A Check List of the Fishes of Iowa With Keys for Identification

By

REEVE M. BAILEY

Reprinted from
Iowa Fish and Fishing

IOWA STATE CONSERVATION COMMISSION
Des Moines, Iowa
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INTRODUCTION

Investigation of the fish fauna of Iowa has been largely concentrated into two periods, extending from 1884 to 1891, and from 1932 to the present. The pioneer work was dominated by Seth Eugene Meek, onetime Professor of Zoology in Coe College, and later Curator of Fishes at Field Columbia Museum (now the Chicago Natural History Museum). As an employee of the U. S. Fish Commission Meek examined streams systematically throughout the state, and the reports (Jordan and Meek, 1885; Meek, 1889 to 1894), together with a paper by Call (1892) still provide the bulk of the published information on the distribution of Iowa fishes. Surveys of the fishes of the Okoboji Lake region (Larrabee, 1926) and of the Keokuk section of the Mississippi River (Coker, 1930) added materially to the knowledge of the fishes of these areas. Potter and Jones (1928) compiled the Iowa fish records and prepared a revised list of the fishes of the state.

During 1932 numerous collections were assembled as part of a fishery survey for the Iowa 25-Year Conservation Plan under the direction of Dr. Carl L. Hubbs (Crane and Olcott, 1933). No report of the fishes has appeared, but the collections have been available to me at the Museum of Zoology of the University of Michigan. Aitken (1936) published a list of Iowa fishes in which the nomenclature was brought up to date by Dr. Hubbs, and a revised check-list appeared in 1941.

As the result of survey work carried on throughout the state between 1939 and 1944 by the author and his associates, from 1946 to the present by Dr. Kenneth D. Carlander and his students at Iowa State College, and in the Mississippi River from 1944 to 1948 by the Upper Mississippi River Conservation Committee, much new distributional data have been assembled, and several additions to the state fish list have been secured. It is not possible here to present the full distributional data, but a revised check-list of the fishes of the state is given.

Comparison of collections taken during the recent period with the records from Meek's survey indicates that during half a century of intensive agriculture the fish fauna has undergone profound change. Many species taken commonly by Meek are now known to be rare, if indeed they still survive in Iowa, and the distribution of others has been much restricted (Harrison, 1950). Probably extensions of range have occurred also, but the data are too limited to verify this.

The keys here presented are an outgrowth of a set of mimeographed keys to the fishes of Iowa prepared for student use at Iowa State College in 1940, when the author was a member of the staff of the Department of Zoology and Entomology. As a result of repeated use many errors have been eliminated. However, the keys included here are completely revised. In their preparation free use has been made of several of the publications listed in the bibliography, especially Forbes and Richardson (1909), the several group revisions by Hubbs and his colleagues, and Bailey (1938).

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[2]Museum of Zoology, University of Michigan, Ann Arbor, Michigan.

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Many persons have contributed materially in the field work and in various phases of the preparation of this paper. I am particularly indebted for assistance in the collection of specimens to the late Max E. Davis, Harry M. Harrison, Jr., and William F. Sigler. Everett B. Speaker, Superintendent of the Biology Department of the Iowa Conservation Commission, in addition to participating in field activities, has aided by providing information from his wide experience with Iowa fishes. The facilities of various field stations of the Iowa Conservation Commission and the cooperation of its personnel have repeatedly been utilized; I am especially grateful to William Albert, Charles King, Otto Koch, and Earl T. Rose for such aid. Kenneth Carlander has urged me to prepare this paper, and I thank him for encouragement. My colleagues, Robert Rush Miller and William Ralph Taylor, have read over most of the keys and have contributed materially in their preparation. William Brudon, staff artist of the Museum of Zoology of the University of Michigan, has prepared the line drawings and has my sincere thanks.

The bulk of the study material from Iowa is preserved in the collections of Iowa State College (I.S.C.) and the Museum of Zoology of the University of Michigan (U.M.M.Z.). Additional materials have been examined in the Chicago Natural History Museum (C.N.H.M.). I wish to thank those in charge of these collections.

SPECIES REMOVED FROM THE IOWA FAUNAL LIST

In the most recent published list, Aitken (1941) admitted 135 species and subspecies of fishes as native to Iowa. Reappraisal of that list in the light of current information indicates the need for deletion of 10 forms and the addition of 16 others. The species deleted are discussed below, and the forms added are incorporated in the revised check-list.

The numerical entry from Aitken's (1941) list is given in parentheses preceding the name (here given as in that list) of each form here deleted from the state faunal list.

(32) *Couesius plumbeus* (Agassiz). The inclusion of this species in the Iowa faunal list stems solely from the report by Meek (1892: 229), as *Couesius dissimilis* (Girard), of two small specimens from the Iowa River at Belmond. This locality is remote from the closest part of the verified range of the species and on this ground alone is subject to serious doubt. A careful perusal of Meek's description makes it clear that a misidentification is involved. The dental formula 1,5—5,1 is in sharp contrast to the typical count (2,4—4,2) of *Hybopsis plumbea,* and other characters do not agree. It is suggested that these fish may be hybrids, with *Chrosomus erythrogaster* (reported to be abundant at this locality) as one parent. The presence of small scales and 5 teeth in the main row are especially suggestive of this identification.

(50) *Notropis boops* Gilbert. The bigeye shiner has long been accorded a place on the Iowa faunal list merely because a footnote reference (Meek, 1893: 109) mentioned its presence in "southwest Iowa." This area is atypical ecologically and is distant geographically from the range of the species. In the absence of substantiating description or specimens this record is regarded as unacceptable.

(57) *Notropis deliciosus stramineus* (Cope). The problem of subspecies in *N. deliciosus* has been insufficiently studied. Whether or not the northeastern subspecies, *stramineus,* will ultimately prove acceptable is uncertain, but present indications are that the large-scaled fish from eastern and northern Iowa are all referable to one subspecies, *N. d. deliciosus,* whereas those from western Iowa, which usually have more than 25 circumferential scale rows, are *N. d. missuriensis.*

(63) *Notropis anogenus* Forbes. Listed from Iowa only on the basis of a record at Austin, Minnesota (Meek, 1892: 233 and 1893: 109), the pugnose shiner is herewith removed to the hypothetical list until such time as its occurrence in Iowa may be demonstrated.

(83) *Schilbeodes miurus* (Jordan) has been included provisionally on Iowa lists (Meek, 1893: 108; and subsequent compilations) because of its supposed occurrence in Minnesota—itself an erroneous assumption. On the basis of its general range the brindled madtom is not regarded as a likely prospect for addition to the Iowa list.

(105) *Percina caprodes caprodes* (Rafinesque). This subspecies was reported by Aitken (1941: 388) from Cedar Rapids, but the Ohio logperch is wholly or chiefly restricted to the Ohio River system. Specimens of the logperch in the Museum of Zoology of the University of Michigan from southeastern Iowa and from northeastern Missouri are identifiable as intergrades between *P. c. semifasciata* (which exists in typical form in northern Iowa) and *P. caprodes carbonaria,* the southern logperch, which is found abundantly in southern Missouri and farther south. The problem is in need of further study, but the deletion of *P. c. caprodes* from the Iowa list seems called for.

(117) *Etheostoma blennioides blennioides* Rafinesque. Meek (1893: 111) mentioned that the greenside darter was "a doubtful resident" of Iowa. For some reason subsequent compilers have retained the species on the list. Not only has continued exploration in Iowa failed to reveal its presence, but the distribution in adjacent areas (*i.e.* Forbes and Richardson, 1909, Atlas, map 89) provides good evidence that it does not enter Iowa.

(125) *Xenotis megalotis megalotis* (Rafinesque). Aitken (1941: 388) added this subspecies to the Iowa list on the basis of specimens identified by C. E. Wilson in the University of Iowa collection. It is very doubtful that more than a single subspecies of the longear sunfish occurs in Iowa, and the few available specimens examined by me prove to be *Lepomis megalotis peltastes* Cope. It is likely that Mr. Wilson misidentified specimens either of this subspecies or of *Lepomis humilis.* Several ichthyologists (Meek among others) have confused the orangespotted and longear sunfishes.

(126) *Eupomotis microlophus* Günther. It is not improbable that the redear sunfish will soon be established in Iowa through introduction, since it is a popular pond fish. It is barely possible that it occurred naturally in southeastern Iowa; however, the existing reports (see Potter and Jones, 1928: 359, listed under *Eupomotis holbrooki*) almost certainly arose from misidentifications, presumably involving interspecific hybrids which are now known to be frequent among sunfishes. In the absence of any acceptable record the species is omitted from the state list.

(133) *Cottus bairdii bairdii* Girard. Because of past confusion of the species of sculpins, it is not safe to accept old reports unless confirmed by examination of specimens. Two species of *Cottus* occur in southeastern Minnesota, and both are to be expected in northeastern Iowa. However, the several Iowa collections examined all have proved to be *C. cognatus. C. bairdi* is therefore transferred to the hypothetical list.

CHECK-LIST OF IOWA FISHES

This list comprises 25 families, 61 genera, 133 species and 137 total kinds, including subspecies, of native fishes. In addition four exotic species (brown trout, rainbow trout, carp, and goldfish) have become established and are included in the list, where they are designated by asterisks.

Recently the present author ventured a critique of the criteria for the delimitation of genera of fresh-water fishes of the United States and Canada.

This report is still unpublished, but the recommendations for change embodied therein are incorporated in this list. Also, there are introduced here a few changes in the nomenclature of species, stemming from the recommendations of the International Commission on Zoological Nomenclature promulgated at the 1948 meeting in Paris.

Petromyzontidae

Ichthyomyzon unicuspis Hubbs and Trautman—Silver lamprey. The silver lamprey was reported from the Mississippi River at Cassville, Grant County, Wisconsin, by Greene (1935: 22), and I have examined specimens in the Iowa State College collection taken in the Mississippi River near Lansing, Iowa.

Ichthyomyzon castaneus Girard—Chestnut lamprey

Lampetra lamottei (LeSueur)—American brook lamprey. The trivial name *lamottenii,* a patronymic in honor of the French explorer Lamotte, is emended in line with the recommendations of the International Commission on Zoological Nomenclature (1950: 67-68, 200-209). The group formerly treated as the genus *Entosphenus* is here regarded as a synonym of *Lampetra.*

Polyodontidae

Polyodon spathula (Walbaum)—Paddlefish

Acipenseridae

Acipenser fulvescens Rafinesque—Lake sturgeon

Scaphirhynchus platorynchus (Rafinesque)—Shovelnose sturgeon

Scaphirhynchus album (Forbes and Richardson)—Pallid sturgeon. This species, referred by some workers to a unique genus *Parascaphirhynchus,* is here included because of Coker's (1930: 154-155) report from the Mississippi River near Keokuk. Confirmation of this report is desirable. The vernacular name "pallid sturgeon" is proposed because the older name "white sturgeon" has been adopted for *Acipenser transmontanus* of the Pacific Coast.

Lepisosteidae

Lepisosteus platostomus Rafinesque—Shortnose gar

Lepisosteus osseus oxyurus Rafinesque—Northern longnose gar

Amiidae

Amia calva Linnaeus—Bowfin

Salmonidae

**Salmo trutta* Linnaeus—Brown trout. Brown trout are stocked regularly in cool spring-fed streams of northeastern Iowa. There is limited natural reproduction, and this European species may be regarded as established in Iowa.

**Salmo gairdneri* Richardson—Rainbow trout. Like the preceding, the rainbow trout is now established through plantings in northeastern Iowa. The trivial name *gairdnerii* is emended to *gairdneri* as the result of recent action by the International Commission on Zoological Nomenclature (1950: 67-68, 200-209).

Salvelinus fontinalis (Mitchill)—Brook trout

Clupeidae

Alosa chrysochloris (Rafinesque)—Skipjack

Alosa ohiensis Evermann—Ohio shad

Dorosoma cepedianum (LeSueur)—Gizzard shad

Hiodontidae

Hiodon alosoides (Rafinesque)—Goldeye
Hiodon tergisus LeSueur—Mooneye

Umbridae

Umbra limi (Kirtland)—Central mudminnow

Esocidae

Esox vermiculatus LeSueur—Grass pickerel
Esox lucius Linnaeus—Northern pike
Esox masquinongy immaculatus Garrard—Northern muskellunge

Catostomidae

Cycleptus elongatus LeSueur—Blue sucker
Ictiobus cyprinellus (Valenciennes)—Bigmouth buffalo
Ictiobus niger (Rafinesque)—Black buffalo
Ictiobus bubalus (Rafinesque)—Smallmouth buffalo
Carpiodes forbesi Hubbs—Plains carpsucker. Although only recently recognized as an inhabitant of Iowa, it is probable that the plains carpsucker is fairly widespread in the state. The University of Michigan has specimens from overflow pools of the Cedar River, Muscatine County, and the Iowa State College collection has examples from the Big Sioux River, Lyon County.
Carpiodes cyprinus (LeSueur)—Quillback
Carpiodes carpio carpio (Rafinesque)—Northern river carpsucker
Carpiodes velifer (Rafinesque)—Highfin sucker
Moxostoma duquesnei[3] (LeSueur)—Black redhorse
Moxostoma erythrurum (Rafinesque)—Golden redhorse
Moxostoma anisurum (Rafinesque)—Silver redhorse
Moxostoma aureolum (LeSueur)—Northern redhorse
Moxostoma carinatum (Cope)—River redhorse
Hypentelium nigricans (LeSueur)—Northern hog sucker
Catostomus commersoni commersoni[3] (Lacépède)—Common white sucker
Minytrema melanops (Rafinesque)—Spotted sucker
Erimyzon sucetta kennerlyi[3] (Girard)—Western lake chubsucker

Cyprinidae

**Cyprinus carpio* Linnaeus—Carp. As a result of repeated introduction and natural dispersal the carp is widely distributed in Iowa, being found in most rivers and large lakes and in many small lakes and ponds.
**Carassius auratus* (Linnaeus)—Goldfish. Although not generally common in natural waters in Iowa, occasional individuals are reported. Large populations are encountered in some municipal and farm ponds.
Notemigonus crysoleucas auratus (Rafinesque)—Western golden shiner
Semotilus atromaculatus atromaculatus (Mitchill)—Northern creek chub
Richardsonius elongatus (Kirtland)—Redside dace. Meek (1892: 234) reported *Leuciscus elongatus?* (Kirtland) from Dry Creek at Palo. Re-examination of the specimen by Dr. Carl L. Hubbs revealed that this was a hybrid minnow of uncertain ancestry, but a species of *Hybognathus* and *Semotilus a. atromaculatus* were believed to be the parents. However,

[3]This name is emended to agree with the recommendations of the International Commission on Zoological Nomenclature (1950: 67-68, 200-209).

Meek also listed *L. elongatus* (*op. cit.*, 242) from Yellow River northeast of Postville, Allamakee County, and his description of the specimens is adequate to verify the occurrence of the redside dace in Yellow River. Recent collections there have not included this species and it may now be extinct in Iowa.

Opsopoeodus emiliae Hay—Pugnose minnow. A single adult specimen of the pugnose minnow was collected by the Upper Mississippi River Survey in the Mississippi River at Muscatine, Iowa, during 1946. It was reported at the confluence of the Mississippi and Rock rivers, Illinois, by Forbes and Richardson (1909, Atlas, map 30).

Chrosomus erythrogaster (Rafinesque)—Southern redbelly dace

Hybopsis biguttata[4] (Kirtland)—Hornyhead chub

Hybopsis gracilis communis[4] (Girard)—Plains flathead chub

Hybopsis storeriana[4] Kirtland—Silver chub

Hybopsis gelida[4] (Girard)—Sturgeon chub. There are specimens of the sturgeon chub and of *Hybopsis meeki* from the Missouri River between Iowa and Nebraska in the University of Michigan and Iowa State College collections. The specimens reported from the Missouri River at Sioux City (Meek, 1892: 245) as *Hybopsis gelidus* were found on re-examination in the Chicago Natural History Museum by Dr. Raymond Johnson (personal communication) to be referable to *H. meeki*. Both species were collected 3 miles southeast of Plattsmouth, Cass County, Nebraska, and 3.5 miles west of Pacific Junction, Mills County, Iowa.

Hybopsis meeki[4] Jordan and Evermann—Sicklefin chub

Hybopsis aestivalis[4] (Girard)—Speckled chub

Hybopsis sp[4]—Gravel chub. This species, referred to as *Hybopsis* or *Erimystax dissimilis* and as *Erimystax* sp. in papers on Iowa fishes, is now rare in the state. It is apparently different from the true *H. dissimilis*, and has no available trivial name.

Rhinichthys atratulus meleagris Agassiz—Western blacknose dace

Rhinichthys cataractae (Valenciennes)—Longnose dace

Phenacobius mirabilis (Girard)—Plains suckermouth minnow

Notropis atherinoides atherinoides Rafinesque—Common emerald shiner

Notropis percobromus (Cope)—Plains shiner. The plains shiner, which may prove to be merely a subspecies of *N. atherinoides*, occurs in Iowa in the Missouri River; specimens are in the Iowa State College collection from 3.5 miles west of Pacific Junction, just above the U. S. 34 highway bridge.

Notropis rubellus (Agassiz)—Rosyface shiner

Notropis umbratilis (Girard)—Redfin shiner

Notropis illecebrosus (Girard)—Silverstripe shiner. A single specimen of the silverstripe shiner taken in the Missouri River at Sioux City by Meek was found in the Chicago Natural History Museum by Raymond E. Johnson. Subsequently I examined the same fish. This locality is not close to any other known station for the species and the possibility of an inaccurately labeled specimen must therefore be considered.

Notropis cornutus frontalis (Agassiz)—Northern common shiner

Notropis chalybaeus (Cope)—Ironcolor shiner. The small species of *Notropis* with a dark lateral band were badly confused by Meek, as a re-examination of his material in the Chicago Natural History Museum indicates. Carl L. Hubbs recognized the confusion and discovered a single specimen of the ironcolor shiner (Number 946) from the Cedar River at West Liberty and three other Iowa specimens (either Number 945 or 976) with uncertain

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[4]The species often placed in the separate genera *Couesius*, *Erimystax*, *Extrarius*, *Hybopsis*, *Nocomis*, *Oregonichthys*, *Platygobio*, and *Yuriria* are here grouped into a single genus, *Hybopsis*, which is properly to be treated as feminine.

locality data. I have confirmed Dr. Hubbs' identification of these specimens.

Notropis roseus richardsoni Hubbs and Greene—Northern weed shiner

Notropis heterodon (Cope)—Blackchin shiner

Notropis hudsonius (Clinton)—Spottail shiner

Notropis blennius (Girard)—River shiner

Notropis dorsalis dorsalis (Agassiz)—Central bigmouth shiner

Notropis amnis Hubbs and Greene—Pallid shiner. This species, which has just been described (in Hubbs, 1951), occurs in the state throughout the Iowa portion of the Mississippi River. *N. amnis* was regarded by Hubbs and Bonham (in Hubbs, 1951) as divisible into two subspecies. The weak character differences constitute clinal gradients which are probably in part, at least, the product of environmental control. The binominal is here adopted since I feel that there is inadequate basis for nomenclatorial segregation.

Notropis spilopterus (Cope)—Spotfin shiner

Notropis lutrensis lutrensis Baird and Girard—Plains red shiner

Notropis deliciosus (Girard)—Sand shiner
N. d. deliciosus (Girard)—Eastern sand shiner
N. d. missuriensis (Cope)—Plains sand shiner

Notropis topeka Gilbert—Topeka shiner

Notropis heterolepis Eigenmann and Eigenmann—Blacknose shiner

Notropis volucellus (Cope)—Mimic shiner
N. v. volucellus (Cope)—Northern mimic shiner
N. v. wickliffi Trautman—Channel mimic shiner

Notropis buchanani Meek—Ghost shiner. Most recent authors have regarded the ghost shiner as a subspecies of *N. volucellus*. The frequent occurrence of this form in company with *N. v. wickliffi*, however, placed the subspecific relationship under suspicion. Recently William Ralph Taylor discovered that in the ghost shiner the infraorbital canal is undeveloped. Utilizing this new character we have been able to identify with confidence specimens which formerly had been labeled as intergrades between the forms. *N. buchanani* is therefore accorded full specific status.

Dionda nubila (Forbes)—Ozark minnow

Hybognathus hankinsoni Hubbs—Brassy minnow

Hybognathus nuchalis nuchalis Agassiz—Western silvery minnow

Hybognathus placita (Girard)—Plains minnow

Pimephales perspicuus (Girard)—Bullhead minnow

Pimephales notatus (Rafinesque)—Bluntnose minnow

Pimephales promelas promelas Rafinesque—Northern fathead minnow

Campostoma anomalum Rafinesque—Stoneroller
C. a. pullum (Agassiz)—Central stoneroller
C. a. oligolepis Hubbs and Greene—Largescaled stoneroller. There are specimens of the largescaled stoneroller in the University of Michigan collection from Buffalo Creek at Coggon, Linn County, and from Lime Creek at Red Mill, 6 or 7 miles above Mason City, Cerro Gordo County. These specimens presumably formed the basis for Greene's (1935: 130) inclusion of eastern Iowa in the range of the subspecies.

Ameiuridae

Ictalurus lacustris lacustris (Walbaum)—Channel catfish. The nominal Mississippi valley form *punctatus* is apparently indistinguishable from the typical subspecies of the Great Lakes.

Ictalurus furcatus (LeSueur)—Blue catfish

Ameiurus nebulosus nebulosus (LeSueur)—Northern brown bullhead

Ameiurus melas melas (Rafinesque)—Northern black bullhead
Ameiurus natalis (LeSueur)—Yellow bullhead
Pilodictis olivaris (Rafinesque)—Flathead catfish
Noturus flavus Rafinesque—Stonecat
Schilbeodes insignis (Richardson)—Slender madtom
Schilbeodes mollis (Hermann)—Tadpole madtom

Anguillidae

Anguilla rostrata (LeSueur)—American eel. The name *rostrata* has line priority over *bostoniensis*, and because of the recent recommendation of the International Commission on Zoological Nomenclature (1950: 330), it becomes necessary to reinstate the name *rostrata*.

Cyprinodontidae

Fundulus diaphanus menona Jordan and Copeland—Western banded killifish
Fundulus dispar dispar (Agassiz)—Northern starhead topminnow
Fundulus notatus (Rafinesque)—Blackstripe topminnow
Fundulus sciadicus Cope—Plains topminnow

Gadidae

Lota lota maculosa (LeSueur)—Eastern burbot

Percopsidae

Percopsis omiscomaycus (Walbaum)—Trout-perch

Aphredoderidae

Aphredoderus sayanus gibbosus LeSueur—Western pirate-perch

Atherinidae

Labidesthes sicculus sicculus (Cope)—Northern brook silversides

Serranidae

Morone chrysops (Rafinesque)—White bass
Morone interrupta Gill—Yellow bass

Centrarchidae

Micropterus dolomieui dolomieui[3] Lacépède—Northern smallmouth bass
Micropterus salmoides salmoides (Lacépède)—Northern largemouth bass
Chaenobryttus coronarius (Bartram)—Warmouth
Lepomis cyanellus Rafinesque—Green sunfish
Lepomis gibbosus (Linnaeus)—Pumpkinseed
Lepomis macrochirus macrochirus Rafinesque—Northern bluegill
Lepomis humilis (Girard)—Orangespotted sunfish
Lepomis megalotis peltastes Cope—Northern longear sunfish
Ambloplites rupestris rupestris (Rafinesque)—Northern rock bass
Pomoxis annularis Rafinesque—White crappie
Pomoxis nigromaculatus (LeSueur)—Black crappie

Percidae

Stizostedion canadense (Smith)—Sauger
Stizostedion vitreum vitreum (Mitchill)—Walleye
Perca flavescens (Mitchill)—Yellow perch

Hadropterus maculatus (Girard)—Blackside darter

Hadropterus evides (Jordan and Copeland)—Gilt darter

Hadropterus phoxocephalus (Nelson)—Slenderhead darter

Hadropterus shumardi Girard—River darter

Percina caprodes semifasciata (DeKay)—Northern logperch. This subspecies occurs in northern Iowa. However, specimens in the University of Michigan collection from Taylors Slough, adjacent to the Mississippi River near Fort Madison, Lee County, Iowa, are identified as intergrades (*P. caprodes: carbonaria* × *semifasciata*) between the southern and northern subspecies.

Crystallaria asprella (Jordan)—Crystal darter

Ammocrypta clara Jordan and Meek—Western sand darter

Etheostoma nigrum Rafinesque—Johnny darter

E. n. nigrum Rafinesque—Central Johnny darter

E. n. eulepis (Hubbs and Greene)—Scaly Johnny darter. This subspecies is present in pure form in Clear Lake, the Dickinson County lakes, and perhaps in other larger lakes in northern Iowa. Intergrades between this subspecies and *E. n. nigrum* are found at many localities in northern Iowa and along the Mississippi River. Hubbs and Greene (1935: 98) first reported *eulepis* from glacial lakes in Iowa.

Etheostoma chlorosomum Hay—Bluntnose darter. The first known Iowa specimen of the bluntnose darter (U.M.M.Z. 146885) was collected in an overflow pool of the Cedar River, 5 miles south of Atalisa, Muscatine County.

Etheostoma zonale (Cope)—Banded darter

Etheostoma asprigenis (Forbes)—Mud darter

Etheostoma exile (Girard)—Iowa darter

Etheostoma caeruleum Storer—Rainbow darter

Etheostoma spectabile spectabile (Agassiz)—Northern orangethroat darter

Etheostoma flabellare lineolatum (Agassiz)—Striped fantail darter

Etheostoma microperca Jordan and Gilbert—Least darter

Sciaenidae

Aplodinotus grunniens Rafinesque—Freshwater drum

Cottidae

Cottus cognatus gracilis Heckel—Eastern slimy sculpin

Gasterosteidae

Eucalia inconstans (Kirtland)—Brook stickleback

ADDITIONAL FISHES WHICH MAY OCCUR IN IOWA

In the author's experience hypothetical lists have a poor record for accuracy in prediction. Nevertheless, knowledge of which among the undiscovered species in an area are most likely to be present is apt to stimulate search for them and to facilitate their capture. The list given here could be greatly lengthened but as presented it includes only those species which seem to have a reasonably good possibility of occurrence.

Ichthyomyzon fossor Reighard and Cummins—Northern brook lamprey. Should be sought in eastern Iowa during the spring spawning period.

Lepisosteus spatula Lacépède—Alligator gar. There is a good possibility that this species occurred in the Mississippi River near Keokuk long ago (it has been reported from above St. Louis, but it is doubtless extinct in Iowa now).

Lepisosteus productus Cope—Spotted gar. Of possible occurrence in northern or eastern Iowa. This species resembles the shortnose gar but has larger scales (in fewer than 60 rows along body) and is boldly spotted.

Catostomus commersoni suckleyi Girard—Western white sucker. Specimens of the white sucker from western Iowa may prove to belong to this subspecies.

Erimyzon oblongus claviformis (Girard)—Western creek chubsucker. This form should be looked for in quiet-water areas in eastern Iowa.

Moxostoma rubreques Hubbs—Greater redhorse. A potential addition to the Iowa list, this redhorse is apt to occur in the Mississippi River in northeastern Iowa.

Notropis cornutus chrysocephalus (Rafinesque)—Central common shiner. This subspecies, which has larger predorsal scales than the northern common shiner, may replace that form near the Missouri border in southeastern or southwestern Iowa.

Notropis anogenus Forbes—Pugnose shiner. This species probably occurred in the past in clear, weedy water in northern Iowa, and may yet be discovered there.

Schilbeodes nocturnus (Jordan and Gilbert)—Freckled madtom. Because it lives in northeastern Missouri, this species is of likely occurrence in southeastern Iowa.

Fundulus kansae (Garman)—Plains killifish. This plains species has been taken in northwestern Missouri and should be looked for in southwestern Iowa.

Gambusia affinis affinis (Baird and Girard)—Western gambusia. A species which is apt to be found in southeastern Iowa.

Etheostoma spectabile pulchellum (Girard)—Plains orangethroat darter. This inhabitant of the Great Plains may occur in southwestern Iowa.

Cottus bairdi bairdi Girard—Northern sculpin. One of the most likely species for addition to the state list, the northern sculpin should be sought in trout streams in northeastern Iowa. It resembles the slimy sculpin but has palatine teeth, unlike *cognatus*, and usually has I, 4 pelvic rays instead of I, 3.

KEYS FOR THE IDENTIFICATION OF IOWA FISHES

No adequate key or guide especially designed for the identification of Iowa fishes has heretofore been published. General works such as those of Jordan and Evermann (1896–1900), Jordan (1929), Pratt (1935), and Schrenkeisen (1938) are largely outdated by the numerous recent advances in American ichthyology. Faunal works on adjacent areas, such as those of Forbes and Richardson (1909), Eddy and Surber (1947), and Hubbs and Lagler (1947), are enormously useful, but because of their geographic limits do not cover all Iowa fishes.

The keys here presented are basically dichotomous; that is, the reader is confronted with two alternatives (*a* and *b*) at a time and makes a choice, then chooses again between two sets of opposed characters, and continues until the name of a species is reached. Item 7 in the family key involves decision from among 4 possible choices (*a*, *b*, *c*, or *d*). The contrasting characters in each pair are always indicated by the same number (for example 3*a* and 3*b*), and it is emphatically urged that users of the keys read both of the opposed characters before making a decision and proceeding.

Those who have never used keys of this sort may at first experience difficulties, but practice in "running" the keys will improve speed and accuracy. Insofar as possible the characters emphasized are external structures; internal features are subordinated. It appears impractical, however, to attempt identification of minnows without recourse to examination of pharyngeal teeth (see pp. 235 and 236). For small fish the use of a good hand lens or a low-power dissecting microscope is almost indispensable.

The accompanying illustrations and glossary of terms (pp. 233 to 237) will aid greatly in gaining familiarity with the terminology and procedures involved in identifying fish with the keys. If two measurements are compared, one is "stepped" with dividers (calipers) into the other. For example, the expression "snout 2.1 to 2.5 in postorbital length of head" means that the length of the snout (7 in fig. 1) if "stepped" with dividers is contained from

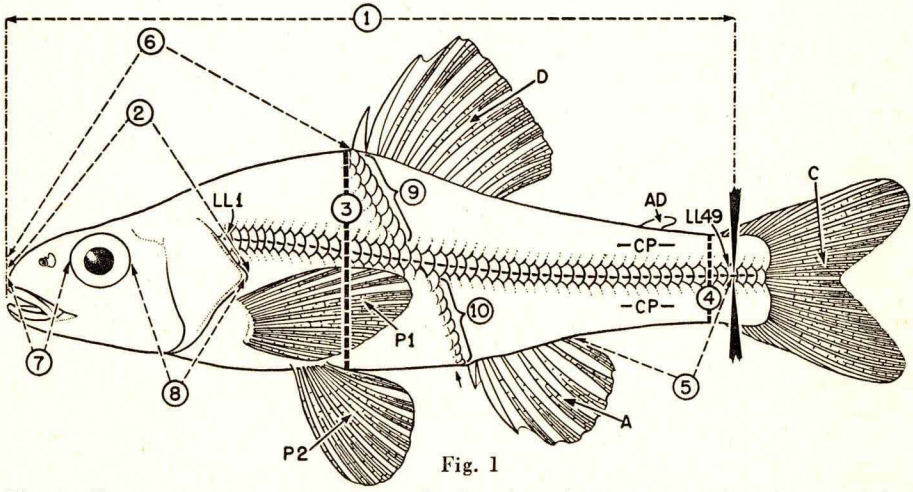


Fig. 1

Fig. 1. Topography of a fish to show the location of structures and regions used in identification and how certain measurements are made.
A., anal fin; AD., adipose fin; C., caudal fin; CP., caudal peduncle; D., dorsal fin; LL1, first scale in lateral line; LL49, last scale in lateral line to be counted; P1, pectoral fin; P2, pelvic fin. 1, standard length; 2, head length (to tip of membrane); 3, body depth; 4, least depth of caudal peduncle; 5, length of caudal peduncle; 6, predorsal length; 7, snout length; 8, postorbital length of head; 9, scales above lateral line; 10, scales below lateral line.

2.1 to 2.5 times in the distance from the back of the orbit to the back of the head (8 in fig. 1).

An unknown fish is first run to the proper family in the initial key. If there is only a single species in that family the reader is directed to the proper page in the check-list for the species name. If there are two or more species in a family a page reference to the next key is provided. After an identification has been made the reader should refer to the amplified account of that species as given elsewhere in this volume.

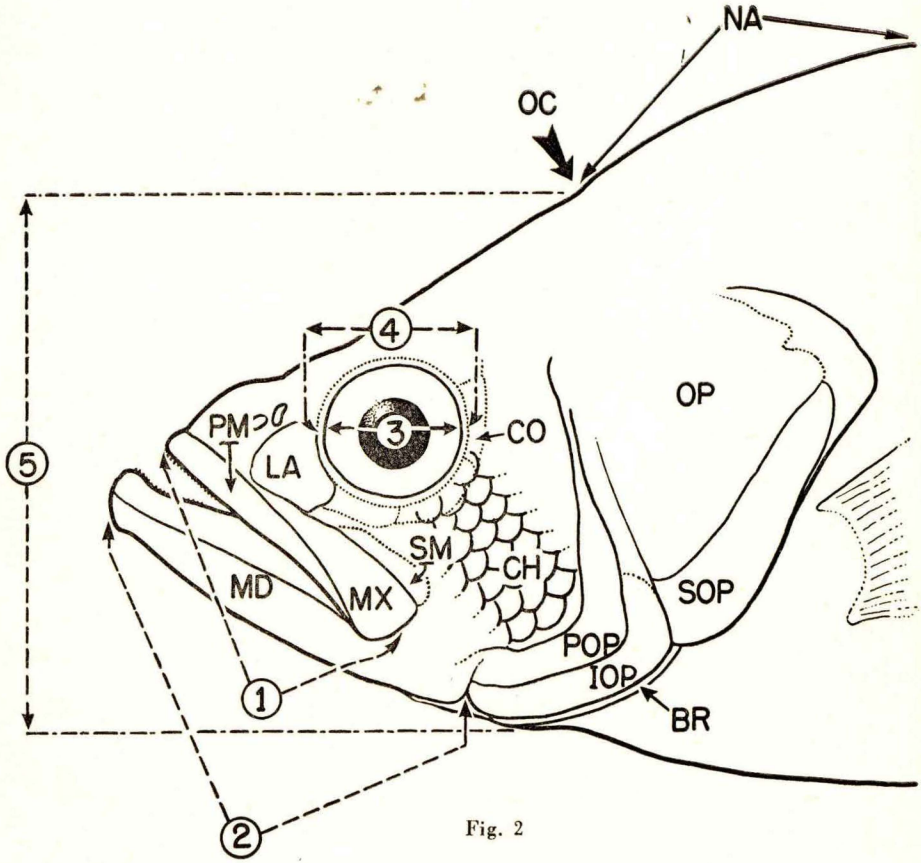


Fig. 2

Fig. 2. Head of a fish to show structures and regions used in identification. BR., branchiostegal ray; CH., cheek; CO., circumorbital; IOP., interopercle; LA., lacrymal (or preorbital); MD., mandible; MX., maxilla; NA., nape; OC., occiput; OP., opercle; PMX., premaxilla; POP., preopercle; SM., supramaxilla; SOP., subopercle. 1, length of upper jaw; 2, length of mandible; 3, diameter of eye; 4 diameter of orbit; 5, depth of head.

ARTIFICIAL KEY TO THE FAMILIES OF FISHES FOUND IN IOWA[5]

1a.—Jaws wanting; mouth a circular disc armed with horny teeth in adults. No paired fins. Nostril single and median in position. Seven pairs of small, pore-like external gill apertures. (Class Monorhina, subclass Cyclostomi) ..... PETROMYZONTIDAE (p. 208)

PETROMYZONTIDAE

1b.—Jaws present. Pectoral fins present; pelvic fins usually present. Nostrils paired. One pair of slit-like external gill apertures. (Class Osteichthyes, subclass Teleostomi) **2**

2a.—Caudal heterocercal (Fig. 3) **3**

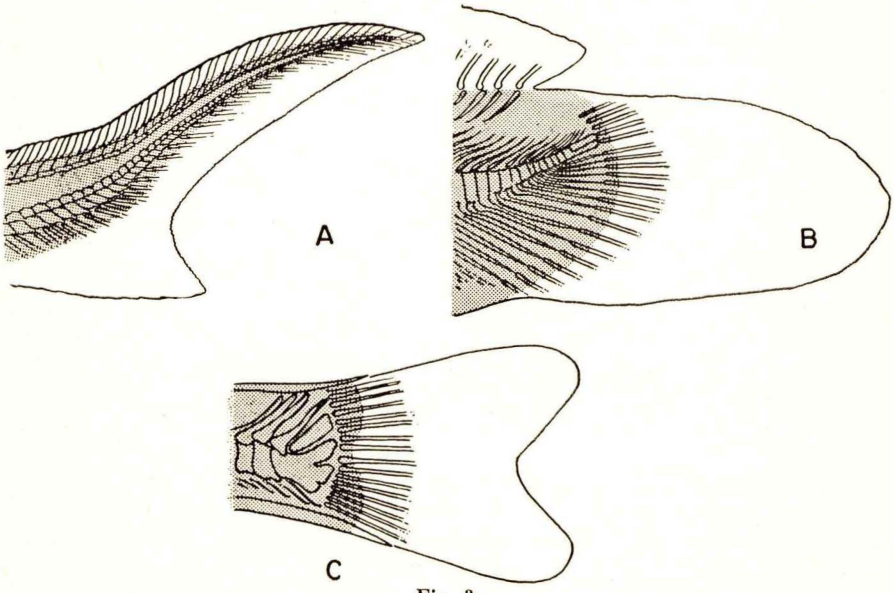


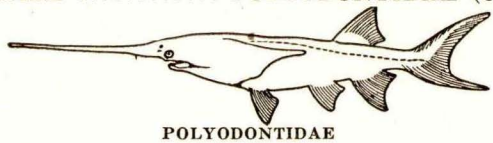
Fig. 3

Fig. 3. Three types of caudal (tail) fins. A., typically heterocercal fin of sturgeon. B., abbreviate heterocercal fin of bowfin. C., homocercal fin typical of most bony fishes.

3a.—Caudal strongly heterocercal, emarginate, the lower lobe well developed. Mouth inferior, shark-like. Jaws almost or quite toothless. Endoskeleton largely cartilaginous **4**

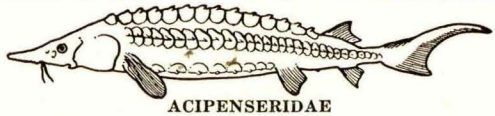
[5]The characters here ascribed to families are believed to be valid for all species living in Iowa but do not always hold for extralimital forms.

4a.—Body not armored. Snout greatly depressed and expanded laterally, paddle-like, with two minute barbels on lower surface ..... POLYODONTIDAE (one Iowa species)



POLYODONTIDAE

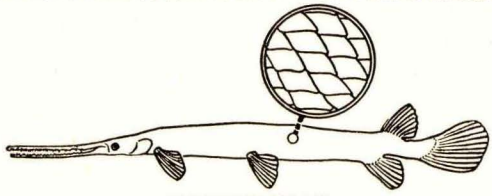
4b.—Body with several longitudinal series of strong bony plates. Snout relatively short, not paddle-like, with four elongate barbels in front of mouth).....ACIPENSERIDAE (p. 208)



ACIPENSERIDAE

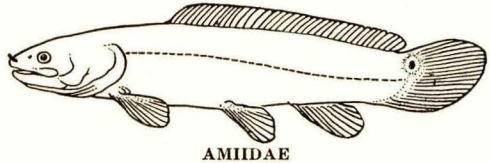
3b.—Caudal abbreviate-heterocercal, the fin rounded behind. Mouth terminal, the jaws strongly toothed. Endoskeleton largely bony **5**

5a.—Scales ganoid. No gular plate. Dorsal short, its origin behind that of anal. Snout produced into an elongate beak .....LEPISOSTEIDAE (p. 209)



LEPISOSTEIDAE

5b.—Scales cycloid. Gular plate present. Dorsal long, its origin anterior to pelvic. Snout blunt and rounded ....AMIIDAE (one Recent species)

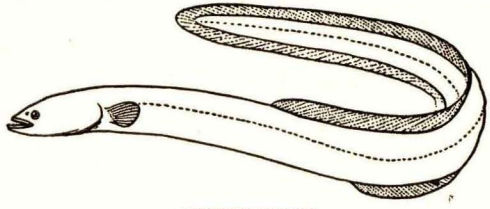


AMIIDAE

2b.—Caudal not heterocercal (the vertebral column not bent upward into the upper lobe), commonly homocercal (Fig. 3) **6**

6a.—No pelvic fins. Dorsal, caudal, and anal fins continuous..... .....ANGUILLIDAE (one Iowa species)

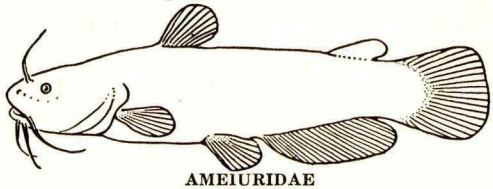
6b.—Pelvic fins present (rarely absent in abnormal individuals). Dorsal, caudal, and anal fins separate **7**



ANGUILLIDAE

7a.[6]—Pelvic fin without spine, with more than 5 soft rays. Scales, if present, cycloid. Anal fin spineless (except in introduced cyprinids). No median chin barbel **8**

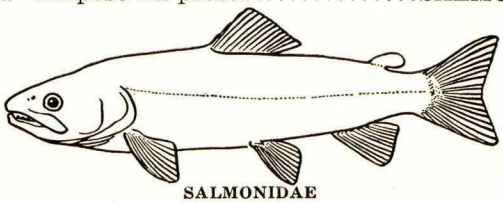
8a.—Pectoral fin with a spine. Body scaleless. Lower jaw with 4 long barbels.....AMEIURIDAE (p. 225)



AMEIURIDAE

8b.—Pectoral fin without spine. Body normally with scales. No barbels on lower jaw **9**

9a.—Adipose fin present.....SALMONIDAE (p. 209)



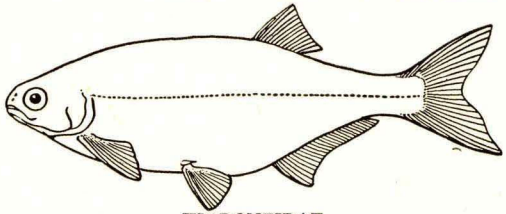
SALMONIDAE

9b.—No adipose fin **10**

10a.—Head scaleless **11**

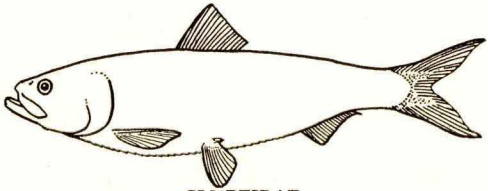
11a.—Branchiostegal membranes free from isthmus; gill slit extended forward to below eye (Fig. 4). Jaws with or without teeth **12**

12a.—Lateral line well developed. Gill rakers few, short and knob-like. Gular fold present. Midline of belly without saw-like keel .....HIODONTIDAE (p. 211)



HIODONTIDAE

12b.—No lateral line. Gill rakers numerous, long and slender. No gular fold. Scales along midline of belly modified to form a saw-like keel .....
.....CLUPEIDAE (p. 211)



CLUPEIDAE

[6]Four alternatives are listed under item 7. Utilize *all* characters provided.

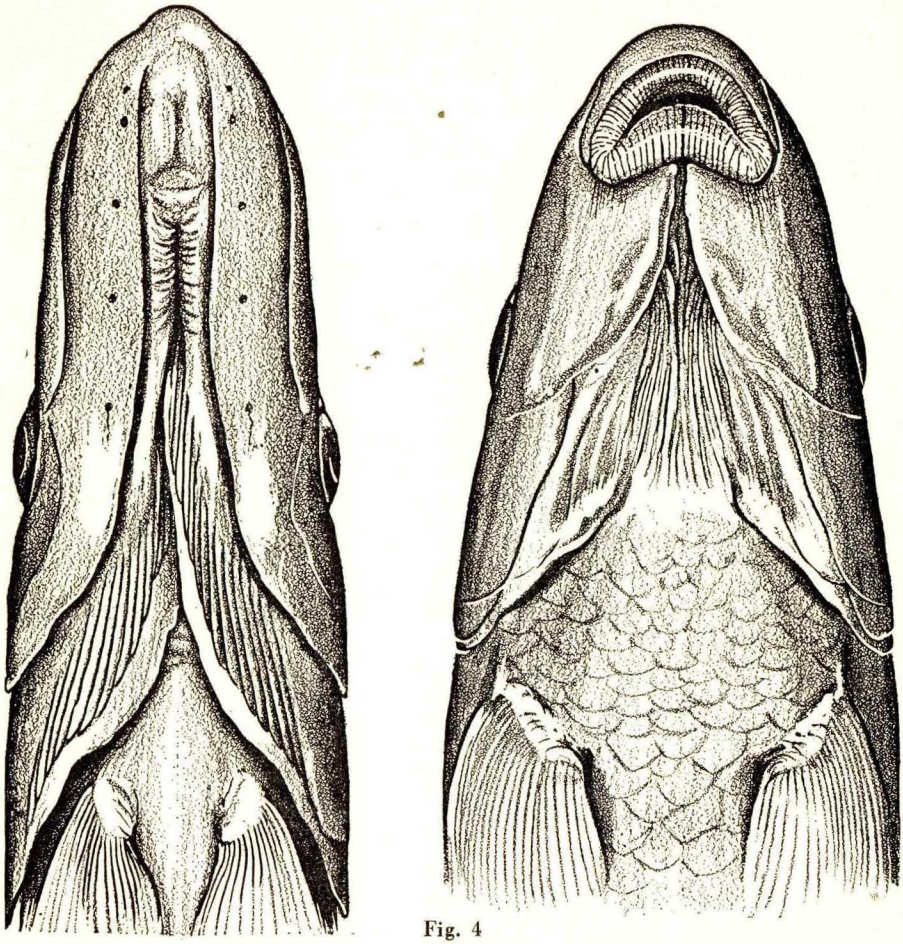


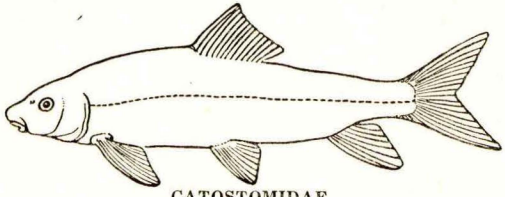
Fig. 4

Fig. 4. Undersurface of head of northern pike, *Esox lucius* (left) and golden redhorse, *Moxostoma erythrurum*. In the pike the branchiostegal membranes are separate and are not attached to the isthmus; in the sucker the membranes are attached to one another and are joined to the isthmus. Note also the series of five mandibular pores on each side in the pike, and the plicate lips of the redhorse.

11b.—Branchiostegal membranes united to isthmus and broadly conjoined, the gill slit not extended forward beyond vertical arm of preopercle (Fig. 4). Jaws toothless **13**

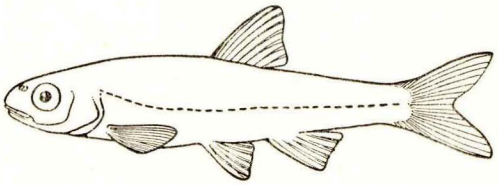
13a.—Pharyngeal arch with a single, long, comblike row of more than 20 teeth. Principal caudal rays typically 18. Anal fin placed well back on body, distance from its origin to middle of caudal base usually less than one-half the distance from anal origin for-

ward to back of head. Dorsal fin usually with 10 or more principal rays, always spineless. Mouth usually inferior, with thick fleshy lips (except in **Ictiobus cyprinellus**) .....CATOSTOMIDAE (p. 212)



CATOSTOMIDAE

13b.—Pharyngeal arch with 1 to 3 short rows of teeth, the principal row with not more than 6 teeth. Principal caudal rays typically 19. Anal fin placed farther forward on body, distance from its origin to middle of caudal base usually more than one-half the distance to head. Dorsal fin with 9 or fewer rays, or, if more numerous, with well-developed dorsal spines. Mouth variable in position, the lips usually thin.... .....CYPRINIDAE (p. 214)



CYPRINIDAE

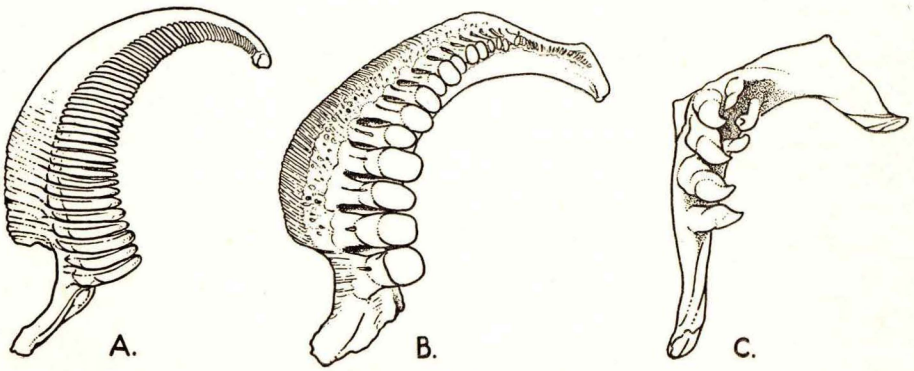


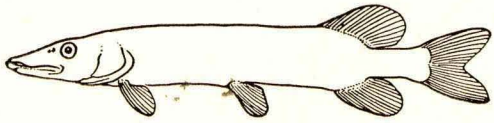
Fig. 5

Fig. 5. Left pharyngeal arches of two suckers and a minnow. A., golden redhorse, *Moxostoma erythrurum*, with many fragile teeth in a single row on a light arch. B., river redhorse, *Moxostoma carinatum*, with many molariform teeth in a single row on a heavy arch. C., creek chub, *Semotilus atromaculatus*, with hooked teeth in two rows, five in the main series and two in the lesser row.

10b.—Head partly scaled **14**

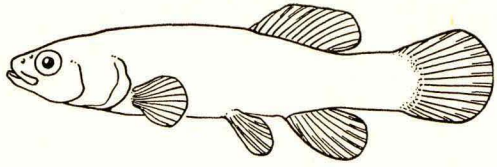
14a.—Premaxillae not protractile (the upper jaw bound to snout by a bridge of skin). Margin of upper jaw formed by premaxilla and maxilla **15**

15a.—Canine teeth present. Jaws moderately produced into a broad, duck-like snout. Branchiostegal rays 11 to 19. Caudal fin forked. Transverse scale rows more than 100 .....ESOCIDAE (p. 211)



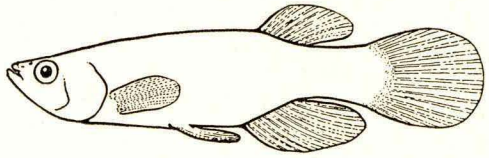
ESOCIDAE

15b.—Teeth villiform. Snout short and bluntly rounded. Branchiostegal rays 3 to 6. Caudal fin rounded. Transverse scale rows about 35..... ..... UMBRIDAE (one Iowa species)



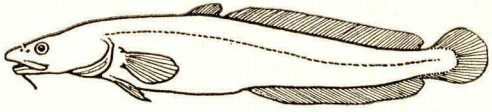
UMBRIDAE

14b.—Premaxillae protractile (the upper jaw and and snout separated by a groove). Margin of upper jaw formed by premaxilla only..... ....CYPRINODONTIDAE (p. 226)



CYPRINODONTIDAE

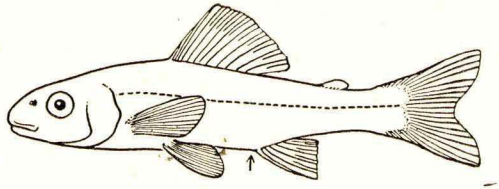
7b.[6]—Pelvic fin without spine, with 6 or 7 soft rays; jugular in position. Scales cycloid. Anal fin spineless. A well-developed median chin barbel. .... GADIDAE (one Iowa species)



GADIDAE

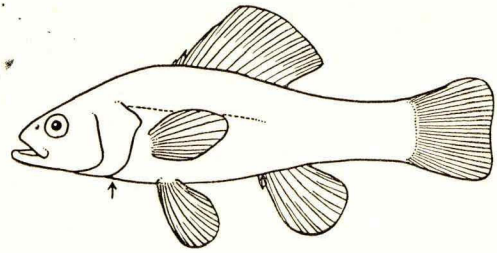
7c.[6]—Pelvic fin with a minute, splint-like spine and 7 or 8 soft rays; subabdominal or subthoracic in position. Scales strongly ctenoid. Anal fin with 1 to 3 spines. No chin barbel **16**

16a.—Adipose fin present. Vent posterior, just in front of anal fin. Preopercle and preorbital almost entire..... .....PERCOPSIDAE (one Iowa species)



PERCOPSIDAE

16b.—No adipose fin. Vent anterior to pelvic fin (except in young. Preopercle and preorbital strongly serrate..... APHREDODERIDAE (one recent species)

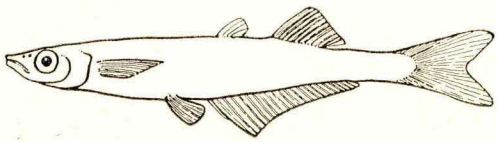


APHREDODERIDAE

7d.[6]—Pelvic fin with a well developed spine (embedded in Cottidae) and 5 or fewer soft rays; usually thoracic in position (abdominal or subthoracic in Atherinidae). Scales, if present, usually ctenoid. Anal fin usually with 1 to 9 spines (none in Cottidae). No single median chin barbel.. **17**

17a.—Pelvic fin with a spine and 5 soft rays. Body covered with scales **18**

18a.—Pectoral fin placed high on side (above axis of body). Dorsal fins well separated, the first with only 4 or 5 spines. Scales cycloid. Pelvic abdominal or subthoracic, placed well behind pectoral ....ATHERINIDAE (one Iowa species)

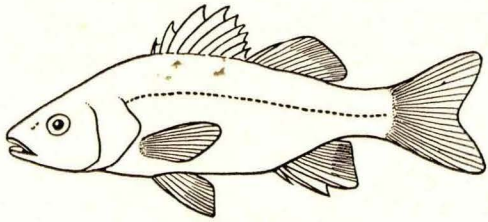


ATHERINIDAE

18b.—Pectoral fin placed lower on side (below axis of body). Usually a single dorsal fin or two fins which are not widely separated at their bases; if the fins are well separated the first has more than 5 spines. Scales ctenoid. Pelvic thoracic, placed below or scarcely behind pectoral. **19**

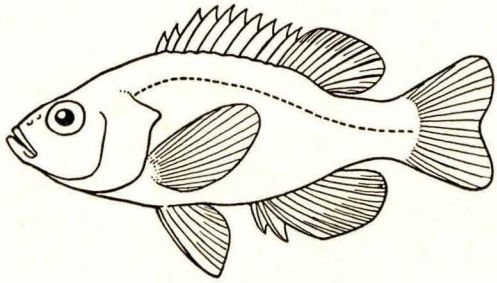
19a.—Anal spines 3 or more. **20**

20a.—Pseudobranchium well-developed, exposed. Opercle with a spine. Anal spines 3. .....
.....SERRANIDAE (p. 227)



SERRANIDAE

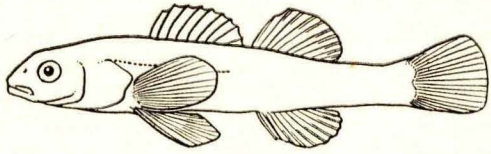
20b.—Pseudobranchium small and concealed by a membrane or wholly absent. Opercle without a developed spine. Anal spines 3 or more.
.....CENTRARCHIDAE (p. 227)



CENTRARCHIDAE

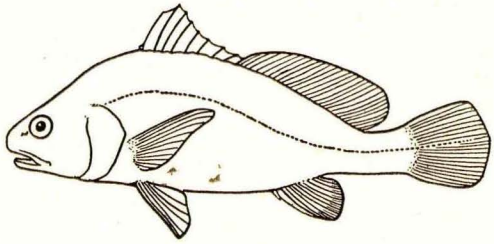
19b.—Anal spines 1 or 2 ..... **21**

21a.—Lateral line not extending far onto caudal fin. Second anal spine, if present, neither very stout nor very long. Head bones not especially cavernous. Inferior pharyngeal bones slender, separate, with sharp teeth. .....
.....PERCIDAE (p. 229)



PERCIDAE

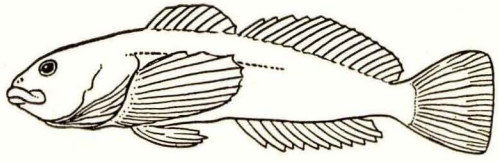
21b.—Lateral line extending well back onto caudal fin. Second anal spine very long and stout. Head bones cavernous. Inferior pharyngeal bones broad and heavy, fused, with blunt molar teeth. ..... SCIAENIDAE
.....(one Iowa species)



SCIAENIDAE

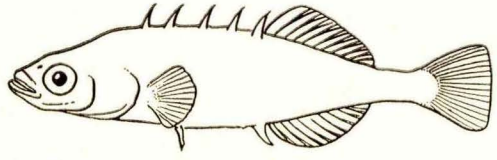
17b.—Pelvic fin with a spine and 1 to 4 soft rays. Body naked or with prickles. **22**

22a.—No free dorsal spines. No anal spine. Pelvic with an embedded spine and 3 or 4 soft rays. Pectoral fin very large and expansive. Caudal peduncle short and more or less compressed .....
.....COTTIDAE (one Iowa species)



COTTIDAE

22b.—A series of 4 to 6 free dorsal spines in front of soft dorsal fin. A single strong anal spine. Pelvic with a prominent spine and 1 soft ray. Pectoral fin not notably enlarged. Caudal peduncle elongate and slender ..... GASTEROSTEIDAE
.....(one Iowa species)



GASTEROSTEIDAE

KEY TO THE SPECIES OF PETROMYZONTIDAE (Lampreys)

1a.—Dorsal fin single, sometimes emarginate but never divided into two distinct fins. Buccal funnel with rows of well-developed horny teeth radiating outward from esophageal opening (in transformed adults). Myomeres between last gill aperture and vent 47 to 56. Adults (in Iowa species) parasitic ..... **Ichthyomyzon,** **2**

2a.—Circumoral teeth (with rare exceptions) all unicuspid. Transverse lingual lamina (with rare exceptions) moderately to strongly bilobed. Supraoral cusps usually 1 or 2 (rarely 3 or 4). Teeth in lateral rows 5 to 8 (usually 6 or 7). Teeth in anterior row 2 to 4 (usually 3).....Silver lamprey, **Ichthyomyzon unicuspis**

2b.—Circumoral teeth in part (1 to 11, usually 6 to 8) bicuspid. Transverse lingual lamina usually linear or weakly bilobed. Supraoral cusps 2 or 3. Teeth in lateral rows 6 to 11 (usually 8 or 9). Teeth in anterior row, 3 to 5 (usually 4 or 5).....
.....Chestnut lamprey, **Ichthyomyzon castaneus**

1b.—Dorsal divided by a deep notch to form two distinct but contiguous fins. Buccal funnel with the weak teeth in clusters, not in radiating rows. Myomeres between last gill aperture and vent 63 to 70. Adults (in Iowa species) free living .....
.....American brook lamprey, **Lampetra lamottei**

KEY TO THE SPECIES OF ACIPENSERIDAE (Sturgeons)

1a.—Caudal peduncle incompletely armored, short and compressed, its length from posterior end of anal to last lateral scute much less than distance from origin of anal to insertion of pelvic. Snout narrower and deeper, more or less blunt and rounded in adults. Spiracle and pseudobranchium present. Accessory opercular gill enormously developed, extending along entire inner face of operculum. Gill rakers on outer face of first arch simple. Posterior nostril smaller than eye. Barbels not fringed. Lower lip with two non-papillose lobes. Caudal fin without filament. .....
.....Lake sturgeon, **Acipenser fulvescens**

1b.—Caudal peduncle completely armored, long and much depressed, its width about twice its depth and its length much more than distance from anal to insertion of pelvic. Snout greatly expanded and depressed, "shovel-like." No spiracle or pseudobranchium. Accessory opercular gill small, with only about 20 filaments. Gill rakers on outer face of first arch fan-shaped, mostly bifid or multifid. Posterior nostril much larger than eye. Barbels coarsely fringed. Lower lip with four papillose lobes. Upper lobe of caudal produced into an elongate filament (often injured in adults). .....
..... **Scaphirhynchus,** **2**

2a.—Belly covered with small dermal plates (except in young). Inner barbel more than 2/3 (usually 3/4 to 4/5) length of outer barbel Lateral scutes larger, the depth of those near middle of trunk greater than fleshy interspace between lateral and ventral series. Snout usually shorter and less sharply angulate as seen from above. Gill rakers on outer face of lower limb of anterior arch mostly 3 to 5 pointed. Eye larger, its diameter greater than (young and half grown) or equal to (adults) anterior narial opening. Color more brownish.....
.....Shovelnose sturgeon, **Scaphirhynchus platorynchus**

2b.—Belly largely naked. Inner barbel less than 2/3 (usually about 1/2 length of outer barbel. Lateral scutes smaller, the greatest depth of those near middle of trunk less than fleshy interspace between lateral and ventral series. Snout longer and more sharply angulate (especially in large individuals). Gill rakers on outer face of lower limb of anterior arch mostly 2 or 3 pointed. Eye smaller, its diameter about equal to (young and half grown) or less than (adults) anterior narial opening. Color more pallid. .....Pallid sturgeon, **Scaphirhynchus album**

KEY TO THE SPECIES OF LEPISOSTEIDAE (Gars)

1a.—Snout short and broad, its least width contained about 5 to 7 times in its length (except in young). Interorbital width about 1.7 in postorbital length of head. Scale rows around caudal peduncle 26 to 30. ..... Shortnose gar, **Lepisosteus platostomus**

1b.—Snout long and narrow, its least width contained about 12 to 20 times in its length (except in young). Interorbital width usually about 2.0 in postorbital length of head. Scale rows around caudal peduncle 19 to 24. .... Northern longnose gar, **Lepisosteus osseus oxyurus**

KEY TO THE SPECIES OF SALMONIDAE (Trouts)

1a.—Scales larger, fewer than 140 along lateral line. Body and fins with more or less definite dark spots. Vomer flattened, the shaft itself bearing 1 or 2 rows of teeth (these not on a free crest), the posterior teeth often lost with age. Parr-markings (when evident, especially in young) scarcely or not at all wider than interspaces ..... **Salmo,** 2

2a.—Dark spots larger, fewer and more irregular; faint or absent on caudal. Adipose with a light margin, more or less orange in life (especially in young). Orange or reddish spots often present on body. Principal anal rays (including one unbranched anterior ray—Fig. 6) typically 9. Dorsal originating farther forward, much closer to tip of snout than to base of caudal (the insertion of pelvic below posterior half of dorsal base.) *Introduced* .... Brown trout, **Salmo trutta**

2b.—Dark spots numerous, smaller, and sharper; especially marked on caudal. Adipose light with a dark margin; often heavily spotted in adults. No orange or reddish spots on body; adults with a broad pink or reddish stripe along side. Principal anal rays 10 to 12 (occasionally 9 in young in which one ray has not yet become branched). Dorsal originating farther back, usually about equidistant from base of caudal and tip of snout in young and juveniles, somewhat closer to snout in adults (the insertion of pelvic below anterior half of dorsal base). *Introduced*..... ..... Rainbow trout, **Salmo gairdneri**

1b.—Scales smaller, more than 190 along lateral line. Body frequently mottled or vermiculated with dark, but without definite small dark spots (red and blue spots often present). Vomer boat-shaped; the shaft depressed, toothless. Parr-marks (when evident) conspicuously broader than interspaces. .... Brook trout, **Salvelinus fontinalis**

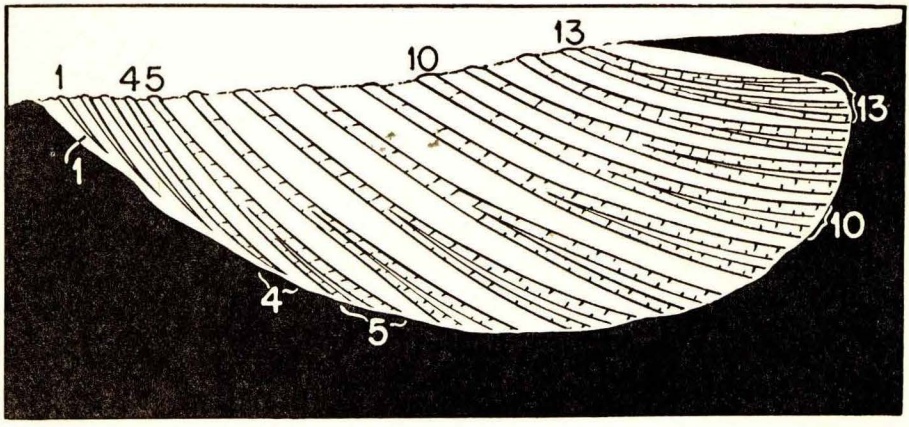


Fig. 6

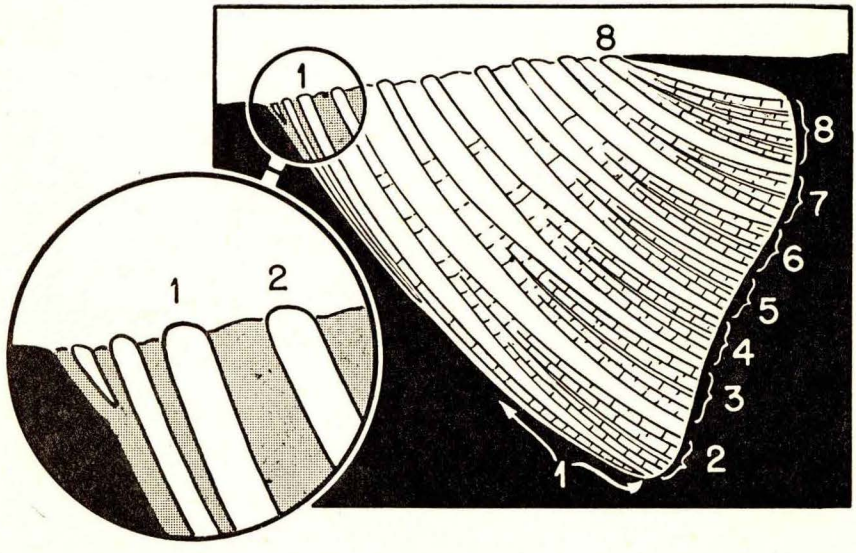


Fig. 6. Two methods of counting rays in the anal fin. Above, *total ray count*, including all rudiments, and often requiring a simple dissection at the front of the fin. Of the 13 rays the first four are simple, the remainder branched. The total ray count is employed in catfishes. Below, *principal ray count*, including all branched rays but only the third unbranched ray. The count is recorded as 8. The principal ray count is employed for both dorsal and anal fins in minnows and suckers.

KEY TO THE SPECIES OF CLUPEIDAE (Herrings)

1a.—Mouth terminal, jaws equal or the lower protruding. Maxilla extending to below center of eye. Dorsal origin in front of pelvic insertion. Posterior ray of dorsal fin not prolonged into a filament. ..... **Alosa,** 2

2a.—Jaws subequal, the upper with an acute notch at middle. Teeth on tongue in a single median row. Lower jaw teeth weak, present only in juveniles. Gill rakers longer, that nearest angle of arch when depressed extending across bases of about 10 to 12 rakers of lower limb, and more numerous, typically more than 30 on lower limb of first arch in young and more than 40 in adults. Mandible with dark pigment along most of its length. ..... Ohio shad, **Alosa ohiensis**

2b.—Lower jaw protruding well beyond upper, which is not notched, the premaxillae meeting at a broadly obtuse angle. Teeth on tongue in 2 to 4 lengthwise rows. Lower jaw teeth present at all ages. Gill rakers shorter, that nearest angle when depressed extending across bases of 6 or 7 rakers of lower limb, and fewer, about 22 on lower limb of first arch. Mandible with dark pigment only anteriorly .....Skipjack, **Alosa chrysochloris**

1b.—Mouth subterminal, the lower jaw included. Maxilla extending only to below front of eye. Dorsal origin behind pelvic insertion. Posterior ray of dorsal fin prolonged into a prominent filament (except in tiny young) .....Gizzard shad, **Dorosoma cepedianum**

KEY TO THE SPECIES OF HIODONTIDAE (Mooneyes)

1a.—Dorsal base about ½ anal base. Dorsal originating before anal; with 11 or 12 principal rays. Fleshy midventral keel not extending in front of pelvic base. Eye larger, the iris silvery. .... Mooneye, **Hiodon tergisus**

1b.—Dorsal base about 1/3 anal base. Dorsal originating behind anal; with 9 or 10 principal rays. A fleshy keel extending along midventral line from just behind pectorals to vent. Eye smaller, the iris golden. ..... Goldeye, **Hiodon alosoides**

KEY TO THE SPECIES OF ESOCIDAE (Pikes)

1a.—Lower half of opercle [as well as cheek] fully scaled. Mandibular pores (Fig. 4). Branchiostegal rays 11 to 13. Scale rows along body fewer than 115. Small, maximum length about 13 inches. .... Grass pickerel, **Esox vermiculatus**

1b.—Lower half of opercle naked. Mandibular pores 5 to 8. Branchiostegal rays 14 to 19. Scale rows along body more than 120. Large, maximum length more than 4 feet. 2

2a.—Lower half of cheek scaled. Mandibular pores 5. Branchiostegal rays 14 to 16. Scale rows along body fewer than 135. Body without dark spots or cross bars. ...Northern pike, **Esox lucius**

2b.—Lower half of cheek naked. Mandibular pores 6 to 8. Branchiostegal rays 17 to 19. Scale rows along body more than 140. Body with dark spots or cross bars ....Northern muskellunge, **Esox masquinongy immaculatus**

KEY TO THE SPECIES OF CATOSTOMIDAE (Suckers)

1a.—Dorsal fin longer, with more than 20 principal rays **2**

2a.—Lateral-line scales more than 50. Lips papillose. Head small, abruptly more slender than body. Eye closer to back of head than tip of snout ..... Blue sucker, **Cycleptus elongatus**

2b.—Lateral-line scales fewer than 50. Lips smooth or weakly plicate. Head larger and not abruptly more slender than body. Eye closer to tip of snout than to back of head **3**

3a.—Cheek shallow and shortened (distance from eye to lower posterior angle of preopercle about ¾ that to upper corner of gill-cleft). Subopercle broadest at middle, subsemicircular. Anterior fontanelle much reduced or obliterated. ..**Ictiobus,** **4**

4a.—Mouth large and oblique; upper lip about level with lower margin of orbit; upper jaw about as long as snout. Lips thin, only faintly striate. Lower pharyngeal arch thin, more than twice as high as wide. ....Bigmouth buffalo, **Ictiobus cyprinellus**

4b.—Mouth smaller, little oblique; upper lip far below lower margin of orbit; upper jaw distinctly shorter than snout. Lips fuller, more or less coarsely striate. Lower pharyngeal arch heavy, about as wide as high **5**

5a.—Body more slender but thicker, its depth 2.6 to 3.2 times in standard length. Back less elevated and less sharpened. Eye smaller. Mouth larger and less inferior. Greatest distance from mandibular symphysis to extreme end of maxilla greater than orbit in large young to small adults, and about twice orbit in large adults. ..... Black buffalo, **Ictiobus niger**

5b.—Body deeper and narrower, its depth 2.2 to 2.8 in standard length. Back more elevated and sharpened. Eye larger. Mouth smaller and more inferior. Greatest distance from mandibular symphysis to extreme end of maxilla about ⅔ orbit in small young, less than or equal to orbit in half grown and small adults, and only slightly greater than orbit in large adults. ....Smallmouth buffalo, **Ictiobus bubalus**

3b.—Cheek relatively deep and long (eye about equidistant from upper corner of gill-cleft and posteroventral angle of preopercle). Subopercle broadest below its middle, subtriangular. Anterior fontanelle well developed. .....**Carpiodes,** **6**

6a.—Scales smaller, in 37 to 40 rows along body. Lower lip without trace of a median, nipple-like projection. Opercular striations weak in adults, scarcely evident in young. Snout greatly produced. Tip of lower lip clearly in advance of anterior nostril; distance from tip of snout to anterior nostril equal to length of eye (much greater than eye in adults). **7**

7a.—Anterior rays of dorsal moderately produced, the longest extending little if any beyond middle of fin. Body broader and more slender, its depth 2.7 to 3.5 in standard length. ..... Plains carpsucker, **Carpiodes forbesi**

7b.—Anterior rays of dorsal greatly elevated, the longest extending nearly to or much beyond posterior end of fin. Body more compressed and deeper, its depth 2.5 to 3.0 in standard length .....Quillback, **Carpiodes cyprinus**

6b.—Scales larger, in 33 to 36 (occasionally 37) rows along body. Lower lip with an evident median, nipple-like projection. Opercle strongly striated in adults (weakly striate in young). Snout little produced. Tip of lower lip scarcely or not at all in advance of anterior nostril; distance from tip of snout to anterior nostril less than eye (equal in large adults). **8**

8a.—Anterior rays of dorsal little produced, the longest ray extending little if any beyond middle of fin. Body more slender, its depth 2.7 (young) to 3.3 (adults) in standard length. Eye smaller. Distance from tip of snout to anterior nostril contained more than 3 times in postorbital length of head ....River carpsucker, **Carpiodes carpio carpio**

8b.—Anterior rays of dorsal greatly elevated, the longest ray when depressed often reaching at least to posterior tip of fin (except in young). Body deep and markedly compressed, its depth 2.9 (young) to 2.4 (adults) in standard length. Eye larger. Distance from tip of snout to anterior nostril contained less than 3 times in head. ..... Highfin sucker, **Carpiodes velifer**

1b.—Dorsal fin shorter, with 17 or fewer principal rays **9**

9a.—Lateral line complete and well developed. **10**

10a.—Lateral line with 50 or fewer scales **11**

11a.—Head not depressed between eyes, the interorbital area flat or convex. Lips plicate, (Fig. 4), or weakly papillose (in **anisurum**). Air bladder with three chambers. .... **Moxostoma,** **12**

12a.—Pharyngeal arch weak, the breadth much less than depth in cross section. All teeth fragile, strongly compressed, in a comb-like series (Fig. 5). No semicircular ring of melanophores at base of each lobe of caudal ... **13**

13a.—Body scales without dark spots at base. Caudal fin olive or slate-colored. Mouth moderate to large, lower lips meeting at an obtuse or sharp angle. Head moderate to large, 3.7 to 4.7 (3.3 to 3.7 in young from 1 to 3 inches) in standard length **14**

14a.—Body more nearly terete; caudal peduncle more slender (its depth typically less than two-thirds its length). Lateral-line scales 42 to 49, usually 44 to 47. Pelvic rays usually 10 (often 9 or 11). Dorsal pointed in front, of 13 (12 to 14) rays. ..... Black redhorse, **Moxostoma duquesnei**

14b.—Body less terete; caudal peduncle deeper and shorter (its least depth typically much more than two-thirds its length). Lateral-line scales 38 to 44, usually 39 to 42. Pelvic rays usually 9 (often 8, rarely 7 or 10). Dorsal ordinarily rounded in front **15**

15a.—Plicae of lips not broken up by transverse creases into papilla-like elements. Dorsal rays 11 to 15, usually 13. Dorsal base less than distance from dorsal to occiput. Body of adults yellowish. .....
....Golden redhorse, **Moxostoma erythrurum**

15b.—Plicae of lips broken up by transverse creases into papilla-like elements. Dorsal rays 14 to 17, usually 15 or 16. Dorsal base about equal to distance from dorsal to occiput. Body of adults silvery .....
.....Silver redhorse, **Moxostoma anisurum**

13b.—Body scales on upperparts each with a dark spot at base. Caudal fin bright red in life. Mouth small, the plicate lower lips meeting in a straight line posteriorly. Head small and subconical, 4.3 to 5.4 (3.5 to 3.8 in young from 1 to 3 inches long) in standard length. [Dorsal fin falcate and pointed in front. Dorsal rays 12 to 14, usually 13; pelvic rays usually 9.] .....
.....Northern redhorse, **Moxostoma aureolum**

12b.—Pharyngeal arch heavy, the thickness greater than depth in cross section. Teeth on lower half of arch greatly enlarged, somewhat cylindrical, and few in number; the crowns worn flat, molar-like (Fig. 5). Each lobe of caudal with a semicircular row of melanophores (convex backward). [Body scales on upperparts each with a dark spot at base. Caudal fin red in life. Mouth large, the lips thick and coarsely plicate.] .....
.....River redhorse, **Moxostoma carinatum**

11b.—Head depressed between eyes, the interorbital area concave. Lips heavily papillose. Air bladder with 2 chambers. .....Northern hog sucker, **Hypentelium nigricans**

10b.—Lateral line with more than 55 scales. [Lips heavily papillose. Air bladder with 2 chambers.] .....
Common white sucker, **Catostomus commersoni commersoni**

9b.—Lateral line incomplete or absent. Lips plicate. Air bladder typically with 2 chambers. **16**

16a.—Lateral line somewhat developed anteriorly in adults. Mouth inferior, horizontal. Color pattern (not developed in young) consisting of rows of dark spots (one on each scale) along sides ..... Spotted sucker, **Minytrema melanops**

16b.—Lateral line wholly lacking at all ages. Mouth subterminal, somewhat oblique. Color pattern consisting of a broad lateral dark streak in young which is broken to form a series of vertical bars or blotches in adults. .....
..... Western lake chubsucker, **Erimyzon sucetta kennerlyi**

KEY TO THE SPECIES OF CYPRINIDAE (Minnows)

1a.—Dorsal and anal each with a strong serrated spine; dorsal fin long, with more than 15 soft rays. *Introduced species* **2**

2a.—Upper jaw with 2 long, fleshy barbels on each side. Lateral-line scales 35 to 38 (body sometimes scaleless—the "leather carp," or partially scaled—the "mirror carp"). Gill rakers on anterior arch 21 to 27. Pharyngeal teeth in 3 rows, 1, 1, 3—3, 1, 1; those of the main row short and heavy .. Carp, **Cyprinus carpio**

2b.—Upper jaw without barbels. Lateral-line scales 26 to 29. Gill rakers on anterior arch, 37 to 43. Pharyngeal teeth in a single row, 4—4, not molar-like ..... Goldfish, **Carassius auratus**

1b.—No spinous rays in dorsal or anal fins; dorsal fin short, with fewer than 10 developed rays. *Native species* **3**

3a.—Abdomen behind pelvic fins with a fleshy keel over which the scales do not pass. Anal rays 10 to 14, usually 11 to 13. Lateral line greatly decurved. Anal fin falcate. [Teeth usually 5—5].. ..... Western golden shiner, **Notemigonus crysoleucas auratus**

3b.—Abdomen behind pelvic fins rounded over and scaled. Anal rays 13 or fewer (9 or fewer in most species). Lateral line little decurved (except in **N. umbratilis**). Anal fin infrequently falcate. **4**

4a.—Pharyngeal teeth in main row typically 5—5 or 5—4 (4—4 only in rare variants). **5**

5a.—Maxilla with a flap-like barbel (Fig. 7) that is placed in a groove well in advance of its posterior tip (barbel small or obsolete in young; the mouth should be opened to expose the groove in searching for the barbel). [Pharyngeal teeth usually 2, 5—4, 2.] .....Northern creek chub, **Semotilus atromaculatus atromaculatus**

5b.—No maxillary barbel **6**

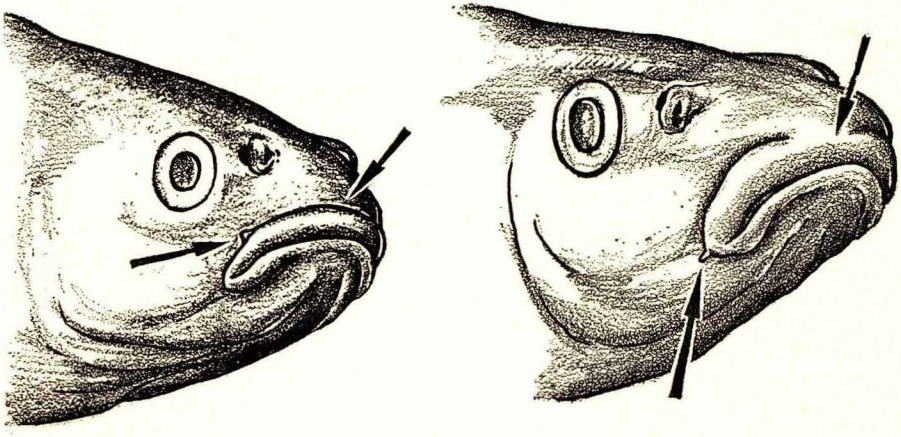


Fig. 7

Fig. 7. Three-quarter views of the heads of two minnows to show barbels and relations of snout and lip. Left: upper lip protractile (with groove, arrow, separating upper lip from snout); maxilla with a superior barbel, arrow, that is placed well in advance of its posterior end, as in *Semotilus*. Right: upper lip not protractile (with a frenum); maxilla with a terminal barbel, arrow, as in *Rhinichthys*.

6a.—Lateral line complete. Peritoneum silvery. Intestine short, less than twice as long as body, with a single main loop. Body with a single, dusky lateral band. Mouth strongly oblique. Scale radii restricted to posterior (exposed) field **7**

7a.—Scales small, in about 65 to 70 rows along body. Pharyngeal teeth usually 2, 5—4, 2. Mouth very large. Dorsal rays typically 8. ....Redside dace, **Richardsonius elongatus**

7b.—Scales large, in about 38 to 40 rows along body. Teeth usually 5—5, serrate. Mouth very small, almost vertical. Dorsal rays typically 9. ....,.....Pugnose minnow, **Opsopoeodus emiliae**

6b.—Lateral line very incomplete. Peritoneum black. Intine elongate, more than twice as long as body, with 2 crosswise coils in addition to the primary loop. Body with 2 black lateral bands. Mouth small, slightly oblique. Scales with radii in all fields. [Scales small, in more than 70 rows along body.] ....Southern redbelly dace, **Chrosomus erythrogaster**

4b.—Pharyngeal teeth in main row 4—4. ..... **8**

8a.—Maxilla with a slender barbel at its posterior end (Fig. 7)... **9**

9a.—Scale radii restricted to the posterior (exposed) field. Lateral-line scales 57 or fewer. Upper jaw protractile, separated from snout by a groove (Fig. 7). . .**Hybopsis,** **10**

10a.—Mouth large, somewhat oblique, the premaxillae terminal or but slightly exceeded by snout, scarcely below lower border of eye. Breeding tubercles (in adult males) large and sharp, directed forward, extending from between nostrils to occiput. A red spot behind eye in adult. [Teeth 1, 4—4, 1.] ....Hornyhead club, **Hybopsis biguttata**

10b.—Mouth smaller, horizontal, inferior, the premaxillae clearly exceeded by snout, and well below level of eye. Breeding tubercles minute, granular, covering most of head. No red spot behind eye. **11**

11a.—Teeth 2, 4—4, 2. Lateral-line scales 48 to 57 (usually more than 50). Head strongly depressed, broader than deep. [Fins high and falcate, pectoral overlapping pelvic in adult.] ..... Plains flathead chub, **Hybopsis gracilis communis**

11b.—Teeth 0 or 1, 4—4, 0 or 1. Lateral-line scales 50 or fewer (rarely more than 48). Head compressed, depth at occiput greater than breadth. **12**

12a.—Teeth 1, 4—4, 1 ..... **13**

13a.—Underside between pectoral and pelvic fins normally scaled. Eye large, contained 4 or less times in head. Gular area almost smooth, the sensory papillae minute. Adults 4 to 10 inches long. ....Silver chub, **Hybopsis storeriana**

13b.—Ventral surface between pectoral and pelvic fins naked, or with scales only below pelvic bones. Eye small, contained 5 or more times in head. Gular area heavily papillose. Adults less than 4 inches long. **14**

14a.—Fins scarcely or not at all falcate; anterior dorsal rays exceeded by posterior rays in the depressed fin; pectoral fin not reaching insertion of pelvic (except in adult male). Body scales with prominent keels. Lateral-line scales 40 to 43. Belly naked. Head depressed and snout more projecting, its length about equal to postorbital length of head ..... Sturgeon chub, **Hybopsis gelida**

14b.—Fins strongly falcate; anterior dorsal rays exceeding posterior rays in the depressed fin; pectoral fin reaching to or beyond insertion of pelvic. Scales without keels. Lateral-line scales 46 to 50. Belly with a few scales in prepelvic area. Head deeper and snout blunter, its length much less than postorbital length of head ..... Sicklefin chub, **Hybopsis meeki**

12b.—Teeth 4—4 ..... **15**

15a.—Anal rays usually 8. Belly (in front of pelvics) naked. Snout projecting far beyond upper lip. Barbel long, about equal to pupil. Pharyngeal arch slender, the teeth without grinding surface. Peritoneum silvery. Intestine shorter than body, with a single, primary S-shaped loop. Body heavily dotted with black..... ..... Speckled chub, **Hybopsis aestivalis**

15b.—Anal rays usually 7. Belly scaled. Snout projecting little beyond upper lip. Barbel about half diameter of pupil. Pharyngeal arch moderately heavy, the teeth with grinding surface. Peritoneum dusky. Intestine elongate, about 1.5 times body length. Body not heavily dotted with black. .....Gravel chub, **Hybopsis** sp.

9b.—Scales with radii in all fields. Lateral-line scales more than 56. Upper jaw not protractile, not separated from snout by a groove (Fig. 7) .....**Rhinichthys,** **16**

16a.—Upper jaw little exceeding lower jaw; mouth somewhat oblique. Eye lateral, larger. Lateral dark stripe rather sharply defined below. Air bladder fairly well developed, its posterior tip well behind insertion of pelvic .....Western blacknose dace, **Rhinichthys atratulus meleagris**

16b.—Upper jaw greatly exceeding lower jaw; the horizontal mouth "shark-like" in appearance. Eye superolateral, smaller. Lateral dark stripe fading out gradually both above and below. Air bladder (of adult) rudimentary, its posterior tip well ahead of insertion of pelvic.....
.....Longnose dace, **Rhinichthys cataractae**

8b.—Maxilla without a barbel (a transitory fleshy flap that simulates a barbel is present at the posterior angle of the mouth in breeding males of **Pimephales notatus**)..... **17**

17a.—Lower lip thick, rugose, with a fleshy projection on each side that is partially separated from mandible by a groove. .....
.....Suckermouth minnow, **Phenacobius mirabilis**

17b.—Lower lip rather thin and smooth, without fleshy lateral projections **18**

18a.—Cartilaginous ridge of lower jaw, if present, less prominent, and not separated by a definite groove from lower lip. Intestine not spirally looped around the air bladder. Gill rakers on first arch fewer than 15, rather short **19**

19a.—Predorsal scales usually neither greatly crowded nor conspicuously smaller than those on rest of body, in 21 or (usually) fewer rows (except in **N. cornutus** and **N. umbratilis** which have 9 or more anal rays). Second (rudimentary) ray of dorsal slender and closely adhering to first principal ray (Fig. 8). Nuptial organs not confined to a cluster of heavy tubercles on front of head.... **20**

20a.—Intestine short, much less than twice standard length, with a single S-shaped loop. Peritoneum usually silvery, often flecked with dark (occasionally or regularly black in a few species). Carnivorous..**Notropis** (see p. 218)

20b.—Intestine, elongate, more than twice standard length, with several loops. Peritoneum black. Herbivorous. [Teeth 4—4. Anal rays typically 8.] **21**

21a.—Mouth U-shaped. Pharyngeal teeth short, hooked. Suborbitals very narrow, little wider than infraorbital canal. Body with a dusky lateral band. .....
..... Ozark minnow, **Dionda nubila**

21b.—Mouth gently curved, crescent-shaped. Pharyngeal teeth long, scarcely hooked. Suborbitals broad, extending half way across cheek. Body more or less silvery or yellowish. ..... **Hybognathus,** **22**

22a.—Body yellowish in life. Scales with the radii numerous (usually nearly 20 in adult) and weak; circuli smoothly curved at basal corners of scale. Head

blunter. Fins more rounded. Size smaller, length to about 4 inches. .Brassy minnow, **Hybognathus hankinsoni**

22b.—Body silvery in life. Scales with the radii few (about 10) and strong; circuli sharply angulate (more or less squared) at basal corners of scale. Head more elongate. Fins higher. Size larger, length to about 6 inches **23**

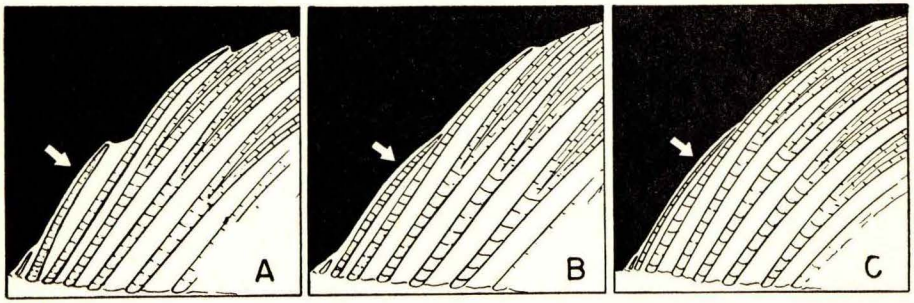


Fig. 8

Fig. 8. Comparison of anterior rays of dorsal fin in bluntnose minnow, *Pimephales notatus*, adult male (A) and adult female (B); and common shiner, *Notropis cornutus* (C). The second unbranched dorsal ray is thickened and well separated from the third (first principal) dorsal ray in A, somewhat less marked in B, and in C the second unbranched ray is slender and closely adherent to the third ray. (The first ray is so small as to be overlooked without dissection.)

23a.—Head width about equal to distance from tip of snout to back of eye. Scale rows across belly 11 to 15, usually 12 to 14 (counted just in advance of pelvic insertion, not including lateral-line rows). Eye larger. .....Western silvery minnow, **Hybognathus nuchalis nuchalis**

23b.—Head width considerably greater than distance from tip of snout to back of eye. Scale rows below lateral-line series 14 to 22, usually 15 to 18. Eye smaller. .....Plains minnow, **Hybognathus placita**

19b.—Predorsal scales crowded, much smaller than those on rest of body, in 21 or more rows. Anal rays 7. Second (rudimentary) ray of dorsal short and stout (Fig. 8), separated from first principal ray by a membrane (best developed in adult males). Nuptial tubercles large, those of head and body confined to a cluster on front of snout and (in **P. promelas**) chin. [Teeth 4—4] ..... **Pimephales,** **24**

24a.—Intestine short, forming a single S-shaped loop. Peritoneum silvery. Pharyngeal teeth rather strongly hooked. Nuptial tubercles typically 9. ....Bullhead minnow, **Pimephales perspicuus**

24b.—Intestine elongate, with several loops. Peritoneum dusky or black. Pharyngeal teeth weakly or not at all hooked. Nuptial tubercles on head usually 16 or more..... **25**

25a.—Lateral line complete. Mouth almost horizontal, subterminal. Body slender and terete. Nuptial tubercles lacking on mandible in breeding males, which have a barbel-like flap at end of maxilla ....Bluntnose minnow, **Pimephales notatus**

25b.—Lateral line incomplete. Mouth strongly oblique, terminal. Body compressed and deeper. Nuptial tubercles present on mandible and snout in breeding males, which have no barbel-like flap of skin..... .....Northern fathead minnow, **Pimephales promelas promelas**

18b.—Cartilaginous ridge of lower jaw prominent and separated by a groove from the fleshy lower lip. Intestine spirally looped about the air bladder. Gill rakers on first arch 29 to 34, moderately long and slender. .....**Campostoma,** **26**

26a.—Lateral-line scales 47 to 58 (usually 49 to 55); scales around body, just before dorsal, 38 to 50 (usually 39 to 46); sum of the two counts 86 to 107 (usually 90 to 100). Form more slender; nape arched and head narrower; gape narrower. Central stoneroller, **Campostoma anomalum pullum**

26b.—Lateral-line scales 41 to 48 (usually 43 to 47); scales around body, just before dorsal, 29 to 38 (usually 31 to 36); sum of the two counts 72 to 85 (usually 75 to 82). Form more robust; head flatter above and broader; gape wider. ..... Largescaled stoneroller, **Campostoma anomalum oligolepis**

KEY TO THE SPECIES AND SUBSPECIES OF NOTROPIS (Shiners)

1a.—Teeth in two rows, 1 or 2, 4—4, 1 or 2 typically 4—4 in **lutrensis**).... **2**

2a.—Principal anal rays 9 to 13 (occasionally 8 in **cornutus and illecebrosus**). Teeth 2, 4—4, 2 ..... **3**

3a.—Origin of dorsal well behind insertion of pelvic, nearer base of caudal than tip of snout. Anal rays usually 10 to 12. ..... **4**

4a.—Dorsal fin without black spot at base of anterior rays. Lateral-line scales 40 or fewer. Predorsal scales fewer than 25. Scales not closely imbricated, the margins more rounded; anterior lateral-line scales not much elevated. Body more slender. Fins with little or no red. **5**

5a.—Snout more blunt and shorter, its length usually contained more than 1.5 times in postorbital length of head. Eye larger, usually equal to or greater than snout. Body more compressed and deeper. Without rosy pigment. **6**

6a.—Eye larger, contained about 3 times in body depth (measured over curve). Body more slender and thicker, its depth contained 1.9 to 2.5 times in distance from dorsal origin to occiput .....Common emerald shiner, **Notropis atherinoides atherinoides**

6b.—Eye smaller, contained about 4 times in body depth (measured over curve). Body deeper and more compressed, its depth contained 1.4 to 2.0 times in distance from dorsal origin to occiput. ....Plains shiner, **Notropis percobromus**

5b.—Snout sharp and produced, its length typically contained less than 1.5 times in postorbital length of head. Eye smaller, less than snout. Body thicker and more slender. Breeding males rosy about head and base of pectoral fin. .....Rosyface shiner, **Notropis rubellus**

4b.—Dorsal fin with prominent black spot at base of anterior rays. Lateral-line scales 41 or more; predorsal scales more than 25. Scales closely imbricated, the exposed portions more diamond-shaped; anterior lateral-line scales greatly elevated. Body compressed, deeper. Fins in breeding males bright red. ....Redfin shiner, **Notropis umbratilis**

3b.—Origin of dorsal ahead of to very slightly behind insertion of pelvic, nearer tip of snout than base of caudal. **6**

6a.—Dorsal fin very high, the anterior rays much exceeding posterior rays in the depressed fin and about equal to length of head. Exposed portions of lateral scales not elevated, rounded behind. Predorsal scales about 15, not crowded or smaller than body scales .... Silverstripe shiner, **Notropis illecebrosus**

6b.—Dorsal fin of moderate height, the anterior rays not or but slightly exceeding posterior rays in the depressed fin, much shorter than head. Exposed portions of lateral scales greatly elevated, diamond-shaped. Predorsal scales more than 20, crowded and much smaller than body scales. ....Northern common shiner, **Notropis cornutus frontalis**

2b.—Principal anal rays 7 or 8 (seldom 6 or 9; typically 9 and occasionally 10 in **lutrensis,** which never has 2, 4—4, 2 teeth)..... **7**

7a.—Body with a pronounced, black lateral band which passes through eye, surrounds snout, and encroaches on mandible so that chin is black. Lateral line usually incomplete, sometimes complete in **N. roseus** **8**

8a.—Teeth usually 2, 4—4, 2 (often with 1 tooth in lesser row of one side). Breast naked below pectoral fin. **9**

9a.—Anal rays typically 8. Lateral line with more than 10 unpored scales. Nuptial tubercles well developed only on lower jaw, where a single or double series of outward-projecting tubercles borders lip; a few tubercles sometimes present on preorbital, lower cheek, and above eye. Lateral stripe more sharply delimited; scales of row below lateral line unpigmented, or with few melanophores, not dark bordered. Dark pigment

conspicuous on inner borders of jaws, floor and roof of mouth, and on oral valve .... Ironcolor shiner, **Notropis chalybaeus**

9b.—Anal rays typically 7. Lateral line with fewer than 10 unpored scales. Nuptial tubercles best developed on top of head; also present on nape, cheek, and lower jaw. Lateral stripe less sharply delimited; scale borders darkened on row below lateral line. Pigmentation on inside of mouth absent except for a few melanophores on oral valve. ..... Northern weed shiner, **Notropis roseus richardsoni**

8b.—Teeth typically 1, 4—4, 1. Breast scaled. [Anal rays usually 8. Mouth oblique, snout rather sharp] ....Blackchin shiner, **Notropis heterodon**

7b.—Body without a pronounced, black lateral band; chin unpigmented. Lateral line complete. **10**

10a.—Dorsal fin pointed in front, the anterior rays much exceeding posterior rays in the depressed fin. Eye larger, more than ¼ head length. Upper jaw straight or gently curved (in lateral aspect). Scales usually not closely imbricated, the exposed surfaces not notably deeper than long. **11**

11a.—Mouth moderately oblique, upper jaw forming an angle of more than 20° with the horizontal. Front of upper lip on level with bottom of pupil. Eyes lateral. Teeth 1 or 2, 4—4, 2 or 1 (usually with 2 teeth on one or both sides) **12**

12a.—Anal rays typically 8. A large, circular, well-defined black spot at base of caudal fin. Dorsal fin higher, its depressed length contained 1.1 to 1.3 times in distance forward to occiput. .... Spottail shiner, **Notropis hudsonius**

12b.—Anal rays typically 7. No black spot at base of caudal fin. Dorsal fin lower, its depressed length contained 1.3 to 1.6 times in distance forward to occiput. ..... River shiner, **Notropis blennius**

11b.—Mouth almost horizontal, upper jaw forming an angle of less than 15° with the horizontal. Front of upper lip on level with bottom of eye. Eyes superolateral. Teeth 1, 4—4, 1 (occasionally with tooth of minor row wanting on one side) **13**

13a.—Snout produced, but extending little in advance of upper lip. Mouth large, length of upper jaw 3.1 to 3.5 in head length. Lower lip attached to maxilla just in front of its posterior tip. Eye equal to (young) or less than length of snout. Origin of dorsal fin nearer caudal base than tip of snout. Dorsal lower, its depressed length 1.2 to 1.5 in distance forward to occiput. .....Central bigmouth shiner, **Notropis dorsalis dorsalis**

13b.—Snout blunt, extending far beyond upper lip. Mouth smaller, length of upper jaw 3.9 to 4.5 in head length. Lower lip attached to maxilla far in front of its posterior tip. Eye greater than snout. Origin of

dorsal fin nearer tip of snout than caudal base. Dorsal very high, its depressed length 0.9 to 1.0 in distance forward to occiput. [Aspect of **Hybopsis storeriana** but without a barbel.] .... Pallid shiner, **Notropis amnis**

10b.—Dorsal fin more or less rounded in front, the anterior rays much shorter than to slightly exceeding posterior rays (small juveniles) in the depressed fin. Eye smaller, less than ¼ head length in adult. Upper jaw with a definite (obtuse) angle near middle of its length. Scales more or less closely imbricated, exposed surfaces notably deeper than long **14**

14a.—Anal rays typically 8 (rarely 7 or 9). Scales usually 36 to 38. Body more elongate, its depth 3.6 to 4.1 in standard length. Dorsal (especially in adults) with a black blotch on membranes between posterior rays. Anal yellow in breeding males. Teeth usually 1, 4—4, 1. ..... Spotfin shiner, **Notropis spilopterus**

14b.—Anal rays usually 9 (often 8 or 10). Scales usually 34 or 35. Body deeper, its depth 2.7 (adults) to 3.7 (young) in standard length. Dorsal without black blotch. Anal red in breeding males. Teeth usually 4—4. ...Plains red shiner, **Notropis lutrensis lutrensis**

1b.—Teeth in a single row, 4—4 (occasionally 1, 4—4, 1 or 1, 4—4, 0 in **lutrensis**). **15**

15a.—Anal rays usually 9 (often 8 or 10). Bodly depth 2.7 to 3.7 in standard length. Scales closely imbricate. .... Plains red shiner, **Notropis lutrensis lutrensis**

15b.—Anal rays 7 or 8 (rarely 9). Body usually slender, depth 3.5 to 5.5 in standard length. Scales not closely imbricate, more or less rounded behind and loosely attached **16**

16a.—Anal rays typically 7 (rarely 6 or 8). **17**

17a.—Mouth nearly horizontal. Fins lower; length of depressed dorsal contained usually 2.2 to 2.3 times in predorsal length. Eye larger, greater than snout length, contained less than 3.5 times in head length. Lateral stripe weakly developed, with at most an indistinct dark spot at base of caudal. Nuptial tubercles granular. Body and fins without red **18**

18a.—Scale rows around body just in advance of dorsal and pelvic fins 21 to 27, usually 22 to 25 ....Eastern sand shiner, **Notropis deliciosus deliciosus**

18b.—Scale rows around body 24 to 37, usually 26 to 29. Plains sand shiner, **Notropis deliciosus missuriensis**

17b.—Mouth oblique, upper jaw forming an angle of over 30° with the horizontal. Fins higher; length of depressed dorsal usually 1.8 to 1.9 times in predorsal length. Eye smaller, less than snout length, contained more than 3.5 times in head. A prominent, lateral dusky stripe terminating at base of caudal in a distinct, though small, dark spot. Nuptial tubercles on head coarse and sharp. Nuptial males with the fins and lower sides bright red or orange. ..... Topeka shiner, **Notropis topeka**

16b.—Anal rays typically 8 (rarely 7 or 9). **19**

19a.—Anterior lateral-line scales not appreciably elevated, rounded behind. Dark lateral band conspicuous, marked with vertical black crescents. Infraorbital canal interrupted, usually in three sections. .... Blacknose shiner, **Notropis heterolepis**

19b.—Anterior lateral-line scales greatly elevated, the exposed surface 2 to 5 times higher than long. Lateral band undeveloped or at most dusky, not marked with black crescents. Infraorbital canal complete or absent, not in three disconnected tubes. **20**

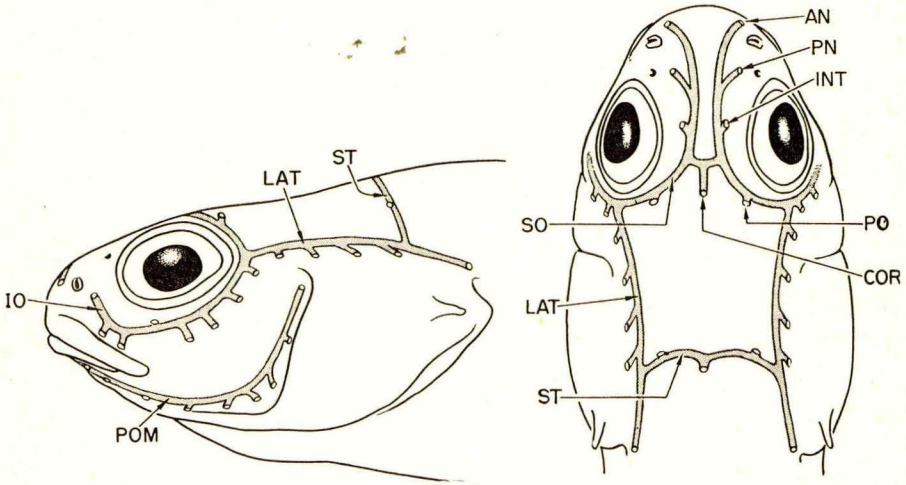


Fig. 9

Fig. 9. Head canals and pores in a darter. The infraorbital and supratemporal canals are complete with 8 and 3 pores respectively. AN., anterior nasal pore; C., coronal pore; IN., interorbital pore; IO., infraorbital canal; LAT., lateral canal; PN., posterior nasal pore; PO., postorbital pore; POM., preoperculomandibular canal; SO., supraorbital canal; ST., supratemporal canal.

20a.—Infraorbital canal complete, extending from lateral canal, below eye, across preorbital to a point in front of nostril. Fins lower and less notably falcate: length of the depressed dorsal 1.9 to 2.6 in predorsal length; pelvic not reaching origin of anal. Length of caudal peduncle 4.2 to 5.1 in standard length. Lateral-line scales less highly elevated. Pigmentation more profuse and more uniformly distributed over body **21**

21a.—Body more slender, greatest depth 4.7 to 5.1 in standard length, and least depth of caudal peduncle 2.7 to 3.1 in head length. Fins lower, height of dorsal 2.2 to 2.6 in predorsal length. Caudal peduncle length 4.2 to 4.7 in standard length. An inhabitant of creeks and lakes. .....Northern mimic shiner, **Notropis volucellus volucellus**

21b.—Body more compressed and deeper, greatest depth 4.0 to 4.7 in standard length, and least depth of caudal peduncle 2.4 to 2.6 in head length. Fins

higher, length of depressed dorsal 1.9 to 2.1 in predorsal length. Caudal peduncle length 4.7 to 5.1 in standard length. An inhabitant of large rivers.... Channel mimic shiner, **Notropis volucellus wickliffi**

20b.—Infraorbital canal wholly undeveloped, or (rarely) represented by a short section of the tube. Fins higher and more falcate: dorsal height 1.8 to 2.0 in predorsal length; pelvic reaching or exceeding origin of anal. Length of caudal peduncle 3.8 to 4.3 in standard length. Anterior lateral-line scales excessively elevated. Very pale, but with melanophores forming a dark spot just in front of dorsal origin, a dark vertical bar at base of caudal, a narrow axial streak on caudal peduncle, and a conspicuous dark peritroct. ..... Ghost shiner, **Notropis buchanani**

KEY TO THE SPECIES OF AMEIURIDAE (Catfishes)

1a.—Adipose fin with posterior margin free; not fused or continuous with caudal fin. **2**

2a.—Anal rays (including all rudiments) 17 to 35. Premaxillary band of teeth transverse, bar-shaped, without lateral, backward projecting processes. Jaws equal or the upper jaw protruding; head not greatly depressed. Adipose of moderate size **3**

3a.—Caudal fin deeply forked. Anal rays 24 to 35. Supraoccipital bone prolonged backward forming a continuous bony bridge from head to dorsal fin. ..... **Ictalurus,** **4**

4a.—Anal shorter, its base about 3.4 to 3.7 in body, with 24 to 29 rays. Body silvery, more or less heavily spotted with dark (spots often obscure in adults, especially during the breeding season). Air bladder with 2 chambers ....Channel catfish, **Ictalurus lacustris lacustris**

4b.—Anal very long, its base about 2.9 to 3.1 in standard length, with 30 to 35 rays. Body silvery, nearly or quite immaculate. Air bladder with 3 chambers. ....Blue catfish, **Ictalurus furcatus**

3b.—Caudal fin not forked, more or less truncate or rounded behind. Anal rays 17 to 27. Supraoccipital bone not reaching dorsal fin, the bony bridge interrupted. .....**Ameiurus,** **5**

5a.—Anal rays (including all anterior rudiments) 17 to 24. Chin barbels dusky. Caudal fin slightly emarginate. **6**

6a.—Anal rays 21 to 24, usually 22 or 23. Pectoral spine with rather strong posterior serrations. Black pigment on anal fin typically densest on the membranes near their margin, or in spots forming an obscure longitudinal bar near base of fin, or in faint mottlings on both rays and membranes (in pale and unmottled specimens membranes and rays are about equally pigmented). Adults with the belly white .....Northern brown bullhead, **Ameiurus nebulosus nebulosus**

6b.—Anal rays 17 to 21. Pectoral spine smooth or only weakly roughened posteriorly. Outer ⅔ of interradial membranes of anal fin uniformly pigmented, always dark-

er than the rays, the fin not mottled, barred, or uniformly pigmented on both membranes and rays. Adults with the belly yellow.....
.....Northern black bullhead, **Ameiurus melas melas**

5b.—Anal rays 24 to 27 (usually 25 or 26). Chin barbels white. Caudal fin convexly rounded. [Black pigment on anal fin usually most pronounced in a narrower, marginal edging and in a wider bar just distal to base of fin. Fin neither mottled nor with dark dashes on interradial membranes.] ..... Yellow bullhead, **Ameiurus natalis**

2b.—Anal fin (including all rudiments) 15 to 17. Premaxillary band of teeth U-shaped, the transverse portion with a backward projecting process on each side. Lower jaw projecting, the head markedly depressed. Adipose very large.....
..... Flathead catfish,**Pilodictis olivaris**

1b.—Adipose fin a low, keel-like fleshy ridge which is fused or continuous with caudal fin. **7**

7a.—Premaxillary band of teeth U-shaped, the transverse portion with a backward-projecting process on each side. Skin thicker and tougher. Size larger, maximum length 9 to 12 inches.....
..... Stonecat, **Noturus flavus**

7b.—Premaxillary band of teeth transverse, bar-shaped, without lateral backward-projecting processes. Skin thinner and smoother. Size small, maximum length about 5 inches..... **Schilbeodes,** **8**

8a.—Pectoral spine strongly serrate along posterior edge. No dark streak along side. Notch between adipose and caudal more or less acute. Head strongly depressed; upper jaw projecting. Anal rays 18 to 21; pectoral rays usually I, 9; and pelvic rays usually 9. ..... Slender madtom, **Schilbeodes insignis**

8b.—Pectoral spine grooved but without serrations. A conspicuous dark narrow streak along side. Notch between adipose and caudal shallow or absent, never acute. Head short and deep; jaws equal. Anal rays 13 to 18, usually 14 to 16; pectoral rays I, 6 or 7; and pelvic rays usually 8.....
..... Tadpole madtom, **Schilbeodes mollis**

KEY TO THE SPECIES OF CYPRINODONTIDAE (Killifishes and Topminnows)

1a.—Dorsal fin originating ahead of anal fin, distance from dorsal origin to caudal base 1.2 to 1.5 in predorsal length. Dorsal fin with 11 to 14 rays. Scale rows on body 38 to 49, usually 40 to 45. Body with vertical dark bars .....
.....Western banded killifish, **Fundulus diaphanus menona**

1b.—Dorsal fin originating behind anal fin, distance from dorsal origin to caudal base 1.9 to 2.5 in predorsal length. Dorsal fin with 7 to 10 rays. Scale rows on body 33 to 36. Body without vertical dark bars except in males of **F. dispar.** **2**

2a.—Pores along preopercular canal 7. Scale rows around body (before pelvic fins 25 to 28. Anal fin rays 10 or 11 (rarely 12). Body pattern prominent **3**

3a.—Body with many lengthwise streaks (females) or with slender vertical bars superimposed on horizontal streaks (males). Chin light. A broad, dark subocular bar. Fins immaculate.
.....Northern starhead topminnow, **Fundulus dispar dispar**

3b.—Body with a black lateral stripe, which is very regular (females) or with vertical projections (males). Chin black. No subocular dark bar. Dorsal, caudal, and anal fins more or less speckled with dark. ....Blackstripe topminnow, **Fundulus notatus**

2b.—Pores along preopercular canal 8. Scale rows around body 30 to 35. Anal fin rays typically 12 (rarely 11 or 13). Body pattern not prominent, with a faint dark lateral band on a uniform dusky body. ..... Plains topminnow, **Fundulus sciadicus**

KEY TO THE SPECIES OF SERRANIDAE (Basses)

1a.—Anal rays III, 11 to 13; the spines graduated in length, the second much shorter than third. Dorsal fins entirely separate at their bases. Lower jaw projecting. Base of tongue with teeth. Color largely silvery, the lateral stripes narrower and not usually sharply broken or offset above origin of anal. .... White bass, **Morone chrysops**

1b.—Anal rays III, 10; the spines not graduated in length, the second and third subequal. Dorsal fins joined at their bases. Jaws nearly equal. Base of tongue toothless. Color largely yellowish or olive, the lower lateral stripes broader and usually sharply broken and offset above origin of anal. ..... Yellow bass, **Morone interrupta**

KEY TO THE SPECIES OF CENTRARCHIDAE (Sunfishes)

1a.—Anal spines 3 (rarely 2 or 4). Dorsal spines usually 10 ..... **2**

2a.—Body elongate, depth 3 to 5 in standard length (somewhat deeper in large adults). Lateral-line scales more than 55. Precaudal vertebrae typically 15. ..... **3**

3a.—Outline of spinous dorsal gently curving, the shortest spine at emargination more than half as long as the longest. Anal and soft dorsal with scales on membranes near base. Pyloric caeca typically unbranched. Scales smaller, 68 to 81 along lateral line, and 14 to 18 rows on cheeks from eye to angle of preopercle. Pattern consisting principally of vertical dark bars, becoming obscured with age; young with base of caudal yellow succeeded by a marked dark band and the edge of fin clear white. ..... Northern smallmouth bass, **Micropterus dolomieui dolomieui**

3b.—Outline of spinous dorsal angulate, the shortest spine at emargination less than half as long as longest. Anal and soft dorsal normally without scales on membranes near base. Pyloric caeca typically branched at base. Scales larger, 58 to 69 along lateral line, and 9 to 12 rows on cheeks from eye to angle of preopercle. Pattern consisting chiefly of a rather regular longitudinal dark stripe on side; young without marked band on caudal. ..... Northern largemouth bass, **Micropterus salmoides salmoides**

2b.—Body compressed, oblong; depth usually 2.0 to 2.5 in standard length. Lateral-line scales fewer than 55. Precaudal vertebrae typically 12. **4**

4a.—Tongue, ectopterygoid, and entopterygoid toothed. Supramaxilla well developed, its length greater than breadth of maxilla. ..... Warmouth, **Chaenobryttus coronarius**

4b.—No teeth on tongue, ectopterygoid, or entopterygoid. Supramaxilla reduced or wanting, its length much less than breadth of maxilla. ..... **Lepomis,** 5

5a.—Opercle (not including membrane) stiff to its margin; not fimbriate along posterior edge 6

6a.—Pectoral short and broadly rounded; about 4 in standard length. Gill rakers moderately long and slender, the largest if depressed extending to base of second (third in young) raker below. Supramaxilla about ⅔ breadth of maxilla. Inferior pharyngeal bone elongate, external margin straight, teeth rather sharp. Palatine teeth fairly well developed. Opercle broadly margined with light, without scarlet in life. .... Green sunfish, **Lepomis cyanellus**

6b.—Pectoral long and pointed; 3.0 to 3.3 in standard length. Gill rakers short and stout, the longest if depressed extending to base of first (second in young) raker below. Supramaxilla about ⅓ breadth of maxilla. Inferior pharyngeal bone broad and heavy, the external margin a sigmoid curve, teeth blunt. Palatine teeth normally absent (often a single tooth developed). Opercular margin dark, with a small semicircular scarlet spot. .....Pumpkinseed, **Lepomis gibbosus**

5b.—Opercle produced into a thin, flexible projection lying within the opercular membrane; often more or less fimbriate or ragged posteriorly. 7

7a.—Gill rakers short and stout, knob-like; the longest when depressed not extending beyond first raker below (except in young). Longest anal spine usually 1.8 to 2.4 (1.4 or more in young) in distance from insertion of pelvic to origin of anal. Pectoral short, obovate. Caudal vertebrae typically 18. ..... Northern longear sunfish, **Lepomis megalotis peltastes**

7b.—Gill rakers rather long and slender, the longest when depressed extending to base of second raker below (third in young). Longest anal spine usually 1.0 to 1.8 in distance from insertion of pelvic to origin of anal (1.0 to 1.4 in young). Pectoral moderate to long. Caudal vertebrae typically 17. 8

8a.—Palatine teeth present. Sensory cavities of head well developed, the supraorbital canals wider than interspace. Opercle extending little into membranous flap, its margin entire; opercular membrane broadly margined with light. Anal III, 7 to 9. No dark blotch on posterior dorsal rays. ....Orangespotted sunfish, **Lepomis humilis**

8b.—Palatine teeth absent. Sensory cavities of head not enlarged, the supraorbital canals much narrower than interspace. Opercle extending almost to membranous margin, edge of opercle fimbriate. Anal III, 10 to 12. A dark blotch on median portion of posterior dorsal rays. ..... Northern bluegill, **Lepomis macrochirus macrochirus**

1b.—Anal spines 5 to 7, usually 6. Dorsal spines not 10. ..... **9**

9a.—Dorsal spines 11 or 12; base of anal contained 1.7 to 2.0 times in base of dorsal. Gill rakers moderate in length, fewer than 15. Branchiostegal rays 6. Preopercle nearly entire. .... Northern rock bass, **Ambloplites rupestris rupestris**

9b.—Dorsal spines 6 to 8; base of anal about equal to base of dorsal. Gill rakers long and slender, more than 30. Branchiostegal rays 7. Preopercle finely serrate. ..... **Pomoxis,** **10**

10a.—Dorsal spines normally 6. Dorsal base much less than distance from origin of dorsal to posterior margin of eye (58 to 65 per cent of distance from tip of snout to origin of dorsal). Caudal vertebrae typically 18. Mouth moderately oblique. ..... White crappie, **Pomoxis annularis**

10b.—Dorsal spines normally 7 or 8. Dorsal base equal to or greater than distance from origin of dorsal to posterior margin of eye (73 to 81 per cent of distance from tip of snout to origin of dorsal). Caudal vertebrae typically 19. Mouth strongly oblique. ..... Black crappie, **Pomoxis nigromaculatus**

KEY TO THE SPECIES OF PERCIDAE (Perches and Darters)

1a.—Preopercle strongly serrate. Branchiostegal rays 7 (rarely 8). No distinct genital papilla. Top of skull ridged; supraoccipital crest high. Fishes of medium to large size. **2**

2a.—Strong canine teeth on jaws and palatine. Pelvic fins widely separated (interspace equal to width of fin base). Body slender and subterete. Anal II, 12 or 13. Pseudobranchium well developed. ..... **Stizostedion,** **3**

3a.—Spinous dorsal with clear-cut black spots (except in young), but without a large black blotch near base of posterior spines. Dorsal soft rays 17 to 20. Cheek usually well scaled. Pyloric caeca 5 to 8, each shorter than stomach. Back with 3 or 4 dark saddles, these expanded laterally to form 3 prominent oblong blotches—one below each dorsal fin and a smaller one on caudal peduncle. ..... Sauger, **Stizostedion canadense**

3b.—Spinous dorsal without clearly defined black spots; a large black blotch near base of posterior spines. Dorsal soft rays 19 to 22 (rarely 19). Cheeks usually with few scales. Pyloric caeca 3, each about as long as stomach. Back crossed with about 6 or 7 narrow dark saddles. .... Walleye, **Stizostedion vitreum vitreum**

2b.—No canine teeth. Pelvic fins close together. Body rather deep and compressed, crossed with about 7 prominent vertical dark bands. Anal II, 6 to 8. Pseudobranchium rudimentary .... Yellow perch, **Perca flavescens**

1b.—Preopercle nearly or quite entire (in Iowa species). Branchiostegal rays 6 (rarely 5). Genital papilla prominent. Top of head nearly or quite smooth; supraoccipital crest weak or absent. Fishes of small size, the largest only 6 or 7 inches long, most much smaller. [Pseudobranchium rudimentary or absent.] **4**

4a.—Interpelvic space and belly either naked (see **5b**) or with enlarged and modified median scales which are strongly ctenoid (modified scales sometimes much reduced in size and occasional-

ly of normal size in females, but at least one enlarged interpelvic scale typically present). Anal fin large, about equal to or larger than soft dorsal (somewhat smaller in **Percina**). Body usually more slender and more terete. [Pelvic fins widely separated, the interspace nearly or quite as great as base of fin. Caudal fin moderately to shallowly forked. Lateral line, infraorbital canal, and supratemporal canal always complete. Vertebrae 38 to 46.] 5

5a.—Anal spines 2, the first commonly stiff. Flesh opaque. Body less elongate, depth 4.9 to 6.7 in standard length. Dorsal fins closely approximated. Interpelvic space with one or more scales; midline of belly usually with scales, at least just in front of anus 6

6a.—Interorbital space neither especially broad nor depressed. Snout not projecting beyond upper jaw. Lateral-line scales fewer than 78 ..... **Hadropterus,** 7

7a.—Belly mostly scaled and with the scales of the midline strongly modified (at least in adult males). Premaxillary frenum broad, not hidden by a cross furrow. Anal fin of adult male not notably elevated, without tubercles (except in **evides**) 8

8a.—Gill membranes separate; distance from junction to tip of mandible less than that to insertion of pelvic. Snout rather blunt, more or less decurved. No contrasting orange band on dorsal fin. 9

9a.—First dorsal with 13 to 16 spines; a prominent dark blotch anteriorly. Dark lateral blotches confined to side, more or less confluent and often forming a black longitudinal stripe; dorsal blotches, if present, more or less alternating with lateral blotches. Base of caudal fin without 2 large, cream-colored spots. Without bright colors. Cheek usually closely scaled; nape usually largely naked. ....Blackside darter, **Hadropterus maculatus**

9b.—First dorsal with 10 to 13 spines; no prominent black blotch anteriorly. Dark lateral blotches vertically elongate, continuous over back to form about 8 saddles. Base of caudal with 2 large, cream-colored spots near base. Adults brightly colored with yellow, greenish-black, orange, and chocolate brown. Cheek almost or completely naked; nape closely scaled. .... Gilt darter, **Hadropterus evides**

8b.—Gill membranes broadly connected; distance from junction to tip of mandible greater than that to insertion of pelvic. Snout long and sharply pointed. Spinous dorsal with an orange submarginal band. ...Slenderhead darter, **Hadropterus phoxocephalus**

7b.—Belly largely scaleless medially, but usually crossed before anus by a bridge of scales; scales of midline little modified. Premaxillary frenum very narrow or hidden by a furrow behind upper lip. Anal fin of adult male excessively elevated, the tips of the longest rays

reaching approximately to base of caudal fin, with prominent tubercles during the breeding season. .... River darter, **Hadropterus shumardi**

6b.—Interorbital space broad, more or less depressed. Snout forming a conical, fleshy protuberance which projects beyond upper jaw. Lateral-line scales 78 to 103. ....Northern logperch, **Percina caprodes semifasciata**

5b.—Anal with a single, thin flexible spine. Flesh pellucid in life. Body extremely elongate, depth 7.1 to 9.0 in standard length. Dorsal fins well separated. Interpelvic space and midline of belly naked. **10**

10a.—Vomer and palatine with teeth. Vertebrae 45 or 46. Anal rays I, 12 to 14. Premaxillae bound to snout by a frenum. Lateral line with more than 80 scales to base of caudal and with 4 or more pored scales on caudal base .... Crystal darter, **Crystallaria asprella**

10b.—Vomer and palatine typically toothless, the vomer occasionally with a single tooth. Vertebrae 39 or 40. Anal rays I, 8 to 10. Premaxillae protractile. Lateral line with fewer than 80 scales to base of caudal, and with 1 or no pored scales on caudal base. .... Western sand darter, **Ammocrypta clara**

4b.—Breast, interpelvic space, and belly variously naked or covered with normal scales, but never with a median series of enlarged and modified scales. Anal fin usually smaller than soft dorsal. Body usually deeper and more compressed. [Pelvic fins separated by a space which varies from nearly as wide as the pelvic base to less than half that distance. Caudal fin forked, truncate, or rounded posteriorly. Lateral line, infraorbital canal, and supratemporal canal complete or incomplete. Vertebrae 32 to 43.] ..... **Etheostoma,** **11**

11a.—Lateral line complete or incomplete, with more than 10 pored scales. Scale rows on body more than 40. Preoperculomandibular canal (Fig. 9) with 9 or more pores. **12**

12a.—Anal spine single, thin and flexible. Premaxillae protractile. [Interpelvic space wide, at least ¾ of each fin base.] **13**

13a.—Lateral line complete or nearly so. Infraorbital canal undeveloped only below eye; 2 or 3 pores open from that part of canal behind eye. Dark bridle on snout interrupted at midline. **14**

14a.—Breast naked; cheek naked or with a few small scales behind eye; nape naked or with a few scales. Central Johnny darter, **Etheostoma nigrum nigrum**

14b.—Breast well scaled; cheek scaled except below front of eye; nape well scaled. ..... Scaly Johnny darter, **Etheostoma nigrum eulepis**

13b.—Lateral line incomplete, terminating near middle of body. Infraorbital canal little developed behind eye; with 1 or no pores. Dark bridle continuous from eye to eye across front of snout above lip. .... Bluntnose darter, **Etheostoma chlorosomum**

12b.—Anal spines two, the first heavy and stiff. Premaxillae bound to snout by a frenum (rarely crossed by a groove in **zonale**). **15**

15a.—Pelvic fins widely spaced, the interspace about ¾ of each fin base. Lateral line complete. Pectoral fin longer than head. Snout very blunt. [Gill membranes broadly joined. Cheek scaled.] .... Banded darter, **Etheostoma zonale**

15b.—Pelvic fins more closely approximated, the interspace less than ⅔ of each fin base. Lateral line incomplete. Pectoral fin shorter than head. Snout more or less sharp, not steeply declivous. **16**

16a.—Gill membranes separate or narrowly united. Dorsal spines usually 9 or more, their tips not thickened. Head with some scales. Supratemporal canal complete (except in **exile**). **17**

17a.—Cheek well scaled..... **18**

18a.—Lateral line extending at least to below middle of soft dorsal; 17 or fewer scales without pores. Supratemporal canal complete. Dorsal soft rays 12 to 14. Body more robust, greatest depth 4.0 to 5.0 in standard length..... ..... Mud darter, **Etheostoma asprigenis**

18b.—Lateral line not extending to below middle of soft dorsal; 27 to 42 scales without pores. Supratemporal canal widely interrupted. Dorsal soft rays 9 to 13, usually 10 to 12. Body slender, greatest depth 5.4 to 6.8 in standard length. ....Iowa darter, **Etheostoma exile**

17b.—Cheek naked or with a few scales behind eye.... **19**

19a.—Infraorbital canal (Fig. 9) complete. Gill membranes narrowly united. Pectoral rays usually 13 or 14. Six dark bands on body from anus to base of caudal, these usually complete, separated (in adult males) by red-orange bands which are continuous across lower edge of peduncle. Adult males without orange stripe on ventrolateral surface, and anal fin with much red-orange. ....Rainbow darter, **Etheostoma caeruleum**

19b.—Infraorbital canal widely interrupted below eye. Gill membranes separate. Pectoral rays usually 11 or 12. Five dark bands on body from anus to base of caudal, these usually interrupted ventrally, separated (in adult males) by red-orange bars which are interrupted ventrally. Adult males with orange stripe on ventrolateral surface, and anal fin with little or no red-orange. .....Northern orangethroat darter, **Etheostoma spectabile spectabile**

16b.—Gill membranes broadly united across isthmus to form a gentle curve. Dorsal spines 7 to 9, often (in adults) with thickened fleshy tips. Head scaleless. Supratemporal canal usually incomplete. ..... Striped fantail darter, **Etheostoma flabellare lineolatum**

11b.—Lateral line rudimentary, with 0 to 7 pored scales. Scale rows on body 34 to 37. Preoperculomandibular canal with 6 to 8 pores. .....Least darter, **Etheostoma microperca**

EXPLANATION OF TERMS USED IN THE KEYS

Adipose fin.—A fleshy, rayless fin on the mid-line of the back between the dorsal and tail fins (sometimes fused to the tail fin). (See Fig. 1.)

Air bladder.—A membranous, gas-filled sac lying in the upper part of the body cavity.

Anal fin.—The single or unpaired fin on the lower side of the fish between the anus and the tail fin. In the count of soft rays the last ray is considered double at the base (counted as one). Where a well-developed anterior ray is present this is counted as the first (principal ray count, as in minnows), but where the rays become gradually shorter anteriorly all rudimentary rays are counted, as in catfishes. (See Fig. 6.)

Barbel.—A fleshy thread-like, flap-like or conical process; usually very small if present in American minnows, but long in catfishes and carp. (See Fig. 7.)

Bicuspid.—Teeth with two points or cusps.

Branchiostegal rays.—The elongate, saber-like bones lying in a membrane (the branchiostegal membrane) just below the gill-cover. (See Fig. 4.)

Buccal.—Pertaining to the mouth; the buccal funnel of a lamprey is the cavity within the oral or mouth disc.

Canine teeth.—Strong and elongate conical teeth.

Caudal fin.—The tail fin. (See Fig. 3.)

Caudal peduncle.—The slender, posterior portion of the body (behind the anal fin) which bears the tail fin. Its length is measured from the posterior base of the anal fin to the base of the tail fin (at its intersection with the lateral line). (See Fig. 1.)

Circuli.—Concentric ridges on fish scales.

Circumoral teeth.—Horny teeth in lampreys which surround the esophageal aperture.

Circumorbital.—One of a series of thin dermal bones which lie behind, below, and in front of eye. The anterior bone, which lies in front of the eye is known as the preorbital or lacrymal, those below the eye are called suborbitals, and those behind the eyes are termed postorbitals. The infraorbital canal commonly penetrates the circumorbitals. (See Fig. 2.)

Compressed.—Thin from side to side; deeper than broad.

Ctenoid.—Scales that bear a patch of spine-like prickles (ctenii) on the exposed or posterior field (for example, the yellow perch). The body feels rough when stroked from back to front.

Cycloid.—More or less rounded scales which bear no ctenii or prickles (for example, trout and minnows). The body feels smooth when stroked from back to front.

Depressed.—Thin from top to bottom; broader than deep.

Dorsal.—Pertaining to the back. Often used as an abbreviation for the dorsal fin.

Dorsal fin.—The single or double, ray-bearing, median fin of the back. In our species it may be composed of spines anteriorly and soft rays posteriorly, two soft portions, or a single series of soft rays. The method of counting soft rays is the same as given for the anal fin. (See Fig. 1.)

Ectopterygoid.—A paired bone of the "inner-jaw" series, lying on the roof of the mouth behind the palatine bone.

Emarginate.—With a shallow notch, as in the moderately forked tail fin of a bass.

Entire.—Not bearing spines or denticulations; referring to an edge, as of a spine or bone, which is smooth; not serrated.

Entopterygoid.—A thin, flattened, paired bone lying far back on the roof of the mouth between the ectopterygoids.

Falcate.—Shaped or curved like a sickle; with the margin markedly concave.

Fontanelle.—An aperture or opening in a bony surface.

Frenum.—A bridge of tissue which binds or restrains any part; as the tissue which binds the upper jaw to the snout. (See Fig. 7.)

Ganoid.—Scales are said to be ganoid when rhombic (diamond-shaped); they are thick, strong interlocking structures.

Gill rakers.—Slender rod-like to blunt knob-like projections from the anterior face of the first gill arch. A dissection is often necessary to obtain an accurate count (including all rudimentary rakers).

Gular fold.—A transverse fold of soft tissue across the throat.

Gular plate.—A large, median, dermal bone lying on the throat of the bowfin.

Head length.—The distance from the tip of the snout to the posterior margin of the opercular membrane. (See Fig. 1.)

Heterocercal.—The tail is heterocercal if the vertebral column turns upward into the upper lobe (which is better developed than the lower). (See Fig. 3.)

Homocercal.—The tail is homocercal if the posterior vertebra (the hypural plate) is modified to support the entire tail fin; neither lobe of the tail fin is invaded by the vertebral column. (See Fig. 3.)

Imbricate.—Overlapping, as the shingles on a roof.

Inferior.—Lower. The mouth is said to be inferior if located on the lower side of the head, the upper lip more or less overhung by the snout.

Infraorbital canal.—That portion of the lateral-line canal system which passes behind and below eye and onto snout. (See Fig. 9.)

Insertion (of fins).—The positions at which the paired fins are joined to the body.

Interorbital width.—The distance across top of head between eyes. It is possible to measure either the bony interorbital width or the fleshy width in some fishes.

Isthmus.—The narrow portion of the breast that projects forward between (and separating) the gill chambers. (See Fig. 4.)

Jugular.—Pertaining to the throat.

Lacrymal.—The preorbital bone, or first circumorbital; it lies just before eye. (See Fig. 2.)

Lateral.—Pertaining to the side.

Lateral line.—A series of tubes and pores, extending on the side of the body backward from the posterior margin of the head. The lateral line may be complete (reaching onto the base of the caudal fin); incomplete (not reaching to the base of the caudal fin); or entirely absent. The lateral line is a structure and should not be confused with pigment stripes or lines. The lateral-line system extends forward onto the head where it divides into several parts. (See Figs. 1 and 9.)

Lateral-line scales.—These scales are counted from the head to the base of the caudal rays (the several scales sheathing the base of the tail fin are not included). Where the lateral line is incomplete or absent, the transverse scale rows are counted along the line where the lateral line normally occurs. (See Fig. 1.)

Lingual lamina.—A transverse, horny ridge on the "tongue" of a lamprey.

Mandible.—The lower jaw.

Mandibular pores.—A series of small apertures along a tube on the lower side of each lower jaw. This is the anterior section of the preoperculomandibular canal. (See Figs. 4 and 9.)

Mandibular symphysis.—The tip of the lower jaw.

Maxilla.—The bone of each upper jaw lying just above (or behind), and parallel to, the premaxilla. (See Fig. 2.)

Melanophore.—A black pigment cell.

Myomere.—A muscle segment.

Nape.—The back of the neck; in a fish that area extending along the back from the occiput to or toward the dorsal fin. (See Fig. 2.)

Nuptial tubercles.—Hardened calcareous concretions developed, especially in adult males, during the breeding season; breeding tubercles.

Occiput.—The posterior dorsal part of the head (often marked by the line separating scaly and scaleless portions of the skin).

Opercle.—The large bone of the gill cover; not including the fleshy membrane. (See Fig. 2.)

Opercular gill.—A gill-like structure lying on the inner surface of the opercle near its edge, in sturgeons. Not to be confused with pseudobranchium.

Oral valve.—Thin membranes, one near the front of each jaw, which function during respiration.

Origin (of fins).—The foremost point at which the dorsal and anal fins are in contact with the body.

Palatine teeth.—Teeth borne by the paired palatine bones which lie on the roof of the mouth behind the median vomer and inside of the upper jaw.

Papilla.—A small, blunt fleshy projection.

Papillose.—Covered with papillae.

Parasitic.—Feeding upon (and at the expense of) another living organism.

Parr-markings.—Large dark blotches on the sides of the body (not continuous over the back or saddle-like as in the yellow perch), especially prominent in young trout.

Pectoral fin.—A paired fin on the side (or on the breast) just behind the head. (See Fig. 1.)

Pelvic (or ventral) fin.—A paired fin inserted on the lower side of the fish. Usually well behind the pectoral (abdominal in position) or beneath the pectoral (thoracic in position). In the pelvic ray count all rudimentary rays are included. (See Fig. 1.)

Peritoneum.—The lining of the body cavity.

Peritroct.—The area that surrounds the anus.

Pharyngeal teeth.—Teeth on the pharyngeal bones, located deep in the throat. In suckers and minnows each pharyngeal arch bears 1 or 2 (3 in the introduced carp) rows of teeth. The formula gives the number of teeth in each of the rows from left to right, thus the formula 2, 5–4, 1 indicates that the pharyngeal bone on the left side has 2 teeth in the outer or lesser row, 5 in the inner or main row, whereas that on the right side has 1 tooth in the outer row and 4 in the main row. A pharyngeal bone may be removed for study by lifting back the gill cover, passing a sharp scalpel between the shoulder girdle and the pharyngeal bone (which lies just in front of the

pectoral girdle), and cutting free the muscles at each end of the bone. It may then be removed with the aid of a pair of forceps and should be cleaned of remaining muscles with the aid of a dissecting needle before examination. Considerable practice is necessary before this dissection can be performed without injuring the specimen or breaking the pharyngeal teeth. (See Fig. 5.)

Plicate.—With a series of parallel folds or soft ridges (plicae). (See Fig. 4.)

Predorsal length.—The distance from the tip of the snout to the origin of the dorsal fin.

Predorsal scales.—The scales lying between the front end of the dorsal fin and the head; the number of rows is counted along the midline of the back.

Premaxilla.—The bone at the front of each upper jaw. The premaxillae join to form part or all of the border of the jaw. (See Fig. 2.)

Preopercle.—The L-shaped bone (with the lower arm directed forward) which lies behind and below the eye (in front of the gill cover). (See Fig. 2.)

Preopercular canal.—That portion of the preoperculomandibular canal that lies on the preopercle. (See Fig. 9.)

Preoperculomandibular canal.—A branch of the lateral-line system that extends along the preopercle (preopercular canal) and the mandible (mandibular canal). (See Fig. 9.)

Preorbital.—The lacrymal, or first circumorbital bone; it lies just below eye.

Protractile.—The upper jaw is so termed when it can be protruded. This ability is indicated when a groove separates the margin of the upper jaw from the snout. When the upper jaw is not protractile a fleshy connection (frenum) binds the premaxillae to the snout and no groove separates them along the midline. (See Fig. 7.)

Pseudobranchium.—A gill-like structure on the inner surface of the gill cover near its upper edge.

Pyloric caeca.—Finger-like appendages arising from the junction of the stomach and the intestine.

Radii.—Grooves on a fish scale which radiate outward from its central part, or focus.

Serrate.—Jagged or tooth-like; the denticulations are termed serrae.

Snout (length).—The distance from its anterior tip to the front margin of the orbit. (See Fig. 2.)

Spiracle.—An opening from the pharyngeal cavity which emerges above and behind the eye in some species.

Standard length.—The straight-line distance from the anterior tip of the snout to the hidden base of the caudal fin rays. The position of the base of the caudal rays is indicated by the sharp crease which is formed by bending the tail fin. (See Fig. 1.)

Subopercle.—That bone of the opercular series which lies just below the opercle (the large bone of the series). (See Fig. 2.)

Suborbitals.—Those of the circumorbital bones which lie below the eye.

Superolateral.—Facing upward and outward.

Supramaxilla.—A small, movable bone adherent to the upper edge of the maxilla near its posterior tip. (See Fig. 2.)

Supraoccipital.—The unpaired bone above the opening from which the spinal cord leaves the skull (the posterior bone on the top of the skull).

Supraoral cusps.—Projections or points on the large horny tooth or transverse plate that lies just in front of the mouth opening in lampreys.

Supraorbital canal.—A paired branch of the lateral-line system that extends along the top of the head between the eyes and forward onto snout. (See Fig. 9.)

Supratemporal canal.—A branch of the lateral-line system which crosses the top of the head at the occiput, connecting the lateral canals. (See Fig. 9.)

Terete.—Having a rounded body form, the body width and body depth about equal.

Terminal.—At the end of something. The mouth is spoken of as terminal when neither upper nor lower jaw projects beyond the other; it is subterminal when the upper jaw slightly exceeds the lower. A terminal barbel is placed at the posterior end of the maxilla.

Thoracic.—Pertaining to the chest; the pelvic fin is thoracic when inserted below the pectoral fin.

Total length.—The greatest overall length, measured from the anteriormost tip (whether upper or lower jaw) to the extremity of the tail fin.

Ventral.—The lower surface. The pelvic fins are referred to as ventral fins by some authors.

Vermiculate.—A pattern of fine, narrow or thread-like lines or vermiculations; worm tracks.

Vertebrae.—A dissection (or X-ray photograph) is necessary to count the number of vertebrae. The precaudal count includes those anterior vertebrae which do not have a well-developed haemal spine; that is, each appears as an inverted Y in cross section. The remaining vertebrae (including the modified last vertebra or hypural plate which supports the tail fin) are listed as caudal vertebrae.

Vomer.—An unpaired bone lying near the front of the roof of the mouth, just behind the margin of the upper jaw.

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