

NOTROPIS ASPERIFRONS, A NEW CYPRINID FISH FROM
THE MOBILE BAY DRAINAGE OF ALABAMA AND
GEORGIA, WITH STUDIES OF RELATED SPECIES

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Nine small species of *Notropis* which possess 2, 4—4, 2 teeth, 7 or 8 anal rays, a dark lateral band on the side of the body (*hypsilepis* excepted) and, for most, a prominent basicaudal spot, are found in the eastern Gulf of Mexico drainages from the Apalachicola Bay drainage of Florida and Georgia to the Mobile Bay drainage of Alabama and Mississippi. Although most are common forms and some are used as bait fishes, their systematic status has been confused. Characters which differentiate the lowland forms, *N. roseus* and *N. petersoni*, and *N. chalybaeus*, and a definition of *N. xaenocephalus*, have recently been given by Bailey, Winn and Smith (1954). Two other forms, *N. baileyi* and *N. hypsilepis*, have been described and their relationships with *N. lutipinnis* and *N. chrosomus* elucidated by Suttkus and Raney (1955 a and b). This study describes a new species, gives comparative data for *Notropis xaenocephalus*, *roseus*, *petersoni*, and to a lesser extent for *chalybaeus*, and offers a key for the identification of the forms mentioned above.

Robert H. Gibbs and Philip P. Caswell, Cornell students, collected many of the types and comparative material housed in the Cornell University fish collection. Many of the specimens from the Black Warrior River system were obtained through Ralph L. Chermock, University of Alabama, and were collected by Bancroft Cooper, Herbert D. Gibson, G. Hollis, T. Taylor, and Barry D. Valentine. Charles D. Hancock assisted the senior author in obtaining the specimens collected in Wilcox County, Alabama, now housed at Tulane University. Helen J. Illick has made available the counts for the cephalic lateral line pores from her unpublished studies. Ernest A. Lachner of the U. S. National Museum, assisted us during our examination of type specimens and critically reviewed the manuscript, as did Reeve M. Bailey and Carl L. Hubbs. We are deeply indebted to all of the above for their assistance. Counts and measurements were taken as detailed in Hubbs and Lagler (1947: 8-15).

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NOTROPIS ASPERIFRONS, sp. nov.

Figs. 1 and 2, Map 1

Notropis xanocephalus.—Gilbert, 1891: 154 and 157 (a complex of *N. roseus*, North R., Tuscaloosa, Ala. and *N. asperifrons*, Mulberry Fork, Blount Springs and Eight Mile Cr., Cullman, Ala.).

The type material consists of 91 specimens, 28 to 60 mm in standard length, which were seined from 12 localities in the Alabama River system. Additional material examined includes 69 specimens, 22-55 mm in standard length, taken from nine localities in the Black Warrior River system. Below, in parentheses, are indicated the numbers of specimens followed by the range of standard lengths in millimeters. In addition to standard abbreviations for states and compass directions, with the following "of" deleted, these abbreviations are used: Co. = County, Cr. = Creek, Hwy. = Highway, mi. = mile or miles, R. = River, trib. = tributary (of), coll. = collected, CU. = Cornell University fish collection, TU = Tulane University fish collection, USNM = United States National Museum.

Material.—Holotype, CU 28262, an adult female 50 mm in standard length, captured in the Alabama R. system in Holly Cr. at Ramhurst, 8 mi. N. Murray Co. line on U. S. Hwy. 411, Murray Co., Georgia, on June 12, 1952, by Robert H. Gibbs and Philip P. Caswell. Seven paratypes, CU 28263 (35-52), bear the same data as the holotype.

Other paratypes, listed below, are from the Mobile Bay drainage. Alabama: CU 28261 (1, 40), trib. Terrapin Cr., approximately 4 mi. N.E. Piedmont on Ala. Hwy. 74 at the Cherokee-Calhoun county line, June 14, 1952; CU 28260 (3, 38-58), Cheaha Cr., trib. Choccolocco R., 3.3 mi. S.W. Munford on U. S. Hwy. 21, Talladega Co., June 14, 1952; TU 4251 (28, 31-42), trib. Waxahatchee Cr., a trib. Coosa R., 4.7 mi. S.W. Columbiana on Ala. Hwy. 25, Shelby Co., June 15, 1952, and Wilcox Co., June 3, 1951: TU 3426 (8, 30-35), Pursley Cr., trib. Alabama R., 3.4 mi. S.W. Camden on Ala. Hwy. 11; TU 2974 (22, 28-36), Gravel Cr., trib. Pursley Cr., 6.3 mi. S. Camden on Hwy. 11; TU 3063 (5, 37-41), trib. Pursley Cr., 1.8 mi. E. Camden on Ala. Hwy. 10; UMMZ 111122 (2, 37-39), between Waverly and Opelika or between Waverly and Lafayette, September 13, 1930; UMMZ 111125 (7, 25-51), Sougahatchee Cr. (Loachapoka Cr.), October 24, 1930; UMMZ 162594 (2, 49-60), Sougahatchee Cr., 4 mi. N. Auburn, Lee Co., October 9, 1940. Georgia: USNM 164968 (1, 45.5) and 164969 (1, 47.9), Etowah R. (probably trib.), Rome by D. S. Jordan; UMMZ 139104 (3, 44-51), trib. Conasauga R., 7.3 mi. S. Dalton, U. S. Hwy. 41, Whitfield Co., August 7, 1936.

Other material examined from the Black Warrior River system, Tuscaloosa Co., Alabama is as follows: CU 19268 (2, 42-44), lower Cottondale Cr. near Hurricane Cr., approximately 2 mi. N. Cottondale, October 9, 1950; CU 28259 (10, 25-43), trib. North R., 1 mi. S.E. Sterling and 5 mi. S.E. New Lexington, June 23, 1951; CU 28258 (9, 30-41), Puro Cr., trib. North R., 4 mi. E. New Lexington, June

23, 1951; CU 28257 (6, 35-44), Blue Cr., trib. Black Warrior R., 25 mi. N.E. Tuscaloosa on Ala. Hwy. 63, March 3, 1951 and from the same locality, CU 28256 (16, 22-44), March 9, 1951; USNM 43474 (8, 33-42), Mulberry R., Blount Springs, coll. by P. H. Kirsch in 1889; USNM 36672 (11, 32-38), Eight Mile Cr., Cullman, coll. by Gilbert and Swain in 1884; UMMZ 88852 (6, 42-55), Blount Springs Cr., Blount Co., September 19, 1929; UMMZ 158285 (1, 39), trib. Locust Fork (flowing W.), 3 mi. N.N.E. Oneonta, Hwy. 32, Blount Co., September 5, 1939.

Diagnosis.—A small species of *Notropis* with 2, 4—4, 2 teeth and 7 anal rays as the typical counts. Other fin rays are: dorsal 8, pectoral 13 or 14, occasionally 12; pelvic 8, occasionally 9; caudal 19. Lateral line on body complete. Anterior lateral line scales, especially the second and third, elevated. Scale counts (typical): predorsal rows 14 or 15; above lateral line to dorsal origin 5; below lateral line to anal origin 3 or 4; in lateral line 36, occasionally 37; around body before dorsal fin 19 to 21; around caudal peduncle 12. Body elongate, wide and slightly compressed. Dorsal and ventral body contours only slightly elevated; caudal peduncle elongate. Head subtriangular as viewed from above and laterally; snout blunt. Mouth inferior. Jaw moderately inclined, rising anteriorly to the lower level of pupil. Dorsal origin slightly behind pelvic origin. Strong but narrow dark lateral band, not reduced on snout; dark chevrons present above and below the anterior lateral line pores. Prominent basicaudal spot continuous with and wider than lateral band on caudal peduncle. Temporal canal outlined by dark line. Mid-dorsal streak before dorsal fin obsolescent; streak behind dorsal lacking or developed only under the posterior base of the dorsal fin. Fins all relatively small. Size small, to 60 mm standard length. Allied to *Notropis xanocephalus*, *hypsilepis*, *roseus* and *petersoni*. *Notropis asperifrons* is the undescribed form alluded to in the paper by Suttkus and Raney (1955b), under *Relationships*.

Description

Some fin and scale counts are included in Table 1 and measurements are given in Table 2. The count of the holotype is the modal count for a given character unless italicized in Table 1 or in the Diagnosis. Many characters are also indicated in Figures 1 and 2. Other descriptive data follow. The body is more elongate than in related species; it is relatively wide and rather sharply compressed. The dorsum is only slightly elevated; the contour is an almost straight line both before and behind the dorsal origin. The ventral contour is only slightly less elevated. The caudal peduncle is long and relatively thin.

The anterior lateral line scales, especially scales two and three, are somewhat more elevated than the others in the lateral line or elsewhere. In this character it is more extreme than *hypsilepis*.

When viewed laterally the head is a rather sharp triangle although the tip of the snout is bluntly rounded. The mouth is inferior; the

TABLE 1.

SCALE AND FIN RAY COUNTS IN FIVE SPECIES OF *Notropis*. THE COUNT FOR THE HOLOTYPE OF *N. asperifrons* IS THE MODAL COUNT EXCEPT FOR THOSE IN ITALICS.

Species	Anal Rays		Pectoral Rays					Predorsal Scale Rows														
	7	8	12	13	14	15	16	13	14	15	16	17										
<i>hypsilepis</i> <i>asperifrons</i> <i>xanocephalus</i> <i>roseus</i> <i>petersoni</i>	47	—	—	3	12	6	1	—	—	8	2	1										
	38	2	2	8	10	—	—	1	4	5	—	—										
	148	9	—	—	10	10	—	—	2	7	1	—										
	25	1	2	3	11	2	2	—	2	6	2	—										
	191	7	—	15	5	—	—	—	1	5	2	2										
Species	Lateral Line Scales					Total Circumferential Scales																
	34	35	36	37	38	19	20	21	22	23	24	25	26	27	28	29	30	31				
<i>hypsilepis</i> <i>asperifrons</i> <i>xanocephalus</i> <i>roseus</i> <i>petersoni</i>	—	10	9	—	—	—	—	1	7	5	3	2	1	—	—	—	—	—				
	—	—	8	2	—	3	4	3	—	—	—	—	—	—	—	—	—	—				
	1	1	23	4	—	—	—	1	15	11	4	—	1	—	—	—	—	—				
	—	1	6	1	1	—	—	—	—	1	7	7	11	2	—	—	—	1				
	3	7	—	—	—	—	—	—	—	—	3	1	6	—	—	—	—	—				
Species	Above Lateral Line						Circumferential Scales												Below Lateral Line			
	8	9	10	11	12	13	14	15	8	9	10	11	12	13	14							
<i>hypsilepis</i> <i>asperifrons</i> <i>xanocephalus</i> <i>roseus</i> <i>petersoni</i>	—	—	1	16	2	—	—	—	—	8	5	4	2	—	—							
	1	6	2	1	—	—	—	—	4	5	1	—	—	—	—							
	—	—	1	26	3	1	—	—	1	26	8	6	—	—	—							
	—	—	—	13	4	11	—	1	—	—	1	18	9	—	1							
	—	—	—	3	3	3	1	—	—	1	1	5	1	1	1	—	—	—				

tip of the snout overhangs the upper lip and the lower lip is included within the upper lip. The mouth is moderately oblique; the gape rises anteriorly to the lower level of the pupil. The posterior tip of the lower jaw just reaches a vertical line projected from the front of the eye. The length of the eye is slightly less than the snout.

All fins are relatively short (Table 2). In the erect position, the posterior border of the dorsal and anal fins is almost straight; when depressed the tip of the first ray greatly exceeds that of the last ray in both.

The pharyngeal arch is moderately developed and is less strong than in *xaenocephalus*. The shelf bearing the lesser row is narrow. The uppermost three teeth in the main row are compressed, pointed and hooked at the tip; the fourth is a cone only slightly curved at the tip. The grinding surface has crenulate edges and is long and well developed on the upper two teeth, is only about half as long in the third, and is practically missing in the lowermost. The two teeth in the lesser row are about half as long as the longest in the major row; each has a well developed grinding surface and a small hook at the tip. The teeth are somewhat more hooked than in *xaenocephalus*.

The tooth count in the holotype of *asperifrons* is 2, 4—4, 2 but apparently this character is subject to considerable variation. In paratypes from the type locality the counts are 2, 4—4, 2 (2); 2, 4—4, 1 (1); 1, 4—4, 2 (1); and 1, 4—4, 1 (3). In another series from the Alabama R. system the count is 2, 4—4, 2 (3). In the Black Warrior R. system variability was noted also although 2, 4—4, 2 was counted in nine out of 16 fish; other counts were 2, 4—4, 1 (2); 1, 4—4, 2 (2); 1, 4—4, 1 (1); 1, 3—4, 1 (1); and 2, 4—3, 1 (1). The reduction in number noted above in the main row is unusual. When reduction occurred in the lesser row no indication of a basal tubercle or socket was discernable and the shelf of the pharyngeal arch often did not seem wide enough to hold another tooth. A summary of the 27 tooth counts follows: 2, 4—4, 2 (15); 2, 4—4, 1 (3); 1, 4—4, 2 (3); 1, 4—4, 1 (4); 2, 4—3, 2 (1); and 1, 3—4, 1 (1).

In five small series of *xaenocephalus* the teeth were 2, 4—4, 2 (16); 1, 4—4, 2 (2); and 1, 4—4, 1 (2). A count of 2, 4—4, 2 was found in *roseus* (4) and in *petersoni* (6).

On the first arch the gill rakers are all small and, including rudiments, number 11 or 12. The vertebrae usually number 36 or 37 (Table 3).

The nape is fully scaled as is the breast as far forward as a line joining the posterior limit of the pectoral fin bases.

The cephalic lateral line canals and pores of five species (*asperifrons*, *xaenocephalus*, *roseus*, *petersoni* and *chalybaeus*) have been compared. The number of specimens counted is given in parentheses. The anteriormost pore is designated number one. The pore counts

TABLE 2.

MEASUREMENTS OF *Notropis* IN THOUSANDTHS OF STANDARD LENGTH.
 FOR EACH CHARACTER IS GIVEN THE RANGE OF VARIATION AND
 BELOW (IN PARENTHESES) THE MEAN. THE MEAN
 VALUES FOR *asperifrons* INCLUDE THE HOLOTYPE.

Species	<i>asperifrons</i>		<i>xaenocephalus</i>	<i>roseus</i>	<i>petersoni</i>
River System	Alabama		Alabama	Alabama, Black Warrior, Perdido	Ogeechee, Apalachicola
No. and sex of spec.	Holotype ♀	Paratype 6 ♀, 3 ♂	5 ♀, 5 ♂	5 ♀, 5 ♂	5 ♀, 5 ♂
Standard length	51.6	35-58	45-55	38-51	41-54
Dorsal origin to snout tip	504	494-528 (506)	490-513 (502)	492-509 (498)	493-525 (507)
Dorsal origin to caudal base	524	491-542 (521)	523-539 (531)	514-540 (529)	496-530 (519)
Dorsal origin to occiput	312	289-320 (305)	288-313 (300)	284-315 (302)	290-314 (303)
Pelvic insertion to snout tip	492	475-506 (483)	472-494 (487)	472-499 (489)	480-512 (492)
Anal origin to caudal base	330	322-351 (335)	327-348 (337)	328-368 (345)	317-349 (333)
Body depth	184	175-197 (187)	199-227 (209)	201-233 (220)	184-234 (211)
Body width	136	125-145 (136)	121-143 (129)	109-146 (127)	115-146 (127)
Dorsal origin to lateral line	113	113-127 (120)	126-143 (129)	125-153 (137)	111-157 (134)
Pelvic insertion to lateral line	079	072-088 (080)	070-090 (081)	081-110 (094)	083-120 (096)
Caudal peduncle length	233	227-257 (242)	206-232 (219)	208-233 (221)	222-259 (233)
Caudal peduncle depth	082	080-091 (086)	088-101 (093)	092-102 (097)	084-097 (092)
Head length	252	236-254 (245)	238-259 (248)	220-259 (247)	229-268 (256)
Head depth	139	136-188 (150)	151-164 (155)	149-165 (157)	150-166 (158)
Head width	126	116-132 (124)	122-136 (128)	122-135 (129)	121-136 (131)
Interorbital, least fleshy	082	079-085 (081)	077-090 (083)	080-092 (086)	081-090 (088)
Snout length	078	073-083 (078)	068-083 (075)	068-084 (074)	077-086 (082)
Eye length	074	069-077 (072)	073-085 (078)	068-084 (076)	076-086 (081)
Upper jaw length	074	059-074 (067)	073-085 (078)	063-077 (069)	072-084 (077)
Suborbital least width	025	016-027 (023)	017-025 (021)	021-028 (025)	024-032 (029)
Dorsal fin, de- pressed length	210	198-223 (210)	223-256 (235)	226-273 (243)	231-258 (249)
Anal fin, de- pressed length	143	140-151 (146)	177-192 (185)	162-197 (184)	173-215 (189)
Caudal fin length from base to tip of longest ray	235	213-245 (236)	238-275 (258)	262-277 (269)	272-303 (284)
Pectoral fin length	178	161-185 (172)	186-233 (207)	171-200 (188)	177-220 (201)
Pelvic fin length	153	139-153 (146)	142-178 (161)	159-186 (170)	155-185 (170)

are summarized in Table 4 and are not repeated in the description below.

The supratemporal canal is always incomplete in the five species. *N. asperifrons* has two pores on each side (5). *N. roseus* has two pores on each side (3), or one pore on each side plus a short branch from the junction with the infraorbital with a pore (1), or a canal with two pores located more dorsally on each side (1). *N. xaenocephalus* has two pores on each side (6), or two pores on the left and one on the right (1). *N. petersoni* has on the average fewer pores, with one pore on each side (3), or two pores on one side and one on the other (2), or one pore on both sides and a short canal of two pores on the left side (1), or two pores on each side (1). *N. chalybaeus* has a higher average pore count and exhibits greater variation than the other species.

The supraorbital canal is complete in *asperifrons*, *roseus*, *xaenocephalus*, and *petersoni*, and incomplete in *chalybaeus*. In *asperifrons* a vertical projected dorsally from the posterior margin of the eye falls between pores six and seven in those with a count of eight and between seven and eight when the count is nine. *N. roseus* is essentially the same. In *xaenocephalus* a vertical projected from the posterior margin of the eye falls between pores six and seven (1) or on pore seven (6). In *petersoni* a projected vertical falls on the next to the last pore (6) and between pores six and seven (1). In *chalybaeus* the canal is complete with a count of eight (4) and incomplete with a count of nine (2); breaks occur between pores two and three and between five and six. The supraorbital canal ends above the posterior margin of the eye or at a point just posterior of this point; a projected vertical falls between the last two pores.

The infraorbital canal of *asperifrons* is complete in specimens with a pore count of thirteen (2) and fourteen (2); in the specimen with the incomplete canal the pore count is fourteen with a break between pores twelve and thirteen. A vertical projected from the anterior margin of the eye falls between pores four and five (4), and between three and four (1). In *N. roseus* this canal is complete in three specimens which have a pore count of thirteen, fourteen and fifteen. One of the specimens with an incomplete infraorbital canal has a pore count of twelve, with a break between pores three and four, and the other canal has fifteen pores with a break between pores twelve and thirteen. A vertical projected from the anterior margin of the eye falls between pores four and five. In *xaenocephalus* the canal is always complete. A vertical from the anterior margin of the eye falls between pores four and five. In *petersoni* the canal is complete in six of the seven specimens studied and the pore count is lower than in the four other species compared here. The incomplete canal has a pore count of twelve with a break between pores ten and eleven; a vertical from the anterior margin of the eye falls between pores three and five. In *chalybaeus* the canal is incomplete in all; a break occurs between pores ten to thirteen.

TABLE 3.
VERTEBRAL COUNTS IN FOUR SPECIES OF *Notropis*

	Trunk					Number of Vertebrae Caudal					Total				
	17	18	19	20	17	18	19	20	17	18	19	20	17	18	19
<i>asperifrons</i>	—	7	19	2	9	18	1	—	—	—	15	11	2	—	—
<i>xaenocephalus</i>	—	11	41	1	4	41	8	—	—	—	8	44	1	—	—
<i>roseus</i>	—	6	21	—	11	15	1	—	—	1	15	10	1	—	—
<i>petersoni</i>	1	12	6	—	11	7	1	—	1	5	11	2	—	—	—

A vertical from the anterior margin of the eye falls between pores three to five (5) or on pore six (1). Contrasting with *N. chalybaeus*, *xaenocephalus* has the canal complete (7), and *petersoni* (6 out of 7) and *asperifrons* (4 out of 5) have the canal normally complete. In *roseus*, *xaenocephalus* and *petersoni* the infraorbital ducts are usually two or three-pointed ventrally; *roseus* also may have two or more ducts between pores two and five. In these three species, pores one through four or five are larger than those more posterior on the infraorbital canal. In *chalybaeus*, the pores, except for one and two, are small. The pore ducts of *chalybaeus* are short and usually only infraorbital duct number two points ventrally, whereas ducts number two and three do so in the other species being compared.

The preoperculomandibular canal is complete in all of the species except *chalybaeus*, in which it may be complete (3) or incomplete (3), with a break between pores five and six. It also has a high average pore count. In all five species under consideration, a vertical projected from the rictus almost always falls between pores three and four.

A close comparison reveals numerous consistent pigmentary characters which permit separation of the five related species, mentioned above, with 2, 4—4, 2 teeth and 7 or 8 anal rays. These differences are brought out in the following comparisons. The species, none of which have been adequately described in the literature, are treated in the following order: (1) *asperifrons*, (2) *xaenocephalus*, (3) *roseus*, (4) *petersoni*, and (5) *chalybaeus*.

Dark lateral band on body.—*N. asperifrons*.—Well developed but narrower than pupil throughout; wider and more diffuse on anterior half. Dorsal aspect of the band a low arch on the anterior half, but straight on the posterior half. Ventral aspect of anterior half of the band consists of dark chevrons formed above and below each lateral line pore. Rarely do melanophores, which are found near the border of the scale, extend more than half scale depth below a lateral line pore in front. Posteriorly the ventral edge of dark band straight and entire. Lateral line dips below the band anteriorly but is included within the posterior half of the band. Paralleling the dark band above is a prominent light band, which is approximately double its width on the posterior half. *N. xaenocephalus*.—Similar to that of *asperifrons*, but aggregations of melanophores, rather than chevrons, are associated with the lateral line pores on the anterior half of the body. Below the lateral line, some scattered dark spots may occur but normally do not extend ventrally more than a distance of one scale. *N. roseus*.—More intense in front than in *asperifrons* and *xaenocephalus*; dorsal and ventral aspects almost parallel and nearly entire; as wide or wider than pupil. A blotch above and below each lateral line pore anteriorly; these become larger and more intense on posterior half of band. Scales of the lateral line row and the first row below with melanophores on the border, except in some specimens in the southern part of range, in which melanophores may be

found further ventrally. Lateral line coincides with ventral edge of the band anteriorly but is included within it posteriorly. Light band poorly developed above the dark band and crossed regularly, especially on its anterior half, by the fine dark lines that border the scales. *N. petersoni*.—Much like that of *roseus*, but more uniform throughout its length. The amount of dark pigment found below the lateral line anteriorly is geographically variable but usually limited to the border of the lateral line scale and the upper half of the scale below. Light band above weak and broken by the dark edges of the scales. *N. chalybaeus*.—Sharply delimited, as wide or slightly wider than the pupil, and uniformly dark except for the light lateral line which is included within the band for its entire length. The parallel light band above is narrow, uniform, in width and dusky, although not as dark as the dorsum.

Caudal spot and adjacent pigment.—*N. asperifrons*.—Continuous with but darker and wider than the dark lateral band on the caudal peduncle; subquadrate, but narrows posteriorly, and extends only a short distance beyond the flesh covered base of the caudal rays. *N. xenocephalus*.—The subcircular spot has about the same intensity as the lateral band; it narrows posteriorly and scarcely extends beyond the flesh overlying the base of the caudal rays. *N. roseus*.—Continuous, or has only a slight constriction anteriorly; of about the same width and only slightly more intense than the band; subquadrate; continues only a short distance beyond the base of the caudal rays. *N. petersoni*.—Not continuous with band. Spot roughly V-shaped, with apex pointed anteriorly; slightly more intense but narrower than the band. *N. chalybaeus*.—Continuous with, but narrower and more intense than the band; width limited to the base of six median caudal rays and extends posteriorly about half the distance from the base of the rays to the caudal fork.

Dark band on side of head behind eye.—*N. asperifrons*.—A few scattered melanophores on the postorbital region, and a moderately strong band on the opercle, with a few scattered melanophores below and above. No pigment on the fleshy margin of the opercle. *N. xenocephalus*.—Similar to that of *asperifrons*, but with more melanophores scattered over the area above the opercle. *N. roseus*.—Similar to that of *asperifrons*, but less sharply defined on the dorsal part of the opercle. *N. petersoni*.—Like that of *roseus*, but with an occasional melanophore on the fleshy margin of the opercle. *N. chalybaeus*.—An intense, continuous band extends behind the eye; reduced slightly on the posterior fleshy margin of the opercle; scattered melanophores above the band on the opercle.

Dark band on side and front of snout.—*N. asperifrons*.—A prominent dark band fades anterior to the nostril, interrupted by a light oval area immediately in front of eye; continues around snout tip, best developed on the lower edge and on the upper lip. A light band extends from eye to nostril. *N. xenocephalus*.—A few superficial melanophores scattered in front of the eye; anteriorly the band rings

the snout and the upper lip. A light triangular area extends from the eye to nostril. *N. roseus*.—A band of scattered melanophores; fades somewhat at the anterior nostril but is well developed on the upper lip. Light area in front of eye has scattered melanophores. *N. petersoni*.—Like that of *roseus*, but band strongly developed in front as well as laterally. *N. chalybaeus*.—A strong band encircles the snout, lips and chin. Melanophores scattered on the preorbital area.

Lower lip, chin, inside of mouth and underside of head.—*N. asperifrons*.—Lower lip has a few melanophores; these almost absent at the symphysis. Chin and inside of mouth and underside of head light. *N. xaenocephalus*.—As in *asperifrons*; both may have a few melanophores on the oral valves. *N. roseus*.—Anterior part of lower lip and chin black. Scattered melanophores prominent on oral valves. Underside of head white. *N. petersoni*.—Lower lip dusky anteriorly; chin dusky with a medial extension of melanophores, but otherwise white below. Scattered melanophores present on oral valves and on the roof of the mouth. *N. chalybaeus*.—Lower lip black except posteriorly; chin black, darkish on inside of mouth. Scattered melanophores present on the isthmus and the gular region.

Pigmentation on temporal area of head.—*N. asperifrons*.—Temporal canal bordered on either side, but especially posteriorly, by a dark line which forms a prominent biconcave occipital bar; this continues obliquely downward as a moderately developed bar on the shoulder girdle which is not continuous to the pectoral fin base in this or in any of the three other species. *N. xaenocephalus*.—Temporal canal not outlined in black. No occipital bar. A weak oblique bar on shoulder girdle. *N. roseus*.—Temporal area with scattered melanophores. No occipital bar. A well developed, oblique, girdle bar present but mostly limited to the width of the lateral band. *N. petersoni*.—Temporal canal with a line of melanophores posteriorly forming a thin occipital bar and continued obliquely downward along the anterior lateral line to form a diffuse bar on the shoulder girdle. *N. chalybaeus*.—Temporal area darkish; an occipital bar continues downward as a short bar on the shoulder girdle.

Middorsal streak before dorsal fin.—*N. asperifrons*.—Obsolescent; a thin line developed part way in some. *N. xaenocephalus*.—Moderately developed; widest at occiput and at a point just anterior to the dorsal origin. *N. roseus*.—Prominent; about half a scale row wide and developed about equally throughout. *N. petersoni*.—Diffuse but well developed except at the occiput; not as wide as in *roseus*. *N. chalybaeus*.—Prominent; about $1/3$ scale row wide.

Pigmentation on body at dorsal fin base.—*N. asperifrons*.—None beyond normal scale pigmentation except for a slight concentration at the base of each ray. *N. xaenocephalus*.—Expanded dark area immediately before the dorsal origin and a well-defined dark line at and between the bases of the last six dorsal rays. *N. roseus*.—A definite and diffuse widening of band before the dorsal fin; several

rows of melanophores continue posteriorly on either side of the dorsal fin base. The posterior half of the dorsal base dark. *N. petersoni*.—No, or very little, expansion of middorsal band. A small dark concentration at the base of dorsal fin rays. *N. chalybaeus*.—Only a slight concentration before the dorsal fin. Dorsal base dusky.

Middorsal streak posterior to dorsal fin base.—*N. asperifrons*.—Absent, or a row of melanophores extends for only a few scale rows behind the dorsal fin base. No concentration anterior to the base of the procurrent caudal rays, although the dark scale margins appear as a series of crescents when viewed from above. *N. xaenocephalus*.—A narrow stripe; consists of 2 or 3 rows of melanophores and less intense than the predorsal stripe. A slight dark concentration present at the base of the procurrent caudal rays. *N. roseus*.—A definite but narrow streak, one to three rows of melanophores wide, present; narrower than the predorsal stripe. Only a slight dark concentration at the base of the procurrent caudal rays. *N. petersoni*.—Somewhat better developed than in *roseus*. No concentration present at procurrent caudal rays. *N. chalybaeus*.—An ill-defined streak present. No concentration located posteriorly.

Coloration of dorsolateral scales.—*N. asperifrons*.—Anterior half light, occasionally with a few scattered melanophores; lighter than in *xaenocephalus*. Posterior edge lined by one or two rows of macromelanophores, preceded by a well defined dark crescent. Appear diamond-shaped in contrast with next species. Row of scales above dark lateral band light colored. *N. xaenocephalus*.—As in *asperifrons*, but the large dark spots on the posterior scale margin lacking; more chromatophores scattered over the anterior half of the scale, so that the clear area is less obvious than in *asperifrons*. The scale row above the dark lateral band light. *N. roseus*.—As in *xaenocephalus*, but with darker dorsal scales; the row above the dark lateral band crossed by the dark scale margin but to a lesser extent posteriorly. *N. petersoni*.—As in *roseus*. *N. chalybaeus*.—Scales darkish with a somewhat darker border outlining the posterior margin.

Pigment on belly and area between the pelvic fin base and the urinogenital orifice.—*N. asperifrons*, *xaenocephalus* and *petersoni*.—Scattered melanophores show through body wall. *N. roseus*.—White with an occasional melanophore just anterior to the orifice. *N. chalybaeus*.—Darkish.

Pigment on body from anus to area about the anal fin base.—*N. asperifrons*.—Scattered melanophores just behind anus connect laterally and anteriorly with those from postpelvic region to outline the urinogenital papilla; dark continued posteriorly and darker immediately laterad and at the anal base. *N. xaenocephalus*.—A row of melanophores laterad of the urinogenital papilla; the area immediately behind the anus and in front of the anal fin light. Prominent melanophores laterad and at the anal fin base. *N. roseus*.—Melanophores laterad of the urinogenital papilla, behind the anus, and before, lateral and at the anal fin. *N. petersoni*.—As in *roseus*, but with more and

smaller melanophores. Those laterad of the anal fin base extend farther dorsad on the body. *N. chalybaeus*.—Dark except for the urinogenital papilla.

Pigment on lower median area of caudal peduncle.—*N. asperifrons*.—A band of two rows with an incomplete median row of melanophores arranged in three loops; the anteriormost loop lies above the last anal fin ray; the hindmost loop small and located at the base of the procurrent caudal rays. *N. xanocephalus*.—As in *asperifrons*, but with the posterior loop little or not developed. *N. roseus*.—A band of three rows of melanophores present on the anterior half only. *N. petersoni*.—A band of three rows of melanophores present; often reduced to two rows on the posterior third. *N. chalybaeus*.—A prominent band of two or three rows of melanophores developed with an occasional additional stellate macromelanophore lying immediately laterad of the band.

Pigmentation of peritoneum.—Large scattered melanophores ventrally and somewhat darker dorsolaterally; *petersoni* and *chalybaeus* darker than the other three species.

Pigmentation of pectoral fin.—All five species have a row of melanophores along each of the outermost five or six rays; darkest in *chalybaeus*.

Pigmentation on pelvic fin.—*N. asperifrons*, *xanocephalus* and *roseus*.—A few or no melanophores scattered on the outermost three rays. *N. petersoni*.—A row of widely spaced melanophores present along the rays of the outer half of the fin. *N. chalybaeus*.—A row of melanophores on either edge of the rays of the outer two-thirds of the fin.

Pigment on anal fin.—*N. asperifrons*.—A line of small melanophores borders the outer two-thirds of the rays. *N. xanocephalus*.—Clear except in an occasional specimen which may have a few melanophores near the margin of the last two rays. *N. roseus*.—Anterior rays clear, posterior four rays outlined by melanophores. *N. petersoni*.—All rays uniformly margined by melanophores, except near their base. *N. chalybaeus*.—All rays uniformly margined except near the base of the anteriormost three or four rays.

Pigment on caudal rays.—*N. asperifrons* and *xanocephalus*.—Fine lines of melanophores border each ray. *N. roseus* and *petersoni*.—Similar, but with central and outer rays darker than intermediate rays. *N. chalybaeus*.—As in *petersoni*, but generally darker and with an extended basicaudal spot.

Pigment on dorsal fin rays.—All five species have the rays bordered by melanophores; blacker in *roseus*, *petersoni*, and *chalybaeus*.

Additional items on coloration of *asperifrons* follow: Melanophores are irregularly scattered on top of the head in front of the eyes. Anterior to the nostrils the fewer melanophores give the effect of a lightish bar. Deep-seated melanophores form two lunate bars above each nostril. Between the eyes are two elongate dark blotches, which narrow gradually anteriorly; the intermediate area is clear. A promi-

nent heart-shaped mark is found on the top of the head posteriorly. Anterior to it is a light oval area which bears scattered melanophores. On the posterolateral margin of the heart-shaped mark is a relatively light area, disrupted laterally by a crescent-shaped dark bar that opens ventrally.

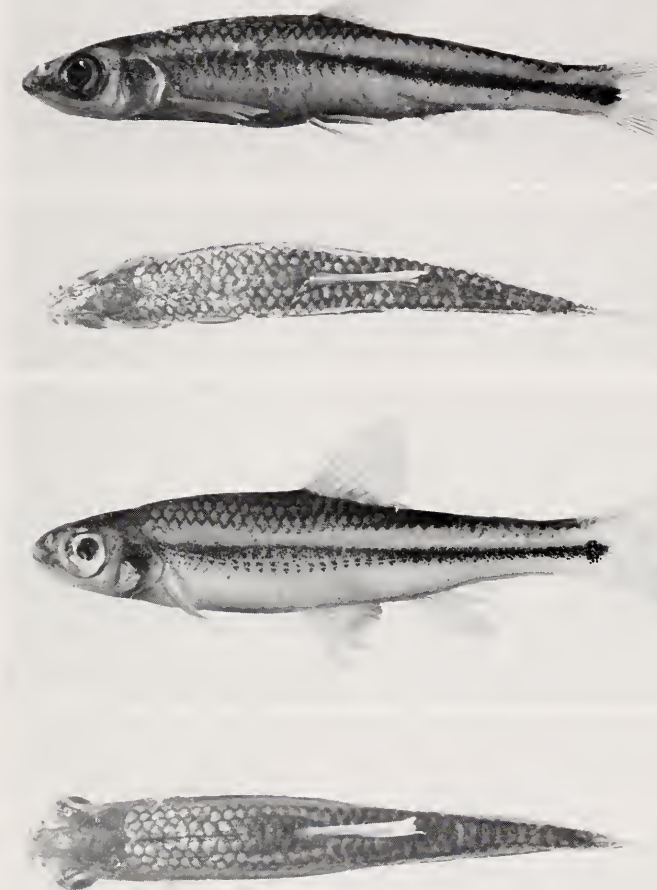
Nuptial Tubercles and Sexual Dimorphism

The anterior part of the snout of the male is densely covered by small white tubercles, which are larger than those on the body or fins. The tubercles are less numerous in the area between and below the nostrils; only an occasional tubercle of the type found on the snout is seen behind the nostril, except for a prominent row that begins behind the posterior nostril and continues upward to a point above and close to the eye. Tubercles of the same type form a patch on the chin and two or three irregular rows on the mandible and gular region. Finer light-colored tubercles are present on the lips, and to a lesser extent on the rest of the head; few or none are present on the opercles. One or occasionally two vertical rows of small tubercles are present on the anterior exposed edge of each scale of the anterior two-thirds of the lateral line, but are absent on other scales. The dorsal aspect of the first seven or eight pectoral fin rays is covered by dense bands of fine tubercles. None was observed on other fins. No large tubercles were found on the many females present in the series taken June 15, 1952 (TU 4251) but small ones, visible only under magnification, were scattered over the head and in a vertical row on the anterior lateral line scales.

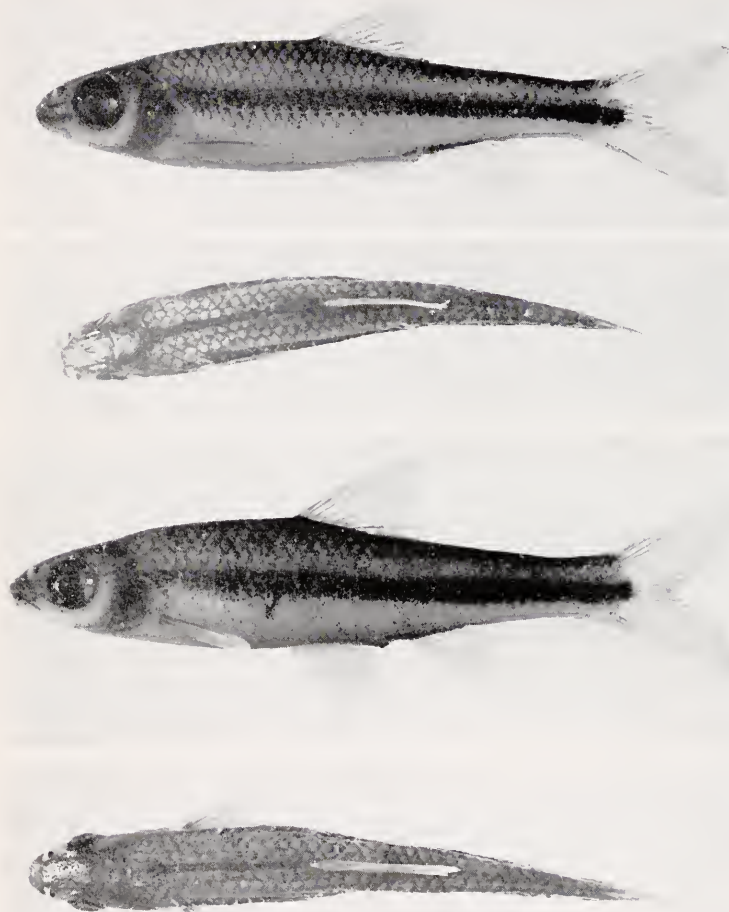
The nuptial tubercles on the snout are larger and more prominent than in *xaenocephalus*. The entire head is covered with fine scattered tubercles but there are fewer on the opercle. They are absent on the scales except for a nearly vertical row of small tubercles on the anterior lateral line scales. The largest tubercles are those on the upper surface of the pectoral fin of the male; here they are arranged in two dense rows on the anterior eight or nine rays and may be useful in holding the female during the spawning act. None is present on the other fins. The females of *xaenocephalus* have only a few small tubercles including the row on the anterior lateral line scales. None is present on the pectoral fin.

Bailey et al. (1954) have pointed out the salient differences in the development of nuptial tubercles in adult males of *roseus*, *petersoni* and *chalybaeus*. The large pointed tubercles present on the snout of *roseus* and *petersoni* are lacking in *chalybaeus* and *asperifrons*. In *roseus*, the tubercles on the snout are numerous and large; in *petersoni* the snout lacks tubercles except for a single or double row of large ones which overhang the upper lip. In *chalybaeus* a single or partly double row of moderately large tubercles on the edge of the snout point downward; their light color contrasts with the dark of the rest of the head.

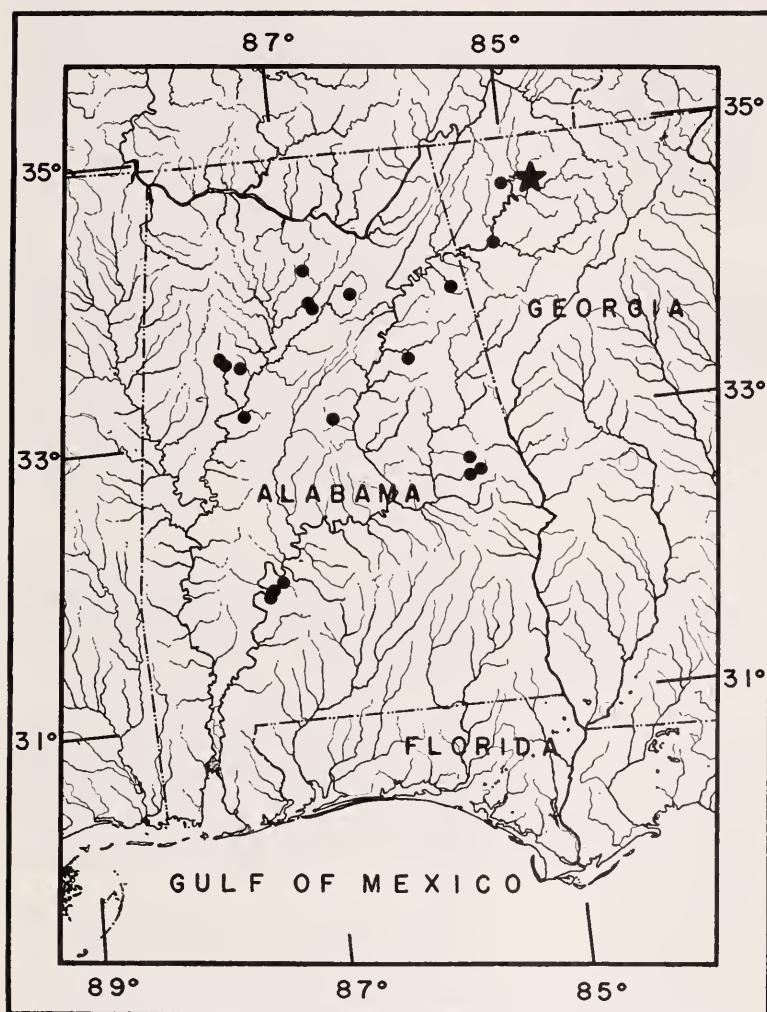
In *asperifrons* the pectoral and anal fins are longer in males than in females. When the fin is depressed the tip of the pectoral reaches



Figures 1-4. **1** (top) *Notropis asperifrons*: side view of the holotype, an adult female, 50 mm in standard length, from Holly Cr., 8 mi. N. Murray Co. line at Ramhurst, Murray Co., Georgia. **2** (second) *Notropis asperifrons*: top view of the holotype. **3** (third) *Notropis xanocephalus*: side view of an adult male, 49 mm in standard length, from Etowah R., 5.4 mi. S. W. Dahlonga, Lumpkin Co., Georgia. **4** (bottom) *Notropis xanocephalus*: top view of the same specimen illustrated in fig. 3 above. (Photographs by Douglass M. Payne.)



Figures 5-8. **5** (top) *Notropis roseus*: side view of an adult female, 50 mm in standard length, from Chipola River, Apalachicola River system, 1 mi. N.W. Grangeburg, Houston Co., Alabama. **6** (second) *Notropis roseus*: top view of the same specimen illustrated in fig. 5 above. **7** (third) *Notropis petersoni*: side view of an adult female, 49 mm in standard length, from Kiokee Cr., trib. Chickasawhatchee Cr., Apalachicola R. system, 3.2 mi. W. Pretoria, Dougherty Co., Georgia. **8** (bottom) *Notropis petersoni*: top view of same specimen illustrated in fig. 7 above. (Photographs by Douglass M. Payne.)



Map 1. Distribution of *Notropis asperifrons*. Star indicates type locality.

a point within two or three scale rows of the pelvic insertion, rather than being five scale rows distant in the female. The tip of the pelvic reaches beyond the anus in the male, rather than ending in front of the anus. Females appear to reach a greater length than males.

Compared with *asperifrons* the pectoral and pelvic fins of *xaenocephalus* are much longer in adults. When depressed the posterior

tip of the pectoral fin of the male nearly reaches the pelvic insertion and is about three to four scale rows distant in the female. In the male the posterior tip of the pelvic fin falls behind the anus but ends well ahead of this structure in the female. The females seem to reach a larger size than the males.

The name *asperifrons*, derived from *asper*, rough, and *frons*, forehead, refers to the tuberculate snout.

Range and Ecology

Apparently *asperifrons* is limited to the Mobile Bay drainage. In the Alabama River system it is known from stations on the upper Coastal Plain, the Piedmont, and from mountain type streams in the headwater tributaries of the Coosa River. The available collections from the Black Warrior River system were taken in the Piedmont area in the vicinity of Tuscaloosa, Cullman, and Oneonta, Alabama. It has been taken in clear streams of small and moderate size, usually 4 to 50 feet in width. Most of these streams have rubble, bed rock and sand bottom and flow through wooded areas. At one or several places it was taken with *Notropis xaenoccephalus*, *roseus*, *chrosomus* or *baileyi*.

KEY TO THE SPECIES OF *Notropis* WHICH INHABIT THE EASTERN TRIBUTARIES OF THE GULF OF MEXICO FROM THE MOBILE BAY TO THE APALACHICOLA BAY DRAINAGE AND WHICH ARE CHARACTERIZED BY THE TYPICAL COUNT (2, 4—4, 2 TEETH, 7 OR 8 ANAL RAYS) AND A DARK LATERAL BAND (EXCEPT FOR *hypsilepis*).

Bailey et al. (1954) have recently cleared up some of the confusion which clouded the status of *Notropis roseus*, *peterstoni* and *xaenoccephalus* in southeastern United States and have given some characters to separate these species as well as the related *chalybaeus*. To summarize the salient differences and to assist in identification we have constructed the following key to the nine species of *Notropis* under discussion.

1. Anal rays 7..... 2
 Anal rays 8..... 7
2. Mouth inferior. Anterior lateral line
 scales elevated. Predorsal dark
 streak absent or obsolescent..... 3
 Mouth terminal. Anterior lateral line
 scales little or not elevated. Pre-
 dorsal dark streak well developed..... 4
3. Muzzle bluntly rounded. Head subquad-
 rate. Gape only slightly oblique, ris-
 ing to lower level of eye anteriorly.
 Body deep. Light colored. Dark lat-
 eral band little or not developed an-
 teriorly. Caudal spot small, wedge-
 shaped and separated from the dark
 lateral band. Lacks dark pigment
 below the lateral line on anterior
 side except for a dark spot just be-

low each pore. Lower jaw light colored. Lacks dark bar on shoulder girdle. Occipital bar absent or obsolescent. Light area present behind anus. Suborbital wide, its least width 31-41 (35); Interorbital wider, its least fleshy width 85-95 (89); dorsal, anal and caudal fins longer, 225-246 (232), 169-193 (181), and 270-304 (282), respectively (measurements in thousandths of standard length). Circumferential body scales 22 to 26. Preoperculomandibular pores 12 or 13. Range: Apalachicola Bay drainage in the Chattahoochee and Flint rivers. *Notropis hypsilepis* Suttkus and Raney

Muzzle acute. Head subtriangular. Gape more oblique, rising to the lower level of the pupil. Body elongate. Moderately dark colored. Dark lateral band well developed anteriorly. Caudal spot large, quadrate, connected with and wider than the lateral band. The dark marks below and above the anterior lateral line pores form chevrons. Lower jaw with scattered melanophores. Dark bar present on shoulder girdle. Occipital bar well developed. Dark area behind anus. Suborbital narrower, its least width 16-27 (23); interorbital narrower, its least fleshy width 79-85 (81); dorsal, anal and caudal fins shorter, 198-223 (210), 140-151 (146), and 213-245 (236), respectively. Circumferential scales 19 to 21. Preoperculomandibular pores 10. Range: Mobile Bay drainage in the Black Warrior and Alabama rivers (Map 1). *Notropis asperifrons* sp. nov.

4. Middorsal stripe variously developed but not solidly encircling dorsal fin base. Mouth small; upper jaw as long as or shorter than eye. Dark lateral band broken immediately behind eye; represented by scattered melanophores. Lateral band on body not uniform; varies in density especially on the anterior half; spots and/or short bars are associated with the lateral line pores. 5

Middorsal dark stripe solidly encircles the dorsal fin base and continues to the procurent caudal rays. Mouth large; upper jaw much longer than eye. Dark lateral band continuous immediately behind eye and of same intensity and width as that on the opercle. Lateral band on side of body fairly uniform in density

throughout; lower margin entire. More closely related to *chrosomus* and *lutipinnis*. Range: Leaf and Chickasawhay rivers of the Pascagoula Bay drainage eastward to the Tombigbee, Black Warrior and Alabama rivers of the Mobile Bay drainage.

.....*Notropis baileyi* Suttkus and Raney

5. Posteriormost four or fewer anal rays outlined in black, in contrast to the light anterior rays. Basicaudal spot quadrate or somewhat rounded; continuous with the dark lateral band on the caudal peduncle; wider than lateral band on peduncle. Median dorsal stripe expanded laterally immediately before the origin of the dorsal fin to form a conspicuous dark blotch. Transverse occipital bar obsolescent or absent. Melanophores are scattered in the internarial area or form diffuse blotches. Tubercles on snout of males fine or if large (*roseus*) are scattered over the entire snout.

6

All anal fin rays edged with scattered melanophores. Basicaudal spot wedge-shaped and separated somewhat by a light area from the posterior end of the lateral band on the caudal peduncle; basicaudal spot as wide as or narrower than band on peduncle. Median dorsal stripe not expanded laterally immediately before dorsal origin. Transverse occipital bar strongly developed and expanded midlaterally. Two large dark crescents in the internarial area. Large nuptial tubercles on snout of male limited to one or two rows circling the anterior edge of the snout. Range: Coastal Plain from the Escambia River eastward to peninsular Florida and northward to the Cape Fear River system, North Carolina.

.....*Notropis petersoni* Fowler

6. Anal fin rays usually clear except for a narrow dark border on the last anal ray; some specimens have a few scattered melanophores on other rays. Basicaudal spot rounded. Anterior half of dark lateral band diffuse. Upper margin of dark lateral band clearly delimited anteriorly; clear stripe above not obscured by dark edges of scales. In the male, fine breeding tubercles are present on the head, snout and lower jaw; tubercles present on anterior scales only. Range: Mobile Bay drainage



Map 2. Distribution of *Notropis xanocephalus*. Star indicates type locality.

where it is limited to the upper Alabama River system (Map 2).—*Notropis xanocephalus* (Jordan)

Last 3 or 4 anal rays have a narrow dark border. Basicaudal spot quadrate. Anterior half of dark lateral band is dark and is about the same density throughout. Upper margin of dark lateral band not clearly demarcated at anterior end; area immediately above obscured by dark color on the scale margins. Coarse breed-

ing tubercles are scattered over top of head and snout; the latter are large and sharp pointed; large tubercles on lower jaw; anterior scales, extending medially along the back and onto the first dorsal ray, are tuberculate. Range (in part from Bailey et al, 1954): From the Ochlockonee River drainage west along the Gulf Coastal Plain to eastern Texas, and north in the Central Lowland to eastern Iowa, southern Wisconsin, and southwestern Michigan.....*Notropis roseus* (Jordan)

7. Eye moderate; shorter than snout. Peritoneum white ventrally; with some melanophores on lateral wall. Lining of mouth white, with few small scattered melanophores on upper oral valve. Light colored on the midline of breast, belly, area behind the pelvis and on the area before and around the anus; body at base of anal fin and on lower edge of caudal peduncle is white or has a few deep seated melanophores. Band on snout lacking or diffuse; chin not black, although it may be finely peppered with small dots; dark lateral band on front of body weak to moderately developed. Only the anterior anal rays have a dark margin. Nuptial tubercles extend the length of body on dorsal scales..... 8

Eye very large; much longer than snout. Peritoneum black ventrally. Lining of mouth black, above and below. Black on midline of breast, belly, area behind pelvis, area before and around anus, body at base of anal fin and the lower edge of caudal peduncle. Black band is intense on snout and chin, and extends posteriorly to the caudal base. Anal rays delicately but evenly dark margined throughout. Nuptial tubercles on scales restricted to anterior half of body. Range (in part from Hubbs and Lagler, 1947: 66): Coastal Plain from southeastern New York to Texas; northward, in the Mississippi Valley to Iowa, northern Indiana and the St. Joseph River system of the Lake Michigan basin.
.....*Notropis chalybaeus* (Cope)

8. Dark lateral band deeper but less intense in front; narrow and darker posteriorly; bordered above by prominent wide light stripe which the darkish scale margins do not cross.

Basicaudal spot present. Strong oblique dark bar on shoulder girdle reaches to pectoral fin base. Black blotch on dorsum located below the posterior half of the dorsal fin base. Postorbital dark band diffuse; spreads ventrally on opercle. Caudal peduncle scales 12. Circumferential body scales 22-24, usually 22 or 23. Posterior tip of jaw barely reaches a vertical from the front of the eye. Upper jaw shorter than snout. Head shorter; into standard length more than 4 times. Body terete. Snout bluntish. Anal fin shorter; into standard length more than 5 times. Fleshy margin of opercle is light colored in projected region of dark lateral band. In the male nuptial tubercles on the body are limited to those on and dorsad of the row of scales below the lateral line; lacks tubercles on pelvic, dorsal, anal and caudal fins. Range: Mobile Bay drainage where it is limited to the upper Alabama River system (Map 3).-----*Notropis chrosomus* (Jordan)

Dark lateral band about the same intensity and diameter throughout; no light stripe above. Lacks a basicaudal spot. Faint, oblique bar on shoulder girdle not reaching pectoral base. Faint blotch on the dorsum below posterior part of the dorsal fin base. Postorbital dark band restricted to the upper part of the opercle. Caudal peduncle scales 14 to 17. Circumferential body scales 26-31, usually 27. Posterior tip of jaw extends behind a vertical from the front of the eye. Upper jaw longer than snout. Head longer; into standard length less than 4 times. Body compressed. Snout sharp. Anal fin longer; into standard length less than 4.5 times. Fleshy margin of opercle is dark in projected region of dark lateral band. In the male nuptial tubercles are present on all body scales; tubercles are present on pelvic, dorsal, anal and caudal fins. Range: Apalachicola Bay drainage in the Chattahoochee River, northeastward to the Santee River system, South Carolina.-----*Notropis lutipinnis* (Jordan and Brayton)



Map 3. Distribution of *Notropis chrosomus*. Star indicates type locality.

Relationships

The writers realize that an attempt to fix the locality at which, and the time when, differentiation occurred, is tentative at best, especially when only the present day evidence is available. However, the following hypothesis of mode, time and place of origin appears to be most consistent with the facts of variation and distribution as worked out in this paper.

Although *N. chalybaeus* is related to *N. roseus* and *N. petersoni*,

TABLE 4.
FREQUENCY DISTRIBUTIONS OF THE CEPHALIC LATERAL LINE PORE COUNTS OF NINE SPECIES OF *Notropis*

Canal	Supratemporal					Supraorbital					Infraorbital					Preoperculomandibular							
Species	2	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	17	8	9	10	11	12	13
<i>hypsilepis</i>	—	3	—	2	—	—	2	1	2	—	—	—	—	1	1	1	2	—	—	—	—	1	4
<i>asperifrons</i>	—	—	5	—	—	—	3	2	—	—	—	—	2	3	—	—	—	—	—	5	—	—	—
<i>xanoocephalus</i>	—	1	6	—	—	—	7	—	—	—	1	1	1	3	1	—	—	—	2	3	2	—	—
<i>roseus</i>	1	—	3	—	1	—	3	2	—	—	—	1	1	1	2	—	—	—	1	3	—	1	—
<i>petersoni</i>	3	2	2	—	—	1	5	1	—	1	2	3	—	1	—	—	—	3	2	2	—	—	—
<i>chalybaeus</i>	—	—	1	3	2	—	4	2	—	—	—	—	—	3	2	1	—	—	—	—	6	—	—
<i>baileyi</i>	—	—	7	1	—	—	6	2	—	—	—	—	1	3	4	—	—	—	2	4	2	—	—
<i>chrosomus</i>	—	—	6	1	—	—	2	4	1	—	—	—	3	1	1	2	—	—	—	4	1	2	—
<i>lutipinnis</i>	—	4	1	—	—	—	3	2	—	—	—	—	1	4	—	—	—	1	3	1	—	—	—

it has long been speciated and differs in many characters, including a typical anal ray count of eight. The range of the lowland *chalybaeus* includes and is greater than that of both *roseus* and *petersoni* and the three species have been taken in the same collection on the eastern Gulf lowland where the ranges of *roseus* and *petersoni* overlap. We postulate that *chalybaeus* and *roseus* were evolved from the same stock, and probably they were isolated early; *roseus* in the Gulf and Mississippi lowlands and *chalybaeus* in the Atlantic Coastal Plain area. Subsequently *chalybaeus* reinvaded the western lowlands where it is now sympatric with *roseus*.

Apparently *N. roseus* and *N. petersoni* are closely related and the latter probably evolved from a Pleistocene invasion of the Atlantic Coastal Plain by *roseus* stock. This eastern component (*petersoni*) evolved to the species level and has reinvaded the Gulf Coastal Plain where it has advanced at least as far as the lower Escambia River. Its subsequent coastwise dispersal to the west and into peninsular Florida, where it is now widely distributed as far southward as the Caloosahatchee River system (Lee Co.) seems to be favored by its tolerance of saline water, a fact recently pointed out by Bailey et al. (1954).

The populations of *petersoni* in peninsular Florida, especially those in the lower west coast drainages, seem to have differentiated and are now characterized by a short (Table 5), slim body, a large eye, bluntish snout, and dark coloration.

While *N. roseus* is primarily a Coastal Plain and lowland species it is presumably physiologically preadapted to permit invasions of upstream habitats. For example it is now known from tributaries of the Black Warrior River, Green and Tuscaloosa counties, Alabama, where it lives sympatrically with *asperifrons*. While *asperifrons*, *hypsilepis* and *xaenocephalus* probably arose from such invasions by *roseus* stock, the time and mode of isolation are not clear. The common characters and the range of *asperifrons* and *hypsilepis* seem to point to a common ancestry (*roseus* or *roseus*-like stock), with subsequent differentiation. Besides sharing the basic characters of 2, 4—4, 2 teeth and 7 anal rays the three are similar to *roseus* in many details of coloration, counts, and proportions as may be seen in the descriptions above and in Tables 1-4. Notwithstanding the close relationships, these forms are differentiated on the species level. *N. roseus* and *asperifrons* are sympatric in the Black Warrior and Alabama River systems of Alabama; *asperifrons* was taken with *xaenocephalus* several times in the Alabama River system; *hypsilepis* and *roseus* occur together in a tributary of Lazier Cr., Flint R. drainage, Talbot Co., Georgia.

An invasion of *roseus* in the Flint River section of the Apalachicola Bay drainage, which is very close to the extreme of its range, has evolved into a population of *roseus* which we believe may prove worthy of subspecific recognition. It is not now designated as such since we believe that *roseus* should be studied throughout its range

TABLE 5.
FREQUENCY DISTRIBUTION OF LARGEST SPECIMEN IN EACH COLLECTION OF FIVE SPECIES OF *Notropis*

Species	Standard Length in mm										No. of Collections	No. of Specimens
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69		
<i>hypsignathus</i>	—	1	—	—	1	—	4	—	—	—	6	47
<i>asperifrons</i>	—	—	—	2	8	1	1	1	—	—	11	120
<i>xaenoocephalus</i>	—	—	—	—	4	8	9	4	3	—	28	677
<i>roseus</i>	—	2	1	5	11	19	27	30	6	1	102	2462
<i>petersoni</i>	2	—	4	13	20	20	26	7	5	1	108	2819
St. Marys R., Fla. to Cape Fear R., N. C.	—	—	2	2	1	9	19	5	3	1	42	1384
Peninsular Fla.	2	—	2	11	16	9	7	2	1	—	50	1308
Econfina R., Fla. to Apalachicola R., Ala. & Ga.	—	—	—	—	3	2	—	—	1	—	6	127

before adding additional names (see Bailey et al., 1954). The trend toward a reduction of tooth number in some samples of *asperifrons*, a *roseus* derivative, also occurs in the northern part of the range of *roseus*. The Flint River population of *roseus* shows a notable difference in body depth. In fifteen specimens from 43-59 mm in standard length, the body depth expressed in thousandths of standard length ranges from 215 to 286, mean 255; eight females averaged 266 and seven males averaged 243 (see Table 2 for measurements of other samples of *roseus*). There is also a greater number of circumferential scales, the count usually being 26 in Flint River specimens and 24 in those taken in lowland situations.

We postulate that *xaenocephalus* evolved from *roseus* stock which invaded the Mobile Bay drainage. It now seems to be limited to the Alabama River system while the related *asperifrons* occurs in both the Alabama and Black Warrior river systems. Many of the salient differences between the two are to be seen in the key, the description given above, in Tables 1-4, and in Figures 1-4. In summary, *asperifrons* differs from *xaenocephalus* in having an inferior mouth; more elevated anterior lateral line scales; a longer slimmer body, with less arched dorsal and ventral contours; a more acute muzzle; smaller, more fragile fins; a more elongate caudal spot; obsolescent or absent predorsal dark mark and middorsal dark streak; the dorsal origin is slightly behind the pelvic insertion rather than the reverse; a lower pectoral ray count; and a much lower circumferential scale count. In practically all characters mentioned in this comparison *xaenocephalus*, *roseus* and *petersoni* are very much alike. Other differences between *asperifrons* and *roseus* may be seen in the key.

A detailed reading of Jordan's (1877: 355) original description of *N. xaenocephalus* with specimens of related species at hand shows clearly that he described the form recognized herein under that name. However, a re-examination of the two types, USNM 20116, which were designated as such in Jordan and Evermann (1896: 289), proves that Jordan had both *N. xaenocephalus* and *N. asperifrons* in his original material. We hereby designate as lectotype of *N. xaenocephalus* the specimen which measures 50.1 mm in standard length and retains the number USNM 20116. The single specimen of *N. asperifrons* has been recataloged as USNM 164969 and is designated as a paratype. Also examined was another series of three specimens originally bearing the number USNM 17886 collected by Jordan near Rome, Georgia and which were probably used at least in part in the original description of *N. xaenocephalus*. Two specimens 48.3 and 38.1 mm in standard length may be considered syntypes of *xaenocephalus*. The third specimen in this series is *N. asperifrons*, an adult 45.5 mm in standard length. It has been removed, designated as a paratype and recataloged as USNM 164968.

The original description of *N. xaenocephalus* by Jordan (1877: 335) stated that "Two varieties or forms may be appreciated, the one larger, stouter, and with a larger mouth and much larger eye.

They seem, however, to shade into each other. They occur together in about equal abundance." Our study of adequate series of *N. xanocephalus* (28 collections numbering 677 specimens) indicates that he was dealing with characters which represented the extremes in size, and also probably in age, and our observations of the characters of large specimens are similar to his. That these ontogenetic changes may be of considerable degree was demonstrated early in our study since in preliminary sorting of specimens, we believed that two species (not including *asperifrons*) were present.

Gilbert (1891: 154) also overlooked *N. asperifrons* and misidentified both *roseus* and *asperifrons* from the Black Warrior River system as *xanocephalus*. In addition, he misidentified *N. baileyi* as *chrosomus*. Two series of *N. baileyi* housed in the United States National Museum were the basis for Gilbert's (1891: 154), records of *N. chrosomus* from a tributary of the Black Warrior River near Tuscaloosa, Alabama. The data for the two series are as follows: USNM 125079 (1, 43), Black Warrior R., Tuscaloosa, Ala., May 21, 1889, collected by P. H. Kirsch and USNM 36690 (10, 39-47) North R., Tuscaloosa, Ala., collected by C. H. Gilbert and Joseph Swain (presumably in 1884).

Since the description of *Notropis baileyi* appeared, two additional lots have been discovered in the University of Michigan, Museum of Zoology, by Reeve M. Bailey. The data for these two series, furnished by him, are as follows: UMMZ 111121 (24, 33-55), 6 mi. W. Auburn, Wire Road, Alabama, June 29, 1930; UMMZ 111124 (2 adults), Willmore Dam, September 13, 1930.

Notropis asperifrons and *N. xanocephalus* have also been taken together in three collections now housed at Cornell. The collections were made by Robert H. Gibbs and Philip P. Caswell in mid-June 1952. Both were found at the type locality of *asperifrons* in Murray Co., Georgia and at two places in Alabama: a tributary of Terrapin Cr. at the Cherokee-Calhoun county line on Alabama Hwy. 74 and in Cheaha Cr., 3.3 mi. S.W. Mumford on U.S. Hwy. 421. Although their ranges overlap, *asperifrons* was taken downstream in the Coosa River system, where *xanocephalus* was not captured. We also have 27 collections of the latter, without *asperifrons*, from the tributaries of Coosa and Etowah rivers in Bartow, Cobb, Gordon, Dawson, Floyd, Lumpkin, Murray, Pickens, and Whitfield counties in north Georgia.

The types of Jordan's (1877: 61) "*Luxilus roseus*," taken in Natalbany R. near Tickfaw, La., were examined. Nineteen specimens representing two genera and four species were present in the series, USNM 17831. Eight specimens of *Notropis roseus* which measured from 36.5 to 53.5 mm in standard length were included. The largest specimen is hereby designated as lectotype. Although the teeth are missing from the left side, those on the right are 4,2 and in other respects it is a typical example of *roseus*. The other eleven specimens in the "type" series were identified and recataloged as follows: *Notropis venustus* (Girard), 1 spec., 26.5 mm recataloged as USNM

163569; *Notropis cornutus* (Mitchill), 9 spec., 23.7-38.4 mm recataloged as USNM 163570; *Hybopsis amblops* (Rafinesque), 1 spec., 47.7 mm recataloged as USNM 163571.

The relationships of *N. hypsilepis* and the allopatric *asperifrons*, both of which were probably derived from *roseus*, are close. The development of an inferior mouth seems to be an adaptation for life on or near the bottom. These two forms may be separated easily by reference to the many characters used in the key; *asperifrons* is dark and elongate whereas *hypsilepis* is light-colored and relatively deep bodied; the back at the dorsal fin base is light posteriorly in *hypsilepis* whereas it is dark in *asperifrons*. Their relationships are indicated by the presence in each of a vertical row of nuptial tubercles on the anterior lateral line scales and elevated anterior lateral line scales.

The following combinations of characters will serve to separate *hypsilepis* from the other species of *Notropis*, (*asperifrons*, *xaenocephalus*, *roseus*, and *petersoni*) in the same general geographical area, with 7 anal rays and 2, 4-4, 2 teeth: Body light colored rather than darkish. Contrasting dark patches on the body at the dorsal and anal fin bases limited to the base of the first 4 or 5 rays and thus appear as blotches rather than being distributed along the entire base. Melanophores absent immediately behind or beside the anus. The dark lateral band weak anteriorly but present posteriorly, rather than being strongly developed throughout its length. The basicaudal spot definitely separated from the lateral band, rather than being continuous or only slightly separated (*petersoni*); wedge-shaped and narrow, being no wider than three caudal rays at its posterior and rather than being quadrate, or, if wedge-shaped, as wide as five or six caudal rays. The upper lip light on its posterior two-thirds, and the lower lip white rather than dusky or black in whole or part.

The characters given in the key will suffice for separating *asperifrons* from *baileyi*, which also has 2, 4-4, 2 teeth and 7 anal rays. As Suttkus and Raney (1955a) have pointed out, the relationships of *baileyi* are with *lutipinnis* and *chrosomus*.

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