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

By
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INTRODUCTION

In a series of prosaic, factual reports on the ichthyological surveys conducted by himself and his associates, Meek (1889-1894; Jordan and Meek, 1885; Call, 1892) wrote the opening chapter in the history of Iowa fishes. At the same time he laid the foundation on which future students might attempt to reconstruct the course of fish-population change in the waters of the North American prairie. That Meek's inquiry was not conducted before the prairie sod was broken prevents us for all time from knowing the condition of fish life when white settlers first arrived. As long ago as 1892 Meek wrote: "I have been informed that many streams, formerly deep and narrow, and abounding in pickerel, bass, and catfishes, have since grown wide and shallow, while the volume of water in them varies greatly in the different seasons, and they are now inhabited only by bullheads, suckers, and a few minnows. The breaking of the native sod for agricultural purposes has especially affected the smaller streams in this respect, while the construction of ditches and the practice of underdraining have had their effects upon the larger ones. Moreover the constant loosening of the soil, in farming, tends to reduce it to that condition in which it is readily transported by the heavy rains to produce muddy currents." Nevertheless, Meek found many fishes in abundance that are now rare, noted some to be widespread that are now of restricted or local occurrence, and caught nearly a score that are wholly extirpated from Iowa. It is doubtful whether any other state has experienced such extensive reduction in its original fish fauna.

Building on Meek's foundation, a number of studies of the Iowa ichthyofauna added materially to our knowledge of limited areas: Larrabee (1926) on the Okoboji Lake area, Coker (1930) on the Mississippi River near Keokuk, Bailey and Harrison (1945) on Clear Lake, and Starrett (1950) on Boone County. 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). From 1939 until 1944 the author and his associates at Iowa State College made collections throughout the state. Checklists of Iowa fishes appeared in 1928 (Potter and Jones), 1936 and 1941 (Aitken), and 1951 (Bailey).

Investigations of Iowa fishes were rapidly accelerated immediately after World War II. Dr. Kenneth D. Carlander and his students in the Iowa Fishery Research Unit at Iowa State College initiated a variety of biological projects in natural and impounded waters. The Upper Mississippi River Conservation Committee studied the fishes and the sport and commercial fisheries of that river (Barnickol and Starrett, 1951). The Biology Section of the State Conservation Commission was instituted under the supervision of Everett B. Speaker. In addition to studies concerned with the life histories, production, and populations of various fishes or on selected waters, many hundreds of fish collections were taken. The resultant reports by Harrison (1950), Cleary (1952 and 1954), and Harrison and Speaker (1954) provide excellent coverage for an understanding of fish distribution throughout most of the state. The available information has been synthesized into the report by Cleary which appears elsewhere in this volume.

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That the Iowa fish fauna is now rather well known is evident from the fact that since 1951, a period of active study, only one species has been added to the state list. Still deserving further investigation are the fishes of the Mississippi and Missouri rivers, the ox-bow lakes and overflow waters of the rivers in southeastern Iowa, and small or isolated spring flowage areas. Especially worthy of careful exploration are clear waters, other than the larger lakes, with an abundance of vegetation. Persistent pools of vegetated water with spring inflow, when discovered, may well yield remnant populations of some of the species not found in Iowa since Meek's time.

ACKNOWLEDGMENTS

By its nature a work such as this involves the compilation of material from many sources. Again I am grateful to all of those who contributed to the preparation of the 1951 version of this list and keys and who were mentioned in that report. In revising the keys I am especially obligated to William Ralph Taylor whose unpublished work on catfishes has been freely used. C. Richard Robins pointed out the utility of the character of the suborbital bones in distinguishing between *Moxostoma* and *Minytrema*. Royal D. Suttkus has called my attention to and loaned the specimens of *Hybopsis plumbea* which constitute the first authentic record for Iowa. William Brudon executed the drawings for the first edition and my wife, Marian K. Bailey, aided in their revision.

In redrafting the keys, copies of the earlier edition were distributed to a number of colleagues whose criticisms were enlisted. They were generous with suggestions and I regret my failure to incorporate all of these into the present draft. Any improvements in this version stem largely from the help of Kenneth D. Carlander, Robert E. Cleary, Shelby D. Gerking, Harry M. Harrison, Raymond E. Johnson, Robert R. Miller, George A. Moore, John B. Moyle, Edward C. Raney, Earl T. Rose, and E. B. Speaker.

SUBSPECIES

Since the appearance of the first edition of this list in 1951, the common taxonomic practice of dividing geographically variable species into named races, or subspecies, has been subjected to critical scrutiny. It has been noted that the pattern of geographic variation in some species takes the form of a rather gradual and progressive gradient, termed a cline. It is now agreed by many taxonomists that despite the high biological significance of this type of variation, it is undesirable to assign subspecific names on the basis of clinal gradients. Five species treated as subspecies in 1951 but herein regarded as binomials because of the clinal nature of the variation are: *Notemigonus crysoleucas*, golden shiner; *Semotilus atromaculatus*, creek chub; *Ictalurus punctatus*, channel catfish (Bailey, Winn, and Smith, 1954: 149); *Pimephales promelas*, fathead minnow (Taylor, 1954: 42); and *Ictalurus melas*, black bullhead.

Commonly the differences between geographic subspecies are slight and are best expressed as average conditions applying to a considerable fraction of individuals, but not to all. It is my revised opinion that acceptable subspecies should evidence high uniformity over their respective ranges and should differ one from another with high constancy. Zones of intergradation should be rather narrow. If they are wide the variation merges insensibly into a clinal gradient. Because of the small magnitude and the low constancy of the alleged differences among subspecies, the following species are here treated as binomials following Bailey, Winn, and Smith (1954: 150): *Lepisosteus osseus*, longnose gar; *Erimyzon sucetta*, lake chubsucker; and *Notropis roseus*, weed shiner. Additional species for which the available evidence appears not to justify the recognition of subspecies are: *Esox masquinongy*, muskellunge; *Catostomus commersoni*, white sucker; *Notropis atherinoides*, emerald shiner; *Notropis dorsalis*, bigmouth shiner; *Notropis lutrensis*, red shiner; *Lota lota*, burbot; and *Micropterus dolomieui*, smallmouth bass.

The ichthyologist, in studying material, often perceives differences among populations from various parts of the geographic range of a species. Such discoveries may presage the definition of validly recognizable subspecies. The premature use of such information without publication of the full data is disconcerting to other workers, who are unable to evaluate the basis for the action. The different stocks sometimes turn out to be fully distinct species. Bailey, Winn, and Smith (1954: 150) have indicated their reluctance to employ trinomials for the following pending presentation of supporting evidence: *Ictalurus nebulosus*, brown bullhead; *Aphredoderus sayanus*, pirate perch; *Labidesthes sicculus*, brook silverside; *Lepomis macrochirus*, bluegill. To these may be added *Hybopsis gracilis*, flathead chub, and *Cottus cognatus*, slimy sculpin.

Four species present special problems with respect to subspecies that are discussed briefly in the list of Iowa fishes: *Notropis volucellus*, mimic shiner; *Hybognathus nuchalis*, silvery minnow; *Campostoma anomalum*, stoneroller; and *Etheostoma nigrum*, Johnny darter.

The subspecific partition of 17 species of Iowa fishes is regarded as resting on a relatively secure body of evidence. It should be cautioned, however, that such status is provisional. In an area where ideas have not fully crystallized and new evidence is constantly being amassed it should be anticipated that changes in subspecific nomenclature will continue. Three species are regarded as having Iowa representatives of two subspecies each. Of these, the races of the sand shiner, *Notropis deliciosus*, are geographic replacements of one another, whereas those of the mimic shiner, *Notropis volucellus*, are classed as ecological rather than as geographic subspecies. The subspecies of the Johnny darter, *Etheostoma nigrum*, are strictly neither geographic nor ecological.

REVISED LIST OF IOWA FISHES

This list comprises 25 families, 56 genera, 133 species, and 136 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. Since 1951 one species (lake chub) has been added to the list and one (plains minnow) has been removed.

Some comments pertaining to nomenclature and occurrence were included in the check-list in the 1951 edition. These have been omitted in this list, but other remarks, dealing especially with changes in names and the status of subspecies, have been inserted. Although not of general interest this material is supplied for fishery workers or others concerned with the technical reasons for modifications in fish names.

Petromyzontidae

Ichthyomyzon unicuspis Hubbs and Trautman—silver lamprey

Ichthyomyzon castaneus Girard—chestnut lamprey

Lampetra lamottei (LeSueur)—American brook lamprey

Polyodontidae

Polyodon spathula (Walbaum)—paddlefish

Acipenseridae

Acipenser fulvescens Rafinesque—lake sturgeon

Scaphirhynchus platorynchus (Rafinesque)—shovelnose sturgeon

Scaphirhynchus album (Forbes and Richardson)—pallid sturgeon. In a recent study of the species of *Scaphirhynchus* (Bailey and Cross, 1954), the validity of the only Iowa record for the pallid sturgeon (Coker, 1930) was questioned. In the same publication, however, it was shown that the pallid sturgeon is generally distributed in the Missouri River from Montana to its mouth. Despite the absence of records it is obvious that the species occurs in Iowa; thorough collecting in the Missouri River would be rewarded not only by the finding of this fish, but of several other species rare or absent elsewhere in the state.

Lepisosteidae

Lepisosteus platostomus Rafinesque—shortnose gar

Lepisosteus osseus (Linnaeus)—longnose gar. Present knowledge of geographic variation in this species is too imperfect to justify the recognition of subspecies (see Bailey, Winn, and Smith, 1954: 117).

Amiidae

Amia calva Linnaeus—bowfin

Salmonidae

Salmo trutta Linnaeus—brown trout

Salmo gairdneri Richardson—rainbow trout

Salvelinus fontinalis (Mitchill)—brook trout

Clupeidae

Alosa chrysochloris (Rafinesque)—skipjack herring
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 americanus vermiculatus LeSueur—grass pickerel. I follow Legendre (1952: 21) in regarding the grass pickerel of the Mississippi basin and Great Lakes as a subspecies of the redfin pickerel of the Atlantic coast. The subspecific indentification of Gulf-coastal material is not yet on a firm basis (Bailey, Winn, and Smith, 1954: 121).

Esox lucius Linnaeus—northern pike

Esox masquinongy Mitchill—muskellunge. The recent study of geographic variation of the muskellunge in Canada (Hourston, 1955) indicates that the two subspecies thought to inhabit that country are not well founded. The evidence presented to date to substantiate the subspecific separation of the Ohio valley population is equally unconvincing. Until impelling new evidence is presented it seems unnecessary to recognize subspecies in the 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

Carpiodes cyprinus (LeSueur)—quillback carpsucker

Carpiodes carpio carpio (Rafinesque)—river carpsucker

Carpiodes velifer (Rafinesque)—highfin carpsucker

Moxostoma duquesnei (LeSueur)—black redhorse

Moxostoma erythrurum (Rafinesque)—golden redhorse

Moxostoma anisurum (Rafinesque)—silver redhorse

Moxostoma aureolum aureolum (LeSueur)—northern redhorse. This species is treated as a complex of two subspecies on the authority of Trautman and Martin (1951).

Moxostoma carinatum (Cope)—river redhorse

Hypentelium nigricans (LeSueur)—northern hog sucker

Catostomus commersoni (Lacépède)—white sucker

Minytrema melanops (Rafinesque)—spotted sucker

Erimyzon sucetta (Lacépède)—lake chubsucker

Cyprinidae

**Cyprinus carpio* Linnaeus—carp

**Carassius auratus* (Linnaeus)—goldfish

Notemigonus crysoleucas (Mitchill)—golden shiner

Semotilus atromaculatus (Mitchill)—creek chub

Gila elongata (Kirtland)—redside dace. In recognition of the close relationship of the eastern species customarily classified as *Clinostomus* Girard, with the western forms assigned to *Richardsonius* Girard, the redside dace was placed in the latter genus (Bailey, 1951: 191). This arrangement fails, however, to express the equally intimate relationship of the western species of *Richardsonius* with the species of *Gila* Girard. A simplified generic arrangement of the western species of the complex (Miller, 1945) removed much existing confusion. Both *Gila* and *Richardsonius* were ranked as genera, but no characters were presented by which they may be distinguished. Since *Gila, Richardsonius,* and *Clinostomus* agree in all those characters generally regarded as of primary (i.e., generic) importance in the classification of the Cyprinidae, and since their general appearance, ecology, and distribution support the inference derived from their morphology that they are, in fact, closely related, I think it best to unite them generically under the oldest name, *Gila* Girard.

The generic classification of the American cyprinids poses many extremely difficult problems. Almost all if not all of the species are closely interrelated, a situation that is masked by the excessive number of genera recognized in recent years. The grouping of *Gila, Richardsonius,* and *Clinostomus* as a single genus contributes to a more functional classification of the Cyprinidae.

Chrosomus erythrogaster (Rafinesque)—southern redbelly dace

Opsopoeodus emiliae Hay—pugnose minnow

Hybopsis plumbea (Agassiz)—lake chub. Recently (Bailey, 1951: 188) the lake chub was removed from the Iowa faunal list since it was shown that the only record was based on a misidentification. Now through the courtesy of Dr. Royal D. Suttkus of Tulane University, in loaning the specimens, it is possible to report an unquestionable record of occurrence of the species in Iowa. On September 8, 1954, Robert K. Chipman collected 7 specimens (41 to 70 mm. in standard length) in Twin Springs Creek, at Carter Road, northwest of Dubuque, Dubuque County. They are number 10208 in the Tulane University collection. Like *Cottus cognatus,* which lives in the area, the lake chubs occurrence in northeastern Iowa far south of the main body of the range of the species, is explainable as a glacial relict. There exists a strong likelihood that these species resided in the nearby Driftless Area during the Wisconsin glaciation. Persistence of these cool-water species is made possible by the presence of numerous springs in northeastern Iowa.

Hybopsis gracilis (Richardson)—flathead chub

Hybopsis storeriana (Kirtland)—silver chub

Hybopsis gelida (Girard)—sturgeon chub

Hybopsis meeki Jordan and Evermann—sicklefin chub

Hybopsis aestivalis (Girard)—speckled chub

Hybopsis sp.—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 specific name.

Hybopsis biguttata (Kirtland)—hornyhead chub

Rhinichthys atratulus meleagris Agassiz—western blacknose dace

Rhinichthys cataractae (Valenciennes)—longnose dace

Phenacobius mirabilis (Girard)—plains suckermouth minnow

Notropis atherinoides Rafinesque—emerald shiner. After examining emerald shiners from various localities in the Great Lakes I am unable to confirm the existence of a pelagic form in Lake Michigan (Hubbs, 1945) that is so distinct as to merit subspecific separation from the typical form in Lake Erie.

Notropis percobromus (Cope)—plains shiner. The differences between this species and *Notropis atherinoides* are not great and perhaps do not have a genetic basis. Until the problem can be studied further I retain the *status quo*, as outlined by Hubbs (1945: 16). I cannot agree, however, to the inclusion of the upper Mississippi River in the range of *N. percobromus*. The two specimens from Minnesota assigned to *N. percobromus* in the Museum of Zoology collections are reidentified as *N. atherinoides*. The only Iowa specimens examined by me which I identify as *N. percobromus* are from the Missouri River (Bailey, 1951: 192).

Notropis rubellus (Agassiz)—rosyface shiner

Notropis umbratilis (Girard)—redfin shiner

Notropis illecebrosus (Girard)—silverstripe shiner. The failure of recent surveys to add to the single known Iowa specimen, from Sioux City (Bailey, 1951: 192), makes it increasingly doubtful that the fish really came from there. The species lives elsewhere in waters with excessively heavy silt loads so it seems doubtful that it has been eliminated from the Missouri River since 1890. If careful seining in the Missouri does not yield new material the silverstripe shiner should probably be removed from the state fish list. Until such collecting is done the entry may be retained on a provisional basis.

Notropis cornutus frontalis (Agassiz)—northern common shiner

Notropis chalybaeus (Cope)—ironcolor shiner

Notropis roseus (Jordan)—weed shiner

Notropis heterodon (Cope)—blackchin shiner

Notropis hudsonius (Clinton)—spottail shiner

Notropis blennius (Girard)—river shiner

Notropis dorsalis (Agassiz)—bigmouth shiner

Notropis amnis Hubbs and Greene—pallid shiner

Notropis spilopterus (Cope)—spotfin shiner

Notropis lutrensis Baird and Girard—red shiner

Notropis deliciosus (Girard)—sand shiner. A careful study of variation in the sand shiner throughout its range is needed. Until that is done the subspecies rest on an unfirm base. Sand shiners from the Great Plains have smaller scales, especially as counted around the body, than do those from the eastern and southern parts of the range. Whether or not this character is clinal is not established, nor is it known whether the difference in scale size is due to genetic or environmental factors. For the present it is convenient to maintain the *status quo* and recognize two subspecies. Study of the data presented by Gerking (1945: 63) makes it evident that the subspecies *stramineus*, irrespective of its possible validity, is not adequately defined.

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. Most subspecies are geographical races of the species; those of the mimic shiner are ecological. *N. v. volucellus* is a creek and lake fish; it is of extremely rare occurrence in northeastern Iowa. *N. v. wickliffi* Trautman inhabits large rivers; it is a common form in the Mississippi River where it lives together with the closely related N. *buchanani.* The complex is deserving of further study.

N. v. volucellus (Cope)—northern mimic shiner
N. v. wickliffi Trautman—channel mimic shiner

Notropis buchanani Meek—ghost shiner
Dionda nubila (Forbes)—Ozark minnow
Hybognathus hankinsoni Hubbs—brassy minnow
Hybognathus nuchalis nuchalis Agassiz—silvery minnow. *Hybognathus nuchalis* and *H. placita* have long been regarded as distinct species by most authors, including myself (Bailey, 1951: 193, 219). Although new data are strongly suggestive, it cannot now be affirmed categorically that the two are conspecific. Nevertheless, I feel sufficiently confident that they belong to one species for me to combine them under the older name, *H. nuchalis.* (The trinomial is employed on the presumption that the Atlantic coastal form *regia* is a distinct subspecies—see Bailey, 1954.) Plains fish customarily have smaller eyes and smaller scales, as counted around the body—especially below the lateral lines, than do those from the central or upper Mississippi valley (Bailey, 1951: 219). Intermediate populations are common, however, and what appear to be more or less typical populations of *nuchalis* are sometimes encountered on the Great Plains. Similarly, fish phenotypic of *placita* range far to the east in and adjacent to the turbid Missouri River, and they occur downstream (but not upstream) in the Mississippi below the mouth of the Missouri. Occasionally the two types occur together, leading to the assumption that two species are represented. This explanation is rendered questionable by the presence of intermediate, hence unidentifiable, populations.

The interpretation that the two forms are conspecific is based in large part on what appeared at first to be a mixture of two species in a collection from the Little Missouri River, at Camp Creek, Harding County, South Dakota, taken in August, 1952. Analysis of the collection shows that the small-eyed, small-scaled fish *(placita)* belong to the 1951 and 1952 year classes. The larger-eyed, larger-scaled fish (closely approaching typical *nuchalis*) belong to the 1950 year class. From these limited data it is inferred that environmental variations at the time of early development, probably chiefly in turbidity (Moore, 1950), are in some way translated into structural differences that can be perceived throughout the life of the fish. From prevailing conditions it may be conjectured that the usual high turbidity of the Missouri River and other plains streams results in small eyes and small scales; the lower turbidity of the Ohio and upper Mississippi basins produces large eyes and large scales. During drought or other local conditions plains streams, or their backwaters and oxbow lakes, may temporarily be relatively clear at the time the eggs and fry are developing. It is at such times, I conclude, that the phenotype "*nuchalis*" appears on the Great Plains (i. e. the 1950 year class in the Little Missouri River). High turbidities comparable to those of the Missouri River are rare and then temporary through the usual range of the "*nuchalis*" type. In this area the "*placita*" type is never encountered, to my knowledge, except in the Mississippi—Missouri River.

It is obvious that experimental study is needed to test the accuracy of this speculative explanation. It is of interest to note that where other Mississippi basin fishes have intimately related species or subspecies on the Great Plains, the same character differences are usually involved. For example, *Notropis percobromus* of the Great Plains differs from *N. atherinoides* chiefly in the smaller eye; *Notropis deliciosus missuriensis* of the plains contrasts with the eastern *N. d. deliciosus* in the more numerous body-circumference scales and the smaller eye.

Pimephales vigilax perspicuus (Girard)—bullhead minnow. The grouping of *Ceratichthys*, *Hyborhynchus*, and *Pimephales* under the latter name, proposed in the first edition of this list, has recently been discussed and supported by Cross (1953) in a paper which also demonstrates the need for the reduction of *perspicuus* to subspecific status under *P. vigilax*.

Pimephales notatus (Rafinesque)—bluntnose minnow

Pimephales promelas Rafinesque—fathead minnow

Campostoma anomalum Rafinesque—stoneroller. That subspecies of the species live in different geographic areas, rarely in diverse habitats in the same area, is widely accepted as a general rule. The reported occurrence of two subspecies of the stoneroller in the same waters in Wisconsin and Iowa (Hubbs and Greene, 1935; Greene, 1935) is therefore cause for suspicion. The association of two structural types of stonerollers, one with a larger mouth and larger scales, has been discovered also in many collections from southern Missouri. To add to the complexity, stonerollers from the eastern part of the range of the species, commonly assigned to the nominate subspecies, are more or less intermediate between these two. It is possible that the sympatric forms, *pullum* and *oligolepis*, are really fully distinct species. On the other hand, they may with greater plausibility merely represent environmental responses to differing conditions during early development. For example, streams emerging as large springs and with relatively uniform temperature may result in structurally different fish from those spawned in nearby waters that are fed by surface runoff and are subject to wider fluctuations in physical conditions. Subsequent movements of the fish would then explain the occurrence of the two types in the same waters. Many of the known localities of occurrence of *oligolepis* are in regions well known for the abundance of springs. Until the uncertainties are clarified it seems best to refer to Iowa specimens of the stoneroller in the binomial.

Ictaluridae

Largely as the result of the investigations by Dr. William Ralph Taylor on the North American catfishes, the classification and nomenclature of the group have been materially changed since the preceding edition. On the basis of his first summary comments (Taylor, 1954: 43-44) and his unpublished material the nomenclature, sequence of species, and the key (p. 363) have been fully revised. In anticipating some of his findings I accept responsibility for any errors that may be introduced. It is doubtful whether the name *Ameiurus* Rafinesque is available as a generic name because it was proposed neither as genus nor as subgenus, but as a section of a subgenus. It was ranked as a full genus, spelled *Amiurus*, by Gill in 1860 and is clearly available as of that date. As a result of the recommended amalgamation of *Amiurus* Gill (= *Ameiurus* Rafinesque) with *Ictalurus* Rafinesque (Taylor, 1954) the family name is changed from Ameiuridae to Ictaluridae. *Ictalurus* Rafinesque and *Ameiurus* Rafinesque are of identical date, but the latter was proposed as a division of the former. Therefore Rafinesque clearly qualifies under the rule of the first reviser. *Ictalurus* is adopted as the generic name not only of the larger, fork-tailed catfishes, but of all of the bullheads as well.

All of the madtoms are referred to *Noturus* in line with Taylor's recommendation.

Ictalurus melas (Rafinesque)—black bullhead
Ictalurus nebulosus (LeSueur)—brown bullhead
Ictalurus natalis (LeSueur)—yellow bullhead
Ictalurus punctatus (Rafinesque)—channel catfish. On the name of this species see Speirs (1952).

Ictalurus furcatus (LeSueur)—blue catfish
Noturus gyrinus (Mitchill)—tadpole madtom

Noturus exilis Nelson—slender madtom. Taylor (ms.) will present evidence to show that the name *insignis* should again be applied to the eastern madtom, necessitating a return to *exilis* as the specific name of the slender madtom.

Noturus flavus Rafinesque—stonecat
Pylodictis olivaris (Rafinesque)—flathead catfish. The generic name of the flathead catfish is corrected to agree with Rafinesque's original spelling.

Anguillidae

Anguilla rostrata (LeSueur)—American eel

Cyprinodontidae

Fundulus diaphanus menona Jordan and Copeland—banded killifish
Fundulus notti dispar (Agassiz)—starhead topminnow. I follow Brown (ms.) and Miller (1955) in applying the specific name *notti*. The names *notti* and *dispar* are of identical date but Garman (1895: 120), as first reviser, selected *notti*.
Fundulus notatus (Rafinesque)—blackstripe topminnow
Fundulus sciadicus Cope—plains topminnow

Gadidae

Lota lota (Linnaeus)—burbot. After an investigation of geographic variation in the burbot, Lindsey (in press) concluded that there are inadequate grounds for subspecific delimitation.

Percopsidae

Percopsis omiscomaycus (Walbaum)—trout-perch

Aphredoderidae

Aphredoderus sayanus (Gilliams)—pirate perch

Atherinidae

Labidesthes sicculus (Cope)—brook silverside

Serranidae

In the earlier edition of this work, Bailey (1951: 194) placed the white bass and the yellow bass in the genus *Morone*. This was an expression of the view, to which I still adhere, that the four species of serranids which commonly enter fresh waters of North America should be united into a single genus. In line with the then prevailing decision of the International Commission on Zoological Nomenclature, *Morone* Mitchill was adopted in preference to *Roccus* Mitchill because of page precedence, the names being of identical date. In 1954, Bailey, Winn, and Smith stated this opinion and referred the striped bass to *Morone*.

In doing so, however, they neglected to apply the reinstatement of the principle of choice of the first reviser, a reversal by the International Commission (1953: 66-67) in the procedure to be employed for the selection among names of identical date. Jordan and Gilbert (1883: 528-531) united *Roccus* and *Morone* under the single generic name *Roccus* and apparently qualify thereby as first revisers. For those who adhere to the generic merger it becomes necessary to assign the American species *saxatilis, chrysops, americanus, mississippiensis,* and the European species *labrax* and *punctatus* to the genus *Roccus* Mitchill.

Roccus chrysops (Rafinesque)—white bass
Roccus mississippiensis (Jordan and Eigenmann)—yellow bass. Unfortunately,

the above change in generic name necessitated by the Rules of Nomenclature makes the current specific name of the yellow bass, *interruptus* (Gill), a secondary homonym of *Perca mitchilli interruptus* Mitchill (a synonym of *Roccus saxatilis*) and thereby unavailable. The oldest available name is *Morone mississippiensis* Jordan and Eigenmann.

Centrarchidae

Micropterus dolomieui Lacépède—smallmouth bass. In line with my revised opinion regarding subspecies (p. 328) I no longer regard the form *M. dolomieui velox* Hubbs and Bailey (1940) as nameworthy.

Micropterus salmoides salmoides (Lacépède)—northern largemouth bass

Chaenobryttus gulosus (Cuvier)—warmouth. The Committee on Nomenclature of the American Society of Ichthyologists and Herpetologists has agreed unanimously that the name *Chaenobryttus coronarius* (Bartram) should be dropped because Bartram was not consistently binomial in the work in question, and on this judgment I reapply the long-familiar name *C. gulosus* even though final action is still pending.

Lepomis cyanellus Rafinesque—green sunfish

Lepomis gibbosus (Linnaeus)—pumpkinseed

Lepomis macrochirus Rafinesque—bluegill

Lepomis humilis (Girard)—orangespotted sunfish

Lepomis megalotis peltastes Cope—northern longear sunfish. Throughout most of the range of the longear sunfish the subspecies are not well understood. The form inhabiting the upper Mississippi valley and the Great Lakes, however, differs so sharply from the nominate form of the Ohio valley and south that the retention of the subspecific name *peltastes* seems justified.

Ambloplites rupestris rupestris (Rafinesque)—northern rock bass

Pomoxis annularis Rafinesque—white crappie

Pomoxis nigromaculatus (LeSueur)—black crappie

Percidae

The species placed in the genus *Hadropterus* in the preceding edition are here referred to *Percina* (Bailey, Winn, and Smith, 1954: 139-141).

Stizostedion vitreum vitreum (Mitchill)—walleye

Stizostedion canadense (Smith)—sauger

Perca flavescens (Mitchill)—yellow perch

Percina maculata (Girard)—blackside darter

Percina phoxocephala (Nelson)—slenderhead darter

Percina caprodes semifasciata (DeKay)— northern logperch. This subspecies occurs in northern Iowa. 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* x *semifasciata)* between the southern and northern subspecies.

Percina evides (Jordan and Copeland)—gilt darter

Percina shumardi (Girard)—river darter

Ammocrypta asprella (Jordan)—crystal darter. The crystal darter is well separated structurally from the other sand darters, but its closest relationship lies in this group. On the premise that the primary function of generic classification is to facilitate the expression of relationship, the placement of *asprella* in *Ammocrypta* seems called for. *Crystallaria* may be retained as a subgenus for the sole inclusion of *asprella;* the species *vivax, pellucida, clara,* and *beani* may be referred to the nominate subgenus, as was done by Bailey and Gosline (1955).

Ammocrypta clara Jordan and Meek—western sand darter

Etheostoma nigrum Rafinesque—Johnny darter. Since the races of Johnny darters inhabiting the northcentral states have somewhat different habitats, they have been regarded as ecological rather than geographical subspecies.

Actually they are geographic forms but the distribution pattern is complex, both historically and at present, as demonstrated by Greene (1935: 174-181). The two forms do not live together although they intergrade freely in areas to which both types have free access. In Iowa relatively pure populations of *eulepis* occur only in Clear Lake and the Dickinson County lakes; intergrading populations are rather widespread in northern Iowa and all along the Mississippi River (an extension of the Wisconsin area noted and mapped by Greene); and typical *nigrum* occurs elsewhere in the state. Greene postulated a Pleistocene *refugium* for *eulepis* in the Driftless Area of Wisconsin, but this argument loses force now that it is known that typical populations of *eulepis* occur in central and southwestern Missouri.

E. n. nigrum Rafinesque—central Johnny darter
E. n. eulepis (Hubbs and Greene)—scaly Johnny darter

Etheostoma chlorosomum Hay—bluntnose darter
Etheostoma zonale (Cope)—banded darter
Etheostoma asprigene (Forbes)—mud darter
Etheostoma caeruleum Storer—rainbow darter
Etheostoma exile (Girard)—Iowa 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 Richardson—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.

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

Moxostoma valenciennesi Jordan—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.

Noturus 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. It may turn up in Iowa as an introduction for the purpose of mosquito control.

Micropterus punctulatus punctulatus (Rafinesque)—spotted bass. A common species in Missouri and southern Illinois, the spotted bass may be present in southeastern Iowa.

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

Cottus bairdi Girard—mottled sculpin. One of the most likely species for addition to the state list, the mottled 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

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 the species is reached. Item 8 in the family key involves decision from among 3 possible choices (*a*, *b*, or *c*). The contrasting characters in each couplet are always indicated by the same number (for example *3a* and *3b*), 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

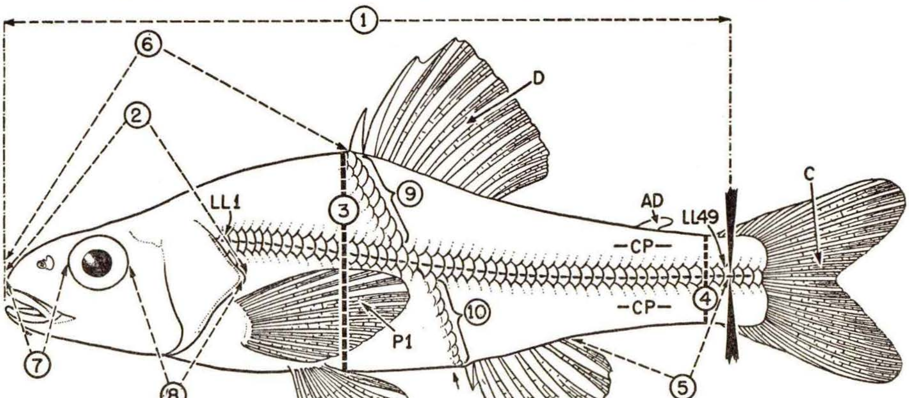


Fig. 1. Topography of a fish to show the location of structures and regions used in identification and how certain measurements are made.
A., anal fin; AD., adipose fin; C., caudal fin; CP., caudal peduncle; D., dorsal fin; LL1, first scale in lateral line; LL49, last scale in lateral line to be counted; 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.

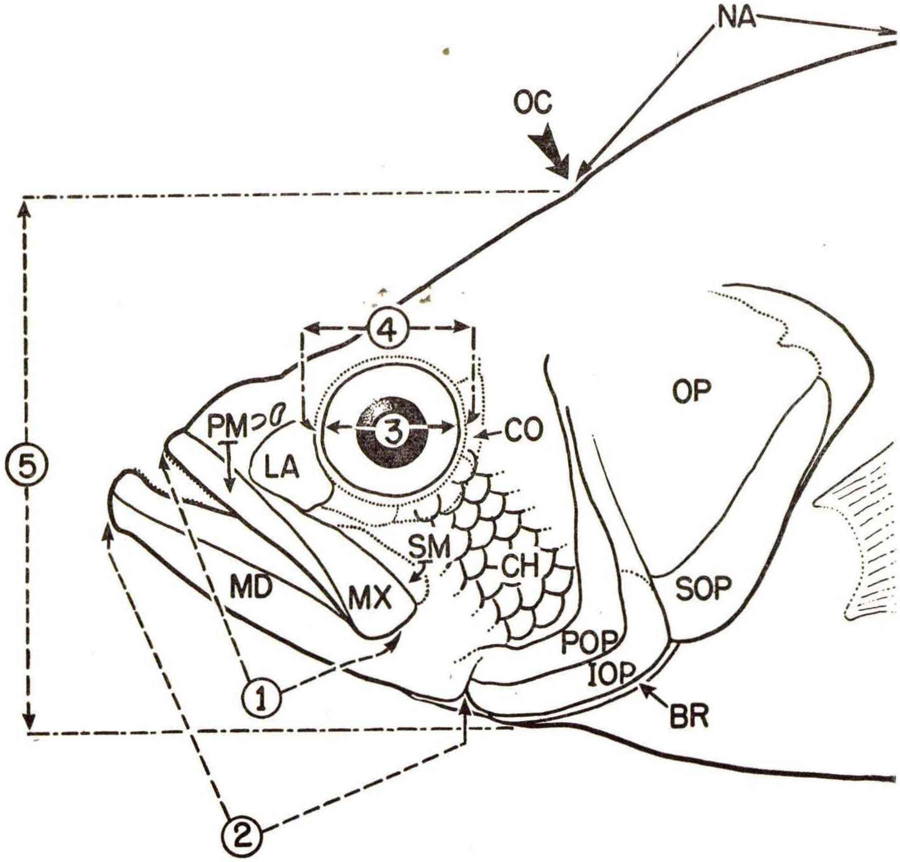


Fig. 2. Head of a fish to show structures and regions used in identification. BR., branchiostegal ray; CH., cheek; CO., circumorbital; IOP., interopercle; LA., lacrymal (or preorbital); MD., mandible; MX., maxilla; NA., nape; OC., occiput; OP., opercle; PM., premaxilla; POP., preopercle; SM., supramaxilla;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

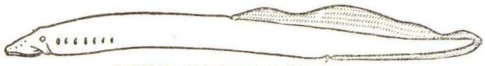
features are subordinated. It appears impractical, however, to attempt identification of minnows without recourse to examination of pharyngeal teeth (see p. 373 and Fig. 5). For small fish the use of a good hand lens or a low-power dissecting microscope is almost indispensable.

The accompanying illustrations and glossary of terms (pp. 370 to 374) 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 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 given elsewhere in this volume.

ARTIFICIAL KEY TO THE FAMILIES OF FISHES FOUND IN IOWA[3]

1a.—No jaws; mouth in adults a circular disc armed with horny teeth. No paired fins. Nostril single and median in position. Seven pairs of small, pore-like external gill apertures. (Class AGNATHA)..Lamprey family, PETROMYZONTIDAE, (p. 348)



PETROMYZONTIDAE

1b.—Jaws present. Pectoral fin present; pelvic fin usually present. Nostrils paired. One pair of slit-like external gill apertures..(Class OSTEICHTHYES, subclass TELEOSTOMI) 2

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

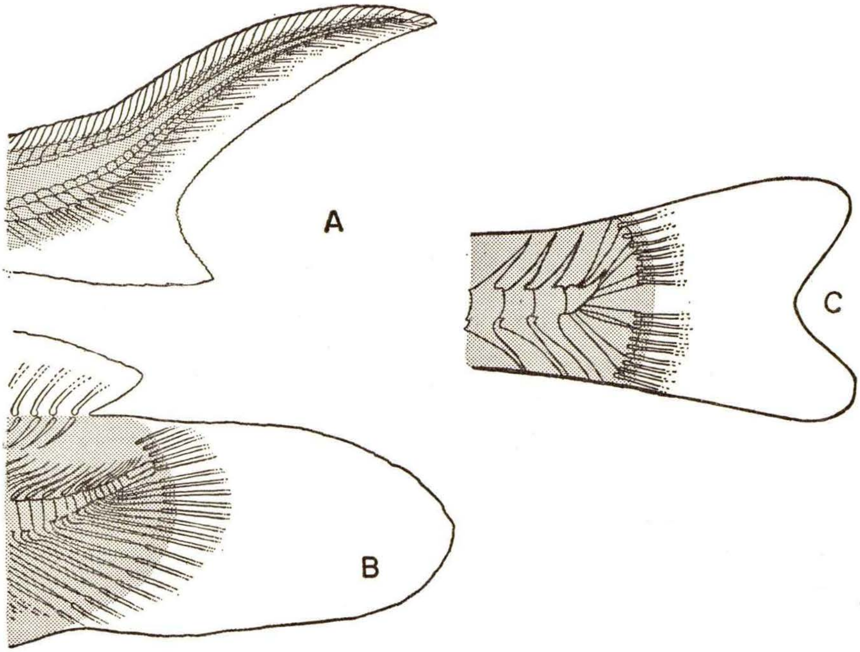
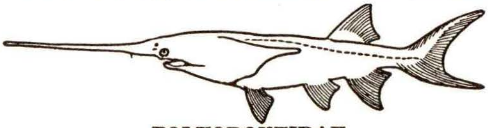


Fig. 3. Three types of caudal (tail) fins. A., typically heterocercal fin of sturgeon. B., abbreviate heterocercal fin of bowfin. C., homocercal fin typical of most bony fishes.

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

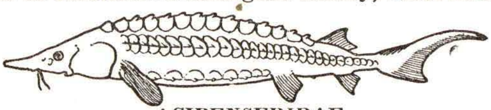
4a.—Body not armored. Snout greatly depressed and expanded laterally, paddle-like, with two tiny barbels on lower surface.......................Paddlefish family, POLYODONTIDAE (one Iowa species, p. 329)



POLYODONTIDAE

[3]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.

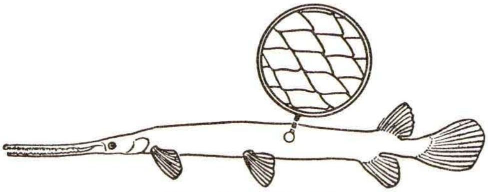
4b.—Body with several longitudinal series of strong bony plates. Snout relatively short, not paddle-like, with four elongate barbels in front of mouth............Sturgeon family, ACIPENSERIDAE (p. 348)



ACIPENSERIDAE

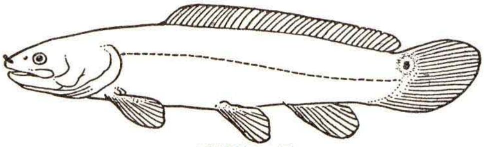
3b.—Caudal fin abbreviate-heterocercal, the fin rounded behind. Mouth terminal, the jaws strongly toothed. Endoskeleton bony...................... 5

5a.—**Scales ganoid (see cut). No gular plate. Dorsal short, it origin** behind that of anal. Snout produced into an elongate beak............ .... Gar family, LEPISOSTEIDAE (p. 350)



LEPISOSTEIDAE

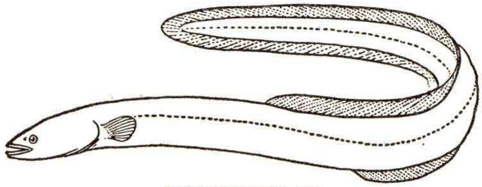
5b.—Scales cycloid. Gular plate present. Dorsal long, its origin anterior to pelvic. Snout blunt and rounded.. ....Bowfin family, AMIIDAE (one Recent species, p. 330)



AMIIDAE

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

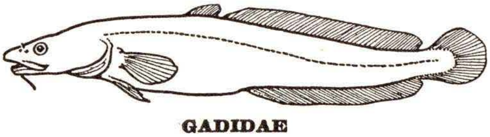
6a.—No pelvic fins. Dorsal, caudal, and anal fins continuous.................... ....Freshwater eel family, ANGUILLIDAE (one Iowa species, p. 335)



ANGUILLIDAE

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

7a.—Pelvic fin jugular, placed in advance of pectoral fin, with 6 or 7 soft rays. A well-developed, median chin barbel. Two dorsal fins, each composed of soft rays.. ....Codfish family, GADIDAE (one Iowa species, p. 335)

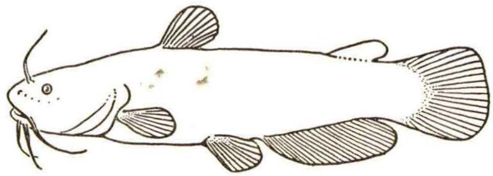


GADIDAE

7b.—Pelvic fin thoracic or abdominal, placed below or behind pectoral fin. No single median chin barbel. Dorsal fin single or, if double, both parts not composed of soft rays........ 8

8a.[4]—Pelvic fin without spine, with more than 5 soft rays, abdominal in position. Scales, if present, cycloid. Anal fin spineless (except in introduced cyprinids)........ 9

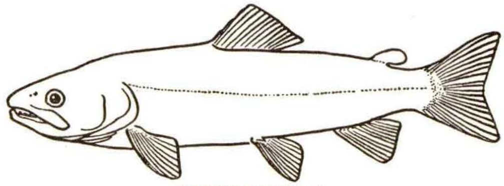
9a.—Pectoral fin with a spine. Body scaleless. Lower jaw with 4 long barbels........Catfish family, ICTALURIDAE (p. 363)



ICTALURIDAE

9b.—Pectoral fin without spine. Body normally with scales. No barbels on lower jaw........ 10

10a.—Adipose fin present........Trout family, SALMONIDAE (p. 351)



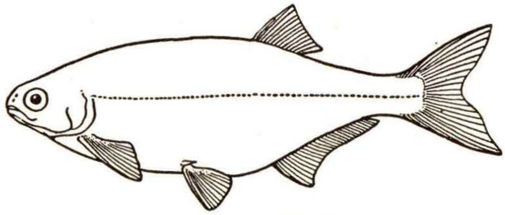
SALMONIDAE

10b.—No adipose fin........ 11

11a.—Head scaleless 12

12a.—Branchiostegal membranes free from isthmus; gill slit extended forward to below eye (Fig. 4). Jaws with or without teeth........ 13

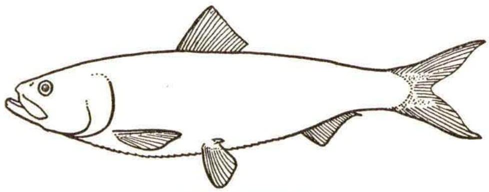
13a.—Lateral line well developed. Gillrakers few, short and knob-like. Gular fold present. Midline of belly without saw-like keel........
........Mooneye family, HIODONTIDAE (p. 351)



HIODONTIDAE

[4]Three alternatives are listed under item 8. Utilize *all* characters provided.

13b.—No lateral line. Gillrakers numerous, long and slender. No gular fold. Scales along midline of belly modified to form a saw-like keel..Herring family, CLUPEIDAE (p. 351)



CLUPEIDAE

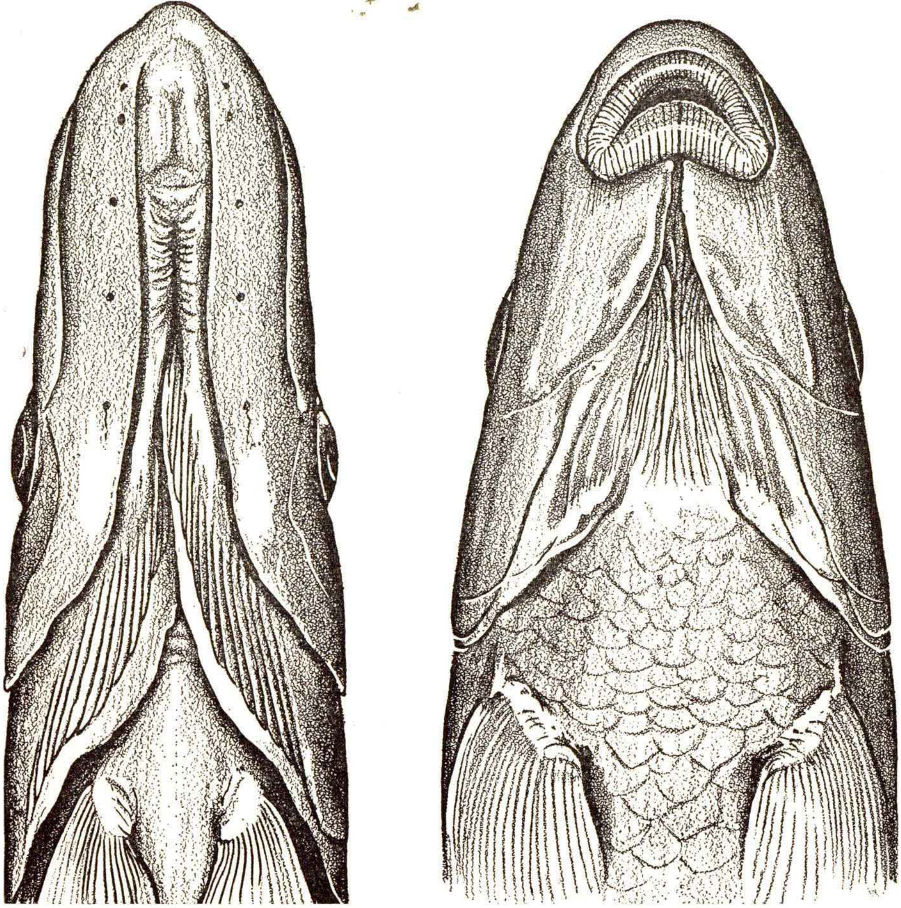
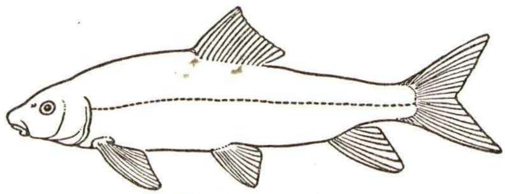


Fig. 4. Uudersurface of heads of northern pike, *Esox lucius* (left) and golden redhorse *Moxostoma erythrurum*. In the pike the branchiostegal membranes are separate and are not attached to the isthmus; in the sucker the membranes are attached to one another and are joined to the isthmus. Note also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

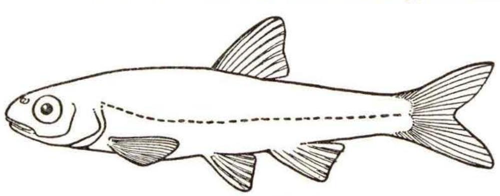
12b.—Branchiostegal membranes united to isthmus and broadly conjoined, the gill slit not extended forward beyond vertical arm of preopercle (Fig. 4). Jaws toothless **14**

14a.—Pharyngeal arch with a single, long, comb-like row of more than 20 teeth (Fig. 5, A and B). 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 forward 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*)............................ ....Sucker family, CATOSTOMIDAE (p. 352)



CATOSTOMIDAE

14b.—Pharyngeal arch with 1 to 3 short rows of teeth, the principal row with not more than 6 teeth (Fig. 5, C). 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.................................... ....Minnow family, CYPRINIDAE (p. 355)



CYPRINIDAE

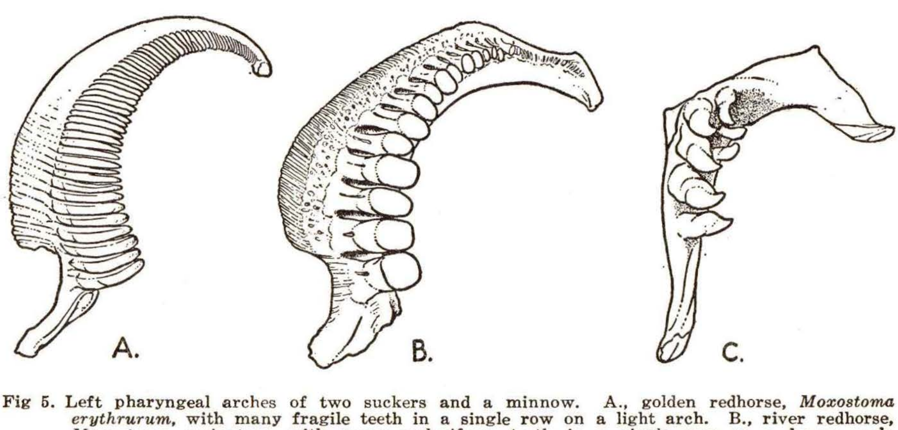
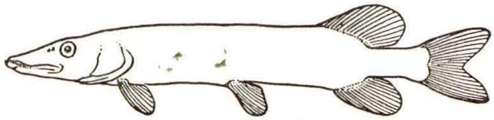


Fig 5. Left pharyngeal arches of two suckers and a minnow. A., golden redhorse, *Moxostoma erythrurum*, with many fragile teeth in a single row on a light arch. B., river redhorse, *Moxostoma carinatum*, with many molariform teeth in a single row on a heavy arch. C., creek chub, *Semotilus atromaculatus*,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

11b.—Head partly scaled.. 15

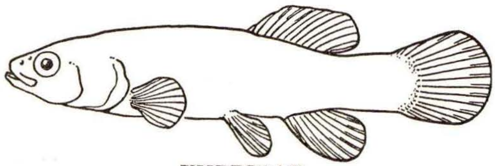
15a.—Premaxillae not protractile (the upper jaw bound to snout by a bridge of skin). Margin of upper jaw formed by premaxilla and maxilla.................................... 16

16a.—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.. ....Pike family, ESOCIDAE (p. 352)



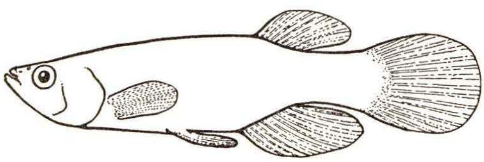
ESOCIDAE

16b.—Teeth villiform. Snout short and bluntly rounded. Branchiostegal rays 3 to 6. Caudal fin rounded. Transverse scale rows about 35.. Mudminnow family, UMBRIDAE ....(one Iowa species, p. 330)



UMBRIDAE

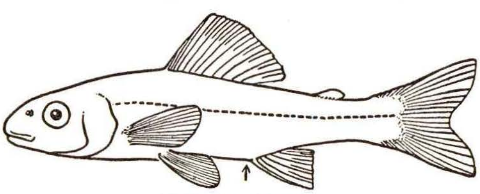
15b.—Premaxillae protractile (the upper jaw and snout separated by a groove). Margin of upper jaw formed by premaxilla only.. ....Killifish family, CYPRINODONTIDAE (p. 365)



CYPRINODONTIDAE

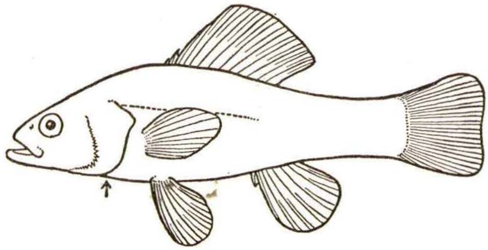
8b.[4]—Pelvic fin with a minute, splint-like spine and 7 or 8 soft rays; subabdominal or subthoracic in position. Scales strongly ctenoid. Anal fin with 1 to 3 spines.. 17

17a.—Adipose fin present. Anus (arrow in cut) located just in front of anal fin. Preopercle and lachrymal almost entire. Trout-perch family, PERCOPSIDAE (one Iowa species, p. 335)



PERCOPSIDAE

17b.—No adipose fin. Anus (arrow in cut) in front of pelvic fin except in young. Preopercle and lachrymal strongly serrate ....Pirate perch family, APHREDODERIDAE ....(one Recent species, p. 335)

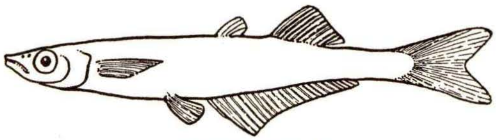


APHREDODERIDAE

8c.[4]—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) **18**

18a.—Pelvic fin with a spine and 5 soft rays. Body covered with scales **19**

19a.—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.. Silverside family, ATHERINIDAE (one Iowa species, p. 335)

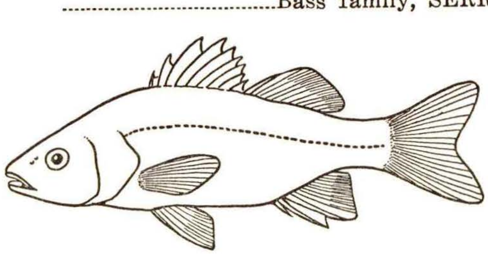


ATHERINIDAE

19b.—Pectoral fin placed low 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................ **20**

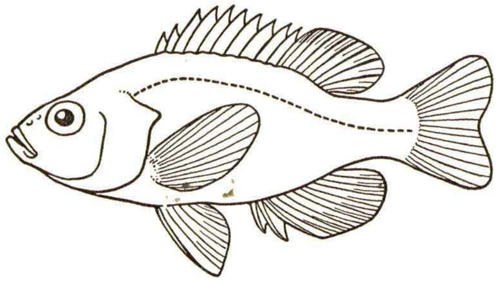
20a.—Anal spines 3 or more.. **21**

21a.—Pseudobranchium well developed, exposed. Opercle with a spine. Anal spines 3.. ....Bass family, SERRANIDAE (p. 365)



SERRANIDAE

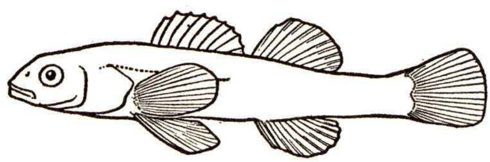
21b.—Pseudobranchium small and concealed by a membrane or wholly absent. Opercle without a developed spine, Anal spines 3 or more.. ....Sunfish family, CENTRARCHIDAE (p. 365)



CENTRARCHIDAE

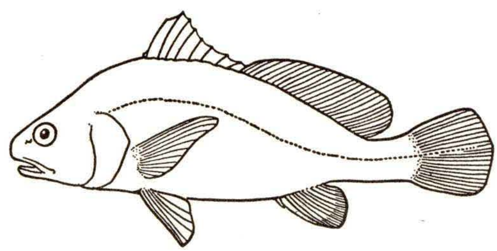
20b.—Anal spines 1 or 2.. 22

22a.—Lateral line not extending far onto caudal fin. Second anal spine, if present, slender, not very long. Head bones not cavernous. Pharyngeal bones slender, separate, with sharp teeth.. ....Perch family, PERCIDAE (p. 367)



PERCIDAE

22b.—Lateral line extending well back onto caudal fin. Second anal spine very long and stout. Head bones cavernous. Pharyngeal bones broad and heavy, fused, with blunt molar teeth.. Drum family, SCIAENIDAE (one Iowa species, p. 337)

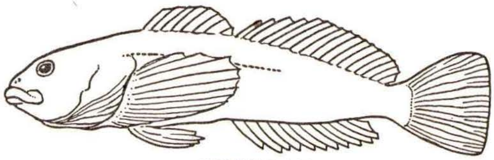


SCIAENIDAE

18b.—Pelvic fin with a spine and 1 to 4 soft rays. Body naked or with prickles 23

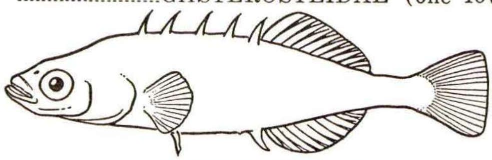
23a.—No free dorsal spines. No anal spine. Pelvic with an embedded spine and 3 or 4 soft rays. Pectoral fin large and

expansive ....
.............Sculpin family, COTTIDAE (one Iowa species, p. 337)



COTTIDAE

23b.—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 Stickleback family..
.........................GASTEROSTEIDAE (one Iowa species, p. 337)



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 in part (1 to 11, usually 6 to 8) bicuspid. Transverse lingual lamina usually 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 (with rare exceptions) all unicuspid. 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. Gillrakers 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 origin of 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. Gillrakers 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

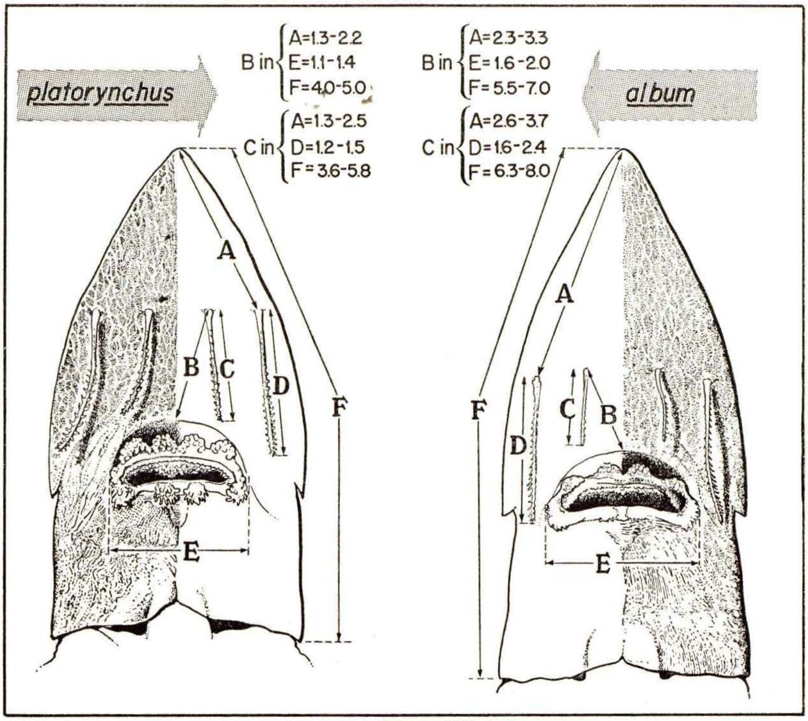


Fig. 6. Comparative diagrams of the lower surface of the head in the shovelnose (*Scaphirhynchus platorynchus*) and pallid (*S. album*) sturgeons, showing several measurement ratios of value for identification (from Bailey and Cross, 1954).

2a.—Belly covered with a mosaic of dermal plates (except in young). Bases of outer barbels in a line with or ahead of inner barbels. Inner barbel heavily fringed and longer (Fig. 6). All barbels placed farther forward on snout. Gillrakers on lower half of first arch mostly with 3 or 4 blunt points. Dorsal fin rays 30 to 36; anal fin rays 18 to 23. Lateral plates larger; eye larger; snout blunter; color darker. Size smaller, maximum weight about 5 pounds, usually much less...Shovelnose sturgeon, **Scaphirhynchus platorynchus**

2b.—Belly largely naked at all ages. Bases of outer barbels lying behind inner barbels. Inner barbel weakly fringed and short (Fig. 6). All barbels placed farther back on snout. Gillrakers on lower half of first arch more fanlike, mostly with 2 blunt tips. Dorsal rays 37 to 43; anal rays 24 to 28. Lateral plates smaller; eye smaller; snout sharper; color more pallid. Size larger, maximum weight over 30 pounds..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 ....Longnose gar, **Lepisosteus osseus**

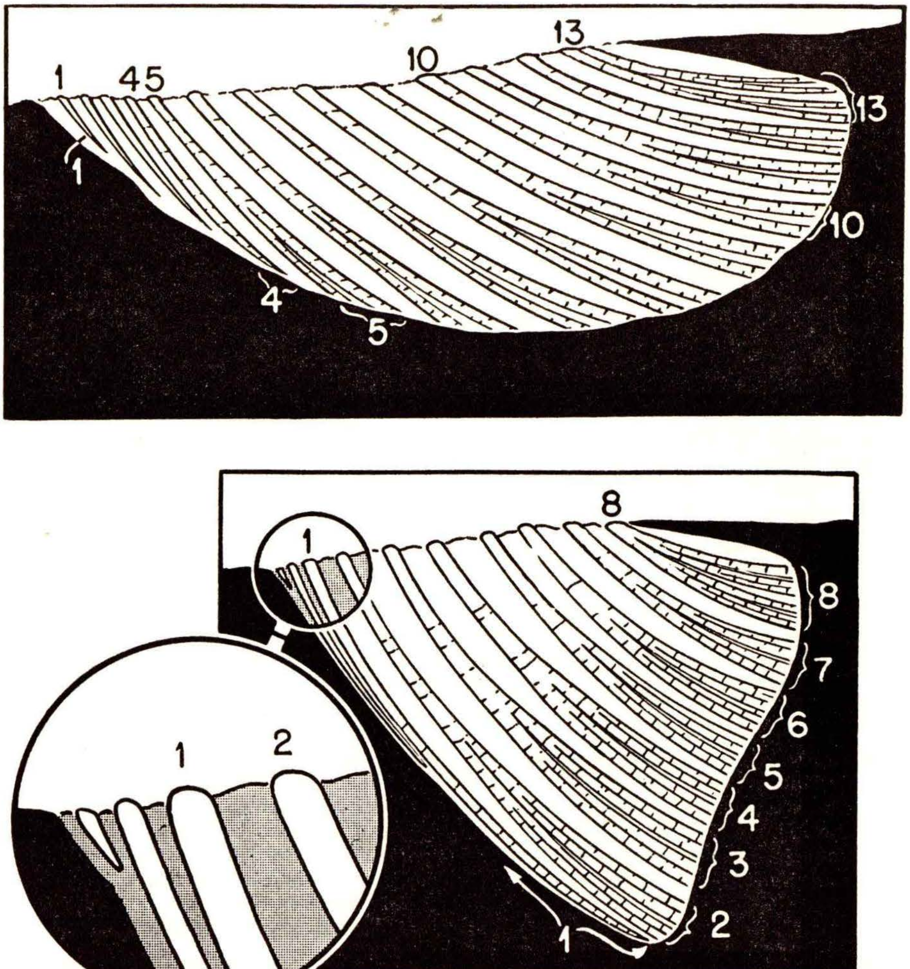


Fig. 7. Two methods of counting rays in the anal fin. Above, *total ray count*, including all rudiments, and often requiring a simple dissection at the front of the fin. Of the 13 rays the first four are simple, the remainder branched. The total ray count is employed in catfishes. Below, *principal ray 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 SALMONIDAE (Trouts)

1a.—Scales larger, fewer than 140 just above 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-marks (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 fin 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. 7) typically 9. Dorsal originating farther forward, much closer to tip of snout than to base of caudal fin (the insertion of pelvic below posterior half of dorsal fin base). **Introduced**....Brown trout, **Salmo trutta**

2b.—Dark spots numerous, smaller, and sharper; especially marked on caudal. Adipose fin 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 fin and tip of snout in young and juveniles, somewhat closer to snout in adults (the insertion of pelvic below anterior half of dorsal fin base). **Introduced**................Rainbow trout, **Salmo gairdneri**

1b.—Scales smaller, more than 190 just above 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**

KEY TO THE SPECIES OF CLUPEIDAE (Herrings)

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

2a.—Jaws subequal. Teeth on tongue in a single median row. Lower jaw teeth weak, present only in juveniles. Gillrakers longer, that nearest angle of arch when depressed extending across bases of about 10 to 12 rakers of lower limb. More than 30 gillrakers 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. Teeth on tongue in 2 to 4 lengthwise rows. Lower jaw teeth present at all ages. Gillrakers shorter, that nearest angle when depressed extending across bases of 5 to 7 rakers of lower limb. About 22 gillrakers on lower limb of first arch. Mandible with dark pigment only anteriorly...Skipjack herring, **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 originating before anal; with 11 or 12 principal rays. Dorsal base about ½ anal base. Fleshy midventral keel not extending in front of pelvic base. Eye larger, the iris silvery........Mooneye, **Hiodon tergisus**

1b.—Dorsal originating behind anal; with 9 or 10 principal rays. Dorsal base about 1/3 anal base. 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) 4. Branchiostegal rays 11 to 13. Scale rows along body fewer than 115. Maximum length about 13 inches..Grass pickerel, Esox **americanus vermiculatus**

1b.—Lower half of opercle naked. Mandibular pores 5 to 8. Branchiostegal rays 14 to 19. Scale rows along body more than 120. 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 bands....................Muskellunge, Esox **masquinongy**

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 to 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 three-fourths that to upper corner of gill-cleft). Subopercle broadest at middle, subsemicircular. Mouth terminal to inferior. 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 two-thirds 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. Mouth inferior. 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 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. Head longer, usually 3.1 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. Head shorter, usually 3.4 to 3.7 in standard length........ Quillback carpsucker, **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 blunter. 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 not more than two-thirds length 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 less 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 more than 3 times in postorbital length of head........ Highfin carpsucker, **Carpiodes velifer**

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

9a.—Circumorbital bones 2 or 3 in addition to lachrymal, narrow or moderate in breadth, greatest width less than half diameter of eye. 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**). Gas 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.—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 long) in standard length. Body scales without dark spots at base........ 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.—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. Body scales on upperparts each with a dark spot at base. Dorsal fin falcate and pointed in front. [Dorsal rays 12 to 14, usually 13; pelvic rays usually 9.]..........Northern redhorse, **Moxostoma aureolum 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. Gas bladder with 2 chambers..........Northern hog sucker, **Hypentelium nigricans**

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

9b.—Circumorbital bones 1 or 2 in addition to lachrymal, broad, greatest breadth more than half diameter of eye, usually two-thirds eye. Lateral line weakly developed or absent. Lips plicate. Gas bladder typically with 2 chambers.......... 16

16a.—Lateral line weakly developed 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..........Lake chubsucker, **Erimyzon sucetta**

KEY TO THE SPECIES OF CYPRINIDAE (Minnows)[5]

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"). Gillrakers 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. Gillrakers 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 principal rays (Fig. 7). **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. Anal fin falcate. Lateral line greatly decurved. [Teeth usually 5-5.] .... Golden shiner, **Notemigonus crysoleucas**

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

4a.—Pharyngeal teeth (for method of counting see p. 373) in main row typically 5-5 or 5-4 (4-4 only in rare variants). Mouth terminal or subterminal, never inferior.......... 5

5a.—Maxilla with a flap-like barbel (Fig. 8A) placed in groove above upper lip well in advance of angle of mouth (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] .... Creek chub, **Semotilus atromaculatus**

5b.—No barbel 6

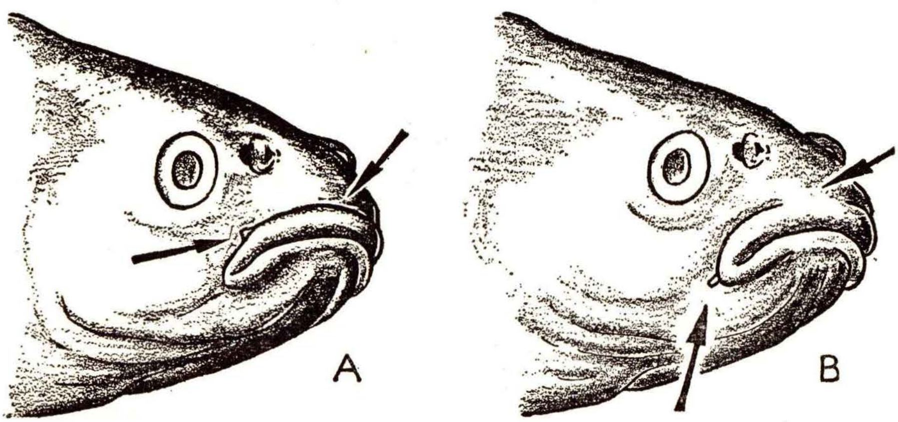


Fig. 8. Three-quarter views of the heads of two minnows to show barbels and relations of snout and lip. A. upper lip protractile (with groove, arrow, separating upper lip from snout); maxilla with a barbel (arrow), that is placed well in advance of its posterior end, as in *Semotilus*. B. upper lip not protractile (with a frenum, arrow); 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

[5]A key to the species and subspecies of *Notropis* appears on page 359.

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

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. Intestine 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. Mouth terminal to inferior........ **8**

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

9a.—Scale radii restricted to the posterior (exposed) field. Upper jaw protractile, separated from snout by a groove (Fig. 8 A). .... **Hybopsis** **10**

10a.—Teeth usually 2, 4-4, 2. Lateral-line scales 48 or more.......... **11**

11a.—Head moderately compressed, deeper than broad. Fins rounded, the pectoral not reaching insertion of pelvic. Scale rows above lateral lines in front of dorsal usually 25 to 27......................................Lake chub, **Hybopsis plumbea**

11b.—Head strongly depressed, broader than deep. Fins high and falcate, the pectoral exceeding pelvic insertion in adult. Scale rows above lateral lines in front of dorsal usually 13 to 15................Flathead chub, **Hybopsis gracilis**

10b.—Pharyngeal teeth 0 or 1, 4-4, 0 or 1. Lateral-line scales 50 or fewer **12**

12a.—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 chub, **Hybopsis biguttata**

12b.—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.. **13**

13a.—Teeth 1, 4-4, 1.. **14**

14a.—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**

14b.—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....... **15**

15a.—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**

15b.—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 pre-pelvic area. Head deeper and snout blunter, its length much less than postorbital length of head. Sicklefin chub, **Hybopsis meeki**

13b.—Teeth 4-4 .... **16**

16a.—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**

16b.—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. Upper jaw not protractile, not separated from snout by a groove (Fig. 8 B). [Lateral-line scales more than 56]...**Rhinichthys** **17**

17a.—Upper jaw little exceeding lower jaw; mouth somewhat oblique. Eye lateral, larger. Lateral dark stripe rather sharply defined below. Gas bladder fairly well developed, its posterior tip well behind insertion of pelvic...................... Western blacknose dace, **Rhinichthys atratulus meleagris**

17b.—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. Gas 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 projects from the posterior angle of the mouth in breeding males of **Pimephales notatus**).. **18**

18a.—Lower lip thick, rugose, with a fleshy projection on each side that is partially separated from mandible by a groove............. ....Plains suckermouth minnow, **Phenacobius mirabilis**

18b.—Lower lip rather thin and smooth, without fleshy lateral projections **19**

19a.—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 gas bladder. Gill-rakers on first arch fewer than 15, rather short........................ **20**

20a.—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. 9). Nuptial organs not confined to a cluster of heavy tubercles on front of head.................... 21

21a.—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)..............................**Notropis** (see p. 359)

21b.—Intestine elongate, more than twice standard length, with several loops. Peritoneum black. [Teeth 4-4. Anal rays typically 8].. **22**

22a.—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**

22b.—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** **23**

23a.—Body yellowish in life. Fins more rounded. Scales with the radii numerous (usually nearly 20 in adult) and weak; circuli smoothly curved at basal corners of scale. Head blunter. Size smaller, length to about 4 inches.. ....Brassy minnow, **Hybognathus hankinsoni**

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

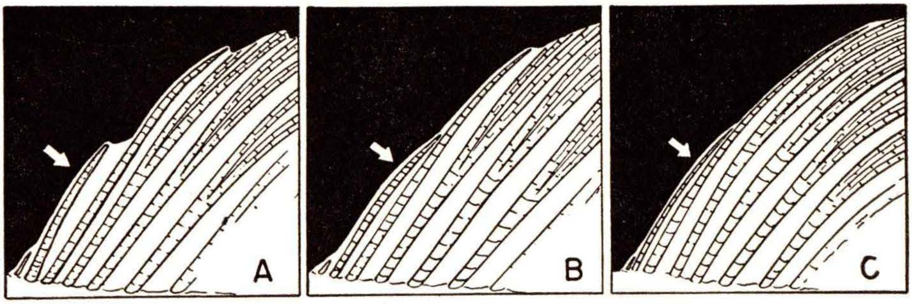


Fig. 9. Comparison of anterior rays of dorsal fin in bluntnose minnow, *Pimephales notatus*, adult male (A) and adult female (B); and common shiner, *Notropis cornutus* (C). The second unbranched dorsal ray is thickened and well separated from the third (first principal) dorsal ray in A, somewhat less 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.)

20b.—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. 9), 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. A dark spot in basal half of front of dorsal;

caudal spot conspicuous. Nuptial tubercles typically 9............Bullhead minnow, **Pimephales vigilax perspicuus**

24b.—Intestine elongate, with several loops. Peritoneum dusky or black. Pharyngeal teeth weakly or not at all hooked. No dark spot in dorsal fin; caudal spot well developed or faint. Nuptial tubercles on head usually 16 or more.. 25

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

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

19b.—Cartilaginous ridge of lower jaw prominent, and separated by a groove from the fleshy lower lip. Intestine spirally looped about the gas bladder. Gillrakers on first arch 29 to 34, moderately long and slender. ....Stoneroller, **Campostoma anomalum**

KEY TO THE SPECIES AND SUBSPECIES OF *NOTROPIS* (Shiners)

1a.—Teeth in two rows, 1 or 2, 4-4, 1 or 2.. 2

2a.—Principal anal rays 9 to 13 (occasionally 8 in cornutus and illecebrosus) 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 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..................................Emerald shiner, **Notropis 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. Anal rays usually 9............ **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 lachrymal, 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............Weed shiner, **Notropis roseus**

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, the anterior rays much exceeding posterior rays in the depressed fin. Eye larger, more than one-fourth 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, well-defined, circular 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..Bigmouth shiner, **Notropis dorsalis**[6]

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, the anterior rays much shorter than to slightly exceeding posterior rays (small juveniles) in the depressed fin. Eye smaller, less than one-fourth 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...Red shiner, **Notropis lutrensis**

1b.—Teeth in a single row, 4-4.. **15**

15a.—Anal rays usually 9 (often 8 or 10). Body depth 2.7 to 3.7 in standard length. Scales closely imbricate. [Teeth occasionally 1, 4-4,

[6]One of the most common problems for the student of Iowa fishes involves the separation of *Notropis dorsalis*, the bigmouth shiner, and *Notropis deliciosus*, the sand shiner. These species both live in abundance over a sand bottom and are frequent associates. *N. dorsalis* usually has the teeth in two rows, 1, 4-4, 1, whereas *N. deliciosus* has only a single row, 4-4. *N. dorsalis* differs from *N. deliciosus* further in that the eyes are superolateral (rather than lateral), the mouth is larger and more broadly U-shaped, the snout is more bluntly rounded (in dorsal aspect), the predorsal scales are smaller and less regularly arranged, the middorsal streak is broader and darker (especially evident behind the dorsal fin), the caudal peduncle is longer and more slender (its depth usually contained 2.4 to 2.8 times in its length rather than 2.0 to 2.4 times), and the anal rays are most often 8 (frequently 7, rarely 9) rather than typically 7 (rarely 6 or 8).

1 or 1, 4-4, 0]..Red shiner, **Notropis 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............**Notropis deliciosus**[6] **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 side bright red or orange......................Topeka shiner, **Notropis topeka**

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

19a.—Anterior lateral-line scales not greatly elevated, rounded behind. Dark lateral band conspicuous, marked with vertical black crescents. Infraorbital canal (Fig. 10) 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 (Fig. 10) complete or absent, not in three disconnected tubes **20**

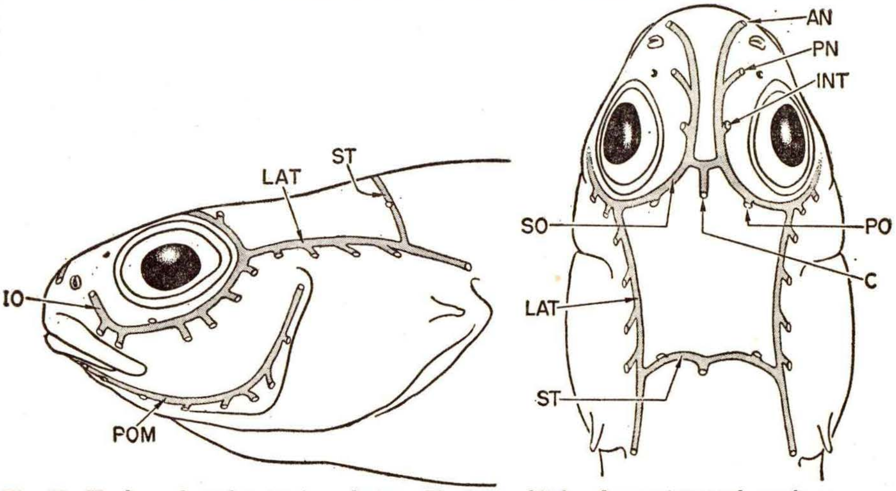


Fig. 10. Head canals and pores in a darter. The infraorbital and supratemporal canals are complete with 8 and 3 pores respectively. AN., anterior nasal pore; C., coronal pore; INT., interorbital pore; IO., infraorbital canal; LAT., lateral canal; PN., posterior nasal pore; PO., postorbital pore; POM., preoperculomandibular canal; SO., supraorbital canal; ST., supratemporal canal.

20a.—Infraorbital canal complete, extending from lateral canal, below eye, across lachrymal 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. Chiefly 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 ICTALURIDAE (Catfishes)

1a.—Jaws equal or the upper protruding, mouth of moderate width. Pectoral spine various; never as in 1b. Preoperculomandibular canals (Fig. 10) separate, the pores 10 or 11. Anterior nasal pore located mediad to anterior nostril. Premaxillary tooth band usually a transverse bar (but see item 8**b**).. 2

2a.—Adipose fin with posterior margin free, not fused or continuous with caudal fin. Gillrakers 11 or more..**Ictalurus** 3

3a.—Caudal fin more or less truncate or rounded behind, not deeply forked. Anal rays (including all anterior rudiments—Fig. 7) 17 to 27. Jaws nearly equal. Supraoccipital bone produced backward but failing to join anterior process from dorsal fin................................ 4

4a.—Anal rays 17 to 24, usually 22 or fewer. Chin barbels dusky. Caudal fin slightly emarginate... 5

5a.—Pectoral spine smooth or only weakly roughened posteriorly. Outer two-thirds of interradial membranes of anal fin uniformly pigmented, always darker than the rays, the fin not mottled, barred, or uniformly pigmented on both membranes and rays. Adults with the belly yellow......Black bullhead, **Ictalurus melas**

5b.—Pectoral spine with rather strong posterior serrations. Black pigment on anal fin typically densest on the membranes near their margin, or in spots that form 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.......................................Brown bullhead, **Ictalurus nebulosus**

4b.—Anal rays 24 to 27, usually 25 or 26. Chin barbels white, rarely faintly dusky. Caudal fin rounded behind. [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, **Ictalurus natalis**

3b.—Caudal fin deeply forked. Anal rays 24 to 35. Upper jaw decidedly longer than lower. Supraoccipital bone produced backward to join with anterior process from dorsal fin.. **6**

6a.—Anal shorter, its base about 3.4 to 3.7 in standard length, with 24 to 29 rays. Body silvery, the young immaculate, older fish more or less heavily spotted with dark (spots often obscure in adults, especially during the breeding season). Gas bladder with 2 chambers....................................Channel catfish, **Ictalurus punctatus**

6b.—Anal longer, its base about 2.9 to 3.1 in standard length, with 30 to 35 rays. Body silvery, nearly or quite immaculate. Gas bladder with 3 chambers..........................Blue catfish, **Ictalurus furcatus**

2b.—Adipose fin a low, keel-like fleshy ridge which is fused or continuous with caudal fin. Gillrakers 3 to 10...**Noturus** **7**

7a.—Head moderately deep. Pectoral-fin spine entire, with deep, long grooves that extend nearly to base. Distance from tip of caudal to adipose-fin notch, 0.8 to 1.5 in distance from that notch to dorsal origin. Caudal rays long, the fin broadly rounded. Pectoral soft rays usually 6 to 8; pelvic rays usually 8. [Jaws about equal; infraorbital and supraorbital canals separate anteriorly.]..Tadpole madtom, **Noturus gyrinus**

7b.—Head notably depressed. Pectoral-fin spine entire or serrate behind, with rather shallow grooves in distal half. Distance from tip of caudal to adipose-fin notch, 1.6 to 2.5 in distance from that notch to dorsal origin. Caudal rays shorter, the fin more or less truncate. Pectoral soft rays usually 9 or 10; pelvic rays usually 9 or 10.......... **8**

8a.—Vertical fins broadly margined with dusky. Jaws about equal. Pectoral spine with developed serrae along posterior edge. Infraorbital and supraorbital canals joined anteriorly (one internasal pore). Preoperculomandibular pores usually 10. Anal rays 17 to 22, usually 19 to 21. Premaxillary tooth band a transverse bar...Slender madtom, **Noturus exilis**

8b.—Vertical fins with white margins. Lower jaw included. Pectoral spine without developed serrae on posterior edge. Infraorbital and supraorbital canals separated anteriorly (2 internasal pores). Preoperculomandibular pores usually 11. Anal rays 15 to 19, usually 16 to 18. Premaxillary tooth band with a long, narrow backward projection on each side; the posterior border trapezoidal. ....Stonecat, **Noturus flavus**

1b.—Lower jaw projecting, the head markedly depressed and the mouth very wide. Pectoral spine strong, almost straight, anterior and posterior edges equally armed with well-developed serrae. Preoperculomandibular canals (Fig. 10) joined in a median pore on chin, the pores 12 on each side (including median pore). Anterior nasal pore located at edge of lip, well in front of anterior nostril. Premaxillary tooth band with a broad backward projection on each side, the posterior border smoothly curved. [Adipose fin large; free from caudal.]..Flathead catfish, **Pylodictis olivaris**

KEY TO THE SPECIES OF CYPRINODONTIDAE (Killifishes)

1a.—Dorsal origin ahead of anal origin, its distance from 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..Banded killifish, **Fundulus diaphanus menona**

1b.—Dorsal origin behind anal origin, its distance from 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. notti** **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..Starhead topminnow, **Fundulus notti 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; second spine 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, **Roccus chrysops**

1b.—Anal rays III, 10; second and third spines 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, **Roccus mississippiensis**

KEY TO THE SPECIES OF CENTRARCHIDAE (Sunfishes)

1a.—Anal spines 3 (very 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 ....**Micropterus** **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. Scales 68 to 81 along lateral line and 14 to 18 on cheek 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, the edge of fin clear white. Pyloric caeca typically unbranched................Smallmouth bass, **Micropterus 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. Scales 58 to 69 along lateral line and 9 to 12 on cheek from eye to angle of preopercle. Pattern consisting chiefly of a rather regular longitudinal dark stripe on side; young without marked band on caudal. Pyloric caeca typically branched at base..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 gulosus**

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. Gillrakers moderately long and slender, the longest if depressed extending to base of second (third in young) raker below. Opercle broadly margined with light, without scarlet in life. Supramaxilla about two-thirds breadth of maxilla. Inferior pharyngeal bone elongate, external margin straight, teeth rather sharp. Palatine teeth fairly well developed. ....Green sunfish, **Lepomis cyanellus**

6b.—Pectoral long and pointed; 3.0 to 3.3 in standard length. Gillrakers short and stout, the longest if depressed extending to base of first (second in young) raker below. Opercular margin dark, with a small semicircular scarlet spot. Supramaxilla about one-third 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)....................................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.—Gillrakers 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.—Gillrakers 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.—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. Palatine teeth present. Sensory cavities of head well developed, the supraorbital canals wider than interspace..Orangespotted sunfish, **Lepomis humilis**

8b.—Opercle extending almost to membranous margin, edge of opercle fimbriate; opercular membrane dark to its margin. Anal III, 10 to 12. A dark blotch on median portion of posterior dorsal rays. Palatine teeth absent. Sensory cavities of head not enlarged, the supraorbital canals much narrower than interspace........................Bluegill, **Lepomis 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. Gillrakers 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. Gillrakers 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 percent 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 percent 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 urogenital 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 breadth of fin base). Body slender and subterete. Anal II, 12 or 13. Pseudobranchium well developed............ .... **Stizostedion** **3**

3a.—Lower lobe of caudal with a milk-white tip. 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........................... ....Yellow walleye, **Stizostedion vitreum vitreum**

3b.—Lower lobe of caudal not tipped with white. 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 9, 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**

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). Urogenital 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 occasionally 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 **P. caprodes**). 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 48] **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......**Percina** **6**

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

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, **Percina 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, **Percina phoxocephala**

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, **Percina 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.. **Ammocrypta** 10

10a.—Vomer and palatine with teeth. Vertebrae 45 to 48. 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, **Ammocrypta asprella**

10b.—Vomer and palatine typically toothless, the vomer occasionally with a single tooth. Vertebrae 38 to 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 41]..**Etheostoma** 11

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

12a.—Anal spine single, thin and flexible. Premaxillae protractile. [Interpelvic space wide, at least three-fourths of 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 three-fourths of 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 two-thirds of 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 usually complete (interrupted 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 asprigene**

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. 10) 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; 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; anal fin with little or no red-orange.................... 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.)

Anal fin (or anal).—The single or unpaired fin on the lower side of the fish between the anus and the tail fin (Fig. 1). 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. 7.)

Barbel.—A fleshy, thread-like, flap-like or conical process (Fig. 8); usually small if present in American minnows, but long in catfishes and carp.

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 (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 (or caudal).—The tail fin (Fig. 3).

Caudal peduncle.—The slender, posterior portion of the body (behind the anal fin) which bears the tail fin (Fig. 1). 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).

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 (Fig. 2). The anterior bone, which lies in front of the eye is known as the preorbital or lachrymal, those below the eye are called suborbitals, and those behind the eye are termed postorbitals. The infraorbital canal commonly penetrates the circumorbitals.

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 (Fig. 1). 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.

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 (Fig. 8).

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

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

Gillrakers.—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, as in the bowfin.

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

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

Homocercal.—The tail is homocercal if the posterior vertebra (the urostylar vertebra, which supports the hypural plate) is modified to support the entire tail fin; neither lobe of the tail fin is invaded by the vertebral column (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 (Fig. 10).

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.

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

Jugular.—Pertaining to the throat.

Lachrymal.—The preorbital bone, or first circumorbital bone; it lies just before eye (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 (Figs. 1 and 10).

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—Fig. 1). Where the lateral line is incomplete or absent, the transverse scale rows are counted along the line where the lateral line normally occurs.

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 (mandibular canal) on the lower side of each lower jaw. This is the anterior section of the preoperculomandibular canal (Figs. 4 and 10).

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 (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 (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 (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.

Operculum.—The gill cover.

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 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-marks.—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 (Fig. 1).

Pelvic (or ventral) fin.—A paired fin inserted on the lower side of the fish (Fig. 1). 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.

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 (Fig. 5). 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 inner or minor row, 5 in the outer or main row, whereas that on the right side has 1 tooth in the inner 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.

Plicate.—With a series of parallel folds or soft ridges (plicae—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 (Fig. 2). The premaxillae join to form part or all of the border of the jaw.

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

Preopercular canal.—That portion of the preoperculomandibular canal that lies on the preopercle (Fig. 10).

Preoperculomandibular canal.—A branch of the lateral-line system that extends along the preopercle (preopercular canal) and the mandible (mandibular canal). (See Fig. 10.)

Preorbital.—The lachrymal, or first circumorbital bone; it lies just before 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 (Fig. 8). 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.

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 (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 (Fig. 1).

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

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 (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 (Fig. 10).

Supratemporal canal.—A branch of the lateral-line system which crosses the top of the head at the occiput, connecting the lateral canals (Fig. 10).

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.

Urogenital papilla.—A flap-like or finger-like projection between the anus and the anal 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 or urostylar vertebra, which with its attached hypural plate 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.

REFERENCES

This list of publications includes literature cited in the foregoing pages, the general and regional references which are most useful to the student of Iowa fishes, and many but not all of the papers dealing specifically with the fishes of Iowa.

Aitken, W. W.
1936 Some Common Iowa Fishes. [Iowa St. Coll.] Ext. Circ., 224: 1-33, figs.
1941 A Preliminary Report on a Check-list of Iowa Teleosts. Proc. Iowa Acad. Sci., 47 (1940): 387-392.

Bailey, Reeve M.
1938 The Fishes of the Merrimack Watershed. N. H. Fish and Game Dept., Surv. Rept. 3: 149-185, 2 pls., Fig. 1.
1951 A Check-List of the Fishes of Iowa, with Keys for Identification. In Iowa Fish and Fishing, by James R. Harlan and Everett B. Speaker. Pp. 185-237, Figs. 1-9. Iowa Conservation Commission.
1954 Distribution of the American Cyprinid Fish *Hybognathus hankinsoni* with Comments on its Original Description. Copeia (4): 289-291, Fig. 1.

Bailey, Reeve M., and Frank B. Cross
1954 River Sturgeons of the American Genus *Scaphirhynchus*: Characters, Distribution, and Synonymy. Pap. Mich. Acad. Sci., Arts, and Letters, 39 (1953): 169-208, Figs. 1-10.

Bailey, Reeve M., and William A. Gosline
1955 Variation and Systematic Significance of Vertebral Counts in the American Fishes of the Family Percidae. Misc. Publ. Mus. Zool. Univ. Mich., 93:1-44, Figs. 1-4.

Bailey, Reeve M., and Harry M. Harrison, Jr.
1945 The Fishes of Clear Lake, Iowa. Iowa St. Coll. Jour. Sci., 20 (1): 57-77, Fig. 1.
1948 Food Habits of the Southern Channel Catfish *(Ictalurus lacustris punctatus)* in the Des Moines River, Iowa. Trans. Amer. Fish. Soc., 75 (1945): 110-138, Figs. 1-5.

Bailey, Reeve M., and Everett B. Speaker
1946 Fisheries of Iowa. *In* Wildlife Resources of Iowa. State of Iowa, Des Moines: Pp. 7-24, 14 figs.

Bailey, Reeve M., Howard Elliott Winn, and C. Lavett Smith
1954 Fishes from the Escambia River, Alabama and Florida, with Ecologic and Taxonomic Notes. Proc. Acad. Nat. Sci. Phila., 106: 109-164, Fig. 1.

Barnickol, Paul G., and William C. Starrett
1951 Commercial and Sport Fishes of the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa. Bull. Ill. Nat. Hist. Surv., 25 (5): 267-350, Figs. 1-15.

Call, R. Ellsworth
1892 The Fishes of the Des Moines Basin. Proc. Iowa Acad. Sci., 1, pt. 2 (1890, 1891): 43-56.

Cleary, Robert E.
1952 An Annotated Check-List of Fishes of the Wapsipinicon River Drainage System in Iowa. Proc. Iowa Acad. Sci., 59 (1952): 435-441, Fig. 1.
1954 An Annotated Check-List of the Fishes of the Iowa-Cedar River Drainage Basin in Iowa. Proc. Iowa Acad. Sci., 60 (1953): 626-635, Fig. 1.

Coker, Robert E.
1930 Studies of Common Fishes of the Mississippi River at Keokuk. U. S. Bur. Fish., Bull. 45: 141-225, Figs. 1-30.

Crane, Jacob L., Jr., and George Wheeler Olcott
1933 Report on the Iowa Twenty-five year Conservation Plan. Des Moines: Pp. xiii + 176.

Cross, Frank B.
1953 Nomenclature in the Pimephalinae, with Special Reference to the Bullhead Minnow, *Pimephales vigilax perspicuus* (Girard). Trans. Kansas Acad. Sci., 56:92-96.

Eddy, Samuel, and Thaddeus Surber
1947 Northern Fishes with Special Reference to the Upper Mississippi Valley. Minneapolis: Univ. Minn. Press. 2nd Ed. Pp. xii + 276, Figs. 1-57.

Evermann, Barton Warren, and Ulysses O. Cox
1896 A Report upon the Fishes of the Missouri River Basin. Rept. U. S. Comm. Fish and Fish., 20 (1894): 325-429.

Forbes, S. A., and Robert Earl Richardson
1909 (and 1920) The Fishes of Illinois. Nat. Hist. Surv. Ill., 3: i-cxxxi, 1-357, many col. pls. and figs. plus atlas of 103 maps.

Garman, S.
1895 The Cyprinodonts. Mem. Mus. Comp. Zool., 19 (1): 1-179, Pls. 1-11.

Gerking, Shelby D.
1945 The Distribution of the Fishes of Indiana. Invest. Indiana Lakes and Streams, 3:1-137, Maps 1-113.

Greene, C. Willard
1935 The Distribution of Wisconsin Fishes. Wis. Cons. Comm., Madison, Wis. Pp. 1-285, Maps 1-96.

Harlan, James R., and Everett B. Speaker
1951 Iowa Fish and Fishing. Iowa Conservation Commission. Pp. 1-237. Illus.

Harrison, Harry M.
1950 An annotated List of the Fishes of the Upper Des Moines River Basin in Iowa. Proc. Iowa Acad. Sci., 56 (1949): 333-342, Fig. 1.

Harrison, Harry M., and Everett B. Speaker
1954 An Annotated List of the Fishes in the Streams Tributary to the Missouri River in Iowa. Proc. Iowa Acad. Sci., 61 (1954): 511-523, Fig. 1.

Hourston, A. S.
1955 A study of Variations in the Maskinonge from Three Regions in Canada. Contr. Roy. Ont. Mus. Zool. and Palaeont., 40: 1-13, Figs. 1-16.

Hubbs, Carl L.
1926 A Check-List of the Fishes of the Great Lakes and Tributary Waters, with Nomenclatorial Notes and Analytical Keys. Misc. Publ. Mus. Zool. Univ. Mich., 15: 1-77, Pls. 1-4.
1930 Materials for a Revision of the Catostomid Fishes of Eastern North America. Misc. Publ. Mus. Zool. Univ. Mich., 20: 1-47, 1 pl.
1945 Corrected Distributional Records for Minnesota Fishes. Copeia (1): 13-22.

Hubbs, Carl L., and Reeve M. Bailey
1940 A Revision of the Black Basses (*Micropterus* and *Huro*) with Descriptions of Four New Forms. Misc. Publ. Mus. Zool. Univ. Mich., 48: 1-51, Pls. 1-6, Fig. 1, Maps 1-2.

Hubbs, Carl L., and John D. Black
1947 Revision of *Ceratichthys*, a Genus of American Cyprinid Fishes. Misc. Publ. Mus. Zool. Univ. Mich., 66: 1-56. Pls. 1-2, Fig. 1, Maps 1-2.

Hubbs, Carl L., and Gerald P. Cooper
1936 Minnows of Michigan. Cranbrook Inst. Sci., Bull. 8: 1-95, Pls. 1-10, Figs. 1-2.

Hubbs, Carl L., and C. Willard Greene
1935 Two New Subspecies of Fishes from Wisconsin. Trans. Wis. Acad. Sci., Arts and Letters, 29: 89-101, Pls. 2-3.

Hubbs, Carl L., and Karl F. Lagler
1947 (2nd Ed., 1949) Fishes of the Great Lakes Region. Cranbrook Inst. Sci., Bull. 26: i-xi, 1-186, Figs. 1-251, many col. pls.

Hubbs, Carl L., and Milton B. Trautman
1937 A Revision of the Lamprey Genus *Ichthyomyzon*. Misc. Publ. Mus. Zool. Univ. Mich., 35: 1-109, Pls. 1-2, Figs. 1-5, Map 1.

International Commission on Zoological Nomenclature
1950 The Official Record of Proceedings of the International Commission on Zoological Nomenclature at its Session held in Paris in July 1948. Bull. Zoological Nomenclature, 4 (1-12): 1-350.
1953 Copenhagen Decisions on Zoological Nomenclature (Francis Hemming, Ed). London. Metcalfe and Cooper, Ltd. xxix + 135.

Jordan, David Starr
1929 Manual of the Vertebrate Animals of Northeastern United States Inclusive of Marine Species (13th Ed.) Yonkers, N. Y.: World Book Co. Pp. xxxi + 446, Figs. 1-15, 1 Map.

Jordan, David Starr, and Barton Warren Evermann
1896-1900 The Fishes of North and Middle America, Pts. I-IV. Bull. U. S. Nat. Mus., 47: i-ix, 1-3313, Pls. 1-392.

Jordan, David S., and Charles H. Gilbert
1883 Synopsis of the Fishes of North America. Bull. U. S. Nat. Mus., 16, 1882: i-lvi, 1-1018.

Jordan, David S., and Seth E. Meek
1885 List of Fishes Collected in Iowa and Missouri in August, 1884, with Descriptions of Three New Species. Proc. U. S. Nat. Mus., 8: 1-17.

Larrabee, Austin P.
1926 An Ecological Study of the Fishes of the Lake Okoboji Region. Univ. Iowa Studies Nat. Hist., new ser., 11 (12): 1-35, Fig. 1.

Legendre, Vianney
1952 Clef des poissons de peche Sportive et Commerciale de la Province de Quebec. Ministere de la Chasse et des Pecheries, Quebec: 1-84, Figs. 1-80.

Meek, Seth Eugene
1889 The Native Fishes of Iowa. Bull. Lab. Nat. Hist. St. Univ. Iowa, 1(2) :161-171.
1890 The Native Food Fishes of Iowa. Proc. Iowa Acad. Sci., 1, pt. 1 (1887, 1888, 1889): 68-76.
1892 Report upon the Fishes of Iowa, Based upon Observations and Collections made during 1889, 1890, and 1891. Bull. U. S. Fish Comm., 10 (1890): 217-248.
1893 The Fishes of the Cedar River Basin. Proc. Iowa Acad. Sci., 1, pt. 3 (1892): 105-112.
1894 Notes on the Fishes of Western Iowa and Eastern Nebraska. Bull. U. S. Fish Comm., 14 (1894): 133-138.

Miller, Robert Rush
1945 A New Cyprinid Fish from Southern Arizona, and Sonora, Mexico, with the Description of a New Subgenus of *Gila* and a Review of Related Species. Copeia (2): 104-110, Pl. 1.
1955 An Annotated List of the American Cyprinodontid Fishes of the Genus *Fundulus*, with the Description of *Fundulus persimilis* from Yucatan. Occ. Pap. Mus. Zool. Univ. Mich., 568: 1-25, Pl. I.

Moore, George A.
1950 The Cutaneous Sense Organs of Barbeled Minnows Adapted to Life in the Muddy Waters of the Great Plains Region. Trans. Amer. Micro. Soc., 69 (1): 69-95, Figs. 1-20.

Potter, George E., and David T. Jones
1928 Compilation and Revision of the Fish Records Published for Iowa. Proc. Iowa Acad. Sci., 34 (1927): 339-366.

Pratt, Henry Sherring
1935 A Manual of Land and Fresh Water Vertebrate Animals of the United States (Exclusive of Birds). (2nd Ed.) Philadelphia: P. Blakiston's Son & Co. Pp. xvii + 416, Figs. 1-184, 1 map.

Schrenkeisen, Ray
1938 Field Book of Fresh-water Fishes of North America. New York: G. P. Putnam's Sons. Pp. xii + 312, frontis. and many figs.

Speirs, J. Murray
1952 Nomenclature of the Channel Catfish and the Burbot of North America. Copeia (2): 99-103, Fig. 1.

Starrett, William C.
1950 Distribution of the Fishes of Boone County, Iowa, with Special Reference to the Minnows and Darters. Amer. Midl. Nat., 43 (1): 112-127, Fig. 1-2.
1950 Food Relationships of the Minnows of the Des Moines River, Iowa. Ecol., 31 (2): 216-233, Figs. 1-3.

Taylor, William Ralph
1954 Records of Fishes in the John N. Lowe Collection from the Upper Peninsula of Michigan. Misc. Publ. Mus. Zool. Univ. Mich., 87: 1-50, Map 1.

Trautman, Milton B., and Robert G. Martin
1951 *Moxostoma aureolum pisolabrum*, a New Subspecies of Sucker from the Ozarkian Streams of the Mississippi River System. Occ. Pap. Mus. Zool. Univ. Mich., 534: 1-10, Pl. 1, Map. 1.