certain features it is unlike them, and has undergone specialization from the presumed ancestral stock, for example in the extreme reduction or loss of the post-temporal bone and in the reduction of elements in the skull and pectoral girdle. *Noturus* and the blind species still retain a "primitive finfold," exemplified in the connected adipose and caudal fins, and their skeletons are typically weak and not heavily ossified.

The presence of eight pelvic rays in *Prietella* and eight or nine in the forms of *Noturus* may indicate a transition from eight in *Ictalurus* to nine or ten in the *Pylodictis* group. Such an evolutionary increase is suggested since many bagrids and pimelodids have six pelvic rays, and in the the Ictaluridae there is a tendency for specimens to have in excess of the modal number of pelvic rays more frequently than fewer (general observation and table 18). In an 8-rayed species, a count of seven rays is rare, whereas nine rays is occasional; in 9-rayed species, ten pelvic rays are encountered much more frequently than eight.

The direction of change in the spines undoubtedly was consolidation and development of spinules or serrae. At one extreme is the strongly serrated, large, specialized pectoral spine such as that of *Noturus furiosus* and at the other a straight, simple, and poorly consolidated structure such as in *Noturus gyrinus*. This trend is repeated in the complex structure of the spine of *Ictalurus punctatus* contrasted to the simpler spine of *Ictalurus melas*.

Other characteristics that are interpreted as specializations include: the formation of a free posterior flap or shortening of the base of the adipose fin (with increase in size as well as with specialization); degeneration or loss of skeletal parts; reduction of the number of hypurals and their fusion distally; development of posterior serrae on the dorsal spine in *Ictalurus;* fusion of the two ossified pectoral radials; extreme development of chewing surfaces, especially those of the premaxilla from a short, rectangular patch; backward elongation of the supraoccipital process; a greatly depressed or a highly arched skull; a short or an extremely long anal fin; a few or many rayed caudal fin; perhaps an included lower jaw; loss of eyes and pigmentation; probably an increase in the number of preoperculomandibular pores; the anterior union of the sensory canals, especially that of the infraorbital and supraorbital canals, in some *Noturus* and *Satan*, and that of the preoperculomandibular canals in *Satan* and *Pylodictis;* excessive elongation or shortening of the posterior process of the cleithrum; and the shortening of, addition of a posterior chamber to, or loss of the air bladder.

The total number of caudal rays in *Ictalurus* and *Pylodictis* is unknown, but they typically have 15 branched rays. In *Noturus*, the range of variation of the total caudal ray count is 39 to 67, and the average of the means for the species is 53.2. The limited available data on *Ictalurus* and *Pylodictis* indicate that they too have approximately 50 caudal rays. This is perhaps close to the primitive condition. If so, divergence may be regarded as a specialization.

The fossil history of the Ictaluridae is little known. Spines and other elements from *Ictalurus*, resembling those of modern bullheads, are known from Lower Pliocene deposits. Also, spines of one close to, if not identical to, *Ictalurus furcatus* have been reported (Hubbs and Hibbard, 1951) from the Lower Pliocene. Elements that seem identical with the recent *Ictalurus punctatus* and *Pylodictis olivaris* are known from Pleistocene deposits, but fossil representatives of *Noturus* and the blind species are unknown. This absence of fossil *Noturus* is undoubtedly due to the nature of the habitat in which they lived. Spines of catfish resembling bullheads are common fossils, but since many *Noturus* occupy riffle habitats or regions of erosion, rather than of deposition as do several of the bullheads, their fossilization is unlikely. *Noturus gyrinus* and others living in lowland streams or lacustrine waters where the chance of fossilization is greater are most likely to be found as fossils.

Despite the poor fossil evidence, it seems plausible to assume that the family arose early, perhaps early in the Tertiary or late in the Cretaceous; that the genera had an early origin; that *Ictalurus* and *Noturus* have had a long history; and that the group represented by

Pylodictis and *Satan* has had nearly as long an ancestry, but that line either has not speciated extensively or the relatives have become extinct. *Pylodictis*, with a well serrated pectoral spine, modified teeth, and a short adipose fin, and *Satan*, adapted to a cave habitat, are undoubtedly highly modified from this old line. They may be postulated to have arisen from a form not greatly unlike some species of *Noturus* of the subgenus *Rabida*. In *Pylodictis* and *Rabida* similarity exists in the presence of serrae on both edges of their pectoral spines; both usually have nine or ten pelvic rays; both, at least as young, have a variegated color pattern; in the *Pylodictis* group the sensory canals of the lower jaw unite at the midline, or open from a median pit, while in the subgenus *Rabida* the anterior pores often approach the medial position and actually open from a common pit in some individuals, and both have relatively high adipose fins and short anal fins.

Ictalurus is relatively less specialized than *Noturus*, but undoubtedly arose from a form like that postulated for an ancestral *Noturus:* with eight pelvic rays, a continuous adipose fin, probably a relatively small size, a weak and poorly armed pectoral spine, a short chunky body, and a slightly arched skull. In *Ictalurus*, it is likely that the bullheads appeared first; they are known as early fossils, have the simplest structures, and are probably the most generalized ecologically. From this ancestral stock, the series of specializations grade in the direction of *Ictalurus punctatus* on the one hand and *Ictalurus furcatus* on the other. In the first, evolution has left several variously specialized forms in Mexico and the southwestern United States and *Ictalurus catus* along the eastern seaboard of the United States. The probable *furcatus* group is represented in Mexico by an endemic species of the Balsas basin, *Ictalurus balsanus*, in addition to the wide ranging *Ictalurus furcatus*. The bullheads, which are generalized and highly successful, have persisted in eastern North America.

The apparent close relatives of each species of *Noturus* are indicated in the discussion of the species. Those species of the subgenus *Rabida* form a relatively compact group with considerable specialization in development of spine serrae. In this subgenus the morphology grades from elongate forms with eight pelvic rays and small, poorly armed spines through those with nine rays to the relatively short, heavy bodied forms with nine pelvic rays and large, well serrated spines. Correlated with the increase in spine size is the increase in length of the humeral process or posterior spine of the cleithrum and to some extent the reduction of the adipose fin. Only the intermediate *Noturus eleutherus* and the relatively primitive *Noturus hildebrandi lautus* have ten preoperculomandibular pores. The lower jaw is included in all species, but it approaches the interpreted generalized condition in *Noturus baileyi*.

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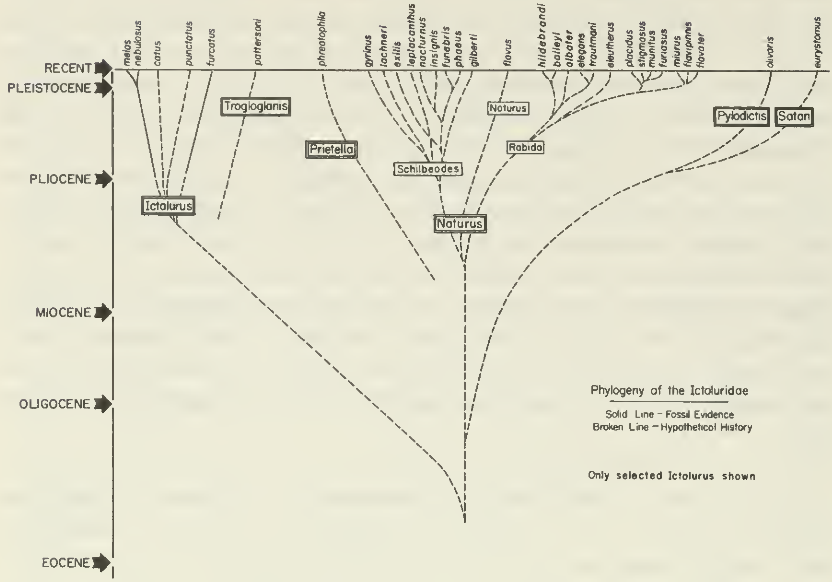

FIGURE 5.—Phylogeny of the Ictaluridae.

The species assigned to the subgenus *Schilbeodes* are more divergent and possibly a heterogeneous assemblage. Prominent generalized characters are found in a number of species. Those with a terminal mouth and ten preoperculomandibular pores (*gyrinus*, *lachneri*, and *exilis*) are very generalized with *gyrinus* being most primitive as judged from its pelvic fin and deeply grooved pectoral spine. In this area, *N. exilis* has diverged considerably with nine pelvic rays and a serrated spine. *Noturus leptacanthus* with eight pelvic rays and a nonserrated spine may be the most primitive of those with an included lower jaw, but *Noturus insignis*, *Noturus phaeus*, and *Noturus funebris* with modally seven hypurals retain a generalized character that may be as significant. *Noturus gilberti* is probably the most highly specialized member of the subgenus. *Noturus flavus*, in the subgenus *Noturus*, resembles *gilberti* in a number of characters but is the only member of the genus constantly retaining the primitive unfused pectoral radials; however it has diverged considerably from the generalized condition with specialization of the teeth and increase in the number of paired fin rays and caudal rays.

In the interpreted phylogeny (fig. 5), only a few of the species of *Ictalurus* are indicated, otherwise the forms are arranged in natural groups. The solid lines indicate the history as judged from fossils; the dashed lines show the hypothetical history.

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Tables 1-28

TABLE 1.--*Comparison of the Genera of Ictaluridae*

(Numbers in parentheses refer to number of specimens examined unless indicated otherwise.)

Character	*Ictalurus*	*Trogloglanis*	*Prietella*
Preoperculomandibular pores (modal number)	10 each side	10-10 (1) or 10-11 (1)	11 each side (but canal interrupted)
Anterior ends of preoperculomandibular canals	Widely separated	Widely separated	Widely separated
Infraorbital canal behind eye	Swings upward and slightly anteriorly	Swings upward and slightly posteriorly	Swings upward and slightly anteriorly
Pelvic rays, each side (modal number)	8	8 (1) or 9 (1); also 8 reported (Eigenmann, 1919)	8
Branched caudal rays	15 (seldom vary, but often 16 in *natalis*)	15 (2)	12 (1) or 13 (12), see Carranza (1954)
Dorsal rays	Normally I,6	I,6 (2)	Spine absent; soft rays normally 7
Ossified pectoral radials, each side	2, free	2, free (1)	2, free
Post-temporal bone (Regan, 1911)	Present, articulates with supracleithrum		Obsolete or nonfunctional as articulation surface
Occipital process	Moderate to long in length; broad or moderately broad above; extends considerably beyond skull or connects with process from dorsal fin base	Long, broad above; extends to process from dorsal fin base	Very short, narrow; barely projects beyond skull
Skull	Slightly depressed to greatly arched	Moderately arched	Moderately depressed

TABLE 1.--*Comparison of the Genera of Ictaluridae*--Continued

(Numbers in parentheses refer to number of specimens examined unless indicated otherwise.)

Character	*Noturus*	*Pylodictis*	*Satan*
Preoperculomandibular pores (modal number)	10 each side (4 species); 10 or 11 (2 species); 11 (17 species)	12 each side	12 each side (see text)
Anterior ends of preoperculomandibular canals	Usually widely separated; rarely join in a pit at midline	Joined; anterior pore common to both sides	Open into a median pit or pore common to both sides
Infraorbital canal behind eye	Swings upward and slightly anteriorly	Swings posteromedially	Swings posteromedially
Pelvic rays, each side (modal number)	8 (5 species); 9 (18 species)	9, often 10	9 (1) or 10 (2)
Branched caudal rays	Variable, 12 to 40, usually 14 to 36	15 (seldom vary)	15 (3)
Dorsal rays	Normally I,6 but often I,5 in 1 species	Normally I,6	I,6 (2) or I,7 (1)
Ossified pectoral radials, each side	2, free in 1 species and frequently in another; usually fused in all others	2, free	2, free (1)
Post-temporal bone (Regan, 1911)	Absent or vestigial; nonfunctional as articulation surface	Present; articulates with supracleithrum	
Occipital process	Very short, narrow; barely projects beyond skull	Of moderate length, narrow; extends well beyond skull	Short, narrow; extends little beyond skull
Skull	Slightly arched to greatly depressed	Greatly depressed	Moderately depressed

TABLE 1.--*Comparison of the Genera of Ictaluridae*--Continued

(Numbers in parentheses refer to number of specimens examined unless indicated otherwise.)

Character	*Ictalurus*	*Trogloglanis*	*Prietella*
Adipose fin	Small, short; a high flap with posterior end free from back and base remote from caudal fin	Long and high; rounded posteriorly; adnate to back and connected at base to caudal fin	Long and moderately high; adnate to back and broadly connected with caudal fin
Procurrent caudal rays	Imbedded in thick fleshy tissue	Surrounded by a thin membrane	Surrounded by a thin membrane
Gill rakers, first arch	Numerous, 11 or more	18 or 19 (2)	10 to 14
Eyes	Present	Absent	Absent
Skin	Variously pigmented	Unpigmented	Unpigmented
Air bladder	Present; 2 or 3 chambers	Absent	Present; 2 chambers

TABLE 1.--*Comparison of the Genera of Ictaluridae*--Continued

(Numbers in parentheses refer to number of specimens examined unless indicated otherwise.)

Character	*Noturus*	*Pylodictis*	*Satan*
Adipose fin	Long, low to moderately high; adnate to back and variously connected to or slightly separated from caudal fin	Large, short; a high rounded flap with posterior end free from back and base remote from caudal fin	Long and high; rounded posteriorly; adnate to back and connected at base to caudal fin
Procurrent caudal rays	Surrounded by a thin membrane	Imbedded in thick fleshy tissue	Surrounded by a thin membrane
Gill rakers, first arch	Few, 3 to 10	10 or more	17 to 19 (3)
Eyes	Present	Present	Absent
Skin	Variously pigmented	Variously pigmented	Unpigmented
Air bladder	Present; 2 chambers	Present; 2 chambers	Absent

TABLE 2.--*Geographic variation in paired fin rays of* Noturus gyrinus (both sides counted)

Area	No. of Pelvic Rays						Total	Mean
	5	6	7	8	9	10		
Michigan:								
Upper Peninsula	-	-	-	17	1	-	18	8.06
Lower Peninsula	2	2	9	370	25	-	408	8.01
Quebec	-	-	1	1	-	-	2	7.50
New Hampshire	-	-	-	4	-	-	4	8.00
New Jersey	-	1	1	35	-	-	37	7.92
Maryland	-	-	2	-	-	-	2	7.00
North Carolina	-	-	-	7	1	-	8	8.13
Georgia	-	-	-	4	-	-	4	8.00
Florida:								
Peninsula	-	-	3	150	53	-	206	8.24
Marianna	-	-	-	12	-	-	12	8.00
Escambia R.	-	-	-	46	20	-	66	8.30
Tombigbee R.	-	-	-	6	38	8	52	9.04
Pascagoula R.	-	-	-	-	18	-	18	9.00
Biloxi Bay Drainage	-	-	-	4	14	-	18	8.78
Bay St. Louis Drainage	-	-	-	4	-	-	4	8.00
Florida Parishes, La.	-	-	-	-	2	2	4	9.50
Mississippi Drainage, Miss.	-	-	-	8	2	-	10	8.20
Other Louisiana	-	-	-	13	7	-	20	8.35
Texas	-	-	2	103	5	-	110	8.03
Oklahoma	-	-	-	25	9	-	34	8.26
Missouri	-	-	1	57	3	-	61	8.03
Illinois	-	-	-	31	3	-	34	8.09
Ohio R., Ind.	-	-	1	60	1	-	62	8.00
Total	2	3	20	957	202	10	1,194	8.16

TABLE 2.--*Geographic variation in paired fin rays of* Noturus gyrinus (both sides counted)--Continued

Area	No. of Soft Pectoral Rays						Total	Mean
	5	6	7	8	9	10		
Michigan:								
Upper Peninsula	-	11	7	-	-	-	18	6.39
Lower Peninsula	3	169	230	1	-	-	403	6.57
Quebec	-	-	2	-	-	-	2	7.00
New Hampshire	2	2	-	-	-	-	4	5.50
New Jersey	-	1	25	3	-	-	29	7.07
Maryland	-	2	-	-	-	-	2	6.00
North Carolina	-	-	8	-	-	-	8	7.00
Georgia	-	-	4	-	-	-	4	7.00
Florida:								
Peninsula	-	15	167	21	-	-	203	7.03
Marianna	-	-	12	-	-	-	12	7.00
Escambia R.	-	2	59	9	-	-	70	7.10
Tombigbee R.	-	-	4	39	7	-	50	8.06
Pascagoula R.	-	-	1	16	1	-	18	8.00
Biloxi Bay Drainage	-	-	8	10	-	-	18	7.56
Bay St. Louis Drainage	-	-	4	-	-	-	4	7.00
Florida Parishes, La.	-	-	-	-	-	4	4	10.00
Mississippi Drainage, Miss.	-	-	7	3	-	-	10	7.30
Other Louisiana	-	-	20	2	-	-	22	7.09
Texas	1	5	99	5	-	-	110	6.98
Oklahoma	-	1	29	4	-	-	34	7.09
Missouri	-	5	52	4	-	-	61	6.98
Illinois	-	2	30	2	-	-	34	7.00
Ohio R., Ind.	-	23	35	-	-	-	58	6.60
Total	6	238	803	119	8	4	1,178	6.91

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TABLE 3.--*Geographic variation of caudal rays in* Noturus gyrinus

Area	No. of Caudal Rays																	Total	Mean
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66		
Great Lakes basin	3	1	7	8	8	4	3	-	-	-	-	-	-	-	-	-	-	34	53.21
New Jersey, New Hampshire, Maryland	1	2	-	3	3	2	6	1	2	1	-	-	-	-	-	-	-	21	54.81
North Carolina	-	-	1	-	-	1	-	1	-	1	-	-	-	-	-	-	-	4	55.75
Ohio R., Indiana	-	-	2	1	3	5	8	5	2	-	3	-	-	-	-	-	-	29	55.97
Missouri	-	-	-	3	2	-	6	3	5	9	1	1	-	-	-	-	-	30	57.20
Texas	-	-	-	1	1	1	3	2	7	5	2	1	1	-	-	1	-	25	58.12
Alabama and Louisiana	-	-	-	-	-	-	-	1	1	-	1	-	2	-	1	-	-	6	60.50
Florida	-	-	-	-	-	-	1	3	9	12	21	10	21	10	5	4	3	99	60.98
Total	4	3	10	16	17	13	27	16	26	28	28	12	24	10	6	5	3	248	57.96

TABLE 4.--*Geographic variation in number of caudal rays in* Noturus exilis

Drainage	No. of Caudal Rays														Total	Mean
	44	45	46	47	48	49	50	51	52	53	54	55	56	57		
Arkansas R.:																
McHenry Cr., Ark.	-	1	2	-	3	1	-	-	-	-	-	-	-	-	7	47.14
Poteau R.	-	-	-	-	2	-	-	-	-	1	-	-	-	-	3	49.67
Illinois R.	1	-	3	6	7	7	7	5	-	-	-	-	-	-	36	48.56
Neosho R.	-	-	2	6	4	1	4	-	-	-	-	-	-	-	17	47.94
Subtotal	1	1	7	12	16	9	11	5	-	1	-	-	-	-	63	48.29
White R.	-	-	-	-	-	6	7	4	10	4	3	-	-	-	34	51.24
Missouri R.:																
Osage and Missouri R.	-	-	-	-	1	1	8	19	6	3	2	3	1	1	45	51.62
Gasconade R.	-	-	-	-	-	-	3	2	1	3	5	1	-	-	15	52.53
Subtotal	-	-	-	-	1	1	11	21	7	6	7	4	1	1	60	51.85
Upper Mississippi R.	-	-	-	-	-	1	2	2	3	-	1	-	-	-	9	51.22
Meramec and lower Mississippi R., Mo.	-	-	-	-	1	1	4	7	4	7	2	-	-	-	26	51.58
Tennessee R.	-	-	1	-	1	1	3	4	-	-	1	-	-	-	11	50.09
Grand total	1	1	8	12	19	19	38	43	24	18	14	4	1	1	203	50.48

TABLE 5.--*Geographic variation in number of anal rays in* Noturus exilis

Drainage	No. of Anal Rays 17	18	19	20	21	22	Total	Mean
Arkansas R.:								
McHenry Cr., Ark.	-	3	3	1	-	-	7	18.71
Poteau R.	-	1	2	-	-	-	3	18.67
Illinois R.	2	6	22	3	3	-	36	18.97
Neosho R.	-	3	9	4	1	-	17	19.18
Subtotal	2	13	36	8	4	-	63	18.98
White R.:								
White R.	-	1	5	10	15	2	33	20.36
Black R.	-	-	-	-	1	-	1	21.00
Subtotal	-	1	5	10	16	2	34	20.38
Missouri R.:								
Osage and Missouri R.	-	2	29	9	2	1	43	19.33
Gasconade R.	-	1	1	6	7	-	15	20.27
Subtotal	-	3	30	15	9	1	58	19.57
Upper Mississippi R.	3	1	4	2	1	-	11	18.73
Meramec and lower Mississippi R., Mo.	-	-	7	14	5	-	26	19.92
Tennessee R.	-	-	1	8	2	-	11	20.09
Grand total	5	18	83	57	37	3	203	19.55

TABLE 6.--*Geographic variation of vertebrae in* Noturus funebris *and* Noturus phaeus (the fused anterior vertebrae are excluded)

Drainage	No. of Vertebrae					Total	Mean
	34	35	36	37	38		
N. phaeus							
Forked Deer River	-	3	8	2	-	13	35.92
Loosahatchie River	-	1	-	-	-	1	35.00
Yazoo River	2	20	34	7	-	63	35.73
Red River	2	17	2	-	-	21	35.00
Little River	-	-	3	1	-	4	36.25
Beaver Creek	-	3	-	-	-	3	35.00
Total	4	44	47	10	-	105	35.60
N. funebris							
Pearl River	-	13	22	-	-	35	35.63
Wolf River	1	1	3	-	-	5	35.40
Escatawpa River	-	3	2	-	-	5	35.40
Tallapoosa River	-	-	-	2	-	2	37.00
Perdido River	-	-	1	-	1	2	37.00
Blackwater River	-	-	1	6	1	8	37.00
Yellow River	-	-	2	5	1	8	36.88
Econfina Creek	-	-	-	1	-	1	37.00
Total	1	17	31	14	3	66	36.02

TABLE 7.--*Geographic variation in paired fin rays of* Noturus leptacanthus (both sides tabulated)

River System	No. of Soft Pectoral Rays				Total	Mean
	7	8	9	10		
Amite	-	25	7	-	32	8.22
Tangipahoa	-	2	-	-	2	8.00
Chefuncte	3	152	75	-	230	8.31
Pearl	1	36	11	-	48	8.21
Wolf	-	2	2	-	4	8.50
Biloxi	-	82	42	-	124	8.34
Pascagoula	-	34	31	-	65	8.48
Tombigbee	-	2	42	8	52	9.12
Alabama	-	3	89	14	106	9.10
Perdido	-	7	27	-	34	8.79
Escambia	-	3	35	-	38	8.92
Blackwater	-	14	84	2	100	8.88
Yellow	-	-	3	-	3	9.00
Choctawhatchee	-	2	24	6	32	9.13
Apalachicola	-	2	41	3	46	9.02
Ochlockonee	-	-	2	2	4	9.50
Suwannee	-	4	51	5	60	9.02
St. Johns	-	-	2	-	2	9.00
Satilla	-	-	-	-	-	-
Altamaha	-	-	4	-	4	9.00
Savannah	-	-	65	8	73	9.11
Combahee	1	-	2	3	6	9.17
Edisto	-	1	7	-	8	8.88
Great Cypress Swamp	-	-	1	-	1	9.00
Total	5	371	647	51	1,074	8.69

TABLE 7.--*Geographic variation in paired fin rays of* Noturus leptacanthus (both sides tabulated)--Continued

River System	No. of Pelvic Rays			Total	Mean
	7	8	9		
Amite	-	32	-	32	8.00
Tangipahoa	-	2	-	2	8.00
Chefuncte	1	232	15	248	8.06
Pearl	1	42	5	48	8.08
Wolf	-	4	-	4	8.00
Biloxi	-	119	5	124	8.04
Pascagoula	-	65	1	66	8.02
Tombigbee	-	49	3	52	8.06
Alabama	-	86	20	106	8.19
Perdido	-	32	2	34	8.06
Escambia	-	38	-	38	8.00
Blackwater	-	99	1	100	8.01
Yellow	-	4	-	4	8.00
Choctawhatchee	-	29	1	30	8.03
Apalachicola	1	42	3	46	8.04
Ochlockonee	-	6	-	6	8.00
Suwannee	-	70	8	78	8.10
St. Johns	-	2	-	2	8.00
Satilla	-	2	-	2	8.00
Altamaha	-	4	-	4	8.00
Savannah	-	66	10	76	8.13
Combahee	-	2	4	6	8.67
Edisto	-	8	-	8	8.00
Great Cypress Swamp	-	2	-	2	8.00
Total	3	1,037	78	1,118	8.07

TABLE 8.--*Geographic variation of anal and soft pectoral rays in* Noturus funebris *and* Noturus phaeus

Drainage	No. of Anal Rays										Total	Mean
	18	19	20	21	22	23	24	25	26	27		
N. phaeus												
Forked Deer River	-	-	7	10	11	2	1	-	-	-	31	21.35
Hatchie River	-	-	4	6	1	-	-	-	-	-	11	20.73
Loosahatchie River	-	1	5	2	1	-	-	-	-	-	9	20.33
Wolf River	-	-	-	1	-	-	-	-	-	-	1	21.00
Yazoo River	1	9	31	32	12	4	-	-	-	-	89	20.64
Ouachita River	-	-	-	1	2	-	1	1	-	-	5	22.80
Little River	-	1	18	50	34	4	-	-	-	-	107	21.21
Red River and Bayou Teche	-	1	13	32	7	1	-	-	-	-	54	20.89
Homochitto River	-	1	1	1	3	1	-	-	-	-	7	21.29
Beaver Creek	-	-	-	3	-	-	-	-	-	-	3	21.00
Total	1	13	79	138	71	12	2	1	-	-	317	20.99
N. funebris												
Pearl River	-	-	2	10	30	13	1	-	-	-	56	22.02
Wolf River	-	-	-	4	8	8	2	-	-	-	22	22.36
Biloxi Bay	-	-	-	1	2	-	-	-	-	-	3	21.67
Pascagoula Bay	-	-	-	3	14	13	1	-	-	-	31	22.39
Chickasaw Creek	-	-	-	1	1	-	-	-	-	-	2	21.50
Tombigbee River	-	-	-	-	1	4	-	-	-	-	5	22.80
Tallapoosa River	-	-	1	4	1	-	-	-	-	-	6	21.00
Perdido River	-	-	-	-	-	1	3	-	-	-	4	23.75
Escambia County and River	-	-	-	-	1	2	1	-	-	-	4	23.00
Blackwater River	-	-	-	-	-	1	5	8	4	1	19	24.95
Yellow River	-	-	-	-	-	1	6	3	1	-	11	24.36
Alaqua Creek	-	-	-	-	-	1	3	-	-	-	4	23.75
Econfina Creek	-	-	-	-	-	1	2	-	-	-	3	23.67
Total	-	-	3	23	58	45	24	11	5	1	170	22.72

TABLE 8.--*Geographic variation of anal and soft pectoral rays in* Noturus funebris *and* Noturus phaeus--Continued

Drainage	No. of Pectoral Rays					Total	Mean
	7	8	9	10	11		
N. phaeus							
Forked Deer River	1	46	15	-	-	62	8.23
Hatchie River	-	12	8	-	-	20	8.40
Loosahatchie River	-	10	8	-	-	18	8.44
Wolf River	-	2	-	-	-	2	8.00
Yazoo River	2	100	68	-	-	170	8.39
Ouachita River							
Little River	-	18	194	1	-	213	8.92
Red River and Bayou Teche	-	34	58	-	-	92	8.63
Homochitto River	-	1	13	-	-	14	8.93
Beaver Creek	-	-	5	1	-	6	9.17
Total	3	223	369	2	-	597	8.62
N. funebris							
Pearl River	-	2	94	10	-	106	9.08
Wolf River	-	2	40	2	-	44	9.00
Biloxi Bay	-	-	4	-	-	4	9.00
Pascagoula Bay	-	-	38	23	1	62	9.40
Chickasaw Creek	-	-	4	-	-	4	9.00
Tombigbee River	-	2	5	5	-	12	9.25
Tallapoosa River	-	-	10	2	-	12	9.17
Perdido River	-	-	5	1	-	6	9.17
Escambia County and River	-	-	5	3	-	8	9.38
Blackwater River	-	-	22	14	-	36	9.39
Yellow River	-	-	16	4	-	20	9.20
Alaqua Creek	-	2	5	1	-	8	8.88
Econfina Creek	-	-	3	2	-	5	9.40
Total	-	8	251	67	1	327	9.19

TABLE 9.--*Comparison of the young of* Noturus flavus *and other species of* Noturus *that have been confused with, and occur in the range of* Noturus flavus

Character	*exilis*	*nocturnus*	*insignis*	*gyrinus*	*flavus*
Head	Moderately to greatly depressed	Generally rounded and arched	Shallowly depressed	Typically rounded or arched	Greatly depressed
Jaws	Nearly equal	Lower included	Lower included	Nearly equal	Lower included
Internasal pores	1-1	2-2	2-2	2-2	2-2
Lateral end of premaxillary tooth band	Usually truncate or rounded behind	Usually truncate or rounded behind	Usually truncate or rounded behind	Usually truncate or rounded behind	Rear edge variable; shallowly V-shaped to having an elongate posterior extension
Pectoral spine (posterior edge)	Serrae distinct, prominent, and not numerous	Roughened, sometimes with a few irregular serrae	A few to many moderate size serrae	Without serrae	Usually only roughened
Median fins	Usually with dark borders	Sometimes with dark submarginal bands; edge frequently light	Usually with dark borders	Typically unicolor	A broad light border usually present; never with a dark border
Light blotch at posterior base of dorsal fin	Typically present	Absent	Absent	Absent	Typically present

TABLE 9.--*Comparison of the young of* Noturus flavus *and other species of* Noturus *that have been confused with, and occur in the range of* Noturus flavus--Continued

Character	*exilis*	*nocturnus*	*insignis*	*gyrinus*	*flavus*
Under surface of head	Lightly pigmented on lower lip anterior to mental barbels; otherwise unpigmented	Typically with heavy pigment on lower lip anterior to mental barbels; otherwise usually unpigmented	Moderate pigment on lower lip anterior to mental barbels; otherwise unpigmented	Entire under surface of head frequently uniformly pigmented; sometimes irregularly pigmented	Unpigmented
Under surface of abdomen	Unpigmented, except a narrow dark band may cross abdomen just anterior to pelvic fins	Usually unpigmented, except a narrow dark band crosses abdomen just anterior to pelvic fins	Unpigmented, except a narrow dark band usually crosses abdomen just anterior to pelvic fins	Variously well pigmented to unpigmented	Unpigmented

TABLE 10.--*Geographic variation of vertebrae in* Noturus hildebrandi (the fused anterior vertebrae are excluded)

Drainage	Number of Vertebrae							Total	Mean
	30	31	32	33	34	35	36		
Homochitto R.	1	-	11	34	11	2	-	59	33.02
Bayou Pierre	-	-	3	14	7	1	-	25	33.24
Yazoo R.:									
Yalobusha R.	-	-	-	-	1	-	-	1	34.00
Yocona R.	-	-	-	1	-	-	-	1	33.00
Tallahatchie R.	-	-	-	2	1	-	-	3	33.33
Coldwater R.	-	-	-	6	2	1	-	9	33.44
Loosahatchie R.	-	-	-	1	1	-	-	2	33.50
Hatchie R.	-	-	-	3	10	11	2	26	34.46
Forked Deer R.:									
South Forked Deer R.	-	-	-	-	2	-	-	2	34.00
Obion R.	-	-	-	5	18	6	-	29	34.03
Total	1	-	14	66	53	21	2	157	33.54

TABLE 11.--*Geographic variation of total preoperculomandibular pores in* Noturus hildebrandi (sum of both sides)

Drainage	Number of Pores						Total	Mean
	18	19	20	21	22	23		
Homochitto R.	-	-	2	15	45	2	64	21.73
Bayou Pierre	-	-	3	4	16	2	25	21.68
Yazoo R.:								
Yalobusha R.	-	-	-	-	1	-	1	22.00
Yocona R.	-	-	-	-	1	-	1	22.00
Tallahatchie R.	-	-	-	2	1	-	3	21.33
Coldwater R.	2	4	1	2	-	-	9	19.33
Loosahatchie R.	1	-	1	-	-	-	2	19.00
Hatchie R.	-	6	10	7	1	-	24	20.13
Forked Deer R.:								
South Forked Deer R.	-	-	2	-	-	-	2	20.00
Obion R.	4	2	22	1	-	-	29	19.69
Total	7	12	41	31	65	4	160	20.92

TABLE 12.--*Geographic variation of anal rays in* Noturus hildebrandi

Drainage	No. of Anal Rays						Total	Mean
	12	13	14	15	16	17		
Homochitto R.	4	22	33	6	-	-	65	13.63
Bayou Pierre	-	5	16	4	-	-	25	13.96
Yazoo R.:								
Yalobusha R.	-	-	-	-	1	-	1	16.00
Yocona R.	-	-	-	1	-	-	1	15.00
Tallahatchie R.	-	-	1	1	1	-	3	15.00
Coldwater R.	-	-	6	3	-	-	9	14.33
Loosahatchie R.	-	-	-	2	-	-	2	15.00
Hatchie R.	-	-	2	18	5	-	25	15.12
Forked Deer R.:								
South Forked Deer R.	-	-	1	1	-	-	2	14.50
Obion R.	-	-	6	16	5	2	29	15.10
Total	4	27	65	52	12	2	162	14.29

TABLE 13.--*Comparison of* Noturus eleutherus *and* Noturus stigmosus

Character	*eleutherus*	*stigmosus*
Size (standard length)	Small; largest specimen 73 mm., most less than 60	Larger; many specimens between 60 and 100 mm.
Lower surface	Plain or dusky; few discrete chromatophores on abdomen	Whitish; many discrete, brownish chromatophores anteriorly on abdomen in smaller individuals
Band on dorsal fin	Narrow or faint	Broad; conspicuous
First dark saddle	Anterior edge at dorsal spine; no distinctive light spots before dorsal fin	Anterior edge irregular, usually enclosing 2 cream colored spots before dorsal fin
Adipose fin blotch	Grayish; rather indefinite in outline; mostly confined to basal half of fin	Brownish; top truncated; enters upper half of fin
Bar at end of caudal peduncle	Dark brown; prominent, except in older individuals	Diffuse or blends into the mottling of the side
Midcaudal band or crescent	Absent; the area dusky	Usually present and extending forward through the procurrent rays
Spines and humeral process	Shorter; more poorly armed	Long; heavily armed
Caudal peduncle	Narrower	Deeper
Anal rays	12 to 16, most frequently 13 or 14	13 to 16, most frequently 14 or 15
Caudal rays	39 to 52, usually 44 to 48	47 to 56, usually 49 to 53
Upper-half caudal rays	21 to 27, usually 22 to 25	24 to 31, usually 25 to 28
Preoperculomandibular pores	Mostly 9 to 11, typically 10	Mostly 10 to 12, typically 11
Soft pectoral rays	Rarely 7, usually 8, sometimes 9	Often 7, usually 8, rarely 9
Stepped in distance dorsal origin to adipose notch:		
Pectoral spine length	2.5 to 3.7, usually 2.5 to 3.6	1.7 to 3.4, usually 2.1 to 3.1
Caudal peduncle depth	5.0 to 6.5	4.0 to 5.1, usually 4.2 to 5.1

TABLE 14.--*Comparison of the species of the* furiosus *group of* Noturus (extremes in parentheses; measurements are stepped)

Character	*placidus*	*stigmosus*	*munitus*	*furiosus*
Size (standard length)	Small; usually less than 50 mm., largest 57.1 mm.	Large; reaches 100 mm.	Intermediate; largest 78 mm.	Large; reaches 100 mm.
Bar on adipose fin	Dusky or grayish; confined to basal half	Dark brown or blackish; extends into upper half of fin but not to margin	Dark brown or black; typically extends across fin to margin	Dark brown or blackish; on lower two-thirds of fin but not extending to margin
Dispersed, single, round, brownish chromatophores (freckles) on abdomen (not the random blotchings or concentrations of pigment cells which often are present)	Present in young to 20 mm.; absent in adults; undersurface otherwise usually immaculate	Present; obscured in larger individuals; chiefly between pectoral fins	Covering abdomen and often on bases of pelvic fins	Absent; undersurface typically immaculate
Color pattern of body	Somber; blotches and saddles not prominent	Saddles and blotches usually distinct	Saddles and blotches usually distinct	Saddles and blotches usually distinct
Pair of light spots just in front of dorsal fin	Faint, small, nearly obscured by the somber color pattern	Usually large, prominent, enclosed by darker pigment; seldom obscure	Present, large, often incompletely enclosed by dark pigment	Small, faint, or absent
Adipose fin in adults	Low, relatively long; moderately connected to caudal fin	Moderate in height and length; nearly free from caudal fin	High, short; nearly free from caudal fin	High, intermediate in length; nearly free from caudal fin

TABLE 14.--*Comparison of the species of the* furiosus *group of* Noturus (extremes in parentheses; measurements are stepped)--Continued

Character	*placidus*	*stigmosus*	*munitus*	*furiosus*
Anterior serrations of pectoral spine	Short; not well developed; length typically less than 1/4 diameter of pectoral spine	Long; longest about 1/2 diameter of pectoral spine	Long, longest about 1/2 diameter of pectoral spine	Long, longest about 1/2 diameter of pectoral spine
Posterior process of cleithrum (humeral process)	Length about equal to diameter of pectoral spine shaft	Length usually greater than diameter of spine plus serrae	Length usually greater than diameter of spine plus serrae	Length usually greater than diameter of spine plus serrae
Anal rays	(13) 14 or 15 (16)	(13) 14 or 15 (16)	(12) 13 or 14 (15)	(14) 15 or 16 (17)
Vertebrae	(32) 33 or 34 (36)	(31) 33 or 34 (35)	(30) 31 or 32 (33)	(33) 34 or 35 (36)
Caudal fin:				
Total rays	(50) 52 to 58 (59)	(47) 49 to 53 (56)	(45) 46 to 50 (52)	(51) 53 to 58 (60)
Upper-half rays	(26) 27 to 29 (31)	(24) 25 to 28 (31)	(23) 23 to 26 (27)	(27) 28 to 31 (33)
Lower-half rays	(24) 25 to 27 (29)	(22) 23 to 25 (26)	(21) 22 to 24 (26)	(23) 25 to 27 (28)
Standard lengths mm., specimens measured	34.0 - 48.6	37.4 - 84.2	21.9 - 78.0	29.3 - 100.0
Head length in standard length	(3.2) 3.2 to 3.5 (3.6)	(3.1) 3.2 to 3.5 (3.6)	(2.7) 2.8 to 3.2 (3.3)	(3.2) 3.2 to 3.7 (3.8)
In predorsal length:				
Caudal peduncle depth	(3.1) 3.3 to 3.8 (3.9)	(3.0) 3.1 to 3.7 (3.8)	(3.5) 3.6 to 4.2 (4.4)	(3.1) 3.1 to 3.6 (4.1)
Dorsal spine length	(2.0) 2.1 to 2.7 (3.2)	(1.8) 1.9 to 3.0 (3.2)	(2.0) 2.1 to 3.1 (3.7)	(2.0) 2.0 to 3.0 (3.4)
In distance dorsal origin to adipose notch:				
Distance adipose notch to tip caudal fin	(1.5) 1.5 to 1.8 (1.8)	(1.4) 1.5 to 2.0 (2.1)	(1.4) 1.4 to 1.9 (2.1)	(1.4) 1.4 to 1.7 (1.9)
Predorsal length	(1.3) 1.3 to 1.5 (1.5)	(1.2) 1.2 to 1.5 (1.5)	(1.1) 1.1 to 1.4 (1.4)	(1.2) 1.3 to 1.5 (1.6)
Pectoral spine length	(1.9) 2.0 to 2.8 (3.0)	(1.7) 2.1 to 3.1 (3.4)	(1.9) 1.9 to 2.9 (3.5)	(1.8) 2.0 to 2.6 (2.8)

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TABLE 15.--*Comparison of hybrids,* Noturus gyrinus × Noturus miurus, *with the parent species*

[The data are as follows: *Noturus miurus*, Michigan (UMMZ 108064, 72 specimens, Huron River); Indiana (USNM 199588, 4 specimens, collected with the hybrid). Hybrid 1, Michigan (UMMZ 157214). Hybrid 2, Michigan (UMMZ 167302). Hybrid, New York (CU 42514). Hybrid, Indiana (USNM 199583). *Noturus gyrinus*, Michigan (UMMZ 136807, 15 specimens, Shiawassee River); Indiana (USNM 199584, 31 specimens, collected with the hybrid). Ranges in variation are followed by means in parentheses. Data from both elements of paired structure are included.]

Character	*miurus* Michigan	*miurus* Indiana	Hybrid 1 Michigan	Hybrid 2 Michigan	Hybrid New York	Hybrid Indiana	*gyrinus* Michigan	*gyrinus* Indiana
Caudal rays:								
Total	55 to 64 (58.9)	58 to 60 (59.5)	53	58	63	63	50 to 56 (52.5)	52 to 60 (56.0)
Upper simple	20 to 29 (24.9)	24 to 26 (25.5)	8	15	19	28	8 to 17 (11.8)	14 to 26 (21.6)
Branched	15 to 24 (17.6)	17 to 21 (18.7)	34	31	30	17	22 to 37 (31.2)	18 to 30 (21.7)
Lower simple	14 to 19 (16.3)	14 to 17 (15.3)	11	12	14	18	8 to 12 (9.5)	10 to 16 (12.6)
Pelvic rays	8 to 10 (9.0)	9 (9.0)	8-8	9-9	9-9	9-8	7 or 8 (8.0)	7 to 9 (8.0)
Soft pectoral rays	7 to 9 (7.9)	7 or 8 (7.9)	7-7	8-8	8-8	7-7	6 or 7 (6.3)	6 or 7 (6.6)
Internasal pores	1 or 2 (1.0)	1 (1.0)	1-1	1-1	1-1	1-2	2 (2.0)	2 (2.0)
Preoperculomandibular pores	10 to 12 (11.1)	11 or 12 (11.1)	11-11	11-11	11-11	10-11	9 to 12 (10.3)	9 to 12 (10.2)

TABLE 15.--*Comparison of hybrids*, Noturus gyrinus X Noturus miurus, ***with the parent species***.--Continued

[The data are as follows: *Noturus miurus*, Michigan (UMMZ 108064, 72 specimens, Huron River); Indiana (USNM 199588, 4 specimens, collected with the hybrid). Hybrid 1, Michigan (UMMZ 157214). Hybrid 2, Michigan (UMMZ 167302). Hybrid, New York (CU 42514). Hybrid, Indiana (USNM 199583). *Noturus gyrinus*, Michigan (UMMZ 136807, 15 specimens, Shiawassee River); Indiana (USNM 199584, 31 specimens, collected with the hybrid). Ranges in variation are followed by means in parentheses. Data from both elements of paired structures are included.]

Character	*miurus* Michigan	*miurus* Indiana	Hybrid 1 Michigan	Hybrid 2 Michigan	Hybrid New York	Hybrid Indiana	*gyrinus* Michigan	*gyrinus* Indiana
Lower jaw	Included	Included	Subterminal	Subterminal	Subterminal	Terminal	Terminal	Terminal
Posterior serrae of pectoral spine	3 to 9 (4.9)		Irregular	Irregular	Irregular	Irregular	None	None

TABLE 16.--*Comparison of the hybrid (UMMZ 137904),* Noturus exilis x Noturus miurus, *from the Poteau River, Oklahoma, with three species of* Noturus

[The data are from eastern Oklahoma specimens as follows: *Noturus miurus*, counts from 12, Poteau River, UMMZ 137902 and measurements from 11, Illinois and Poteau Rivers, UMMZ 137864 and 137902; *Noturus exilis*, measurements from 20 and counts from 32, Illinois River, UMMZ 137863; *Noturus nocturnus*, counts and measurements from 12, Poteau River, UMMZ 137903. Ranges of variation are followed by means in parentheses. Proportional measurements are stepped. Data from both elements of paired structures are included.]

Character	*miurus*	Hybrid
Standard length (mm.)	33.0 to 52.4 (44.0)	51.1
Caudal rays:		
Total	57 to 62 (59.6)	56
Upper simple	21 to 27 (24.9)	24
Total branched	15 to 20 (17.6)	17
Lower simple	16 to 19 (17.1)	15
Soft pectoral rays	7 to 9, usually 8 (8.0)	9-9
Internasal pores	1 (1.0)	1-1
Preoperculomandibular pores	11 or 12, usually 11 (11.0)	10-10
Posterior serrae of pectoral spine	Regular; 5 to 7 (6.2)	Regular; 7-8
Lower jaw	Included	Subterminal
Pigmentation of lower jaw	Light	Light
Black or darkened borders of fins	Prominent	Obvious
Head length in standard length	3.2 to 3.5 (3.4)	3.35
In predorsal length:		
Dorsal spine length	2.4 to 3.4 (2.7)	3.4
Pectoral spine length	1.8 to 2.6 (2.2)	(2.6)
In distance dorsal origin to adipose notch:		
Predorsal length	1.2 to 1.4 (1.3)	1.5
Head length	1.6 to 1.8 (1.7)	1.85
Caudal peduncle depth	4.1 to 4.8 (4.4)	5.0
Distance adipose notch to caudal fin tip	1.1 to 1.5 (1.3)	1.65

TABLE 16.--*Comparison of the hybrid (UMMZ 137904),* Noturus exilis X Noturus miurus, *from the Poteau River, Oklahoma, with three species of* Noturus--Continued

[The data are from eastern Oklahoma specimens as follows: *Noturus miurus*, counts from 12, Poteau River, UMMZ 137902 and measurements from 11, Illinois and Poteau Rivers, UMMZ 137864 and 137902; *Noturus exilis*, measurements from 20 and counts from 32, Illinois River, UMMZ 137863; *Noturus nocturnus*, counts and measurements from 12, Poteau River, UMMZ 137903. Ranges of variation are followed by means in parentheses. Proportional measurements are stepped. Data from both elements of paired structures are included.]

Character	*exilis*	*nocturnus*
Standard length (mm.)	43.1 to 58.5 (50.0)	44.0 to 81.2 (62.9)
Caudal rays:		
Total	46 to 51 (48.8)	56 to 62 (58.3)
Upper simple	15 to 19 (17.0)	20 to 25 (22.3)
Total branched	16 to 21 (18.2)	19 or 20 (19.4)
Lower simple	11 to 16 (13.6)	15 to 18 (16.6)
Soft pectoral rays	8 or 9, normally 9 (8.5)	9 or 10, usually 9 (9.1)
Internasal pores	1 (1.0)	2 (2.0)
Preoperculomandibular pores	9 to 11, usually 10 (10.0)	10 or 11, usually 11 (10.9)
Posterior serrae of pectoral spine	Usually regular; 5 to 10 (6.9)	Not distinct or uniformly developed
Lower jaw	Terminal	Included
Pigmentation of lower jaw	Never heavy	Heavy
Black or darkened borders of fins	Usually prominent	Usually indistinct
Head length in standard length	3.8 to 4.4 (4.0)	3.3 to 3.8 (3.5)
In predorsal length:		
Dorsal spine length	3.3 to 4.8 (4.1)	3.3 to 5.1 (4.2)
Pectoral spine length	2.6 to 3.6 (3.0)	2.6 to 3.8 (3.3)
In distance dorsal origin to adipose notch:		
Predorsal length	1.7 to 2.1 (1.9)	1.4 to 1.6 (1.5)
Head length	2.1 to 2.7 (2.4)	1.8 to 2.1 (1.9)
Caudal peduncle depth	4.8 to 5.9 (5.2)	4.1 to 5.2 (4.6)
Distance adipose notch to caudal fin tip	1.9 to 2.5 (2.2)	1.5 to 1.8 (1.6)

TABLE 17.--*Frequency distribution of anal rays in the species of* Noturus

Species	Number of Anal Rays																No.	Mean
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27		
gyrinus	1	11	64	123	84	23	4	-	-	-	-	-	-	-	-	-	310	15.17
lachneri	-	-	-	-	3	5	2	1	-	-	-	-	-	-	-	-	11	17.09
exilis	-	-	-	-	-	5	18	84	57	37	3	-	-	-	-	-	204	19.55
leptacanthus	-	-	3	27	61	29	3	1	-	-	-	-	-	-	-	-	124	16.04
nocturnus	-	-	-	4	39	65	42	4	1	-	-	-	-	-	-	-	155	17.04
insignis	-	-	-	2	9	31	55	37	5	2	-	-	-	-	-	-	141	17.99
funebris	-	-	-	-	-	-	-	-	3	23	58	45	24	11	5	1	170	22.72
phaeus	-	-	-	-	-	-	1	13	79	138	71	12	2	1	-	-	317	20.99
gilberti	-	-	9	24	13	1	1	-	-	-	-	-	-	-	-	-	48	15.19
flavus	-	-	-	15	46	44	26	1	-	-	-	-	-	-	-	-	132	16.64
hildebrandi	4	27	65	52	12	2	-	-	-	-	-	-	-	-	-	-	162	14.29
baileyi	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	12.40
albater	-	11	34	39	12	-	-	-	-	-	-	-	-	-	-	-	96	14.54
elegans	-	-	5	30	47	23	5	1	-	-	-	-	-	-	-	-	111	15.96
trautmani	-	2	11	3	1	-	-	-	-	-	-	-	-	-	-	-	17	14.18
eleutherus	5	34	77	15	1	-	-	-	-	-	-	-	-	-	-	-	132	13.80
placidus	-	1	31	45	9	-	-	-	-	-	-	-	-	-	-	-	86	14.72
stigmosus	-	18	70	55	10	-	-	-	-	-	-	-	-	-	-	-	153	14.37
munitus	19	88	39	1	-	-	-	-	-	-	-	-	-	-	-	-	147	13.15
furiosus	-	-	17	50	36	10	-	-	-	-	-	-	-	-	-	-	113	15.35
miurus	-	4	43	96	48	6	-	-	-	-	-	-	-	-	-	-	197	15.05
flavipinnis	-	-	4	8	1	-	-	-	-	-	-	-	-	-	-	-	13	14.77
flavater	-	-	10	21	8	2	-	-	-	-	-	-	-	-	-	-	41	15.05

TABLE 18.--*Frequency distribution of paired fin-ray counts in the species of* Noturus (both sides were counted)

Species	Pelvic Rays								No.	Mean	Soft Pectoral Rays							No.	Mean
	5	6	7	8	9	10	11	12			5	6	7	8	9	10	11		
gyrinus	2	3	20	957	202	10	-	-	1,194	8.16	6	238	803	119	8	4	-	1,178	6.91
lachneri	-	-	-	15	7	-	-	-	22	8.32	-	-	2	17	3	-	-	22	8.05
exilis	-	-	-	6	357	31	-	-	394	9.06	-	-	-	90	297	3	-	390	8.78
leptacanthus	-	-	3	1,037	78	-	-	-	1,118	8.07	-	-	5	371	647	51	-	1,074	8.69
nocturnus	-	-	-	14	284	28	-	-	326	9.04	-	-	1	9	234	75	2	321	9.21
insignis	-	-	-	5	243	28	-	-	276	9.08	-	-	1	26	233	15	-	275	8.95
funebris	-	-	1	5	267	17	-	-	290	9.03	-	-	-	8	251	67	1	327	9.19
phaeus	-	-	2	11	556	26	-	-	595	9.02	-	-	3	223	369	2	-	597	8.62
gilberti	-	-	-	-	70	26	-	-	96	9.27	-	-	-	-	63	31	-	94	9.33
flavus	-	-	-	5	198	85	-	-	288	9.28	-	-	-	-	74	201	9	284	9.77
hildebrandi	-	-	2	301	21	-	-	-	324	8.06	-	-	1	109	202	8	-	320	8.68
baileyi	-	-	-	10	-	-	-	-	10	8.00	-	-	1	9	-	-	-	10	7.90
albater	-	-	-	3	186	9	-	-	198	9.03	-	-	-	19	159	7	-	185	8.94
elegans	-	-	-	5	199	16	-	-	220	9.05	-	-	-	170	50	-	-	220	8.23
trautmani	-	-	-	1	33	-	-	-	34	8.97	-	-	-	21	13	-	-	34	8.38
eleutherus	-	-	-	5	231	29	-	-	265	9.09	-	-	8	234	19	-	-	261	8.04
placidus	-	-	-	3	166	10	-	1	180	9.06	-	-	5	169	4	-	-	178	7.99
stigmosus	-	-	-	5	256	49	-	-	310	9.14	-	-	71	215	2	-	-	288	7.76
munitus	-	-	1	4	289	-	-	-	294	8.98	-	-	26	267	1	-	-	294	7.91
furiosus	-	-	-	2	217	7	-	-	226	9.02	-	-	9	194	23	-	-	226	8.06
miurus	-	-	-	3	388	13	-	-	404	9.02	-	-	32	330	21	-	-	383	7.97
flavipinnis	-	-	-	2	24	-	-	-	26	8.92	-	-	6	19	1	-	-	26	7.81
flavater	-	-	-	-	80	2	-	-	82	9.02	-	-	8	71	2	-	-	81	7.93

TABLE 19.--*Frequency distribution of total caudal rays in the species of* Noturus

Species	Number of Caudal Rays																	
	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
gyrinus	-	-	-	-	-	-	-	-	-	-	-	4	3	10	16	17	13	27
lachneri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
exilis	-	-	-	-	-	1	1	8	12	19	19	38	44	24	18	14	4	1
leptacanthus	-	-	-	-	-	-	-	-	4	10	10	20	20	25	22	7	1	2
nocturnus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	15
insignis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
funebris	-	-	-	-	-	-	-	-	-	-	-	2	6	8	12	15	14	12
phaeus	-	-	-	-	-	-	-	-	-	-	-	5	9	13	13	23	20	18
gilberti	-	-	-	-	-	-	-	1	1	4	6	13	7	9	4	3	-	-
flavus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	3
hildebrandi	-	1	1	1	9	19	30	43	26	19	9	3	1	-	-	-	-	-
baileyi	-	-	-	-	-	3	-	1	1	-	-	-	-	-	-	-	-	-
albater	-	-	-	-	-	-	2	3	9	20	23	18	12	7	2	2	-	-
elegans	-	-	-	-	-	-	-	3	8	11	26	23	26	5	5	2	1	-
trautmani	-	-	-	-	-	-	1	-	2	2	4	5	2	-	-	-	-	-
eleutherus	1	-	1	4	8	16	21	37	19	11	6	3	3	1	-	-	-	-
placidus	-	-	-	-	-	-	-	-	-	-	-	1	3	7	17	23	14	8
stigmosus	-	-	-	-	-	-	-	-	4	6	18	29	35	31	21	5	3	1
munitus	-	-	-	-	-	-	5	31	37	35	25	10	2	2	-	-	-	-
furiosus	-	-	-	-	-	-	-	-	-	-	-	-	1	3	12	20	24	17
miurus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	7
flavipinnis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	3
flavater	-	-	-	-	-	-	-	-	-	-	-	-	1	1	4	5	7	7

TABLE 19.--*Frequency distribution of total caudal rays in the species of* Noturus--Con.

Species	Number of Caudal Rays											No.	Mean
	57	58	59	60	61	62	63	64	65	66	67		
gyrinus	16	26	28	28	12	24	10	6	5	3	-	248	57.96
lachneri	2	3	1	2	1	-	-	-	-	-	-	11	58.18
exilis	1	-	-	-	-	-	-	-	-	-	-	204	50.49
leptacanthus	3	1	-	-	-	-	-	-	-	-	-	125	51.34
nocturnus	21	19	18	20	18	9	3	3	-	-	-	129	58.94
insignis	5	11	14	28	21	19	18	12	11	1	1	145	61.10
funebris	6	2	-	-	-	-	-	-	-	-	-	77	54.13
phaeus	8	3	1	-	-	-	-	-	-	-	-	113	54.10
gilberti	-	-	-	-	-	-	-	-	-	-	-	48	50.58
flavus	7	18	18	18	21	12	9	5	4	2	2	123	60.24
hildebrandi	-	-	-	-	-	-	-	-	-	-	-	162	45.99
baileyi	-	-	-	-	-	-	-	-	-	-	-	5	45.00
albater	-	-	-	-	-	-	-	-	-	-	-	98	49.27
elegans	-	-	-	-	-	-	-	-	-	-	-	110	49.82
trautmani	-	-	-	-	-	-	-	-	-	-	-	16	48.94
eleutherus	-	-	-	-	-	-	-	-	-	-	-	131	45.90
placidus	4	6	1	-	-	-	-	-	-	-	-	84	54.32
stigmosus	-	-	-	-	-	-	-	-	-	-	-	153	51.04
munitus	-	-	-	-	-	-	-	-	-	-	-	147	47.63
furiosus	17	13	4	1	-	-	-	-	-	-	-	112	55.48
miurus	23	40	32	37	32	18	7	4	1	-	-	204	59.43
flavipinnis	1	-	3	2	1	2	-	-	-	-	-	13	58.54
flavater	8	4	3	1	-	-	-	-	-	-	-	41	55.78

TABLE 20.--*Frequency distribution of upper-half caudal rays in the species of* Noturus

Species	Number of Upper-half Caudal Rays																	No.	Mean
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37		
gyrinus	-	-	-	-	-	-	3	12	21	40	44	53	46	23	4	4	-	250	31.48
lachneri	-	-	-	-	-	-	-	-	-	-	5	2	4	-	-	-	-	11	31.91
exilis	-	1	3	20	34	45	52	27	12	1	1	-	-	-	-	-	-	196	26.33
leptacanthus	-	-	1	10	22	40	27	9	4	3	-	-	-	-	-	-	-	116	26.21
nocturnus	-	-	-	-	-	-	-	1	15	35	34	25	10	3	-	-	-	123	30.89
insignis	-	-	-	-	-	-	1	1	9	32	37	36	22	8	1	-	-	147	31.35
funebris	-	-	-	-	3	15	33	18	7	-	-	-	-	-	-	-	-	76	27.14
phaeus	-	-	-	3	10	23	37	28	9	3	-	-	-	-	-	-	-	113	27.03
gilberti	-	1	4	10	15	12	5	-	-	-	-	-	-	-	-	-	-	47	25.02
flavus	-	-	-	-	-	-	1	3	11	27	35	27	13	6	-	1	-	124	31.11
hildebrandi	3	15	41	63	30	9	1	-	-	-	-	-	-	-	-	-	-	162	23.82
baileyi	-	-	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-	5	23.60
albater	-	1	7	22	37	20	8	2	-	-	-	-	-	-	-	-	-	97	25.03
elegans	-	-	1	6	27	48	21	5	2	-	-	-	-	-	-	-	-	110	25.95
trautmani	-	-	1	2	3	8	2	-	-	-	-	-	-	-	-	-	-	16	25.50
eleutherus	7	16	51	36	15	4	2	-	-	-	-	-	-	-	-	-	-	131	23.43
placidus	-	-	-	-	-	2	23	36	17	3	2	-	-	-	-	-	-	83	28.02
stigmosus	-	-	-	8	15	31	53	28	6	2	1	-	-	-	-	-	-	144	26.76
munitus	-	-	12	63	52	15	5	-	-	-	-	-	-	-	-	-	-	147	24.58
furiosus	-	-	-	-	-	-	5	19	31	39	15	2	1	-	-	-	-	112	29.45
miurus	-	-	-	-	-	-	-	-	-	3	26	43	63	43	12	6	1	197	32.92
flavipinnis	-	-	-	-	-	-	-	-	2	-	2	2	5	2	-	-	-	13	32.08
flavater	-	-	-	-	-	1	3	7	11	11	7	2	-	-	-	-	-	42	29.36

TABLE 21.--*Frequency distribution of lower-half caudal rays in the species of* Noturus

Species	Number of Lower-half Caudal Rays															Total	Mean
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		
gyrinus	-	-	-	5	11	30	42	32	46	34	29	13	4	1	-	247	26.50
lachneri	-	-	-	-	-	-	2	5	3	1	-	-	-	-	-	11	26.27
exilis	-	-	2	16	33	72	48	24	1	-	-	-	-	-	-	196	24.14
leptacanthus	-	-	-	1	8	25	42	26	12	2	-	-	-	-	-	116	25.10
nocturnus	-	-	-	-	-	-	-	11	28	41	30	11	2	-	-	123	28.07
insignis	-	-	-	-	-	-	-	2	4	14	46	39	27	9	4	145	29.74
funebris	-	-	-	-	-	1	8	15	29	16	7	-	-	-	-	76	26.95
phaeus	-	-	-	-	-	2	9	26	35	29	7	5	-	-	-	113	27.07
gilberti	-	-	-	-	1	5	15	18	8	-	-	-	-	-	-	47	25.57
flavus	-	-	-	-	-	-	-	2	14	24	38	28	9	6	3	124	29.15
hildebrandi	2	5	36	58	46	12	3	-	-	-	-	-	-	-	-	162	22.17
baileyi	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	5	21.40
albater	-	-	-	1	20	41	24	10	1	-	-	-	-	-	-	97	24.26
elegans	-	1	1	9	29	36	29	5	-	-	-	-	-	-	-	110	23.86
trautmani	-	-	-	1	8	6	1	-	-	-	-	-	-	-	-	16	23.44
eleutherus	-	3	22	37	48	14	4	1	-	-	-	-	-	-	-	129	22.50
placidus	-	-	-	-	-	3	16	34	19	9	2	-	-	-	-	83	26.25
stigmosus	-	-	-	5	25	45	58	10	-	-	-	-	-	-	-	143	24.30
munitus	-	-	1	40	61	42	2	1	-	-	-	-	-	-	-	147	23.05
furiosus	-	-	-	-	2	3	32	32	38	5	-	-	-	-	-	112	26.04
miurus	-	-	-	-	2	4	28	65	58	26	11	-	-	-	-	194	26.52
flavipinnis	-	-	-	-	-	-	4	2	4	3	-	-	-	-	-	13	26.46
flavater	-	-	-	-	-	-	10	13	11	8	-	-	-	-	-	42	26.40

TABLE 22.--*Frequency distribution of sensory-canal pores in the species of* Noturus (both sides were counted)

Species	Internasal Pores			Total	Mean	Preoperculomandibular Pores						Total	Mean
	1	2	3			8	9	10	11	12	13		
gyrinus	10	675	2	687	1.99	3	28	739	197	9	-	976	10.19
lachneri	22	-	-	22	1.00	-	-	22	-	-	-	22	10.00
exilis	527	14	-	541	1.03	-	1	386	7	1	-	395	10.02
leptacanthus	-	223	-	223	2.00	-	-	30	180	4	-	214	10.88
nocturnus	4	396	-	400	1.99	-	6	307	595	8	-	916	10.66
insignis	1	279	-	280	2.00	-	1	12	260	7	-	280	10.98
funebris	2	161	-	163	1.99	-	-	3	156	5	-	164	11.01
phaeus	1	234	-	235	2.00	-	-	8	261	5	-	274	10.99
gilberti	1	81	2	84	2.01	-	1	20	60	3	-	84	10.77
flavus	7	223	1	231	1.97	-	-	7	216	6	1	230	11.00
hildebrandi	6	318	-	324	1.98	-	26	125	166	4	-	321	10.46
baileyi	2	8	-	10	1.80	-	-	-	10	-	-	10	11.00
albater	17	167	-	184	1.91	-	-	14	166	-	-	180	10.92
elegans	22	198	-	220	1.90	-	-	11	201	8	-	220	10.99
trautmani	1	32	-	33	1.97	-	-	3	29	2	-	34	10.97
eleutherus	3	273	-	276	1.99	2	15	378	13	-	-	408	9.99
placidus	-	179	1	180	2.01	-	-	13	157	10	-	180	10.98
stigmosus	-	290	-	290	2.00	1	6	45	267	22	-	341	10.89
munitus	1	290	-	291	2.00	-	2	30	248	8	-	288	10.91
furiosus	-	219	-	219	2.00	-	1	9	204	5	-	219	10.97
miurus	665	36	-	701	1.05	-	1	21	328	44	-	394	11.05
flavipinnis	2	24	-	26	1.92	-	-	5	21	-	-	26	10.81
flavater	4	127	-	131	1.97	-	1	3	78	-	-	82	10.94

TABLE 23.–*Frequency distribution of vertebral counts in the species of* Noturus
(the fused anterior vertebrae are excluded)

Species	Number of Vertebrae													Total	Mean
	30	31	32	33	34	35	36	37	38	39	40	41	42		
gyrinus	-	-	3	36	81	53	16	5	-	-	-	-	-	194	34.30
lachneri	-	-	-	-	-	-	-	4	7	-	-	-	-	11	37.64
exilis	-	-	-	-	-	-	3	6	34	40	24	6	-	113	38.83
leptacanthus	-	-	1	7	16	60	13	2	-	-	-	-	-	99	34.84
nocturnus	-	-	-	-	-	7	29	36	11	-	-	-	-	83	36.61
insignis	-	-	-	-	-	-	-	7	69	160	50	3	1	290	38.92
funebris	-	-	-	-	1	17	31	14	3	-	-	-	-	66	36.02
phaeus	-	-	-	-	4	44	47	10	-	-	-	-	-	105	35.60
gilberti	-	-	-	-	-	-	1	14	23	5	1	-	-	44	37.80
flavus	-	-	-	-	-	-	-	2	26	54	44	7	-	133	39.21
hildebrandi	1	-	14	66	53	21	2	-	-	-	-	-	-	157	33.54
baileyi	-	-	-	1	4	-	-	-	-	-	-	-	-	5	33.80
albater	-	-	-	-	-	1	18	40	5	1	-	-	-	65	36.80
elegans	-	-	-	-	13	26	36	9	-	-	-	-	-	84	35.49
trautmani	-	-	3	7	7	-	-	-	-	-	-	-	-	17	33.24
eleutherus	-	5	32			[illegible]	-	-	-	-	-	-	-	87	32.66
placidus	-	-	3	[illegible]			1	-	-	-	-	-	-	52	33.62
stigmosus	-	1	2	33	48	[illegible]	-	-	-	-	-	-	-	90	33.62
munitus	10	65	61	2	-	-	-	-	-	-	-	-	-	138	31.40
furiosus	-	-	-	1	43	70	6	-	-	-	-	-	-	120	34.68
miurus	-	-	1	1	60	90	48	12	-	-	-	-	-	212	35.03
flavipinnis	-	-	-	-	9	4	-	-	-	-	-	-	-	13	34.31
flavater	-	-	-	-	8	23	6	-	-	-	-	-	-	37	34.95

TABLE 24.--*Frequency distribution of precaudal and caudal vertebral elements in the species of* Noturus (the fused anterior vertebrae are excluded)

Species	No. of Precaudal Vertebrae						No. of Caudal Vertebrae											
	7	8	9	10	11	12	22	23	24	25	26	27	28	29	30	31	32	33
gyrinus	5	16	1	-	-	-	-	-	-	3	7	8	4	-	-	-	-	-
lachneri	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
exilis	-	-	25	1	-	-	-	-	-	-	-	-	2	13	11	-	-	-
leptacanthus	2	10	1	-	-	-	-	-	-	1	6	4	2	-	-	-	-	-
nocturnus	-	-	12	4	-	-	-	-	-	-	2	7	5	2	-	-	-	-
insignis	-	1	11	24	4	-	-	-	-	-	-	-	9	17	10	3	-	1
funebris	-	2	1	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-
phaeus	-	5	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	-
gilberti	-	-	5	1	-	-	-	-	-	-	-	-	2	3	1	-	-	-
flavus	-	-	-	-	20	1	-	-	-	-	-	5	7	6	2	-	-	-
hildebrandi	4	2	-	-	-	-	-	-	-	2	1	1	2	-	-	-	-	-
baileyi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
albater	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
elegans	4	1	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-
trautmani	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
eleutherus	2	2	1	-	-	-	-	-	2	3	-	-	-	-	-	-	-	-
placidus	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
stigmosus	-	-	13	3	-	-	-	2	8	6	-	-	-	-	-	-	-	-
munitus	-	-	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-
furiosus	-	-	5	1	1	-	-	-	2	4	1	-	-	-	-	-	-	-
miurus	-	9	17	2	-	-	-	-	1	2	15	7	3	-	-	-	-	-
flavipinnis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
flavater	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-

TABLE 25.--*Frequency distribution of branchiostegal rays, ribs, and hypurals in species of* Noturus

Species	No. of Branchiostegal Rays					No. of Ribs						No. of Hypurals		
	8	9	10	11	12	5	6	7	8	9	10	(3+2) 5	(3+3) 6	(3+4) 7
gyrinus	14	43	3	-	-	4	36	5	-	-	-	-	39	1
lachneri	-	-	-	2	-	-	2	-	-	-	-	-	2	-
exilis	-	4	27	7	-	-	6	28	-	-	-	1	16	-
leptacanthus	-	-	22	4	-	7	19	-	-	-	-	-	13	-
nocturnus	2	7	23	-	-	-	-	13	18	1	-	-	24	-
insignis	-	9	58	24	2	-	1	56	37	-	-	-	10	37
funebris	-	-	2	4	-	-	4	2	-	-	-	-	3	36
phaeus	-	2	10	-	-	-	5	5	-	-	-	-	7	36
gilberti	-	-	1	9	2	-	-	8	4	-	-	-	10	-
flavus	-	4	39	4	-	-	-	-	6	25	3	-	41	3
hildebrandi	-	4	8	-	-	8	4	-	-	-	-	-	6	-
baileyi	-	-	-	-	-	-	-	-	-	-	-	-	4	-
albater	-	2	-	-	-	-	-	2	-	-	-	-	1	-
elegans	-	-	10	-	-	-	10	-	-	-	-	-	14	-
trautmani	-	2	-	-	-	-	-	2	-	-	-	-	1	-
eleutherus	2	2	6	-	-	-	1	9	-	-	-	-	5	-
placidus	-	2	-	-	-	-	-	-	2	-	-	-	1	-
stigmosus	9	12	8	1	-	-	-	19	11	-	-	-	20	-
munitus	-	4	-	-	-	-	-	4	-	-	-	-	59	1(?)
furiosus	4	10	-	-	-	-	-	6	8	-	-	-	73	1(?)
miurus	2	27	13	-	-	-	21	21	-	-	-	-	49	-
flavipinnis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
flavater	-	2	-	-	-	-	-	-	2	-	-	-	1	-

TABLE 26a.--*Proportional (step) measurements of species of* Noturus *of the subgenera* Schilbeodes *and* Noturus

[The range is followed by the mean in parentheses. Ratios are the measurement indicated stepped into the distance from the origin of the dorsal fin to the adipose notch.]

	gyrinus	*lachneri*	*exilis*	*leptacanthus*	*nocturnus*
Standard length (mm.)	24.1-60.0 (41.9)	23.0-66.3 (40.8)	31.3-80.5 (53.3)	33.1-78.7 (49.5)	30.8-121.5 (60.5)
Number	85	10	63	40	40
Tip of caudal fin to adipose notch ratio	0.8-1.5 (1.1)	1.2-1.6 (1.4)	1.6-2.5 (2.0)	1.5-1.9 (1.7)	1.3-1.8 (1.6)
Predorsal length ratio	1.1-1.5 (1.3)	1.3-1.6 (1.5)	1.5-2.1 (1.8)	1.2-1.8 (1.5)	1.3-1.6 (1.5)
Head length in standard length	3.0-3.8 (3.4)	3.7-4.2 (3.9)	3.6-4.4 (3.9)	3.3-4.0 (3.6)	3.3-3.8 (3.4)
Head length ratio	1.4-1.9 (1.6)	1.8-2.1 (1.9)	1.9-2.7 (2.3)	1.6-2.4 (2.0)	1.6-2.1 (1.9)
Caudal peduncle depth in predorsal length	2.1-3.1 (2.7)	2.0-2.5 (2.3)	2.4-3.2 (2.8)	2.0-3.4 (2.8)	2.4-3.4 (2.8)
Pectoral spine length in predorsal length	1.6-3.7 (2.4)	2.5-3.0 (2.9)	2.5-3.7 (3.0)	3.3-5.8 (4.6)	2.5-4.9 (3.4)
Dorsal spine length in predorsal length	2.0-4.5 (3.0)	2.6-4.7 (3.6)	3.0-5.3 (3.8)	3.6-5.8 (4.5)	3.3-6.2 (4.3)

TABLE 26a.--*Proportional (step) measurements of species of* Noturus *of the subgenera* Schilbeodes *and* Noturus--Continued

[The range is followed by the mean in parentheses. Ratios are the measurement indicated stepped into the distance from the origin of the dorsal fin to the adipose notch.]

	insignis	*funebris*	*phaeus*	*gilberti*	*flavus*
Standard length (mm.)	46.8-89.6 (67.0)	60.1-97.8 (82.4)	43.1-94.6 (60.2)	39.9-74.0 (58.9)	52.1-170.5 (117.5)
Number	21	15	12	30	20
Tip of caudal fin to adipose notch ratio	1.4-1.9 (1.6)	1.5-1.9 (1.7)	1.5-1.9 (1.7)	1.7-2.1 (1.9)	1.6-2.0 (1.8)
Predorsal length ratio	1.3-1.8 (1.5)	1.1-1.7 (1.4)	1.4-1.5 (1.4)	1.7-2.1 (1.9)	1.4-1.7 (1.5)
Head length in standard length	3.4-4.0 (3.7)	3.1-3.9 (3.5)	3.3-3.8 (3.6)	3.5-4.5 (3.9)	3.3-3.8 (3.6)
Head length ratio	1.7-2.3 (2.0)	1.5-2.1 (1.9)	1.7-2.1 (2.0)	2.0-2.6 (2.4)	1.7-2.2 (1.9)
Caudal peduncle depth in predorsal length	2.3-3.2 (2.7)	2.7-3.3 (2.9)	2.6-3.4 (2.9)	2.1-2.5 (2.3)	2.4-3.1 (2.9)
Pectoral spine length in predorsal length	2.1-3.8 (2.8)	3.9-4.6 (4.2)	3.2-4.6 (3.9)	3.2-6.7 (4.6)	2.8-4.6 (3.4)
Dorsal spine length in predorsal length	3.1-4.6 (3.7)	3.5-5.8 (4.2)	3.7-5.0 (4.2)	4.0-7.7 (5.9)	4.5-8.0 (5.7)

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TABLE 26b.—*Proportional (step) measurements of species of* Noturus *of the subgenus* Rabida

[The range is followed by the mean in parentheses. Ratios are the measurement indicated stepped into the distance from the origin of the dorsal fin to the adipose notch.]

	hildebrandi hildebrandi	*hildebrandi lautus*	*baileyi*	*albater*	*elegans*
Standard length (mm.)	27.0-41.3 (35.8)	36.0-46.9 (41.5)	42.7-49.4 (45.2)	37.4-84.9 (61.1)	40.3-61.2 (47.1)
Number	26	20	5	21	20
Tip of caudal fin to adipose notch ratio	1.6-2.1 (1.9)	1.7-2.3 (2.1)	2.0-2.2 (2.1)	2.1-2.5 (2.3)	1.7-2.4 (2.0)
Predorsal length ratio	1.5-1.7 (1.6)	1.6-2.0 (1.8)	1.7-2.0 (1.8)	1.6-2.0 (1.8)	1.4-2.1 (1.7)
Head length in standard length	3.0-3.7 (3.3)	3.4-4.1 (3.8)	3.4-3.8 (3.6)	3.7-4.2 (3.9)	3.3-4.0 (3.6)
Head length ratio	1.7-2.0 (1.9)	2.0-2.4 (2.2)	2.0-2.4 (2.2)	2.2-2.6 (2.3)	1.7-2.6 (2.2)
Caudal peduncle depth in predorsal length	3.2-4.1 (3.8)	2.8-3.7 (3.2)	2.3-2.8 (2.6)	2.3-3.2 (2.8)	2.3-3.4 (2.9)
Pectoral spine length in predorsal length	2.2-3.3 (2.7)	2.3-3.4 (2.8)	2.5-3.2 (2.9)	2.2-3.2 (2.7)	2.1-3.0 (2.4)
Dorsal spine length in predorsal length	3.1-5.1 (4.1)	3.3-4.6 (4.0)	3.9-5.5 (4.8)	2.3-3.7 (3.1)	2.4-3.4 (2.8)

TABLE 26b.--*Proportional (step) measurements of species of* Noturus *of the subgenus* Rabida--Continued
[The range is followed by the mean in parentheses. Ratios are the measurement indicated stepped into the distance from the origin of the dorsal fin to the adipose notch.]

	trautmani	*eleutherus*	*placidus*	*stigmosus*	*munitus*
Standard length (mm.)	23.2-44.1 (31.2)	26.0-62.0 (41.8)	34.0-48.6 (41.5)	37.4-84.2 (54.5)	21.9-78.0 (44.9)
Number	10	40	22	31	40
Tip of caudal fin to adipose notch ratio	1.6-2.0 (1.8)	1.6-2.3 (1.9)	1.5-1.8 (1.6)	1.4-2.1 (1.7)	1.4-2.1 (1.7)
Predorsal length ratio	1.5-1.9 (1.6)	1.4-1.7 (1.5)	1.3-1.5 (1.4)	1.2-1.5 (1.4)	1.1-1.4 (1.3)
Head length in standard length	3.3-3.7 (3.5)	3.1-3.8 (3.3)	3.2-3.6 (3.4)	3.1-3.6 (3.3)	2.7-3.3 (3.0)
Head length ratio	1.9-2.1 (2.0)	1.6-2.2 (1.9)	1.7-2.0 (1.8)	1.4-2.0 (1.8)	1.4-1.8 (1.5)
Caudal peduncle depth in predorsal length	2.8-3.1 (2.9)	3.4-4.0 (3.8)	3.1-3.9 (3.5)	3.0-3.8 (3.4)	3.5-4.4 (3.9)
Pectoral spine length in predorsal length	2.0-2.5 (2.3)	1.6-2.5 (2.0)	1.5-2.1 (1.8)	1.4-2.5 (1.8)	1.4-2.6 (1.8)
Dorsal spine length in predorsal length	2.9-4.2 (3.6)	1.9-3.3 (2.4)	2.0-3.2 (2.5)	1.8-3.2 (2.3)	2.0-3.7 (2.7)

TABLE 26b.--*Proportional (step) measurements of species of* Noturus *of the subgenus* Rabida--Continued

[The range is followed by the mean in parentheses. Ratios are the measurement indicated stepped into the distance from the origin of the dorsal fin to the adipose notch.]

	furiosus	*miurus*	*flavipinnis*	*flavater*
Standard length (mm.)	29.3-100.0 (68.7)	31.1-69.0 (46.7)	27.7-86.9 (46.8)	30.2-109.1 (77.4)
Number	22	32	13	20
Tip of caudal fin to adipose notch ratio	1.4-1.9 (1.6)	1.1-1.6 (1.4)	1.4-1.7 (1.5)	1.4-2.0 (1.7)
Predorsal length ratio	1.2-1.6 (1.4)	1.2-1.5 (1.3)	1.2-1.5 (1.3)	1.3-1.6 (1.5)
Head length in standard length	3.2-3.8 (3.4)	3.0-3.6 (3.4)	3.3-3.7 (3.5)	3.1-3.7 (3.3)
Head length ratio	1.6-2.0 (1.7)	1.5-1.9 (1.7)	1.6-1.9 (1.7)	1.6-2.1 (1.9)
Caudal peduncle depth in predorsal length	3.1-4.1 (3.3)	2.9-3.7 (3.2)	3.0-3.6 (3.2)	2.8-3.4 (3.1)
Pectoral spine length in predorsal length	1.3-2.1 (1.7)	1.6-2.6 (2.1)	1.7-2.4 (2.0)	1.6-2.5 (2.0)
Dorsal spine length in predorsal length	2.0-3.4 (2.6)	2.1-3.4 (2.6)	1.9-3.1 (2.4)	2.1-3.6 (2.7)

TABLE 27.—*Measurements of type-specimens of* Noturus, *subgenera* Schilbeodes *and* Noturus, *expressed as thousandths of the standard length*

	lachneri holotype USNM 201592	*phaeus* holotype USNM 202143	*flavus* neotype USNM 202494
Sex	♀	♂	♂
Standard length (mm.)	40.0	94.6	114.2
Greatest body depth	163	207	157
Caudal peduncle depth	123	128	123
Snout to dorsal origin	328	411	355
Dorsal origin to adipose fin	260	307	-
Dorsal origin to adipose notch	528	538	544
Adipose notch to tip of caudal fin	385	288	291
Anal fin origin to base of caudal fin	408	362	350
Caudal peduncle length	198	126	164
Longest dorsal ray	160	173	111
Length of dorsal spine	100	94	59
Adipose fin length	258	233	-
Adipose fin height	30	41	25
Caudal fin length	225	208	184
Length of anal base	208	247	196
Longest anal ray	133	128	92
Pectoral fin length	165	163	163
Pectoral spine length	118	97	123
Pelvic fin length	133	134	116
Humeral process tip to base pectoral spine	45	68	49
Head length	253	308	276
Head depth	125	151	119
Head width	200	232	218
Snout length	88	118	104
Width of mouth	115	183	142
Nasal barbel length	130	122	74
Maxillary barbel length	183	166	136
Outer mental barbel length	158	161	117
Inner mental barbel length	138	84	74
Eye diameter	35	30	32
Distance snout to anal fin	590	638	647
Distance snout to pelvic fin	450	492	487

TABLE 28.—*Measurements of type-specimens of* Noturus, *subgenus* Rabida, *expressed as thousandths of the standard length*
[All specimens are holotypes except the lectotypes of N. furiosus and N. miurus.]

	hildebrandi UMMZ 157620	*hildebrandi lautus* USNM 201665	*baileyi* USNM 201602	*albater* UMMZ 151171	*elegans* UMMZ 167597	*trautmani* UMMZ 187098	*eleutherus* USNM 29678
Sex	♀	♀	♂	♂	♂	♂	♂ ?
Standard length (mm.)	41.3	40.3	45.8	61.2	44.1	44.1	62.0
Greatest body depth	177	171	168	219	206	177	168
Caudal peduncle depth	97	112	120	123	150	125	100
Snout to dorsal origin	370	361	310	368	347	349	365
Dorsal origin to adipose fin	274	263	306	361	351	290	298
Dorsal origin to adipose notch	567	591	622	644	601	605	573
Adipose notch to tip of caudal fin	303	288	301	270	283	295	-
Anal fin origin to base of caudal fin	385	402	380	346	397	349	319
Caudal peduncle length	206	194	197	203	168	184	177
Longest dorsal ray	169	139	148	144	-	168	-
Length of dorsal spine	90	87	79	116	122	120	140
Adipose fin length	278	306	323	294	259	322	298
Adipose fin height	41	40	44	56	39	50	-
Caudal fin length	203	213	214	201	211	215	-
Length of anal base	179	191	183	176	234	195	142
Longest anal ray	143	134	140	131	193	152	121
Pectoral fin length	203	191	179	173	177	197	218
Pectoral spine length	145	129	105	121	156	147	173
Pelvic fin length	148	144	116	127	143	156	145
Humeral process tip to base pectoral spine	48	52	57	46	66	52	69
Head length	315	268	293	281	274	288	306
Head depth	128	136	144	155	150	154	131
Head width	220	233	225	201	218	224	237
Snout length	119	99	107	106	102	113	106

TABLE 28.--*Measurements of type-specimens of* Noturus, *subgenus* Rabida, *expressed as thousandths of the standard length*--Continued
[All specimens are holotypes except the lectotypes of N. furiosus and N. miurus.]

	placidus UMMZ 167653	*stigmosus* UMMZ 165843	*munitus* TU 26250	*furiosus* USNM 39932	*miurus* MNHN A1308	*flavipinnis* USNM 163801	*flavater* UMMZ 151322
Sex	♂	♂	♂	♂	♂	♀	♂
Standard length (mm.)	43.0	66.9	50.5	73.0	59.5	65.2	102.9
Greatest body depth	233	224	211	177	163	186	220
Caudal peduncle depth	114	121	106	99	113	124	132
Snout to dorsal origin	414	404	447	403	370	379	394
Dorsal origin to adipose fin	298	345	295	326	254	365	340
Dorsal origin to adipose notch	558	571	498	529	462	555	564
Adipose notch to tip of caudal fin	347	286	318	284	-	319	326
Anal fin origin to base of caudal fin	353	336	310	356	329	336	347
Caudal peduncle length	177	182	162	166	171	161	177
Longest dorsal ray	184	182	172	168	-	169	150
Length of dorsal spine	156	164	178	158	138	150	130
Adipose fin length	260	224	227	207	215	202	224
Adipose fin height	47	48	43	-	40	28	48
Caudal fin length	251	212	235	184	-	222	241
Length of anal base	174	173	140	195	183	184	182
Longest anal ray	174	127	168	-	121	140	124
Pectoral fin length	272	245	287	253	200	219	217
Pectoral spine length	214	218	225	222	170	186	188
Pelvic fin length	165	112	178	148	129	164	145
Humeral process tip to base pectoral spine	102	91	122	100	67	101	82
Head length	321	317	366	304	301	290	306
Head depth	167	173	178	145	151	149	161
Head width	279	256	285	281	255	229	239
Snout length	123	123	142	112	108	107	126

TABLE 28.—*Measurements of type-specimens of* Noturus, *subgenus* Rabida, *expressed as thousandths of the standard length*--Continued
[All specimens are holotypes except the lectotypes of N. furiosus and N. miurus.]

	hildebrandi UMMZ 157620	*hildebrandi lautus* USNM 201665	*baileyi* USNM 201602	*albater* UMMZ 151171	*elegans* UMMZ 167597	*trautmani* UMMZ 187098	*eleutherus* USNM 29678
Sex	♀	♀	♂	♂	♂	♂	♂ ?
Width of mouth	155	124	133	152	136	163	155
Nasal barbel length	61	62	85	77	77	79	95
Maxillary barbel length	150	146	155	142	145	159	152
Outer mental barbel length	155	87	140	168	145	141	-
Inner mental barbel length	92	55	98	98	113	98	-
Eye diameter	58	47	39	52	54	66	50
Distance snout to anal fin	622	620	635	658	615	649	674
Distance snout to pelvic fin	470	447	463	458	478	474	473

TABLE 28.--*Measurements of type-specimens of* Noturus, *subgenus* Rabida, *expressed as thousandths of the standard length*--Continued
[All specimens are holotypes except the lectotypes of N. furiosus and N. miurus.]

	placidus UMMZ 167653	*stigmosus* UMMZ 165843	*munitus* TU 26250	*furiosus* USNM 39932	*miurus* MNHN A1308	*flavipinnis* USNM 163801	*flavater* UMMZ 151322
Sex	♂	♂	♂	♂	♂	♀	♂
Width of mouth	172	167	194	148	138	141	155
Nasal barbel length	102	85	93	-	-	123	102
Maxillary barbel length	207	167	269	-	-	219	185
Outer mental barbel length	174	130	229	-	-	169	151
Inner mental barbel length	119	103	166	-	-	127	121
Eye diameter	60	60	63	62	55	71	52
Distance snout to anal fin	626	673	685	653	661	667	669
Distance snout to pelvic fin	491	514	546	493	496	502	515

Plates 1–21

PLATE 1

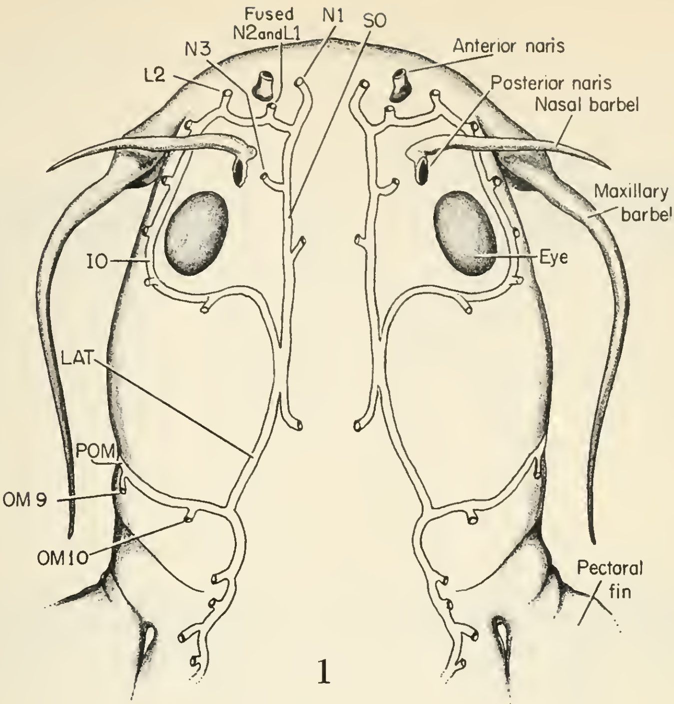
Sensory canal system of two species of Ictaluridae (slightly diagrammatic).

FIGURE 1. Dorsal view of *Noturus exilis* Nelson.

FIGURE 2. Dorsal view of *Pylodictis olivaris* (Rafinesque).

(IO=Infraorbital canal; LAT=Lateral canal; L1 and L2=First and second infraorbital canal pores; N1, N2, and N3=First, second, and third supraorbital canal pores; OM9, OM10, OM11, OM12=Ninth through twelfth preoperculomandibular canal pores; POM=Preoperculomandibular canal; SO=Supraorbital canal.)

L1 and N2 are fused and there are ten preoperculomandibular pores in *Noturus exilis*. In *Pylodictis*, these pores are unfused, N1 and N2 are located more anteriorly, the infraorbital canal extends diagonally backward, and there are twelve preoperculomandibular pores. The canal arrangements in the species of *Noturus*, *Prietella*, *Trogloglanis*, and *Ictalurus* are essentially as in *Noturus exilis*, but the number of preoperculomandibular pores and the fusion of L1 and N2 varies (see p. 11). *Satan eurystomus* Hubbs and Bailey is much like *Pylodictis*, but N1 is more posterior in position and L1 and N2 are fused.



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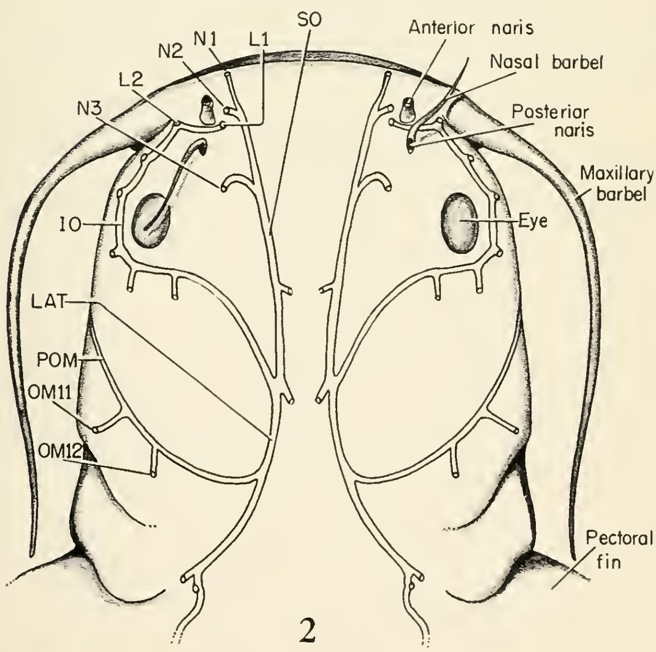

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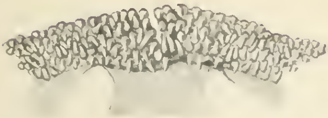
Premaxillae of representative species of *Noturus*, showing their ethmoidal attachment and some of the variations in tooth arrangement. [Drawings by Dorothea Schultz.]

FIGURE 1. *Noturus gyrinus* (USNM 174905, Michigan).

FIGURE 2. *Noturus exilis* (USNM 174904, Kansas).

FIGURE 3. *Noturus flavus* (USNM 174908, Michigan).

FIGURE 4. *Noturus stigmosus* (USNM 174906, Michigan).



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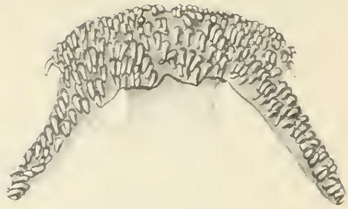

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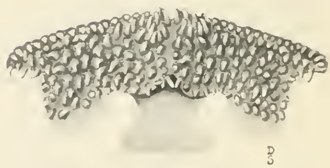

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PLATE 2

PLATE 3

Left pectoral spines of members of the subgenera *Noturus* and *Schilbeodes*, and of hybrids among the species of *Noturus*, all drawn to the same scale. [Figure 2 was drawn by Dorothea Schultz; all others by W. L. Brudon.]

FIGURE 1. *Noturus gyrinus* (Mitchill) (female; SL 52.8 mm.). UMMZ 152504, Missouri: Clear Cr., 2 mi. W. of Knobnoster, Johnson Co.

FIGURE 2. *Noturus lachneri*, new species (male; SL 69.5 mm.). USNM 165901, Arkansas: trib. of Saline R., 1 mi. NW. Benton, Saline Co.

FIGURE 3. *Noturus exilis* Nelson (female; SL 55.9 mm.). UMMZ 111413, Missouri: Niangua R., U.S. Hwy. 66, E. of Marshfield, Webster Co.

FIGURE 4. *Noturus leptacanthus* Jordan (female; SL 51.8 mm.). UMMZ 110975, Florida: Spring Cr., 3 mi. SE. of Marianna, Jackson Co.

FIGURE 5. *Noturus nocturnus* Jordan and Gilbert (female; SL 58.2 mm.). UMMZ 139501, Missouri: St. Francis R., near Saco, Madison Co.

FIGURE 6. *Noturus insignis* (Richardson) (female; SL 62.3 mm.). UMMZ 109631, New York: Tioughnioga R., Itaska, Broome Co.

FIGURE 7. *Noturus funebris* Gilbert and Swain (female; SL 70.4 mm.). DBUF, Florida: stream at Portland, 4 mi. W. of Freeport, Walton Co.

FIGURE 8. *Noturus phaeus*, new species (female; SL 53.5 mm.). UMMZ 161058, Mississippi: Mimosa Spa, 1.5 mi. N. of Waterford, Marshall Co.

FIGURE 9. *Noturus gilberti* Jordan and Evermann (female; SL 64.5 mm.). CU 20767, Virginia: Roanoke R., Glenvar, Roanoke Co.

FIGURE 10. *Noturus flavus* Rafinesque (female; SL 71.3 mm.). UMMZ 165842, Michigan: Huron R., below North Territorial Road, Washtenaw Co.

FIGURE 11. Hybrid: *Noturus exilis* Nelson × *Noturus miurus* Jordan (male; SL 51.1 mm.). UMMZ 137904, Oklahoma: Poteau R., Slate Ford, Le Flore Co.

FIGURE 12. Hybrid: *Noturus gyrinus* (Mitchill) × *Noturus miurus* Jordan (sex?; SL 108.8 mm.). UMMZ 157214, Michigan: Huron R., N. of Milford, Oakland Co.

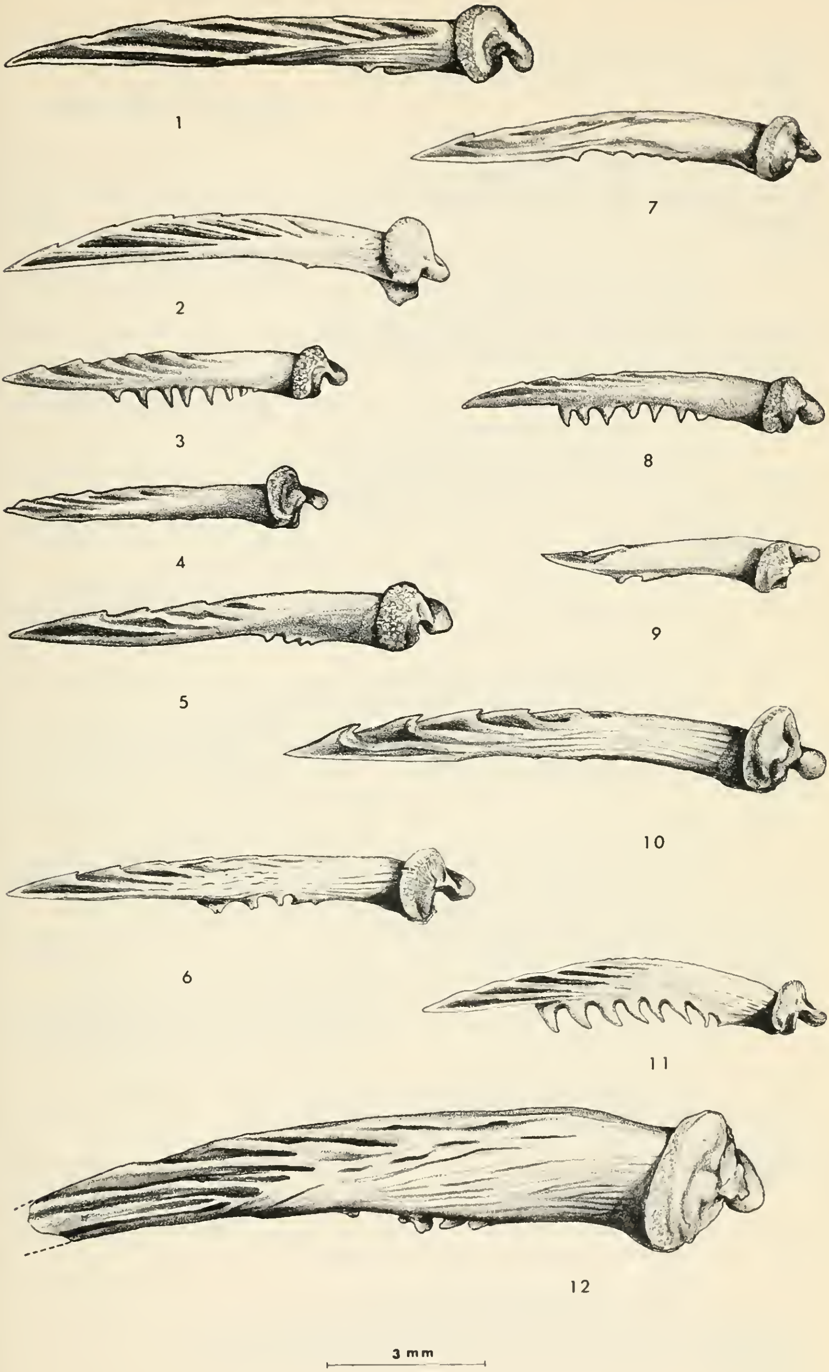
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PLATE 4

Left pectoral spines of members of the subgenus *Rabida*, all drawn to same scale. [Figures 2, 3, and 6 were drawn by Dorothea Schultz; all others by W. L. Brudon.]

FIGURE 1. *Noturus hildebrandi hildebrandi* (Bailey and Taylor) (female; SL 38.8 mm.). UMMZ 155338, Mississippi: Brushy Cr., 4 mi. NE. of Coles, Amite Co.

FIGURE 2. *Noturus hildebrandi lautus*, new subspecies (female; SL 40.0 mm.). USNM 193470, Tennessee: North Fork Obion R., Henry Co.

FIGURE 3. *Noturus baileyi*, new species (female; SL 42.7 mm.). USNM 201601, Great Smoky Mountains National Park: Abrams Cr.

FIGURE 4. *Noturus albater*, new species (female; SL 53.2 mm.). UMMZ 151407, Missouri: Flat Cr., 0.5 mi. S. of McDowell, Barry Co.

FIGURE 5. *Noturus elegans*, new species (female; SL 52.2 mm.). UMMZ 155526, Kentucky: Fallen Timber Cr., Hwy. 90, 8 mi. SE. of Glasgow, Barren Co.

FIGURE 6. *Noturus elegans*, new species (female; SL 59.2 mm.). USNM 201600, probably Duck River system, Tennessee (see p. 143).

FIGURE 7. *Noturus trautmani*, new species (male; SL 42.4 mm.). OSU 5914, Ohio: Big Darby Cr., 1 mi. S. of Fox, Pickaway Co.

FIGURE 8. *Noturus eleutherus* Jordan (female; SL 59.4 mm.). OSU 5157, Ohio: Little Miami R., Red Bank, Hamilton Co.

FIGURE 9. *Noturus placidus*, new species (female; SL 44.0 mm.). UMMZ 167654, Kansas: Neosho R., U.S. Hwy. 50, near Emporia, Lyon Co.

FIGURE 10. *Noturus munitus* Suttkus and Taylor (female; SL 44.0 mm.). USNM 197708, Mississippi: Pearl R., 2.3 mi. E. of Sandy Hook, Marion Co.

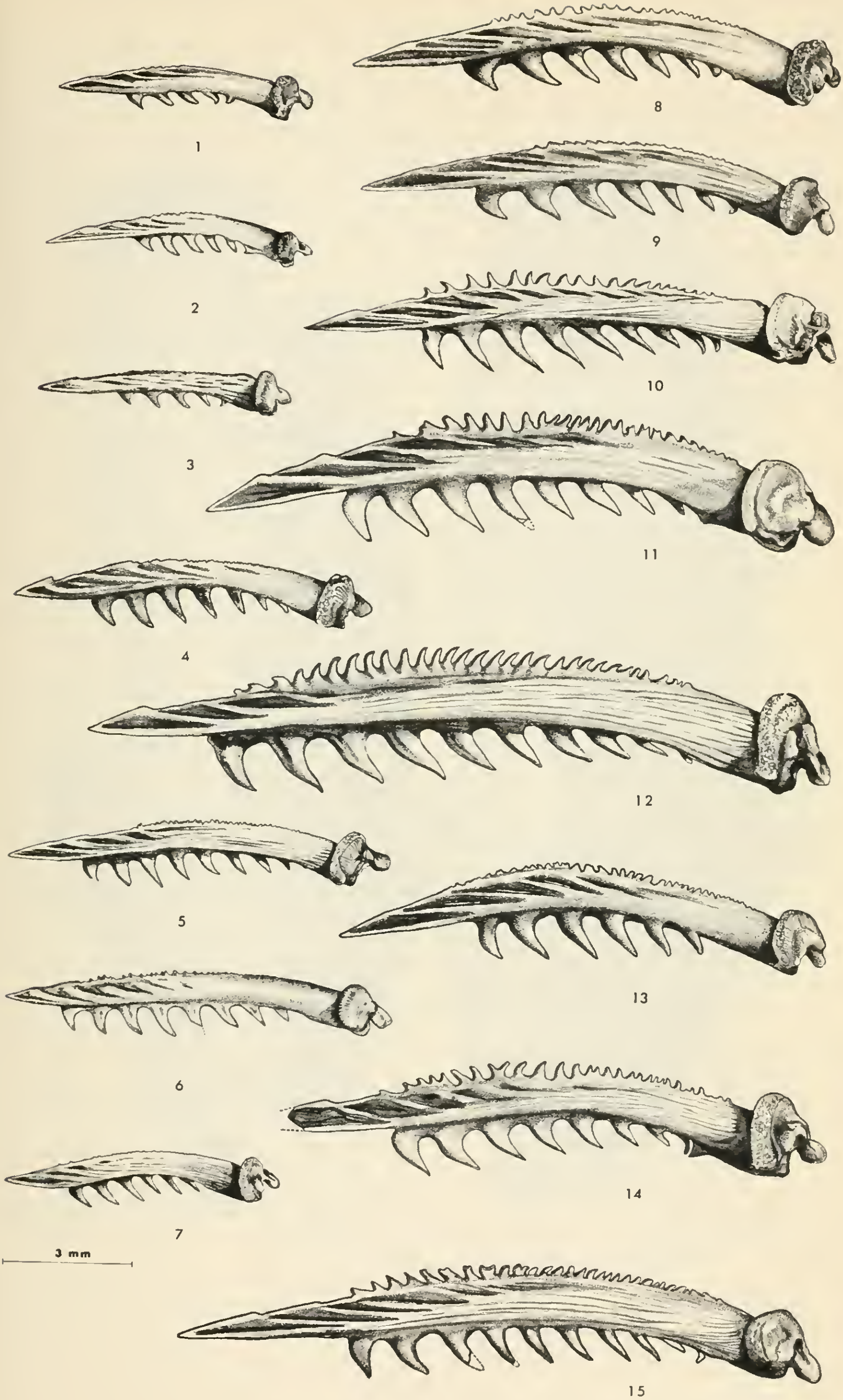
FIGURE 11. *Noturus stigmosus*, new species (female; SL 57.5 mm.). UMMZ 108063, Michigan: Huron R., above Dexter, Washtenaw Co.

FIGURE 12. *Noturus furiosus* Jordan and Meek (female; SL 69.2 mm.). UMMZ 165855, North Carolina: Raleigh.

FIGURE 13. *Noturus miurus* Jordan (female; SL 58.0 mm.). UMMZ 165840, Michigan: Huron R., 1.75 mi. NW. of Dexter, Washtenaw Co.

FIGURE 14. *Noturus flavipinnis*, new species (female; SL 63.8 mm.). SU 4606, locality unknown; thought to be from the upper Tennessee River basin.

FIGURE 15. *Noturus flavater*, new species (female; SL 57.1 mm.). UMMZ 152091, Missouri: North Fork White R., Tecumseh, Ozark Co.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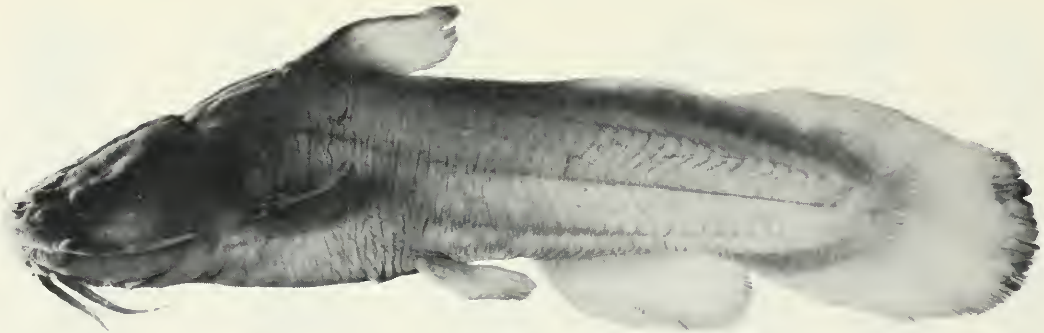

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FIGURE 1. *Noturus gyrinus* (Mitchill) (male; SL 79.4 mm.). UMMZ 116339, Michigan: North Br. Cass R., 1.5 mi. E. of Cass City, Tuscola Co.

FIGURE 2. *Noturus lachneri*, new species (paratype; male; SL 66.3 mm.). USNM 165901, Arkansas: trib., Saline R., 1 mi. NW. Benton, Saline Co.

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FIGURE 1. *Noturus exilis* Nelson (male; SL 60.4 mm.). UMMZ 152062, Missouri: North Fork White R., Hwy. M14, Douglas Co.

FIGURE 2. *Noturus insignis* (Richardson) (male; SL 78.2 mm.). UMMZ 147590, North Carolina: Tar R., U.S. Hwy. 15, Granville Co.

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FIGURE 1. *Noturus funebris* Gilbert and Swain (female; SL 94.5 mm.). UMMZ 155498, Florida: creek at Milton, Hwys. 87 and 89, Santa Rosa Co.

FIGURE 2. *Noturus phaeus*, new species (paratype; female; SL 77.1 mm.). UMMZ 161058, Mississippi: Mimosa Spa, 1.5 mi. N. of Waterford, 8 mi. S. of Holly Springs, Marshall Co.

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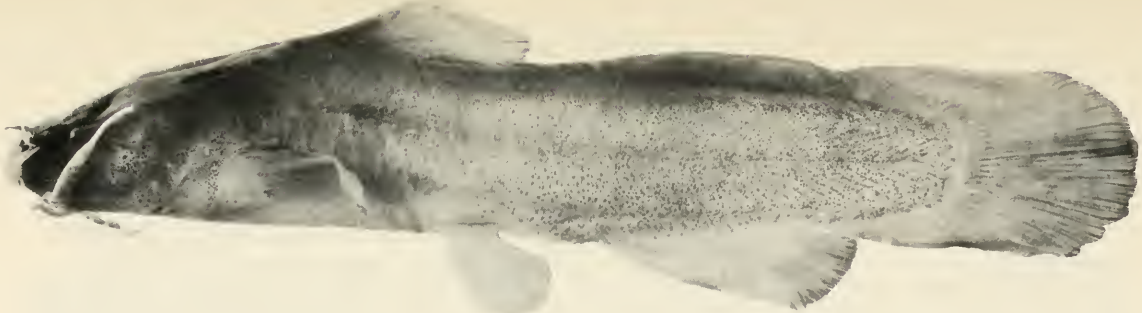

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FIGURE 1. *Noturus nocturnus* Jordan and Gilbert (female; SL 69.5 mm.). UMMZ 165883, Illinois: Post Cr., 1 mi. E. of Karnak, Pulaski Co.

FIGURE 2. *Noturus leptacanthus* Jordan (male; SL 61.4 mm.). UMMZ 165878, Georgia: Rocky Cr., U.S. Hwy. 78, about 2 mi. SW. of Augusta, Richmond Co.

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Figure 1. *Noturus gilberti* Jordan and Evermann (male; SL 72.6 mm.). UMMZ 138522, Virginia: Roanoke R., Glenvar, Roanoke Co.

Figure 2. *Noturus flavus* Rafinesque (female; SL 88.3 mm.). UMMZ 165842, Michigan: Huron R., below North Territorial Road, Washtenaw Co.

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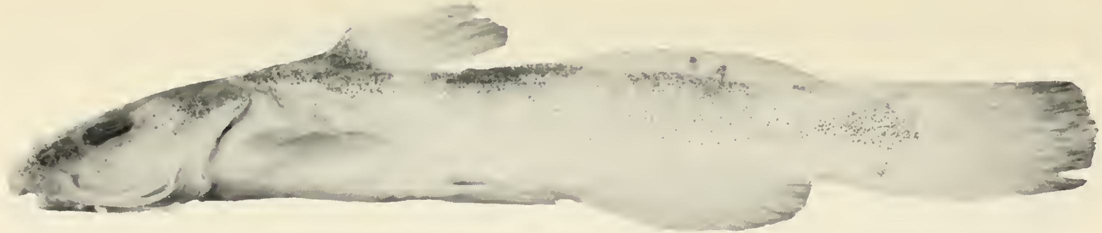

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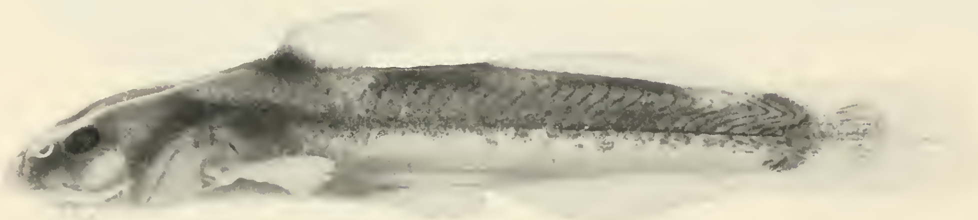

FIGURE 1. *Noturus hildebrandi hildebrandi* (Bailey and Taylor) (paratype; male; SL 39.0 mm.). UMMZ 155338, Mississippi: Brushy Cr., 4 mi. NNE. Coles, Amite Co.

FIGURE 2. *Noturus hildebrandi lautus*, new subspecies (holotype; female; SL 40.3 mm.). USNM 201665, Tennessee: North Fork Obion R., Hwy. 69, Henry Co.

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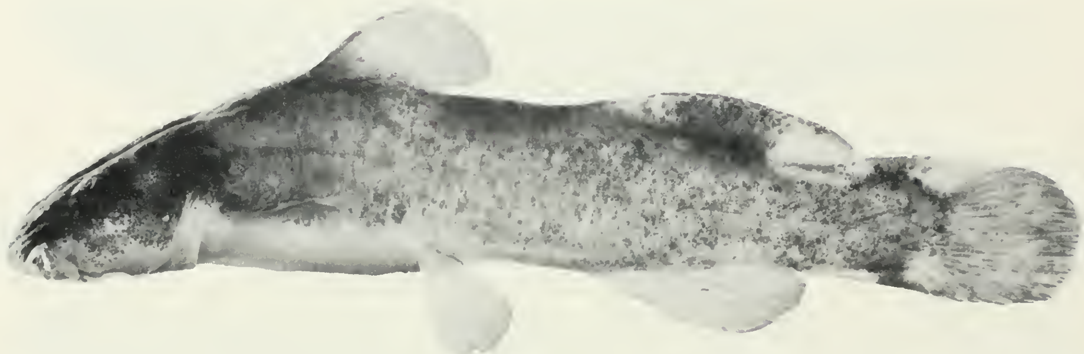

FIGURE 1. *Noturus baileyi*, new species (holotype; male; SL 45.8 mm.). USNM 201602, Great Smoky Mountain National Park: Abrams Cr.

FIGURE 2. *Noturus albater*, new species (holotype; male; SL 61.2 mm.). UMMZ 151171, Missouri: White R., Hwy. M80, Forsyth, Taney Co.

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FIGURE 1. *Noturus elegans*, new species (holotype; male; SL 44.1 mm.). UMMZ 167597, Kentucky: Fallen Timber Cr., Hwy. 90, 8 mi. SE. of Glasgow, Barren Co.

FIGURE 2. *Noturus elegans* (female; SL 59.5 mm.). USNM 201600, probably Duck River system, Tennessee (see p. 143).

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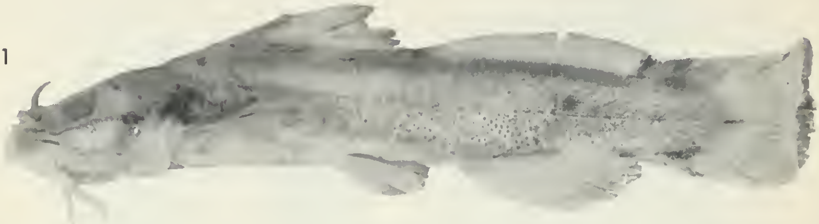

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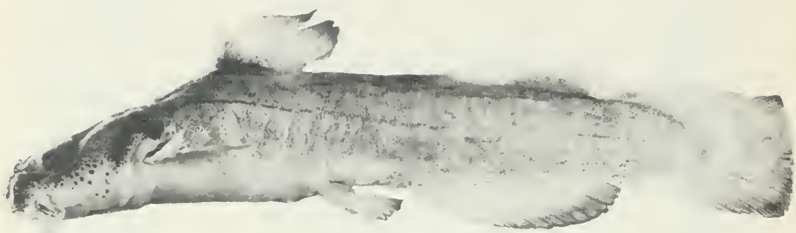

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Figure 1. *Noturus trautmani*, new species (holotype; male; SL 44.1 mm.). UMMZ 187098, Ohio: Big Darby Cr., 1 mi. S. of Fox, Jackson Twp., Pickaway Co.

Figure 2. *Noturus elegans*? (male; SL 51.2 mm.). UMMZ 131386, Tennessee: Dunn Cr., at Jones Cove, Sevier Co. [The dorsal and anal fins are not dark margined, as shown here; instead a dark background shows through these relatively clear fins.]

Figure 3. *Noturus elegans*? (male; SL 32.0 mm.). UMMZ 165877, Alabama: Piney Cr., Limestone Co.

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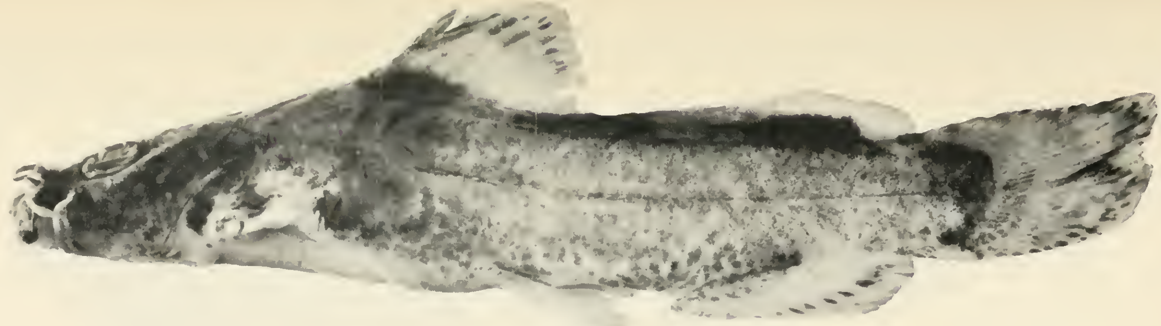

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FIGURE 1. *Noturus eleutherus* Jordan (male; SL 45.8 mm.). UMMZ 157575, Tennessee: South Fork Holston R., 0.25 mi. above South Holston dam (before impoundment), Sullivan Co. The anal fin was dissected from body anteriorly.

FIGURE 2. *Noturus eleutherus* Jordan (male; SL 54.7 mm.). OSU 3/74, Ohio: Scioto R., Clay Twp., Scioto Co.

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FIGURE 1. *Noturus furiosus* Jordan and Meek (male; SL 65.5 mm.). UMMZ 165884, North Carolina: Neuse R., Wake Co.

FIGURE 2. *Noturus placidus*, new species (holotype; male; SL 43.0 mm.). UMMZ 167653, Kansas: Neosho R., just S. of U.S. Hwy. 50, near Emporia, Lyon Co.

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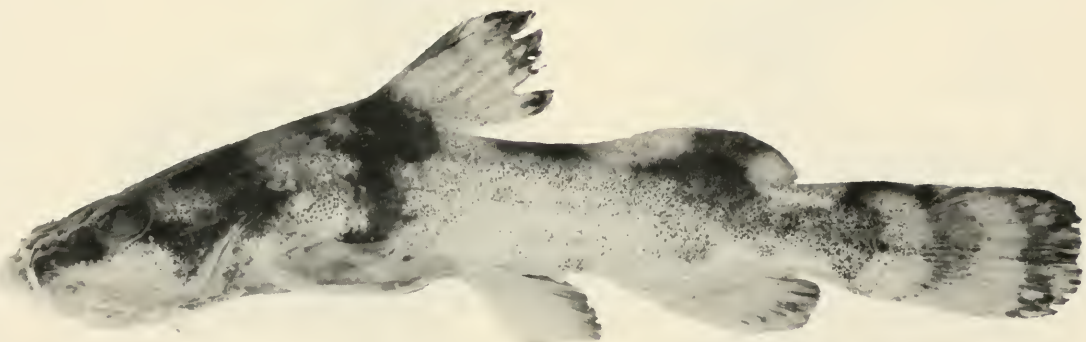

FIGURE 1. *Noturus stigmosus*, new species (holotype; male; SL 66.9 mm.). UMMZ 165843, Michigan: Huron R., below North Territorial Road, Washtenaw Co.

FIGURE 2. *Noturus munitus* Suttkus and Taylor (paratype; male; SL 46.1 mm.). USNM 197708, Mississippi: Pearl R., 2.3 mi. E. of Sandy Hook, Marion Co.

FIGURE 1. *Noturus furiosus* Jordan and Meek (male; SL 65.5 mm.). UMMZ 165884, North Carolina: Neuse R., Wake Co.

FIGURE 2. *Noturus placidus*, new species (holotype; male; SL 43.0 mm.). UMMZ 167653, Kansas: Neosho R., just S. of U.S. Hwy. 50, near Emporia, Lyon Co.

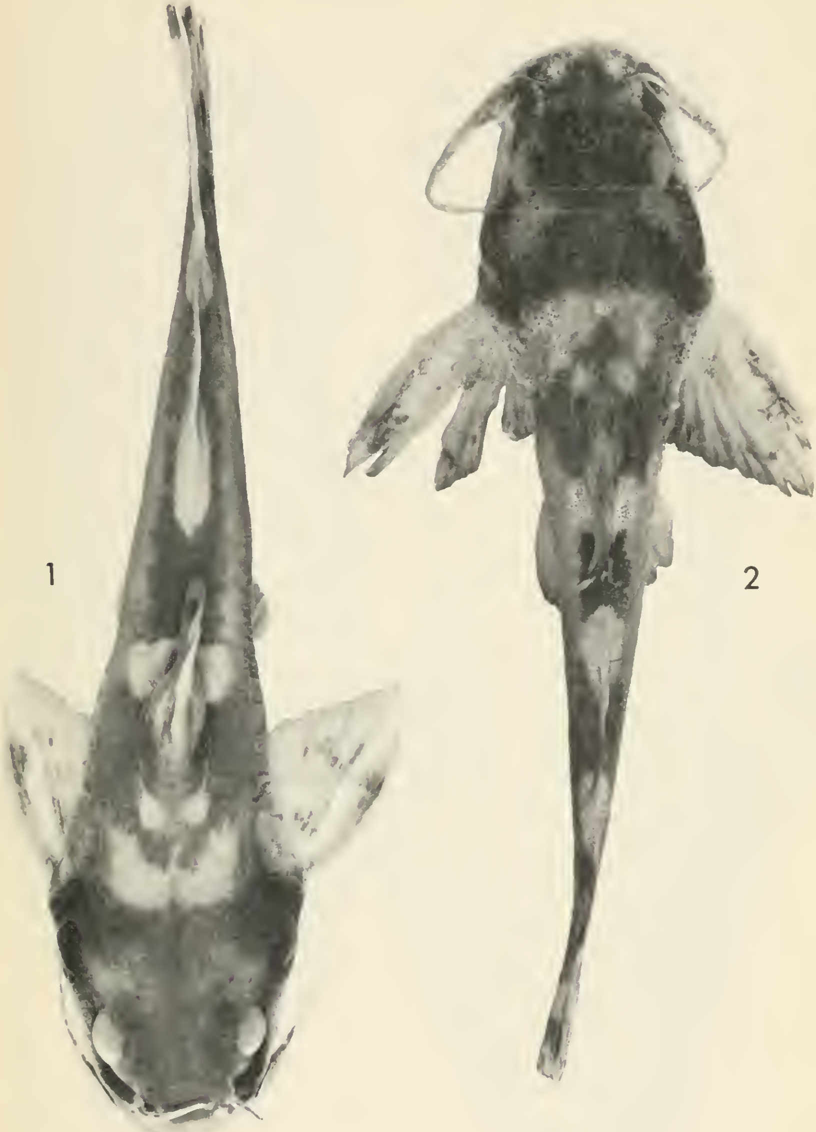

FIGURE 1. *Noturus stigmosus*, new species (holotype; male; SL 66.9 mm.). UMMZ 165843, Michigan: Huron R., below North Territorial Road, Washtenaw Co.

FIGURE 2. *Noturus munitus* Suttkus and Taylor (paratype; male; SL 46.1 mm.). USNM 197708, Mississippi: Pearl R., 2.3 mi. E. of Sandy Hook, Marion Co.

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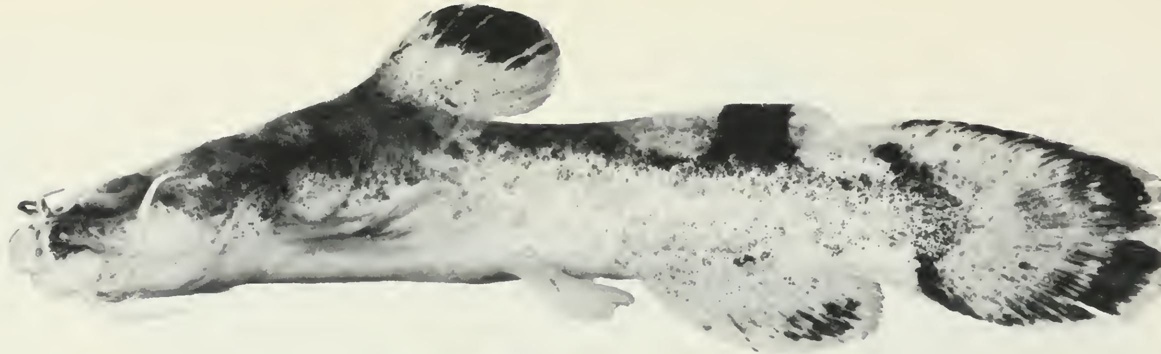

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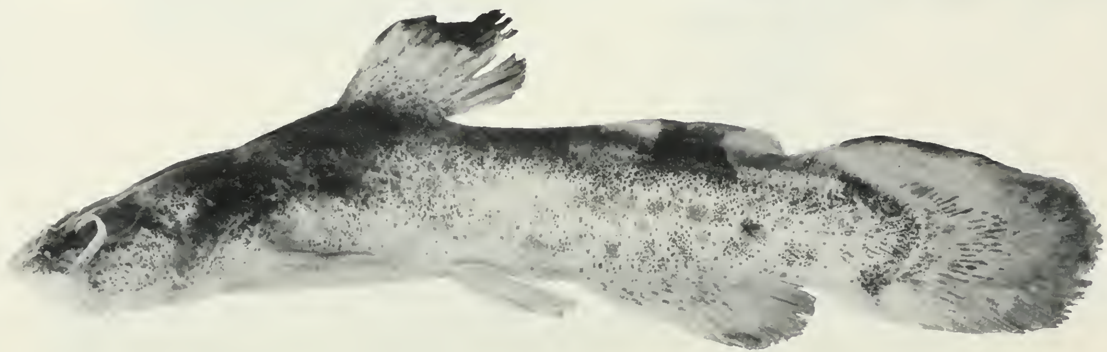

FIGURE 1. *Noturus miurus* Jordan (male; SL 52.4 mm.). UMMZ 165840, Michigan: Huron R., 1.75 mi. above Dexter, Washtenaw Co.

FIGURE 2. *Noturus miurus* Jordan (male; SL 53.3 mm.). UMMZ (Delavan and Creaser No. 31–57), Louisiana: Jena, La Salle Parish.

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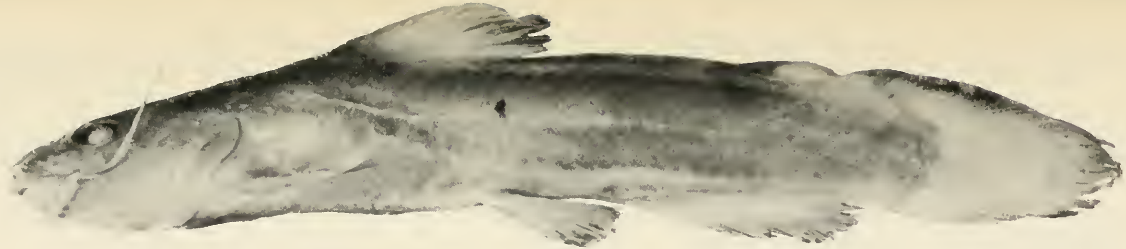

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FIGURE 1. *Noturus flavipinnis*, new species (holotype; female; SL 65.2 mm.). USNM 163801, Tennessee: Hines Cr., Clinton. [The two dark areas at the upper and lower margins of the caudal fin are due to the dark background showing through the transparent portions of the fin.]

FIGURE 2. *Noturus flavater*, new species (holotype; male; SL 102.9 mm.). UMMZ 151322, Missouri: Flat Cr., Hwy. M39, 12 mi. NE. of Cassville, Barry Co.

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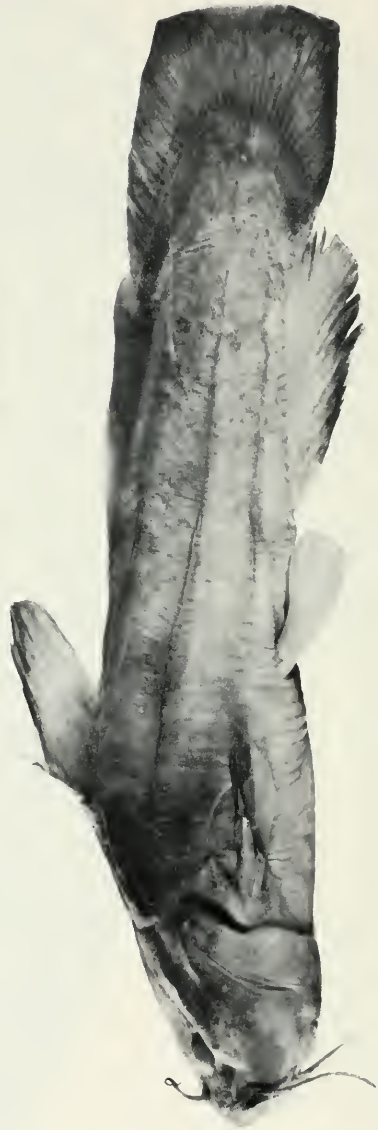

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FIGURE 1. Hybrid: *Noturus exilis* Nelson × *Noturus miurus* Jordan (male; SL 51.1 mm.). UMMZ 137904, Oklahoma Poteau R., Slate Ford, near Shady Point, Le Flore Co.

FIGURE 2. Hybrid: *Noturus gyrinus* (Mitchill) × *Noturus miurus* Jordan (sex?; SL 108.8 mm.). UMMZ 157214, Michigan: Huron R., sec. 13, T. 2 N., R. 7 E., N. of Milford, Oakland Co.

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[Names of new species in italics, page numbers of principal accounts in boldface]

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