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NOTROPIS AMNIS, A NEW CYPRINID FISH OF THE MISSISSIPPI FAUNA, WITH TWO SUBSPECIES[1]

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RECENT exploration of the rich cyprinid fish fauna of eastern North America, accelerating through the past quarter century, has revealed and is continuing to reveal new species referable to the dominant genus *Notropis.* One of these is a small species that has been called *Notropis amnis,* though it has never been assigned an available name. It is the purpose of this paper to propose this name formally, to diagnose the 2 subspecies into which it is divisible, to summarize and clarify their confused nomenclatorial history, to discuss their intergradation, and to map and interpret their geographical distribution.

Most of the material on which this paper is based is deposited in the University of Michigan Museum of Zoology (U.M.M.Z.) and the United States National Museum (U.S.N.M.). Use has also been made of the specimens in the collections of the Illinois Natural History Survey, the University of Wisconsin, Indiana University, the University of Texas, the Oklahoma Agricultural and Mechanical College, the Agricultural and Mechanical College of Texas, and the Upper Mississippi River Survey Committee.

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George S. Myers and later Leonard P. Schultz, as the curators of fishes at the National Museum, and Reeve M. Bailey, my successor at the University of Michigan Museum, have accorded every facility in this and other studies. Bailey, further, has contributed helpful suggestions during the preparation of the manuscript. Schultz, with the aid of Clarence M. Tarzwell, collected most of the types of *N. a. amnis*. For specimens and records or for laboratory assistance, I have thanks to express to other associates and former students, including John D. Black, Shelby D. Gerking, John T. Greenbank, George V. Harry, Clark Hubbs, Raymond E. Johnson, Chancey Juday, Canuto G. Manuel, George A. Moore, D. John O'Donnell, I. A. Rodeheffer, Philip W. Smith, Laurence C. Stuart, and George W. Wagner. Especial thanks are due C. Willard Greene, who collaborated in the discovery and definition of *N. a. amnis*, and Kelshaw Bonham, who, similarly, collaborated in the recognition of *N. a. pinnosa* and, in addition, made the many measurements and scale counts that are summarized in Table IV and took the photographs that are reproduced as Plate I. Laura C. Hubbs aided materially in processing the data, in spot-mapping the distributional records, and in other ways. Kirby H. Walker provided data on the habitat of *N. atrocaudalis*.

PALLID SHINER

Notropis amnis Hubbs and Greene, new species

Notropis nocomis (2 species originally confused; diagnosis refers to a subspecies of *N. volucella*).—Jordan, 1885: 812 (24, sep.) (ascribed to "Jordan & Gilbert, 1885," without trace of description[P]; fresh water, Southwest[P]). Evermann, 1892: 78–79 (original description as "sp. nov."[P]; Trinity River at Magnolia Point and Buffalo Bayou near Houston, Texas[P]). Evermann and Kendall, 1894: 83, 89, 91, 100, 126, Pl. 17, middle fig. (Rio Comal at New Braunfels [in small part], Trinity River at Magnolia Point, Trinity River at Dallas [in part], Texas[P]). Jordan and Evermann, 1896*a*: 268 (description[P]; records and range, in part [after Evermann and Kendall[P]]; locally abundant[P]); 1896*b*: 253 (listed, same localities[P]); 1900: 3241, Pl. 17, Fig. 118[P]. Pratt, 1923: 78 (diagnosis[P]; same localities[P]).

Hybopsis nocomis.—Jordan, 1929: 78 (diagnosis[P]; range, St. Louis[A] to Texas[P]). Jordan, Evermann, and Clark, 1930: 135 (records and range, in part [after Evermann and Kendall][P]). Pratt, 1935: 74 (same as Pratt, 1923: 78[P]).

Notropis deliciosus (misidentification).—Jordan and Gilbert, 1886: 23–24 (Comal River at New Braunfels, Texas, in small part[P]). Evermann and Kendall, 1894: 80, 91, 100 (Jordan and Gilbert's record[P]).

[*Notropis*, species] "closely resembling *N. cayuga.*"—Jordan, 1891: 18 (characters[P]; Rio Comal at New Braunfels, Texas[P]).

Notropis cayuga (misidentifications).—Meek, 1896: 347 (Old River at Buckhorn Landing near Greenway, Arkansas[I]; scarce[I]). Jordan and Evermann, 1896*a:* 260 (Arkansas record only[I]). Forbes, 1909: 386 (range, in part, "Lower Miss[I]. and Ohio"). Forbes and Richardson, 1909 and ed. 2, 1920: lxxvii, 133 (range in part[I]; Arkansas and lower Mississippi Valley [both presumably based on Meek's record, also included under *N. c. atrocaudalis*][I]; Comal River[P] [in part; Neches River cited with no obvious basis], Texas). Thompson and Hunt, 1930: 24, 43, 98 (characters in key, habitat, and nomenclature, in part[A]; Champaign County, Illinois[A]).

Notropis cayuga atrocaudalis (misidentifications).—Forbes, 1909: 386 (range in part, "Lower Miss[I]. and Ohio"). Forbes and Richardson, 1909 and ed. 2, 1920: lxxvii, 134 ("Lower Miss[I]. and Ohio"; Greenway, Arkansas[I]). Thompson and Hunt, 1930: 24 (subspecies identification of form otherwise treated as "*Notropis cayuga,*" revised to *N. heterolepis*[A]; habitat[A]; Champaign County, Illinois[A]).

Notropis atrocaudalis.—Greene, 1927: 305 (Wisconsin[A]). Wiebe, 1928: 161 (Minnesota River at Fort Snelling and St. Croix River above bridge[A] [but not the record for Minnesota River above Cedar Avenue Bridge, which proves on re-examination of material to have been based on *N. h. heterolepis*]). O'Donnell, 1935: 482 (streams of Champaign County, Illinois[A]).

Notropis heterolepis atrocaudalis.—Hubbs and Ortenburger, 1929: 67 (may be a distinct species[A,P]; evidence of intergradation with *N. h. heterolepis* [false]; records from Arkansas River system in Arkansas and Oklahoma[P]; characters[P]; pale in silty water[P]; Old River near Greenway, Arkansas, with reference to Meek[I]).

Hybopsis atrocaudalis.—Jordan, 1929: 79 (range, Minnesota[A] to Texas[P]).

Notropis heterolepis (misidentification).—Thompson and Hunt, 1930: 98 (revised identification of *N. cayuga* from Champaign County, Illinois, also identified as *N. c. atrocaudalis*[A]).

Notropis amnis amnis (accredited to Hubbs and Greene, but in no previous paper indicated as new).—Greene, 1935: 96–97, Map 37 ("pale, delicate minnow"[A]; records and postglacial redispersal in Wisconsin[A]; Mississippi River and large tributaries in Minnesota, Iowa, Wisconsin, Illinois, and Missouri[A]; Ohio Valley to Great Pigeon River, Indiana[I]; represented in Arkansas[I,P], Oklahoma[P], and Texas[P] by a related subspecies). Eddy and Surber, 1943: 143 (southern Minnesota and Wisconsin southward to Missouri[A], Illinois[A], and Indiana[I]; Mississippi River records from Greene[A]). Gerking, 1945: 62 (Iroquois River, Indiana[A]; White Creek, Lick Creek, and Big Pigeon River, Indiana[I]).

Notropis amnis.—Lamb, 1941: 44 (5 collections, San Jacinto River system, Texas[P]). Shoup, Peyton, and Gentry, 1941: 69 (3 records, Cumberland River system, Tennessee[I]). Eddy and Surber, 1947: 162 (range, "south-

ern Minnesota[A] and Wisconsin[A] southward to Texas[P]''; Mississippi River records after Greene, 1935[A]). Baughman, 1950: 130 (Texas[P]).

The synonymy applies to the species as a whole. The matter that is applicable to *N. a. amnis,* to *N. a. pinnosa,* and to intergrades is indicated by the superscripts A, P, and I, respectively.

DIAGNOSIS.—This is a small species of *Notropis,* not known to exceed 55 mm. in standard length. The mouth appears to be very small, for the upper lip reaches only to below the posterior nostril or very slightly beyond, though the upper jaw is really of average length: very distinctively, the posterior third of the upper jaw is nearly fleshless and is completely concealed beneath the suborbital; the width of the frenum of the lower lip equals the distance from the front of the gape to a line joining the corners of the gape. The pharyngeal teeth number 1, 4—4, 1; those in the main row are strongly hooked, smooth-edged, and provided with a flat grinding surface; those in the lesser row are weakly developed and are occasionally lacking on one or even both sides. Typically, there are 8 anal rays. The scales are rather large (34 to 37 in the lateral line) and are not especially elevated. The body is not markedly elevated or compressed and the eye is not less than one-fourth the length of the head. The upper surface is stippled, but not markedly darkened near the nape, along the base of the dorsal fin, or before the caudal fin; the predorsal stripe is weakly developed; on the entire upper sides dark edges line the scale pockets, but the head and body are devoid of melanophores below the lateral band, except on areas just behind the anus, along the base of the anal fin, and in 3 irregular files on the lower edge of the caudal peduncle; a dark stripe extends on the side of the snout, behind the eye, immediately above the lateral line on the trunk (with intensifications just above and just below each lateral-line pore), and along the lateral line on the urosome; it is expanded somewhat and truncated just in advance of the small, posteriorly frayed basicaudal spot; just above the dark band the dark pigment on the head and body fades out slightly to form a somewhat lighter streak (because the species commonly occurs in silty water, the dark pattern is often very faint, scarcely evident in life). The subhorizontal lips and the chin are wholly unpigmented. (Diagnosis by Hubbs and Greene.)

COMPARISONS AND RELATIONSHIPS.—In combination, the characters

just stated serve to distinguish the species readily from all others. Its immediate relationships within the genus are not apparent, and it may be made the type of a distinct subgenus when *Notropis* receives the much needed general revision.

There appears to be no immediate consanguinity with *N. heterolepis* Eigenmann and Eigenmann (*"N. cayuga"* of authors), *N. atrocaudalis* Evermann, *N. volucella* (Cope), and *N. deliciosa* (Girard), the species with which *N. amnis* has usually been confused, because of superficial similarities. From these 4 species *N. amnis* differs in typically having a tooth in the lesser row, as well as in the peculiar mouth structure described above. From each of the other species it differs further in several ways: from *N. atrocaudalis* and *N. deliciosa,* in usually having 8 instead of 7 principal anal rays; from *N. heterolepis,* in having the dark lateral band less disrupted into black crescents; and from *N. volucella,* in not having the lateral-line scales especially elevated.

The minnow that *Notropis amnis* perhaps most closely resembles in superficial appearance is *Hybopsis amblops* (Rafinesque). The resemblance, in fact, is extremely close between the respective southern subspecies, *H. a. winchelli* Girard and *N. a. pinnosa,* the ranges of which are separated by the flood area of the lower Mississippi Valley (*H. a. winchelli* ranges westward to Amite River, 15 miles east of Baton Rouge, Louisiana, where specimens were collected by Nelson Marshall on December 30, 1939). Were it not for the very peculiar mouth structure of *N. amnis,* which *H. amblops* hardly shares, one might even postulate that *amnis* was derived from *amblops* by the loss of the small maxillary barbel. That possibility is not wholly excluded, for *H. a. winchelli* occasionally lacks the barbel on one or even both sides and the mouth structure somewhat approaches that of *N. amnis.* The concealed part of the maxillary remains shorter, however, and the width of the frenum of the lower jaw is only two-thirds the distance from the front of the gape to a line joining the corners of the gape.

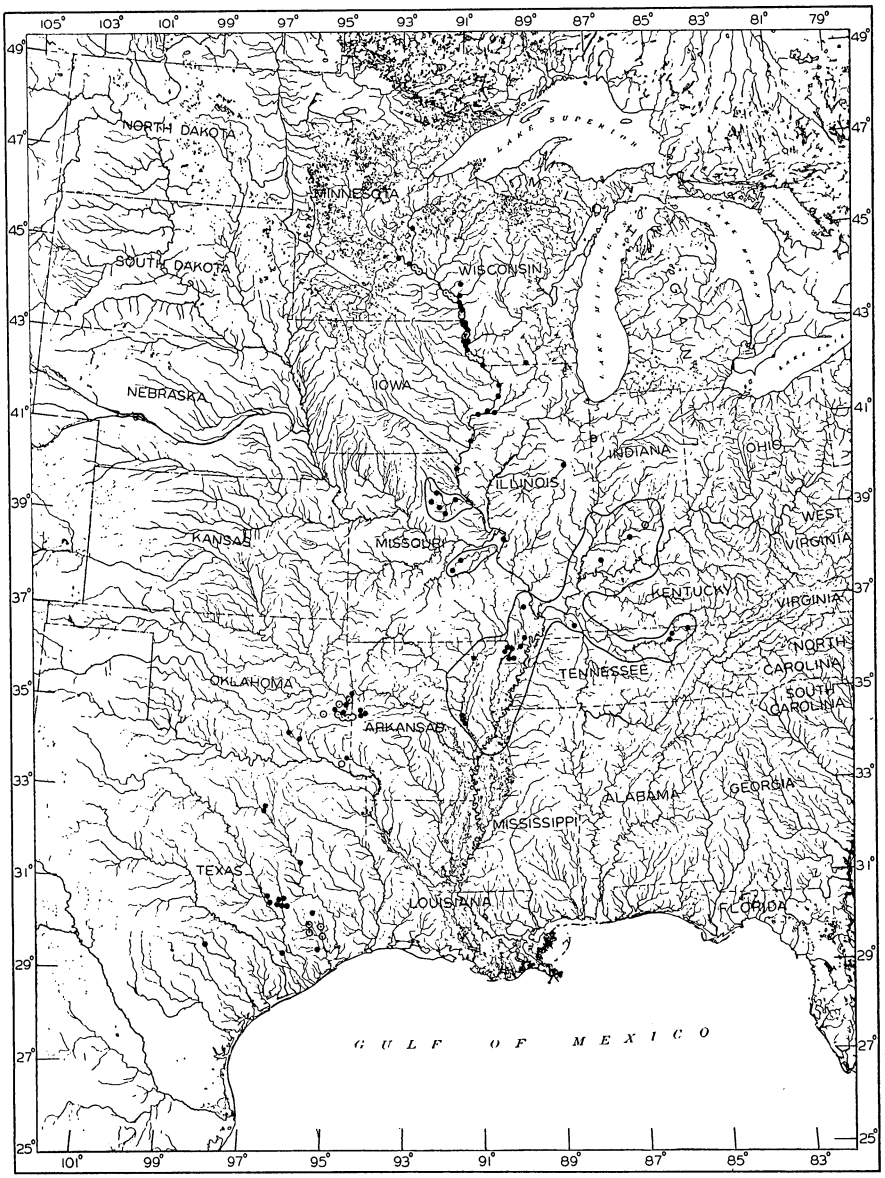
NUPTIAL TUBERCLES.—The isolated position of this species is emphasized by the strength and by the pattern of the nuptial tubercles. In the material at hand, these are well developed only in certain specimens of the southwestern subspecies from Texas, but the pattern was observed in examples from other localities and it is extremely improb-

able that the subspecies differ in tuberculation. The organs are particularly strong on the cheek, which they stud like a war club, standing, with swollen bases in contact, in 6 to 8 rows. A few large ones are scattered on the branchiostegals. Similar organs cover much of the preorbital region below the nostrils (leaving some lacunae), down to the rostral fold, with a few on the front of the maxillary. They become obsolete on the top and front of the snout, in advance of the nostrils. They line the orbit and cover the anterior interorbital region. They are sparse over the parietal region, but thick and strong in a band along the occipital line. They are well developed behind the eye and a few arm the upper part of the opercle. The occipital band extends onto the body scales and, in a narrow triangle thence backward to the origin of the dorsal fin, some of the scales bear a submarginal file of small bluntish tubercles. The anterior (or outer) two-thirds or three-fourths of the pectoral rays, except near their bases and tips, are thickened and armed on the upper surface with erect, pointed nuptial organs, grading outward from 1 series to 2 and then to a band, with many organs to each ray segment. The other fins are unarmed, as is the entire body except in the predorsal region. The specimen illustrated as Plate I, Figure 4, is a nuptial male, but the tubercles are not very obvious in the figure.

RANGE, HABITAT, AND ABUNDANCE.—*Notropis amnis* is one of many species confined to the Gulf drainage basin. It occupies the lowlands, from the larger rivers of the Mississippi River system in Minnesota, southward to the Gulf streams of Texas (Map 1). Toward the west it scarcely penetrates the tributary streams in Minnesota and Iowa and in the extensive fish survey of Missouri (by George V. Harry) it has been taken only in the Salt and Bourbeuse river systems and in the ditches and creeks of the depressed St. Francis Basin, all near the

MAP 1. Records and distribution of *Notropis amnis,* including subspecies *N. a. amnis* (northern) and *N. a. pinnosa* (southwestern) and intergrades, with the areas of intergradation outlined.

The hollow dots represent records unconfirmed by re-examination of the specimens. Those for the upper Mississippi River, stemming from the Upper Mississippi River Survey, were furnished by Raymond E. Johnson and John T. Greenbank and to large extent represent identifications by John D. Black; those from Indiana were published by Shelby D. Gerking; the ones from Oklahoma were provided by George A. Moore; those from Texas were published by Leonard D. Lamb.


105° 103° 101° 99° 97° 95° 93° 91° 89° 87° 85° 83° 81° 79°
49° 47° 45° 43° 41° 39° 37° 35° 33° 31° 29° 27° 25°
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WISCONSIN
NEBRASKA
IOWA
INDIANA
OHIO
ILLINOIS
KANSAS
MISSOURI
WEST VIRGINIA
KENTUCKY
VIRGINIA
NORTH CAROLINA
TENNESSEE
SOUTH CAROLINA
OKLAHOMA
ARKANSAS
GEORGIA
ALABAMA
MISSISSIPPI
TEXAS
LOUISIANA
FLORIDA
GULF OF MEXICO

Mississippi River. It lives in the White River system in Arkansas and in the Poteau River drainage basin and in adjacent waters of the Arkansas River system in Arkansas and Oklahoma. In the Red River system there are 4 records, all in southeastern Oklahoma. It is common in the streams of eastern Texas and penetrates westward in the Trinity River as far as Dallas. Toward the east it occurs, rarely, in a few Mississippi River tributaries in western Wisconsin, across Illinois, and barely into northern Indiana. It penetrates the Ohio River system, in great scarcity, to southwestern Indiana, to Kentucky near the mouth of the Tennessee River, and up the Cumberland River in Tennessee to near the Kentucky line. Below the Ohio River it has not been taken east of the Mississippi. Thus, the range extends to the west of the Mississippi in the south and almost entirely to the east of the Mississippi in the north. In consequence, the entire range is a band trending northeast from eastern Texas. Several other species have a similar distributional pattern. One, records of which have been plotted (Hubbs and Black, 1947: 29–33, Map 1), is *Ceratichthys vigilax.* Recent work shows that *C. perspicuus* is conspecific with *C. vigilax,* as formerly suspected, and warrants the deletion of the northwestern-most records for *C. v. perspicuus,* namely those in the Missouri River drainage basin of Iowa, Nebraska, and South Dakota, and those in northeastern South Dakota.

Toward the north, as its specific name implies, *N. amnis* is mainly confined to the larger lowland rivers; in the south, it more commonly inhabits small to medium-sized streams. Avoidance of the excessive turbidity of the main streams in the south may be the chief factor in this differential habitat selection, but temperature is perhaps also involved, for in the north this essentially southwestern species avoids the smaller streams, which are generally cooler, and may find only the larger waters sufficiently warm. The differential distribution corresponds rather well with the subspecies pattern (Map 1), as it does to some extent also in *Ceratichthys vigilax,* for *N. a. amnis* is primarily a large-river form, whereas *N. a. pinnosa* is more at home in smaller rivers and creeks. In the area of intergradation both large and small streams seem to be inhabited, though in Missouri the Mississippi River proper seems to be largely if not entirely avoided (the one record, for St. Louis, is based on a specimen collected more than 75 years ago by Louis Agassiz).

The relative abundance and general occurrence of the pallid shiner in the upper Mississippi River, in northern Illinois, Iowa, Wisconsin, and Minnesota, and its apparent scarcity or absence in the river farther south, no doubt reflect in part the more thorough collecting in the north, but may also be attributed to the excessive turbidity of the Mississippi below the mouth of the Missouri. As Reeve M. Bailey pointed out (in conversation), and as I also have noticed, a number of species become very scarce below the Missouri River, where their place is taken by such silt-loving forms as *Scaphirhynchus album, Hybopsis (Macrhybopsis) meeki, H. (M.) gelida, Hybopsis (Platygobio) gracilis communis,* and *Hybognathus placita.*

Within its area of abundance in the upper Mississippi River there seems to be a definite hiatus in the range of *N. a. amnis* (Map 1). The stretch of river for which there are no records for this shiner has been markedly altered by the inflow of the Chippewa River. In the northern half of the hiatus the Mississippi River is broadly and deeply ponded behind the barrier produced by the Chippewa Delta. For about a like distance downstream, as I am informed by John T. Greenbank, the main river conditions are modified by the vast quantities of sand brought in by the Chippewa. The lack of distributional records does not reflect inadequate collecting, for this section, as well as those above and below, has been thoroughly covered by the Upper Mississippi River Conservation Committee.

Although it seems to avoid excessive silt, *N. amnis,* according to the 40 records of ecological conditions accompanying the series in the University of Michigan Museum of Zoology, is tolerant of a wide range of turbidity, as well as of other environmental factors. The turbidity reports are about equally divided between "clear" or "almost clear" and moderately turbid or "muddy," with a few noted as "murky" or "very muddy." Aquatic vegetation was noted as absent about as often as present and was occasionally recorded as very dense. The records for the type of bottom vary from very soft mud, through sand and gravel to rock, with various admixtures of materials of different particle size. Summer temperatures grade from "cold" (presumably meaning cool) to "warm," with 2 records of nearly 23° C. for *N. a. amnis,* 6 readings averaging 29° for intergrades, and 5 more averaging 33° for *N. a. pinnosa.* The reports on current are about equally divided between "none" or "almost none" and

"slow" to "rapid," with slow flows predominating over swift. The delicate fins and skin and the only moderately streamlined build conform with these habitat indications.

Except locally, *N. amnis* appears to be a very rare species, perhaps headed toward extirpation. In Minnesota and Wisconsin it has been proved by thorough collecting to be excessively rare except in the Mississippi River, its main tributaries, and immediately adjacent waters, and even in these waters it is estimated by Reeve M. Bailey and by John T. Greenbank to constitute less than 1 per cent of the minnow population. There are no records for Iowa away from the main river and the species apparently has been taken only twice in the interior of Illinois and only 4 times in Indiana, although much collecting has been done in these states. Only 1 specimen has come from Kentucky and only 3 small series from Tennessee. South of Iowa, except for the specimen taken by Louis Agassiz at St. Louis, Missouri, there are no records from the Mississippi or from east of that river. The very thorough collecting across Missouri has disclosed it to be moderately common only in the Salt River system and in the St. Francis Basin and elsewhere has yielded only 2 single-specimen samples from the Bourbeuse River of the Meramec River system (all tributaries to the Mississippi in the eastern part of the state). The Arkansas survey by John D. Black and earlier collecting in that state yielded only 2 samples from the St. Francis Basin, 4 from the White River system, and 3 from the Arkansas River system near the Oklahoma line. In Oklahoma the species has been taken once in the Arkansas River and only 4 times in the Red River system, in addition to samples from the Poteau River system, where it seems to survive in numbers. In eastern Texas the species is rather generally distributed and is locally common.

The scarcity of *Notropis amnis* is indicated by comparing its relatively few record stations (Map 1) with the multitudinous records for *Ceratichthys vigilax* (including *perspicuus*), a species with a similar distribution pattern and like ecological preferences.

NOMENCLATORIAL HISTORY.—Although it is rare over most of its range, *N. amnis* has been collected repeatedly since 1884 and has been reported under a number of names. It is surprising, therefore, that neither the northern or the southern subspecies yet bears a valid

name. The fluctuating nomenclature is outlined and epitomized in the preceding synonymy, but requires some further elaboration and clarification.

The first specimens of *Notropis amnis* to be named and recorded were collected by Jordan and Gilbert in 1884 in Comal River at New Braunfels, Texas, and were included in a composite series to which they assigned the manuscript name *Notropis nocomis.* This name was entered, as a strict *nomen nudum,* in Jordan's list of North American fresh-water fishes (1885: 812). Jordan and Gilbert (1886: 23–24) then promptly abandoned the recognition of the series as a new species, but specified as the basis of *N. nocomis* their own specimens from the Comal, which they briefly described under the identification of *N. deliciosus.* Examination of their cotypes (U.S.N.M. No. 36531) has disclosed a complex comprising 55 specimens of *N. volucella* (recatalogued as No. 36531, lectoholotype, and No. 93516, lectoparatypes, of *N. v. nocomis*), only 7 of *N. amnis pinnosa* (paratypes No. 93514), and 2 "sleepers" each of *N. l. lutrensis* and *N. amabilis.* The specimens from San Marcos River at San Marcos, Texas (U.S.N.M. Nos. 36514 and 46219), which Jordan and Gilbert (1886: 22) also referred to *N. deliciosus* (with the statement that they do not differ evidently from specimens from the Des Moines River), were also catalogued as *N. nocomis.* They are reidentified *in toto* as *N. volucella nocomis* and are regarded as cotypes thereof (*N. a. pinnosa,* however, has recently been found in the San Marcos River). Those from Lampasas River at Belton, Texas (U.S.N.M. No. 36558), similarly reported by Jordan and Gilbert (1886: 19) as *N. deliciosus,* but catalogued originally as *N. nocomis,* are also referred to *N. volucella nocomis.* Jordan and Gilbert's description of the Comal River specimens definitely applies to the examples of *N. volucella,* which greatly predominated among their cotypes. Jordan (1891: 18) not long after recognized that Jordan and Gilbert had confounded 2 species. He qualified the one now identified as *N. amnis pinnosa* as "closely resembling *N. cayuga,*" which it does, superficially.

It seems that the name *Notropis nocomis* Jordan and Gilbert is nomenclatorially available in accordance with established rules and practices, since the description is recognizable in connection with the locality and general identification (see Opinion 52, International Commis-

sion on Zoological Nomenclature) and since it has generally been interpreted that the availability of a published name is not dependent on its acceptance by the original author. On the basis of this interpretation, the name *nocomis* is available for the southwestern creek subspecies of *N. volucella* that is represented by Jordan and Gilbert's specimens from the Comal, San Marcos, and Lampasas rivers in Texas. *N. v. nocomis* seems to range from the type locality (Comal River) and other streams in southeastern Texas northward to Missouri. It is one of several southwestern creek subspecies of *N. volucella,* none of which has been adequately defined in print. The status of the species and its northern subspecies has been treated by Hubbs and Raney (1947: 2–3), with references to previously published treatments.

The acceptance of the name *nocomis* as available under the date of 1886 and its application to a subspecies of *N. volucella* preclude its use for any other species. For this reason, *Notropis nocomis* Evermann (1892: 78–79) is regarded as an unavailable homonym. Under this name Evermann described and figured, as a "sp. nov.," another kind of *Notropis* that he regarded as indistinguishable from the species with which the same name was earlier associated by Jordan and Gilbert. Evermann's description and figure clearly apply to the form herein called *N. amnis pinnosa.* On re-examination, all cotypes from Trinity River at Magnolia Point, Texas, have been found to represent this species and subspecies. One of these cotypes, retaining the original catalogue number of the series (U.S.N.M. No. 45556), has been designated as the lectoholotype of *N. nocomis* Evermann (*nec* Jordan and Gilbert) and as the holotype of *N. amnis pinnosa* Hubbs and Bonham; the others (U.S.N.M. No. 93517) have been recatalogued as paratypes of the 2 nominal forms. The cotypes from San Marcos River at San Marcos, Texas (U.S.N.M. No. 58792) turned out to be *Dionda episcopa couchi* Girard, of which I collected 5 other specimens at the same locality on June 22, 1938. These misidentified cotypes were obviously not involved in Evermann's type description. The specimens referred to *N. nocomis* by Evermann, but not designated as types, have been reidentified as follows: the 1 from Buffalo Bayou at Houston, Texas (U.S.N.M. No. 69335) becomes a paratype of *N. amnis pinnosa;* of the 2 from Trinity River at Dallas, Texas, which Jordan and Gilbert collected in 1884, 1 is designated as *N. amnis pinnosa*

(U.S.N.M. No. 36475) and the other is an unidentified species of *Notropis.*

Soon after these complexities had been perpetrated, Jordan (1891: 17–18) initiated the confusion of *N. amnis* with "*N. cayuga*" by his qualification of Texas specimens (*N. a. pinnosa*) as "closely resembling *N. cayuga.*" Others followed this error, with the further confounding of *N. atrocaudalis* and "*N. cayuga*" (= *N. heterolepis*). Variously, these authors have reported *N. amnis* as *N. cayuga, N. cayuga atrocaudalis, N. heterolepis atrocaudalis, N. atrocaudalis,* and *N. heterolepis* (see synonymy). Currently, these 3 names are disposed as follows. *N. cayuga* Meek is a synonym of *N. bifrenata* (Cope), though most of the reports of *N. cayuga* were based on *N. heterolepis* Eigenmann and Eigenmann (Hubbs, 1926: 36, 40–41). *N. atrocaudalis* is obviously a full, valid species, confined so far as known to Texas, and differing from the northern *N. heterolepis* in having 7 instead of 8 anal rays, smaller hardly crescentic marks about the lateral line pores, bolder basicaudal spot, less conspicuous light band between the dark back and the lateral band, weaker margining of the scale pockets on the back, more oblique mouth, and in other respects. It differs further in habitat, for, according to Kirby H. Walker (personal communication), it occurs chiefly in the shallow, sandy, flowing sections of streams, rather than in the quiet weedy situations frequented by *heterolepis.* From other shiners with 4—4 teeth and 7 anal rays, *N. atrocaudalis* differs in numerous respects (Hubbs and Raney, 1947: 4–10).

Hubbs and Ortenburger (1929: 67) first suggested that a distinct species might be represented by the Mississippi River Basin minnow which had been confused with *cayuga, atrocaudalis,* and *heterolepis.* Along with all subsequent workers, however, they failed to appreciate that the same species had been described by Evermann as *N. nocomis.* On the basis of material collected on the Wisconsin fish survey, Hubbs and Greene confirmed the distinctiveness of this fish and, in manuscript, named it *N. amnis amnis.* This designation was used by Greene (1935: 96–97), but the brief characterization "pale, delicate minnow" does not satisfy the requirements of Article 25, Item *c* of the International Rules of Zoological Nomenclature.

The new species takes as its type description the following account

of the typical subspecies, *N. a. amnis.* The southern subspecies, to which the name *N. nocomis* was invalidly applied, is also described as new, under the designation *N. a. pinnosa* Hubbs and Bonham. The intergrades are separately treated.

ETYMOLOGY.—The name *amnis* (used as the genitive of *amnis,* river) refers to the habitat of the type subspecies; *pinnosa* is from *pinna,* fin, and the suffix *-osus,* signifying the quality of abundance. The feminine termination is used because it is obvious, from the wording of the original description, that the final term of the generic name *Notropis* was derived from τρόπις (feminine), keel. Similarly, I use the feminine termination for species of *Hybopsis,* since ὄψις is feminine, and the neuter ending for species of *Scaphirhynchus,* since ῥύγχος is neuter. There is no valid reason for perpetuating the misinterpretation by zoologists of the gender of Greek words.

NORTHERN PALLID SHINER

Notropis amnis amnis Hubbs and Greene

(Pl. I, Figs. 1–2; Map 1)

TYPE MATERIAL.—We (Hubbs and Greene) retain as the types of *Notropis amnis amnis,* and hence of the species as well, the material from the Mississippi River and adjacent waters in Wisconsin, Iowa, and Minnesota that we utilized in diagnosing the species and subspecies prior to the first use of the name. The holotype (U.M.M.Z. No. 75435), an adult 43 mm. in standard length, was seined by Leonard P. Schultz and Clarence M. Tarzwell on August 27, 1928, in a channel of the Mississippi River, 1 mile north of Prairie du Chien, Crawford County, Wisconsin. There are 71 paratypes from this collection, 25 to 45 mm. long (U.M.M.Z. No. 78246, 3 now in the Museum of Comparative Zoology, No. 36079).

Other paratypes, with U.M.M.Z. catalogue numbers—and, in parentheses, the number of specimens—bear the following data:

Minnesota.—No. 72004 (2), Minnesota River at Fort Snelling, A. H. Wiebe, August 17, 1926.

Wisconsin.—No. 72022 (1), St. Croix River above bridge at Prescott, A. H. Wiebe, August 19, 1926; No. 76634 (3), Wisconsin River at Blue River Bridge, Grant County, C. Willard Greene and Laurence

C. Stuart, August 4, 1927; No. 76797 (2), Mississippi River at Cassville, Grant County, Greene and Stuart, August 10, 1927; No. 77705 (8), slough of Black River 5 miles east of Galesville, border of La Crosse and Trempealeau counties, like all following Wisconsin series collected by Leonard P. Schultz and Clarence M. Tarzwell in August, 1928; No. 77959 (1), St. Croix River above Never's Dam, 10 miles above St. Croix Falls, Polk County; No. 78186 (30), slough of Mississippi River 2 miles north of Victory, Vernon County; No. 78222 (18; 2 now in United States National Museum, No. 117559), slough of Mississippi River 3 miles south of Lynxville, Crawford County; No. 78279 (11), Mississippi River at Glenhaven, Grant County; No. 78312 (11), Mississippi River 0.5 mile above Wisconsin Bridge, near Dubuque (Iowa), Grant County; No. 78361 (8), Sugar River 6 miles east of Juda, Green and Rock counties.

Iowa.—No. 100918 (2), mouth of side slough of Mississippi River about midway between Lansing and mouth of Upper Iowa River, Carl L. Hubbs, August 5, 1932; No. 100949 (4), Mississippi River, 2 miles below Lansing, Hubbs, August 5, 1932.

All available record stations for nontype material, as well as the type and paratype localities just listed, are plotted on Map 1.

RANGE, HABITAT, AND ABUNDANCE.—The typical subspecies of *Notropis amnis* occupies the northern part of the range of the species, where it is mainly confined to the Mississippi River and adjacent sloughs and stream mouths (as is outlined on pp. 8–9). In these waters it appears to be of rather general occurrence, though it is seldom very abundant. There are very few records for the medium-sized to small streams of Wisconsin, Illinois, and Indiana and none for such waters in Minnesota or Iowa (Map 1).

The status of the subspecies across Illinois and in northern Indiana and the pertinence of the literature records call for some consideration. Three specimens from Rock River, northwestern Illinois, collected at Oxbow Island on July 10, 1925, seem to be *N. a. amnis,* though they were once desiccated (pectoral ray counts, 13—13 in 2, 13—14 in 1). Specimens typical of *N. a. amnis* came from Sugar River, southern Wisconsin, in the Rock River system. An adult specimen from the Sangamon River, 2 miles west of Dewey, Illinois, collected August 17, 1928, presumably the single example from Cham-

paign County reported by Thompson and Hunt (1930: 24, 43, 98) variously as *Notropis cayuga, N. cayuga atrocaudalis,* and *N. heterolepis,* is particularly significant, for it came from deep within the state yet is fully typical of *N. a. amnis* in form, proportions, and pectoral ray count (12—13). It may therefore be assumed that other series from tributaries of the Illinois River, including Gerking's (1945: 62) from Iroquois River, Indiana, are referable to the typical subspecies.

Much doubt pertains to other published records from Illinois, particularly because of the confusion of *N. amnis* with the unnamed southern subspecies of *Notropis "cayuga"* (= *heterolepis*) having a complete lateral line. Under the heading *Notropis cayuga atrocaudalis* Forbes and Richardson (1909 and 2d ed., 1920: 134) reported: "ten collections of this minnow, containing thirteen specimens from the Illinois and adjacent waters, near Meredosia, and one from the main river at Havana. A specimen from Mackinaw creek in Woodford County, one from Anderson's branch, in Union county, and one from Little Fox River at Phillipstown may be referred with some uncertainty to this variety. Specimens taken at Greenway, Arkansas, by Dr. Meek, are, without much question, identical with the form here described." The Arkansas specimens are *Notropis amnis,* but I think that most if not all the Illinois records pertain to the southern subspecies of *N. heterolepis.* It is clear from the record of the number of collections of typical *cayuga* and from the assigned localities, that Forbes and Richardson included on their map for *N. cayuga* their 5 localities for *N. cayuga atrocaudalis,* misplacing the dot for the "Little Fox River at Phillipstown." An examination of all the "*Notropis cayuga*" specimens extant in the collection of the Illinois Natural History Survey discloses that the remaining collections of the 5 attributed to *N. c. atrocaudalis,* namely series from Meredosia and 1 specimen from Kappa (on Mackinaw River, on the border of Woodford County), represent the southern form of *N. heterolepis,* as do also collections that represent mapped records of "*N. cayuga*" from Pecunsagen Creek north of Utica, Sugar Creek at Milford, and Sangamon River at Mahomet. Unless contrary evidence is forthcoming, none of the specimens treated by Forbes and Richardson as *N. cayuga atrocaudalis* can be referred to *N. amnis* and the entire account, in-

cluding the description, may be referred to the southern subspecies of *Notropis heterolepis.* I find no basis for O'Donnell's (1935: 482) statement that "*Hybopsis atrocaudalis*" is "found in small numbers in the Kaskaskia" and no evidence, other than the single specimen from Sangamon River mentioned above, that *N. amnis* occurs in "the streams of Champaign county."

In a broad band south of Iowa, Illinois, and northern Indiana all series examined appear to be intergrades (pp. 26–27), with the exception of a single specimen collected long ago at St. Louis, Missouri, by Louis Agassiz. This specimen, a mature female, was found in a series of *Hybognathus nuchalis* at the Museum of Comparative Zoology (M.C.Z. No. 1904) and was the basis for the inclusion of St. Louis in the range of "*Hybopsis nocomis*" by Jordan (1929: 78). It appears, from the notes I made in 1928, to be typical of *N. a. amnis,* as would be expected. It is a mature female with the body deeper (depth 4.0 in standard length), the back more elevated, and the snout sharper than in *N. a. pinnosa;* the dorsal fin begins over the pelvic insertion, nearer the caudal base than the tip of the snout; dorsal rays, 8; anal rays 8; teeth 1, 4—4, 1.

The available records indicate that this subspecies, like the intergrades and *N. a. pinnosa,* occupies a wide variety of ecological conditions, as is outlined for the species on pages 9–10. It probably occurs most frequently in moderately turbid water, with or without vegetation, on mud or sand bottom—for such conditions prevail along the main river.

SOUTHWESTERN PALLID SHINER

Notropis amnis pinnosa Hubbs and Bonham, new subspecies

(Pl. I, Figs. 3–5; Map 1)

TYPE MATERIAL.—We (Hubbs and Bonham) designate as the holotype of *N. a. pinnosa* a specimen 45 mm. in standard length, U.S.N.M. No. 45556, discussed on page 11, along with paratypes first reported by Jordan and Gilbert and by Evermann. Other paratypes, all from Texas, are deposited in the University of Michigan Museum of Zoology and in the collections of the Agricultural and Mechanical College of Texas and the University of Texas. They came from localities represented by black dots on Map 1.

RANGE, HABITAT, AND ABUNDANCE.—*N. a. pinnosa* seems to be restricted to eastern Texas, where it is often rather common in small to medium-sized streams; to the tributaries of the Red River in eastern Oklahoma, where it is rare; and to the Arkansas River system in the region of the Poteau River in Arkansas and Oklahoma (Map 1). These records suggest that the range of *pinnosa,* like that of the intergrades, may be disrupted into several areas, or at least into regions of marked differences in abundance. Because of their high silt loads, the lower Red and Arkansas rivers, like the Mississippi below the confluence with the Missouri (p. 9), may serve as a distributional barrier. Since the St. Francis Basin and the lower and middle parts of the White River basin are occupied by intergrades, it is possible that the Arkansas River population of *N. a. pinnosa* is separated from the main part of the range of the subspecies, much as the Red River population of *Ceratichthys v. vigilax* is broken off by the southward extension of the range of the northern subspecies (*perspicuus*) in the lower waters. We should not, however, overlook the fact that very little field work has been done on the fishes of the lower parts of the Arkansas, Red, and Mississippi rivers, or on those of the streams between the Mississippi and the Trinity rivers; that is, in the region from which there are no records of *N. amnis.*

The account of the habitat of the species (pp. 9–10) was largely compiled from field records for this subspecies.

NOMENCLATURE.—The complicated nomenclature of this subspecies is reviewed in the analytical synonymy, with pertinent matter indicated by the superscript P, and is discussed on pages 10–14.

DIAGNOSIS AND SUBSPECIES COMPARISON.—*Notropis amnis pinnosa* checks with the specific diagnosis (p. 4) in all items and agrees more or less well with *N. a. amnis* in other characters. Points of agreement as well as discrepancy, both significant, are brought out in the following comparison and in the tables of counts and measurements.

After the subspecies had been separated on the basis of appearance and measurements, it was discovered that a moderately sharp separation could be made on the basis of the number of pectoral rays (with practice, these rays may be counted with precision under a binocular dissecting microscope, by using good illumination with moderately high magnification). The pectoral rays number 10 to 13 in 84 per

cent of the specimens of *N. a. amnis* counted; 14 to 16 in 77 per cent of the *N. a. pinnosa* counts (Tables I and II). Thus, the 75 per cent separability now conventionally adopted for subspecies recognition is exceeded on this one criterion. The differentiation is sharper than

TABLE I

FIN RAY COUNTS IN SUBSPECIES AND INTERGRADES OF NOTROPIS AMNIS

Principal rays are counted in the dorsal, anal, and caudal fins; all rays, including smallest rudiments, in the paired fins. In the dorsal and anal fins the last 2 elements are enumerated as 1 ray. Paired fins were counted and separately tabulated for both sides.

	Dorsal Rays				
	7	8	9	N	M ± SE
N. a. amnis	..	157	2	159	8.01 ± .01
Intergrades	3	108	3	114	8.00 ± .02
N. a. pinnosa	1	108	2	111	8.01 ± .02

	Anal Rays				
	7	8	9	N	M ± SE
N. a. amnis	3	151	4	158	8.01 ± .02
Intergrades	16	95	3	114	7.89 ± .04
N. a. pinnosa	12	118	1	131	7.92 ± .03

	Caudal Rays								
	15	16	17	18	19	20	21	N	M ± SE
N. a. amnis	..	..	1	4	94	8	2	109	19.05 ± .04
Intergrades	..	..	..	2	104	2	..	108	19.00 ± .02
N. a. pinnosa	1	..	1	4	95	..	..	101	18.90 ± .05

	Pelvic Rays							
	4	5	6	7	8	9	N	M ± SE
N. a. amnis	..	..	..	16	231	13	260	7.99 ± .02
Intergrades	1	..	..	11	209	7	228	7.96 ± .03
N. a. pinnosa	..	..	..	1	188	10	199	8.05 ± .02

	Pectoral Rays								
	10	11	12	13	14	15	16	N	M ± SE
N. a. amnis	2	12	67	168	45	3	1	298	12.86 ± .05
Intergrades	..	..	8	117	93	9	..	227	13.45 ± .04
N. a. pinnosa	..	1	5	42	146	15	..	209	13.81 ± .04

TABLE II

PERCENTAGE OF SPECIMENS SEPARABLE (OR IDENTIFIABLE) ON BASIS OF PECTORAL RAY COUNTS

Data from Table I.

	Pectoral Rays	
	10–13	14–16
Notropis amnis amnis	84	16
Intergrades	55	45
Notropis amnis pinnosa	23	77

TABLE III

REGIONAL VARIATION IN THE NUMBER OF PECTORAL RAYS IN NOTROPIS AMNIS

	Number of Pectoral Rays								
	10	11	12	13	14	15	16	N	M±SE
N. a. amnis									
Upper Mississippi	2	12	67	168	45	3	1	298	12.86±.05
Intergrades									
Southern Indiana	..	..	..	3	1	2	..	6	13.8?
Cumberland River	..	..	..	17	9	..	..	26	13.35±.09
Kentucky	..	..	..	...	..	2	..	2	15.0?
Missouri									
Salt R. system	..	..	7	61	38	..	..	106	13.29±.06
Bourbeuse R.	..	..	..	1	3	..	..	4	13.75?
St. Francis Basin	..	..	1	22	32	5	..	60	13.68±.08
White R. system, Ark.	..	..	..	13	10	..	..	23	13.43±.10
N. a. pinnosa									
Poteau R. system	..	..	..	13	52	2	..	67	13.84±.05
Red R. system, Okla.	..	..	..	2	15	3	..	20	14.05±.11
Texas	..	1	5	27	79	10	..	122	13.75±.06

the figures indicate, for in *N. a. amnis* most of the fins with 14 rays had the lowermost ray extremely small, or were matched on the opposite side of the fish with a 13-rayed fin, whereas in *N. a. pinnosa* most of the 13-rayed fins had the lowest ray larger than usual, or were matched on the other side by a 14-rayed fin.

A main distinction, involving some overlap, is the relative shortening of the anterior parts and the elongation of the posterior regions in *N. a. pinnosa.* The differences show up in the figures (Plate I) and in the ranges and means for the appropriate measurements (Table IV),

TABLE IV

MEASUREMENTS AND SCALE COUNTS OF NOTROPIS AMNIS

The methods used are those proposed by Hubbs and Lagler (1941 or 1947). The measurements are expressed in thousandths of the standard length. The specimens of *N. a. amnis* are from the Mississippi River in Wisconsin and Iowa; 1 intergrade came from Wolf River, Tennessee; the 2 to 4 others, from the White River system, Arkansas; the *pinnosa* specimens are, respectively, from the Poteau River system in Arkansas and Oklahoma and from eastern Texas. The measurements and counts were made by Kelshaw Bonham, collaborating with the author.

Measurement or Count	Subspecies	Number	Minimum	Maximum	Mean
Standard length, mm.	*N. a. amnis*	14	30	44	38.8
	Intergrades	5	40	47	43.8
	Poteau (*pinnosa*)	5	43	47	44.8
	Texas (*pinnosa*)	23	34	55	44.1
Predorsal length	*N. a. amnis*	14	489	515	504
	Intergrades	5	487	511	498
	Poteau (*pinnosa*)	5	487	502	495
	Texas (*pinnosa*)	23	472	503	489
Prepelvic length	*N. a. amnis*	5	493	514	504
	Intergrades	3	491	499	496
	Poteau (*pinnosa*)	5	472	501	485
	Texas (*pinnosa*)	12	467	515	488
Body depth	*N. a. amnis*	5	200	240	221
	Intergrades	3	203	229	217
	Poteau (*pinnosa*)	5	195	227	214
	Texas (*pinnosa*)	12	199	280	234
Body width	*N. a. amnis*	5	132	141	137
	Intergrades	3	132	136	134
	Poteau (*pinnosa*)	5	129	138	134
	Texas (*pinnosa*)	12	125	163	146
Caudal peduncle depth	*N. a. amnis*	5	105	112	108
	Intergrades	3	106	114	109
	Poteau (*pinnosa*)	5	92	115	102
	Texas (*pinnosa*)	12	92	121	107
Caudal peduncle length	*N. a. amnis*	5	217	232	225
	Intergrades	3	210	240	223
	Poteau (*pinnosa*)	5	219	252	237
	Texas (*pinnosa*)	12	225	245	234.5
Head length	*N. a. amnis*	5	262	283	274
	Intergrades	3	273	280	277
	Poteau (*pinnosa*)	5	254	265	260
	Texas (*pinnosa*)	12	257	279	264
Head depth	*N. a. amnis*	5	165	172	168
	Intergrades	3	165	169	167
	Poteau (*pinnosa*)	5	155	163	159
	Texas (*pinnosa*)	12	152	184	167

TABLE IV (*Cont.*)

Measurement or Count	Subspecies	Number	Minimum	Maximum	Mean
Snout length	*N. a. amnis*	5	77	86	82
	Intergrades	3	81	86	83
	Poteau (*pinnosa*)	5	79	89	85
	Texas (*pinnosa*)	12	82	93	87
Eye length	*N. a. amnis*	14	78	87	83
	Intergrades	5	81	91	84
	Poteau (*pinnosa*)	5	71	75	73
	Texas (*pinnosa*)	23	66	81	74
Interorbital width	*N. a. amnis*	5	78	93	86
	Intergrades	3	83	87	86
	Poteau (*pinnosa*)	5	80	109	91
	Texas (*pinnosa*)	12	82	94	87
Upper jaw length	*N. a. amnis*	13	65	74	70
	Intergrades	5	61	78	68
	Poteau (*pinnosa*)	5	67	73	70
	Texas (*pinnosa*)	23	63	74	68
Gape width (between corners)	*N. a. amnis*	4	53	61	58.5
	Intergrades	3	58	61	59
	Poteau (*pinnosa*)	5	51	64	58
	Texas (*pinnosa*)	12	53	71	61
Dorsal origin to lateral line	*N. a. amnis*	5	112	143	131
	Intergrades	3	119	137	125
	Poteau (*pinnosa*)	4	119	123	121
	Texas (*pinnosa*)	12	118	151	136
Pelvic insertion to lateral line	*N. a. amnis*	5	97	103	100
	Intergrades	3	87	108	95
	Poteau (*pinnosa*)	4	96	102	100
	Texas (*pinnosa*)	12	91	136	111
Dorsal height	*N. a. amnis*	14	260	307	276
	Intergrades	5	265	280	273
	Poteau (*pinnosa*)	5	244	277	261
	Texas (*pinnosa*)	23	231	299	269
Anal height	*N. a. amnis*	5	208	218	213
	Intergrades	3	209	222	215
	Poteau (*pinnosa*)	5	190	217	205
	Texas (*pinnosa*)	12	180	238	211
Anal base	*N. a. amnis*	5	95	116	106
	Intergrades	3	104	111	107
	Poteau (*pinnosa*)	5	98	115	104
	Texas (*pinnosa*)	12	93	115	104
Caudal, longest ray	*N. a. amnis*	5	283	315	301
	Intergrades	3	303	316	308
	Poteau (*pinnosa*)	5	263	320	293
	Texas (*pinnosa*)	12	255	333	292

TABLE IV (*Cont.*)

Measurement or Count	Subspecies	Number	Minimum	Maximum	Mean
Pectoral length	*N. a. amnis*	5	203	215	209
	Intergrades	3	200	211	205
	Poteau (*pinnosa*)	5	168	212	195
	Texas (*pinnosa*)	12	177	221	193
Pelvic length	*N. a. amnis*	5	182	194	188
	Intergrades	3	185	200	190
	Poteau (*pinnosa*)	5	174	194	184
	Texas (*pinnosa*)	12	162	207	183
Scales above lateral line	*N. a. amnis*	5	4	5	4.8
	Intergrades	3	5	5	5.0
	Poteau (*pinnosa*)	5	5	5	5.0
	Texas (*pinnosa*)	12	5	5	5.0
Scales along lateral line	*N. a. amnis*	5	35	36	35.2
	Intergrades	3	34	36	35.3
	Poteau (*pinnosa*)	5	35	37	35.6
	Texas (*pinnosa*)	12	34	36	35.1
Scales below lateral line	*N. a. amnis*	5	3	4	3.8
	Intergrades	3	4	4	4.0
	Poteau (*pinnosa*)	5	3	4	3.8
	Texas (*pinnosa*)	12	4	5	4.25
Scales, pelvic to lateral line	*N. a. amnis*	5	3	4	3.6
	Intergrades	2	4	4	4.0
	Poteau (*pinnosa*)	5	3	4	3.8
	Texas (*pinnosa*)	12	3	5	3.75
Predorsal scales, midline	*N. a. amnis*	5	13	16	14.6
	Intergrades	2	13	19	16.0
	Poteau (*pinnosa*)	5	18	22	19.6
	Texas (*pinnosa*)	12	14	19	15.8
Predorsal scale rows	*N. a. amnis*	5	12	14	13.2
	Intergrades	2	11	14	12.5
	Poteau (*pinnosa*)	5	13	14	13.4
	Texas (*pinnosa*)	12	13	14	13.25
Scales around greatest depth	*N. a. amnis*	5	22	26	24.0
	Intergrades	3	24	26	24.7
	Poteau (*pinnosa*)	5	23	26	24.4
	Texas (*pinnosa*)	12	23	26	25.2
Scales around caudal peduncle	*N. a. amnis*	5	12	12	12.0
	Intergrades	3	12	12	12.0
	Poteau (*pinnosa*)	5	12	12	12.0
	Texas (*pinnosa*)	12	12	13	12.2

though some overlap is perhaps due to age and sex differences that are not separately analyzed and to incomplete precision in measuring. We note for *N. a. pinnosa* lower values for the predorsal, prepelvic, and head lengths and compensatingly higher values for the length of the caudal peduncle. A simple determination of the difference is made by stepping forward the distance from the caudal base (point of bending) to the extreme dorsal origin. In *N. a. pinnosa* the measurement extends to a point about one length of the eye in advance of the tip of the snout, varying from half the eye diameter (rarely less than that amount) to about twice the eye length. In *N. a. amnis* the point of the dividers in this measurement usually lies about one-fourth the eye length in advance of the snout, but may lie at any point from slightly behind the snout tip to nearly an eye's diameter before the snout. A point about 0.6 eye length in advance of the snout separates the measurements of about 80 per cent of the specimens of each subspecies. To some extent this measurement of the dorsal fin position also reflects the subspecific difference in the size of the eye.

In *N. a. pinnosa* the eye is usually less enlarged than in *N. a. amnis.* There is only a moderate overlap in the proportional measurements (Table IV). When stepped into the head length, the corneal length usually measures 3.4 to 4.0 times in the head, rather than 3.1 to 3.6 times. Perhaps in compensation, the snout averages the longer in *N. a. pinnosa* (Table IV). Furthermore, the snout in the southern subspecies is usually more gibbous and the head, consequently, is less pointed and less conical. Because of the smaller eye and often a longer upper jaw (not reflected by the measurements in Table IV), the upper jaw is usually a little longer than the eye in *N. a. pinnosa,* but is much shorter in *N. a. amnis.* Stepped into the head length, the upper jaw measures 3.5 to 4.3 times in *N. a. pinnosa;* 3.8 to 4.6 times in *N. a. amnis.*

Another average difference not brought out in Table IV is the body depth. Some of the specimens of *N. a. pinnosa* measured for this table came from populations with the body relatively deep, often as deep as in *N. a. amnis,* but more typically the southern form is the slenderer. In adults the depth in *N. a. pinnosa* usually enters the standard length 4.3 to 5.0 times; in *N. a. amnis,* 4.1 to 4.7 times.

In general the pigmentation in *N. a. pinnosa* is moderately well developed, but in *N. a. amnis* it is much reduced and concealed. This distinction no doubt reflects in large part the turbidity of the water, but in small part may be inherent.

There are also differences in general body form (Pl. I). *N. a. pinnosa* is typically more terete, for the body retains greater width in the mid-sections and posteriorly, is flatter across the back, and is less elevated at the dorsal origin (in the deeper specimens of *pinnosa* the body is usually deep and pudgy throughout, not markedly compressed toward the dorsal and caudal fins, and the dorsal contour is not sharply elevated at the front of the dorsal).

There is also an average difference in size that may be genetic. Some adults of *N. a. pinnosa* reach 55 mm. in standard length and many exceed 45 mm., which is the maximum known size of *N. a. amnis,* except in 1 lake collection, containing fish as long as 50 mm. (Diagnosis by Hubbs and Bonham.)

VARIATION.—Within *N. a. pinnosa,* even after the elimination of the more *pinnosa*-like intergrades, there is considerable local variation. Some populations approach *N. a. amnis* in 1 or a few characters, such as the depth of the body, the size of the eye, or even the number of pectoral rays. Included in the subspecies are some pool-and-riffle creek ecotypes with the fins unusually short and rounded (as is indicated by the low minimum and the low average proportions given in Table IV); elsewhere, the fins are unusually large and pointed. There is likewise much variation in the intensity of pigmentation. The specimens shown in Figures 3 and 5 on Plate I show differences in this respect, though the lighter one is by no means as pale as some examples of the subspecies. These 2 specimens differ also in one pattern feature, for in the lighter one (Fig. 3) the black specks along the anterior lateral line pores are more conspicuous than the dark streak on the trunk, whereas in the darker one (Fig. 5), the reverse is true.

The Red River and Arkansas River populations have apparently even higher average numbers of pectoral rays than those from Texas. In the forward position of the dorsal fin 3 specimens from Bachman's Lake, Dallas, Texas, are definitely extreme. Despite such local variations, a consideration of all characters suffices to identify each adequate series.

INTERGRADES

Notropis amnis: amnis × pinnosa

Between the ranges of the northern and the southwestern subspecies (Map 1) there are a number of more or less completely isolated populations of *Notropis amnis,* which, because of their intermediate or mixed characters, are treated as subspecific intergrades. The intermediacy is particularly well indicated by the pectoral ray counts, the single significant meristic character (Tables I–III). In form and proportions they are variably intermediate.

As their more or less complete and wide isolation would lead us to expect, the intergrade populations are not uniform. Of the 3 available specimens from southwestern Indiana the 1 from the Great Pigeon River has 13 pectoral rays on one side, as in *N. a. amnis,* and 14 on the other, as in *N. a. pinnosa,* and is apparently intermediate in other characters, and the 2 from Lick Creek, 2 miles east of West Baden, Orange County, are typical of *N. a. amnis* in form and general appearance, but 1 has 15 pectoral rays on each side (a high count even for *N. a. pinnosa*) and the other has 13 rays in each fin, as is usual for *N. a. amnis.* The Cumberland River population approaches *N. a. amnis* in the pectoral ray count, but in form and proportions is rather nearer *N. a. pinnosa.* The single individual from Kentucky (collected by Clarence M. Tarzwell and Henry H. Howell on October 18, 1942, in East Fork of Clark River, near the mouth of Tennessee River) would certainly have been referred to *N. a. pinnosa* had it come from the southwest, and may in fact represent a local stock inseparable from that subspecies; on geographical grounds it is provisionally retained in the intergrades. The series from Salt River in northeastern Missouri is closer to *N. a. amnis* than to *N. a. pinnosa* in pectoral ray number and is just intermediate in the position of the dorsal fin: when measured forward the distance from the caudal base to the dorsal origin usually extends to a point in front of the snout tip about 0.5 to 0.6 the eye length. The 2 specimens from the Bourbeuse River and the collections from the St. Francis Basin, from central-eastern and southeastern Missouri, respectively, are closer to *N. a. pinnosa* in pectoral ray counts, but somewhat nearer *N. a. amnis* in the position of the dorsal fin: the point just discussed is usually about 0.3 to 0.5 the eye

length in advance of the tip of the snout. The White River specimens, from northeastern Arkansas, seem to be approximately intermediate in both characters.

The intermediate characters of these series from areas intervening between their respective ranges demand subspecific rather than specific status for the 2 forms here referred to *Notropis amnis*.

SUMMARY

Notropis amnis, new species, has been named, but never validly proposed. An outstanding character is the concealment beneath the preorbital of the relatively long and nearly fleshless end of the maxillary. The nuptial tubercles are strong. The synonymy is complicated. The name *N. nocomis* Evermann was based on the same species, but is reregarded as a homonym of *N. volucella nocomis* Jordan and Gilbert. The immediate relationships of *N. amnis* are not apparent. It is not closely related to *N. volucella*, *N. deliciosa*, *N. heterolepis*, or *N. atrocaudalis*, the species with which it has been confused. These forms are compared. *N. atrocaudalis* is a distinct species, confined to Texas. *N. amnis* ranges from Minnesota to the Gulf, chiefly in the main rivers in the north and in smaller streams in the southwest. The range trends northeastward from Texas. Wide ecological tolerance is shown,

TABLE V

SUMMARY OF MAIN SUBSPECIES DIFFERENCES IN NOTROPIS AMNIS

The distinctions are more fully outlined in the text (pp. 18–25) and are detailed in Tables I to IV.

Characters	Subspecies	
	N. a. amnis	*N. a. pinnosa*
Pectoral rays, including rudiments, typically	13 or fewer	14 or more
Distance from caudal base to dorsal origin usually extends to a point before tip of snout	Less than 0.6 eye length	More than 0.6 eye length
Eye length in head, usually	3.1 to 3.6	3.4 to 4.0
Depth of body in standard length, in adults, usually	4.1 to 4.7	4.3 to 5.0
Pigmentation typically	Very pallid	Moderate
Maximum known size (standard length)	45 mm. (50 mm. in 1 lake)	55 mm.

but excessive turbidity seems to be a barrier. On the basis of characters outlined in Table V the species is divided into the nominate northern form and a southwestern subspecies, *N. a. pinnosa* (new), with intergrades in more or less isolated intervening areas. The distributional and speciational patterns are much like those of *Ceratichthys vigilax.*

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PLATE I

Notropis amnis, new species, with 2 new subspecies. Photographs by Kelshaw Bonham.

FIG. 1. *N. a. amnis:* holotype, 43 mm. in standard length, from Mississippi River, Crawford County, Wisconsin.

FIG. 2. *N. a. amnis:* dorsal view of adult paratype from slough of Mississippi River, Crawford County, Wisconsin (in series U.M.M.Z. No. 78222).

FIG. 3. *N. a. pinnosa:* adult paratype, 54 mm. long, from San Jacinto River, Harris County, Texas, collected by Kelshaw Bonham, Leonard D. Lamb, and party on October 13, 1940.

FIG. 4. *N. a. pinnosa:* dorsal view of mature male paratype from San Bernard River, between Austin and Wharton counties, Texas, collected by Kelshaw Bonham and A. Halloran on May 12, 1940.

FIG. 5. *N. a. pinnosa:* anterior half of adult paratype from Winter's Bayou, San Jacinto County, Texas, collected by Leonard D. Lamb on June 6, 1940.

PLATE I