

## Further Notes on The Fishes of Oklahoma

### WITH DESCRIPTIONS OF NEW SPECIES OF CYPRINIDAE\*

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The authors of this paper are attempting an analysis of the fish fauna of Oklahoma, and this paper is the second of a series which they hope to prepare. The first paper, entitled "A report on the fishes of Oklahoma, with description of new genera and species," by A. I. Ortenburger and Carl L. Hubbs, was published in 1926.<sup>1</sup> As before, Ortenburger is directing the field work, while Hubbs is making most of the identifications of the specimens obtained. The authors are mutually responsible for all general statements and for the conclusions drawn from both the field and laboratory studies. The photographs were made by Ortenburger.

In the course of this investigation, it has already become distinctly evident that a really satisfactory interpretation of the fish fauna of Oklahoma can only be arrived at after a considerable amount of new study has been accorded the fishes of the neighboring states. With this situation in mind, Hubbs has been making an investigation of the fishes of Kansas, Colorado, and New Mexico. Most of these supplementary studies are based upon specimens received during the last few years by the Museum of Zoology of the University of Michigan. Further collections are urgently needed from the states mentioned, and even more so from Texas and Arkansas, since so many of the southwestern fishes were described from these two states. A plea is here entered for fish collections, large or small, from all of the southwestern states.

The following species of Cyprinidae from Oklahoma are described in this report as new to science:

*Extrarius australis*

*Notropis bairdi*

*Notropis girardi*

During the months of June and July in 1926, the Museum of Zoology of the University of Oklahoma continued the survey, begun the previous summer of the fish fauna of this state. The field party, again led by Dr. Ortenburger, probably collected more specimens of fishes in the state than had been obtained on all previous expeditions. Despite this fact, only thirty-two species were secured, on

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<sup>1</sup>Proc. Okla. Acad. Sci. 6: 123-141.

account of the sparseness of the fauna in the region worked. Almost all of the material obtained in 1926 was seined out of the upper or western parts of the Red, Canadian and Cimarron basins. Inasmuch as the upper waters of these systems had seldom been reached by previous collectors, the species obtained have proved to be of much interest. In addition to these collections from western Oklahoma, some supplementary series were taken in the Norman region. Furthermore, the material obtained by the University of Oklahoma has again been supplemented by a collection made by Miss E. R. Force in the vicinity of Okmulgee.

The more important discoveries arrived at in the present study of the 1926 Oklahoma collections may be briefly mentioned here, leaving the more detailed discussion of each case to the running list of species. The resulting changes of nomenclature, in the cases of the subspecies of *Pimephales promelas* and *Ameiurus melas*, have been incorporated in the first report, which was delayed in publication. (The present report, also delayed in publication, has been revised to October, 1928.)

1. The probable occurrence of a compact form-series uniting the species of *Extrarius* having four developed barbels with others having but two barbels.

2. An unexpected variability in the number and size of the barbels in this group.

3. The existence in the Red River system of a new species of *Extrarius*, the second known species of American minnow with four barbels.

4. The slight differentiation of *Notropis deliciosus* in Oklahoma into two races, occupying respectively the Red and Arkansas basins.

5. The occurrence of *Notropis volucellus buchamani* in the Red River drainage, farther south and farther west than any prior record.

6. The specific validity of the Red River and the Arkansas River representatives of *Notropis sabinac*, both of which were discovered in 1925, but are herein named for the first time as new species—*N. bairdi* and *N. girardi*.

7. The presence of "*Cochlognathus*" in the Red River system.

8. The restriction of the most trenchant character of "*Cochlognathus*," namely the exposed, sharp-edged jaws, to the breeding season, and to the male sex.

9. The apparent identity of *Cochlognathus ornatus* with the species originally named *Ceratichthys vigilax*.

10. The need for another name for the species ordinarily called *Cliola* or *Ceratichthys vigilax*. We suggest *Hypargyrus velox* (Girard).

11. An error in the assigned type-locality of *Ceratichthys vigilax*, as well as of *Leuciscus lutrensis*, and *Leuciscus bubalinus*, and *Pomotis breviceps*. The types were taken in Otter Creek, southwestern Oklahoma, not in Arkansas as generally stated.

12. The identity of *Pimephales promelas maculosus* of the Arkansas and Red basins with *P. p. confertus* of the Rio Grande.
13. The connection of the bullhead subspecies *catulus* with *Ameiurus melas* rather than with *A. nebulosus*.
14. The occurrence of *Cyprinodon* in Oklahoma.
15. The presence of *Micropterus pseudaplites* in western Oklahoma.
16. The occasional association of all three species of black bass in the same pool.
17. The occasional but extensive hybridization of *Micropterus dolomieu* and *M. pseudaplites*.
18. The sporadic hybridization of Oklahoma sunfishes: of *Apomotis cyanellus* with *Xenotis megalotis breviceps*, and of *Allotis humilis* with *Apomotis cyanellus*.
19. The identity of *Pomotis fallax* with *Pomotis breviceps*. The long-eared sunfish of the Southwest should therefore be known as *Xenotis megalotis breviceps* (Baird and Girard).
20. Advance notice is given in this paper of systematic discoveries in the genera *Moxostoma*, *Hybognathus* and *Poeciliichthys*.

These new investigations extend our knowledge of the fish fauna of Oklahoma to such a degree, that it now becomes possible to offer some provisional suggestions regarding the distribution of fish life in the state. The conclusions, of course, must be submitted to the test of the new facts and records, which we trust will be obtained in the future continuation of the fish survey of the state.

The fact that the central portion of the divide between the Red and the Arkansas River systems traverses the length of Oklahoma, leads one dealing with the distribution of the fishes of that state first of all into a comparison of the faunas of the two basins. It now appears highly probable that the two stream systems draining Oklahoma are populated by fish faunas somewhat differentiated from one another, as well as from the faunas of surrounding systems. This distinction involves the seemingly exclusive occurrence of certain southern types in the Red system and of some northern genera and species in the Arkansas, and the racial or specific differentiation of certain forms on the two sides of the stream-divide.

At least two southern or Rio Grande types, *Ceratichthys* (*sensu strictu*) and *Cyprinodon*, inhabit the Red River system of Oklahoma, but apparently nowhere cross over the intervening divide into those waters which flow into the Arkansas River. Northern types which range southward into the Arkansas drainage of central and western Oklahoma, but which have not, to date, been recorded from any locality in the Red basin, are *Platygobio* and *Perca*.

Of more arresting interest are those cases, all discovered in the course of the present fish survey of Oklahoma, and all discussed in the text of this and the preceding report in which one species or species-group has become measurably differentiated in the two river systems of the State. Thus *Notropis deliciosus* is represented in the two drainages by races (here called *deliciosus* and *missuriensis*)

which can be distinguished from one another by series-examination. *Notropis cornutus isolepis* is confined to the Red system, whereas the more northerly and easterly form, *N. c. chrysocephalus*, alone occurs in the Arkansas system. *Notropis bairdi* is the Red River and *N. girardi* is the Arkansas River representative of *N. sabiniae*. *Extrarius australis* of the Red River basin represents *E. tetranemus* of the Arkansas.

These facts suggest that the faunas of the upper portion of the Red and of the Arkansas basin have been in part at least isolated for a considerable period of time. On the other hand the fact that a large number of species occur without measured differentiation in both systems proves that the faunas have been long or frequently in at least partial communication. Some of the species common to the two systems range only northward and others only southward, but a considerable number have ranges which extend both northward and southward. The proportions which may be included in each of these categories cannot be accurately computed until a more thorough study has been made of the fish faunas of the states surrounding Oklahoma.

The fish fauna of eastern Oklahoma is obviously richer than that of the western part of the State. It will be a problem of the future to determine the western limits of the ranges of the many species which enter the state from the east but fail to reach its western border, and to attempt to find environmental factors which may be responsible for this limitation of their distribution.

There follows a list of the twenty-one new fish collections from Oklahoma which are reported on in this article. All but the last three were made by the University of Oklahoma Museum of Zoology field party of 1926.

#### A. Collections in Red River System

Station 1:—West Cache Creek, near Camp Boulder, Wichita National Forest, Comanche County. Plate I, Fig. 1. This is here a very clear stream, without taste, and derived from granite rock; pH 7.6; vegetation absent, except for filamentous green algae; bottom clean, of sand, gravel and rock; shore wooded, or gravelly or rocky; width 5 to 30 feet; temperature 82° to 84° F.; current swift between pools; depth generally slight, but 23 to 27 feet in one pool; June 7 to 12 (eight situations fished).

Station 2:—Headquarters Creek, 1 to 2 miles west of Headquarters, Wichita National Forest, Comanche County. This is also a clear stream, without taste; with a gravel, sand or rock bottom; with wooded and gravelly or rocky banks; width to 25 feet in pools; 84° F.; current slight; depth 2½ feet in pools; June 10 and 11 (three situations fished).

Station 3:—Red River, 6 to 9 miles southwest of Hollis, Harmon County. Plate I, Fig. 2. The water is red and muddy and a little salty to taste; pH 7.7 in running water after rain; no vegetation, except many sedges in pools; bottom of quicksand and deep soft mud; lined with sandy shores or rocky cliffs; pools usually 15 to 20 feet wide; depth to 3 feet in pools; June 16.

Station 4:—Sand Creek (also mapped as Lebos Creek), 3 miles

east and  $\frac{1}{2}$  mile south of Hollis, Harmon County. Water fairly clear in part, but dark, muddy, and foul-smelling (polluted?) in one place; vegetation scanty in clear water but thick in other situation; bottom sandy to muddy; banks low but steep, of bare mud; stream lined with willows and cottonwoods; width 4 to 12 feet; current moderate; depth to 2 feet; June 21 (two situations worked).

Station 5:—Buck Creek,  $7\frac{1}{2}$  miles southwest of Hollis, Harmon County. Water clear in creek, but black and muddy in cut-off slough; vegetation practically absent, except for a few sedges; bottom mostly of sand in creek, of black mud eight inches deep in slough; width of creek 2 to 6 feet where flowing, of slough 35 feet; temperature  $83^{\circ}$  F. in creek; current none to swift in creek, none in slough; depth to  $1\frac{1}{2}$  feet in creek, to 8 feet in slough; June 20 (two situations fished, but only *Cyprinodon* caught in slough).

Station 6:—Salt Fork of Red River, 11.4 miles north of Hollis, Harmon County. Plate II, Fig. 3. Water clear, tasting a little "slick," but not salty; vegetation undeveloped, except for a little sedge growth along the banks; bottom of sand and mud; most pools cut off; current, generally none; depth 1 to 2 feet; June 21 to 24.

Station 7:—Elm Fork, 4 miles north of Mangum, Greer County. Plate II, Fig. 4. Water fairly clear, but distinctly salty to taste; very little vegetation; a sand and sand-mud bottom; collections from running water as well as from cut-off pools; June 21.

Station 8:—Pond near Sayre, Beckham County (just south of river). Water very muddy; bottom of deep mud; margin grassy; width 115 feet; depth about 4 feet; June 24, 1926.

Station 9:—North Fork of Red River, near Sayre, Beckham County. Water quite clear, running, shallow; June 24.

Station 10:—Washita River,  $1\frac{1}{2}$  miles north of Cheyenne, Roger Mills County. Plate III, Fig. 6. Water very muddy and current swift (a little flooded); practically no vegetation; sandy bottom; banks 6 to 20 feet high; width 10 to 20 feet in current; depth  $\frac{1}{2}$  to 2 feet; June 24 to 26.

### B. Collections in Arkansas River System

Station 11:—South Canadian River, 6 miles northwest of Durham, Roger Mills County. Plate IV, Fig. 7. Water muddy (stream rising in flood); practically no vegetation, other than sedges; a sand-mud bottom; sandy banks 6 to 20 feet high; pools 10 to 20 feet wide; current swift between pools; depth, 1 to 3 feet; last week in June.

Station 12:—Coldwater Creek, 8 miles southeast of Guymon, Texas County. Plate IV, Fig. 8. Water usually clear, but muddy because high when fished; some sedges; sandy and grassy shores; width mainly 6 to 10 feet;  $85^{\circ}$  F.; 1 to 3 feet in depth; about July 1.

Station 13:—Cimarron River, 3 miles northwest of Kenton, Cimarron County. Plate V, Fig. 9. Water very clear; width about 6 feet in current, between pools;  $82^{\circ}$  to  $84^{\circ}$  F.; depth 4 to 8 inches; July 2 to 7.

Station 14:—Cimarron River,  $1\frac{1}{2}$  miles north of Kenton, Cimarron County. Plate V, Fig. 10. A pond in the channel of the river, which here flows only in flood; July 7.

Station 15:—Willow Pond, a "cattle tank" on Tucker Ranch,  $4\frac{1}{2}$

miles north of Kenton, Cimarron County. (Fishes said to have been introduced.) July 7.

Station 16:—West Carrizzo Creek,  $3\frac{1}{2}$  miles north of Kenton, Cimarron County. A clear stream, spring-fed nearby, quite cold; July 7.

Station 17:—Salt Fork of Arkansas River, 7 miles east and 2 miles north of Ingersoll, Alfalfa County. Water exceedingly muddy, the stream 100 to 400 feet wide, the current swift and the depth 1 to 3 feet (stream in flood); July 11.

Station 18:—Sleeping Bear Creek, about 20 miles southeast of Buffalo, Harper County. A clear, cool stream 10 to 15 feet wide and about 1 foot deep; July 11.

Station 19:—South Canadian River, 4 miles south of Norman, Cleveland County; July 21.

Station 20:—Little River, 10 miles east of Norman, Cleveland County. A queer stream about 5 to 10 feet deep and normally not much wider, but subject to large floods; it flows through rich bottom land, in which it has entrenched itself; collection made by J. B. Cooper, May 30, 1926.

Station 21:—Streams near Okmulgee, Okmulgee County; the fishes collected by Miss Edith R. Force, 1925-1926.

### CLUPEIDAE

#### 1. *Dorosoma cepedianum* (Le Sueur)

Red River system:—Sta. 8, pond near Sayre, Beckham County.

Arkansas River system:—Sta. 20, Little River, east of Norman.

The depth in half-grown to adult specimens from Sta. 8 is contained from 2.7 to 2.8 times in the standard length.

### CATOSTOMIDAE

#### 2. *Carpiodes carpio* (Rafinesque)

Arkansas River system:—Sta. 17, Salt Fork of Arkansas River, near Ingersoll; Sta. 20, Little River, east of Norman.

Red River system:—Sta. 8, pond near Sayre, Beckham County.

Two adults were obtained at Sta. 8, each somewhat more than a foot in total length. Dorsal rays, 22 and 23; scales 35 and 36; depth 2.4 to 2.6. The head, snout, and mouth are typical; the dorsal is moderately elevated (the second ray 1.6 in base of dorsal, moderately osseous at base).

#### 3. *Moxostoma duguesnii* (Le Sueur)

Red River system:—Sta. 1 and 2, West Cache and Headquarters creeks, Wichita National Forest.

Several young and one half-grown specimen were secured.

The status and nomenclature of this species, and the next, will be discussed in a later paper by Hubbs.

#### 4. *Moxostoma erythrurum* (Rafinesque)

Red River system:—Sta. 1, West Cache Creek, Wichita National Forest.

The five specimens taken are half-grown. When fresh, the lower fins were more or less red.

The record of *Moxyostoma aureolum* in our first report applies to this species.

### CYPRINIDAE

#### Genus **EXTRARIUS** Jordan

*Hybopsis* of most authors, in part.

*Extrarius* Jordan, Proc. Acad. Nat. Sci., Phila., 1918 (1919): 342; Copeia, no. 130, 1924: 51.

The genus *Extrarius*, as defined by Jordan, differs from *Macrhybopsis* and other units of the old *Hybopsis*-complex in having, like no other American minnows, four barbels, two at each end of the maxillary. This character, however, in itself cannot serve as an absolute generic criterion, because of its variability. Some of the races of (or forms confused with) "*Hybopsis*" *aestivalis* show a rudimentary or even a fairly well developed second barbel. Furthermore, *Extrarius tetranemus*, the type-species of the genus, occasionally has the lesser barbel of one or both sides rudimentary. The evidence afforded by the material now preserved in various museums (admittedly insufficient) in fact suggests that a fairly complete gradation may eventually be found, connecting races or forms having a single barbel of moderate length with those exhibiting two long ones, on each side.

We are therefore forced to the conclusion that *Extrarius tetranemus* should not be generically set off from the otherwise similar forms with but two barbels in all. We propose to include in this genus the following cluster of nominal species: *hyostomus marconis*, *aestivalis*, *sterletus*, *tetranemus* and *australis*. The last two, which form the extremes of the genus in the high development of the barbels, are alone treated in this paper. The interrelations and validity of the four other nominal forms must at present be left an open problem.

The group *Extrarius*, as thus circumscribed, may be defined as follows. The primary barbel is more or less elongated, and pendant from the posterior edge of the maxillary; a secondary barbel is often formed, either in rudimentary or well developed condition, from the thickened skin covering the lower posterior angle of the maxillary bone. The snout projects notably beyond the mouth, and is provided on its lower surface, around the front of the mouth, by a rostral pad, which is pointed on each side behind, and which overlies the front of the maxillary bone. The teeth, 4-4 n number, have no grinding surfaces. The fins are large and sharp; the dorsal is located well forward, in advance of the middle of the standard length; the anal has 7 to 9 rays. The scales are large (fewer than 40 in the lateral line); each in outline is an excentric polygon, with the basal margin (formed of two of the sides of the hexagon) markedly truncated; the focus is far basad; the ridges are well developed on all fields, evenly rounded between the basal and lateral fields and between the dorsal and ventral halves of both basal and apical fields, and they are spaced more

than twice as widely on the exposed as on the concealed field; the radii are strongly divergent and numerous (more than 15); the scales, except of course those along the lateral line, bear no median ridge. The body is very conspicuously marked by irregularly isolated giant melanophores.

*Extrarius* is perhaps most closely related to *Macrhybopsis*<sup>2</sup> with which it has been in part confounded. Despite their variability, all the forms of *Extrarius* differ from *M. gelidus*, the single species of *Macrhybopsis*<sup>3</sup>, in lacking a median ridge, resembling a lateral line tube, on the various scales of the body; in having a less triangular and rather larger scales (fewer instead of more than 40 in the lateral line); in the greater elongation of the barbel; in the lesser production of the snout, and in the development of isolated gigantic melanophores. From *Erimystax*, it differs in lacking the grinding surface on the teeth, and in having rather larger scales of different structure (in *Erimystax* the apical ridges and radii are much fewer and more widely spaced, and the ridges are abruptly bent subvertically on the line of contact between the basal and lateral fields). From *Erimonax*<sup>4</sup> it differs at least in having larger scales. From the other genera of the old *Hybopsis*-complex, the dissimilar *Nocomis* (in part)<sup>5</sup> and *Yuriria* excluded, it differs in the lack of a lesser row of teeth and in one or more other details.

The allocation of *Extrarius* in the minnow series involves an interpretation of the phyletic significance of the extra barbel. It appears to us virtually certain that this structure was elaborated *de novo* within the *Formkreis* which we call *Extrarius*, and therefore that the presence of two barbels on each side is no indication of phyletic relationship with such Old-World genera as *Barbus*, *Cyprinus*, etc., which have a pair of well separated barbels on each side. This conclusion was derived from a consideration of the following facts. (1) No American cyprinid, other than the closely related forms here being discussed, has more than one barbel on a side. (2) Within the same apparently compact genus are forms with a single barbel. (3) The position of the anterior and smaller barbel in *Extrarius* does not agree with that of the lesser barbel in the Old-World genera, in which it hangs from the lower border of the snout, above (or over) the anterior part of the maxillary (instead of from the lower posterior angle of that bone). (4) The smaller barbel in *Extrarius*, like a similar process in *Hyborhynchus notatus*, appears to have been elaborated from the swollen skin covering the angle of the maxillary. (5) The extra barbel may be looked on as a new adaptation to the excessively silty streams of the Great

<sup>2</sup>Cockerell and Allison, 1909, Proc. Biol. Soc. Wash., 22, 162.

<sup>3</sup>An examination of the type-specimens in the National Museum has made it clear that *Hybopsis montanus* Meek is a synonym of *Notropis dorsalis piptolepis*; the types of the latter have no barbel (the jaw skin, torn on one side of one example, simulates a barbel), and lack the scales on the back before the dorsal. *Hybopsis meeki* Jordan and Evermann (1896, p. 317) represents still another generic type; it is the species figured by Forbes and Richardson as *Platygnobio gracilis*.

<sup>4</sup>Jordan, 1924, Copeia, No. 130, 52.

<sup>5</sup>See Hubbs, 1926, Misc. Pub. Mus. Zool., Univ. Mich., No. 15, 27.



Plains of North America: as a sensory structure developed in compensation for the reduced vision. There is, in fact, a striking negative correlation between the size of the eye and the development of the barbels in the *Extrarius* series, that is, from *hyostomus* to *australis* (the correlation is not quite perfect however, since the barbels average longer on *australis* than in *tetranemus*, although the eye averages larger). (6) As a final indication of the recent independent evolution of the second barbel within *Extrarius*, we may call further attention to the variability of barbel structure in this genus. Thus we find not only forms in which the supernumerary barbel is rudimentary, but even in *tetranemus* it may be lacking or very poorly developed: in an Oklahoma specimen it is rudimentary on one side but developed on the other, and in others its length varies greatly; of two specimens from the Arkansas River near Oxford, Kansas, otherwise essentially alike, one has four barbels and the other two. Furthermore, we find that the barbels in *E. australis* are variable not only in size but occasionally also in number: a few examples show three barbels on one or both sides; one has a comb-like cluster of seven barbels on one side; another has the number increased not only at the two ends of the maxillary, but also at the front of the upper jaw, in a position not normally occupied by barbels in any known species of cyprinid. We conclude, therefore, that the extra barbel often developed in *Extrarius* arose *de novo* within the group, and that this genus bears no direct relation to Old-World genera having four barbels.

In this connection we might parenthetically remark that we now have no evidence that any of the Old-World types with four barbels ever reached the American continent. The barbel of *Semotilus* and *Margariscus*, although farther forward than in other American minnows, is pendant from the lower edge of the posterior part of the maxillary, and therefore appears to be homologous with the posterior rather than the anterior barbel of those genera having two barbels on each side. Furthermore, in a hybrid between *Rhinichthys*, which has a terminal barbel, and *Semotilus*, a single barbel is evident, and it occupies an intermediate position.

Hitherto but one species of *Extrarius* with four developed barbels has been recognized, namely *E. tetranemus* of the Arkansas basin. The 1926 expedition not only obtained this species for the first time in western Oklahoma, but also secured a new related species, *E. australis* of the Red River system.

##### 5. *Extrarius tetranemus* (Gilbert)

This species has been recorded from several points in the Arkansas basin of Kansas and Arkansas. We now have the pleasure of identifying it from the following localities in Oklahoma, all lying in the Arkansas River system:—Sta. 12, Coldwater Creek near Guymon, Texas County; Sta. 17, Salt Fork of Arkansas River near Ingersoll; Canadian River just south of Norman, Cleveland County (specimen recorded as *Macrhybopsis aestivalis aestivalis* in our first report).

*E. tetranemus* obviously spawns in summer, for breeding adults

only were taken about July 1 whereas both young and adults were caught July 11. .

6. **EXTRARIUS AUSTRALIS** Hubbs and Ortenburger, new species

Red River system:—Sta. 3, Red River southwest of Hollis, Harmon County; Sta. 5, Buck Creek, in the same region; Sta. 6, Salt Fork of Red River, north of Hollis; Sta. 7, Elm Fork, north of Mangum, Greer County; Sta. 10, Washita River, north of Cheyenne, Roger Mills County.

*Extrarius australis* is obviously the Red River representative of *E. tetranemus*. It differs from that form in having 7 anal rays instead of 8 (rarely 7 or 9); the pectorals much longer and more falcate, in the male typically extending well beyond the pelvic insertion, instead of failing to reach that fin; the eye averaging larger (5.0 to 7.0, usually about 6.0, instead of 6.0 to 8.0, usually about 7.0 in head), and the barbels averaging longer (the larger 3.2 to 5.0, instead of 4.0 to 7.0 in head; the shorter 5.0 to 7.5 instead of 7.0 to rudimentary).

*E. australis*, like *E. tetranemus*, spawns in the summer. Only adults were taken during the period, throughout the latter half of June, when this species was being collected, and these were all mature with the exception of the smallest, which were obviously yearlings.

*The holotype*,—Cat. No. 80347, Museum of Zoology, University of Michigan,—is a mature male specimen 44 mm. long to caudal, from Sta. 3. All of the numerous other specimens, including mature females as long as 51 mm., are designated as paratypes, and are deposited in the museums of the Universities of Oklahoma and Michigan.

*Description of the type*.—The head is a little more than one-fourth the standard length. The body is very slender, especially attenuate posteriorly; the greatest depth is contained 5.4 times in the standard length (females are more robust); the slender caudal peduncle is less than half as deep as long, and its depth is about one-third the length of the head. The lower contour is almost straight and horizontal from the snout to the anus, whereas the dorsal contour is elevated backward as far as the dorsal fin, rising in a gentle curve broken only by a slight protuberance above the nostrils. The snout is rather sharp, and projects nearly the length of the eye beyond the front curve of the gape; it is almost as long as the postorbital length of the head. The raised rim of the anterior nostril is carried around the front of the rounded flap which separates the two nostrils. The maxillary is everywhere concealed when the mouth is in repose—posteriorly by the suborbitals (which are as wide as the small eye), and anteriorly by a fleshy pad, extended into a point on each side posteriorly, and forming the lower surface of the snout in front of the premaxillaries. On account of the pad the weakly sigmoid suborbital border ends blindly in front. The horizontal mouth is far below the eye, and nearly on a level with the lower margin of the body. The maxillary extends backward to below the septum between nostril

and eye, and bears two long barbels on each side, the larger pendant from the posterior edge of the maxillary, and the shorter from the lower posterior angle of this bone. The sensory papillae on the head and the scaleless breast and the paired fins are better developed than in most minnows, and in fact are enlarged in the region between the mandibles and between the branchiostegals to form thickly set wart-like prominences, and minute barbels along the outer ray of the pectoral and of the pelvic fins. (These sensory structures seem to be a little better developed in the male than in the female.) There are no nuptial tubercles, but the pectoral rays are modified in the breeding male: the individual articulations are thickened and produced on the upper surface of the fin as antrorse hooklets, except on the inner lobe of the fin.

The teeth, 4-4, are hooked but have no developed grinding surfaces. The gill-rakers are rudimentary.

The fins are large and rather sharp. The dorsal is inserted a little farther forward than the pelvic, the length of snout and eye nearer tip of snout than base of caudal; it has a rather long base, because its 8 rays are rather widely spaced; it is falcate, for the end as well as the front is produced into a point; the longest ray when depressed fails to reach the end of the last ray by a distance equal to length of eye; the longest ray is as long as the distance from dorsal to occiput, and is contained 1.2 times in the head. The caudal is deeply forked, as its shortest ray is little more than half as long as the longest; the lobes are subequal and narrow, and each is almost as long as the head; the caudal has 19 principal rays. The anal is shaped much like the dorsal, but is smaller (the longest ray is only two-thirds as long as the head), and has only 7 rays. The broad 8-rayed pelvic reaches the anus. The pectoral is unusually long, almost equal in length to the head, and strongly falcate and arched on its outer border; it extends the diameter of the eye beyond the pelvic base; rays 15. (In the female the fins are somewhat narrower and shorter; this is especially true of the pectoral, which in that sex is but little falcate and fails to reach the pelvic.)

The scales are large, 6-36-4 (5 to the pelvic), but somewhat crowded before the dorsal (about 18); they are lacking on the breast.

The general color tone is very light, grading from pale gray above to silvery below. The two areas of the body are separated by a silvery streak, which is narrower than the eye, extends from the upper end of the gill-opening to the caudal base and is bordered above by a dark streak widest in front, and made up of evident punctulations. The scale pockets above the silvery streak are very faintly and narrowly margined with dusky. The ridge of the back before the dorsal is dusky, but there is no definite mid-dorsal streak here and only a weak one behind the dorsal; the actual base of the dorsal is darkened along the median third, and this color is especially intensified in 3 or 4 black spots. There are no markings about or behind the anal base. The caudal is pale, except for a dark blotch near the base of each lobe. The fins otherwise are

pale. The head is dusky above (blackish over the brain) and pale yellowish below, but bright-silvery on the opercles. The body is marked with a number of gigantic melanophores. In the type these spots are relatively few and small; in other specimens they are highly variable, both in number and size, as some are small and others may be almost as large as the pupil; in general they are irregularly scattered and show little tendency to cluster together, although they are usually most abundant on the middle of the sides toward the head; frequently on the back of the caudal peduncle and occasionally elsewhere, however, these giant melanophores are clustered on single scales, which are thus darkened like the isolated black scales of *Rhinichthys* and other genera. The peritoneum is bright silvery, and immaculate except on the dorsal wall of the body cavity.

#### 7. *Platygobio gracilis* (Richardson)

We are now recording the second locality for this species in Oklahoma, where it appears to be confined to the Arkansas River system:—Sta. 11, South Canadian River, 6 miles from Durham, Roger Mills County.

#### 8. *Notropis deliciosus* (Girard)

Red River system (*N. d. deliciosus*): Sta. 1 and 2, West Cache and Headquarters creeks, Wichita National Forest; Sta. 3, Red River southwest of Hollis; Sta. 10 Washita River, near Cheyenne.

Arkansas River system (*N. d. missuriensis*):—Sta. 12, Coldwater Creek, southwest of Guymon; Sta. 13, Cimarron River near Kenton; Sta. 16, West Carrizzo Creek, north of Kenton; Sta. 17, Salt Fork of Arkansas River near Ingersoll; Sta. 18, Sleeping Bear Creek, about 20 miles southeast of Buffalo; Sta. 20, Little River, east of Norman; Alva (specimens in Field Museum).

The subspecies of *Notropis deliciosus* are not very sharply differentiated, and a finally satisfactory division of the complex must await the statistical study of large series from various parts of the range of the species. Their relationships to one another, as well as to the subspecies of *Notropis volucellus*, with which they have been confused, has been discussed by Hubbs and Greene\*. (To the synonyms of *Notropis deliciosus missuriensis* as there listed, we find, after examining the types in the Field Museum, that we should add *Notropis phenacobius* Forbes.)

In Oklahoma we have found two races of *Notropis deliciosus*, occupying respectively the Red and the Arkansas River systems. They can be distinguished quite readily from one another by series-examination. The Arkansas basin form, identified with *missuriensis*, differs from the Red River race (here referred to *N. d. deliciosus*) in averaging larger, and heavier in the head, in being paler in coloration and especially in having the scales before the dorsal typically more crowded and numerous. The Red River race oddly approaches the distant *stramineus* in the somewhat slender body and especially the shortness of the pectoral fins.

\*Pap. Mich. Acad. Sci., Arts and Letters, 8, 1927 (1928); 375-380.

In many Oklahoma specimens of *deliciosus*, especially in males from the Red River drainage area, the pectoral fins appear distinctly pink in life. This color may even be suffused over the body, especially along middle of sides, mid-dorsal streak and occipital region.

Throughout Oklahoma, as elsewhere, this species of minnow spawns late in the season, and over a long period. Mature females were taken in 1926 from May 30 to July 11, and although young of the year were secured in nearly all collections made after the first week in June, most of the adults were found to be still ripe as late as July 7. The nuptial tubercles, as also in the northeastern subspecies *stramineus*, are small but hardly minute, and are developed on the top and front of the head and on the chin.

#### 9. *Notropis volucellus buchanani* Meek

*Notropis buchanani* Meek, Bull. U. S. Fish Comm., 15, 1895 (1896): 342; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 3, 1898: 2800.

*Notropis volucellus buchanani* Hubbs and Greene, Pap. Mich. Acad. Sci., Arts and Letters, 8, 1927 (1928): 379.

Red River system:—Sta. 7, Elm Fork, four miles north of Mangum, Greer County.

The range of this peculiar form,—which we are calling the “ghost shiner,”—may now be extended southward and westward to the locality listed above.

#### 10. *Notropis boops* Gilbert

We<sup>1</sup> have followed Fowler<sup>2</sup> in extracting this name from the synonymy of *N. shumardi* and *N. illecebrosus*. We now find that the case is complicated, in that two species are now at least included among the types of *illecebrosus*: these are the two species later described as *chamberlaini* and *boops*. Of those now retained in the National Museum, 18 are of the former species and 5 are of the latter form; the 3 cotypes preserved in the Museum of Comparative Zoology and the single ones deposited in the Academy of Natural Sciences of Philadelphia, the Museum of Zoology of the University of Michigan and the Field Museum at Chicago, all represent the *chamberlaini* type. The original description is either highly inaccurate or else based on both species; the figure in the Railroad Survey looks more like *chamberlaini* than *boops*. The first redescription of the species and the designation of the type was apparently by Meek<sup>3</sup>, who dealt with the example in the Philadelphia Academy. We therefore still maintain *boops* as a distinct species, and synonymize *chamberlaini* with *illecebrosus*.

#### 11. *NOTROPIS BAIRDI* Hubbs and Ortenburger, new species

Red River system:—Sta. 3, Red River, and Sta. 5, Buck Creek, both southwest of Hollis, Harmon County; Sta. 6, Salt Fork of Red River north

<sup>1</sup>Hubbs, Misc. Publ. Mus. Zool., Univ. Mich., No. 15, 1926: 43; Ortenburger and Hubbs, Proc. Okla. Acad. Sci., 6, 1926: 126.

<sup>2</sup>Proc. Acad. Nat. Sci. Phila., 1910: 276.

<sup>3</sup>In Jordan, Proc. U. S. Nat. Mus., 8, 1885: 123, footnote 4.

of Hollis; Sta. 7, Elm Fork, north of Mangum, Greer County; Sta. 9, North Fork of Red River, near Sayre, Beckham County; Sta. 10, Washita River, north of Cheyenne, Roger Mills County.

*Holotype*.—Cat. No. 80346, Museum of Zoology, University of Michigan,—a ripening female 64 mm. long to caudal, collected at Sta. 3. The hundreds of paratypes are deposited in the Museum of Zoology at the University of Oklahoma and at the University of Michigan. Another series of paratypes, from the Red River four miles east of the Oklahoma-Arkansas line (taken on Texas side of river), was provisionally referred in our previous paper<sup>20</sup> to *Notropis sabinæ* Jordan and Gilbert.

*N. bairdi* differs from *N. sabinæ*, as already pointed out by us (*l. c.*), at least in the crowding of the scales before the dorsal and their usual absence on the nape, and in the smaller size of the eye. Furthermore, the dorsal fin is inserted farther back, usually a little behind instead of before the middle of the standard length. Since our abundant new material serves to confirm the constancy of these characters throughout a wide area in the Red River system, we must now name this form. It is now possible to extend the range of *sabinæ* as well, as the specimens which were collected by Meek at Greenway, Arkansas, have been examined; these specimens have no teeth in the lesser row and hence cannot be classified with *N. longirostris*, a species known only from Gulf streams east of the Mississippi.

*Description of the type*.—The body is rather chubby (depth 3.9), and the head, which strongly suggests that of *Semotilus*, is probably heavier in build than in any other species of *Notropis*: the width of the head is just equal to its depth and is contained 1.65 times in its length; the width of the mouth between the ends of the gape is equal to the length of the upper jaw. (Young females, and especially males, are more slender and have a much less chunky head). The length of the head, inclusive of the opercular membrane, is contained 3.5 (3.4 to 3.8) times in the standard length (the head averages shorter in males than in females). The depth of the caudal peduncle is about half its length from the end of the anal base, and about one-third the length of the head. The ventral contour is far from straight, but is less curved than the dorsal; the nuchal region is somewhat humped (not so in the male); both contours of the head are rather abruptly increased in steepness before the vertical through the nostrils. The snout is broadly rounded and nearly one-third as long as the head. The mouth is strikingly enlarged for a species of the genus *Notropis*; the upper jaw extends backward, at an angle of about 40° (often less) with the vertical, to below the front of the pupil and is one-third as long as the head. The fleshy tip of the snout (which forms no distinct fold or pad) lies on a horizontal with the lower margin of the eye, and projects very slightly beyond the front of the premaxillaries, within which the tip of the mandible is included. The edge of the suborbital is entire, and strongly concave; the sub-

<sup>20</sup>Ortenburger and Hubbs, Proc. Okla. Acad. Sci., 6, 1926: 128.

orbital width equals length of eye. The slightly arched interorbital is nearly twice as wide as the small eye, the length of which is contained 5.4 (4.5 to 6.0) times in the head (in half-grown specimens the interorbital may be only one-half wider than eye). The teeth number 4-4, and show a plane but scarcely concave grinding surface along the shoulder below the hook; the gill-rakers are rudimentary (these structures examined in paratypes).

Scales, 6-36-5; 4 to pelvics. The breast region is largely devoid of scales, as is also the nape and the mid-dorsal line backward nearly to the dorsal (in some specimens there are more scales on the breast, particularly near the pelvic fins, and the nape is more or less completely devoid of scales; when mostly present, however, they are crowded and vary from 16 to 20 in numbers along or near the mid-dorsal line between dorsal fin and occiput). The lateral line is but little decurved (in the type many of the scales lack pores, but the lateral line is usually nearly or quite complete). The angles of the scales in individual outline are rounded and the focus is far basad; the lateral fields are much narrowed and not distinctly set off. The radii are strong, widely divergent and numerous, more than 15 in the adult. The ridges are nowhere angulated, and are rather weak on the exposed field, where they are moderately spaced and about twice as distant one from the next as on the basal field.

The fins are rather small and rounded in the female, but larger and more pointed in the males: in the females the length of the depressed dorsal is slightly less, in the males decidedly more than two-thirds the distance from dorsal to occiput; the caudal is only three-fourths as long as the head in the female, but nearly equal in length to the head in the male; the longest anal ray in the female is nearly and in the male quite half as long as the head; the pelvic only in the male reaches back to the anus; the somewhat falcate pectoral shows the greatest sexual dimorphism, for in the female it is only two-thirds as long as the head, does not nearly reach the pelvic fin and extends only half-way to the anus, whereas in the male it is nearly as long as the head, and typically extends beyond the pelvic insertion, and reaches two-thirds the distance to the anus. The principal fin-rays number: dorsal, 8; anal, 7 (rarely 6 or 8); caudal, 19; pelvic, 8; pectoral, 15. The origin of the dorsal is somewhat nearer the caudal than the tip of the snout (occasionally as near and rarely a little nearer tip of snout than caudal base).

The general color tone, as of most Plains fishes, is pale, made gray by fine punctulations on the upper half of the body, but clear silvery on the lower half. The lateral silvery band is very diffuse. A rather narrow dusky band runs from above the gill-opening to the middle of the base of the upper caudal lobe (in many examples this is obsolete). Below this band is a more or less distinct dark streak along the axial septum, wide and diffuse (or concentrated into black spots) anteriorly, usually narrower on the caudal peduncle; this streak is sometimes more distinct, in other cases less so, than the dark band above it. The anterior pores of the lateral

line are more or less distinctly set off by black pigment, as in *N. deliciosus*. On the upper sides and back the scale pockets are narrowly bordered with dusky (the distinctness of these markings varies widely, and often the pigment is concentrated near the apex of the scales). The mid-dorsal streak is distinct, and especially wide before the dorsal fin; it is continued and somewhat intensified along the base of the dorsal fin; there is no streak about or behind the anal base. The lower fins are pale, the dorsal and caudal more or less dusky; the base of the caudal rays are variably blackened, so as to produce a dusky caudal spot. The top of the head is blackish over the brain but dusky elsewhere, as also on the snout and preorbital; the cheeks are pale; the opercles are silvery, marked with large melanophores behind the eyes. The peritoneum is bright silvery, with black punctulations.

This species is obviously a summer-spawner, for no young were included among the hundreds of adults taken in fine-meshed seines from June 16 to 26, at which time nearly all specimens were found to be ripe or nearly so. Only a few of the smaller specimens taken show no evidence of maturity; females as small as 24mm. to caudal are full of ripe eggs. It therefore seems probable that yearling and older females spawn about the same time.

Nuptial tubercles are developed on the top of the head in nearly ripe males, but they are very fine and weak.

(*Bairdi*: named for Spencer Fullerton Baird, an early student of the fishes of the southwest, and one of the outstanding figures in American zoology).

## 12. NOTROPIS GIRARDI Hubbs and Ortenburger, new species

Arkansas River system:—Sta. 11, South Canadian River, northwest of Durham, Roger Mills County; Sta. 12, Coldwater Creek, southeast of Guymon, Texas County; Sta. 13, Cimarron River, northwest of Kenton, Cimarron County; Sta. 16, West Carrizzo Creek, north of Kenton; Sta. 17, Salt Fork of Arkansas River, near Ingersoll, Alfalfa County; Sta. 18, Sleeping Bear Creek, about twenty miles southwest of Buffalo, Harper County; Sta. 20, Little River, ten miles east of Norman, Cleveland County.

*Holotype*.—Cat. No. 80439, Museum of Zoology, University of Michigan,—a ripe female 51 mm. long to caudal, from Sta. 13, (Cimarron River, near Kenton). The hundreds of paratypes came from the stations listed above, and from the Canadian River 4½ miles southwest of Norman (series recorded by Ortenburger and Hubbs, *l. c.*) and from the Arkansas River, near Kinsley, Kansas (a series collected by Hubbs and Schultz).

This new material enables us to define the character and to delimit a range for this, the Arkansas River representative of *Notropis sabinæ*. Throughout its range, as now known, *N. girardi* differs from *N. sabinæ* in the greater crowding of the scales before the dorsal, in the smaller average size of the eye, and the higher number of anal rays (7 to 9, usually 8, instead of only 7). *N. girardi* differs quite as sharply from its Red River cognate *bairdi* for it has the breast largely and the nape completely scaled over, and has



one more anal ray (rays 6 to 8, typically 7, in *bairdi*); the pectorals usually shorter and less falcate, in the males usually not reaching to pelvic insertion, seldom beyond and never far past that point; in the more anteriorly placed dorsal (origin typically near tip of snout than base of caudal, often much nearer and never farther away, in *girardi*, but typically nearer caudal base than snout tip and only seldom a little nearer the latter point in *bairdi*); owing largely to its more anterior insertion, the dorsal fin seems larger in *girardi* than in *bairdi*, its depressed length being more than two thirds the interval from dorsal fin to occiput (in the female nearly and in the male quite half the distance from dorsal fin to tip of snout); in the lesser degree of sexual dimorphism (for the two sexes are less dissimilar in size of fins, chunkiness of head, etc.), and in the somewhat larger average size of the eye (4.0 to 5.0 instead of 4.5 to 6.0 in head). The suborbital is narrower than, instead of equal in width to the eye. *N. girardi* apparently does not attain as large a size as *bairdi*, as the largest females known of each are respectively 54 and 64 mm. long to caudal.

Despite these many differences, which in the aggregate render the distinguishing of specimens of *bairdi* and *girardi* an easy matter, these two species are obviously very closely allied. Except as indicated above, the description here given of *bairdi* applies equally well to *girardi*. They distinctively agree in the general form of head and body in each sex, and in showing similar sexual differences in this respect; in having the coloration alike, in both cases intermediate between that of *Notropis deliciosus* and that of *Hybognathus nuchalis*; in having the pectorals falcate, and longer and more falcate in the male than in the female; in the crowding of the scales before the dorsal; in dentition; in having the eye very small (for a *Notropis*) and the mouth very large, and in the obsolescence of the nuptial tubercles. Both species, although not small for the genus, spawn first at a very small size, for specimens of each only 24 mm. (less than an inch) long to caudal, obviously yearlings, have mature ova; a few individuals of each species, of a somewhat smaller size, fail to mature, and these must be the runts of the previous year's hatching. Both of the species furthermore are summer-spawning. This phenomenon is demonstrated in the case of *girardi* by the fact only adults were taken in fine-meshed seines from July 1 to 11. In both species the females are heavier and reach a larger size than the males. Such physiological resemblances we construe to be among the best indications of relationship.

(*Girardi*: we think it fitting to associate with this species and the last, especially as they are closely related, the names of Baird and Girard, who were among the first to make known the rich fish fauna of the southwest).

### 13. *Notropis lutrensis* (Baird and Girard)

Red River system:—Sta. 3, Red River southwest of Hollis; Sta. 4, Sand Creek, south and east of Hollis; Sta. 5, Buck Creek, southwest of Hollis; Sta. 6, Salt Fork of Red River north of Hollis; Sta. 7, Elm Fork, north of

Mangum; Sta. 9, North Fork of Red River, near Sayre; Sta. 10, Washita River, north of Cheyenne.

Arkansas River system:—Sta. 11, South Canadian River, 6 miles northwest of Durham; Sta. 12, Coldwater Creek, southeast of Guymon; Sta. 13 and 14, Cimarron River, northwest and north of Kenton; Sta. 16, West Carrizzo Creek, north of Kenton; Sta. 17, Salt Fork of Arkansas River east and north of Ingersoll; Sta. 18, Sleeping Bear Creek, about twenty miles southeast of Buffalo; Sta. 19, South Canadian River, south of Norman; Sta. 20, Little River, east of Norman; Sta. 21, streams near Okmulgee.

Although the dentition of many examples from various localities in Oklahoma, as well as in Kansas and Colorado, have been examined, the formula has almost always been found to be 4-4. Only a very few have shown the teeth in the lesser row attributed to *N. bubalinus*, a species supposed by some authors to be especially characteristic of Oklahoma. The anal rays, however, are throughout this territory typically 9 (occasionally 8 or 10), the number assigned to *bubalinus*. We in fact regard *bubalinus* as a synonym of *lutrensis*. That species appears to be divisible into subspecies, but even if so the name *bubalinus* cannot be used for one of the intergrading forms, since the types of both *lutrensis* and *bubalinus* were taken in the same small stream—Otter Creek, southwestern Oklahoma (not Arkansas, as uniformly stated).

*Notropis l. lutrensis* spawns over an unusually long period, for fully mature fishes were taken as early as May 30 and as late as July 21; small young were secured from June 16 to July 11. Some of the fishes do not spawn as yearlings, that is, in their second summer, while others apparently do, for some breeding examples are very small.

#### 14. *Notropis*, species?

Arkansas River system:—Sta. 12, Coldwater Creek, southeast of Guymon.

A single specimen was obtained here of a *Notropis* which has defied attempts at identification. It is further discussed in the following paper, under the head of *Notropis fumeus*.

#### 15. *Phenacobius mirabilis* (Girard)

Arkansas River system:—Sta. 12, Coldwater Creek, southeast of Guymon, Texas County; Sta. 13, Cimarron River, northwest of Kenton, Cimarron County; Sta. 16, West Carrizzo Creek, north of Kenton; Sta. 17, Salt Fork of Arkansas River, east and north of Ingersoll; Sta. 18, Sleeping Bear Creek, about twenty miles southeast of Buffalo, Harper County.

This minnow would appear from these records to characterize the Arkansas River fauna only, in Oklahoma, but it has been obtained in the Red River system in this state and even in coast-wise streams in Texas. It appears to range farther westward in the Arkansas basin than in the Red.

This fish spawns in June, for young were taken from July 1 to 11; One mature female was secured about July 1.

#### 16. *Notemigonus crysoleucas crysoleucas* (Mitchill)

Arkansas River system:—Sta. 12, Coldwater Creek, southeast of Guymon;

Sta. 19, South Canadian River, south of Norman; Sta. 20, Little River, east of Norman; Sta. 21, streams near Okmulgee.

We give here further counts of the number of anal rays in the Oklahoma population of this species, including with these new counts those we gave in the preceding report (each of the earlier counts is increased by one, to make them agree with the counts of Schultz<sup>22</sup>, who has reported the latest study of geographical variation in this species). The 117 counts now available for all Oklahoma give the low average of 12.48 rays.

Table I. Principal anal rays in *Notemigonus* in Oklahoma

	Principal anal rays					
	10	11	12	13	14	15
Poteau R., south of Wister .....	—	—	—	1	—	—
Canadian R., and pond, near Norman ..	—	1	9	11	5	—
Little River, east of Norman .....	—	—	3	2	—	—
Streams near Okmulgee .....	2	10	36	28	6	2
Coldwater Creek, near Guymon .....	—	—	—	1	—	—
Totals .....	2	11	48	43	11	2

Specimens taken in Little River on May 30 are mature. The males have no nuptial tubercles.

#### 17. *Hybognathus placitus* Girard

Red River system:—Sta. 3, Red River southwest of Hollis; Sta. 4, Sand Creek, near Hollis; Sta. 5, Buck Creek, southwest of Hollis; Sta. 6, Salt Fork of Red River; Sta. 7, Elm Fork, north of Mangum; Sta. 9, North Fork of Red River, near Sayre; Sta. 10, Washita River, north of Cheyenne.

Arkansas River system:— Sta. 11, South Canadian River, 6 miles northwest of Durham; Sta. 12, Coldwater Creek, southeast of Guymon; Sta. 13, Cimarron River, northwest of Kenton; Sta. 16, West Carrizzo Creek, north of Kenton; Sta. 17, Salt Fork of Arkansas River, east and north of Ingersoll; Sta. 18, Sleeping Bear Creek, about twenty miles southeast of Buffalo; Sta. 19, South Canadian River, south of Norman.

This form is very abundant in western Oklahoma, where thousands of specimens were seined. Its specific distinctness will be demonstrated by Hubbs in a forthcoming paper.

The nuptial tubercles or pearl organs of the male, extremely fine and numerous, are developed on the top of the head, on the back, and on the inner side of the pectoral fin.

Although this species occasionally spawns before the middle of June (young of the year were obtained as early as June 16), most of the adults taken as late as July 11 had not yet spawned.

#### 18. *Ceraticthys vigilax* Baird and Girard

Red River system:—Sta. 4, Sand Creek (Lebos Creek), three miles east and one-half mile south of Hollis, Harmon County; Sta. 5, Buck Creek, 7½ miles southwest of Hollis; Sta. 6, Salt Fork of Red River, 11.4 miles

<sup>22</sup>Pap. Mich. Acad. Sci., Arts and Letters, 7, 1926 (1927): 417-432.

north of Hollis; Sta 10, Washita River, 1½ miles north of Cheyenne, Roger Mills County.

A specimen of this species from Flat Creek, at Goodland, Oklahoma, has been recorded by Meek<sup>22</sup> as *Chiola vigilax*. It has been examined at the Field Museum.

The original types of *Cochlognathus ornatus* and of *Ceratichthys vigilax* (see following discussion) are the only other examples of this species heretofore known, for the two subsequent records were both based on erroneously determined specimens. *Cochlognathus biguttatus* Cope<sup>23</sup> from the Trinity River at Fort Worth, Texas, was based on specimens of "*Ceratichthys vigilax*" (*Hypargyrus velox*) lately reexamined in the collection of the Philadelphia Academy. The record of *C. ornatus* from "Colorado"<sup>24</sup> was based on examples of *Notropis deliciosus*, as has recently been determined by a study of the specimens, preserved in the same institution.

Comparison of our material with the several types of *Cochlognathus ornatus* in the National Museum, the Philadelphia Academy and the Museum of Comparative Zoology has yielded no indication that they might be specifically distinct.

Dorsal rays 8 (not counting the first or clavate ray); principal anal rays 6 (rarely) or 7.

As we have already pointed out, the nuptial tubercles in this genus and species are reduced in number to a single row on the snout. The very distinctive generic feature of the hard sharp jaws is produced by the strengthening and sharpening, and breaking through the lips, of the jaw bones in the breeding male only. This conclusion rests on the examination of our series of ripe females and of males showing several stages in degree of sexual maturity and of elaboration of these secondary sexual characters. Nuptial males of "*Ceratichthys vigilax*" (*Hypargyrus velox*) show only an incipient variation in the same direction. The nuptial males of the true *Ceratichthys vigilax* (*Cochlognathus ornatus*) are black on the head and outer margin of pectoral fin, and plain brownish-black on the body, and they have distinctly reddish fins having a color pattern like those of *Hypargyrus velox*.

The discovery of the fact that all the known generic characters of "*Cochlognathus*" are confined to the breeding males, throws open the question of the proper name to be employed for the genera and species hitherto known as *Chiola* or *Ceratichthys vigilax* and as *Cochlognathus ornatus*. We are now convinced that the original type of *Ceratichthys vigilax* was a female or unripe male of the species described from ripe males by the same authors, in the following year, as *Cochlognathus ornatus*. In addition to the reason advanced in the next paragraph, we adopt this view because the type was taken in southwestern Oklahoma (not in Arkansas as carelessly and erroneously stated); that is, in a region where we se-

<sup>22</sup>Bull. U. S. Fish. Comm., 15, 1895 (1896): 342.

<sup>23</sup>Cope, Bull. U. S. Nat. Mus., 17, 1880: 37; Fowler, Proc. Acad. Nat. Sci. Phila., 76 1924: 404.

<sup>24</sup>Fowler, *l. c.*: 404.

cured only "*Cochlognathus ornatus*." The form ordinarily called *Ceratichthys vigilax* must therefore receive a new generic and specific name. For the specific name we have a choice between *Cliola velox* and *Cliola vivax*, described together by Girard in 1856. We choose the former name because Girard figured *velox* (in the General Report on the Fishes of the Pacific Railroad Survey), and his figures clearly show an example of the species generally called *vigilax*. For the generic name we have available *Hypargyrus* Forbes, based on *Hypargyrus tuditanus* (Cope) Forbes, which equals *C. velox* (the fact that the original *Hyborhynchus tuditanus* of Cope is now shown by examination of the types to be synonymous with *Hyborhynchus notatus* cannot, under present nomenclatorial practice, alter the situation). The forms currently described as *Cochlognathus ornatus* should therefore be called *Ceratichthys vigilax* Baird and Girard, and the species generally assigned the latter name, should be known as *Hypargyrus velox* (Girard).

It is so difficult to distinguish females of these two species that examples of the true or original *Ceratichthys vigilax* (equals *Cochlognathus ornatus*) which are not adult males may by some authors have been incorrectly identified as "*Ceratichthys vigilax*," (equals *Hypargyrus velox*) although a search in the National and Field Museums and the Philadelphia Academy has resulted in the finding of but one specimen so misidentified (the one from Goodland, Oklahoma, already mentioned).

Perhaps the most reliable means of distinguishing *Ceratichthys vigilax* from *Hypargyrus velox* in the absence of mature males is by measuring the eye. That of *velox* (3.3 to 4.5 in head), is usually more, and that of *vigilax* (4.0 to 5.5 in head) less than one-fourth as long as the head. The original type of *Ceratichthys vigilax* is lost; according to the description the eye is large, but Girard's measurements of small fishes are entirely untrustworthy; the original figure, which is a fairly good representation of the species called *Cochlognathus ornatus*, shows the eye very small. It is noteworthy that the two other minnows described in the same report (*Leuciscus lutrensis* and *L. bubalinus*) represent another small-eyed species, in this respect correctly figured, but erroneously described as large-eyed. The type of *Cliola velox* is supposedly lost, but the eye was figured as well as described as large. A specimen labeled as the type of *Cliola vivax* (with the statement that it is the type of *C. velox* scratched out) is extant, and has been examined in the National Museum; although the species which it is now supposed to represent was described as having the eye smaller than in *Cliola velox* it is an example of that species. The types of *Alburnops taurocephalus* Hay are also referable to *Hypargyrus velox*, but those of *Hybopsis tuditanus* Cope are examples of *Hyborhynchus notatus*.

The fact that both male and female specimens collected from June 20 to 26; exhibit a wide range of developing maturity shows that this species breeds over a rather long period during the sum-

mer, as do the related forms *Pimephales promelas* and *Hyborhynchus notatus*.

19. *Hyborhynchus notatus* (Rafinesque)

Arkansas River system:—Sta. 21, streams near Okmulgee.

20. *Pimephales promelas confertus* (Girard)

Red River system:—Sta. 3, Red River southwest of Hollis; Sta. 4, Sand Creek, near Hollis; Sta. 5, Buck Creek, southwest of Hollis; Sta. 6, Salt Fork of Red River, north of Hollis; Sta. 9, North Fork of Red River, near Sayre; Sta. 10, Washita River, north of Cheyenne.

Arkansas River system:—Sta. 11, South Canadian River, 6 miles northwest of Durham; Sta. 12, Coldwater Creek, southeast of Guymon; Sta. 13 and 14, Cimarron River, northwest and north of Kenton; Sta. 15, Willow Pond, and Sta. 16, West Carrizzo Creek, both north of Kenton; Sta. 17, Salt Fork of Arkansas River, near Ingersoll; Sta. 18, Sleeping Bear Creek, about twenty miles southwest of Buffalo; Sta. 19, South Canadian River, south of Norman; Sta. 20, Little River, east of Norman; Sta. 21, streams near Okmulgee; Alva (specimens in Field Museum).

This is one of the commonest and most widely distributed fishes in Oklahoma.

We find no character on which one might separate the *Pimephales* of the Arkansas system, usually called *P. promelas maculosus*, from *P. p. confertus* of southern Texas and northeastern Mexico. On examining Mexican material in the Field Museum, Hubbs has found that Meek miscounted the scales in *confertus*; the actual number to caudal base instead of being higher averages as low or even lower than in *maculosus*. For Mexican material the revised counts are 43 to 49, whereas for Oklahoma examples the variation is from 45 to 53. The supposedly distinctive coloration of the breeding male in *confertus* is exactly duplicated in *maculosus* as well as in typical *promelas*. Since such authors as Jordan and Gilbert who have recognized the identity of *maculosus* and *confertus*, originally described in the same paper, have adopted the latter name, this subspecies must be known as *Pimephales promelas confertus*.

This southwestern subspecies differs from the more northern races, all referred by us at present to *P. p. promelas*, in having the lateral line nearly or quite complete, the mouth less oblique and nuptial tubercles lacking on the chin. The two types grade together in central Kansas, where one meets especially with specimens having the lateral line nearly as complete as in typical *confertus*, the mouth of intermediate obliquity and the chin tubercles either absent or variously developed.

Young of the year to mature adults were taken throughout the period from June 16 to July 11.

21. *Campostoma anomalum* (Rafinesque)

Red River system:—Sta. 1 and 2, West Cache and Headquarters Creeks, respectively, in Wichita National Forest.

Arkansas River system:—Sta. 13, 15 and 16, Cimarron River, Willow Pond and West Carrizzo Creek, all near Kenton, Cimarron County; Sta. 18, Sleeping Bear Creek, about twenty miles southeast of Buffalo, Harper County.

Small adult males have few tubercles on the head and often fail to develop those on the body and along the front of the dorsal; one had only a single cone, located between left eye and nostril.

As in the north, this minnow spawns early. Young of the year of not very small size were taken from June 6 to July 11, and in most of the collections predominated over the adults.

### AMEIURIDAE

#### 22. *Ameiurus melas catulus* (Girard)

Red River system:—Sta. 3, Red River, southwest of Hollis, Harmon County; Sta. 8, pond near Sayre, Beckham County.

Arkansas River system:—Sta. 11, South Canadian River, 6 miles northwest of Durham, Roger Mills County; Sta. 12, Coldwater Creek, southeast of Guymon, Texas County; Sta. 13, Cimarron River, northwest of Kenton, Cimarron County; Sta. 16, West Carrizzo Creek, north of Kenton; Sta. 17, Salt Fork of Arkansas River, east and north of Ingersoll, Alfalfa County; Sta. 18, Sleeping Bear Creek, about twenty miles southeast of Buffalo, Harper County; Sta. 19, South Canadian River, south of Norman, Cleveland County; Sta. 20, Little River, east of Norman; Sta. 21, streams near Okmulgee.

The type of *Pimelodus catulus* Girard, lately examined in the National Museum, is clearly an example of the form here being discussed.

An examination of a large number of bullheads from various localities in the Mississippi and Great Lakes basins has yielded the view that the form *catulus* is a subspecies of *Ameiurus melas* rather than of *A. nebulosus*. Subspecies *catulus* varies directly into *melas*: the anal fin becomes higher, more rounded, shorter and of fewer rays toward the north, and at the same time the pectoral and dorsal spines become shorter, and the head more swollen. The obsolescent denticulation of the pectoral spine and the coloration of body and fins, however, are constant throughout the range of *melas*. *Ameiurus nebulosus* varies in the same fashion and same direction as *melas*, but also maintains a geographic constancy in the denticulation of the pectoral spine in the young and in the coloration. Because the two species vary in the same direction, and since this variation involves all but two of the differences which are known to exist between them, it results that the southern subspecies of *melas*, namely *A. m. catulus*, is in form and proportions almost the counterpart of the northern race of *nebulosus*. Wherever they occur together, however, the two species are usually easy to distinguish, for *nebulosus* at any one locality has a lower, flatter, and longer anal of more rays, longer fin spines and a narrower head, than *melas*. Material is being gathered for a statistical study of variation in the species of *Ameiurus*, which will give the full data at the basis of these conclusions.

*A. m. catulus* ranges from Texas northward at least through Kansas. The typical subspecies *melas* is distributed from Kentucky (examples at hand) to North Dakota.

23. *Ameiurus natalis* (Le Sueur)

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, Wichita National Forest.

CYPRINODONTIDAE

24. *Fundulus notatus* (Rafinesque)

Arkansas River system:—streams near Okmulgee.

25. *Plancterus kansae* (Garman)

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, Wichita National Forest; Sta. 3, 4, 5 and 6, Red River, Sand Creek, Buck Creek and Salt Fork of Red River, all near Hollis, Harmon County; Sta. 7, Elm Fork, north of Mangum, Greer County; Sta. 9, North Fork of Red River, near Sayre, Beckham County, and Sta. 10, Washita River, near Cheyenne, Roger Mills County.

Arkansas River system:—Sta. 11, South Canadian River, 6 miles northwest of Durham, Roger Mills County; Sta. 12, Coldwater Creek, southeast of Guymon, Texas County; Sta. 13, 14, 15, and 16, Cimarron River (two stations), Willow Pond and West Carrizzo Creek, all near Kenton, Cimarron County; Sta. 17, Salt Fork of Arkansas River, east and north of Ingersoll, Alfalfa County; Sta. 18, Sleeping Bear Creek, about twenty miles southeast of Buffalo, Harper County; Sta. 20, Little River, east of Norman, Cleveland County.

Our numerous record-stations and thousands of specimens attest to the abundance of this species throughout western Oklahoma.

The females show only a trace of the bright colors developed in the breeding males, in which the anal and pelvic fins and the lower part of the pectoral are orange or dusky red, and the rest of the pectoral fin and dusky dorsal and pale caudal fins and the predorsal stripe and the lips show more or less orange, which color may also be suffused over the body. The vertical bars in the adult male are generally fewer and wider than in females, as they total only 12 to 18, but a considerable number of these may be vertically divided by a light streak. The first bar, just behind the gill-opening, is shortened and blackened; more rarely the first two bars are so intensified, and occasionally several may be blackened in an intensity which gradually decreases backward.

Although this species is not little for an ally of *Fundulus*, it matures first at a small size (nuptial males may be as short as 35 mm. long to caudal). Young of the year were collected as early as June 16, and breeding adults were found common throughout the latter half of that month. From July 1 to 11 most of the fishes were spent, only a few remaining mature.



26. *Cyprinodon bovinus rubrofluviatilis* (Fowler)

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, Wichita National Forest; Sta. 3, Red River, six to nine miles southwest of Hollis, Harmon County; Sta. 5, Buck Creek, 5½ miles southwest of Hollis; Sta. 6, Salt Fork of Red River, 11.4 miles north of Hollis; Sta. 7, Elm Fork, four miles north of Mangum, Greer County, and Sta. 9, North Fork of Red River, near Sayre, Beckham County.

This form has hitherto been known only from Texas. These records therefore extend its range, and that of the genus in interior waters, some distance northward. Pending the completion of a revision of the species of *Cyprinodon* now being prepared by Hubbs, we refer our specimens to the form which Fowler<sup>12</sup> has rather recently described from the Red River system.

Adult females in a fresh state of preservation are brassy, with dusky brown markings; breast white; branchiostegal membranes tinged with dusky reddish. The breeding males are more pronouncedly brassy, especially on the breast. They have the body broadly and diffusely marked with purplish brown; top of head deep brown; opercles dusky; chin yellowish; branchiostegal membranes tinged with reddish. The dorsal fin of the male is dusky brassy; base of caudal fin marked with a yellow bar having a stippled border; rest of caudal often yellowish; the posterior edge of the fin indistinctly margined with black; the median region of caudal with a very indistinct and indefinite broad bar; anal fin widely margined with orange below and narrowly bordered with reddish behind; pelvics bright orange; pectorals yellowish, especially toward lower edge.

Young to adults were taken from June 16 to 21.

## POECILIIDAE

27. *Gambusia patruelis* (Baird and Girard)

Arkansas River system:—Sta. 20, Little River, ten miles east of Norman; Sta. 21, creek at Okmulgee.

The topminnow is probably confined, in Oklahoma, to the eastern half of the state.

The two females taken May 30 are swollen with young.

## PERCIDAE

28. *Poecilichthys coeruleus pulchellus* (Girard)

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, Wichita National Forest.

This lone record testifies to the scarcity of darters in western Oklahoma.

Fresh specimens are largely orange, with half bars and saddles more or less connected longitudinally toward the head, and composed of black specks connected by fine lines along the scale rows. The branchial membrane and all of the fins show an orange tinge.

<sup>12</sup>Proc. Acad. Sci. Phila., 68, 1916: 430, fig. 4.

The first dorsal is marked on the membranes by three separated lengthwise streaks, of which the median is red, and the submarginal and subbasal ones dusky; the dorsal spines are checked with black dashes.

The nomenclature of this form—usually called *Etheostoma lepidum*—is discussed in our next report.

### CENTRARCHIDAE

#### 29. *Micropterus dolomieu* Lacépède

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, Wichita National Forest.

This specimen, taken in a very deep pool, is unusually slender and speckled. Although much nearer *dolomieu* than *pseudaplites* in its appearance, it probably had the latter form for one of its ancestors (possibly even one of its parents). It comes from a locality where hybrids between these two species are excessively common.

#### 30. *Micropterus pseudaplites* Hubbs

We have a number of young and half grown paratypes of this recently named species<sup>10</sup>, all taken in the Red River system, at Sta. 1,—West Cache Creek, near Camp Boulder, Wichita National Forest. These were taken together with a large number of probable hybrids between this species and the preceding one. In the "Forty-foot Hole," found to be 23 to 27 feet deep, examples were taken with both other species of black bass.

#### 31. *Aplites salmoides* (Lacépède)

Red River system:—Sta. 1, West Cache Creek (taken in very deep pool), near Camp Boulder, Wichita National Forest; Sta. 8, muddy pond near Sayre, Beckham County.

Arkansas River system:—Sta. 12, Coldwater Creek, 8 miles southeast of Guymon, Texas County.

#### 32. *Apomotis cyanellus* (Rafinesque)

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, and Sta. 2, Headquarters Creek near Headquarters, both in Wichita National Forest; Sta. 4, Sand Creek, east and south of Hollis, Harmon County.

Arkansas River system:—Sta. 11, South Canadian River, 6 miles northwest of Durham, Roger Mills County; Sta. 12, Coldwater Creek, southeast of Guymon, Texas County; Sta. 13, Cimarron River, northwest of Kenton, Cimarron County; Sta. 17, Salt Fork of Arkansas River, east of Ingersoll, Alfalfa County; Sta. 20, Little River, ten miles east of Norman, Cleveland County, and Sta. 21, streams near Okmulgee.

Two hybrids between this species and *Allotis humilis* were taken at Sta. 20. One hybrid of another combination, *Apomotis cyanellus* × *Xenotis megalotis breviceps*, was caught at Sta. 2. These will be described and discussed later by Hubbs.

<sup>10</sup>Occ. Pap. Mus. Zool., Univ. Mich: No. 184, 1927: 1-15.

33. *Allotis humilis* (Baird and Girard)

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, Wichita National Forest; Sta. 6, Salt Fork of Red River, north of Hollis, Harmon County; and Sta. 7, Elm Fork, north of Mangum, Greer County.

Arkansas River system:—Sta. 17, Salt Fork of Arkansas River, east and north of Ingersoll, in Alfalfa County; Sta. 19, South Canadian River, four miles south of Norman; Sta. 20, Little River, ten miles east of Norman; and Sta. 21, streams near Okmulgee.

The very frail end of the bony opercle occasionally extends well beyond the middle of the black opercular or "ear" flap, very rarely almost to its margin. In such extreme variants, the degree of variation from the normal condition is different on the two sides of the fish.

34. *Helioperca incisor* (Cuvier and Valenciennes)

Red River system:—Sta. 1, West Cache Creek, near Camp Boulder, Wichita National Forest; Sta. 8, pond near Sayre, Beckham County.

Arkansas River system:—Sta. 17, Salt Fork of Arkansas River, east and north of Ingersoll, Alfalfa County, and Sta. 19, South Canadian River, south of Norman, Cleveland County.

35. *Xenotis megalotis breviceps* (Baird and Girard)

Red River system:—Sta. 1 and 2, West Cache and Headquarters Creeks, Wichita National Forest, and Sta. 4, Sand Creek near Hollis, Harmon County.

These specimens came from the general vicinity of the type-locality of *Pomotis breviceps* Baird and Girard, for the Otter Creek visited by the original collector, Capt. Marcy, is in southwestern Oklahoma, rather than in Arkansas, as always erroneously stated. The original figure of *breviceps* shows clearly that it was based on the same form later called *Pomotis fallax* by the same authors.

A hybrid between this species and *Apomotis cyanellus* was taken in Headquarters Creek, between one and two miles west of Headquarters, Wichita National Forest, Comanche County.

36. *Pomoxis sparoides* (Lacépède)

Red River system:—Sta. 8, pond near Sayre, Beckham County.

Arkansas River system:—Sta. 21, streams near Okmulgee.

The dorsal spines in both examples are 7 in number; the color and form of body, head and fins are as in northern specimens.

37. *Pomoxis annularis* (Rafinesque)

Arkansas River system:—Sta. 21, streams near Okmulgee.

## ATHERINIDAE

38. *Labidesthes sicculus* (Cope)

Several fine adults of the brook silversides were taken in the Arkansas system at Sta. 21, near Okmulgee.