

The Distribution of the Fishes of Indiana
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**INVESTIGATIONS
of
INDIANA LAKES
AND STREAMS**

VOLUME III

1. Shelby D. Gerking: Distribution of the fishes of Indiana.
2. Karl F. Lagler: Economic relations and utilization of turtles.

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Investigations of Indiana Lakes and Streams

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1. The Distribution of the Fishes of Indiana

by

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ABSTRACT

Indiana fishes were collected in the summers of 1940, 1941, 1942, and 1943, in order to map the distribution of the various species in the state and to relate this distribution to various ecological, geographical, and geological factors. All the available literature concerning collections of fishes made by others was also utilized. The total number of species now known to occur or to have occurred in the state is 170, arranged in 94 genera and 28 families. The addition of 16 subspecies brings the total number of forms to 186. Richest in number of species are the sucker family (20 species), the minnows (45 species), the perches and darters (30 species) and the sunfish family (15 species). As compared with other parts of the world, Indiana and other central and southern states are the home of a relatively large number of archaic fresh water fishes, including two sturgeons, the paddlefish, the bowfin, and four kinds of gars.

The drainage relations attending the retreat of the Wisconsin glacier were found to greatly influence the invasion of fishes into a territory previously unavailable to them. For instance, in northeastern Indiana there was once a connection between the Wabash River and Lake Erie by way of the Maumee River. The distributional patterns of certain species such as *Ammocrypta pellucida*, the sand darter, and *Notropis photogenis*, the silver shiner, clearly show that the Maumee outlet was the only pathway used by them to enter the Great Lakes basin. The occurrence of *Notropis chalybeus*, the iron-color shiner, reflects the former existence of a connection between the Tippecanoe and Kankakee drainages.

Of equal importance in influencing fish dispersal are the ecological conditions which exist in the lakes and streams of the state. A great number of species find suitable habitats in all drainage systems of the state. The common bluegill, *Lepomis m. machrochirus*, and the rock bass, *Ambloplites r. rupestris* are examples of those having general distribution. Other fishes are confined to the northern part of the state, where Lake Michigan and the small glacial lakes offer particular types of environments. In central and southern Indiana there are no glacial lakes and the streams become turbid and warm. *Micropterus p. punctulatus*, the northern spotted bass, and *Extrarius aestivalis hyostomus*, the speckled dace, are two of the many species representative of this territory. *Gambusia a. affinis*, the western mosquito-fish, is a species restricted to the southwest and *Poeciliichthys variatus*, the variegated darter, is limited to the southeast.

By comparing recent collections with those of 50 years ago, it was found that increased water turbidity has restricted the distribution of clear-water fishes such as *Eucalia inconstans*, the brook stickleback. Possibly for the same reason, there has been a rather general decrease in the abundance and variety of the darters found in the state. Pollution of waters with sewage, cannery waste, coal mine drainage, etc., has been an important factor in exterminating many species locally.

The most numerous and important Indiana game and food fishes belong to the family Centrarchidae, including the black basses, sunfishes and crappies. Other fishes utilized by man include perch and pike perch, white bass, pike, a number of catfishes, the lake herrings and the whitefish, lake trout and three species of stream trout, and most of the suckers, buffalofishes and carp.

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1. The Distribution of the Fishes of Indiana¹

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INTRODUCTION

The state of Indiana has been partially covered by glaciers at least twice in its geological history. The presence of such an ice sheet precludes the existence of most plants and animals in the area covered, and the majority of present-day species must have moved into the glaciated area from adjacent regions as the last ice sheet retreated. Thus, the study of the distribution of an animal group in Indiana is partly a problem of migration, and fishes are a particularly suitable group to show migration because they are compelled to follow established waterways. When the glaciers retreated, new drainage channels were established which provided new routes of travel. These routes can be interpreted from geological data and these in turn give information concerning the paths of fish dispersal.

Two great drainage systems, the Mississippi and Great Lakes, are represented in Indiana, and abundant geological evidence reveals that connections once existed between them. Of the 170 Indiana fish species, 95 are common to both systems, 66 are found only in the Mississippi drainage, and 9 are restricted to the Great Lakes watershed. Records from other states show that about half of the second category are known from the Great Lakes drainage elsewhere, and seven of the nine species comprising the third category are found in the Mississippi drainage. The fishes that are common to both drainage systems undoubtedly used the connections between the Great Lakes and Mississippi drainages in their northward dispersal. Species are restricted to the waters of the Mississippi watershed for two reasons: either they did not arrive in the state until the pathways to the north were broken, or they were prevented from migration northward by some ecological or physical barriers which existed at the time the northward dispersal routes were open. *Osmerus mordax* and *Pungitius pungitius* are the only Indiana species known to be absent from all parts of the Mississippi drainage. *Osmerus mordax*, the American smelt, is a species which has been recently introduced into the Great Lakes and would not be expected to occur outside the general bounds of its intro-

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duction. *Pungitius pungitius*, the nine-spined stickleback, is a circumpolar species that may have migrated into the Great Lakes from unglaciated parts of the northwest; however, it may once have inhabited Mississippi waters and since become extinct there. There is no positive evidence that any of Indiana's fishes have migrated into this region by way of the Great Lakes from the Atlantic coastal drainage.

Drainage changes are the only specific conditions which are known to have regulated migration, but it is possible that ecological conditions played at least an equally important part in governing fish dispersal. Even though a way was open into new territory, prevailing ecological conditions in the new channel could have provided an adequate barrier to migration. For example, the water issuing from a glacier is cold, and hence only fishes tolerating cold water throughout the year could have existed under these conditions. As the water became progressively warmer, conditions would allow the migration of other species into a region previously unavailable to them. Even after the complete retreat of the glacier and the attainment of modern drainage systems, ecological factors still could have acted and may continue to act as barriers to the penetration of some fishes into all parts of the state. For example, certain species prefer slow-moving, almost stagnant, situations, found in the turbid waters of the lowlands. These fishes are restricted to the southwestern corner of the state where the preferred conditions are found. By a combination of natural barriers and differences in habitat requirements diverse types of distributional patterns have been built up by different species.

HISTORICAL

The earliest recorded collections of fish from Indiana were made by SAMUEL RAFINESQUE, whose work has been both annoying and valuable to students of early natural history in this country. His *Ichthyologia Ohiensis*, which was originally published in 1820, contains references to fishes collected in the Wabash River and at the Falls of the Ohio River near Jeffersonville, Indiana. RAFINESQUE'S descriptions were often vague and localities were not usually given with the species; consequently, a comprehensive list of species which he found in Indiana cannot be drawn up.

Following RAFINESQUE'S work, brief references are made to Indiana fishes by CUVIER and VALENCIENNES in *Histoire Naturelle des Poissons* published in 1833. Other early references are included in papers by KIRTLAND, LESUEUR, and PLUMMER between 1827 and 1851.

It was not until 1875 that an intensive study of Indiana's fishes was begun by DAVID STARR JORDAN. After a period of work near Indianapolis, he and his associates continued at Bloomington the studies which made Indiana University a center of ichthyological interest. Following JORDAN'S departure from the University in 1891, Dr. CARL H. EIGENMANN continued work on the fishes of the state. Many collections were made by these men and their collaborators throughout the state. In an effort to bring together the information concerning Indiana's fishes, EIGENMANN and BEESON

(1894) and HAY (1894) each published a list of species together with a list of localities from which each species was known.

Only scattered and infrequent collections have been made in Indiana since 1895, when KIRSCH finished his work based on collections made in northern Indiana. Among the more important collections made since that time are MEEK and HILDEBRAND'S 1910 paper where several localities in the Lake Michigan region are listed, EVERMANN and CLARK'S Volume I of *Lake Maxinkuckee* (1920), and SHOEMAKER'S 1942 paper on the fishes of Wayne County. Mr. H. R. BECKER made collections in southern Indiana in 1927 which are now in the Museum of Zoology, University of Michigan. The complete results of these collections have never been published but have been utilized in a number of taxonomic studies emanating from Michigan. Dr. W. S. BLATCHLEY in 1938 published *The Fishes of Indiana*, which is principally a resumé of older published work. Unfortunately a complete bibliography is lacking and the nomenclature is outmoded.

PLAN OF OPERATIONS

Collections were begun in the summer of 1940. The state was covered as fully as possible to insure maximum accuracy in mapping the distribution of the species found. During this first summer 46 localities were visited. The acquisition of material collected by CLARENCE SHOCKLEY, Dr. W. E. RICKER, Dr. KARL F. LAGLER, and the members of the Riverside and Wawasee State Fish Hatcheries added substantially to the summer's work. One hundred seventy-five collections were made in the summer of 1941 and 163 localities were visited in 1942. Short collecting trips in 1943 rounded out the survey with a total of 412 original collections scattered throughout the state. (See MAP 2.)

Most of the collections were made with $\frac{1}{4}$ -inch mesh seines of lengths from 8 to 40 feet. Gill-net captures by both commercial fishermen and the survey were utilized. All specimens obtained were preserved in 10 percent formalin and marked with identification tags giving locality and date. Later the specimens were soaked in water for one or two days and placed in 70 percent alcohol for final preservation.

At the time of each collection, notes were made as to the turbidity of water, type of bank or shoreline, vegetation, bottom, current, depth, width, type of gear, and in some cases the temperature of the water. Additional notes were made of any other special features of the body of water involved or species taken.

Various keys were used in the identification of specimens. The most useful keys for the fishes of this region are found in HUBBS and LAGLER (1941), FORBES and RICHARDSON (1920) and TRAUTMAN (1940). In order to check the provisional identification made with the keys, a semester was spent in the Museum of Zoology of the University of Michigan where use of the collection of fishes was made available to the writer by the former Curator of Fishes, Dr. CARL L. HUBBS.

DEVELOPMENT OF DRAINAGE SYSTEMS

In pre-glacial times, as today, a great river coursed through the state. WOOD (1916, pp. 12-13) in a discussion based on a study by Leverett states, "The Northern Devonian Valley with its dip of 20 feet to the mile, must have had a pre-glacial Wabash running down its axis; we find its continuation in a valley from about Lafayette south, and certainly from Covington south. . . . The head of the pre-glacial Wabash may have been up in Lake Michigan but more likely it wandered down the steeper, northwest-dipping limestones of the Cincinnati Island where a pre-glacial valley has been traced under the glacial drift by well logs, from Shelby County, Ohio, to Blackford County, Indiana."

The state has been partially covered by at least two ice sheets, the Illinoian and the Wisconsin. The southern limits of these two glaciations are shown on all the distribution maps. The more southerly line locates the border of the Illinoian glacier; the more northerly shows the Wisconsin limit. The drainage relations attending the melting of the outer border of the Illinoian glacier have been discussed by THORNBURY (1937, FIGURES 3 and 8), who has found evidence of Illinoian drainage through the Blue River system and also the East Fork of the White River and its tributaries. Clear drainage systems following the retreat of the Illinoian glacier are obscured by the great drift deposited by the Wisconsin advance.

Inasmuch as a detailed account of the drainage in Indiana at the time of the Wisconsin invasion can be found in a standard work such as LEVERETT and TAYLOR (1915), it is needless to give a complete story of the Wisconsin ice sheet. However, a general sketch will be described to better understand the routes utilized by fishes entering Indiana.

In the early stages of ice retreat, the glacial waters followed several courses. At an early period in the recession of the ice sheet, there were two outlets in the eastern part of the state. The Whitewater River, flowing in a southerly direction, accepted much of the water; and the headwaters of the East Fork of the White River, flowing generally westward, offered another course. In the central part of the state the West Fork of the White River, with Fall Creek acting as a source, carried its share toward the Mississippi. The western area was drained by Walnut Creek, Sugar Creek, and the Wabash River.

Three lobes of the Wisconsin glacier penetrated Indiana, the Michigan lobe, the Saginaw lobe, and the Huron-Erie lobe. Speaking in general, they came respectively from the northwest, north, and northeast. The first lobe to retreat was the northern Saginaw lobe, and the water associated with the more rapid melting of this lobe was carried by the upper Tippecanoe valley. There is good evidence that this valley was once connected with the Iroquois and Kankakee drainages. After the Michigan lobe retreated, allowing free drainage in a westerly direction, there presumably was a direct connection between the future Illinois and Wabash systems, and fishes were free to use this course in their migration.

As the Saginaw lobe melted farther back, the St. Joseph valley was opened for drainage. It is probable that the St. Joseph valley was the principal line of discharge from the Saginaw lobe, and was connected for a considerable period of time with the Kankakee drainage and hence the Illinois River. This was probably a very potent factor in the distribution of fishes from the Mississippi valley into the present Great Lakes drainage of Indiana.

Presumably no new drainage systems in Indiana were constructed when the Michigan lobe retreated.

After the three lobes of the glacier retired farther north, the Great Lakes began to be formed. A summary of the more important stages of their development, taken from LEVERRETT and TAYLOR (1915) and COLEMAN

TABLE 1
Summary of the recent history of the Great Lakes drainage

Stage	Direction of flow	Outlet (not necessarily through entire period)
HURON-ERIE-ONTARIO DEVELOPMENT		
Lake Maumee	Southwest	Wabash River
Lake Arkona	Southwest	Grand River to Chicago Outlet
Lake Whittlesey	Southwest	Grand River to Chicago Outlet
Lake Wayne	East	Mohawk Valley-Hudson River
Lake Warren	Southwest	Grand River to Chicago Outlet
Lake Lundy	East	Mohawk Valley-Hudson River
SUPERIOR-MICHIGAN-HURON DEVELOPMENT		
Lake Chicago	Southwest	Chicago Outlet
Lake Algonquin	East	Kirkfield to Champlain Sea
	Southwest	Chicago Outlet (finally abandoned)
	East	Port Huron (simultaneous with Chicago Outlet before it was abandoned)
Nipissing Great Lakes	East	Ottawa River (before uplift)
	East	Port Huron (after uplift)
PRESENT GREAT LAKES DRAINAGE		
Lakes Superior, Michigan		
Huron, Erie	East	Niagara Falls
Lake Ontario	East	St. Lawrence River

(1922), is given in TABLE 1. The retreat of the Huron-Erie lobe established Lake Maumee, which was the first lake to form in the Great Lakes basin. Its site was just southwest of the present Lake Erie, and it extended into northeastern Indiana as far as Fort Wayne. The lake first occupied the space between the Fort Wayne moraine and the ice front with an outlet at Fort Wayne flowing south to the Wabash River at Huntington.

Upon retreat of the ice, the level of Lake Maumee gradually lowered while the area of the lake expanded, producing in gradual steps lakes Arkona, Whittlesey, Wayne, Warren, and Lundy in the same general

region. During the change from Lake Maumee to Lake Arkona, the southern discharge from Lake Maumee by way of the Maumee and Wabash Rivers was abandoned. At that time the Maumee River reversed its course and began to flow in its present northeasterly direction. Although the permanent connection between the Erie and Wabash drainages disappeared early in the history of the region, unusually heavy rainfall will occasionally send water across the divide even yet.

At about the same time as Lake Maumee was formed, the Michigan lobe of the glacier retreated in the northwest part of the state. A lake was formed by melting ice between the ice border and the last moraine it deposited. This lake, known as Lake Chicago, had an outlet which led down the Illinois River, in the region of the present city of Chicago. The establishment of this outlet provided a new highway into the Great Lakes for fishes.

During the evolution of Lake Maumee to Lake Erie, pronounced drainage changes took place. As previously stated, Lake Maumee discharged into the Wabash River in its early history. The water of the two following lake stages, Lake Arkona and Lake Whittlesey, drained westward through the Grand River, a channel which cut the "thumb" of Michigan approximately into halves and connected the present Lakes Huron and Michigan. At the time of Lake Whittlesey, the first route from the Atlantic to the present Great Lakes drainage was formed when the Susquehanna valley acted as an outlet for glacial waters of the Finger Lakes region. However, ice barriers probably prevented fishes entering the western Great Lakes region at this time.

Lake Wayne, the next step in the Huron-Erie-Ontario development, probably drained eastward to the Mohawk valley and the sea. However, the ice sheet readvanced closing this eastern route, and the outlet of Lake Warren, the fifth stage, was again forced to follow the Grand River westward to Lake Chicago. During this time the Chicago outlet from Lake Michigan was always in use.

Lake Lundy, preceding the final formation of Lake Erie, used the Mohawk Valley-Hudson River outlet to the east, the same course as that utilized by Lake Wayne. However, it has been stated that during both these lake stages great cataracts probably existed in this eastern outlet near Syracuse, New York. Consequently, this may have acted as a formidable barrier to fish dispersal, even though the east-to-west route had been opened.

It is now time to consider the upper three basins, those of Lakes Huron, Michigan, and Superior. A farther retreat of the glacier converted these three basins into one vast area of water, Lake Algonquin. Early in the Algonquin stage an outlet appeared at Kirkfield, Ontario, flowing east, indirectly to the salty Champlain Sea. At one time this drained most, if not all, of the upper Great Lakes watershed; but an uplift occurred shifting the water discharge to the Chicago outlet and into Lake Erie at Port Huron, both of which outlets may have been partially retained during the Algonquin stage. The Port Huron outlet was through easily eroded drift

deposits while the Chicago outlet was over a rock sill. As the Port Huron connective deepened, the Chicago outlet was gradually abandoned.

At the time of the "Nipissing Great Lakes" all the water was discharged through the Ottawa River and Port Huron. Thus, from the time the Hudson River was established as an outlet there has usually been a westward migration route accessible to eastern species. When the Ottawa River connection with the St. Lawrence drainage was lost, only the impassable Niagra Falls outlet remained. At the present time, however, the Welland locks and canals traverse the Niagara region offering some slight opportunity for fish migration around the Niagara Falls barrier. Since the fish fauna of Indiana is much more closely allied to that of the Mississippi valley than the eastern fauna, it appears that the Mississippi valley has been the principal distributional center for this region, the east-to-west migration route being utilized little, if at all.

The present drainage of Indiana is obvious upon inspection of a topographic map. The St. Joseph and Maumee Rivers are the main streams leading into the Great Lakes. The Kankakee and Iroquois Rivers lead into the Illinois River of the Mississippi drainage. The Wabash and White Rivers carry the main water burden of the state to the Ohio River. A few streams in the extreme south, the largest of which are the Whitewater and the Big Blue Rivers, lead directly into the Ohio River.

BARRIERS TO FISH DISPERSAL

Barriers to fish dispersal can be classed into two groups: man-made barriers and natural barriers. Man-made obstructions such as dams act as barriers to fish migration, the most formidable ones being located on the Wabash, White, Tippecanoe, and St. Joseph Rivers. However, fishes are able to by-pass this type of barrier by taking advantage of fish ladders which are present on a few of the dams and by means of connected pools of water reaching above and below the dams after periods of high flood. In isolated cases pollution sources may act as factors in limiting fish migration. SHOEMAKER (1942: 295) discusses the fact that pollution may have affected the distribution of fishes in the Whitewater River near Richmond, Wayne County. For a more detailed discussion of the pollution problem refer to the section of this study entitled "Changes in Fish Fauna."

Natural barriers comprise diverse ecological and geological factors that prevent the migration of fishes. At the present time the greatest natural barrier limiting fish dispersal in Indiana is the divide separating the Great Lakes and Mississippi drainages. However, this divide is low and it is possible that water connections could be established between the drainages. During a period of high water in 1914, Dr. C. A. MALOTT, of the Geology Department of Indiana University, observed water in the region of Fort Wayne connecting the Maumee and Wabash river systems, by way of the glacial channel which drained the early stages of Lake Erie. An artificial connection between the Mississippi and Great Lakes drainages was estab-

lished when the Wabash-Erie canal was completed in 1836 from Lake Erie to the Wabash River at Huntington, Indiana. This artificial connection also followed the glacial channel cut by the outlet of Lake Maumee. The canal eventually reached Evansville in 1853, by way of the White River and lesser streams, but was in use for its full length only a short time. Other canals, such as the Whitewater canal, were proposed to connect with the Wabash-Erie canal but were never completed. The Wabash-Erie canal was abandoned in the late 1870's.

Cataract Falls in Mill Creek, Owen County, is probably the only major waterfall which offers any appreciable barrier to present-day fish dispersal. Fish are plentiful above this point and must have reached their habitats before the falls developed their present proportion. A cataract in the Wabash River, Posey County, and Hindustan Falls in the East Fork of the White River, Martin County, may also offer some obstruction to fish migration. Water flows in only the extremely fast portions of both these localities in times of drought. It is evident that the present-day barriers to fish dispersal in Indiana are few and without doubt rather ineffective over a long period of time.

ECOLOGICAL DISCUSSION

Fishes are found in all types of aquatic habitats which offer food, oxygen, and suitable spawning conditions. The requirements of different species naturally vary, and it is not surprising that most species are confined to particular environs. In many cases the habitat suited to a species can be found throughout the state, and the species is usually well distributed. Conversely, if a type of habitat occurs in only a limited area, the distribution of a species occupying this habitat will likewise be restricted. In the following discussion various ecological factors influencing fish distribution will be presented.

The most important lentic environments of this region are found in the glacial lakes. The majority of these lakes are found among the interlobate moraines which were formed when the Wisconsin glacier retreated. Only a few of Indiana's lakes have the sand and gravel beaches with scant vegetation so typical of the more northern glacial lakes. Many of them have developed a luxuriant growth of submerged vegetation which becomes more abundant in the later summer months. Among the important plants of this type may be mentioned species of *Ceratophyllum*, *Pontederia*, *Sagittaria*, *Ranunculus*, *Myriophyllum*, *Potamogeton*, and *Vallisneria*. In the winter most of these plants die and settle to the bottom, forming a rich organic mixture. The usual emergent fringe of *Scirpus*, *Juncus*, *Nymphaea*, *Nuphar*, and *Zizania* can be noted along the shore.

There are a number of lakes with only scant vegetation which are classed as "marl" lakes. In these lakes marl-producing plants such as *Chara*, *Nitella*, *Potamogeton* and some of the blue-green algae have utilized the carbon dioxide from half-bound carbonates leaving the insoluble car-

bonates to settle to the bottom. These plants have literally dug a grave for themselves and other non-marl producers. After the marl deposit becomes thick, rooted aquatic plants are unable to grow, presumably because the bottom offers no nutrient material.

Most of the lakes are shallow but a few are deep enough to afford a deep-water habitat. Of course, Lake Michigan offers the best opportunity for deep-water species to enter the state. Many of these species are valuable commercial fish. However, the southern end of the lake is relatively shallow and commercial fishermen are not able to depend entirely upon Indiana waters for their livelihood.

Another type of natural lake, occurring in southern Indiana, is the "ox-bow" lake or bayou. These lakes are formed in abandoned river channels. Since these bayous are located near large rivers, species are free to move to and from the lake and river during times of flood. Many of the bayous are choked with vegetation and others are relatively free from higher aquatic plants. This lake type usually harbors those species of the river from which it was derived, if a suitable environment is offered. HUBBS and LAGLER (1942) have recently published a study based on Foots Pond, which gives a list of species taken in this type of lake.

Bogs, marshes, and swamps are of little importance in the total fish life of the state. Most of the former bogs and marshy lands are now dry, either from natural or artificial causes. At one time there was a vast marsh in the Kankakee region, but ditches were cut which at the present time are draining the land at a rapid rate. There were at least three cypress swamps in the southern part of the state. One of these has been drained, and only after floods or heavy rains is there any water available for fish life. The outlet of another cypress swamp, Hovey Lake, has been dammed to permit the establishment of a constant water level, thus altering its natural condition. Artificial ponds and lakes are also of minor importance in consideration of the ecological factors influencing fish distribution as they offer no habitat which is greatly different from that found in natural standing waters.

Large rivers form a rather distinct ecological type for fishes. "Large river" is a term difficult to define and any demarcation will obviously be an arbitrary one. The lower Wabash River, lower White River (including both forks), and the Ohio River will be regarded as large rivers. The strong, steady current in the main channel is an environment preferred by some fishes while other species are found in the slower, deeper pools. Along the course of such streams in Indiana, riffles of shallow, fast water are infrequent, but certain fishes find resting places under and around rocks of various sizes in these situations. The character of the bottom also varies from sand, gravel, and rock to silt deposits of various consistencies. The temperature of rivers of this category lags slightly behind that of the air. All grades of aquatic vegetation from unicellular and filamentous algae to rooted aquatic seed plants offer food and protection. There is little rooted vegetation in the main channels because the current is strong and turbidity of the water prevents free penetration of light.

The smaller streams of the state are naturally more numerous, and when considered as a unit, present a much wider variety of habitats than any of the above categories. In a general discussion it is permissible to speak of northern and southern streams as rather separate entities. However, certain habitats are found in both sections. Riffles occur in both northern and southern streams. Some species, especially certain darters, commonly frequent the riffles, leaving the quieter pools for fishes preferring that habitat.

Streams in the northern third of the state often run clear and a few are cool enough to support trout populations. Frequently, the creeks are shaded by bushes and trees, aiding in maintaining a low temperature. Creeks and ditches of this portion of the state, especially in the northwest corner, are particularly well vegetated with plants such as *Elodea*, *Vallisneria*, and *Radicula* in addition to many varieties of algae. In the glaciated section sand and gravel creek bottom are characteristic. Where the current is slow and vegetation is most abundant, soft bottoms of organic matter are found.

Creeks of the central and southern part of Indiana are usually turbid and warm. In midsummer one shallow stream, flowing over rocky bottom, had a temperature of 96° F. The plants mentioned above become scarcer and an extremely common emergent plant, *Dianthera*, the water willow, chokes the riffles of the smaller streams in summer. Mud and bed rock stream bottoms are numerous. Many clay-bottomed streams have banks cut so sharply that they would appear to have been dredged, but for their sinuous course.

Special mention should be made of southwestern Indiana. The lowland area of the broad Mississippi valley extends up the Ohio River into this region, which can be considered a flood plain of the lower Wabash and Ohio Rivers. Certain southern species are restricted to this corner of the state while other fishes do not find a suitable habitat here and generally avoid this region. Many of the southwestern streams are slow-moving and usually carry a heavy load of suspended material. The original stream bottoms consisted of sand carried down from moraines in northern Indiana and redistributed by wind action. Subsequently, the weak stream currents have allowed the deposit of a thick layer of silt which has obscured the sand bottoms in most localities. Also, the stream currents have not been strong enough to carry away debris such as tree limbs, logs, etc., and many creeks are choked with this material. There is great fluctuation of the amount of water that southwestern streams carry, and spring floods of both large rivers and creeks are common. Many streams stagnate or completely dry up in summer.

Very often diverse ecological conditions may be met in a short stretch of stream. Such a stream presents the most favorable conditions for collecting fishes, and a greater number of species will be captured there than a monotonous creek offering only few ecological types.

DISTRIBUTIONAL PATTERNS

Merely to describe the distributional patterns presented by the fishes of the state is not sufficient. Some formulation of the influences which affect fish distribution can be correlated with these patterns. Geological, geographical, and ecological influences interlace and in some cases are interdependent. For instance, most of Indiana's lakes have been formed as a result of glaciation, a geological factor; they are located in the northern part of the state, a geographical factor; they offer a definite type of habitat, an ecological factor. Therefore, when a species inhabits a lake it may be because of any one or a combination of the three agents. It is reasonably certain in most cases which factor has played the dominant role in determining the distribution of individual species.

In order to get a broad picture of the distribution problems, it is necessary to consider species in rather definite geographical and ecological categories. However, it should be realized that each species of a category has some individual differences which set it apart from the rest. The generalizations are therefore made to satisfy the discussion of distributional patterns and not the strict habitat preferences of individual species. Most of the fishes occurring in Indiana will be found in this discussion. Insufficient knowledge regarding the occurrence of certain forms necessitates their omission, while other species are absent for reasons which are apparent elsewhere in this study.

GENERAL DISTRIBUTION

A majority of the species occurring in Indiana are generally distributed. The various environmental requirements of the members of this group are to be found throughout the state. Four fishes of this category are found only in clear water.

Chrosomus erythrogaster, Southern redbelly dace
Rhinichthys atratulus, Blacknose dace
Cottus bairdii, Muddler
Eucalia inconstans, Brook stickleback

The remainder having statewide distribution seem to have no strict turbidity limitation. Although some of the species to be considered further are found more consistently in clear water, they are often taken where suspended material is noticeable.

The waters of large rivers harbor some species which have also found a suitable environment in the Lake Michigan and glacial lake districts. These fishes are taken in the lower portions of the large rivers over muddy bottoms. This fits in very well with their occurrence in the lakes of the north.

Polyodon spathula, Paddlefish
Dorosoma cepedianum, Gizzard shad
Megastomatobus cyprinella, Bigmouth buffalo fish
Lepibema chrysops, White bass
Aplodinotus grunniens, Freshwater sheepshead

The minnow species form the majority of fishes which occur in streams having moderate current and hard bottoms of sand, gravel, or rock. These streams seldom have an abundant growth of vegetation.

Hypentelium nigricans, Hog sucker
Hybopsis amblops, Bigeye chub
Notropis photogenis, Silver shiner
Notropis rubellus, Rosyface shiner
Notropis volucellus, Mimic shiner (also in lakes)
Notropis deliciosus, Sand shiner (also in lakes)
Ericymba buccata, Silverjaw minnow
Micropterus dolomieu, Smallmouth bass (also in lakes)
Lepomis humilis, Orangespot sunfish
Percina caprodes, Logperch (also in lakes)

A number of generally distributed species prefer a somewhat weedy habitat with a weak current. Soft bottoms of plant detritus frequently occur in weedy streams with slow current. The game fishes of the state occupy an important place in this category. It is true that certain ones of the group, compiled below, are sometimes caught in non-weedy environments, yet the young usually seek the weeds for food and protection.

Lepisosteus osseus, Longnose gar
Erimyzon oblongus, Creek chubsucker (only occasionally in weedy environments)
Cyprinus carpio, Carp (not always in weedy situations but nearly always in mud)
Notemigonus crysoleucas, Golden shiner
Schilbeodes mollis, Tadpole madtom
Aphredoderus sayanus, Pirateperch
Huro salmoides, Largemouth bass
Chaenobryttus coronarius, Warmouth
Lepomis cyanellus, Green sunfish
Lepomis megalotis, Longear sunfish
Lepomis macrochirus, Bluegill
Ambloplites rupestris, Rock bass
Pomoxis annularis, White crappie
Pomoxis nigro-maculatus, Black crappie
Fundulus notatus, Blackstripe topminnow
Fundulus dispar, Starhead topminnow

There has yet to be mentioned the riffles of the smaller streams where the rocky bottoms vary from pebbles to large stones. The current is swift in this situation and algae are practically the only plants which are characteristic. The darters make up the greatest share of the species occupying this habitat.

Phenacobius mirabilis, Suckermouth minnow (in fast water if not in riffles)
Schilbeodes miurus, Brindled madtom (at times in weedy situations)
Poeciliichthys caeruleus, Rainbow darter
Etheostoma blennioides, Greenside darter
Poeciliichthys spectabilis, Orangethroat darter (also in weedy habitats)
Catnotus flabellaris, Fantail darter

Several species taken in Indiana have a very wide distribution both ecologically and geographically. Although these fishes may be found more often in one type of habitat, they have been taken in localities of standing water, running water, turbid water, clear water, etc.

Amia calva, Bowfin
Catostomus commersonii, White sucker
Semotilus atromaculatus, Creek chub
Notropis cornutus, Common shiner
Notropis spilopterus, Spotfin shiner
Hyborhynchus notatus, Bluntnose minnow
Boleosoma nigrum, Johnny darter

There are still a few species of general distribution which have not been listed. They do not fit into any particular category described, and it was thought suitable to discuss them separately. The bullheads, *Ameiurus melas*, *Ameiurus nebulosus*, *Ameiurus natalis*, are occupants of muddy bottoms in both lakes and streams. They usually do not inhabit weedy environments but occasionally are taken under these conditions. *Labidesthes sicculus*, the brook silverside, lives in the open water of lakes and streams, over all kinds of bottoms, in silty or in clear water. The life history of *Ictalurus lacustris*, the channel catfish, is not fully understood, but apparently it frequents the swifter water when young, and goes to deep, quiet pools when a large size is attained. The channel catfish is also found in some of the clear lakes of northern Indiana. *Notropis umbratilis*, the redbfin shiner, and *Pimephales promelas*, the fathead minnow, are both captured in the quieter portions of streams, but not in lakes. It is not apparent why the fathead minnow is mainly confined to eastern Indiana, regardless of drainage.

The habitats of many of the suckers are not particularly suited for discussion in any of the previous categories. *Minytrema melanops*, the spotted sucker, has been found in as widely different environments as silty streams and clear, weedy lakes, but it is commonly found over soft bottoms. Experience has shown that the species *Moxostoma erythrurum*, *Moxostoma duquesnii*, *Moxostoma anisurum*, and *Carpionodes cyprinus* live on both mud and hard bottoms. *Moxostoma erythrurum* is more frequently taken in smaller streams than the other three, although none of the group consistently inhabits the largest rivers.

NORTHERN DISTRIBUTION

Fishes confined to the northern portion of the state can be roughly divided into several categories. Some Indiana species occur only in Lake Michigan. By reason of its deep, clear water, or its sandy shores, it is a particularly suitable habitat for the species listed below.

Osmerus mordax, American smelt
Coregonus clupeaformis, Great Lakes whitefish
Cristivomer namaycush, Lake trout
Catostomus catostomus, Sturgeon sucker
Notropis atherinoides acutus, Lake emerald shiner
Lota lota, Burbot

Leucichthys artedi, the cisco, is another deepwater form which is found in Lake Michigan and some of the smaller glacial lakes of northern Indiana. *Notropis hudsonius*, the spottail shiner, a common shore inhabitant of

Lake Michigan, has also found its way into the smaller lakes where it is sparsely distributed. It was found by the writer only once in a flowing stream, Singleton Ditch in the Kankakee drainage. Although this district was once an area of standing water, it is surprising that some of the species have persisted in the ditches now draining this area.

Fishes occurring in both streams and lakes in the northern part of the state are usually associated with weedy conditions. Among these are:

- Lepisosteus productus*, Spotted gar (also in bayous and swamps in the south)
- Erimyzon sucetta*, Lake chubsucker
- Notropis heterodon*, Blackchin shiner
- Notropis heterolepis*, Blacknose shiner
- Esox lucius*, Northern pike
- Fundulus diaphanus*, Banded killifish
- Lepomis gibbosus*, Pumpkinseed (also introduced in the south)
- Poeciliichthys exilis*, Iowa darter
- Microperca microperca*, Least darter
- Perca flavescens*, Yellow perch (few localities in the south)

There are two minnows restricted to the northern part of the state which have been found only in streams. Both of them live in situations of abundant vegetation.

- Notropis xanocephalus richardsoni*, Northern weed shiner
- Notropis chalybeus*, Ironcolor shiner

Two other minnows can be included in those of northerly distribution: *Nocomis biguttatus*, hornyhead chub, and *Nocomis micropogon*, river chub. They obviously have a decided preference for streams of sand and gravel bottoms in the glaciated regions of the central and northern parts of the state. Although the young of *N. biguttatus* are usually found in weedy conditions, the adults are not confined to this habitat. *N. micropogon* is found more commonly in larger streams than *N. biguttatus*.

CENTRAL AND SOUTHERN DISTRIBUTION

Species may be confined to the central and southern parts of the state for a number of reasons. All the largest, silty rivers are found in this region. Since there are fishes which prefer such large rivers, they naturally will be found in the south. The principal species which inhabit the slower parts of the large rivers, however, are also found in some localities in the north and are therefore of general distribution. There remain two groups of river fish which must be considered: those living principally in the deeper parts of the channel where the current is only moderately strong, and those frequently the riffles where it is shallow and the current is swift. In these cases the bottom consists mainly of sand and gravel with some large rocks.

CHANNEL FORMS:

- Pomolobus chrysochloris*, Skipjack
- Lepisosteus platostomus*, Shortnose gar
- Ictiobus bubalus*, Smallmouth buffalofish
- Carpionodes velifer*, Highfin sucker

Hybopsis storerianus, Silver chub
Extrarius aestivalis, Speckled dace
Notropis a. atherinoides, Common emerald shiner
Notropis whipplii, Steelcolor shiner (also in tributaries)
Notropis blennioides, River shiner
Hybognathus nuchalis, Silvery minnow (also in tributaries)
Ceratichthys perspicuus, Bullhead minnow (also in quiet back-waters)
Pilodictis olivaris, Shovelhead catfish
Stizostedion canadense, Sauger
Imostoma shumardi, River darter

RIFFLE FORMS:

Erimystax species, Spotted chub
Hadropterus phoxocephalus, Slenderhead darter (also in weedy situations to the north)
Noturus flavus, Stonecat (also in some smaller streams)
Schilbeodes eleutherus, Furious madtom (also in some smaller streams)

Micropterus punctulatus, the spotted bass, is generally distributed in the central and southern parts of the state, and has been taken in both large and small streams. In recent years hatchery practice has introduced this species fairly generally in the north. Since no evidence of its presence was found in northern Indiana, it can be concluded that this species is rather closely restricted to its habitat of slow, turbid streams. TRAUTMAN (1942) has shown how the abundance of the spotted bass is correlated with low stream gradient. *Notropis boops* is also found in this section of the state where it inhabits the pools of smaller streams with hard bottoms and little aquatic vegetation.

SOUTHWESTERN DISTRIBUTION

In the extreme southwestern tip of Indiana there is an area of Wabash River and Ohio River flood plain. This area is generally avoided by some species (e.g. *Hybopsis amblops*), while four species are peculiarly limited to this region.

Gambusia affinis, Mosquitofish
Hololepis gracilis, Swamp darter
Centrarchus macropterus, Round sunfish
Boleosoma chlorosomum, Bluntnose darter

While not confined to this region, *Opsopoeodus emiliae*, the pugnose minnow, was captured in the creeks of the southwest more than elsewhere.

SOUTHEASTERN DISTRIBUTION

The streams of southeast Indiana have a steeper gradient and the water of the larger ones tumbles over riffles of large rocks. The water in this section is much less turbid than farther west. The rose-fin shiner, *Notropis ardens*, is found only in this region. *Poeciliichthys variatus*, the variegated darter, is another fish typical of the southeast corner; it is an inhabitant of swift riffles composed of large rocks. There are other riffles of this general type which occur throughout the Wabash valley and *Poeciliichthys*

camurus, the bluebreast darter, is found here. Although *P. camurus* was taken once in the same river system, as *P. variatus* (Big Blue River), these two large darters have never been taken in the same collection.

DISTRIBUTIONAL PATTERNS AND MIGRATION ROUTES

All species which have a statewide distribution could have utilized the main glacial or the contemporary migratory channels to gain access to their present localities. An example is found in *Notropis deliciosus* (MAP 47), the sand shiner. Undoubtedly the Wabash system, streams directly draining into the Ohio River, the Chicago outlet into Lake Michigan, and the Maumee outlet into the Erie drainage were all used in its dispersal.

An unusual distributional pattern is portrayed by two unrelated species, *Percopsis omiscomaycus*, the troutperch, and *Poeciliichthys zonalis*, the banded darter. They are both found in the northwestern and southeastern parts of the state but have not been found between these general areas. Both fishes occur in southeastern streams draining directly into the Ohio River, although the darter is represented by many more localities. In the northwestern corner of the state the troutperch has been found only in Lake Michigan, while the banded darter is generally distributed in the district of the Kankakee and Iroquois rivers. Apparently these forms did not use the Wabash River in their migration, although habitats suitable to them are present in the drainage. For example, *Percopsis omiscomaycus* has been taken in moderate-sized, silty, mud bottom streams of the Ohio valley. Especially in the lower Wabash flood plain these conditions are also realized. *Poeciliichthys zonalis* occurs in swift sections of small and moderate-sized streams where aquatic vegetation is present, and naturally such conditions do exist in the Wabash drainage.

In addition to the main pathways into the state, there have been minor glacial connectives between the Great Lakes and Mississippi drainages. *Notropis chalybeus* (MAP 41), the ironcolor shiner, will serve as an example of the use of these routes. This species is found in the Iroquois, Kankakee, upper Tippecanoe, and St. Joseph river systems. It will be recalled that there were early glacial connections between the Tippecanoe River and the Illinois River by way of either the Kankakee and Iroquois rivers, or both. There was also a connection between the St. Joseph and Kankakee drainages. It is obvious that these routes were ideally situated for the migration of this species into its present location, and account for its absence in other parts of the state. WRIGHT (1932) has shown good evidence for the post-glacial distribution of certain species of snails from the Kankakee to the Tippecanoe River systems by way of the Kankakee-Tippecanoe connection.

The habitats existing in this region, both today and in the immediate past are such as are suited to this minnow. *Notropis chalybeus* lives strictly in slow-moving streams loaded with aquatic vegetation. There is good evidence that in early, post-glacial times parts of the Kankakee, St. Joseph and upper Tippecanoe systems were ponded, which would allow

a growth of aquatic vegetation in small lakes or slow connecting streams. In their present state these drainage systems also present a characteristic habitat.

At present a route to the upper Tippecanoe region exists by way of the Wabash River, but it is improbable that the species used this pathway. No records were obtained from the southern and central parts of the state where pockets of vegetation occur which might hold this minnow. Neither was it found in weedy tributaries of the upper Wabash, other than the Tippecanoe.

Fundulus diaphanus (MAP 69), the banded killifish, is an inhabitant of lake shores and presents a similar distribution to *Notropis chalybeus*. Its presence in Lake Michigan and nearby tributaries implies that migration through the Chicago outlet was used in its spread into the region, because these localities could most easily have been reached by natural means through this channel. The presence of this killifish in other localities could be explained in the same manner as the migration of *Notropis chalybeus*.

CHANGES IN FISH FAUNA

Civilization has affected Indiana waters in a number of ways. Possibly most important among them has been soil erosion and the disposal of waste material. A direct result has been the silting of streams and the use of streams and lakes to carry domestic sewage and industrial wastes from centers of population. Naturally the presence of these materials in the water has altered the aquatic environment from its original condition.

Recent agricultural methods have favored quick drainage of the soil. Soil drainage by means of ditches has accelerated run-off and profoundly changed the streams into which the ditches empty. The effects of dredging on the abundance and variety of stream fishes has been discussed by TRAUTMAN (1939). In times of heavy rain quick drainage forces extra water into the streams, with the result that floods nowadays tend to become more severe than formerly. Conversely, in times of drought, streams carry much less water than formerly, and many which once flowed continually now periodically dry up completely. Both these conditions influence fishes; the first condition often spreads fishes to unaccustomed environments, such as temporary pools, and the second precludes the existence of aquatic life altogether.

Unfortunately no figures exist which compare water turbidity in the streams from the time the forests began to be cleared down to the present day. However, the removal of a good part of the forest cover has undoubtedly resulted in rapid soil erosion, quick run-off from the land, and greatly increased turbidity of the streams. The present emphasis on soil erosion is enough evidence that removal of the topsoil has been accelerated by some agricultural methods and neglect. GABRIELSON (1941: 19) mentions the fact that man has speeded soil erosion by stripping the land of its cover of trees, grass, and other forms of vegetation.

There is some evidence that the resulting turbidity of the water, correlated with soil erosion, has affected the fish fauna of Indiana's streams. EIGENMANN and FORDICE (1886) published a list of fishes from Bean Blossom Creek, Monroe County, which contained the species *Cottus bairdii*, *Rhinichthys atratulus*, and *Chrosomus erythrogaster*, all of which are found only in clear water. On July 15, 1942, the writer made numerous collections in this stream from its source to its mouth which failed to reveal their presence. Throughout most of its length the creek is now sluggish and turbid with steeply cut banks. On the above date the water was clear for only a short distance at the source. Two other examples may be cited. JORDAN (1887a) also lists the above species in collections made by him and COPELAND in the White River and tributaries near Indianapolis. *Cottus bairdii* was caught in Fall Creek near Indianapolis on July 7, 1942, but the other two species were not found in that vicinity. *Rhinichthys atratulus*, *Cottus bairdii*, and *Eucalia inconstans*, all clear water species, were listed by SHANNON (1887b) from the Flat Rock River, Decatur County. Although the exact locality where Shannon made his collection is not known, this stream was visited by the writer on July 12, 1942, and none of these species were found in its now turbid water.

The establishment of municipalities led to the disposal of large quantities of sewage and industrial wastes. Streams are considered a convenient carrier for these materials, and for many years wastes were deposited in streams with little or no previous treatment to eliminate their harmful effect upon aquatic life. MILLING (1943: 205) states that in Indiana there was an estimated 1400 miles of polluted waterway in 1920. The same author shows that abatement of pollution in 680 miles of stream has been carried out up to 1940. The principal sources of pollution in Indiana are city sewage, cannery waste, coal mine drainage, paper mill waste, and dairy-products factory waste. The establishment of treatment methods of these wastes before their deposition in streams has done much to alleviate the problem, but much work remains to be done before pollution control is fully realized.

Several collections of fishes made by the survey show the pollution effect clearly. JORDAN (1887a) originally listed 69 species, of which 53 are now recognizable, occurring in the White River and tributaries near Indianapolis. On July 15, 1942, the writer made two collections in the White River at Indianapolis which totaled only 10 species. Even if only a third of Dr. JORDAN'S list was obtained from the White River itself, there is still a wide discrepancy between the collections. The Indianapolis area is known to pollute the White River for many miles downstream.

One of the most striking illustrations of the effect of pollution on fishes is that found in the Big Blue River, below New Castle, Henry County. A collection of 10 species was listed by EIGENMANN and BEESON (1894) from the Big Blue River at Knightstown, Henry County. On June 28, 1942, a collection was made by the writer three miles northeast of Knightstown in which only four species were found, although a careful search was made for a considerable distance. The water of the stream was clear at

this time, but the bottom gravel was coated with a bright orange material. Above the city of New Castle a collection of 14 species was made, and below Knightstown, 10 miles north of Shelbyville, Shelby County, 20 species were found. The effect of pollution is obvious in this case.

Just below the city of Anderson, Madison County, only eleven species were taken in the White River, although a wide variety of habitats, including long riffle, backwaters, and small channels, were seined. It appeared to be an excellent collecting site, but the submerged rocks were coated with a material characteristic of polluted conditions. The White River below the city of Muncie, Delaware County, was seined but only one specimen of *Cyprinus carpio* was obtained. Characteristic signs of pollution appeared here also. In Busseron Creek, Sullivan County, a stream known to carry coal mine drainage, only seven species were obtained.

Three collections were made along the course of Cedar Creek, a stream polluted with cannery waste and city sewage. Near Auburn city sewage from both that city and the town of Garrett enter the stream. About four miles below this point only eight species were collected. Above Auburn, near Waterloo, 21 species were found even though cannery waste is known to be deposited in the stream at certain times of the year at Waterloo. Near the mouth of the stream 15 species were collected. It appears that the sewage from Garrett and Auburn has been effective in limiting the populations of fishes for a few miles downstream. Other instances of pollution effect could be cited, but these few suffice to show the influence of pollution upon fish life.

The species which were collected in more than one of the polluted waters just discussed are:

Catostomus commersonii
Cyprinus carpio
Semotilus atromaculatus
Campostoma anomalum
Notemigonus crysoleucas

Notropis cornutus
Notropis umbratilis
Notropis spilopterus
Lepomis megalotis

Experience in the field has led to the belief that the absence of darters (small representatives of the Percidae) from a stream, particularly the riffles, is a good indication of the presence of pollution. In the examples of streams polluted by sewage and industrial wastes only one collection, White River at Indianapolis, contained darters.

There is also a suggestion that some other factor, such as increased turbidity, has been effective in reducing the numbers of this group. A number of collections were made in the same localities that previous collectors had visited, in order to compare the collections and observe any changes in the fish fauna that had occurred over a period of years. The most striking change seemed to be that fewer species of darters were obtained in recent years. In TABLE II are listed some of the localities which were revisited, together with the number of darters species collected by the writer and those obtained toward the close of the last century. In parentheses beside the number of darters caught is given the total number

of species collected. In the case of other authors this number applies only to the species which were comparable; species which were confused were omitted and obsolete names were rejected.

TABLE II.

The number of darters and (in parentheses) the total number of species collected at various localities in recent years (1940-42) and in early years

Locality	Number Collected		Number in Early Collections		
	in 1940-42				
Bean Blossom Cr., Brown and Monroe Cos.	6	(31)	7	(35)	(Eigenmann and Fordice, 1886)
Patoka R., Patoka, Gibson Co.	0	(13)	5	(18)	(Jordan, 1890)
Deer Cr., Camden, Carroll Co.	6	(20)	8	(19)	(Evermann and Jenkins, 1892)
Wabash R., Delphi, Carroll Co.	3	(19)	13	(40)	(Evermann and Jenkins, 1892)
Wabash R., 8 mi. W. Mt. Vernon, Posey Co. (including collection by K. F. Lagler)	0	(31)	4	(33)	(Jordan, 1890)
Big Pigeon Cr., Evansville, Vanderburg Co.	2	(23)	1	(14)	(Jordan, 1890)
Logansport, Cass Co.	3	(28)*	8	(20)	(Eel R., Jordan, 1890)
Wabash R., New Harmony, Posey Co.	3	(33)	12	(40)	(Jordan, 1890)
Wildcat Cr., near Burlington, Carroll Co.	3	(16)	7	(29)	(Evermann and Jenkins, 1892)
Raccoon Cr., 6 mi. S. W. Rockville, Parke Co.	2	(20)	6	(20)	(Eigenmann and Beeson, 1894)

* This collection was at the confluence of the Eel and Wabash Rivers.

The discrepancy in the collections can be attributed to one of two causes: the writer's inability to capture the darter species, or a changed environment resulting in few species being represented in the localities listed. As regards the first, strong efforts to catch darters were put forth on every occasion. Since other bottom dwelling species were caught with ease and in as great or greater variety than the authors quoted above, there seems no reason why adequate representation of the darters was not obtained. If the darters collected adequately represent those present, only a changed environment would explain the general decline in number of species from particular localities over a period of years. A number of changes could be postulated to account for such changes, but there is little evidence concerning any one of them. Perhaps riffles and other darter habitats do not exist where they formerly did, or possibly the increased silting of the streams has locally exterminated some species.

DISTRIBUTIONAL LIST OF INDIANA FISHES

Several new additions were made to the fish fauna of the state during the course of the recent work. They are:

- Ichthyomyzon unicuspis*, Silver lamprey
- Moxostoma rubreques*, Greater redhorse
- Rhinichthys cataractae*, Longnose dace
- Notropis illecebrosus*, Silverband shiner (by K. F. Lagler)
- Notropis xanocephalus richardsoni*, Northern weed shiner
- Notropis chalybeus*, Ironcolor shiner
- Notropis volucellus buchmanani*, Ghost mimic shiner.
- Hybognathus hayi*, Cypress minnow

Fundulus catenatus, Studfish

Ammocrypta clara, Western sand darter (from UMMZ)

Centrarchus macropterus, Round sunfish

While all the above are important contributions to the fauna of the state, *Fundulus catenatus* stands out boldly from the rest. To the writer's knowledge its occurrence has never before been reported north of the Cumberland River drainage in Kentucky. Many miles of waterway through the Mississippi, Ohio, Wabash, and White rivers separate the known distribution of this species in Indiana and Kentucky. There are still other forms which have not yet been taken in Indiana, but which may occur here rarely. The most probable of these are named in APPENDIX A.

The following list contains the species of fishes known to occur in Indiana waters. The habitat preference of such species is discussed, with the exception of those forms which were collected so rarely that the data do not suffice for a discussion of their habits. The probable mode of distribution of a species is explained only when its distributional pattern gives an insight into particular pathways used in its migration. For other species, it is probable that most or all of the previously discussed routes of dispersal have been utilized; or, at least, there is no longer any evidence that their invasion of the state was restricted to only one or two of the available routes.

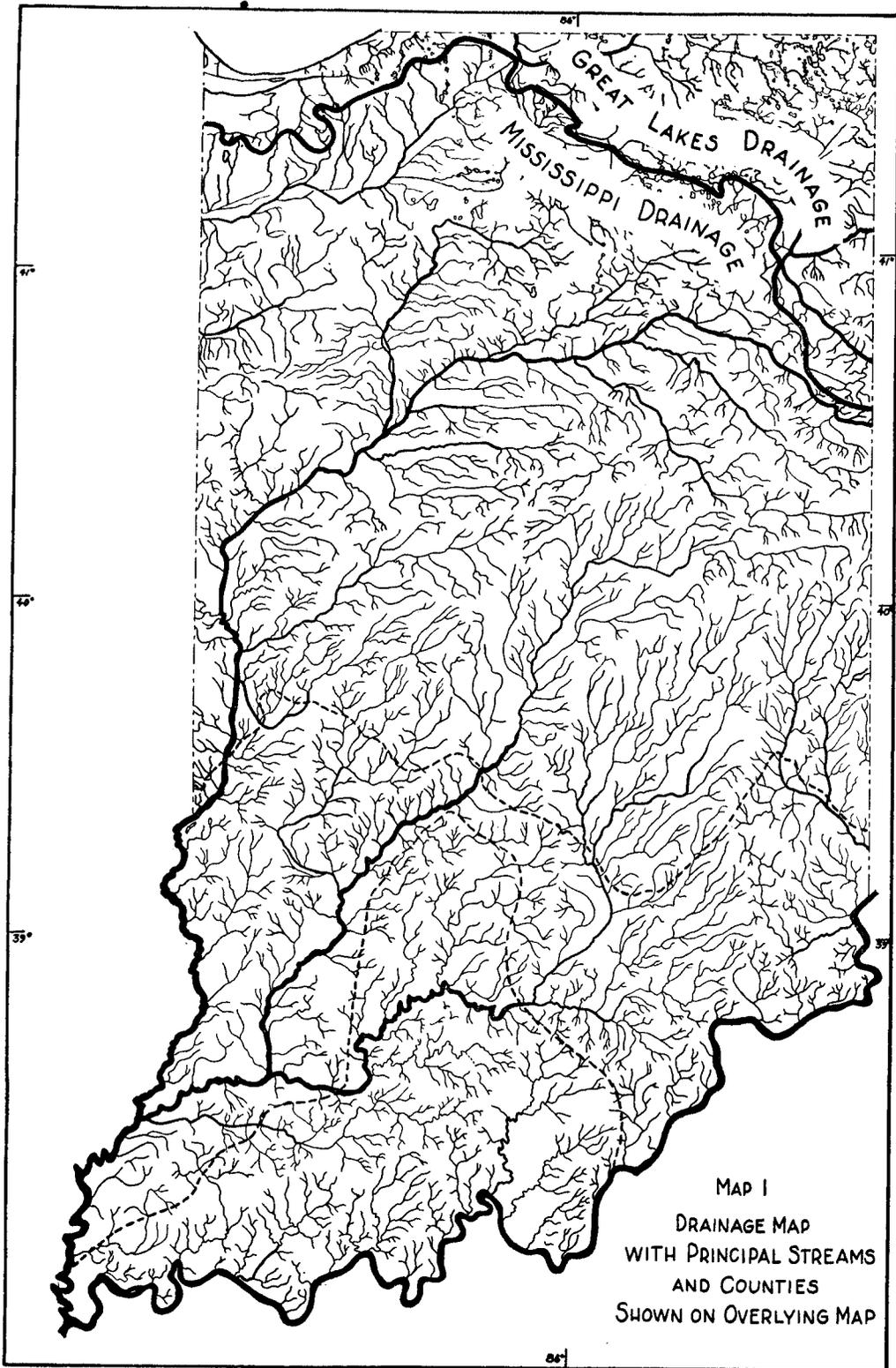
In order to facilitate the location of collecting sites, transparent overlying maps accompany the first three maps. MAP 1 shows the divide between the Great Lakes and Mississippi drainages, and its overlying map is an outline of the counties and principal streams of the state. The distribution of all the collections made in this study is given on MAP 2, and the numbers on the accompanying, overlying map are the locality numbers from our original records. A list of these numbers together with their accurate locality identification is also given (APPENDIX B). The same plan was carried out in the presentation of the important literature records (MAP 3 with overlying, numbered map, and APPENDIX C). The literature records represented on MAP 3 are the most important collections made by other authors which could be spotted with reasonable accuracy. A few scattered records for single fishes, such as *Amblyopsis spelaesus*, were not included. APPENDIX D lists by counties all the localities represented on MAPS 2 and 3. By checking the localities of any species against MAPS 1, 2, 3 and APPENDIX D, a ready identification of the particular localities in question will be assured.

No rigid rule was followed in the selection of species for mapping. Species were chosen either because there were too many localities to list or because their distribution presented interesting or unusual features. Original collections are represented on the maps by solid dots, and unverified reports are identified by hollow circles. The literature records are symbolized by a dot and concentric circle. The greater part of the earlier Indiana collections are now in the California Academy of Sciences and it was not possible to verify the identification of these specimens. Therefore, only those records in the literature were used which were completely



MAD 1
 & DRAINAGE MAP
 WITH PRINCIPAL STREAMS
 AND COUNTIES
 SHOWN ON OVERLYING MAP





unambiguous; species which were confused in the early literature and names whose significance is doubtful were rejected. In EIGENMANN and BEESON'S (1894) review of the "Fishes of Indiana," there are a number of localities listed which had never before appeared in the literature. The most important of these localities are treated separately and given in the species list and APPENDIX D preceding the above authors' names. In all other cases the localities were traced back to the original collector and the proper authority given due credit. BLATCHLEY and ASHLEY (1901) also utilized material of other authors in compiling the lists of species occurring in the marl lakes of northern Indiana. These authors' names appear only when the species lists were directly attributable to them.

The data concerning the ranges of fishes occurring in the Great Lakes drainage were derived from HUBBS and LAGLER (1941), as was the systematic arrangement of species. For brevity, page references to this work were made only when specific points of interest were involved. Abbreviations have been used to designate terms used commonly in listing localities: R.—river; Cr.—creek; m.—mile; N.—north; S.—south; E.—east; W.—West; UMMZ—University of Michigan, Museum of Zoology; Co.—county.

EIGENMANN and BEESON (1894) listed 26 families, 65 genera, and 158 species of fishes known from Indiana. The above list of fishes new to the state, systematic changes, and additions from scattered publications have raised all these figures. The tabulation of Indiana's fishes now includes 28 families, 94 genera, and 170 species. The addition of 16 subspecies brings the total number of forms to 186.

PETROMYZONIDAE Lampreys

Ichthyomyzon Girard

The genus *Ichthyomyzon* has been carefully reviewed by HUBBS and TRAUTMAN (1937). Some original collections of Indiana material were used in their study, and specimens which had been recorded in the literature were re-examined when possible. In the present paper, all new records are based on specimens whose identity has been checked by Dr. HUBBS. Since so few records of the lampreys are available, no attempt will be made to judge their mode of distribution.

Ichthyomyzon unicuspis Hubbs and Trautman

Silver lamprey

Carroll Co.: ? Wabash R., Delphi (Evermann and Jenkins, 1892).

Crawford Co.: ? Blue R., Wyandotte (Eigenmann and Beeson, 1894).

Floyd Co.: ? Ohio R., New Albany (Jordan and Fordice, 1886).

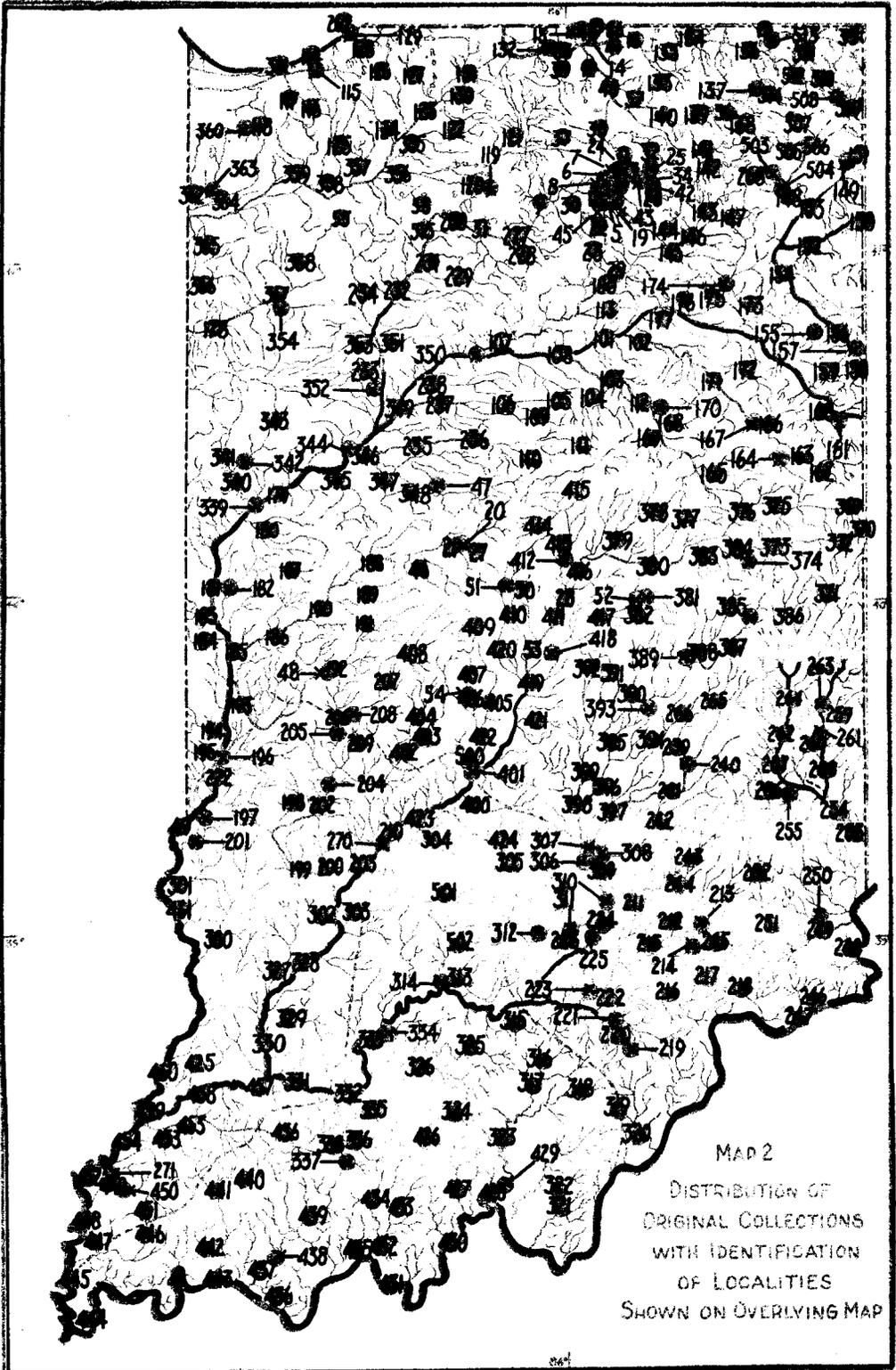
Kosciusko Co.: ? Tippecanoe R., Warsaw (Hubbs and Trautman, 1937); ? Turkey Creek, Syracuse (Hubbs and Trautman, 1937); ? Wawasee Lake, Syracuse (Eigenmann, 1896).

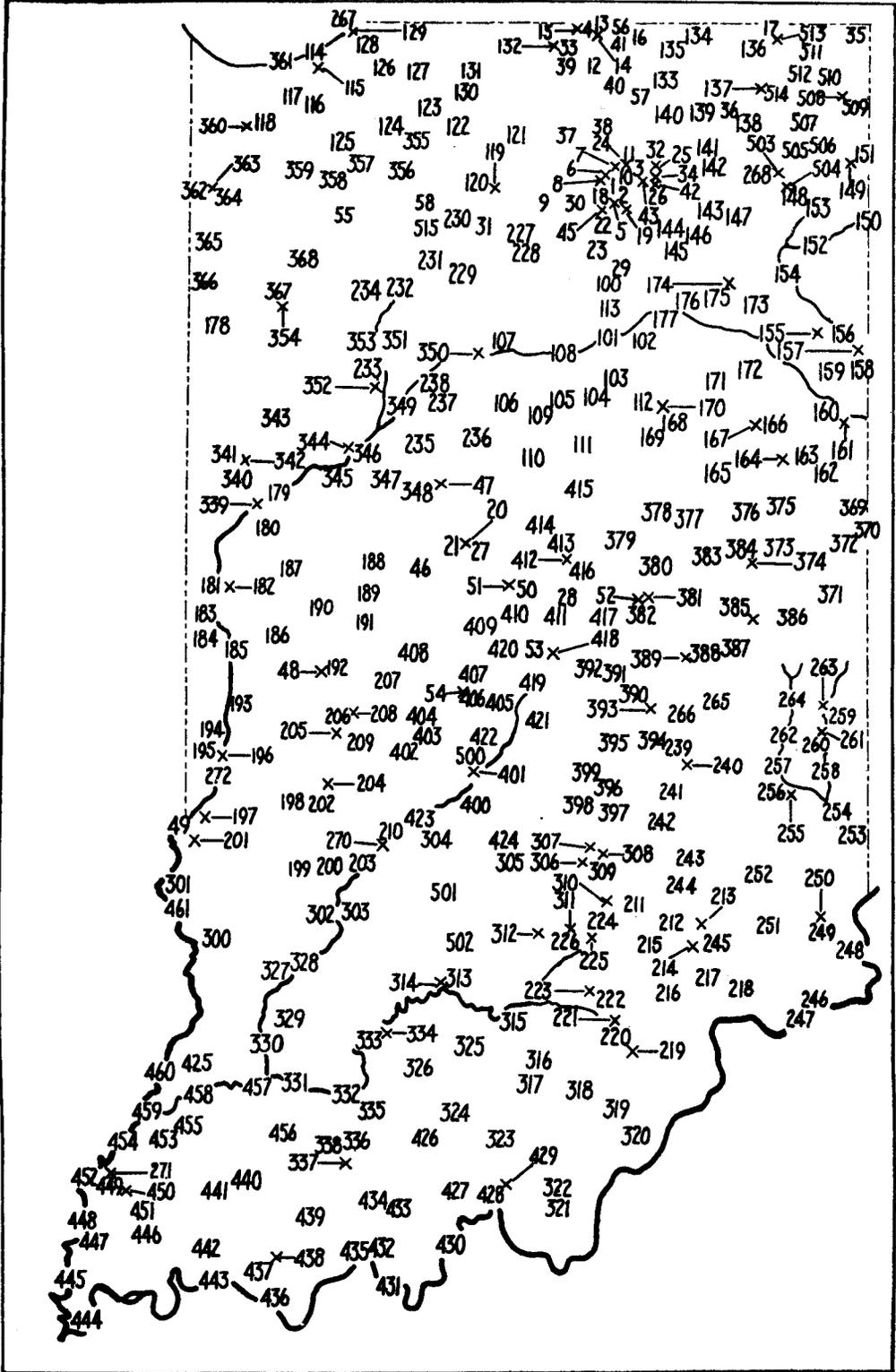
Lake Co.: ? Calumet Lake, near Hammond (Nelson, 1878).

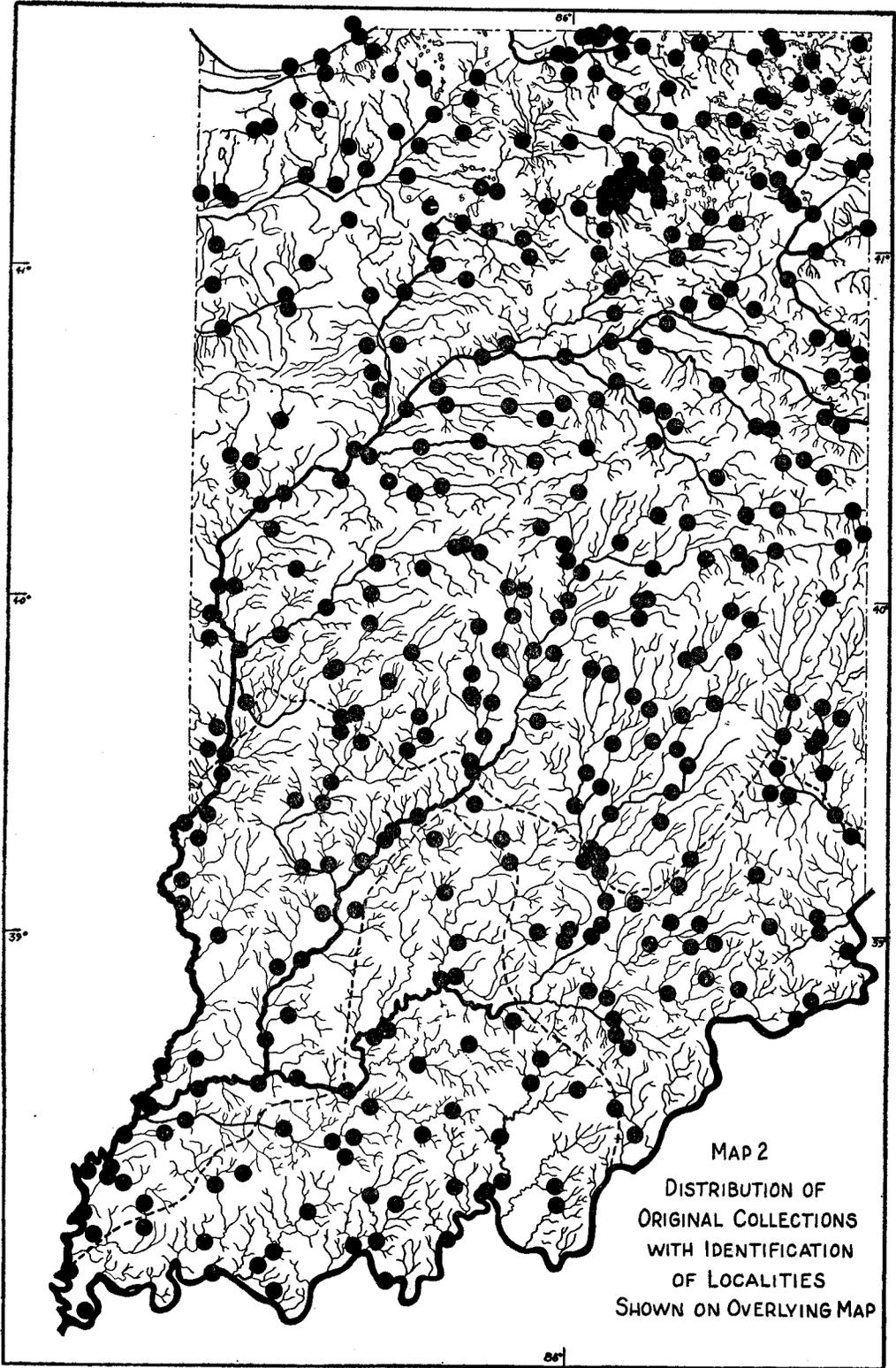
Marion Co.: ? White R., near Indianapolis (Jordan, 1877a).

Marshall Co.: ? Outlet of Lost Lake, near Culver (Hubbs and Trautman, 1937).

Owen Co.: White R., 4 m. S. Spencer.







MAP 2
DISTRIBUTION OF
ORIGINAL COLLECTIONS
WITH IDENTIFICATION
OF LOCALITIES
SHOWN ON OVERLYING MAP

Posey Co.: ? Wabash R., New Harmony (Jordan, 1890).

Warren Co.: Wabash R., Attica.

Whitley Co.: ? Blue R., Columbia City (Kirsch, 1895a).

The silver lamprey is a parasitic species which inhabits large rivers. The large proportion of doubtful records in the list above stems partly from the difficulty of identifying ammocoetes, and partly from uncertainty of early records. Two specimens were obtained in our collections which are referable to this species. The White River specimen was brought in by a fisherman and the other was caught while seining. In the table below are the characters which were relied upon in identification:

	<i>White River</i>	<i>Wabash River</i>	<i>From Hubbs and Trautman (1937)</i>
No. of myomeres	49	52	49-52
Supraoral cusps	2	3	1-4 (rarely more than 2)
Teeth in ant. row	4	3	2-4 (usually 3)
Teeth in lat. row	6	6	5-8 (usually 6 or 7)
Circumoral teeth	All unicuspid	One bicuspid	All unicuspid

Ichthyomyzon fossor Reighard and Cummins

Michigan brook lamprey

Kosciusko Co.: ? Tippecanoe R., Warsaw (Hubbs & Trautman, 1937); Tippecanoe R., south of Leesburg (UMMZ, 1939); Tippecanoe R., Warsaw (UMMZ, 1939); Turkey Cr., Syracuse (UMMZ, 1895).

Marshall Co.: ? Outlet of Lost Lake, near Culver (Hubbs and Trautman, 1937).

This is a nonparasitic lamprey found in smaller rivers and creeks. This species had not positively been identified from Indiana in 1937, according to HUBBS and TRAUTMAN, but there are specimens in the UMMZ which were determined as *Ichthyomyzon fossor* by Dr. HUBBS.

Ichthyomyzon castaneus Girard

Chestnut lamprey

Elkhart Co.: Elkhart R., Goshen (Hubbs and Trautman, 1937).

Lake Co.: ? Calumet Lake, near Hammond (Nelson, 1878); Lake Michigan, Edgemoor (Meek and Hildebrand, 1910); Lake Michigan, Whiting (Meek and Hildebrand, 1910).

Lawrence Co.: E. Fk. White R., 10 m. S.W. Bedford.

St. Joseph Co.: St. Joseph R., 5 m. E. South Bend (Hubbs and Trautman, 1937).

The chestnut lamprey is a parasitic species which was only known to frequent the lakes and rivers of the Lake Michigan drainage, but in 1944 it was taken in abundance in the East Fork of the White River, after a period of pollution had killed many fishes.

Ichthyomyzon bdellium (Jordan)

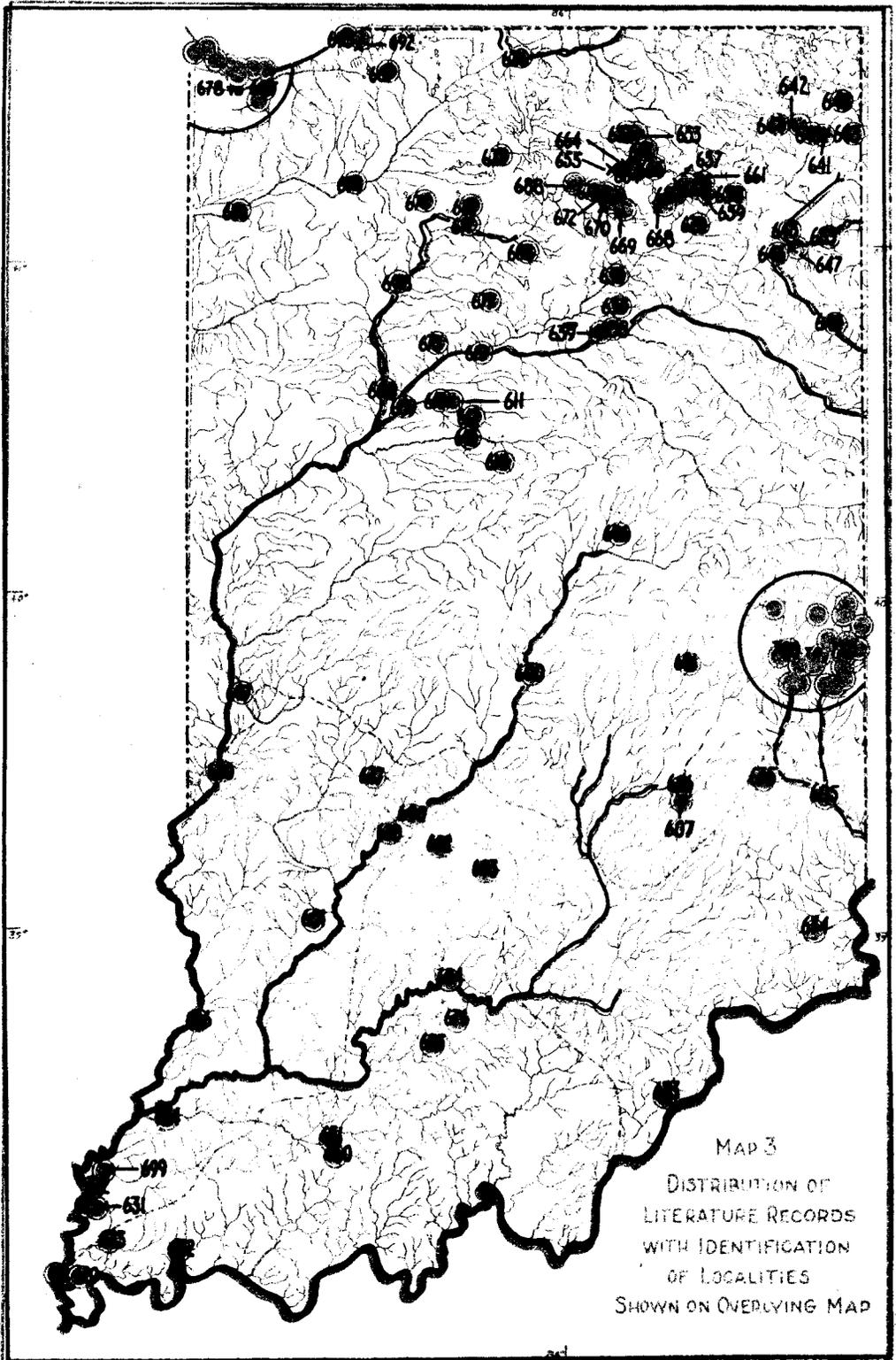
Ohio lamprey

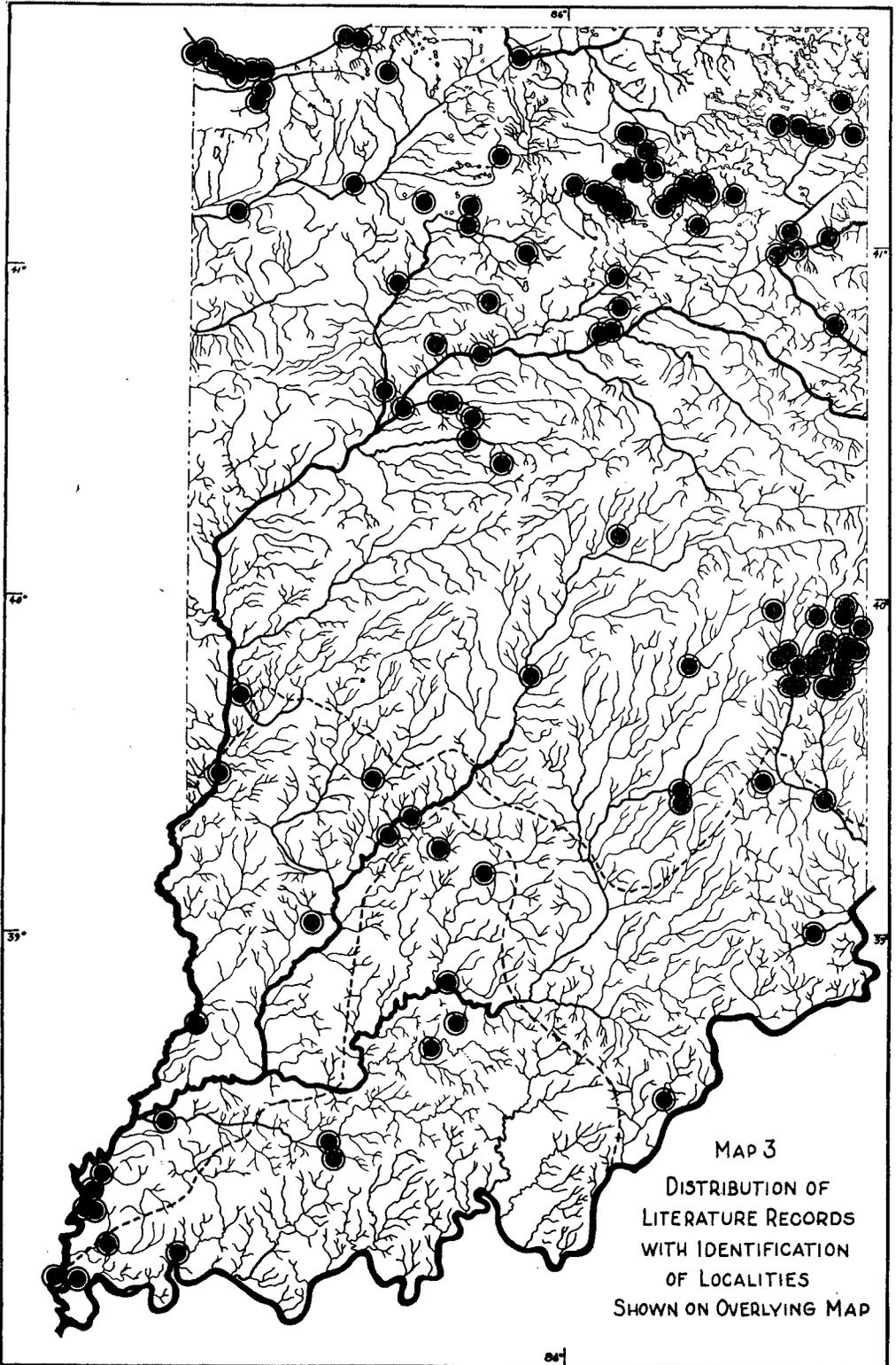
Cass Co.: Mud Creek (UMMZ, 1930).

Clark Co.: ? Falls of Ohio, Jeffersonville (Call, 1896).

Fulton Co.: Tippecanoe R., near Rochester (Hubbs and Trautman, 1937).

Marshall Co.: Lake Maxinkuckee Outlet, Culver (Everman and Clark, 1920).





Pulaski Co.: Tippecanoe R., 6 m. N. Winamac (3 specimens collected by D. Scott during the summer of 1944).

Vigo Co.: Wabash R., Terre Haute (Hubbs and Trautman, 1937).

Wayne Co.: ? Near Richmond (Plummer, 1851).

The only specimens of the Ohio lamprey which were secured during the study were captured by Mr. DONALD SCOTT from the upper Tippecanoe River. No doubt the adults of this species are much more abundant in the large and medium-sized streams of the Wabash drainage than our records suggest.

Entosphenus Gill

Entosphenus lamottenii (LeSueur).

American brook lamprey

LaPorte Co.: Little Kankakee R., 5 m. E. LaPorte.

Kosciusko Co.: Winona Lake Outlet, Warsaw (Blatchley and Ashley, 1901).

Wayne Co.: Noland's Fork, 7 m. E. of Richmond (Shoemaker, 1942).

The two specimens from the Little Kankakee River were larvae found in a mud bank. The myomere counts were 65 and 67 which agree with the description of this species. It is a non-parasitic species frequenting small streams.

Eudontomyzon Regan

Eudontomyzon aepypterus (Abbott)

Ohio brook lamprey

Orange Co.: Lick Creek, near West Baden (Creaser, 1939).

The specimen of this species was sent to Dr. CHARLES CREASER (1939) who identified and recorded its occurrence in Indiana. No other record of its occurrence has been found in the literature, and no specimens were taken in the survey. It is a non-parasitic species found usually in small streams.

POLYODONTIDAE Paddlefishes

Polyodon Lacépède

Polyodon spathula (Walbaum)

Paddlefish, Spoonbill

MAP 4

The paddlefish has entered Indiana by the large rivers available to it, the Wabash and Ohio. It has never been found in the Great Lakes drainage of our state. However, there are reports of its occurrence in Lake Erie. This would indicate that the Maumee outlet was used in its dispersal, and as GREENE has stated (1935: 24), this locality could also have been reached by way of canal connections. Tippecanoe Lake, its northernmost locality in the state, is only a few miles from the divide which separates the Great Lakes and Mississippi watersheds.

Conversations with commercial fishermen along the large rivers have conveyed the impression that the abundance of this species is diminishing. In these conversations frequent allusions to large catches made with the use

of dynamite and large seines gives an indication of the factors contributing to its decreased abundance. On the other hand, it is still known to be locally abundant. No specimens were taken during our seining operations, but a number of reports were gathered from fishermen which added considerably to the localities from which this species is known.

The paddlefish is an inhabitant of the quieter portions of large, silty rivers of the south. It is also known from bayous and one cypress swamp, Hovey Lake, Posey County. Turbidity must not be a limiting factor to its distribution, since it is present in the larger, northern glacial lakes. Its existence in these lakes is also evidence for its preference of quiet waters.

ACIPENSERIDAE Sturgeons
Acipenser Linnaeus
Acipenser fulvescens (Rafinesque)
Rock sturgeon

Clark Co.: Falls of Ohio, Jeffersonville (Rafinesque, 1820).

Lake Co.: Lake Michigan, Edgemoor (Meek and Hildebrand, 1910); Lake Michigan, Millers (Meek and Hildebrand, 1910); Lake Michigan, Pine (Meek and Hildebrand, 1910).

Posey Co.: Wabash R., New Harmony (Jordan, 1890).

Spencer Co.: Ohio R., Rockport (Eigenmann and Beeson, 1894).

Vigo Co.: Wabash R., Terre Haute (Blatchley, 1938); Wabash R. (Jenkins, 1887).

The present-day scarcity of this species is generally attributed to exploitation by commercial fishermen. Other factors which may have been active in contributing to their decrease in numbers are unknown.

The above records give a fair picture of its occurrence, in past years, in the Indiana waters of the Mississippi drainage and Lake Michigan. Use of the Chicago outlet into the Great Lakes is obviously indicated. It is a large fish of the quieter portions of large rivers and lakes.

Scaphirhynchus Heckel
Scaphirhynchus platyrhynchus (Rafinesque)
Hackleback

Carroll Co.: Wabash R., Delphi (Evermann and Jenkins, 1892).

Clark Co.: Falls of Ohio, Jeffersonville (Rafinesque, 1820).

Jefferson Co.: Ohio R., Madison (Blatchley, 1938).

Owen Co.: W. Fk. White R., near Spencer.

Posey Co.: Wabash R., near New Harmony.

Vigo Co.: Wabash R., Terre Haute (Jordan and Evermann, 1934); Wabash R., Terre Haute (Jenkins, 1887); Wabash R., between Lafayette and Terre Haute (Blatchley, 1938); Wabash R., Terre Haute.

Knowledge concerning the relative abundance of the hackleback is rather vague, but the general impression indicates that it is relatively rare in Indiana waters. This sturgeon is a true Mississippi valley form, having never been recorded in the Great Lakes. The large, silty rivers are a typical habitat for this species, and it has utilized only these waters in its dispersal.

LEPISOSTEIDAE Gars
Lepisosteus Lacépède
Lepisosteus spatula Lacépède
 Alligator gar

Clark Co.: Falls of Ohio, Jeffersonville (Rafinesque, 1820).
 Posey Co.: Wabash R., New Harmony (Jordan, 1890).

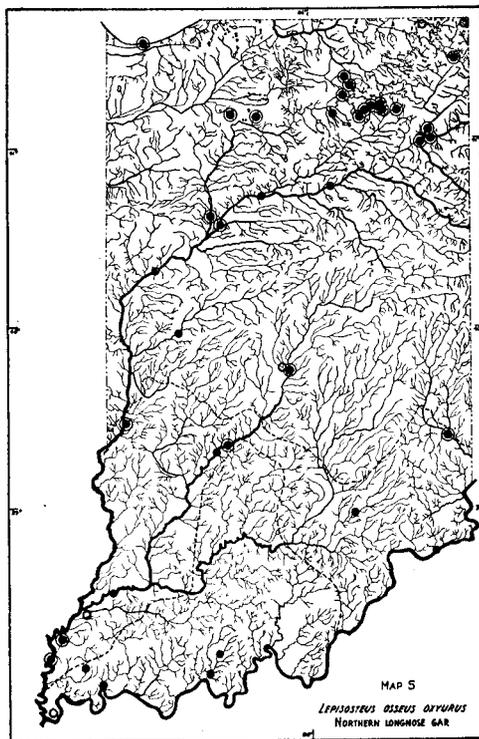
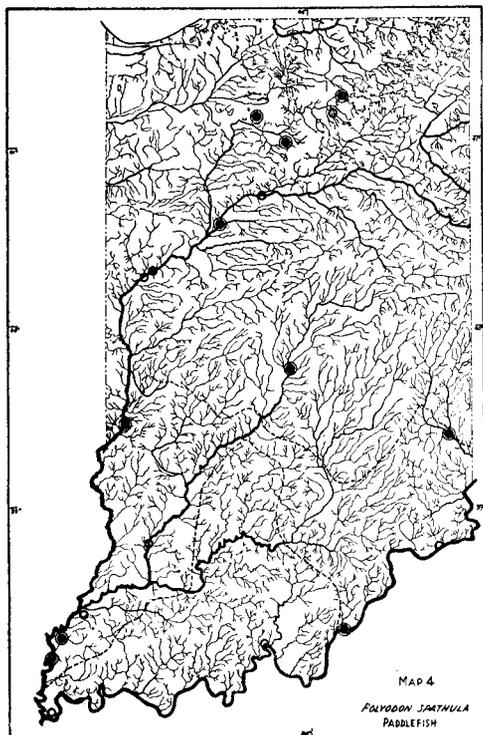
The alligator gar has not been known in Indiana waters for at least 55 years when its occurrence was reported by JORDAN, who based his record on a specimen in the collection of Mr. JAMES SAMPSON of New Harmony.

Lepisosteus platostomus Rafinesque
 Shortnose gar

Cass Co.: Wabash R., Logansport.
 Daviess Co.: E. Fk. White R., 3 m. W. Washington.
 Gibson Co.: Foots Pond, 5 m. N.E. Poseyville; Wabash R., 5 m. N.W. Garrett; Wabash R. and Bayous, 11 m. W. Princeton.
 Posey Co.: Wabash R., 8 m. W. Mt. Vernon; Wabash R., 3 m. S.W. New Harmony.

No literature records were considered in listing the localities for this species or the next, since the shortnose and spotted gars have long been confused. HUBBS and LAGLER (1942: 76) give a convenient table of characters which distinguish these two species.

Most frequently it was caught in the main channels of large silty rivers having little or no vegetation and a hard bottom of sand, gravel or



rock. Foots Pond, Gibson County, was the only place where the shortnose gar was caught in standing water. This locality is frequently flooded by the Wabash River and the species undoubtedly made its way to the pond from the river during a flood period. It is not found in the Great Lakes drainage, so obviously its route of migration in Indiana has been confined to the Ohio and Wabash rivers and their tributaries.

Lepisosteus productus Cope
Spotted gar

Gibson Co.: Foots Pond, 5 m. N.W. Poseyville.

Kosciusko Co.: Muskellunge L., 4 m. S. Warsaw (report); Ridinger L., 5 m. S. North Webster; Shoe L., 5 m. N.E. Warsaw (report); Winona L., Winona Lake (report).

Posey Co.: Hovey L., 10 m. S. Mt. Vernon.

Steuben Co.: Mud L., 2 m. W. Orland (report).

St. Joseph Co.: St. Joseph R., ½ m. N. Osceola.

In contrast to the shortnose gar, this species is common in the clear weedy glacial lakes of the northern part of the state. It has been found only once in a flowing stream, a slow, weedy backwater of the St. Joseph River near Osceola, St. Joseph County. The two southern records are both from standing water: Foots Pond and a cypress swamp, Hovey Lake. The water in these latter two localities is very turbid, so clear water must not be an essential factor governing its distribution.

Records from the Lake Michigan drainage and various parts of the Lake Erie basin outside Indiana's boundaries suggest the use of both the Chicago and Maumee outlets in the original migration northward from the Mississippi valley.

Lepisosteus osseus oxyurus Rafinesque

Northern longnose gar

MAP 5

Since the longnose gar is easily distinguished from the two previous species, free use of literature records was made. This gar inhabits the standing waters of both the north and south. Among flowing streams, it generally occurs in the open waters of the large rivers, although it has occasionally been caught in smaller tributaries. This form is represented in all the principal drainage systems of the state.

AMIIDAE Bowfins

Amia Linnaeus

Amia calva Linnaeus

Bowfin

MAP 6

The bowfin is a predatory fish which is generally distributed over the state. The great majority of the northern records are from lakes, but it occurs abundantly in streams as well. Its known southerly distribution is limited to the Wabash-Ohio flood plain of the southwestern corner where it has been found in large rivers, small tributaries, bayous, and swamps.

All these localities vary widely in the abundance of vegetation and turbidity of the water, and it appears that the bowfin is tolerant of widely different conditions.

HIODONTIDAE Mooneyes and Goldeyes

Hiodon LeSueur

Hiodon tergisus LeSueur

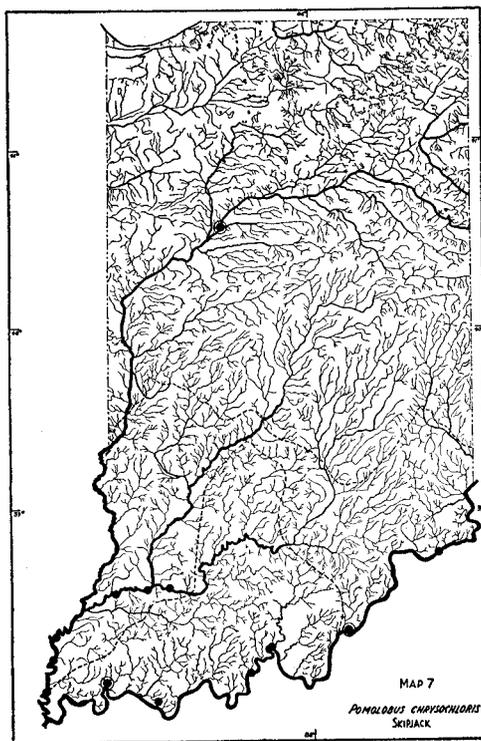
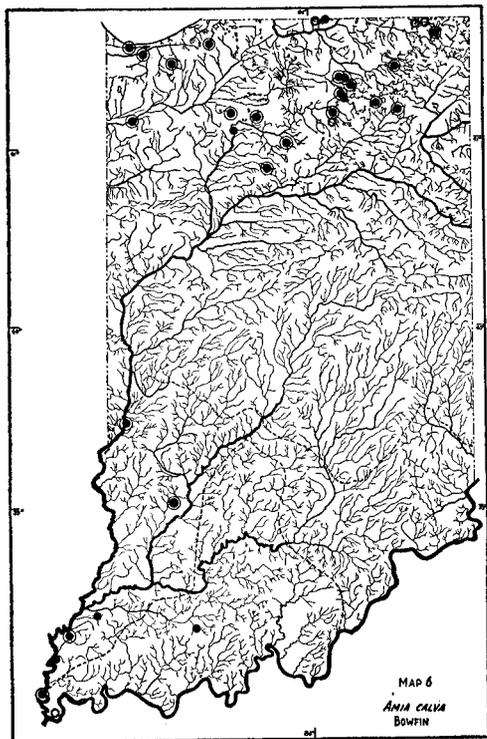
Mooneye

Carroll Co.: Tippecanoe R. (Evermann and Jenkins, 1892).

Lawrence Co.: E. Fk. White R., 10 m. S.W. Bedford.

Owen Co.: McCormick's Cr. State Park, 2 m. N.E. Spencer.

Scarcity of information concerning occurrence of the mooneye in Indiana does not allow discussion of its habits. The presence of this species in Lake Michigan and Lake Erie is known and implies the use of both the Chicago and Maumee outlets. BLATCHLEY (1938: 25) states, "Recorded only by Gilbert from a swamp at Switz City . . .". This record is a mistake since GILBERT's (1885b) paper has been checked and no mention of this species was made.



Amphiodon Rafinesque

Amphiodon alosoides (Rafinesque)

Goldeye

Clark Co.: Falls of Ohio, Jeffersonville (Call, 1896).

Owen Co.: W. Fk. White R., Gosport (Eigenmann and Beeson, 1894).

Posey Co.: Wabash R., New Harmony (Jordan, 1890).

Vanderburgh Co.: Ohio R., near Evansville (UMMZ, 1924).

Vigo Co.: Wabash R. (Jenkins, 1887).

From the reports at hand this species apparently prefers the large, silty rivers. Since goldeye is not found in the Great Lakes, it may have migrated into the Ohio and Wabash valleys after the glacial outlets were dried up.

CLUPEIDAE Herrings
Pomolobus Rafinesque
Pomolobus chrysochloris Rafinesque
 Skipjack
 MAP 7

In every instance this species was taken in or near a large silty river. The one locality where the skipjack occurred in standing water was a stagnant ditch draining an area of Ohio River flood plain. It could easily have been transported to this situation in times of high water or found its way up the series of connected ditches in this area. Reports that this fish is found in the Great Lakes are now generally discredited (HUBBS and LAGLER, 1941: 27).

Alosa Linck
Alosa ohioensis Evermann
 Ohio shad

Clark Co.: Ohio R., Jeffersonville (Evermann, 1902).

This fish has not been captured in Indiana since EVERMANN first caught and described the species.

Dorosoma Rafinesque
Dorosoma cepedianum (LeSueur)
 Gizzard shad
 MAP 8

This species generally follows the courses of the large rivers and their main tributaries, where it is generally caught in backwaters and other quiet places. It is also known from a swamp and bayous in the south and three northern lakes. Apparently this fish prefers open waters where the young are commonly observed in large schools.

This species has neither been taken in the Lake Michigan drainage, nor in the Kanakakee or Iroquois rivers; it is represented in all the other watersheds. The presence of *Dorsoma* in the Maumee River suggests its presence in the glacial outlet of Lake Maumee. However, GREENE (1937; 32) questions this interpretation; it is his opinion that the shad has entered Lake Erie (and the other Great Lakes) by way of canal connections.

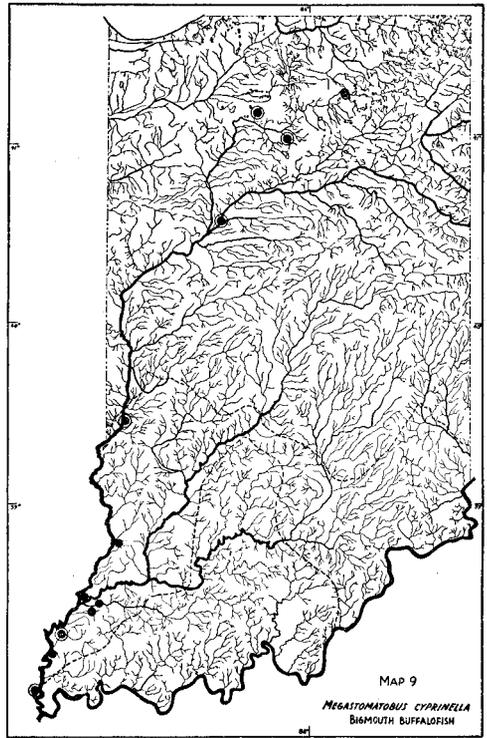
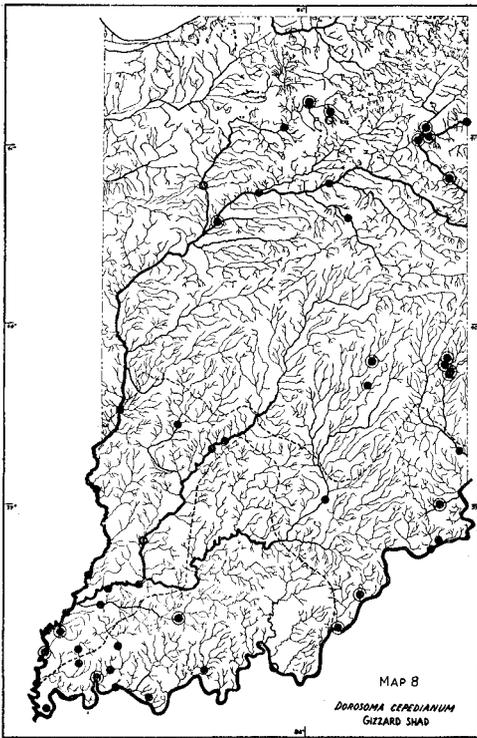
OSMERIDAE Smelts
Osmerus Linnaeus
Osmerus mordax (Mitchill)
 American smelt

LaPorte Co.: L. Michigan, Michigan City.

Porter Co.: Indiana Dunes State Park (report).

The smelt is possibly the most recent immigrant into Indiana waters. CREASER (1926) has outlined the history of the introduction of the smelt into the upper waters of the Great Lakes. In 1906 and succeeding years smelt eggs were planted from a hatchery at Green Lake, Maine, into various parts of northern Lake Michigan. They quickly established themselves and in recent years have been taken in commercial quantities in the Lake.

A specimen of the smelt was obtained from Lake Michigan on a trip taken with commercial fishermen. Employees of the Indiana Dunes State Park supplied the information that smelt runs occur in a small bog outlet which enters Lake Michigan at the State Park.



COREGONIDAE Whitefishes

Leucichthys Dybowsky

In 1931 KOELZ proposed an elaborate systematic arrangement for the whitefishes of northeastern America which has been in general use since that time. In Indiana he recognized two subspecies of *Leucichthys artedi*, *L. a. artedi* and *L. a. sisco*. However, HILE (1936) published a summary of morphometric work done on this species in Wisconsin which casts doubt on the validity of KOELZ'S criteria for differentiating the forms of this cisco. In the light of HILE'S work it appears that many of the subspecies originally distinguished by KOELZ are not sufficiently distinct to merit taxonomic designation. Therefore, it seems advisable in this study to drop

the subspecific name *sisco*, which was originally proposed by JORDAN (1875b) from Tippecanoe Lake specimens, until further systematic work is done here.

Leucichthys artedi (LeSueur)

Cisco

Fulton Co.: Manitou L., Rochester (Eigenmann and Beeson, 1894).

Kosciusko Co.: Tippecanoe L., Oswego (Jordan, 1875b).

LaPorte Co.: L. Michigan off Michigan City.

Marshall Co.: Twin L. group, 4 m. S.W. Plymouth (report).

Noble Co.: Big L., 3 m. W. Merriam (Kirsch, 1895a); Crooked L., 3 m. S.W. Merriam (Kirsch, 1895a); Indian Village, 4 m. N.E. North Webster (Hile, 1931); Gordy L., 2 m. S.E. Indian Village (Hile, 1931); Hindman L., 3 m. S.E. Wilmot (Hile, 1931).

Steuben Co.: Clear L., 7 m. E. Fremont (report); Gage L., 6 m. N.W. Angola (report); Snow L., 7 m. N. Angola (Scott, 1931); James L., 6 m. N. Angola (Scott, 1931).

Whitley Co.: Cedar L., 14 m. W. Churubusco (Kirsch, 1895a); Shriner L., 6 m. W. Churubusco (Kirsch, 1895a).

The southern limit of the range of the cisco is reached in northern Indiana, where it is an inhabitant of deep, clear, cool lakes of both the Great Lakes and Wabash drainages. The cisco's preference for cool water suggests that it closely followed the retreat of the glacier. If it did follow this mode of northward migration, it would encounter silt-laden glacial waters which are greatly in contrast to its present environment. Apparently, however, it was able to exist in such situations, for the presence of ciscoes in both the Wabash and the Great Lakes drainages secures the premise that it followed the ice retreat and became established in the glacial lakes as they were formed.

Coregonus Linnaeus

Coregonus clupeaformis clupeaformis (Mitchill)

Great Lakes whitefish

Lake Co.: L. Michigan, Pine (Meek and Hildebrand, 1910); L. Michigan, Millers (Meek and Hildebrand, 1910).

LaPorte Co.: L. Michigan off Michigan City.

This is a commercially important species in Lake Michigan. Its migration into the Great Lakes is generally assumed to be the same as *Leucichthys*.

SALMONIDAE Trouts

Salmo Linnaeus

Numerous plantings of the species of this genus and the next have been carried out in cool creeks of both the northern and southern parts of the state. In many cases it is impossible to determine whether trout populations have become established, but it is reasonably certain that the southern plantings have survived no considerable length of time. In the discussion below, only those streams where trout have been known for period of years are listed. Most of the information was obtained from Mr. JOHN GOTTSCHALK, former Supervisor of Fisheries, Indiana Department of Conservation, and Dr. W. E. RICKER, who is making a study of the tagging and recapture of trout in Indiana's northern streams.

MURRAY (1938) made a study of the trout streams of northern Indiana and lists the brown, brook, and rainbow trouts being taken from some of the streams investigated. Unfortunately he did not give the localities from which the individual species were taken, so the records cannot be used here.

Salmo trutta fario Linnaeus

Brown trout

- Elkhart Co.: Little Elkhart R., Bristol (report); Cobus Cr., 5 m. W. Elkhart (report); Solomon's Cr., 7 m. S.E. Goshen (report).
 Lagrange Co.: Pigeon Cr., Mongo (report); Buck Cr., 2 m. W. Lagrange (report); Emma Cr., 7 m. W. Lagrange (report); Little Elkhart R., 8 m. W. Lagrange (report); Fly Cr., 4 m. N.E. Lagrange (report); Bloody Run, 9 m. E. Lagrange (report).
 LaPorte Co.: Kankakee R., 3 m. S.E. Union Center; Massarouga Cr., 8 m. W. LaPorte (report); Trail Cr., 6 m. N.W. LaPorte (report); Snake Cr., 2 m. E. Michigan City (report).
 Porter Co.: Coffee Cr., 2 m. S. Chesterton (report); Crooked Cr., 5 m. S.E. Valparaiso (report).
 Steuben Co.: Pigeon Cr., 6 m. W. Angola (report).
 St. Joseph Co.: Judy Cr., 2 m. N.E. So. Bend (report); Willow Cr., 6 m. E. So. Bend (report).

The brown trout has been introduced into America from Europe.

Salmo gairdnerii irideus Gibbons

Coast rainbow trout

- Elkhart Co.: Cobus Cr., 5 m. W. Elkhart (report); St. Joseph R., Elkhart (report); Little Elkhart R., Bristol (report); Sheep Cr., 2 m. W. Bristol (report); Solomon's Cr., 7 m. S.E. Goshen (report).
 Lagrange Co.: Pigeon R., Mongo (report); Buck Cr., 2 m. W. Lagrange (report); Emma Cr., 7 m. W. Lagrange (report); Little Elkhart R., 8 m. W. Lagrange (report); Fly Cr., 4 m. N.E. Lagrange (report); Bloody Run, 9 m. E. Lagrange (report).
 Lake Co.: L. Michigan, Pine (Meek and Hildebrand, 1910); L. Michigan, Millers (Meek and Hildebrand, 1910).
 LaPorte Co.: Little Kankakee R., 5 m. E. LaPorte; Massarouga Cr., 8 m. W. LaPorte (report); Trail Cr., 6 m. N.W. LaPorte (report); Snake Cr., 2 m. E. Michigan City (report).
 Steuben Co.: Pigeon Cr., 6 m. W. Angola (report).
 St. Joseph Co.: Judy Cr., 2 m. N.E. So. Bend (report); Willow Cr., 6 m. E. So. Bend (report).

This species was introduced into the state from western America. Quite a number of northern streams now have trout populations which provide good fishing. Usually both brown and rainbow trout can be taken in them, and from May through August they are fished by an increasing number of anglers. Almost all these streams receive plantings of hatchery-raised fry or fingerlings each year, or every few years, so it is impossible to say whether trout would remain in the state as permanent members of its fauna if these activities were discontinued. However, some natural reproduction does take place successfully.

Salvelinus Richardson
Salvelinus fontinalis fontinalis (Mitchill)

Common brook trout

Elkhart Co.: Cobus Cr., 5 m. W. Elkhart (report).

Lagrange Co.: Curtiss Cr., 3 m. W. Mongo (report).

Of the three trout species, the brook trout is the only one whose original distribution could have included Indiana, but there is no evidence that it naturally occurred here. The two localities listed are known to have been stocked with brook trout.

Cristivomer Gill and Jordan
Cristivomer namaycush namaycush (Walbaum)

Common lake trout

Lake Co.: L. Michigan, Pine (Meek and Hildebrand, 1910); L. Michigan, Millers (Meek and Hildebrand, 1910).

Laporte Co.: L. Michigan, off Michigan City.

In Indiana the lake trout lives in close association with the whitefish and cisco in the deep parts of Lake Michigan. Presumably, *Cristivomer* was dispersed in the same manner as the coregonids.

CATOSTOMIDAE Suckers

Megastomatobus Fowler

Megastomatobus cyprinella (Valenciennes)

Bigmouth buffalofish

MAP 9

The bigmouth buffalofish is an inhabitant of the slower portions of large streams. It also occurs in southern bayous and at least some of the northern lakes of the Wabash drainage. There are records of this species from the Great Lakes drainage in western Lake Erie where it is said to be ". . . rare, but probably native . . ." (HUBBS and LAGLER 1941: 41). If this is true, the fish was doubtless present in Lake Maumee at the time it drained into the Wabash River, but the possibility of *M. cyprinella* having entered Lake Erie via the Wabash-Erie canal cannot be overlooked.

Ictiobus Rafinesque

Ictiobus niger (Rafinesque)

Black buffalofish

Clark Co.: Presumably from Falls of Ohio, Jeffersonville (Rafinesque, 1820).

Gibson Co.: Foots Pond, 5 m. N.E. Poseyville (Hubbs and Lagler, 1942).

Wabash River (In his 1930 paper Hubbs states that the *Carpiodes vitulus* of Agassiz is really based on specimens of *I. niger*.)

This species has been reported from both Lake Michigan and Lake Erie, outside Indiana's boundaries. No specimens were captured during the field work.

Ictiobus bubalus (Rafinesque)

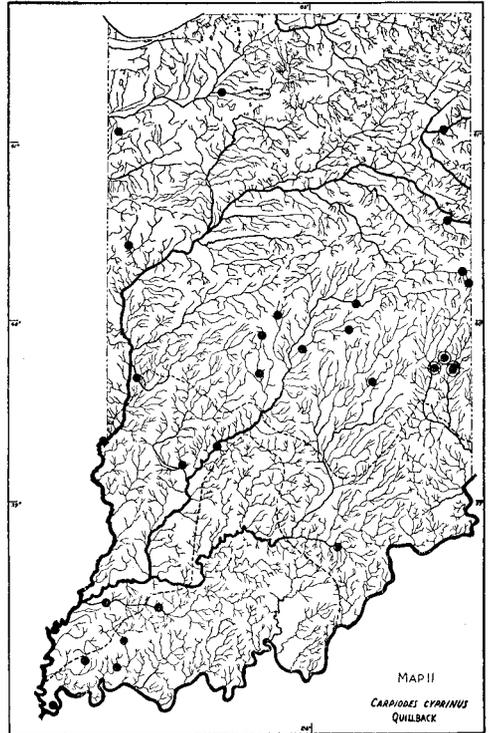
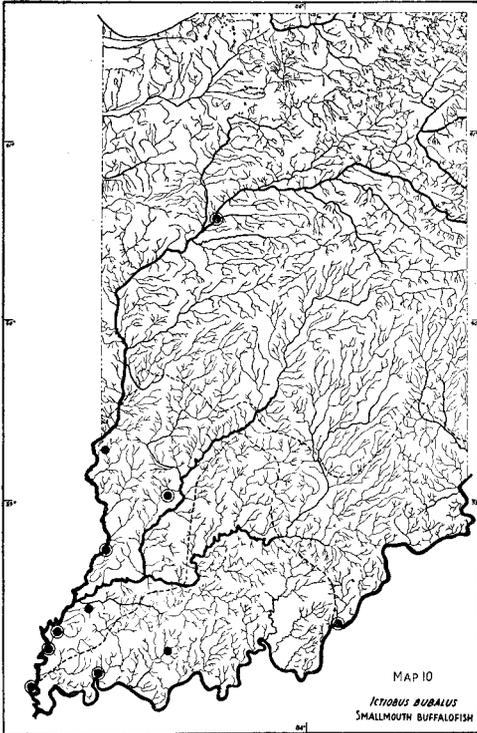
Smallmouth buffalofish

MAP 10

Ictiobus bubalus has been found in most types of southern Indiana habitats: large rivers and their small tributaries, a bayou, and a swamp. It is apparent that the smallmouth buffalofish inhabits both flowing and standing water of a silty nature. One record is known from the Great Lakes drainage in the St. Joseph River, Homer, Michigan (HUBBS, 1930: 13).

Carpiodes Rafinesque

Until 1930 when HUBBS reviewed the catostomid fishes, the species of the genus *Carpiodes* had been confused, and for this reason, only those records were used which have been identified since then.

*Carpiodes cyprinus* (LeSueur)

Quillback

MAP 11

Although occurring in both large rivers and creeks, it was found much more commonly in the creeks. The majority of the streams from which it was taken had a hard bottom of sand, gravel, or rock and only little vegetation. The quillback is represented in all drainages of the state except that of Lake Michigan. Our Maumee River collection and Lake

Michigan records from other states show that the quillback probably used both of the main glacial routes to the Great Lakes in its dispersal.

Carpiodes carpio carpio (Rafinesque)

Northern carpsucker

Parke Co.: Sugar Cr., Turkey Run St. Park (UMMZ, 1934).

Posey Co.: Big Cr., 2 m. S. Cynthiana; Wabash R., 6½ m. W. Mt. Vernon (UMMZ, 1940).

Gibson Co.: Patoka R., Patoka (UMMZ, 1927); Fools Pond, 5 m. N.W. Poseyville; White River, Hazelton.

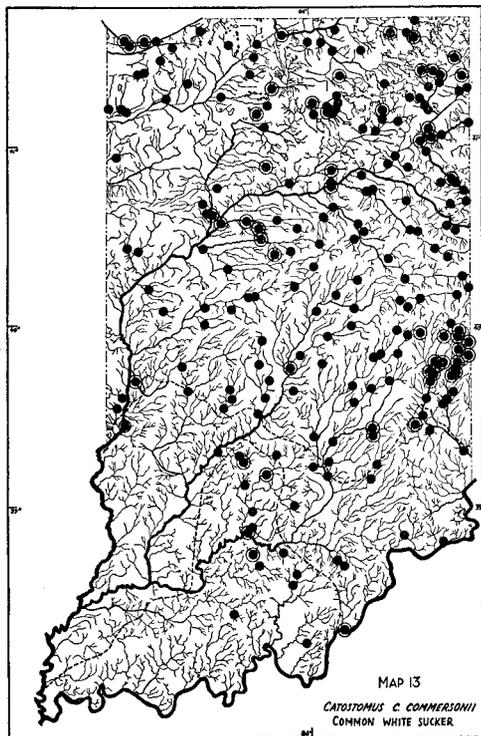
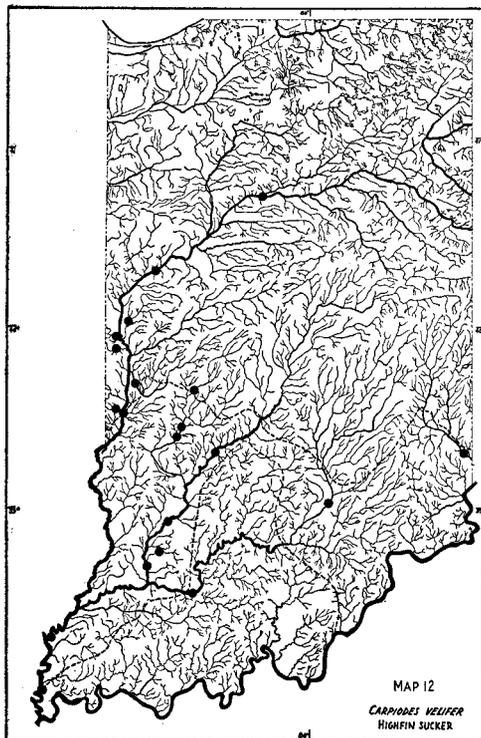
All the records are from turbid waters of southwestern Indiana. This fish has been taken once in the Maumee River in Ohio which is the only report of its occurrence in the Great Lakes drainage.

Carpiodes velifer (Rafinesque)

Highfin sucker

MAP 12

The highfin sucker is chiefly found in the large, silty rivers. The few tributary records are near the entrance of the streams into a large river. It was found over weedless, sandy bottoms, sometimes with an admixture of mud. No vegetation was ever associated with its occurrence. The species is a true Mississippi valley form, having never been found in the Great Lakes drainage.



Cycleptus Rafinesque
Cycleptus elongatus (LeSueur)

Blue sucker

Clark Co.: Falls of Ohio, Jeffersonville (Call, 1896).

Franklin Co.: Vicinity Brookville (Evermann, 1886).

Switzerland Co.: Ohio R., near Vevay (report).

Vigo Co.: Wabash R. (Jenkins, 1887); Wabash R., Prairietown (report); Wabash R., Terre Haute.

All the records are from large, turbid streams of southern Indiana. Commercial fishermen report that the species is only rarely caught and then in large schools. This sucker is said to be commonly called the "muskellunge" in the lower Wabash River region. This is another Mississippi valley species.

Catostomus LeSueur
Catostomus commersonii commersonii (Lacépède)

Common white sucker

MAP 13

Most frequently this species is found in creeks, only occasionally being caught in the larger streams; it is also found in the northern lakes. The common white sucker has been taken in habitats varying widely in the amount of vegetation, type of bottom, and turbidity of water. In regard to the turbidity, it may be said that the headwater creeks, where it is most abundant, are generally clearer than the lower courses of the large streams.

The common white sucker is found in all the drainage systems of the state. However, it has avoided the southwestern Wabash-Ohio flood plain region where the streams are mainly sluggish, very turbid and have heavy bottom deposits of silt.

Catostomus catostomus catostomus (Forster)

Eastern sturgeon sucker

Lake Co.: L. Michigan, Millers (Meek and Hildebrand, 1910); L. Michigan, Pine (Meek and Hildebrand, 1910).

LaPorte Co.: L. Michigan off Michigan City.

In this latitude the sturgeon sucker inhabits the cooler waters of the Great Lakes.

Hypentelium Rafinesque
Hypentelium nigricans (Lacépède)

Hog sucker

MAP 14

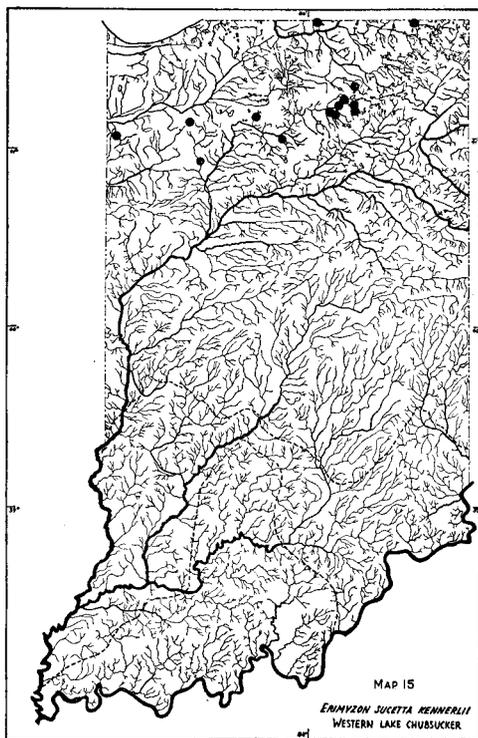
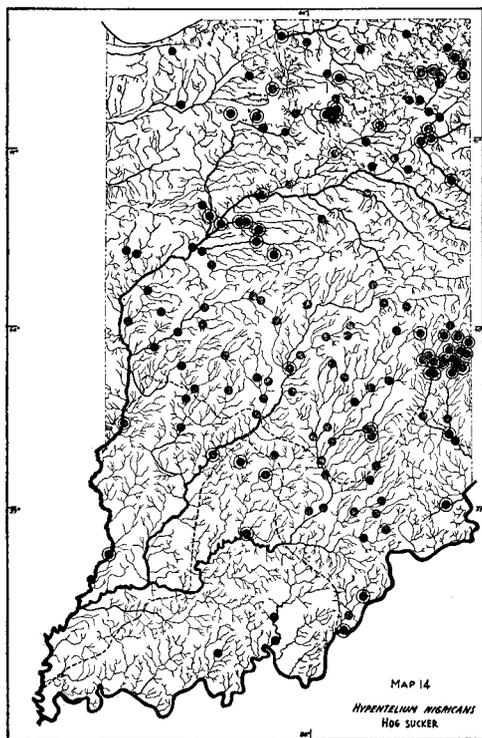
The hog sucker prefers the hard bottoms of smaller streams which have a moderate to strong current. Frequently it is caught in the riffles of these streams, whereas the white sucker usually inhabits the pools. The hog sucker is similar in distribution to the white sucker.

Erimyzon Jordan
Erimyzon sucetta kennerlyi (Girard)

Western lake chubsucker

MAP 15

The two species of the genus were confused in the early literature, so none of these records were included on the distribution maps. As the name implies, this species is almost entirely confined to lakes in Indiana. In this habitat it is usually found in weedy situations, especially the young. The lake chubsucker has also been taken in slow, weedy streams. An interesting sidelight can be noted concerning its occurrence in Beaver Lake Ditch, the westernmost locality on the distribution map. Before ditches were cut in the Kankakee region, Beaver Lake was present in this approximate region. Although the lake no longer exists, this characteristic lake form still inhabits the region.



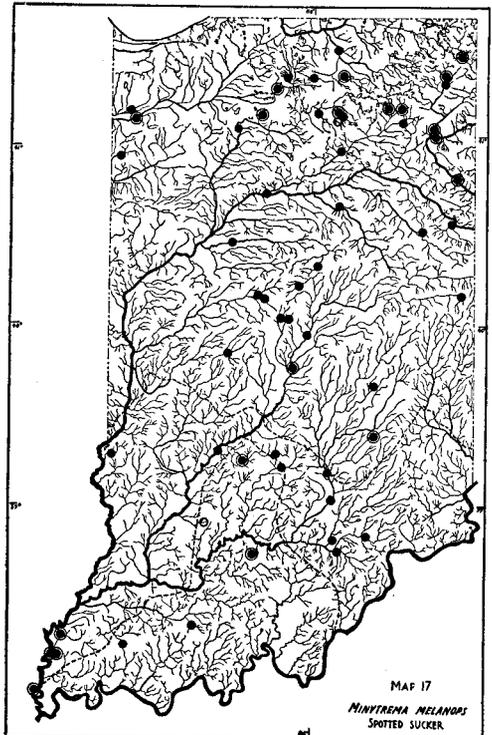
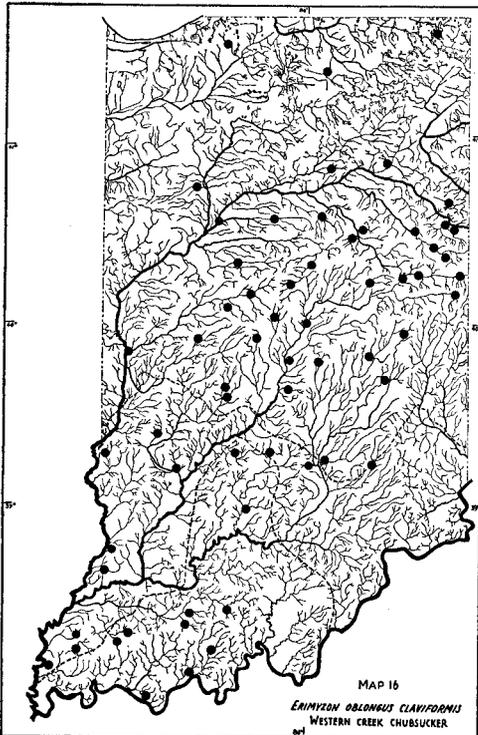
The lake chubsucker has been found only in the Lake Michigan drainage of the Great Lakes basin in Indiana, but its occurrence in tributaries of Lake Erie is known (HUBBS and LAGLER, 1941: 42). If additional collecting in the Maumee drainage fails to discover this species, it would suggest that the lake chubsucker entered the Erie drainage by some route other than the early Maumee glacial outlet.

Erimyzon oblongus claviformis (Girard)

Western creek chubsucker

MAP 16

This is a characteristic creek species as the distribution map shows. It has been found in both clear and turbid waters, over hard and soft bottoms. In only few localities was this sucker found in weedy streams; this would explain the presence of only one record in the region of the weedy ditches draining the Kankakee marshland. The creek chubsucker is represented in all the principal Indiana drainage systems.

*Minytrema* Jordan*Minytrema melanops* (Rafinesque)

Spotted sucker

MAP 17

The spotted sucker is an inhabitant of creeks, rivers, and northern lakes. At almost every locality where it was found, a soft bottom of muck, plant detritus or other settled material was noted. It appeared most commonly in quiet pools where this type of bottom would most likely be found. *Minytrema* is not averse to a weedy environment as it is found in

several of the weedy glacial lakes. This species has been collected in all the main drainage systems.

Moxostoma Rafinesque

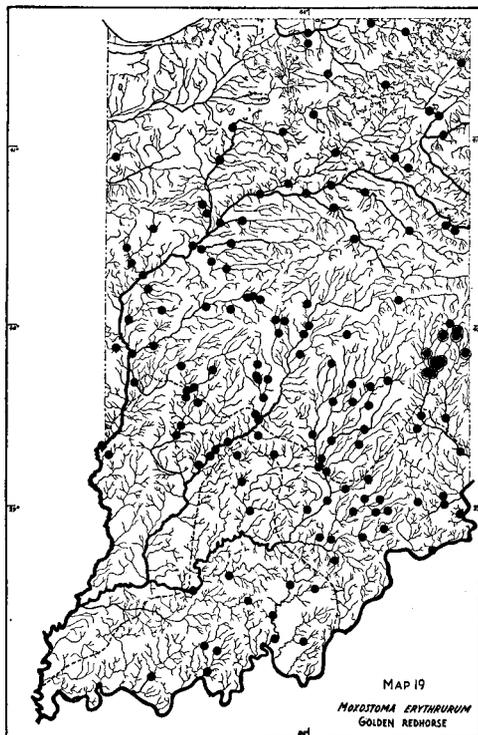
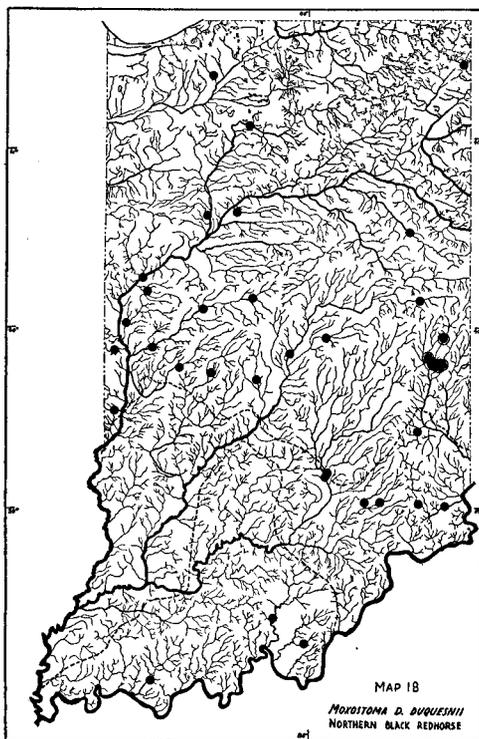
The species of this genus were confused by the early workers and it was not until 1930 that HUBBS separated them as they appear below. Thus, no literature records were used on the distribution maps.

Moxostoma duquesnii duquesnii (LeSueur)

Northern black redbhorse

MAP 18

This sucker is chiefly an inhabitant of small and medium-sized streams, having been recorded only once from a large river, the Wabash River at the mouth of Pine Creek, Attica, Warren County. It is usually found on hard bottoms of streams having little aquatic vegetation. Both clear and turbid streams contain the black redbhorse, but it generally avoids the southwestern streams of high turbidity and soft, muddy bottoms. Only one record exists in the northwestern, clear, soft-bottom streams which have abundant vegetation. Although it was not caught in the Lake Michigan drainage of Indiana, it has been taken in that drainage in Michigan. Both glacial outlets appear to have been used in its migration.



Moxostoma rubreques Hubbs

Greater redhorse

Cass Co.: Eel R., Adamsborough.

Only one specimen collected in the survey is thought to be referable to this species. The diameter of the eye in our specimen (TABLE III) is much less than in *M. erythrurum* of comparable size, but it is not quite as small as the range given by HUBBS (1930: 28). However, the range given by HUBBS was for somewhat smaller specimens, in which the eye tends to be larger in relation to the head. The rounded posterior margin of the dorsal fin in this specimen contrasts sharply with the concave (or occasionally straight) margin in *erythrurum*. None of the other characters listed in the table are capable of distinguishing *rubreques* from *erythrurum*, though in most instances our specimen is more nearly centered in the range of *rubreques*. On the available evidence, this specimen seems fairly clearly distinguishable as *rubreques*, though additional specimens would be desirable.

The Wabash River specimens of *M. erythrurum* included in the table were taken less than five miles downstream from Adamsborough at the mouth of Eel River. They did not tend to have a smaller eye or a convex dorsal fin.

TABLE III.

Comparison of measurements of *Moxostoma rubreques* and *M. erythrurum*

	<i>Moxostoma rubreques</i>		<i>Moxostoma erythrurum</i>
	Eel R. specimen	Hubbs 1930: 28	Range of Sugar Cr. and Wabash R. specimens (7)
Size range of specimens	88 mm.	50-87 mm.	73-88 mm.
<u>Standard length</u>	3.52	3.65-4.25	3.39-4.00
Depth of body			
<u>Head length</u>	2.3	2.4-2.7	2.2-2.61
Depth caudal peduncle			
<u>Length caudal peduncle</u>	1.105	1.15-1.25	.910-1.06
Depth caudal peduncle			
<u>Length head</u>	1.43	1.45-1.8	1.44-1.83
Width of body			
<u>Standard length</u>	3.82	3.5-3.9	3.54-3.79
<u>Head length</u>	3.96	4.25-5.1	3.34-3.55
<u>Eye diameter</u>	3.96	4.25-5.1	3.34-3.55
<u>Head length</u>	2.61	2.3-2.7	2.53-2.97
Snout length			
<u>Origin of dorsal to occiput</u>	1.4	1.2-1.4	1.37-1.68
Length dorsal fin base			
Scales	43	42-46	38-42
Shape of posterior edge of dorsal fin	Convex	Straight or convex	Concave

Moxostoma erythrurum (Rafinesque)

Golden redhorse

MAP 19

The habitat preferred by the golden redhorse is generally the same as the preceding forms. However, this sucker is represented in more rivers of large size, such as the Wabash River and the two forks of the White River. As in the case of *M. d. duquesnii*, *M. erythrurum* has avoided the southwestern corner of the state, and only one record was obtained in streams tributary to the Illinois River. The golden redhorse has been taken in all the main drainage systems.

Moxostoma anisurum (Rafinesque)

Silver redhorse

MAP 20

The silver redhorse has been found in Indiana most frequently in large and medium-sized rivers. This sucker also prefers streams with hard bottoms and little vegetation. The distribution of this species is roughly the same as *M. duquesnii* and *M. erythrurum*. *M. anisurum* is known from the Lake Michigan drainage in other states, although it has not been found in this region in Indiana.

Moxostoma aureolum (LeSueur)

Northern redhorse

MAP 21

The distribution map was included to show the occurrence of this fish in the lower Wabash region, which the other sucker species avoided. It was not found in the northwestern streams and has not yet been taken in the Maumee drainage of Indiana.

Placopharynx Cope*Placopharynx carinatus* Cope

River redhorse

Carroll Co.: Tippecanoe R. (Evermann and Jenkins, 1892).

Clark Co.: Falls of Ohio, Jeffersonville (Call, 1896).

Lawrence Co.: Mitchell (Hahn, 1909, as *Placopharynx duquesnii*).

Vigo Co.: Wabash R., Terre Haute (Jenkins, 1887).

Tippecanoe Co.: Wabash R., Lafayette (Cope, 1871).

Waters tributary to the lower Wabash (Jordan, 1877b).

Placopharynx carinatus was described in 1871 by COPE from a Wabash River specimen taken at Lafayette. It has been caught in Indiana only infrequently since that time and has not been recorded here for 36 years.

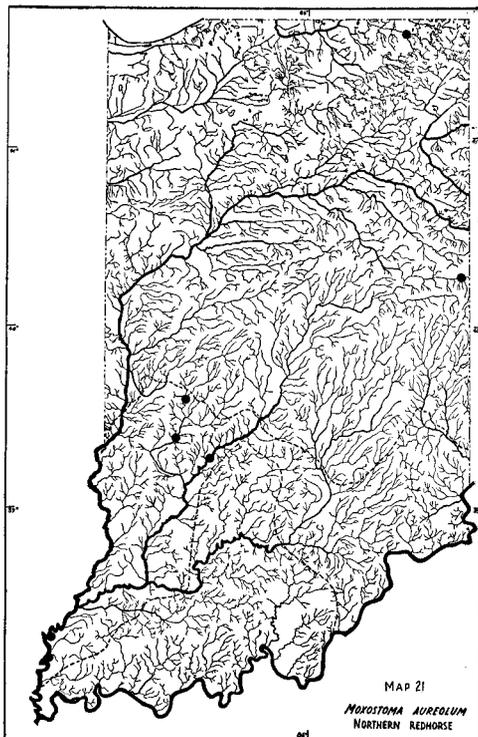
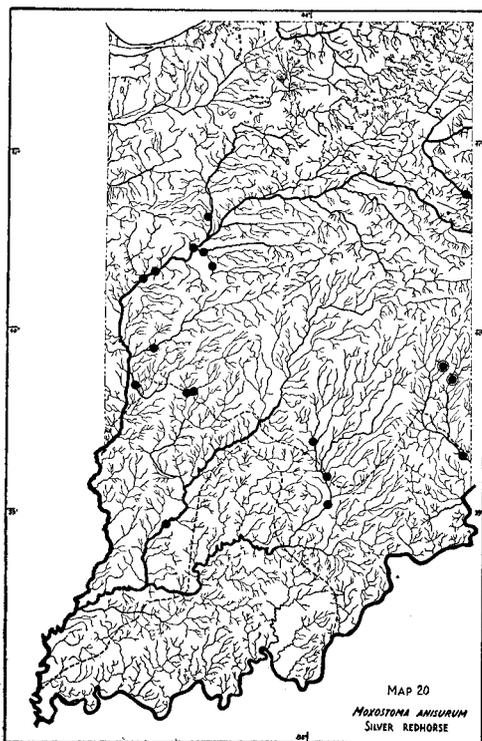
Lagochila Jordan and Brayton*Lagochila lacera* Jordan and Brayton

Harelip sucker

Decatur Co.: (Evermann and Jenkins, 1892).

Tippecanoe Co.: Tippecanoe R., west of Delphi (Evermann and Jenkins, 1892).

The occurrence of this species has not been reported in its entire range for many years (HUBBS and LAGLER, 1941: 43).



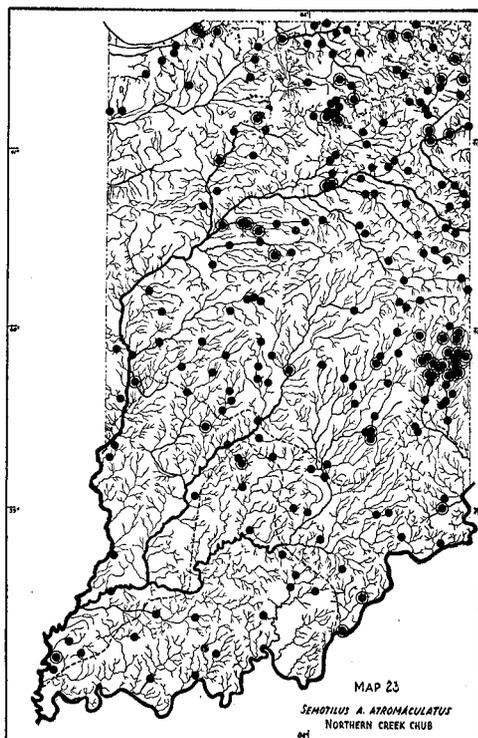
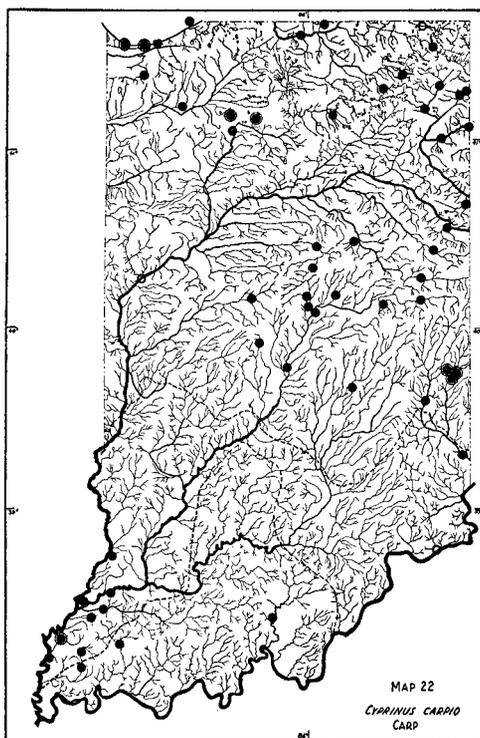
CYPRINIDAE Minnows
Cyprinus Linnaeus
Cyprinus carpio Linnaeus
 Carp
 MAP 22

The introduction of the carp from the eastern hemisphere has led to its widespread occurrence in this country. It is particularly common in weedy streams and lakes with soft bottoms of plant detritus. It can exist in heavily polluted waters. The establishment of the carp in all Indiana drainages is shown on the distribution map.

Carassius Nilsson
Carassius auratus (Linnaeus)
 Goldfish

Marion Co.: Fall Cr., Indianapolis (report).
 Morgan Co.: Indian Cr. near Martinsville (report).

This is another member of the minnow family which has been introduced from the Old World. Commercial propagation of the goldfish has been carried on for many years by Grassyfork and other hatcheries near Martinsville. The report of this species in Indian Creek, near Martinsville (information supplied by ALFRED MCKEE, Lake and Stream Survey, 1942) can probably be explained on the grounds that individuals have



either been planted or escaped from hatchery rearing ponds. Many fishermen now use the goldfish for bait throughout the state, and the escape or release of this bait may lead to future populations of the goldfish becoming established in the state.

Semotilus Rafinesque

Semotilus atromaculatus atromaculatus (Mitchill)

Northern creek chub

MAP 23

The creek chub has a ubiquitous distribution over the state. Most of the localities from which it was taken were creeks; however, its occurrence in moderate-sized streams was not uncommon. It is tolerant of many types of habitats; type of bottom, turbidity, or amount of vegetation have not appeared to limit its distribution. The creek chub usually spawns on a gravel bottom (HUBBS and COOPER, 1936: 50), but it has been taken in streams where no gravel was observed.

Nocomis Girard

In the literature the two members of this genus, which are now recognized, were not separated. Either one or both species were most often referred to under the name *Hybopsis kentuckiensis*. Therefore, none of these literature records were used on the distribution maps.

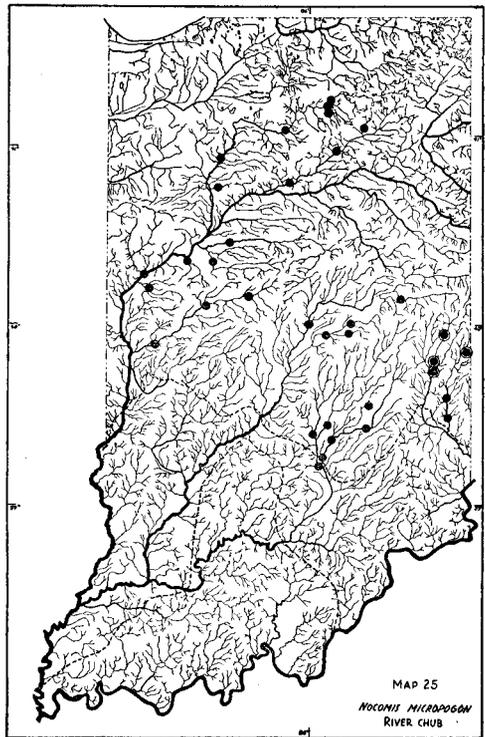
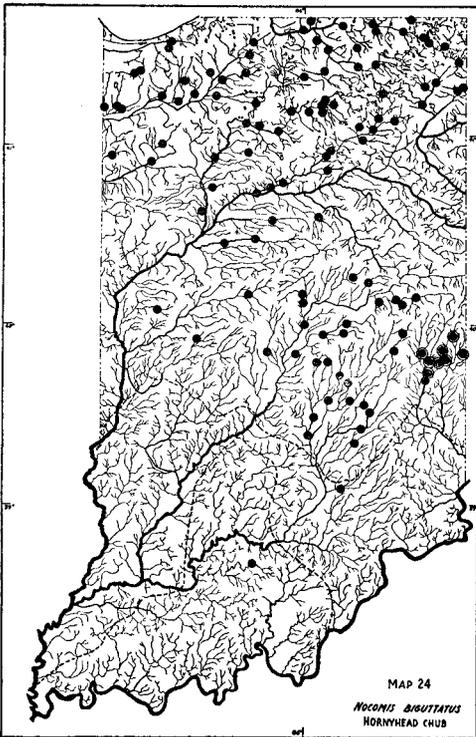
Nocomis biguttatus (Kirtland)

Hornyhead chub

MAP 24

The habitat of the hornyhead chub is determined by the presence of a hard stream bottom, usually gravel or rock. It has not been found in the large rivers, being confined to streams of small and moderate size. The adults show a rather definite aversion to weedy environments, but the young are often found in dense submerged vegetation.

N. biguttatus and *N. micropogon* are the best examples of Indiana fishes showing a distinct preference for glaciated regions. Only two records of *N. biguttatus* are found below the limit of the Wisconsin glacier and one of these is a borderline case. It is interesting that the species does not generally inhabit the area covered by the Illinois sheet where leaching, erosion and other geologic processes have been in operation for a much longer time.

*Nocomis micropogon* (Cope)

River chub

MAP 25

As in the case of *N. biguttatus*, *N. micropogon* is found in hard-bottomed streams. No evidence was found that the young of this species preferred weedy habitats. The distribution map shows that the river chub is not common in the creeks, being caught more frequently in medium-sized streams.

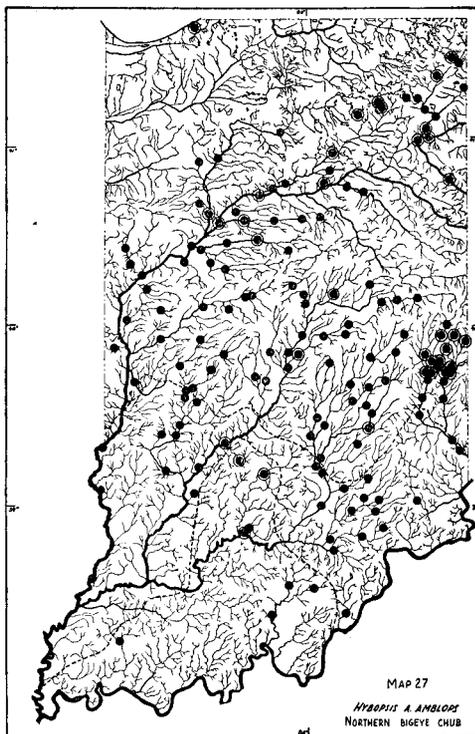
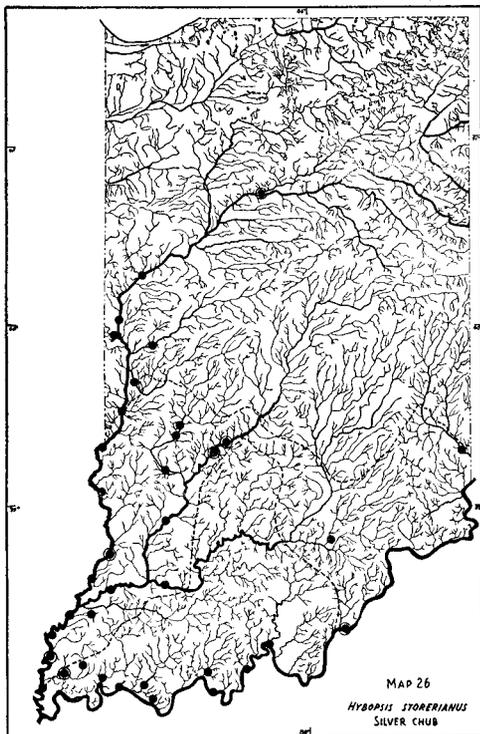
In general the southern border of the Wisconsin glacier limits the southern distribution of the river chub; one record was taken about three miles south of the glaciation line. Although the river chub was not found in Indiana streams draining into Lake Michigan or Lake Erie, it is known from the basins of both these lakes in other states.

Hybopsis Agassiz
Hybopsis storerianus (Kirtland)
 Silver chub
 MAP 26

The silver chub has been taken most frequently in the channels of large silty rivers and the lower portions of their larger tributaries. More often it was caught on a gravel bottom, but occasionally it was taken on a mud bottom. Since the silver chub is not known from the Lake Michigan drainage and is present in the Lake Erie basin (HUBBS and LAGLER, 1941: 54), only the Maumee glacial outlet appears to have been utilized by this minnow in entering the Great Lakes.

Hybopsis amblops amblops (Rafinesque)
 Northern bigeye chub
 MAP 27

The bigeye chub is more common in the small and moderate-sized streams but has been taken occasionally in the large rivers. It is usually found in hard-bottomed streams with little vegetation. Although the big-



eye chub is not limited by water turbidity, its abundance in the headwater streams would indicate a preference for clearer water. This might explain why this species was found in so few collections in the southwestern corner of the state.

H. amblops is absent in the Kankakee system in Indiana and FORBES and RICHARDSON (1920, map XLIX in Atlas) show only one record from a tributary of the Kankakee. The Kankakee system in Indiana is primarily weedy, and since the bigeye chub does not prefer heavily vegetated habitats, the presence of this environment may have acted as a barrier to its entrance into the state by this route. Our collections of this minnow from the Lake Erie drainage show that it probably used the Maumee dispersal route in its northward migration. HUBBS and LAGLER (1941: 54) state that the bigeye chub is known from southeastern Michigan, but do not mention its occurrence in the Lake Michigan drainage. The record of *H. amblops* from Trail Creek in the Lake Michigan drainage (northernmost locality on the distribution map) was taken from EIGENMANN and BEESON (1894). If their identification of this species was correct, this would indicate that the bigeye chub also used the Chicago outlet in its northward dispersal.

Erimystax Jordan

Erimystax new species Hubbs and Crowe

Spotted chub

Franklin Co.: Whitewater R., Cedar Grove.

Gibson Co.: Wabash R., 5 m. N.W. Garrett.

Jackson Co.: E. Fk. White R., Seymour.

Knox Co.: Wabash R., 12 m. S.W. Vincennes.

Martin Co.: E. Fk. White R., Shoals.

Putnam Co.: Walnut Cr., 5 m. S.W. Greencastle.

Vermillion Co.: Big Vermillion R., 4 m. N.W. Cayuga; Brouillette's Cr., 2½ m. S.W. Clinton.

Warren Co.: Wabash R., Attica.

In the UMMZ comparisons were made between Indiana material and this species, which is to be described by HUBBS and CROWE. Specimens from the above localities all seem to be referable to this species; however, the writer awaits the publication of the species description before making confirmatory identification.

Erimystax dissimilis (Kirtland)

Streamline chub

Bartholomew Co.: Flat Rock R., 2 m. N.E. Columbus.

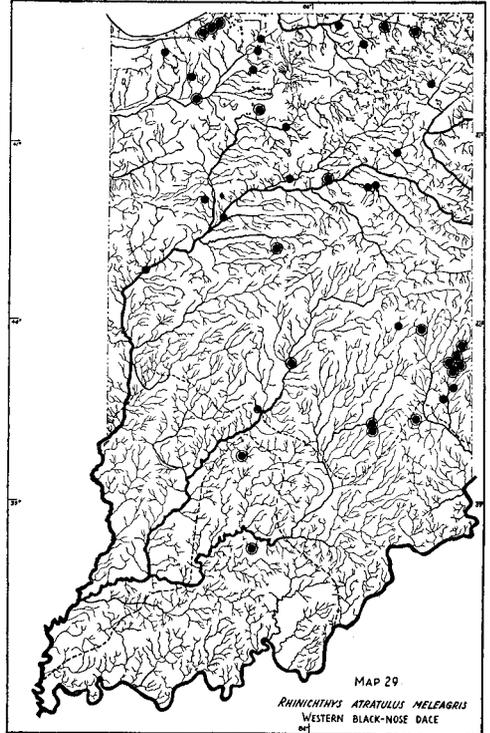
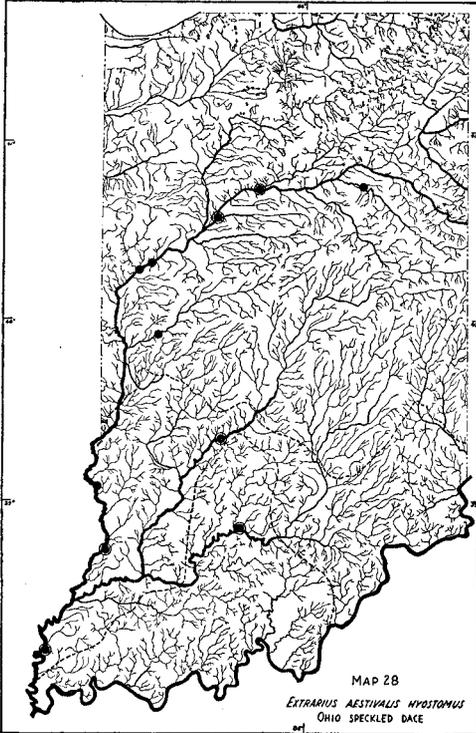
Crawford Co., Blue R., Milltown.

Because they have long been confused, the extralimital distribution of our two species of *Erimystax*, and hence their possible routes of migration into Indiana, cannot be discussed. The streamline chub has been found in relatively clear, moderate-sized streams having hard bottoms and scant vegetation. Most of the records of the preceding species were taken in large, turbid rivers or their immediate tributaries.

Extrarius Jordan
Extrarius aestivalis hyostomus (Gilbert)
 Ohio speckled dace

MAP 28

This is a southern species which has been taken only in the Wabash and White River watersheds in Indiana. The speckled dace has been found only twice in localities other than the large, silty rivers. These localities were near the mouth of two main tributaries of the Wabash River, Sugar Creek and the Salamonie River.



Rhinichthys Agassiz
Rhinichthys atratulus meleagris Agassiz
 Western blacknose dace

MAP 29

The blacknose dace was usually caught in the swifter parts of cool creeks having hard bottoms. A few localities in larger streams are shown on the distribution map. Most of the records lie north of the southern boundary of the Wisconsin glacier, where the greater part of the cool, clear creeks are found. It has been caught in all the main drainage systems.

Rhinichthys cataractae cataractae (Valenciennes)
 Great Lakes longnose dace

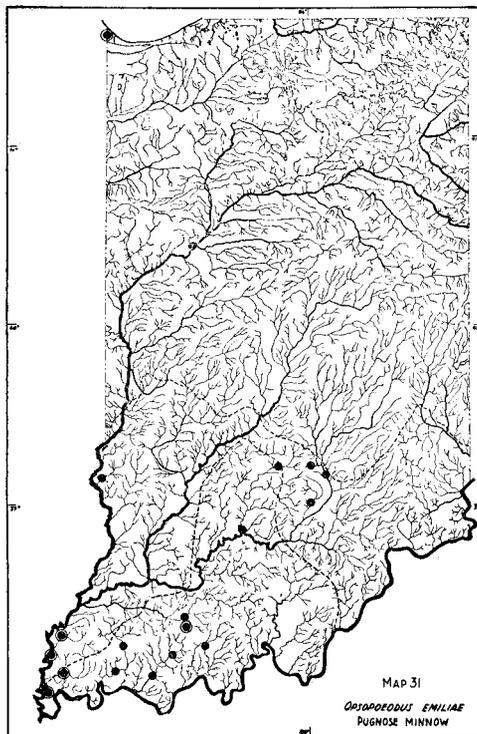
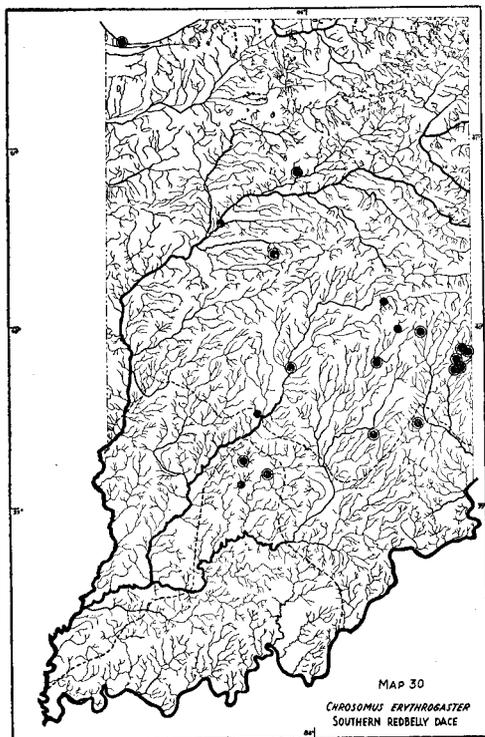
Elkhart Co.: St. Joseph R., Elkhart.

This is the first time this fish has been recorded from the state. Specimens were taken in clear water at the head of a fast riffle of gravel and rock.

Chrosomus Rafinesque
Chrosomus erythrogaster Rafinesque
 Southern redbelly dace

MAP 30

The redbelly dace was only taken twice in the survey, Bell Cr., 2 m. S.E. Yorktown, Delaware Co., and Blue R., 3 m. N.E. New Castle, Henry Co. Both localities were clear creeks with hard bottoms and scant aquatic vegetation. Apparently the abundance of the redbelly dace has decreased since the latter part of the last century when most of the localities on the distribution map were recorded. The only recent records, other than those given above, are from the Whitewater drainage (SHOEMAKER, 1942: 280).



Clinostomus Girard
Clinostomus elongatus (Kirtland)
 Redside dace

Wabash Co.: (Hay, 1894).

Wayne Co.: Vicinity of Richmond (Plummer, 1851).

It is apparent that this northern species has never become generally established in the state, and it has not been recorded here for 51 years. Intensive collections by SHOEMAKER (1942) in Wayne County and numerous collections by ULREY (1894) and the writer in Wabash County have failed to record the redside dace in the regions where it was found earlier, so it seems quite probable that it has become extinct in Indiana. It is

even possible that the early records were in error, as EIGENMANN and BEESON (1894) remark that there were no authentic specimens extant even then. However, it is improbable that so distinctive a minnow would be determined or recorded incorrectly by two different writers.

Opsopoeodus Hay
Opsopoeodus emiliae Hay

Pugnose minnow

MAP 31

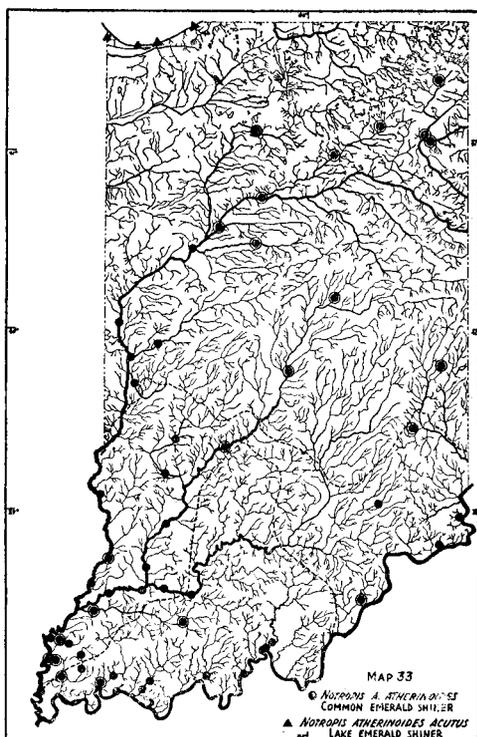
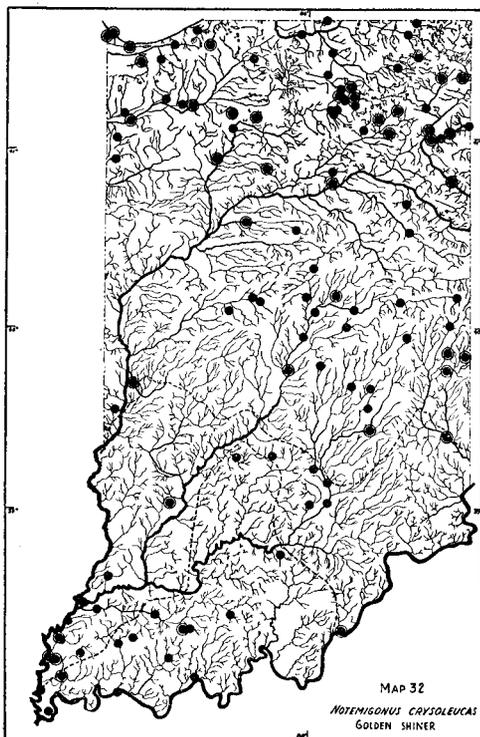
The pugnose minnow was most frequently taken in sluggish, turbid streams with a muddy bottom. No vegetation was found associated with its occurrence. Only two records are known above the line of Wisconsin glaciation in Indiana. The most northern locality is from Wolf Lake, Lake County, in the Great Lakes drainage. The pugnose minnow is found in western Lake Erie but is not known from that drainage in this state.

Notemigonus Rafinesque
Notemigonus crysoleucas auratus (Rafinesque)

Western golden shiner

MAP 32

Experience has shown that the golden shiner is usually found in slow-moving pools or lakes with mucky bottoms of plant debris. It is commonly found in or near patches of submerged vegetation; the abundance of this



minnow in the Kankakee region is correlated with this habitat. The golden shiner is generally distributed in both turbid and clear water of the main Indiana drainages. Toward the southwest it grades into the following form.

Notemigonus crysoleucas:

auratus (Rafinesque) × *boscii* (Valenciennes)

HUBBS and LAGLER (1941: 78) tentatively identified four specimens from Foothills Pond, Gibson County, as intergrades between these two subspecies of the golden shiner. Examination of 81 specimens from the southwestern corner of the state reveals that there were 4 individuals with 11 anal rays, 20 with 12, 36 with 13, and 20 with 14 (24.6% with 14). In the northern part of the state 89 golden shiners have been counted as 1 specimen with 10 anal rays, 4 with 11, 41 with 12, 34 with 13, and 9 with 14 (10.1% with 14). Thus, it appears that there is a tendency for an increased number of anal rays to occur in this species toward southwestern Indiana. This approximates the condition found in the southern United States where a still greater percentage of the population of *N. c. boscii* have 14 anal rays.

Notropis Rafinesque

Notropis atherinoides Rafinesque

Emerald shiner

Dr. HUBBS has recently reviewed the subspecies of *N. atherinoides* (1942: 78) and has concluded that the Lake Erie and Mississippi valley forms are identical and should be subspecifically named *atherinoides*. Those found in Lake Michigan and northern Lake Huron are distinct from the above and their subspecific designation is now *acutus*. These two forms are represented on distribution MAP 33 by different symbols.

Notropis atherinoides acutus (Lapham)

Lake emerald shiner

MAP 33

This minnow is abundant along the shores of Lake Michigan and probably acts as a good forage fish for the larger, carnivorous, shore-inhabiting fishes.

Notropis atherinoides atherinoides Rafinesque

Common emerald shiner

MAP 33

The common emerald shiner inhabits the open waters of large rivers and some of their tributaries. In this habitat the current is always strong, and the fish must constantly oppose the current's force to maintain its position.

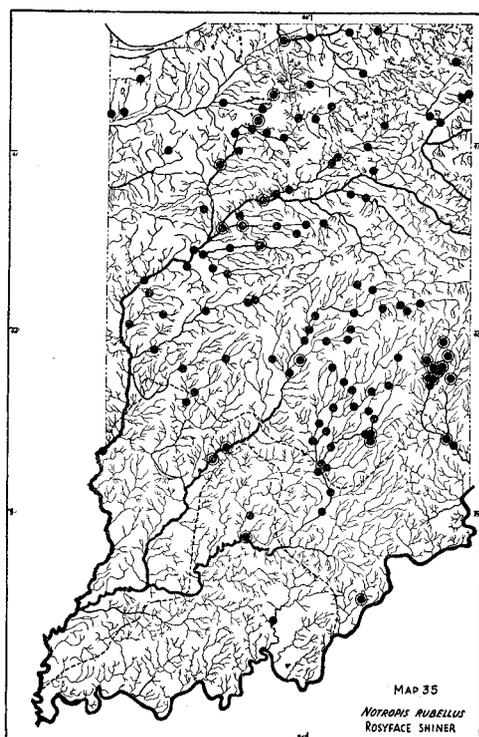
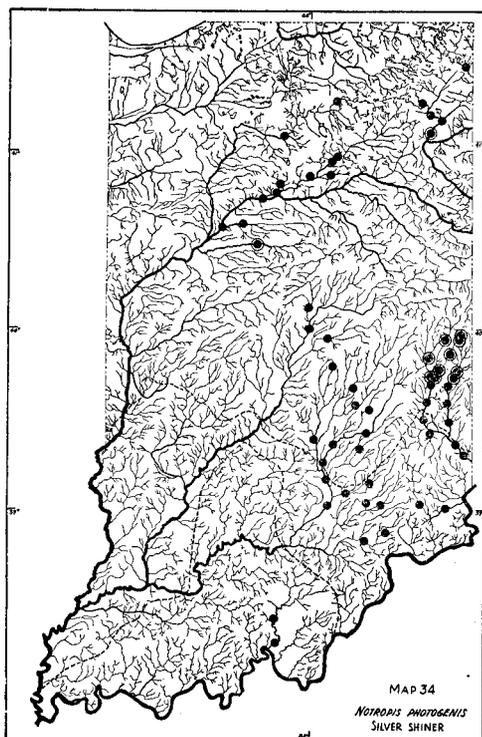
Notropis photogenis (Cope)

Silver shiner

MAP 34

The silver shiner inhabits the open water of rivers where the current is strongest. It has not been found where the water is sluggish and silty or where aquatic vegetation is abundant. Most streams in which it was

taken had hard bottoms varying from sand and gravel to bed rock. It is more commonly found in the rivers' upper courses and tributaries, where water is clearer than in the large rivers. Some such apparently suitable habitats are, however, not used: for example, the Eel River drainage of the West Fork of the White River system. The species is absent in the Lake Michigan drainage but present in that of Lake Erie, suggesting its dispersal by way of the Maumee outlet only.



Notropis rubellus (Agassiz)

Rosyface shiner

MAP 35

This is another open water species. It has frequently been caught on gravel riffles or at the heads of pools immediately below these riffles. The rosyface shiner prefers hard-bottomed streams, which accounts for its absence in the southwestern area. There are only few records of its occurrence south of the limit of the Wisconsin glacier as compared with those above this limit.

Notropis ardens lythrurus Jordan

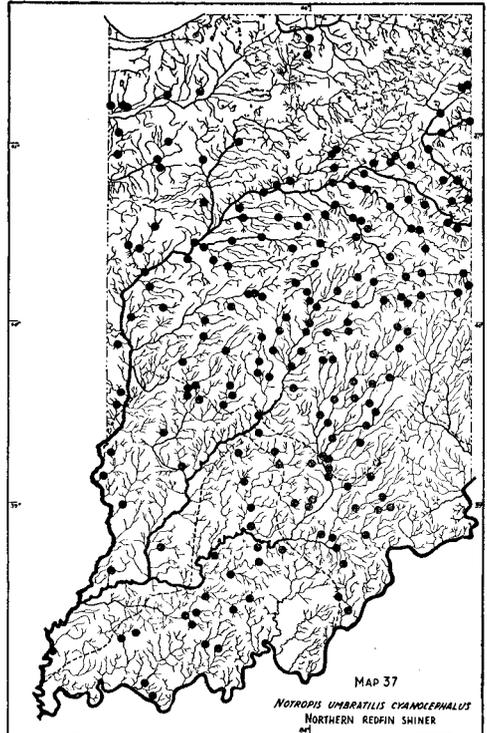
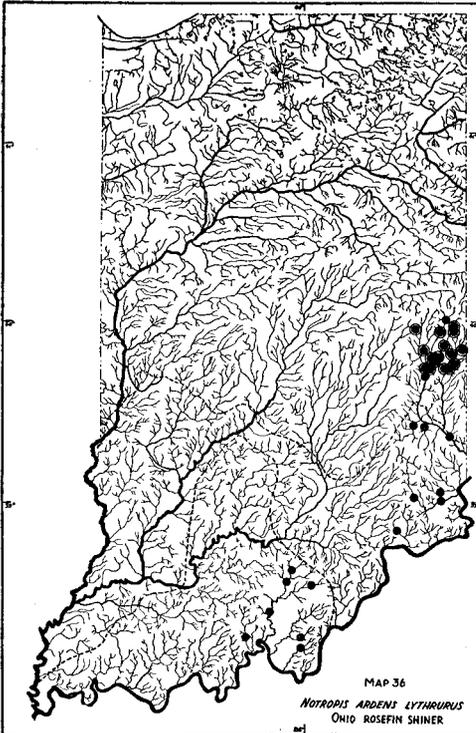
Ohio rosefin shiner

MAP 36

N. ardens lythrurus has been confused with *N. umbratilis cyanocephalus* in the past, so literature records of these two species were not generally used. Records of this species from Wayne County (SHOEMAKER, 1942)

were mapped, since Dr. HUBBS had identified some specimens from this region.

This form occurs in the southeast and south-central parts of the state wherever the streams are relatively clear, the bottoms are hard, and aquatic vegetation is scant. Among the streams where the rosefin shiner was taken, the larger ones had a moderate current while the smaller ones were slow.



Notropis umbratilis cyancoephalus (Jordan and Copeland)
Northern redfin shiner

MAP 37

This is a species more commonly found in creeks, but is not uncommon in moderate-sized streams. The redfin shiner frequents the quiet pools, where it has been observed spawning. Turbidity, amount of vegetation, or type of bottom do not seem to affect its distribution in the state. An interesting result is obtained if the distribution maps of this and the preceding species are superimposed. The redfin and rosefin shiners have never been taken in the same collection in Indiana, and their distribution patterns fit the state like large pieces of a jigsaw puzzle.

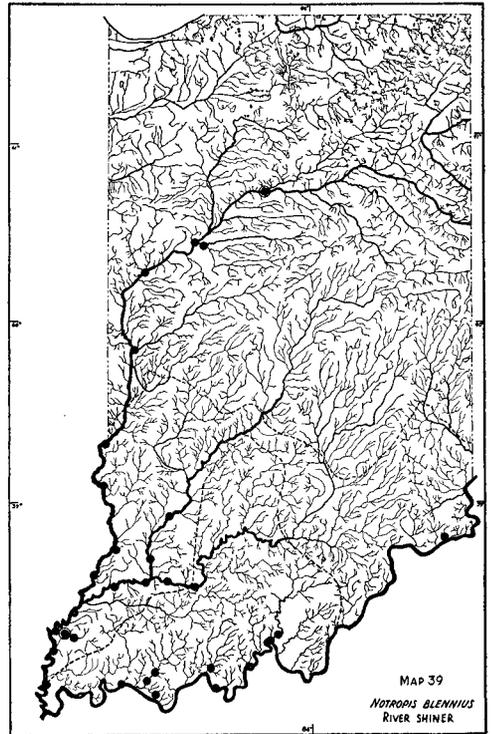
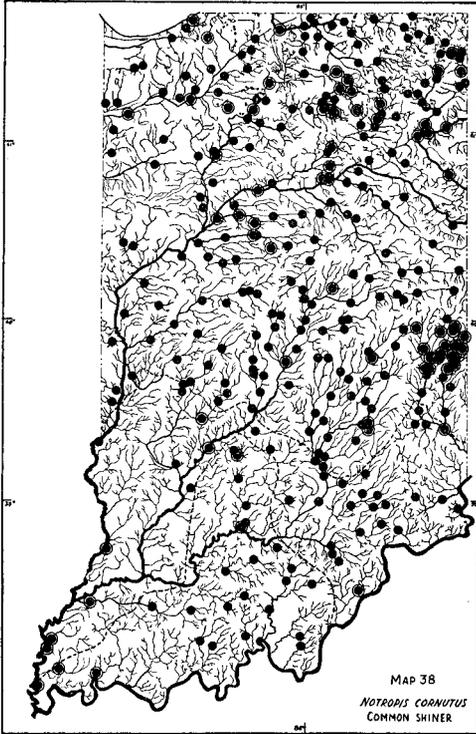
Notropis cornutus (Mitchill)
Common shiner

MAP 38

This species is one of the most common minnows of the state. Most of the records of the common shiner are from the smaller streams, but

are not exclusively confined to them. It has a wide tolerance of ecological conditions, accounting for its widespread occurrence.

The common shiner is divisible into two subspecies in the state, *N. c. chrysocephalus* and *N. c. frontalis*. These forms can be most satisfactorily distinguished by the number of predorsal scales, fewer than 22 for *chrysocephalus* and more than 26 for *frontalis*. Intermediate scale counts are usually considered as intergrades between the subspecies. The predorsal scales of specimens from about half the collections were counted.



Notropis cornutus chrysocephalus (Rafinesque)

Central common shiner

A line drawn between the 40° and 41° parallels roughly shows where the subspecies begin to show differentiation. South of this line *N. c. chrysocephalus* is the abundant form and is generally distributed in streams of all types. There is a scarcity of records in the southwestern part of the state, as compared to other regions.

Notropis cornutus: chrysocephalus (Rafinesque) × *frontalis* (Agassiz)

Immediately above the 40° and 41° parallels *N. c. chrysocephalus* is still dominant but a few populations of intergrades show up. Proceeding northward, localities with these populations increase in number and become intermingled with those of the following form.

Notropis cornutus frontalis (Agassiz)

Northern common shiner

The *N. c. frontalis* localities increase northward and become most numerous near the state line. This does not mean, however, that all the localities in this region are *frontalis*, as there are still populations of *chrysocephalus* and intergrades scattered among them. It is probably best to call the area north of the 40°-41° belt a zone of intergradation. Three localities on clear tributaries of the Eel River in Morgan and Hendricks Counties have been identified as *frontalis*, and specimens from one tributary of the East Fork of the White River in Hancock County have been identified as intergrades. This shows that the intergrading zone is much broader than the arbitrary line suggests. The northern streams are generally cooler and clearer than those of the south. It appears that this species has shown a morphologic change in correlation with this geographic and ecologic difference.

Notropis illecebrosus (Girard)

Silverband shiner

Posey Co.: Wabash R., 6½ m. W. Mt. Vernon (UMMZ, 1940).

This species was first collected in Indiana by Dr. KARL F. LAGLER and assistants in 1940.

Notropis blennioides (Girard)

River shiner

MAP 39

The distribution map clearly shows the preference of the river shiner for the large, silty rivers. It appears in very few of their tributaries. For the most part it was caught over the sand and gravel bottoms of rivers where aquatic vegetation is scant and the current is strong. HUBBS and LAGLER (1941: 57) state that only one Great Lakes record is known for this species. This may indicate that the Chicago outlet was used by the river shiner in its northward migration.

Notropis hudsonius hudsonius (Clinton)

Great Lakes spottail shiner

MAP 40

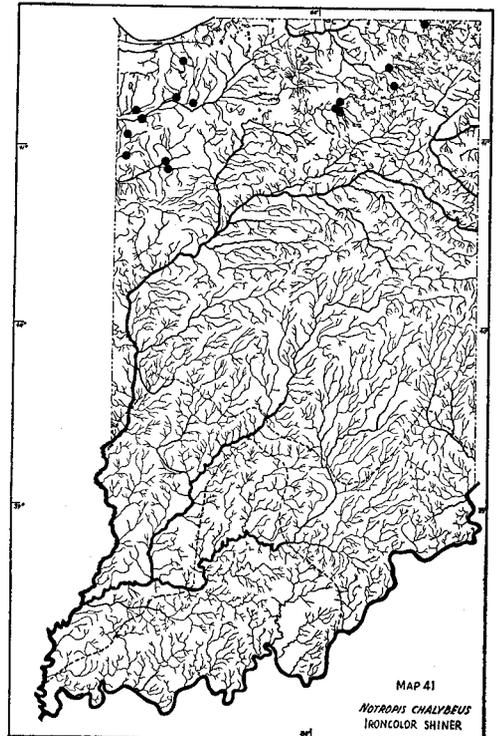
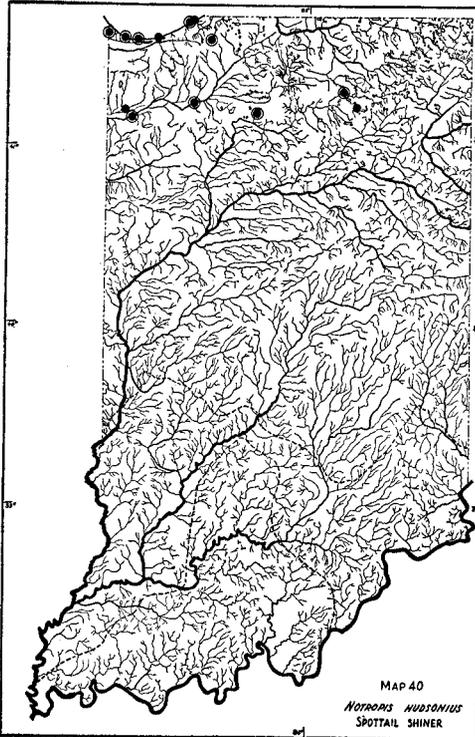
The true taxonomic relationships of the subspecies of the spotted shiner have not been determined (HUBBS and LAGLER, 1941: 57-58). It appears best at the present time to continue the use of the name *hudsonius* for our specimens until this problem has been satisfactorily worked out. There is no evidence that a second subspecies is represented in Indiana's waters. The spottail shiner is most abundant along the sandy shores of Lake Michigan. It has also been taken in the Kankakee area and three lakes of the Wabash drainage.

Notropis chalybeus (Abbott)

Ironcolor shiner

MAP 41

This is the first published account of this species from the midwest; for many years it had been confused with the *N. xenocephalus* group. Dr. HUBBS has recently identified some of our collections, and specimens in the Museum of Natural History in Chicago, as the ironcolor shiner. *Notropis chalybeus* prefers quiet, weedy situations. The geographical distribution of the ironcolor shiner was discussed earlier.

*Notropis xenocephalus* Jordan

Weed shiner

Two subspecies of the weed shiner are provisionally recognized in Indiana. *N. x. richardsoni* has been taken only in the Kankakee region and the other, *N. x. aletes*, was found in a tributary of the lower Wabash River. There is no complete certainty, however, that *aletes* will prove to be a useful subspecific name, when more extensive materials become available. An examination of the pharyngeal teeth of five southern specimens revealed that four of them showed a formula of 4,2-2,4 (the teeth of one were damaged either through natural causes or at the time of examination). The teeth of eleven northern specimens were about equally divided between the formula 4,2-2,4 and 4,1-1,4. The snout appeared sharper and the mouth larger in the southern specimens.

Notropis xaenocephalus aletes (Jordan and Evermann)

Indiana weed shiner

Knox Co.: DeShee R., 10 m. S. Vincennes.

The DeShee River, where five individuals of this form were taken, is the only stream seined in the southwestern part of the state which had abundant vegetation. The stream was about ten feet wide with clear water, moderate current, and a bottom of sand and muck.

Notropis xaenocephalus richardsoni (Hubbs and Greene)

Northern weed shiner

MAP 42

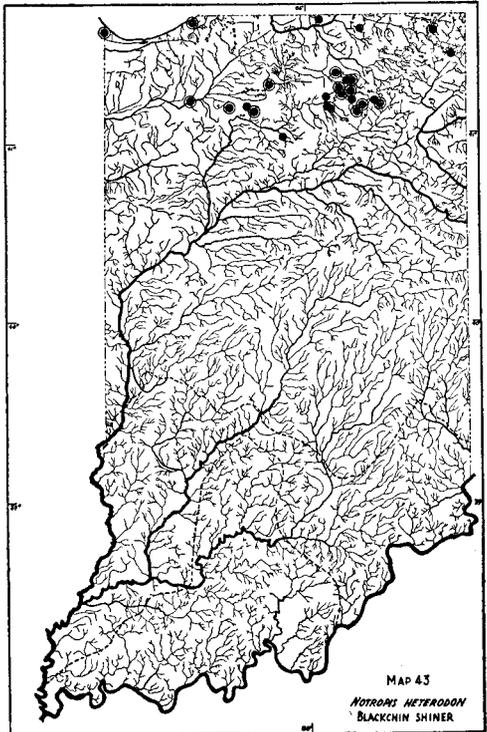
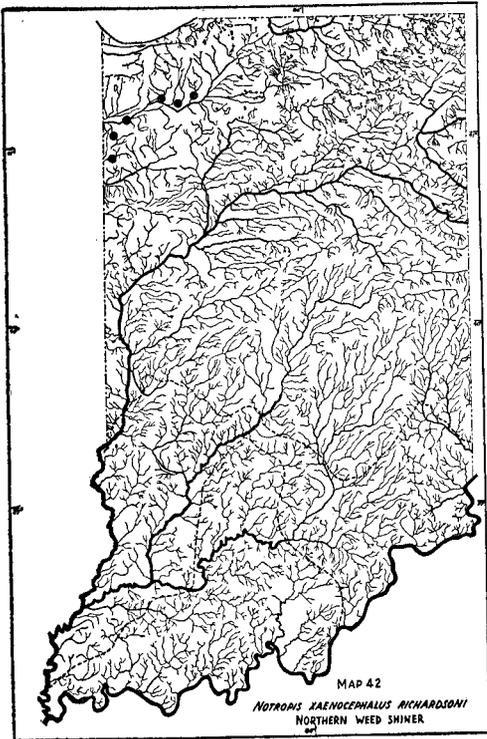
Five of the six localities from which this species is known are tributaries of the Kankakee River. The sixth locality is a tributary of the Iroquois River, which like the Kankakee, flows into the Illinois River. All these creeks and ditches are heavily vegetated and in general fit the above description of the DeShee River. This subspecies is also found in the Great Lakes drainage of Wisconsin and Michigan.

Notropis heterodon (Cope)

Blackchin shiner

MAP 43

The blackchin shiner is generally distributed in the lakes and streams of both the Wabash and Great Lakes drainages of northern Indiana. *N. heterodon* is usually caught in quiet weedy conditions, mostly in lakes.



GILBERT (1885b) recorded *N. heterodon* from the Switz City Swamp, Greene County. It was impossible to check this record from specimens in the same locality, since the marshland where GILBERT obtained his specimens has been drained for many years. However, this locality is far removed from any of our collections of this species, and it seems likely that GILBERT'S specimens were misidentified.

Notropis ariommus ariommus (Cope)

Northern popeye shiner

Jackson Co.: E. Fk. White R., Rockford (Hay, 1894).

Marion Co.: W. Fk. White R. and tributaries, Indianapolis (Jordan, 1877a).

Parke Co.: Raccoon Cr., Mecca (Eigenmann and Beeson, 1894).

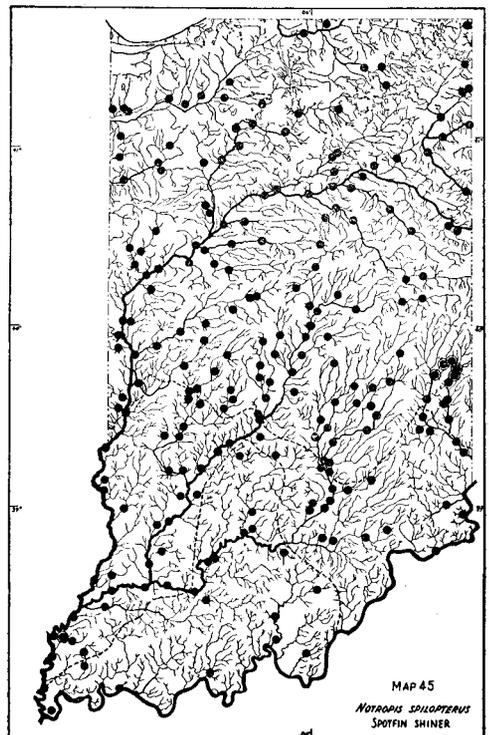
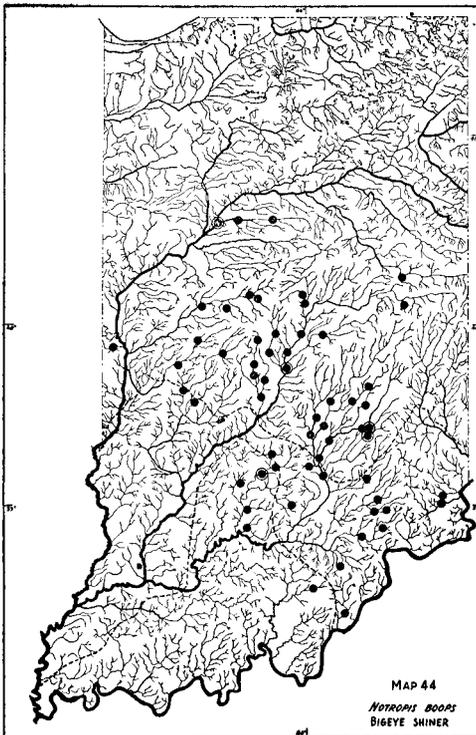
HAY (1894: 212) remarked that the popeye shiner "lives in clear and rapid streams." Many central Indiana streams have become more turbid over a period of years, so possibly this species has found the increased turbidity unsuitable to its requirements. Though it is certain that the popeye shiner is not common in the state, subsequent collecting may reveal a few isolated populations in the clear headwaters of such streams as the White River.

Notropis boops Gilbert

Bigeye shiner

MAP 44

The bigeye shiner is mainly concentrated at the headwaters of the two forks of the White River. It has a rather spotty distribution in the creeks of other regions. The streams where *N. boops* was recorded all have



gravel bottoms, are relatively clear, and have a moderate current. No aquatic vegetation was associated with its occurrence. Its aversion to the turbid streams of the southwest is very evident. The presence of the big-eye shiner in the Maumee drainage (HUBBS and LAGLER, 1941: 58) implies the use of only the Maumee outlet in its migration from the Mississippi to the Great Lakes drainage.

Notropis amnis amnis Hubbs and Greene
Northern pallid shiner

Jackson Co.: White Cr., 5 m. S.W. Cortland.

Newton Co.: Iroquois R., 3 m. N. Kentland.

Orange Co.: Lick Cr., 2 m. E. West Baden.

Warrick Co.: Big Pigeon R., Elberfield Coal Mine (UMMZ, 1927).

A sharp lookout was kept for this minnow, but it was caught only few times and appears to be rare in the state.

Notropis spilopterus (Cope)
Spotfin shiner

MAP 45

N. spilopterus is a species of statewide distribution and tolerant of widely different habitats. It occurs with equal regularity in large rivers and creeks and is known from the clear, heavily vegetated ditches of the northwest to the mud-bottomed, turbid streams of the southwest.

Notropis whipplii (Girard)
Steelcolor shiner

MAP 46

The distinction between the steelcolor and spotfin shiners has been clarified recently by HUBBS and LAGLER (1942: 78-79), who give a table of differential characters. The steelcolor minnow is more common in the large and medium-sized rivers of the south, where the water is generally turbid. It lives in the open water and is not usually found in the slower parts of streams. Thus far this minnow has not been reported from the Great Lakes drainage.

Notropis deliciosus (Girard)
Sand shiner

MAP 47

A total of 330 specimens of the sand shiner from 39 localities were examined in order to determine the variation of this species. The localities were spread evenly in all drainage systems of the state so that the result would be as representative as possible. The two characters which were examined are: the length of the depressed dorsal fin divided by the distance from the origin of the dorsal fin to the occiput, and the number of lateral line scales. These two characters are used by HUBBS and LAGLER (1941) to separate the subspecies *deliciosus* and *stramineus*, which respectively occur in the Mississippi and Great Lakes drainages. According to them, the ratio of the first character listed above should be more than .667 in *deliciosus* and about .667 in *stramineus*; the number of lateral line

scales commonly varies in *deliciosus* from 32 to 35 and in *stramineus* from 34 to 38. The collections were grouped by drainage systems and averages of the measurements are shown in TABLE IV. The range of variation is given in parenthesis beside the average figures.

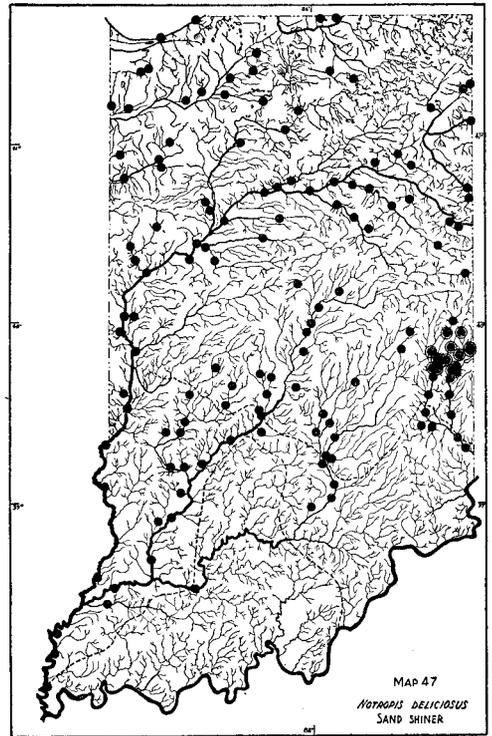
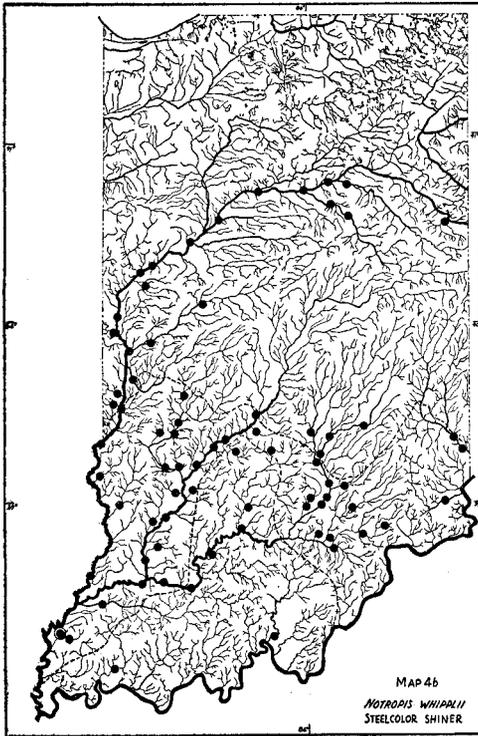


TABLE IV
Analysis of two characters of *Notropis deliciosus* in Indiana

Drainage	No. of specimens	Lateral line scales	Dorsal fin length Occiput to dorsal
Whitewater	52	32.7 (31-35)	0.730 (0.609-0.860)
Lower Wabash R. and White R.	113	32.9 (31-36)	0.706 (0.574-0.800)
Upper Wabash	18	33.3 (32-35)	0.754 (0.628-0.786)
Maumee	36	33.4 (32-36)	0.726 (0.615-0.800)
Illinois	60	33.1 (31-36)	0.731 (0.627-0.862)
Lake Michigan	27	33.9 (32-36)	0.694 (0.615-0.780)

Notropis deliciosus deliciosus (Girard)

Southern sand shiner

An inspection of TABLE IV shows that the specimens from all the drainage systems are within the limits of this subspecies (see *N. d. stramineus* for discussion of Lake Michigan drainage). As its name implies, this minnow is most frequently found in sandy streams and lakes. There are fewer streams with sandy bottoms in the extreme southern part of the state, and a scarcity of records was to be expected in this region.

Notropis deliciosus stramineus (Cope)

Northeastern sand shiner

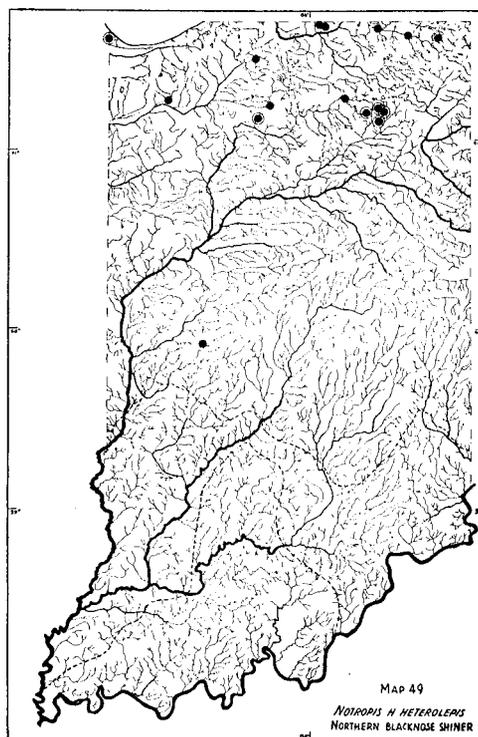
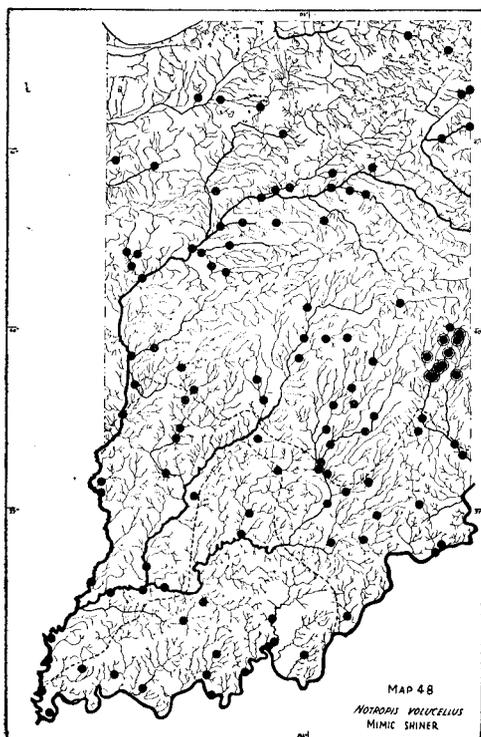
TABLE IV shows that the Lake Michigan drainage is the only one which intimates that the subspecies *stramineus* occurs in the state, and even then the lumped averages and ranges of variation are within the limits of *deliciosus*. However, the averages of specimens from Lake Michigan itself (34.6 and 0.705), and from Simonton Lake (34.8 and 0.664), both conform to *stramineus*, while populations from Deep River of the Calumet drainage (32.7 and 0.725) seem to tend toward the *deliciosus* type. Individuals from Indian Lake (33.5 and 0.670) could be interpreted as intergrades. No tendency toward intergradation was found in specimens from the Maumee (Lake Erie) drainage.

Notropis volucellus (Cope)

Mimic shiner

MAP 48

It was only a few years ago that *N. volucellus* and *N. deliciosus* were recognized as separate species, and for this reason only SHOEMAKER'S (1942) recent records of these two minnows have been mapped. It was not possible to make an intensive study of the three subspecies of the mimic shiner. However, one of the subspecies, *N. v. buchanani*, which was identified from several localities in the southern part of the state, is a new form to add to the state's list. Intergrades between the three subspecies undoubtedly exist in the state.



The species prefers lakes and quiet pools of creeks in northern Indiana, while in the south it inhabits the slow-moving parts of the larger rivers. It is known from all drainage systems in Indiana.

Notropis volucellus volucellus (Cope)
Northern mimic shiner

This is the dominant subspecies in our state. All the localities above the lower courses of the large rivers have populations of this form. On numerous occasions it was caught in the same locality as its near relative, *N. deliciosus*.

Notropis volucellus wickliffi Trautman
Channel mimic shiner

This subspecies is catalogued in the UMMZ from the lower Wabash and Patoka rivers. Possibly some additional specimens are included in our records of *N. v. volucellus*.

Notropis volucellus buchamani Trautman
Ghost mimic shiner

Specimens from the Ohio River, the lower White River, and their tributaries have been identified as the subspecies *buchamani*.

Notropis heterolepis heterolepis Eigenmann and Eigenmann
Northern blacknose shiner

MAP 49

The lakes and slow moving parts of creeks offer a suitable environment for the blacknose shiner. In almost every case this species has been found in a weedy habitat. The presence of this minnow in a tributary of Raccoon Creek and localities which drain into the upper Eel River suggests that it has entered the state by way of the Wabash River. The blacknose shiner is known from the entire Great Lakes drainage, but it has not been recorded from the Maumee drainage of this state.

Notropis anogenus Forbes
Pugnose shiner

Kosciusko Co.: Wawasee L., Syracuse (Eigenmann, 1896).

Steuben Co.: Hamilton L., Hamilton.

Whitley Co.: Blue L. and Blue R., 2 m. N.W. Churubusco (Kirsch, 1895a).

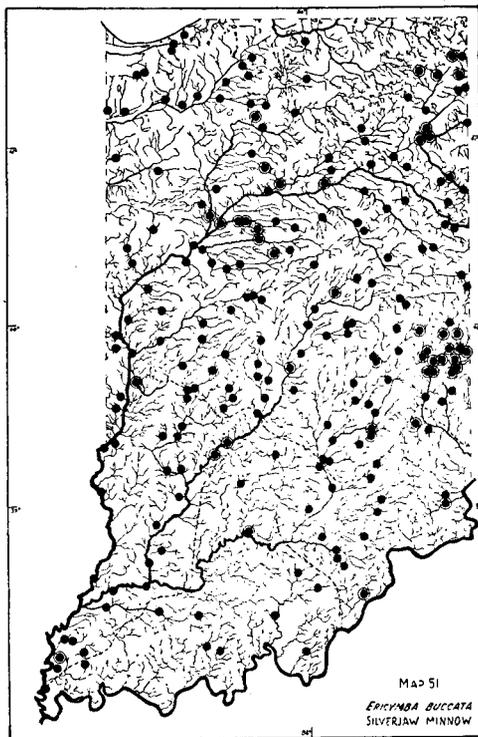
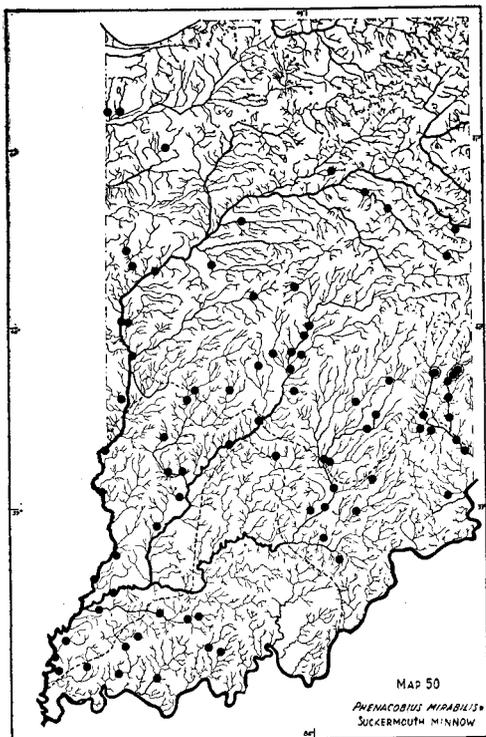
The pugnose shiner is rare in Indiana, but it is interesting to note that the three localities from which it is known represent three main drainage systems: the Wabash, Lake Michigan, and Lake Erie.

Phenacobius Cope
Phenacobius mirabilis (Girard)

Suckermouth minnow

MAP 50

Many times the suckermouth minnow was caught in the fast water of riffles, but it is not exclusively confined to this habitat, being found also in the slow-moving streams of the southwest. It is represented in our collections only in the Mississippi drainage, though elsewhere it is known from the Lake Erie drainage.



Ericymba Cope
Ericymba buccata Cope
Silverjaw minnow
MAP 51

The abundance of this minnow in all drainage systems is well represented on the distribution map. The silverjaw minnow was taken in rivers, creeks, and lakes with sandy bottoms, a habitat which would appear to be relatively barren of food. It is a bottom dweller, and its distribution has not been affected by stream size or water turbidity.

Hybognathus Agassiz
Hybognathus nuchalis nuchalis Agassiz
Western silvery minnow
MAP 52

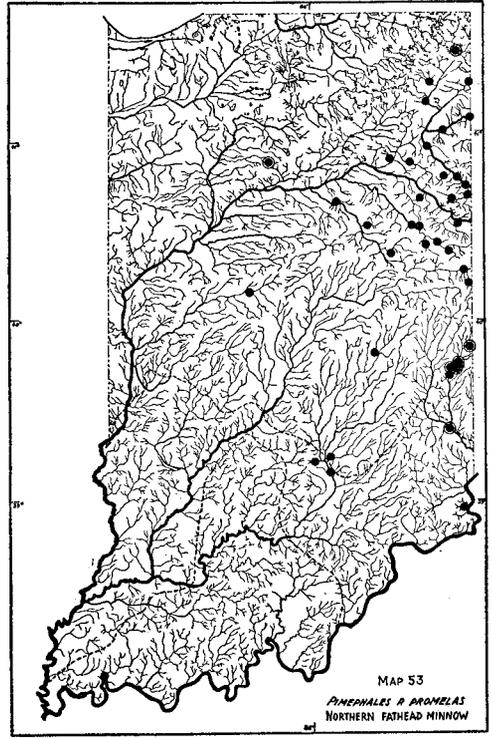
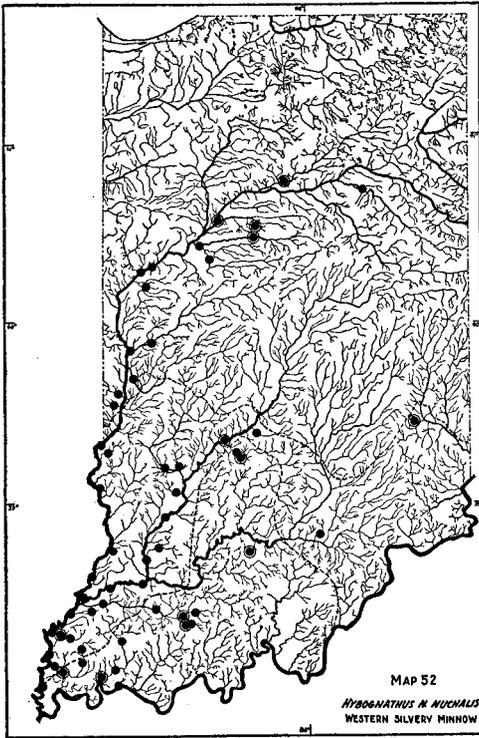
The silvery minnow generally follows the large, silty rivers and a few of their tributaries. It is particularly abundant in the lower Wabash River where large schools were seined at every locality. However, *H. n. nuchalis* is not averse to quiet waters, as it has been found in southern creeks, a bayou, and a cypress swamp. This subspecies of *H. nuchalis* is listed in the Great Lakes fauna on the basis of two records of doubtful validity (HUBBS and LAGLER 1941: 60). No records from this drainage are known from Indiana.

Hybognathus hayi Jordan

Cypress minnow

Warrick Co.: L. Pigeon Cr., 7 m. S.E. Boonville; L. Pigeon Cr., 10 m. N.E. Boonville;
Big Cr., 5 m. W. Lynnville; Big Pigeon Cr., 1 m E. Elberfeld.

The collections of the cypress minnow represent a new species for the state and the easternmost records of this southern fish in the Ohio River valley. The known distribution of the species in Indiana is restricted to only one southwestern county, where it was found in steep-banked muddy creeks, lacking aquatic vegetation. The creek bottoms varied from light-weight rocks to muck, and the current was very slow in two localities and moderate in the others.

*Pimephales* Rafinesque*Pimephales promelas promelas* Rafinesque

Northern fathead minnow

MAP 53

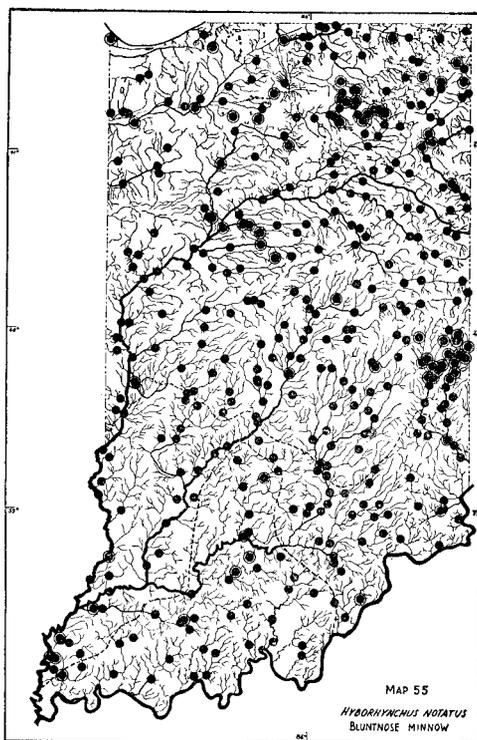
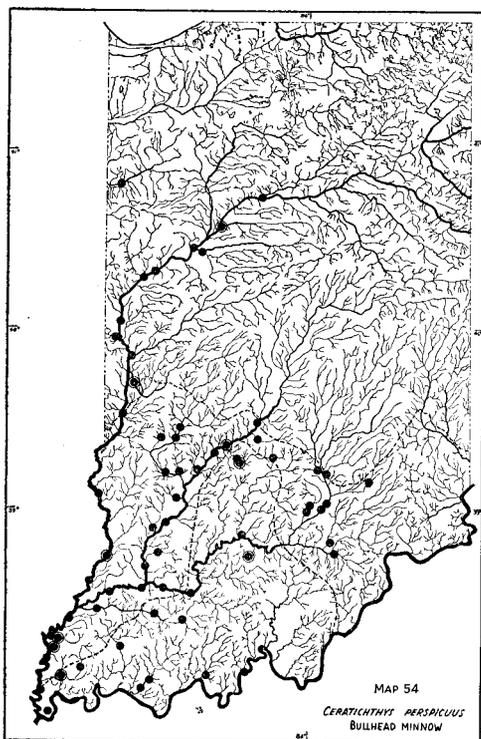
The fathead minnow is a creek species for the most part but occasional captures from medium-sized streams are noted on the distribution map. In many cases it was found in turbid, slow-moving pools with muddy bottoms. The concentration of records of this species in the eastern part of the state is not readily explained. Habitats as described above are certainly present in the western area, and *P. promelas* is generally distributed in Illinois (FORBES and RICHARDSON, 1920, map XXVII in Atlas).

Ceratichthys Baird and Girard
Ceratichthys perspicuus (Girard)

Bullhead minnow

MAP 54

The bullhead minnow follows the turbid waters of the large and moderate-sized streams of the south for the most part. Except for a projection into glaciated territory along the Wabash River and one locality in the Iroquois River, this minnow was most frequently found below the limit of the Wisconsin glacier. Only two records of the occurrence of *C. perspicuus* are known from the Great Lakes drainage, both of these in other states (HUBBS and LAGLER, 1941: 61).



Hyborhynchus Agassiz
Hyborhynchus notatus (Rafinesque)

Bluntnose minnow

MAP 55

This is probably the most abundant minnow in the state, as testified by its ubiquitous distribution in all drainage systems. The bluntnose minnow is seldom, if ever, found where there is a fast current, but other than this no particular habitat can be assigned to this tolerant species.

Campostoma Agassiz
Campostoma anomalum (Rafinesque)
 Stoneroller
 MAP 56

The variation of the stoneroller was studied in order to determine whether the subspecies *anomalum* and *pullum* both exist in Indiana. HUBBS and LAGLER (1941: 61) have related the complex distribution of these two forms. A total of 229 specimens from 41 well distributed localities were examined. In TABLE V average measurements of the specimens have been grouped into drainage systems. In parenthesis beside the averages is given the range of variation of the individuals examined. HUBBS and LAGLER'S (1941) diagnosis of the two subspecies is also included in the table for comparable purposes.

TABLE V
 Analysis of three characters of *Campostoma anomalum* in Indiana

Drainage	No. of specimens	Lateral line scales	Scales around body	$\frac{\text{Head length}}{\text{Gape width}}$
Whitewater	33	46.8 (42-54)	38.1 (32-44)	3.89 (2.86-4.80)
Streams directly enter-				
Ohio R.	31	47.9 (44-51)	39.3 (36-44)	3.96 (3.10-4.75)
Lower Wabash	53	49.6 (43-55)	41.2 (34-46)	4.26 (3.30-5.20)
Upper Wabash	62	50.4 (46-55)	42.4 (39-47)	4.15 (3.07-5.34)
Kankakee	25	49.9 (45-57)	39.8 (34-46)	4.14 (3.15-5.10)
Great Lakes	25	48.9 (46-52)	39.6 (34-43)	4.01 (2.39-5.24)
<i>C. a. anomalum</i>	(Hubbs and Lagler, 1941)	48-51	36-42	3.7-4.4
<i>C. a. pullum</i>	(Hubbs and Lagler, 1941)	49-55	39-46	4.6-5.5

Campostoma anomalum anomalum (Rafinesque)
 Ohio stoneroller

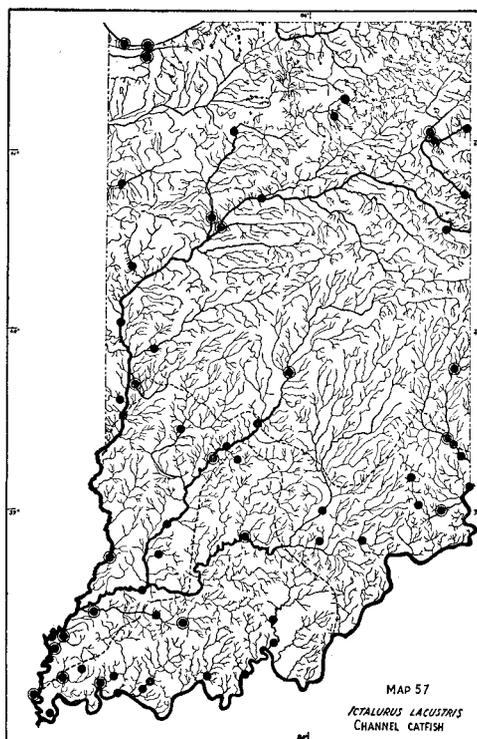
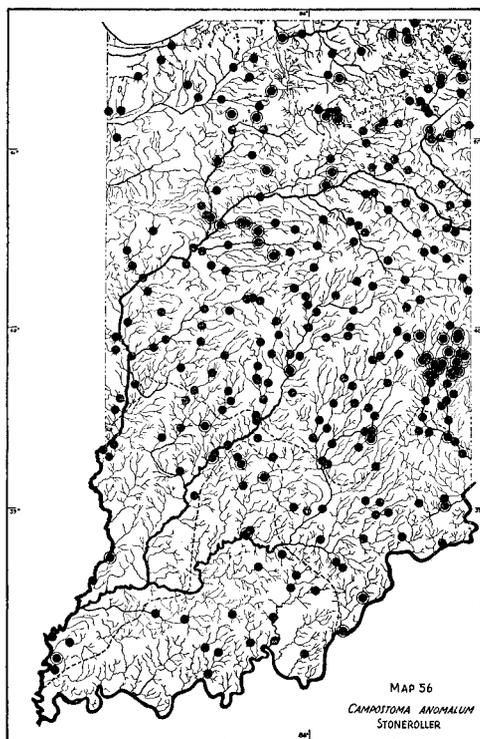
The Whitewater drainage is the only group in the above table which agrees in all three characters with one of the subspecies, *C. a. anomalum*. The other groups all have lateral line scales and scales around the body which are toward the upper limit of *C. a. anomalum* and within the lower limit of *C. a. pullum*. The relation of the gape to the head is typical of *C. a. anomalum* in all cases. This suggests that Indiana is in a zone where the subspecies are intergrading. No distinct difference was found between specimens of the Great Lakes and Mississippi drainages.

The stoneroller is generally distributed in streams having a firm bottom. On many occasions it was caught in the fast riffles of streams, and it usually prefers a habitat with moderate current. Most of the records of this species are from creeks, but several moderate-sized streams are included in its distribution. The stoneroller is relatively uncommon in the large rivers as compared to its abundance in the smaller streams.

AMEIURIDAE Catfishes
Ictalurus Rafinesque
Ictalurus lacustris (Walbaum)
 Channel catfish

MAP 57

Comparisons were made between specimens of the Lake Erie drainage and the Wabash drainage. Unfortunately only a few juvenile individuals from the Maumee River were available for comparison with a number of juvenile channel catfish from other parts of the state. The measurements showed that the head lengths divided by the width of the body varied from



1.29 to 1.33 in the Maumee specimens while those from the Mississippi drainage varied from 1.35 to 1.43. The writer does not feel that this limited material is adequate for distinguishing two forms in the state, but a tentative distinction will be made for convenience. A variation study on a large series of adult and juvenile individuals from both the northern and southern parts of the state is needed to determine the relationships of these forms. A study of the channel catfish in the northern lakes is particularly desirable.

Ictalurus lacustris punctatus (Rafinesque)
 Southern channel catfish

The tentative identification of two subspecies in the state includes this form which inhabits the large rivers and standing waters of the south.

Ictalurus lacustris lacustris (Walbaum)

Northern channel catfish

The northern channel catfish is found in Lake Michigan, the rivers of the Lake Erie drainage, and possibly some of the smaller glacial lakes of the north.

Ictalurus furcatus furcatus (Valenciennes)

Northern blue catfish

Gibson Co.: Wabash R., 5 m. N.W. Garrett.

Jefferson Co.: Ohio R., Madison (Blatchley, 1938).

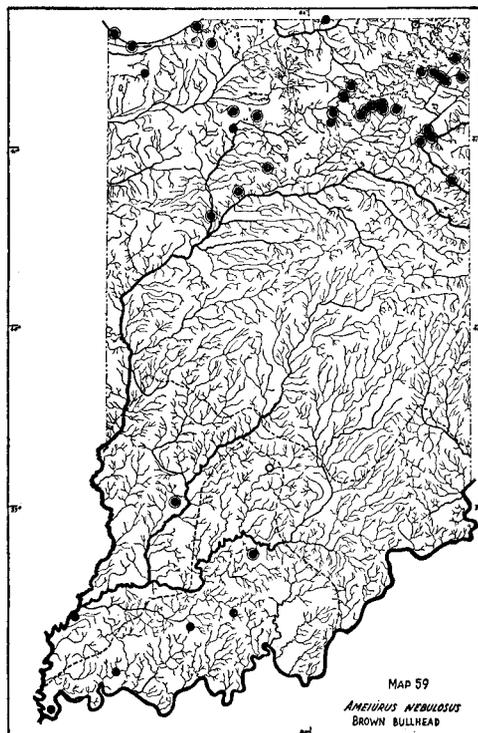
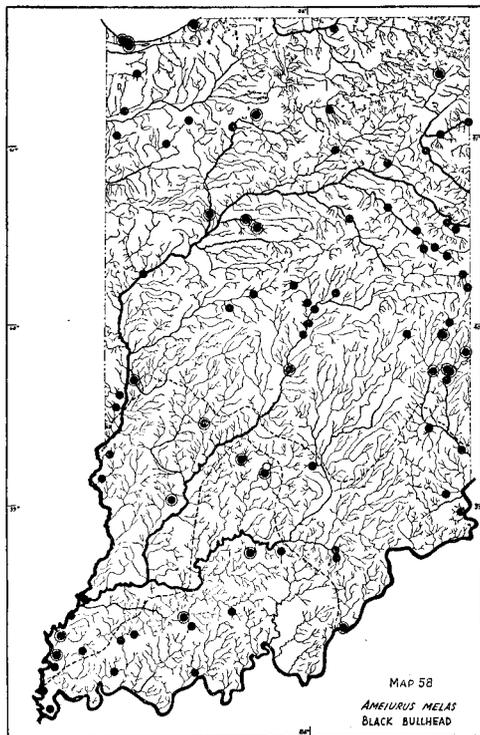
The localities listed above are the only two precise records that exist for this species in the state, though it is probably not uncommon in large southern rivers.

Ameiurus Rafinesque*Ameiurus melas* (Rafinesque)

Black bullhead

MAP 58

Specimens from southwestern Indiana differ in two morphological characters from individuals in other parts of the state. When viewed from the side, the region of the body from the snout to the origin of the dorsal fin gives a flattened or slightly concave appearance in southwestern specimens. This region of the body is slightly rounded (convex) in specimens from other parts of the state. A determination of the head length divided by the pectoral spine length was made, and it was found that the pectoral



spines of the southwestern individuals were longer than the spines of black bullheads from other regions: average from southwest, 2.07 (range 1.97-2.32); average of others, 2.41 (range, 2.11-2.87). Measurements of a number of southeastern individuals agreed with those from the north and were included in the averages. Most of the specimens examined were about 130 mm. long.

Ameiurus melas: melas (Rafinesque) \times *catulus* (Rafinesque)

The identification of the southwestern individuals as intergrades follows the practice of Dr. HUBBS, who has identified material from the lower Wabash region.

Ameiurus melas melas (Rafinesque)

Northern black bullhead

The northern black bullhead is the most abundant of the two forms, and is found in slow moving parts of streams and lakes where it is usually caught over soft bottoms. The intergrading form occupies the same habitat in the southwest.

Ameiurus nebulosus (LeSueur)

Brown bullhead

MAP 59

So few specimens of this species were collected in southern Indiana that no variation study was made. However, the specimens at hand from this region showed a flattened dorsal contour and longer pectoral spines just as the southwestern form of *Ameiurus melas*. No brown bullheads have been taken in central Indiana, making a distinct break in its distribution. The difference in morphologic characters makes an equally sharp break, and no evidence of intergradation was noted.

Ameiurus nebulosus marmoratus (Holbrook)

Southern brown bullhead

The southern brown bullhead has its habitat in the sluggish turbid streams and standing waters of the south.

Ameiurus nebulosus nebulosus (LeSueur)

Northern brown bullhead

The slower portions of the northern streams hold the northern brown bullhead, and is frequently caught in the glacial lakes.

Ameiurus natalis natalis (LeSueur)

Northern yellow bullhead

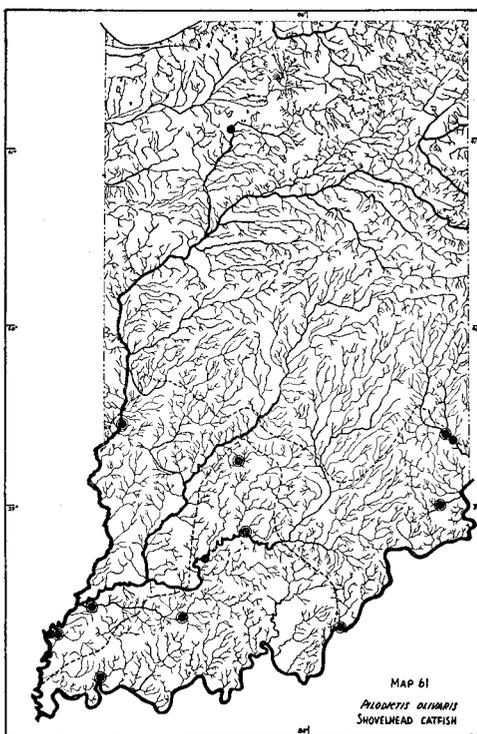
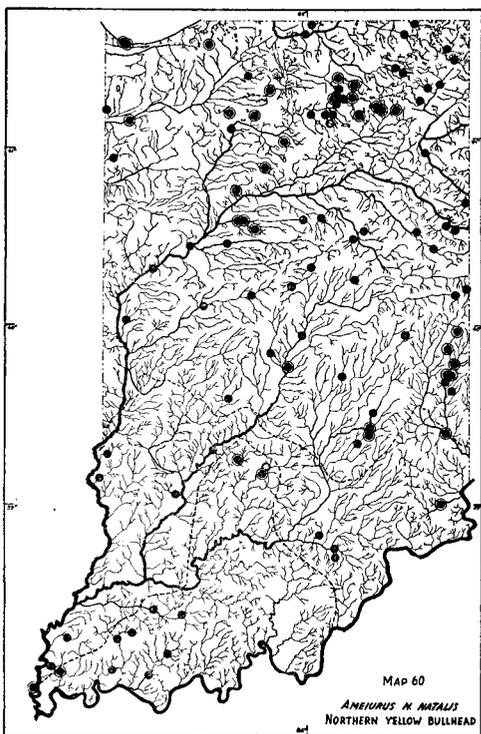
MAP 60

No morphological differences between northern and southern specimens were found. The yellow bullhead inhabits the sluggish, turbid streams of the south and the clearer waters of northern lakes and streams. Like the black and brown bullheads, it is well represented in all the main drainage systems.

Pilodictis Rafinesque
Pilodictis olivaris (Rafinesque)
 Shovelhead catfish

MAP 61

The shovelhead catfish follows the courses of the large rivers and a few of their tributaries. The most northern locality is far removed from the others, and it is felt that the distribution map does not fairly represent its abundance between these points. This catfish is known from the Great Lakes drainage of other states.



Noturus Rafinesque
Noturus flavus Rafinesque
 Stonecat

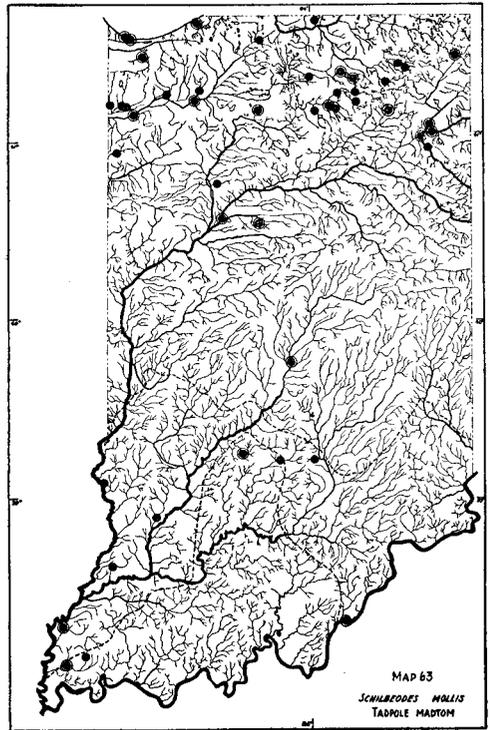
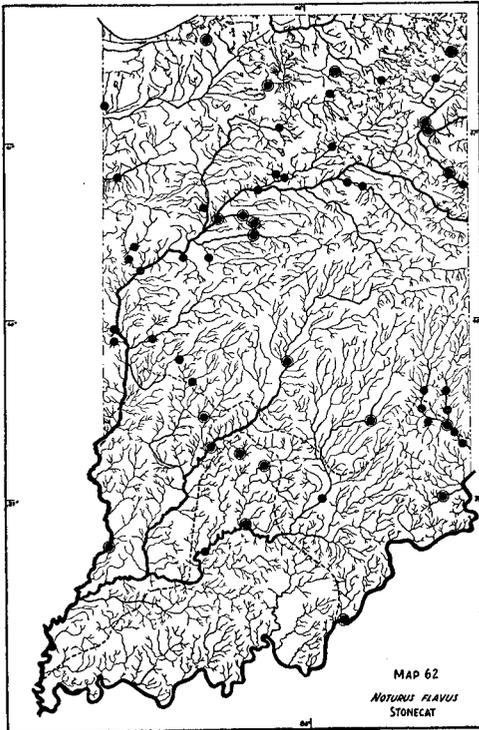
MAP 62

The stonecat is one of the riffle inhabiting species. The majority of records have been obtained in moderate to large-sized streams where the riffles consisted of large, flat rocks. The Whitewater River is a good example of this type of stream, and its abundance in this river is well represented on the distribution map.

Schilbeodes Bleeker
Schilbeodes mollis (Hermann)
 Tadpole madtom

MAP 63

The sluggish, weedy, soft-bottomed streams form the predominant habitat of the tadpole madtom. It has also been caught frequently in weedy, glacial lakes. Water turbidity does not seem to affect its overall distribution, but it is more abundant in the clear water of northern creeks, lakes, and ditches. HUBBS and RANEY (1944) have changed the name of the tadpole madtom from *S. gyrinus* to *S. mollis* on the basis of an early description written in 1804 by JOHANNES HERMANN.



Schilbeodes nocturnus (Jordan and Gilbert)
 Freckled madtom

- Dearborn Co.: Whitewater R., 3 m. N.E. Osgood.
- Franklin Co.: Whitewater R., Cedar Grove.
- Jackson Co.: E. Fk. White R., Seymour.
- Parke Co.: Sugar Cr., 3 m. N. Marshall.
- Vanderburg Co.: Big Pigeon Cr., Evansville (Jordan, 1890).
- Vermillion Co.: Little Vermillion R., 4 m. N.W. Cayuga.
- White Co.: Big Cr., 2 m. N.W. Chalmers.

The freckled madtom superficially resembles the young of *Noturus flavus* so field identification was not made nor were notes concerning its habitat secured. However, all the streams where it was found could be

classed as moderate-sized with firm bottoms. (The Big Creek record was taken near the Tippecanoe River.) Riffles were seined in all of the localities, and it was in this habitat that the fish was taken. All of the Indiana records are from the Wabash and Ohio drainages, but one record exists from the Lake Erie drainage of Ohio (HUBBS and LAGLER, 1941 : 64).

Schilbeodes insignis (Richardson)

Slender madtom

Carroll Co.: Tippecanoe R. (Evermann and Jenkins, 1892).

Monroe Co.: Bean Blossom Cr. (Eigenmann and Fordice, 1886).

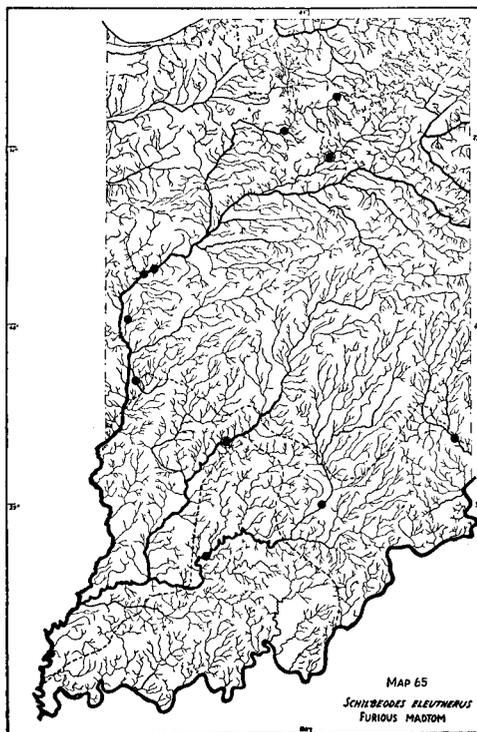
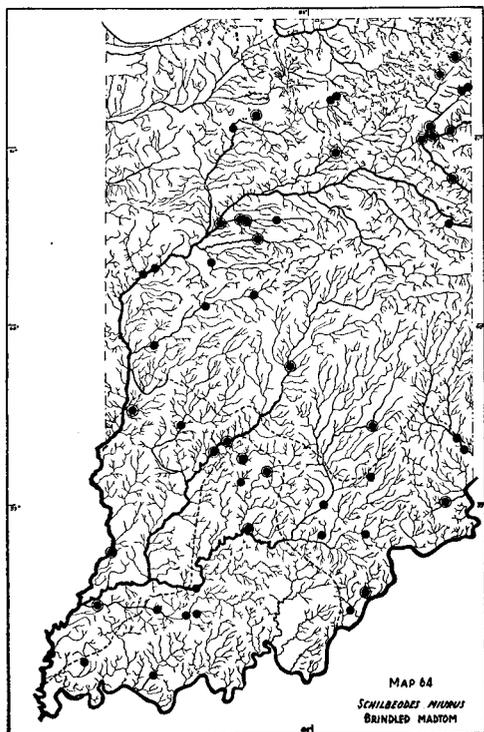
This species is now exceedingly rare, if present at all, in Indiana waters. In a recent paper HUBBS and RANEY (1944) have changed this madtom's name from *S. exilis* to *S. insignis*.

Schilbeodes miurus (Jordan)

Brindled madtom

MAP 64

In Indiana the brindled madtom has been found in hard bottomed portions of streams, either in riffles or stream sections where the current is moderate. On a few occasions this madtom was found in clumps of submerged vegetation growing in stream channels. The distribution map would imply that this species has found its way into the Great Lakes watershed through the Maumee outlet. This is borne out by the absence of records from states bordering Lake Michigan.



Schilbeodes eleutherus (Jordan)

Furious madtom

MAP 65

The furious madtom inhabits the faster waters of medium to large-sized streams with hard bottoms of gravel or rock. Occasionally it has been found in association with *S. miurus*. Our records do not show its presence in the Lake Erie drainage, but it is known from that drainage in Michigan and Ohio (HUBBS and LAGLER, 1941: 65). This would suggest the Maumee outlet as its dispersal route into the Great Lakes.

UMBRIDAE Mudminnows

Umbra Krämer*Umbra limi* (Kirtland)

Western mudminnow

MAP 66

The mudminnow is commonly found in soft-bottomed creeks and lakes and has often been seined in patches of dense aquatic vegetation. The concentration of records in the north indicates its preference for clear water. All but one (the most southern) of the southern records were collected by early authors.

ESOCIDAE Pickerels

Esox Linnaeus*Esox vermiculatus* LeSueur

Mud pickerel

MAP 67

The mud pickerel is abundant in weedy environments of lakes and streams. Usually this type of habitat has a slow current, if any, and the characteristic soft bottom that accompanies heavy growths of aquatic vegetation.

Esox lucius Linnaeus

Northern pike

Allen Co.: St. Joseph R., Cedarville.

DeKalb Co.: Cedar L., 4½ m. N.W. Waterloo (Kirsch, 1895b).

Elkhart Co.: Simonton L., 4 m. N. Elkhart (report).

Kosciusko Co.: Winona L., Warsaw; Muskellunge L., 4 m. S.E. Warsaw (report);

L. Wawasee, Syracuse (report).

Lake Co.: Calumet R., Clark (Meek and Hildebrand, 1910).

Marshall Co.: L. Maxinkuckee, Culver (Evermann and Clark, 1920).

Porter Co.: L. Michigan, Ogden Dunes.

Posey Co.: Wabash R., New Harmony (Jordan, 1890).

Pulaski Co.: Tippecanoe R., 6 m. N. Winamac (collected by D. Scott, 1943).

Starke Co.: Bass L., 6 m. S. Knox (Blatchley and Ashley, 1901).

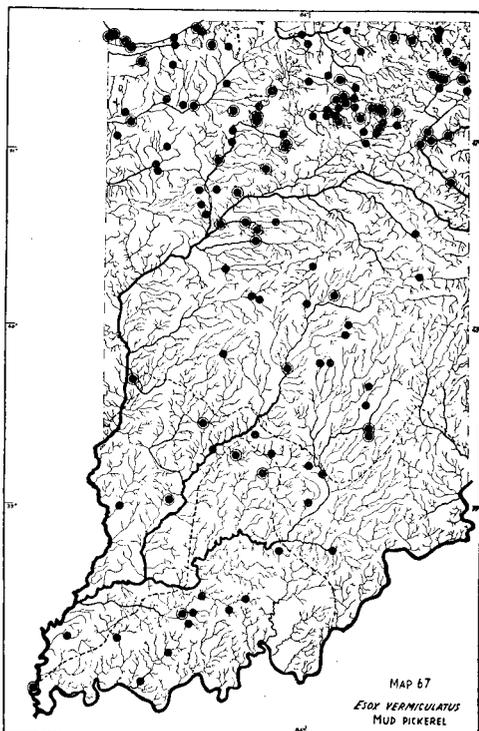
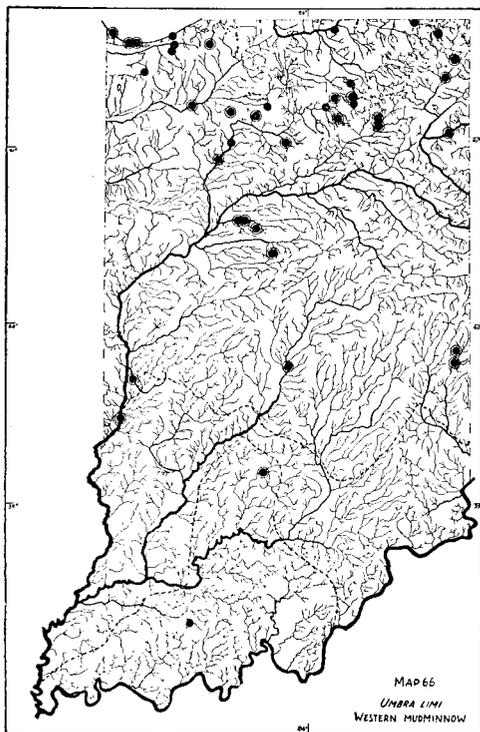
St. Joseph Co.: St. Joseph R., South Bend (Dolley, 1933).

Wabash Co.: Paw Paw Cr. (Ulrey, 1894).

Whitley Co.: Eel R. and Stoney Cr. (Kirsch, 1895a).

The northern pike is one of the largest of Indiana's game fishes, and the weedy lakes and rivers of the north are its chief habitats. The New

Harmony record, which was recorded by JORDAN as *Lucius lucius*, is far removed from any of the other pike records. The specimen that JORDAN reported was in the collection of JAMES SAMPSON, of New Harmony. CUVIER and VALENCIENNES (1833, vol. XVIII, p. 336) also reported this fish from New Harmony under the name *Esox debrandus*. Perhaps a century ago this species had a much wider range to the south than at present.



Esox masquinongy Mitchill
Muskellunge

The writer follows JORDAN (1929: 98-99) in distinguishing the Ohio River valley form from that of the Great Lakes.

Esox masquinongy ohioensis Kirtland
Ohio muskellunge

Crawford Co.: Little Blue R., near Sulphur (collected by J. Gottschalk, identified by the writer, 1942).

Floyd Co.: Ohio R., New Albany (Meek and Newland, 1886).

The Ohio muskellunge is rare in Indiana, but Mr. JOHN GOTTSCHALK indicates that a sizable population exists in the Little Blue River, a tributary of the Ohio River.

Esox masquinongy masquinongy Mitchill
Great Lakes muskellunge

Lake Co.: L. Michigan, Edgemoor (Meek and Hildebrand, 1910).

The Edgemoor record is the only precise locality in Indiana from which the Great Lakes muskellunge is known. EIGENMANN and BEESON (1894) mention that it occurs in English Lake, which was once an expansion of the Kankakee River in Starke County, since drained by dredging. This record is from the Mississippi drainage. It is far removed from the known range of *E. m. ohioensis* and close to that of *E. m. masquinongy*, so it is questionable which of the subspecies it resembled.

ANGUILLIDAE Eels

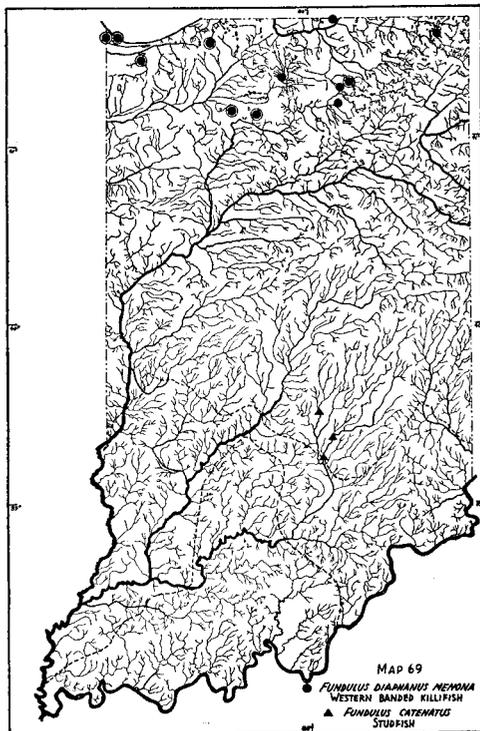
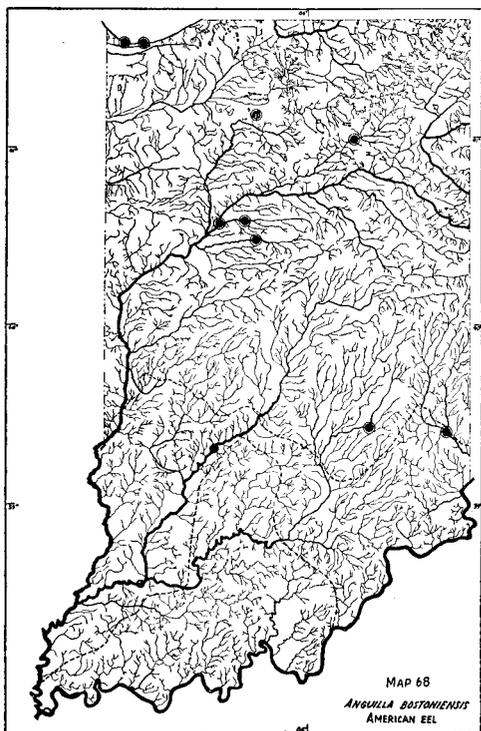
Anguilla Shaw

Anguilla bostoniensis (LeSueur)

American eel

MAP 68

Only two eels were observed during the work. One was a live specimen in the museum at McCormick's Creek State Park, Owen County, which had been taken from the West Fork of the White River nearby, and the other had been killed by cannery pollution in the East Fork of the White River near Bedford, Lawrence County. Inquiry brought to light two other recent reports of this fish: the Ohio River near Hovey Lake, Posey County, and the White River, Petersburg, Pike County. It would seem that the



abundance of the eel in our waters has diminished in recent years. HUBBS and LAGLER (1941: 66) note that this species is not native to the Great Lakes above Niagara Falls, but has been introduced into these waters.

CYPRINODONTIDAE Topminnows

Fundulus Lacépède

Fundulus diaphanus menona Jordan and Copeland

Western banded killifish

MAP 69

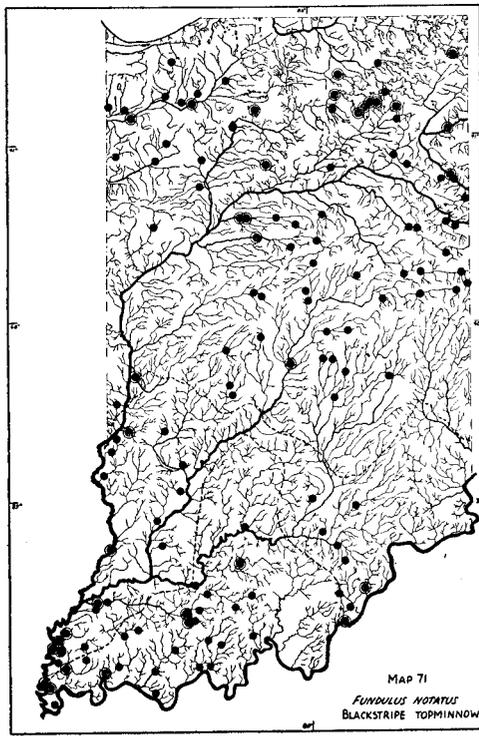
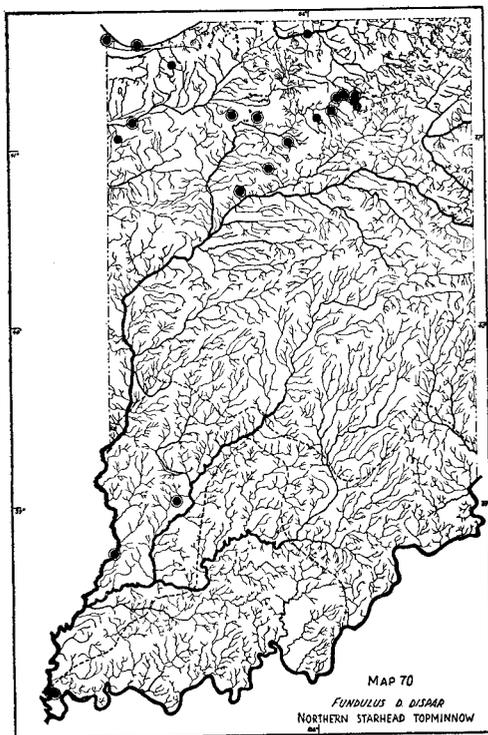
This is strictly a lake inhabiting species in Indiana and is found in shallow water along the shores. The distribution of the banded killifish has been discussed on page 18.

Fundulus dispar dispar (Agassiz)

Northern starhead topminnow

MAP 70

The northern starhead topminnow prefers the quiet, weedy portions of streams and lakes, where it swims near the surface of the water, usually within the zone of vegetation. The only record from the St. Joseph River was made by JORDAN (1877b) from an unidentified locality in this drainage system. This species was caught by us at numerous localities from the northern part of the state but was not obtained from southern Indiana. The records from the latter region were all made by early authors prior to 1900.



Fundulus notatus (Rafinesque)

Blackstripe topminnow

MAP 71

By far the most common cyprinodont of the state, the blackstripe topminnow inhabits the shorelines of both lakes and streams. It swims at the water surface and sometimes seeks the marginal aquatic vegetation. Neither water turbidity nor stream size limits its distribution.

Fundulus catenatus (Storer)

Studfish

MAP 69

At two of the three places where it was caught, the studfish was found on a fast, gravel riffle in clear water with no aquatic vegetation. The third locality was a small, clear, sand-bottomed road ditch which led into Sugar Creek, 5 miles east of Franklin, Shelby County. The general distribution of this species has been discussed on page 22.

Gambusia Poey*Gambusia affinis affinis* Baird and Girard

Western mosquitofish

MAP 72

The mosquitofish is restricted to the extreme southwestern corner of the state where it was found in quiet, vegetated waters of a swamp, bayous, and a ditch. The records from the Wabash River were made by other collectors, and their specimens were probably obtained in quiet backwaters.

AMBLYOPSIDAE Blindfishes

Amblyopsis DeKay*Amblyopsis spelaeus* DeKay

Mammoth Cave blindfish

All the localities listed below have been taken from BANTA (1907: 23) and EIGENMANN (1909: 71) who give complete bibliographies concerning the occurrence of *A. spelaeus*. Our only recent information (1944) is that it is still abundant in Shawnee Cave in Spring Mill State Park.

Crawford Co.: Wyandotte Cave, Wyandotte; Little Wyandotte Cave, Wyandotte; Sibert's Well Cave, Wyandotte.

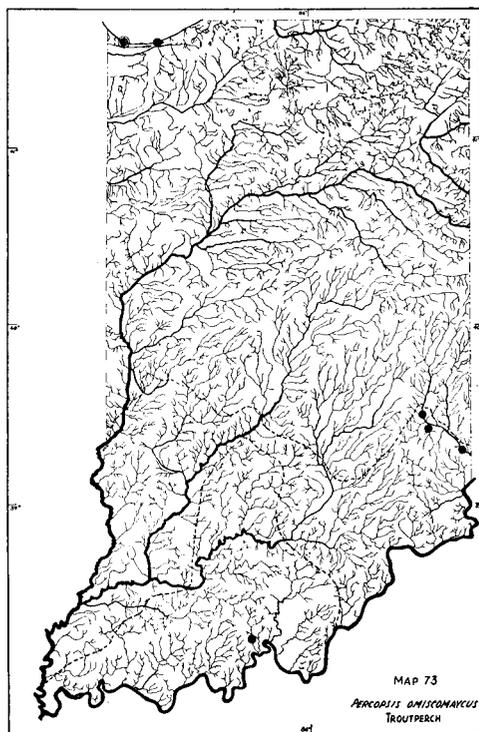
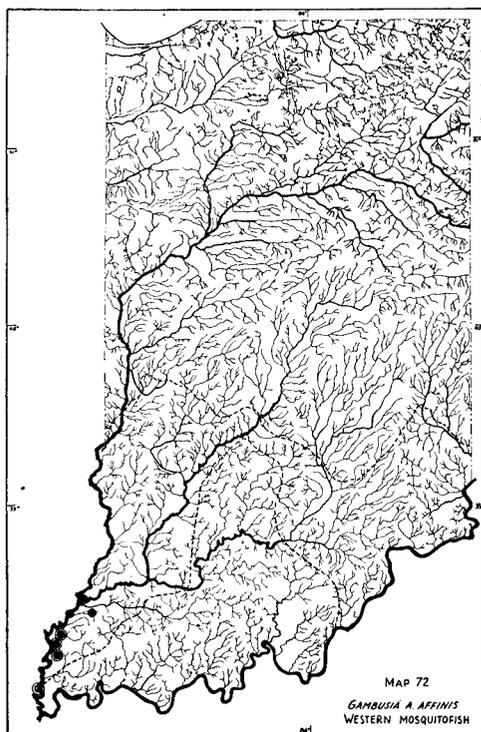
Harrison Co.: Rhodes' Cave near Corydon.

Lawrence Co.: Hamer's and Shawnee Caves near Mitchell.

Orange Co.: Eliot's Cave, 4 m. W. Orleans; Lost River near Orangeville.

Washington Co.: Clifty Caves near Campbellsburg.

Wherever it occurs, this interesting species excites the curiosity of scientists and the general public. A generation ago the blindfish of Indiana was the subject of many scientific treatises. Dr. C. H. EIGENMANN and his associates at Indiana University contributed much to biology by their studies of its structure, development, distribution, evolution and behaviour. The blindfishes have the strictest habitat requirements of all Indiana fishes. They live in the complete darkness of caves formed by underground streams coursing through Indiana's large limestone belt.



Typhlichthys Girard
Typhlichthys wyandotte Eigenmann
Wyandotte blindfish

The Wyandotte blindfish is known only from a well at Corydon, Harrison County, Indiana (EIGENMANN, 1909: 86). Dr. CARL L. HUBBS has visited the site in more recent years and found that the well had been sealed.

PERCOPSIDAE Troutperches
Percopsis Agassiz
Percopsis omiscomaycus (Walbaum)

Troutperch

MAP 73

In Indiana the troutperch is found in such widely varying habitats as the sandy shores of Lake Michigan and the quiet portions of turbid southern streams. The Chicago outlet is indicated as one of its means of entering the Great Lakes (distribution discussed on p. 17).

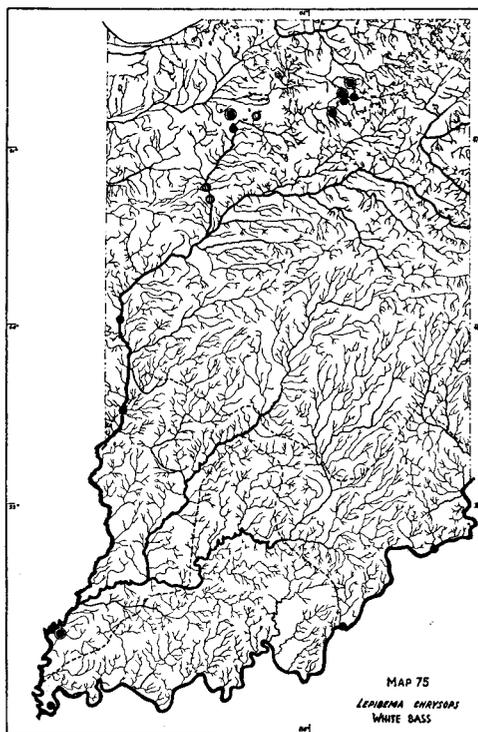
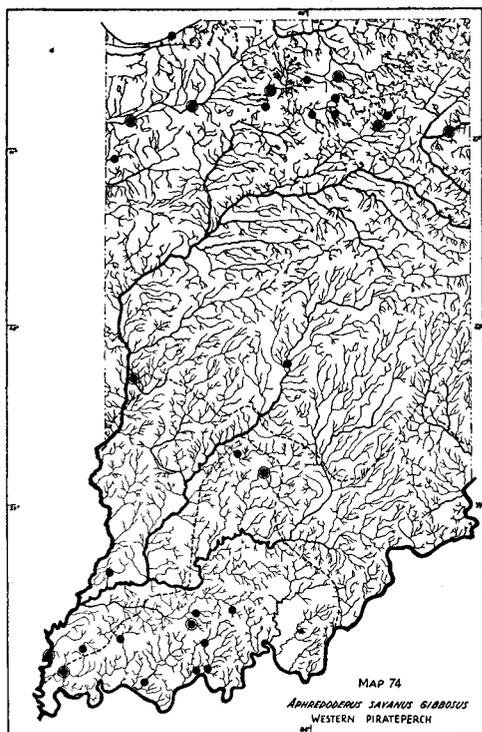
APHREDODERIDAE Pirateperches
Aphredoderus LeSueur
Aphredoderus sayanus gibbosus (LeSueur)

Western pirateperch

MAP 74

In all the northern collections the pirateperch was taken in dense patches of aquatic vegetation in the slow portions of clear streams.

Toward the south, however, it was not associated with aquatic vegetation but was often caught in the turbid water of slow-moving, mud-bottomed pools. A few of the early records were from larger streams, but it has been found only in our creek collections.



SERRANIDAE Basses
Lepibema Rafinesque
Lepibema chrysops (Rafinesque)

White bass

MAP 75

The white bass ranges from the large, silty rivers and standing waters of the south to the clear glacial lakes of the north. It has been captured over both firm and muddy bottoms and is known from weedy and weedless environments. The Chicago outlet is the only northward migration route suggested by our collections, since it does not occur in the Maumee drainage or nearby localities. However, the white bass is generally distributed in all the Great Lakes except Superior (HUBBS and LAGLER, 1941: 68, 69).

The white bass is a game fish which is abundant in several of the larger northern lakes and it affords excellent sport fishing, especially in Bass Lake, Tippecanoe Lake, and the artificial lakes Shafer and Freeman.

Morone Mitchill
Morone interrupta Gill
 Yellow bass

Gibson Co.: Foots Pond, 5 m. N.W. Poseyville (Hubbs and Lagler, 1942).

Posey Co.: Hovey L., 10 m. S. Mt. Vernon.

Vigo Co.: (Jenkins, 1887).

The yellow bass is restricted to the southwestern part of the state. The two recent records are from turbid, standing waters, but doubtless it is also found in the larger rivers.

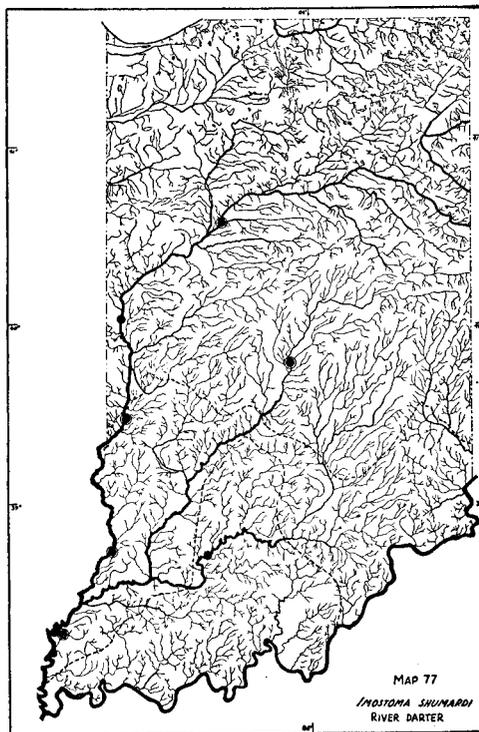
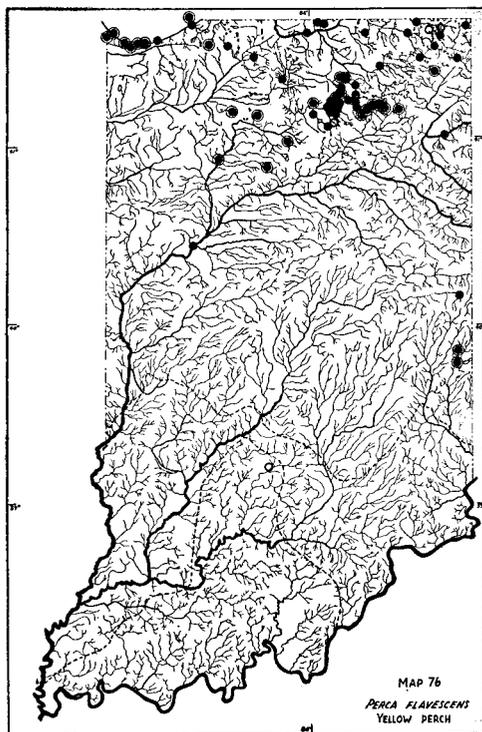
PERCIDAE Perches and Darters

Perca Linnaeus
Perca flavescens (Mitchill)

Yellow perch

MAP 76

The main concentration of the yellow perch in the northern glacial lakes is well demonstrated on the distribution map. It was taken a few times from northern streams and is especially abundant along the shores of Lake Michigan. Below the 40° parallel, SHOEMAKER'S record (1942: 288) and a report from Yellowwood Lake, 11 miles east of Bloomington, Brown County, are known to be recent introductions. The other locality,



near Richmond, was taken from PLUMMER (1851) who recorded it as *Bodianus flavescens*; this may well refer to native rather than introduced specimens.

Stizostedion Rafinesque
Stizostedion canadense canadense (Smith)

Eastern sauger

Crawford Co.: Ohio R., Leavenworth.

Franklin Co.: Vicinity of Brookville (Evermann, 1886).

Gibson Co.: Fooths Pond, 5 m. N.E. Poseyville (Hubbs and Lagler, 1942); Wabash R., 5 m. N.W. Garrett.

Perry Co.: Ohio R., 1 m. E. Cannelton.

Posey Co.: Wabash R., 3 m. S.W. New Harmony.

Vigo Co.: Wabash R., Terre Haute (Jenkins, 1887).

The sauger has been found in the southern waters of large, silty rivers, and in one bayou, Fooths Pond. It has been taken in our collections over a firm bottom in the main river channels. The sauger is known from Lake Erie, but there is no indication from our data that it entered this region through the Maumee outlet.

Stizostedion vitreum vitreum (Mitchill)

Yellow pikeperch, walleye

Clark Co.: Falls of Ohio R., Jeffersonville (Call, 1896).

Kosciusko Co.: Winona L., Warsaw (report).

LaPorte Co.: L. Michigan (report).

Marshall Co.: L. Maxinkuckee, Culver (Evermann and Clark, 1920).

Starke Co.: Bass L., 5 m. S.E. Knox (Ricker and Gottschalk, 1941).

Vigo Co.: Wabash R. (Jenkins, 1887).

White Co.: Tippecanoe R., below Monticello (Blatchley, 1938); L. Freeman and L. Shafer, near Monticello (report).

No specimens of this species were taken in our collections. Neither adults nor young are readily captured by seining near shore, so other methods would have to be employed to catch them. The yellow pikeperch is probably not as rare as the above records suggest, especially in the northern glacial lakes. In Bass Lake and the two artificial lakes of the Tippecanoe River, it is one of the important game fish.

Imostoma Jordan
Imostoma shumardi (Girard)

River darter

MAP 77

Imostoma shumardi is restricted to western Indiana where it follows the large, silty rivers. In our collections it has been taken on hard gravel bottoms where the current is moderate to fast. The distribution of the river darter in Indiana gives no clue concerning its means of dispersal, but its presence in eastern Michigan and Lake Erie suggests the use of the Maumee outlet.

Imostoma uranidea (Jordan and Gilbert)

Stargazing darter

Knox Co.: Wabash R., 1½ m. N. Vincennes (Jordan, 1890).

Posey Co.: Wabash R., New Harmony (Jordan, 1890).

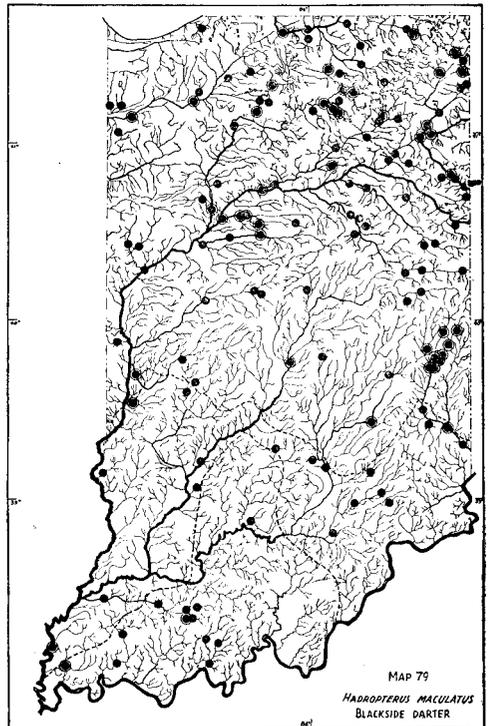
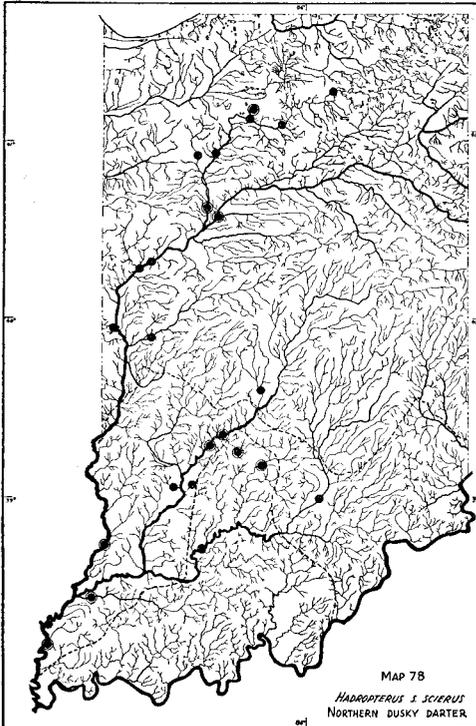
Apparently the stargazing darter is rare in the Wabash valley. FORBES and RICHARDSON (1920:288) found it only once, in a collection from the Wabash River at New Harmony.

Hadropterus Agassiz*Hadropterus scierus scierus* Swain

Northern dusky darter

MAP 78

The dusky darter was caught on most occasions in fast, shallow water on a gravel bottom. It was not found under the stones of rocky riffles where many other darters find a suitable habitat. For the most part our records are from large and medium-sized streams of the Wabash drainage; it does not occur in the Great Lakes basin. The dusky darter is equally common in clear northern streams and the turbid waters of the south.



Hadropterus maculatus (Girard)

Blackside darter

MAP 79

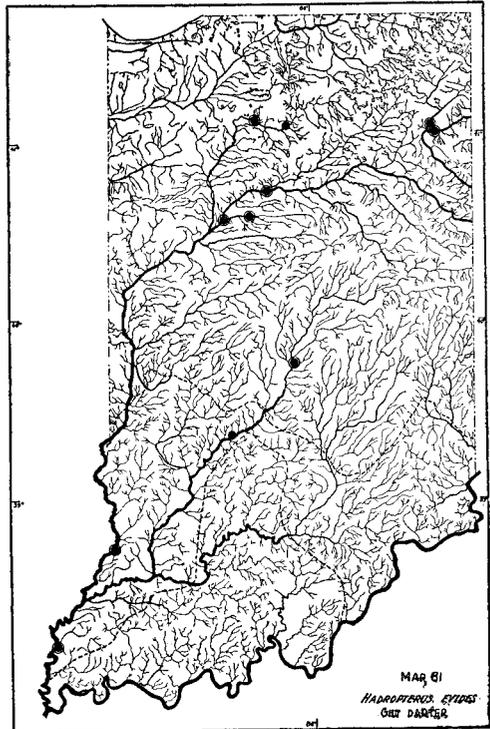
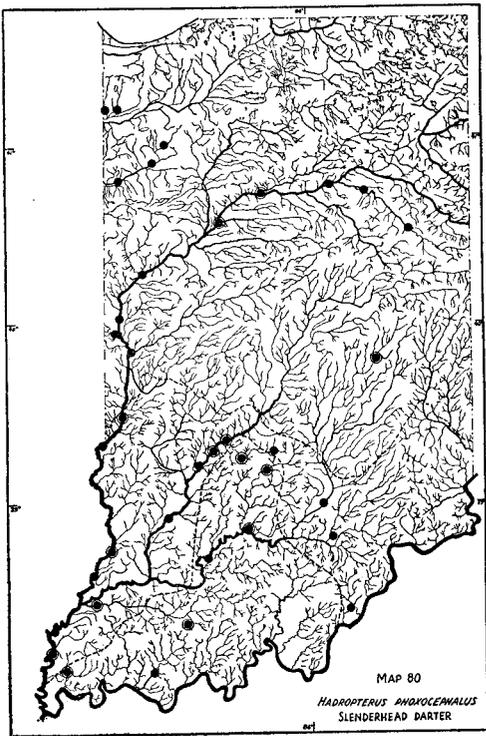
H. maculatus is found in the slow-moving pools of small to moderate-sized streams in all drainage systems and has occasionally been taken in the northern lakes. Our collections show it to be more common in northern Indiana than the turbid southern waters.

Hadropterus phoxocephalus (Nelson)

Slenderhead darter

MAP 80

Essentially the slenderhead darter is a riffle species which is found in the large southern rivers and a few of their tributaries. *H. phoxocephalus* is more commonly taken in a fast current on a gravel bottom; however, it has been collected in a sandy pool and in riffles containing large rocks. In



creeks and ditches draining northwestern Indiana, it has been found in dense aquatic vegetation. Thus, it seems that in this state the slenderhead darter tolerates various ecological conditions. As HUBBS and LAGLER (1941: 73) mention, this species has been able to penetrate the Great Lakes drainage only in Wisconsin.

Hadropterus evides (Jordan and Copeland)

Gilt darter

MAP 81

This species was not collected during the seining operations, although the sites of five of the eleven literature records shown on the map were revisited. It is possible that the abundance of the gilt darter has greatly decreased in recent years.

*Percina Haldeman**Percina caprodes* (Rafinesque)

Logperch

MAP 82

The degree of nape squamation is the best character distinguishing the two forms of the logperch. The nape of *semifasciata* has a triangular scaleless area while this region in *caprodes* is closely scaled.

Percina caprodes caprodes (Rafinesque)

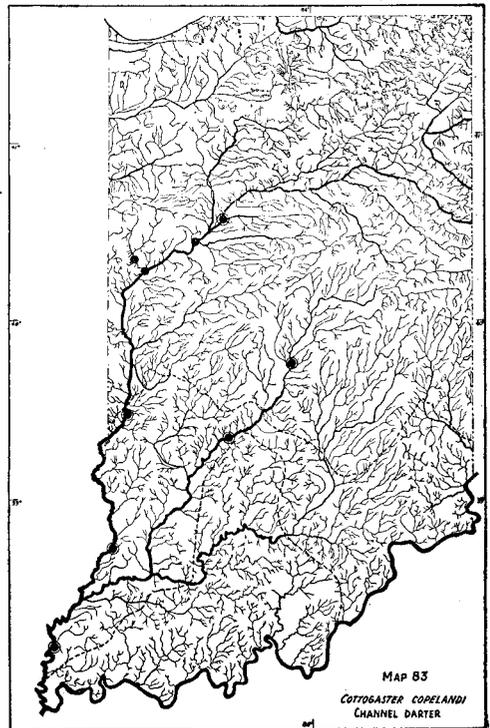
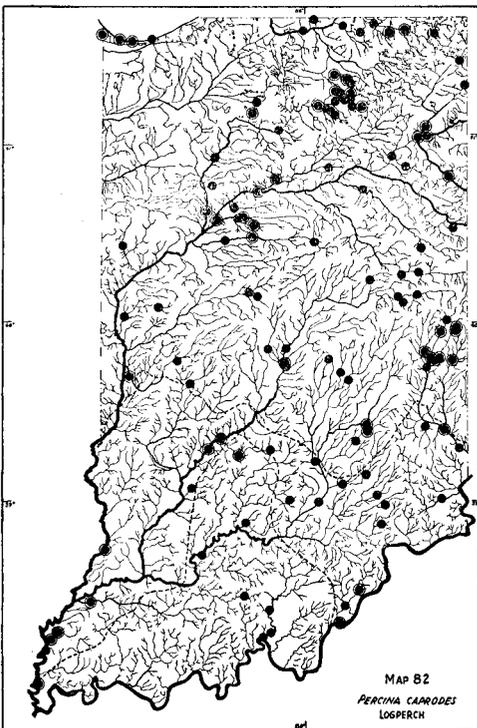
Ohio logperch

This is the state's most common form and is found throughout southern and central Indiana.

Percina caprodes semifasciata (DeKay)

Northern logperch

Differentiation between the Indiana subspecies begins near the 41° parallel. North of this line are found intergrading populations as well as



typical representatives of both *caprodes* and *semifasciata*. Specimens from an intergrading population show a graded series from incompletely to completely scaled napes.

Cottogaster Jordan
Cottogaster copelandi (Jordan)

Channel darter

MAP 83

The channel darter is represented in only two of our collections: Big Pine Creek, 5 miles N.W. Attica, Fountain County, and Wabash River, Attica, Warren County. At these localities it was taken on a sand and gravel bottom in turbid water with a moderate to fast current. Its routes of migration cannot be deduced from its distribution in Indiana, but its presence in eastern Michigan and Lake Erie (HUBBS and LAGLER, 1941: 74) implies the use of the Maumee outlet.

Crystallaria Jordan and Gilbert
Crystallaria asprella asprella (Jordan)

Northern crystal darter

Knox Co.: Wabash R., 1½ m. N. Vincennes (Jordan, 1890).

Ohio Co.: Laughery Cr., near Milton (Evermann and Jenkins, 1892).

Posey Co.: Wabash R., New Harmony (Jordan, 1890).

Nothing is known concerning the habits of this rare darter in Indiana.

Ammocrypta Jordan
Ammocrypta pellucida (Baird)

Northern sand darter

MAP 84

Our information shows that the sand darter is restricted to the sandy bottoms of large and medium-sized streams. This species is one of the best examples of fishes using only the Maumee channel as an entrance into the Great Lakes drainage. HUBBS and LAGLER (1941: 74) give its eastward distribution as "from southeastern Michigan and southern Ontario to the Lake Champlain drainage in Vermont. . . ." It is not known from the Lake Michigan drainage of Michigan, Wisconsin (GREENE, 1935: 173), Illinois (FORBES and RICHARDSON, 1920: map XCII in Atlas), or Indiana, some or all of which should now be populated if the species had entered the Great Lakes by way of the Chicago outlet.

Ammocrypta clara Jordan and Meek

Western sand darter

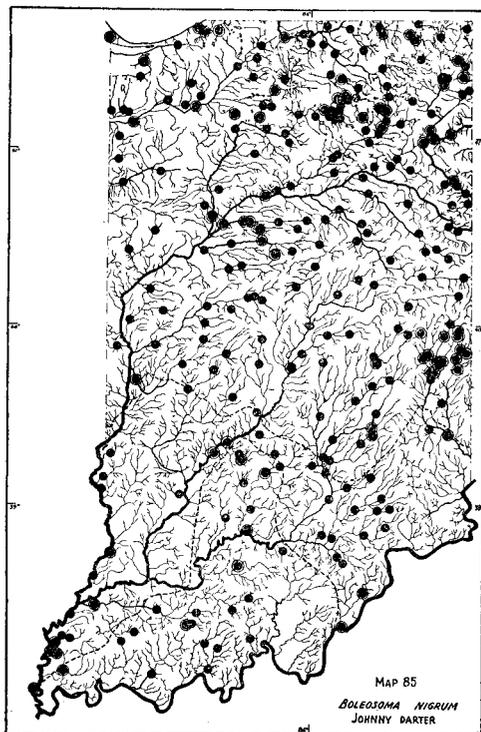
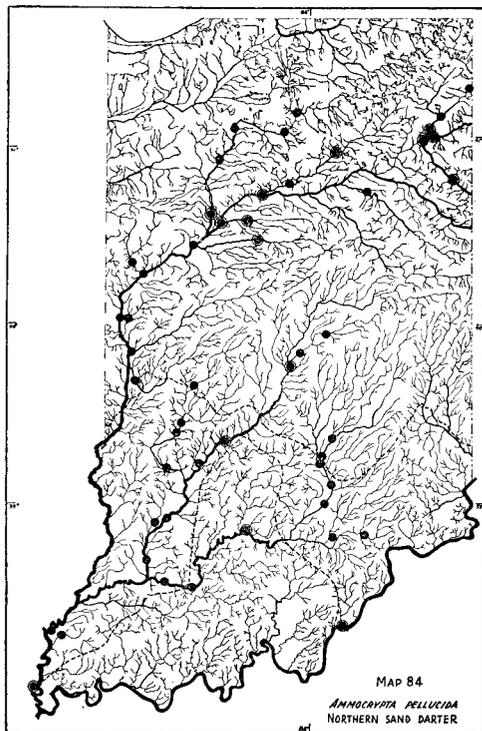
Posey Co., Wabash R., 7 m. W. Mt. Vernon (UMMZ, 1927).

Little is known concerning the habits of the western sand darter, but it is said to occur in the deep waters of the large southern rivers, as does *Crystallaria a. asprella*.

Ulocentra Jordan
Ulocentra histrio (Jordan and Gilbert)
 Harlequin darter

Gibson Co.: Patoka R., Patoka (Jordan, 1890).

U. histrio, if still present, must be exceedingly rare in southern Indiana. FORBES and RICHARDSON (1920) do not list it from Illinois.



Boleosoma DeKay
Boleosoma nigrum (Rafinesque)
 Johnny darter

MAP 85

As in the case of the logperch, the degree of squamation distinguishes two forms of johnny darter in this state. The subspecies *eulepis* has the nape, cheeks, and breast well scaled; *nigrum* has scaleless nape, cheeks, and breast.

This little darter is caught in lakes and the quiet waters of small and medium-sized streams. Seldom is it taken in a fast current or on a bottom other than sand or mud.

Boleosoma nigrum eulepis Hubbs and Greene
 Scaly johnny darter

The scaly johnny darter has been identified from creeks of northwestern Indiana which were abundantly vegetated. Interspersed among the *eulepis*

form were populations of *nigrum* and some which were considered inter-grades.

Boleosoma nigrum nigrum (Rafinesque)

Central johnny darter

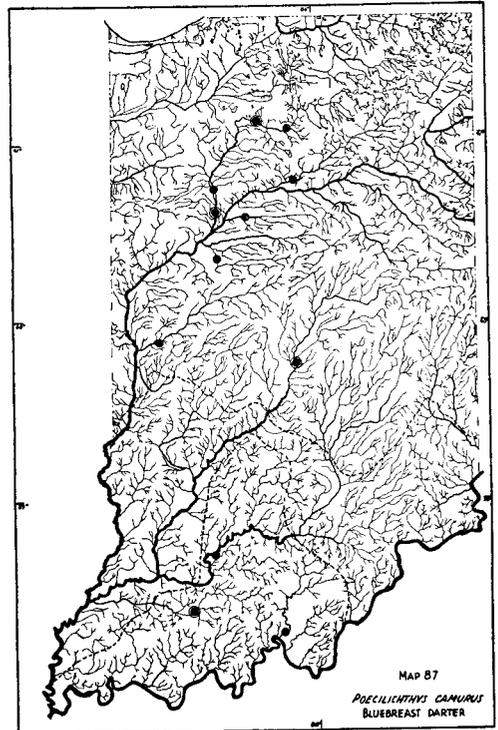
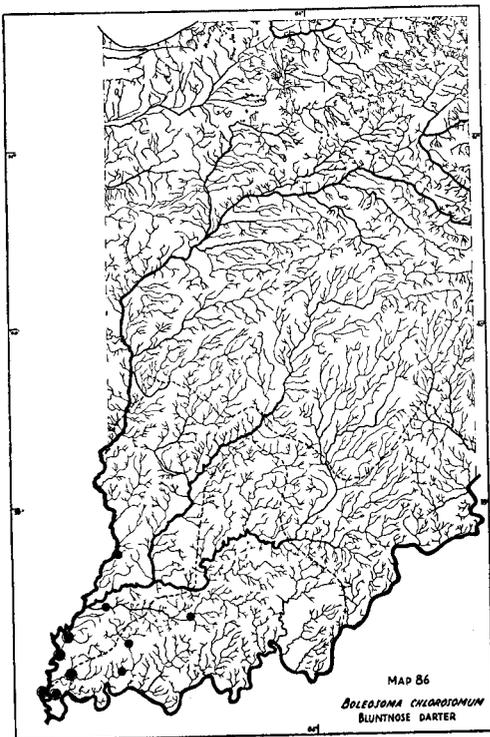
Populations of typical *nigrum* are found in all parts of the state other than the northwestern corner.

Boleosoma chlorosomum (Hay)

Bluntnose darter

MAP 86

The bluntnose darter occurs in southwestern Indiana where it was found by us in two collections: Hunley Creek, 3 miles N. of Huntingburg, Dubois County, and Big Pigeon Creek, 10 miles N.E. of Evansville, Warrick County. Both of these creeks are sluggish and turbid. Hunley Creek was stagnant with a mud-sand bottom and Big Pigeon Creek had a mud bottom covered with flood debris. This is one of the many Mississippi valley species which has invaded Indiana and states to the west; it has been found only once in the Lake Michigan drainage (FORBES and RICHARDSON, 1920, map XCI in Atlas).



Poecilichthys Agassiz
Poecilichthys camurus Cope

Bluebreast darter

MAP 87

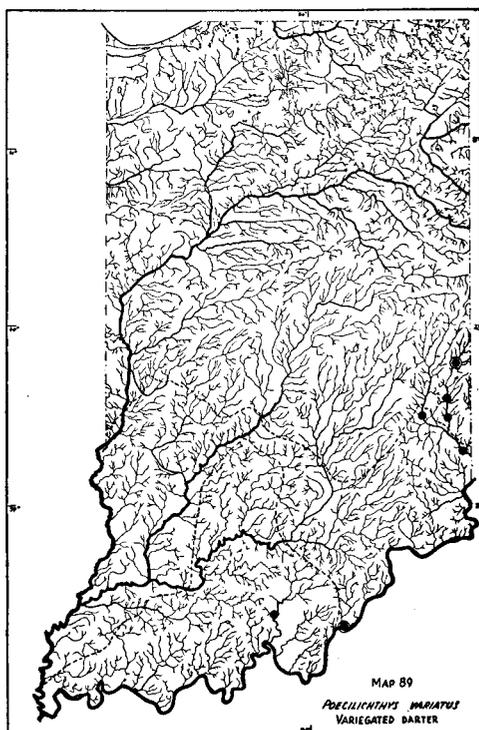
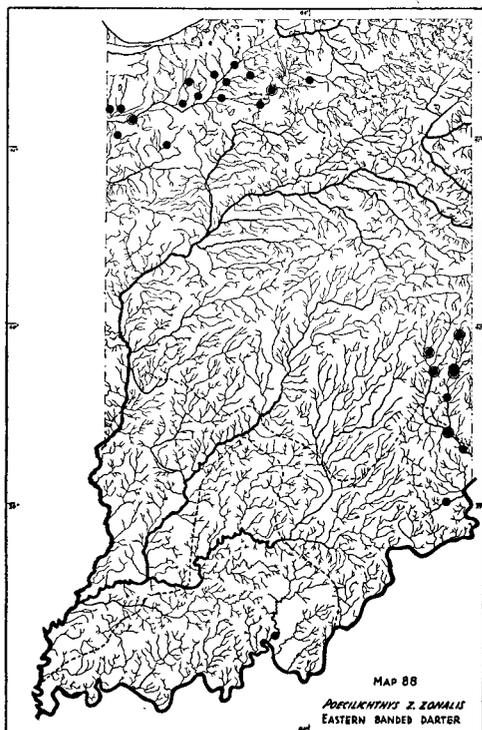
A distinctive habitat of swift, rocky riffles marks the bluebreast darter. It is necessary to violently disturb the rocks in order to dislodge the darter from its resting place beneath them. *P. camurus* was found in medium-sized streams with but one exception, a long riffle in the East Fork of White River at Shoals, Martin County. In Ohio one doubtful record from the Great Lakes drainage exists for this species (HUBBS and LAGLER, 1941: 75).

Poecilichthys zonalis zonalis Cope

Eastern banded darter

MAP 88

The eastern banded darter is not specific in its habitat preference in Indiana. To the northwest it was found in both the riffles and slow-moving parts of creeks and ditches which are generally heavily vegetated. In the southeast it was found in fast riffles composed of large rocks; aquatic vegetation was scant in this region, but some algae were growing on the rocks of a riffle in one locality.



The interesting distribution of this darter shows that it has entered northwestern Indiana by way of the Kankakee and Iroquois rivers and southeastern Indiana from the Ohio River. The only record known from the lower Wabash system (FORBES and RICHARDSON, 1920, map XCIII in Atlas) would indicate that this major river system was used only incidentally in the northward dispersal of the species. HUBBS and LAGLER (1941: 75) state that the banded darter has been recorded from the Great Lakes drainage in Wisconsin, Illinois (one record), and Ohio (one doubtful record). The native occurrence of this species in a Lake Erie tributary in Ohio becomes even more doubtful since we have discovered no additional evidence suggesting that the Maumee outlet was used in its migration.

Poecilichthys variatus (Kirtland)

Variiegated darter

MAP 89

In the Ohio valley of southcentral and southeastern Indiana, there are two medium-sized streams which have swift riffles made up of large rocks: the Big Blue River and the Whitewater River. It was in this environment that the variegated darter was caught. The habitats of *P. variatus* and *P. camurus* are very similar, and although they both were captured in the same stream, Big Blue River, they were never taken together at the same collecting site.

Poecilichthys jessiae asprigenis Forbes

Northern mud darter

Carroll Co.: Wabash R., Delphi (Evermann and Jenkins, 1892).

Gibson Co.: Fools Pond, 5 m. N.W. Poseyville (Hubbs and Lagler, 1942).

Knox Co.: Wabash R., 1½ m. N. Vincennes (Jordan, 1890).

Posey Co.: Wabash R., New Harmony (Jordan, 1890); Big Cr., 6½ m. N. Mt. Vernon (Jordan, 1890).

Our collections in Indiana did not reveal this species, although it is abundant in Illinois (FORBES and RICHARDSON, 1920, map XCIV in Atlas). HUBBS and LAGLER (1941: 75) list the mud darter in the Great Lakes fauna on the basis of one doubtful record from a tributary of the Maumee River in Ohio.

Poecilichthys exilis (Girard)

Iowa darter

MAP 90

The Iowa darter is restricted to northern Indiana where it is an inhabitant of the weedy glacial lakes of all three main drainage systems. It has also been found on a few sandy-bottomed creeks which were lake outlets, and at two localities along the lower Tippecanoe River.

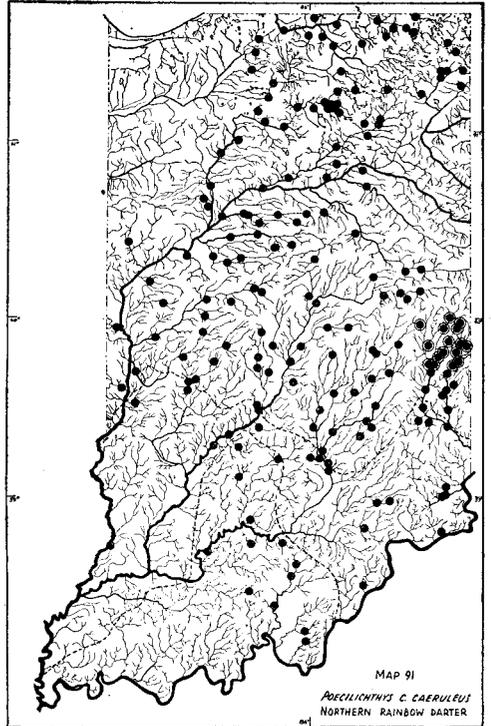
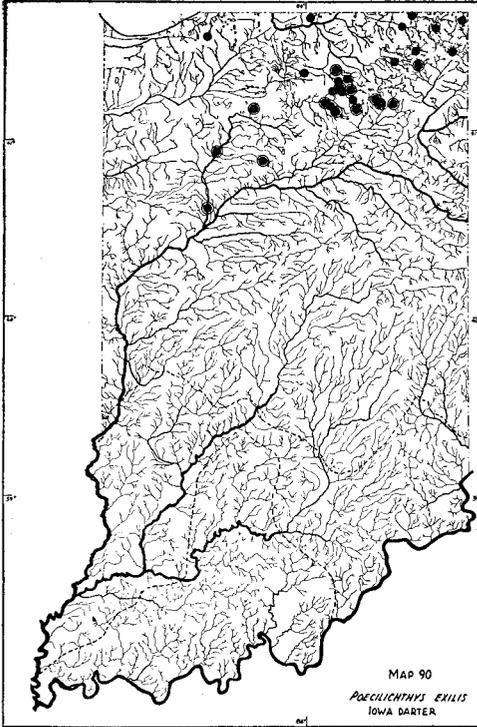
Poecilichthys caeruleus caeruleus (Storer)

Northern rainbow darter

MAP 91

This colorful darter is very common in fast, stony riffles of creeks and medium-sized streams of all Indiana drainages. A scarcity of records exists in the Kankakee-Iroquois region and in the southwestern, lowland

creeks. An explanation of this darter's absence in the former region lies in the fact that it was once a marshy area with little, if any, fast drainage streams; if riffles were present, they would have been destroyed by the extensive dredging carried out in this section. In the southwest the sluggish streams have none of the riffle habitats preferred by this species.

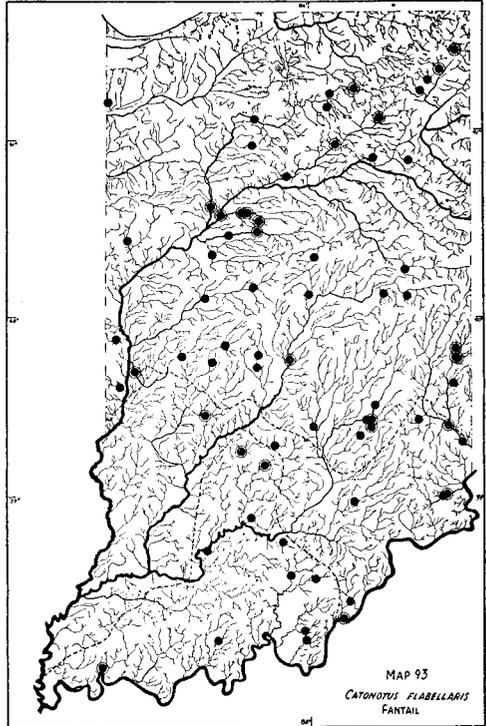
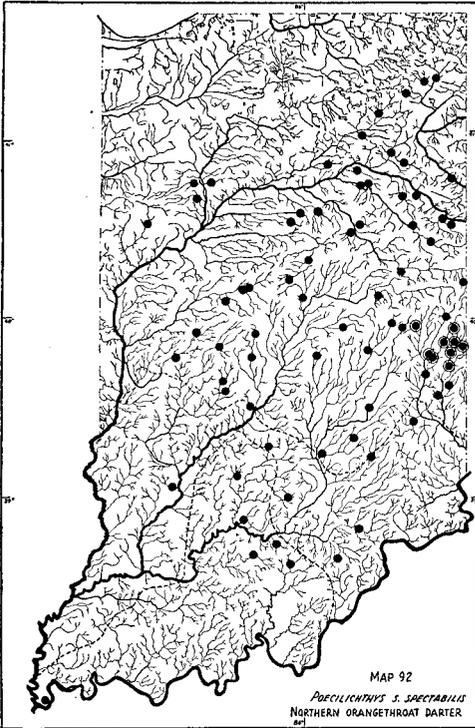


Poecilichthys spectabilis spectabilis Agassiz
Northern orangethroat darter

MAP 92

This darter is essentially a creek species, having been caught in other environments only a few times. Generally speaking, the orangethroat darter lives in less rapid riffles than the rainbow darter, though they have been taken together on a number of occasions. In fact *P. s. spectabilis* was taken a few times in weedy creeks where there were no riffles. This darter is absent in Indiana's Lake Michigan drainage, but occurs in the Wabash and Lake Erie drainage of Indiana, southeastern Michigan and western Ohio. This clearly indicates dispersal by the Maumee outlet but not the outlet of Lake Chicago.

Only recently have good characters been found to separate *P. spectabilis* and *P. caeruleus*. For that reason records of these two species from early authors were not placed on the distribution maps.



Poecilichthys tippecanoe (Jordan and Evermann)

Tippecanoe darter

Fulton Co.: Tippecanoe R., Marshland (Jordan and Evermann, 1891); Tippecanoe R., between Talma and Rochester (UMMZ, 1925).

Martin Co.: E. Fk. White R., Hindustan Falls near Shoals (UMMZ, 1936); E. Fk. White R., Shoals.

The Tippecanoe darter is rare in Indiana and was taken by us only on a long, swift, rocky riffle in the East Fork of White River where it was found along with *H. phoxocephalus* and other riffle-inhabiting species.

Catonotus Agassiz

Catonotus squamiceps (Jordan)

Spottail darter

Posey Co.: Gresham's Cr., 1½ m. E. New Harmony (Jordan, 1890); Black R., New Harmony (Jordan, 1890).

Although southwestern Indiana where Jordan caught this species was intensively collected, no specimens of the spottail darter were taken.

Catonotus flabellaris (Rafinesque)

Fantail

MAP 93

The only character separating the two fantail subspecies which occur in Indiana is not very distinctive. HUBBS and LAGLER (1941: 72) state that the lengthwise rows of dots or dashes are inconspicuous (fairly well

developed in breeding males) in *C. f. flabellaris* but are conspicuous (even in females) in *C. f. lineolatus*.

The greater part of fantail populations were obtained on gravelly and stony riffles of small creeks. As yet it has not been found in the Lake Michigan drainage of this state.

Catnotus flabellaris flabellaris (Rafinesque)

Barred fantail

Of the specimens examined only those from the Whitewater drainage seemed definitely referable to this subspecies. In the UMMZ, however, *flabellaris* is catalogued from the White River drainage as far south as Bloomington, Monroe County.

Catnotus flabellaris lineolatus Agassiz

Striped fantail

With the exception of the Whitewater drainage, individuals from all other parts of the state showed the *lineolatus* character, or at least a tendency in that direction. The UMMZ record of intergrades from Twelve Mile Creek, near Hoover, Cass County, tends to confirm this conception. HUBBS and LAGLER (1941: 76) have said that *C. f. lineolatus* is found ". . . to the western part of the Ohio River system in Indiana (at least as intergrades with *C. f. flabellaris*)." From our material it appears justifiable to identify some of the southern specimens as representative of typical *lineolatus*. Individuals from Buck Creek and Indian Creek, Harrison County, show a distinct lengthwise row of dashes, but those from central and northern Indiana may well be considered intergrades.

Hololepis Putnam

Hololepis gracilis (Girard)

Swamp darter

MAP 94

The swamp darter is a Mississippi valley species and is known in Indiana only from the lowland southwestern streams and one swamp. In four of our five collections of this species, it was taken in sluggish, turbid water on a rather firm bottom of sand (or sand and mud). The DeShee River, Knox County, has been previously described as a heavily vegetated ditch; the swamp darter was taken here in clear water with a moderate current on a sand bottom.

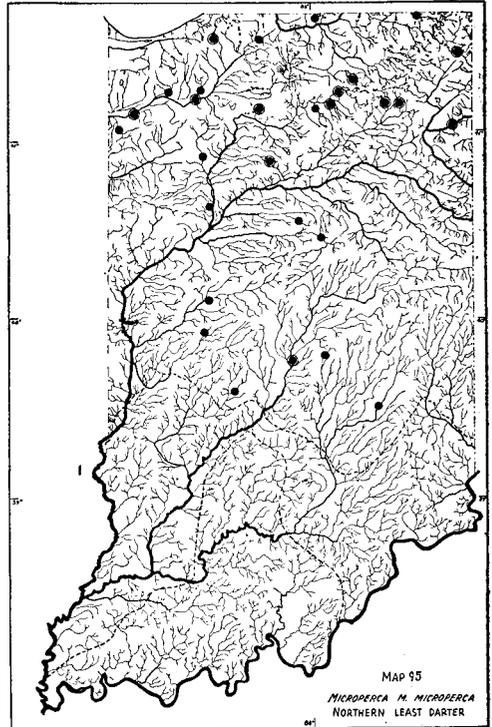
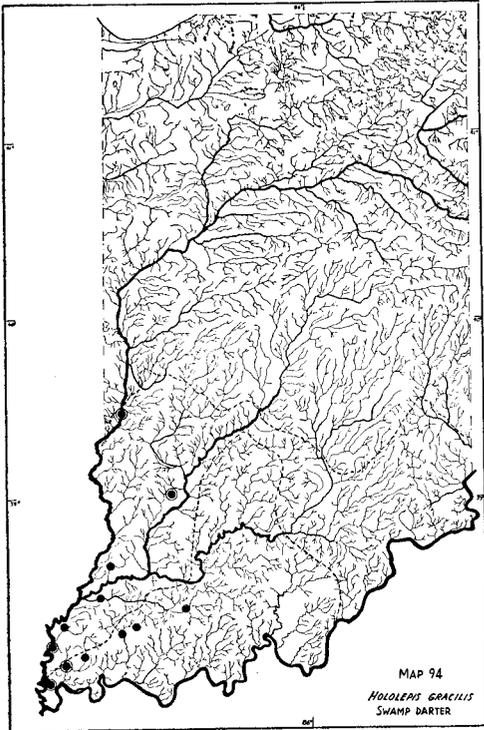
Microperca (Jordan and Gilbert)

Microperca microperca microperca (Jordan and Gilbert)

Northern least darter

MAP 95

In every case the least darter was seined in heavily vegetated environments of lakes, slowly moving creeks, and ditches. Its occurrence in our main drainage systems is correlated with clear water and soft bottoms of plant detritus.



Etheostoma Rafinesque
Etheostoma blennioides blennioides Rafinesque
Northern greenside darter

MAP 96

This is another one of the riffle-inhabiting darters frequenting small to medium-sized streams and occasionally larger ones. The rainbow and greenside darters are commonly taken together, but the latter appeared more abundant in riffles composed of large rocks. Only one record of this darter exists from the Lake Michigan drainage (HUBBS and LAGLER, 1941: 76). GREENE (1935: 190) mentions that this occurrence may have been caused by stream piracy or flood connections. If this is true the Chicago outlet would be excluded as a possible migratory route, leaving the Maumee outlet as its only entrance into the Great Lakes.

CENTRARACHIDAE Sunfishes and Black Basses

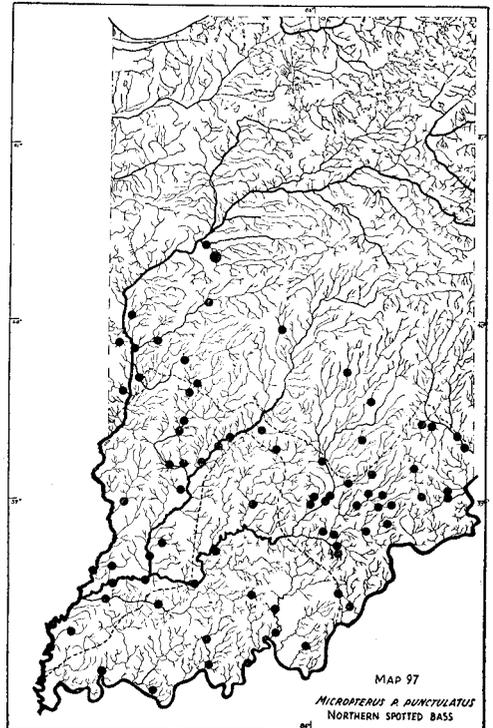
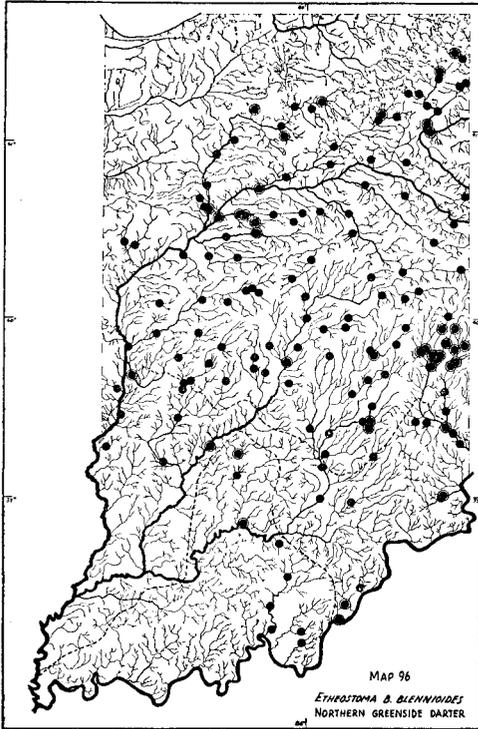
Micropterus Lacépède
Micropterus punctulatus punctulatus (Rafinesque)
Northern spotted bass, Kentucky bass

MAP 97

It was only a few years ago (HUBBS, 1927) that the spotted bass was recognized as a new species. Southern Indiana fishermen still do not usually recognize this fish, commonly referring to it as the largemouth bass. The

spotted bass is included among Indiana's game fishes and is well represented in the anglers' catch each year.

The distribution and habitat of the spotted bass have been discussed on page 16. In addition it can be stated that our collection from Wildcat Creek 14 miles northeast of Lafayette, Tippecanoe County, is the most northern record of this species. Naturally no literature records before 1927 were used for this or the other two species of black basses, as it is possible that early authors may have confused both the smallmouth and largemouth basses with the spotted bass.

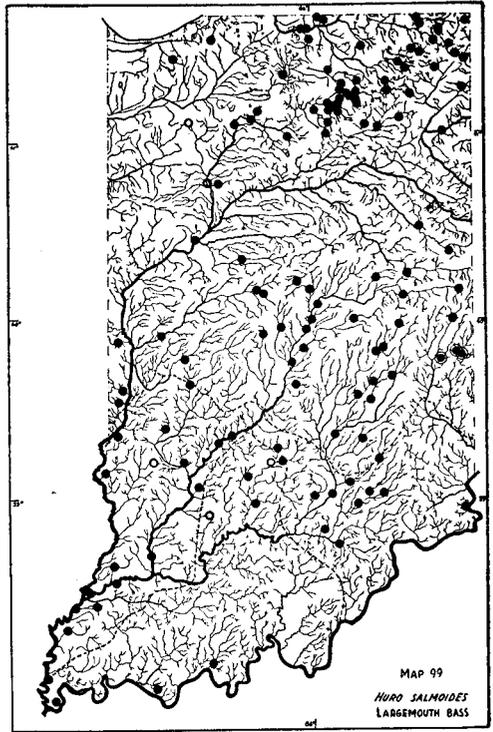
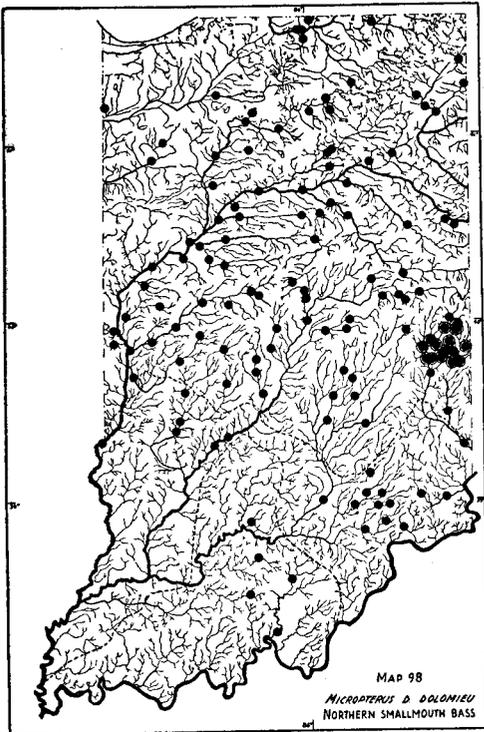


Micropterus dolomieu dolomieu Lacépède

Northern smallmouth bass

MAP 98

The smallmouth bass is a popular game fish whose fighting quality is ranked high by sport fishermen and has been planted extensively throughout the state. The usual habitat of the smallmouth bass in our waters is the gravel-bottomed streams of medium to large size and lakes having sandy or stony shores. Strictly weedy lakes do not suit it, and in such it is rare or absent. It is also absent from the lowland environments of southwestern Indiana.



Huro Cuvier
Huro salmoides (Lacépède)
Largemouth bass

MAP 99

Successful planting of the largemouth bass has been carried out for many years in Indiana's lakes and streams. The preference of *H. salmoides* for quiet, usually vegetated waters is manifested by its abundance in the northern lakes, where it is a prized game fish. It is also plentiful in the sluggish southwestern waters where *M. dolomieu* is absent.

Chaenobryttus Gill
Chaenobryttus coronarius (Bartram)

Warmouth

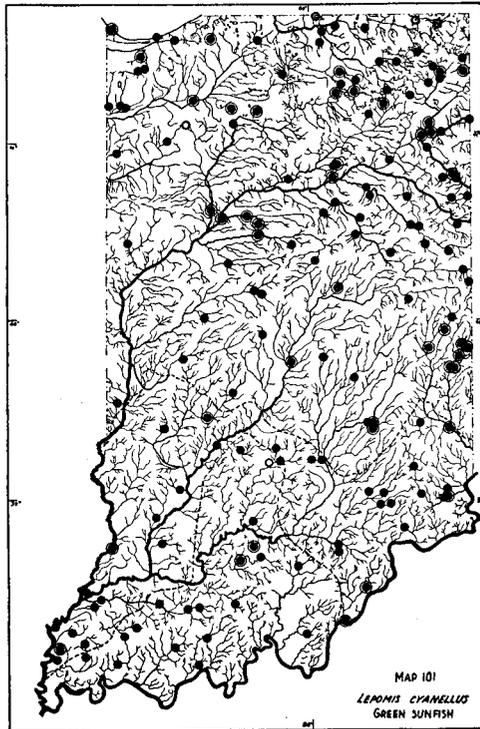
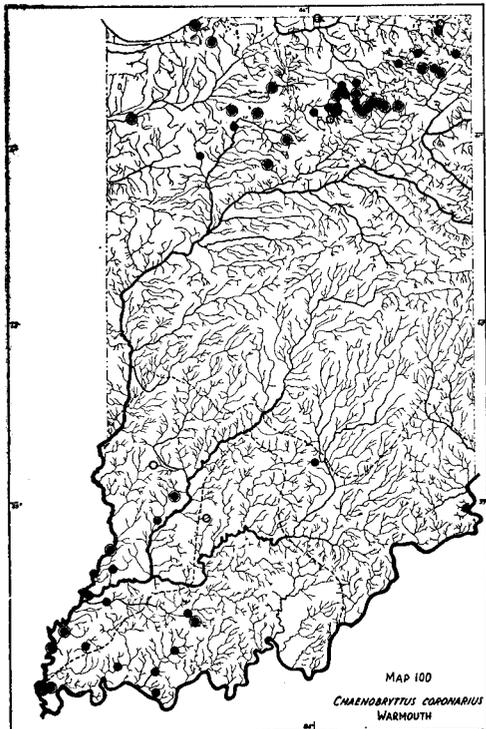
MAP 100

In northern Indiana the warmouth inhabits sluggish, soft-bottomed, excessively weedy situations in the lakes and streams. The majority of the southern collections of this species were not associated with weedy environments, but the many localities in the southwestern corner clearly show a preference for mud-bottomed, sluggish streams and standing water. There is a distinct break in its distribution in central Indiana where the proper habitat is scarce or lacking. Although the warmouth is common enough in the northern lakes, it is not usually sought after by pan-fish anglers.

Lepomis Rafinesque
Lepomis cyanellus Rafinesque
 Green sunfish

MAP 101

The green sunfish is chiefly distributed in the northern lakes and creeks of the state where it is abundant in weedy situations. However, this species rarely attains a size large enough to attract anglers. It is very tolerant of oxygen scarcity and other conditions of stagnation, hence is often the only centrarchid found in small ponds, or half-dried creeks.



Lepomis punctatus miniatus (Jordan)

Western spotted sunfish

Posey Co.: Wabash R., 7 m. W. Mt. Vernon (Jordan, 1890).

This is the only known locality for the spotted sunfish in Indiana. FORBES and RICHARDSON (1920, map LXXV in Atlas) also recorded it from the Wabash River near Jordan's collecting site.

Lepomis gibbosus (Linnaeus)

Pumpkinseed

MAP 102

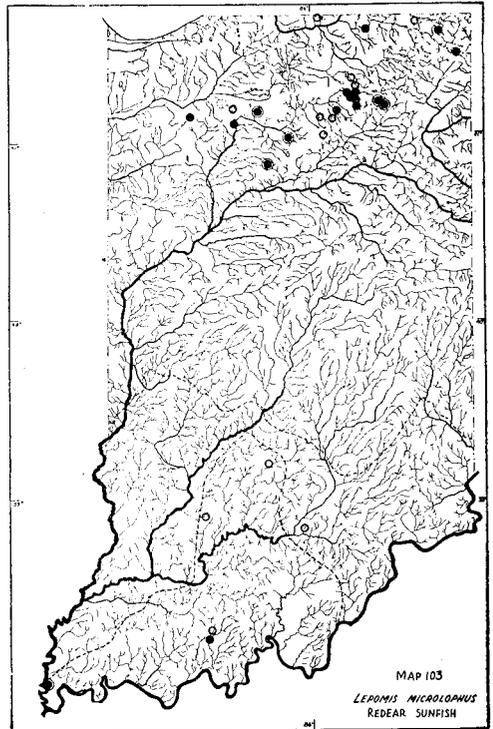
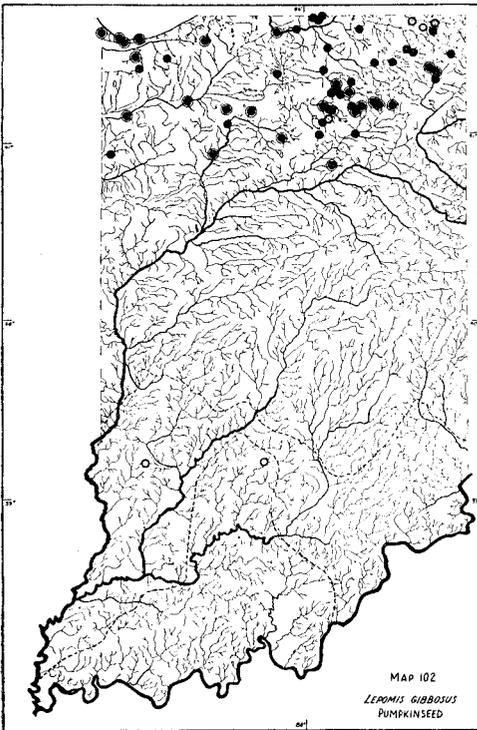
The pumpkinseed is a common pan-fish in the weedy parts of Indiana's northern lakes and streams. The two southern reports on the distribution map are from artificial lakes which have been recently stocked with this species.

Lepomis microlophus (Günther)

Redear sunfish, shellcracker

MAP 103

The original distribution of the redear sunfish in Indiana has been obscured by the propagation and stocking carried out by the state's fish hatcheries since 1932. JORDAN (1890) first recorded this species in Indiana from the Wabash River, 7 miles west of Mt. Vernon, Posey County, as *Lepomis notatus*, and another early record from Round Lake, Whitley County, is found in KIRSCH'S (1895a) paper. BLATCHLEY (1901) includes it in a list of species taken from Lake Manitou, Fulton County, by EIGENMANN, NORMAN and GOULD. EVERMANN and CLARK (1910) found the redear sunfish in Fletcher Lake, Fulton County, and the same authors (1920) list it from Lake Maxinkuckee, Marshall County.



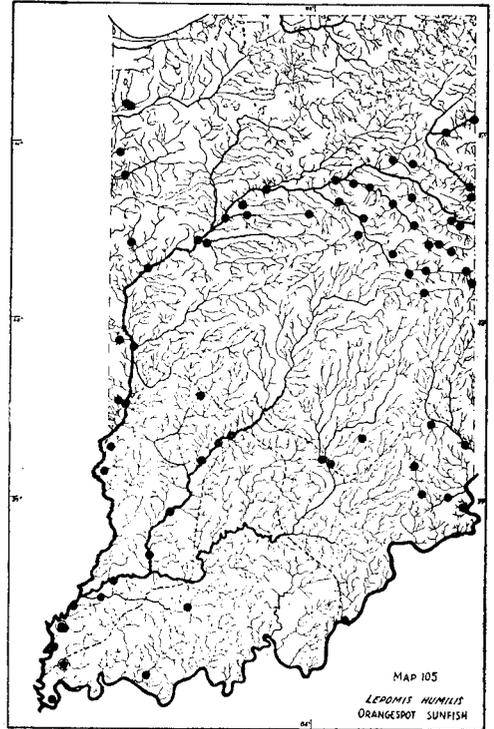
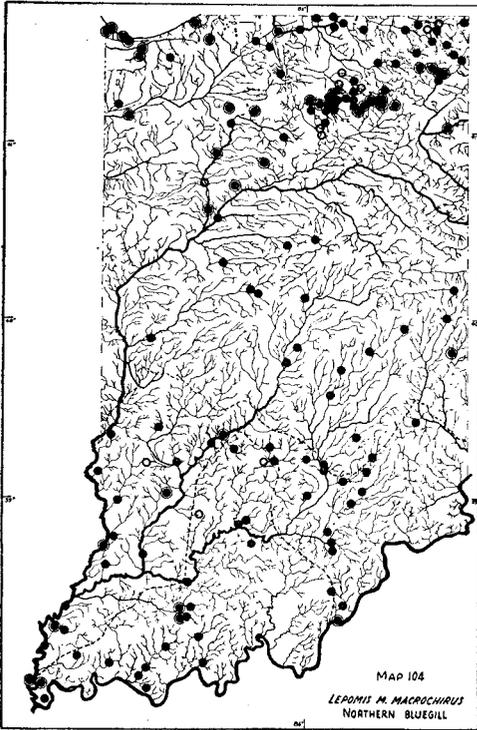
Although this sunfish has been planted in both lakes and streams, it has thrived only in the lakes. Of the two stream occurrences, one was taken by D. SCOTT in a backwater of the Tippecanoe River near Winamac, a locality which had recently been stocked, and where pond-like conditions prevailed. The other stream specimens were captured in the Anderson River, St. Meinard, Spencer County; this stream is an outlet of an artificial lake into which this species had been introduced.

Lepomis macrochirus macrochirus Rafinesque

Northern bluegill

MAP 104

The bluegill is our most abundant pan-fish, and the total angler's catch of this species no doubt exceeds any of the other centrarchids. It has been extensively stocked throughout the state, particularly in the lake district, being much more abundant in lakes than in the flowing streams. In both lakes and the quiet pools of streams aquatic vegetation is included in its habitat requirements, and the fingerlings, especially, seek the weeds for food and protection.

*Lepomis humilis* (Girard)

Orangespot sunfish

MAP 105

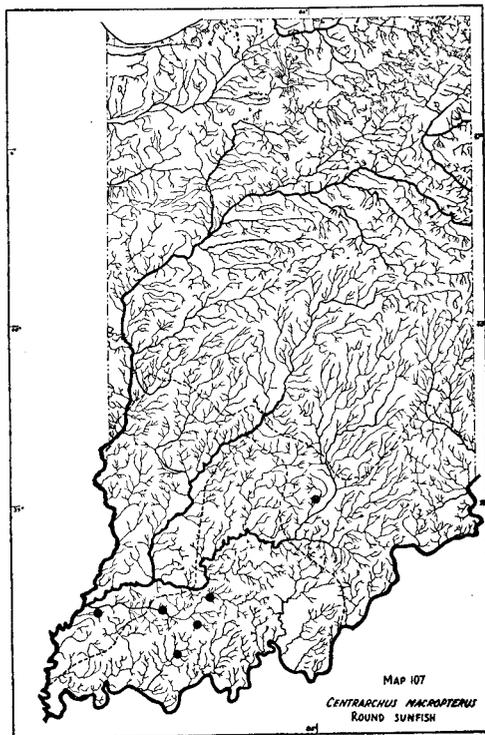
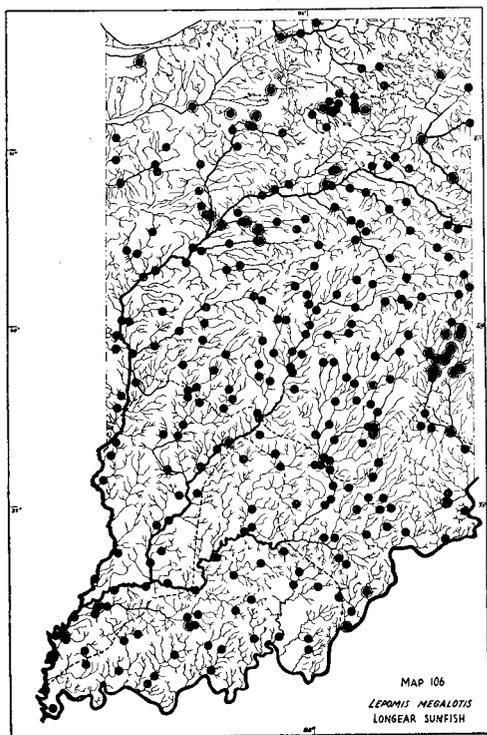
The orangespot sunfish is widely distributed in the Wabash, Ohio and Maumee drainages but is noticeably absent in the streams of the Lake Michigan watershed. It is not confined to any particular type or size of stream, having been caught in weedy ditches and large rivers; however, it is much more abundant in silty streams than in the clear ones. The Wabash is the only stream which *L. humilis* has consistently followed, and it has become abundantly established in two upper feeder streams, the Mississinewa and Salamonie rivers.

Lepomis megalotis (Rafinesque)
Longear sunfish

MAP 106

It has not been possible to make a statistical comparison of specimens of the longear sunfish from the north and south. However, experience gained from handling several hundred individuals from all parts of the state has given the impression that the length of mature northern longears is less than the length of those from the south. This impression falls in line with the results of HUBBS and COOPER (1935) who found that the longear sunfish becomes progressively dwarfed toward the north.

This sunfish is probably the most abundant centrarchid of our state. It lives in most lakes, and in the pools of streams of various sizes. The fingerlings are usually found in aquatic vegetation or quiet backwaters, but the adults have been found in all types of habitats.



Lepomis megalotis megalotis (Rafinesque)
Central longear sunfish

This subspecies is found in central and southern Indiana, however, there undoubtedly exists a broad zone of intergradation in the north between this and the following form.

Lepomis megalotis peltastes Cope

Great Lakes longear sunfish

This is the northern dwarfed subspecies which occupies the Great Lakes drainage (HUBBS and LAGLER, 1941: 79), and probably extends into some of the upper Wabash tributaries.

Centrarchus Cuvier and Valenciennes*Centrarchus macropterus* (Lacépède)

Round sunfish

MAP 107

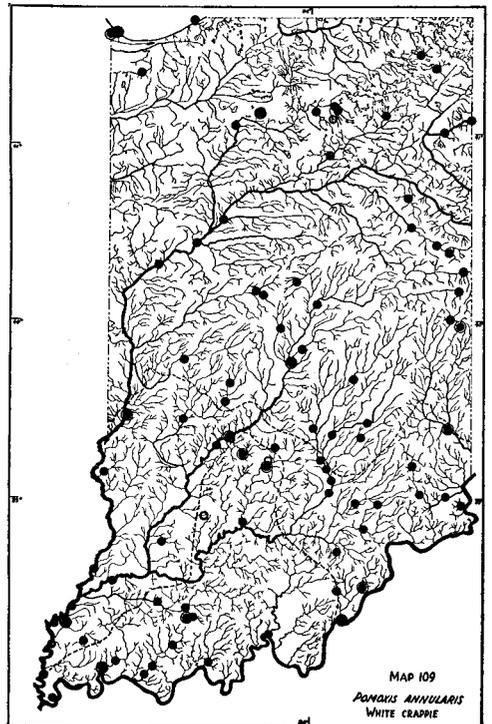
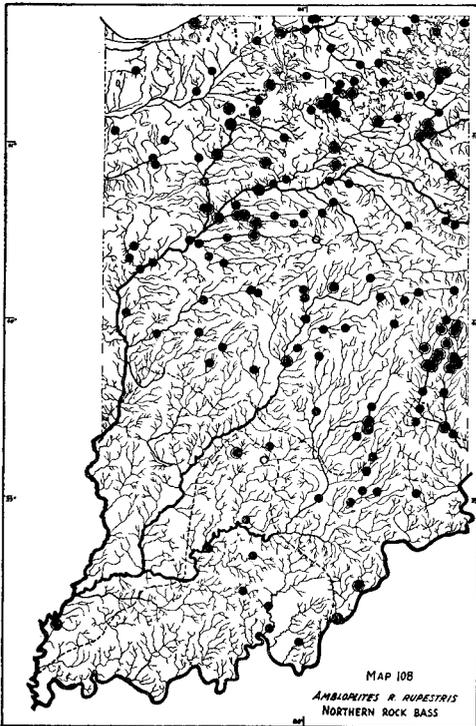
Although the round sunfish has never before been recorded in Indiana, its distribution covers a rather wide area in the Wabash and Ohio drainages of southern Indiana. This species has been caught only in quiet turbid water of small streams, usually over a mud bottom. It has a similar distribution and habitat in southern Illinois (FORBES and RICHARDSON 1920: 242 and map LXXII in Atlas).

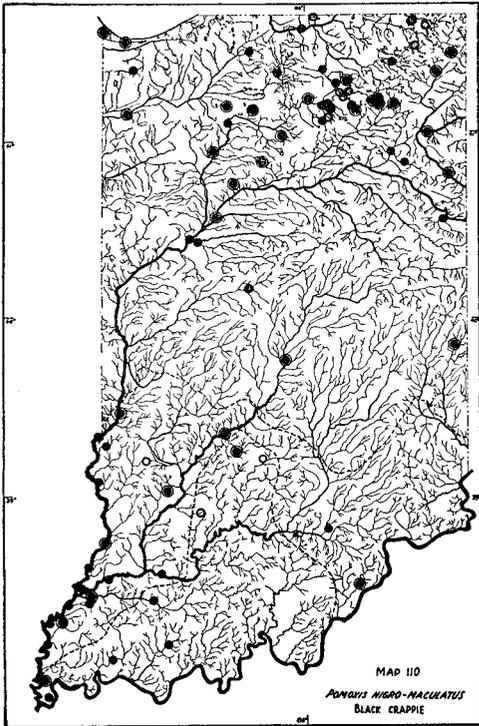
Ambloplites Rafinesque*Ambloplites rupestris rupestris* (Rafinesque)

Northern rock bass

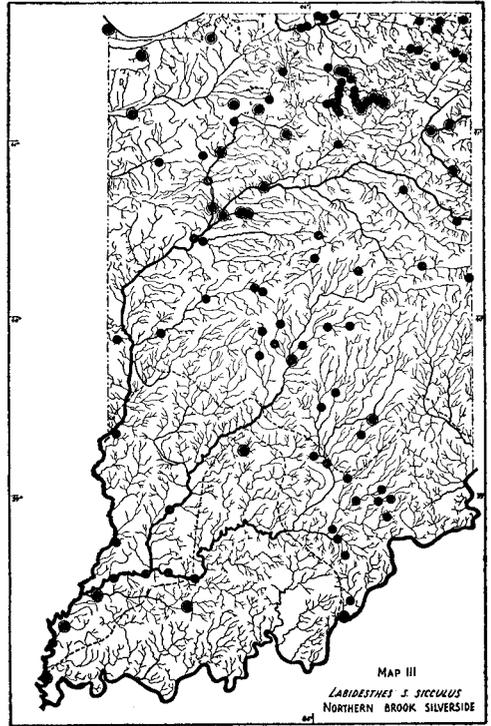
MAP 108

The rock bass is abundant in all parts of the state except the lowland environments of the southwest corner. Its most common habitat is hard-





MAP 110
POMOXIS NIGRO-MACULATUS
BLACK CRAPPIE



MAP 111
LABIDESTHES S. SICCULUS
NORTHERN BROOK SILVERSIDE

SCIAENIDAE Sheepsheads

Aplodinotus Rafinesque

Aplodinotus grunniens Rafinesque

Freshwater sheepshead, Drum, White perch

MAP 112

This species is a valuable commercial fish, particularly in the south where it abounds in the large rivers and their tributaries. In our collections it has been found more frequently in backwaters and sluggish streams; however, commercial fishermen catch the sheepshead in the stream channels. MEEK and HILDEBRAND (1910: 335) recorded the three localities in the Lake Michigan drainage. It has never been taken from the upper Wabash or Maumee drainages, but is common in Lake Erie.

COTTIDAE Muddlers

Cottus Linnaeus

Cottus bairdii Girard

Muddler

MAP 113

Two subspecies of *C. bairdii* and perhaps a third occur in the state. In the UMMZ specimens of the muddler from Michigan City are catalogued as the lake form, *C. b. kumbieni*, but the writer wishes to defer the inclusion of this form in Indiana's waters until more definite information is available. One very small specimen in our collections from Trail Creek

bottomed streams where it was usually caught in pools near undercut banks, large rocks, and flood debris. The young rock bass were most often obtained among weeds. The northern glacial lakes, except the smaller weedy ones, also provide suitable living conditions for this species, and it offers considerable sport fishing.

Pomoxis Rafinesque
Pomoxis annularis Rafinesque

White crappie

MAP 109

Both the black and white crappies are popular sport fishes in Indiana. They are both distributed in all our main drainage systems, but the black crappie is more abundant in the north while the white crappie dominates in the south. *P. annularis* is found in lakes, bayous, swamps, creeks, and large rivers. In flowing streams the white crappie is common in slow-moving pools and backwaters with mud bottoms; it is seldom taken in stream channels. Frequently the fingerlings have been seined in weedy situations. The black and white crappies have both been stocked in the natural and artificial lakes of the state.

Pomoxis nigro-maculatus (LeSueur)

Black crappie

MAP 110

In southern waters (both standing and flowing) where the two crappies were taken in the same collection, the white crappie was much the more abundant form. The glacial lake district is studded with *P. nigro-maculatus* records while only a few scattered localities are known for *P. annularis* from this region. Of the two species it appears that the black crappie is the least tolerant of silty water. Otherwise this species occupies much the same habitat as its fellow member of the genus.

ATHERINIDAE Silversides

Labidesthes Cope

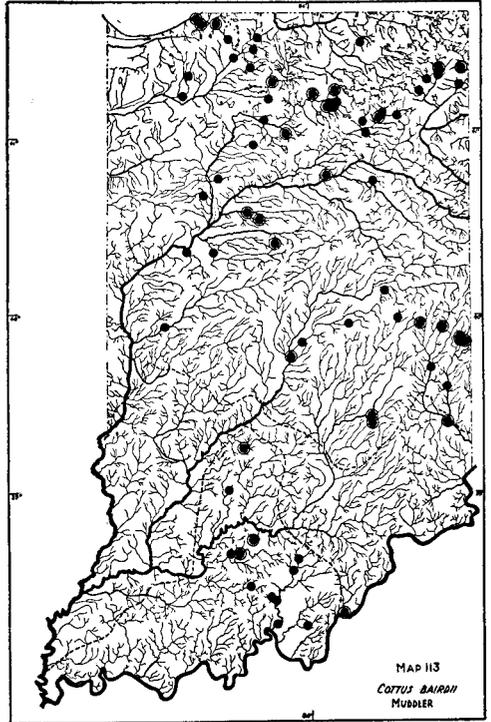
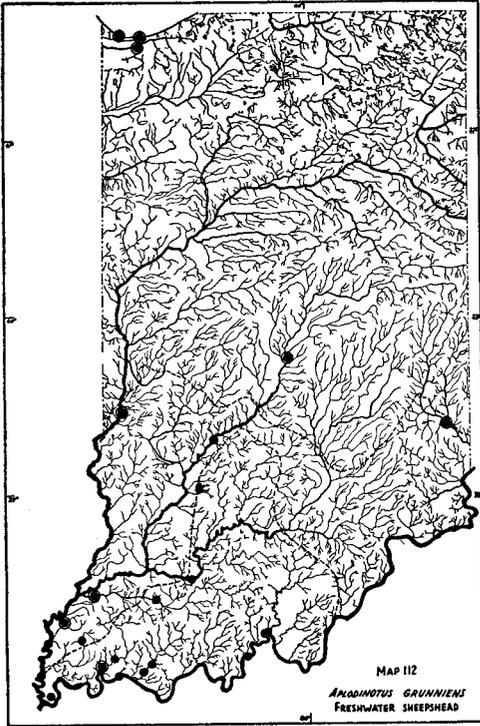
Labidesthes sicculus sicculus (Cope)

Northern brook silverside

MAP 111

The brook silverside is very common in the Indiana lakes and has been frequently taken from both small and large streams of the state's principal drainages. Where the brook silverside occurs, it is found in large schools; seldom are stray individuals seen. Occasionally it may be observed in weed beds, but primarily it is an open-water species, swimming at the water surface near shore and occasionally jumping clear of the water, as suggested by its popular name "skipjack." Neither stream size nor water turbidity has affected its distribution in Indiana, and it apparently has no preference for the type of bottom over which it lives, for it has been found in such varying habitats as marl lakes and rocky streams.

near Michigan City seemed to be *C. b. bairdii*. The other two forms, *C. b. bairdii* and *C. b. carolinae*, are very distinct, however. The subspecies *carolinae* differs from *bairdii* in having a complete lateral line and more distinct vertical bars. Both forms of the muddler occur in clear, cool creeks and are many times found under the rocks of riffles.



Cottus bairdii carolinae (Gill)

Tennessee muddler

Of all the specimens examined only those in a restricted region of south-central Indiana can be identified as this subspecies. The localities from which it was identified are: Patoka River, 10 miles south Paoli, Orange County; Little Indiana Creek, 4 miles southeast Corydon, Harrison County; the entire course of the Big Blue River in Washington and Harrison counties. The UMMZ has some *carolinae* individuals from a few of the south-central cave outlet creeks. Our southern specimens from the Whitewater River showed the *bairdii* characteristics, and SHOEMAKER (1942: 294) also classified Whitewater populations as *bairdii*.

The two subspecies appear to be sharply distinct; no evidence of intergradation was found in our material. However, Dr. HUBBS has catalogued intergrading specimens from Donaldson's Cave, 3 miles east Mitchell, Lawrence County.

Cottus bairdii bairdii Girard

Northern muddler

This species is the most abundant form, being found in all parts of the state except the south-central region. It is particularly common in the northern creeks where it is an associate of trout.

GASTROSTEIDAE Sticklebacks

Eucalia Jordan*Eucalia inconstans* (Kirtland)

Brook stickleback

Decatur Co.: Tributaries to Flat Rock R. and Clifty Cr. and from Clifty Cr. itself (Shannon, 1887).

Marshall Co.: L. Maxinkuckee, Culver (Evermann and Clark, 1920).

Wabash Co.: Kentner Cr. (Ulrey, 1894).

Wayne Co.: Spring pools of old marsh near Richmond (Shoemaker, 1942); vicinity of Richmond (Plummer, 1851).

This species was not found in our collections although it possibly occurs in more of the weedy, northern lakes.

Pungitius Coste*Pungitius pungitius* (Linnaeus)

Nine spine stickleback

BLATCHLEY (1938: 78) states that the nine spine stickleback is known in Indiana from Lake Michigan and the Calumet River. No early authors have recorded it in Indiana, and it must be assumed that BLATCHLEY observed the specimens himself. It is also known from other parts of Lake Michigan.

GADIDAE Cods

Lota Oken*Lota lota maculosa* (LeSueur)

Eastern burbot

Lake Co.: L. Michigan, Pine (Meek and Hildebrand, 1910); L. Michigan, Millers (Meek and Hildebrand, 1910).

LaPorte Co.: L. Michigan off Michigan City.

Our only representative of the cod family occurs in the deep, cold waters of Lake Michigan.

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APPENDIX A

Species of probable or possible occurrences in Indiana

From fishes known to occur in surrounding states. Dr. CARL L. HUBBS and the writer drew up the following list of species which may be found in Indiana.

Petromyzon marinus Linnaeus. Sea lamprey. This large parasitic lamprey is a recent migrant into Lake Michigan and may possibly be transported into the state attached to one of the larger species of lake fishes.

Leucichthys reighardi reighardi Koelz, Michigan shortnose chub; *L. zenithicus* (Jordan and Evermann), Shortjaw chub; *L. alpenae* Koelz, Longjaw chub; *L. kiyi kiyi* Michigan kiyi; *L. hoyi* (Gill), Great Lakes bloater; *L. nigripinnis nigripinnis* (Gill), Michigan blackfin; *L. johanna* (Wagner), Deepwater chub. Most of these species of lake herring prefer deep water, but they may at times be found in the Indiana waters of Lake Michigan.

Prosopium cylindraceum quadrilaterale (Richardson). Common Menoninee whitefish. The common Menoninee whitefish is a northern species which might also be found in southern Lake Michigan.

Carpiodes forbesi Hubbs. Slender carpsucker. This species is present west of the Mississippi and has been rarely reported from Ohio and Illinois.

Moxostoma breviceps (Cope). Shorthead redhorse. This sucker grows to a large size and is reported to be abundant in the Ohio River in Ohio. No doubt more intensive collecting in the Ohio River will reveal this species in Indiana.

Couesius plumbeus plumbeus (Agassiz). Lake northern chub. This is another Lake Michigan fish which may occur rarely in Indiana.

Platygobio gracilis communis (Girard). Flathead chub. This minnow is an inhabitant of the streams of the Missouri River drainage and has been taken in Illinois.

Extrarius aestivalis, new subsp. Hubbs.

Macrhybopsis meeki (Jordan and Evermann); *Macrhybopsis gelidus* (Girard). These two species are Mississippi valley forms which may penetrate Indiana waters.

Parexoglossum hubbsi Trautman. Chub minnow. M. B. TRAUTMAN described this species in 1931 from specimens collected in western Ohio. Thus far it has not been found in Indiana.

Clinostomus vandoisulus (Valenciennes). Rosy dace.

Margariscus margarita nachtriebi (Cox). Northern pearl dace. This minnow may rarely be found in the cold, springfed creeks of our Great Lakes drainage.

Pfrille neogea (Cope). Finescale dace. This is another northern minnow which may be found in the cool waters of the Great Lakes drainage.

Chrosomus eos (Cope). Northern redbelly dace. This species is the northern relative of *Chrosomus erythrogaster*, which is the southern representative of the genus found in Indiana. *C. eos* may rarely occur in cool northern situations.

Notropis umbratilis umbratilis (Girard). Southern redbfin shiner. This is the southern subspecies of *Notropis umbratilis*. None of our collections of the redbfin shiner were identified as this southern subspecies, but further detailed study is required before this form can be conclusively excluded from the state's fish fauna.

Notropis venustus cercostigma (Cope). Central blacktail shiner. A southern species.

Notropis lutrensis lutrensis (Baird and Girard). This minnow is known from the Mississippi River and its tributaries. Extensive collections in southwestern Indiana may reveal that it occasionally migrates up the Ohio River as far as our state.

Notropis dorsalis dorsalis (Agassiz). Central bigmouth shiner. Local populations of the central bigmouth shiner almost surely occur in the waters of Indiana, although our extensive collections have failed to find them. It is known from southern Michigan, Illinois, and Ohio.

Notropis heterolepis, new subsp. Hubbs.

Dionda nubila (Forbes). This is a species of the western United States which has been found rarely in Illinois and further collecting may reveal it in southern Indiana.

Hybognathus hankinsoni Hubbs. Brassy minnow. The brassy minnow occurs in the northern part of the United States from Montana to New England. It may rarely be found in northern Indiana.

Hybognathus placitus placitus Girard.

Pimephales promelas: confertus × *promelas*. The southern subspecies of the fat-head minnow may intergrade with the northern form in southern Indiana, but our collections of *P. promelas* in this region were not sufficient to determine the suspected intergradation.

Forbesichthys papilliferus (Forbes). A cave fish found in southern Illinois. It differs from our *Amblyopsis* in being pigmented and having less degenerate eyes.

Poecilichthys maculatus (Kirtland). Spotted darter.

Catnotus kennicottii Putnam, subsp. Stripetail darter. This southern darter may possibly reach its northern limit in southern Indiana.

Microperca proelialis Hay. Cypress darter. The cypress darter may still be found in the existent cypress swamps of the southwestern part of the state.

Elassoma zonatum Jordan. Pigmy sunfish. This tiny sunfish may also be found in the lowlands of southern Indiana.

Lepomis symmetricus Forbes. Small sunfish. Since the small sunfish is known from Illinois, it may well occur in scattered localities of our state.

Trigloopsis thompsonii Girard. Deepwater sculpin. This species prefers deep waters and may occasionally be a migrant into the Indiana waters of Lake Michigan.

Cottus bairdii kumlieni (Hoy). Great Lakes muddler. More extensive collections of the creeks entering Lake Michigan may reveal that this subspecies occurs in the state.

Cottus cognatus Richardson. Slimy muddler. This is another muddler which may enter the Indiana waters of Lake Michigan.

Cottus ricei Nelson. Spoonhead muddler. The spoonhead muddler is another deep water inhabitant of the Great Lakes which may occasionally be found in the Lake Michigan waters of Indiana.

APPENDIX B

Locality identification of numbers shown on MAP 2

1940 COLLECTIONS

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Winona Lake—Winona Lake, Kosciusko Co. 2. Cherry Creek—Winona Lake, Kosciusko Co. 3. Shoe Lake—5 m. N.E. Warsaw, Kosciusko Co. 4. Simonton Lake—3 m. N. Elkhart, Elkhart Co. 5. Winona Lake Outlet—Winona Lake, Kosciusko Co. 6. Tippecanoe River—3 m. N. Warsaw, Kosciusko Co. 7. Tippecanoe River—1½ m. S.W. Oswego, Kosciusko Co. 8. Tippecanoe River—1½ m. N. Warsaw, Kosciusko Co. 9. Tippecanoe River—3 m. N.W. Mentone, Marshall Co. 10. Chapman Lake—4 m. N.E. Warsaw, Kosciusko Co. 11. Dewart Lake—5 m. N.E. Leesburg, Kosciusko Co. 12. Yellow Creek—2 m. S.E. Elkhart, Elkhart Co. 13. Duck Pond of John Banks—7 m. N.E. Elkhart, Elkhart Co. 14. Heaton Lake—4 m. N.E. Elkhart, Elkhart Co. 15. Christiana Creek—4 m. N. Elkhart, Elkhart Co. 16. Little Elkhart River—1½ m. E. Bristol, Elkhart Co. 17. Fawn River—1 m. W. Orland, Steuben Co. 18. Center Lake—Warsaw, Kosciusko Co. 19. Pike Lake—Warsaw, Kosciusko Co. 20. Sugar Creek—2 m. E. Mechanicsburg, Boone Co. 21. Sugar Creek—1 m. E. Mechanicsburg, Boone Co. 22. Carr Lake—2 m. N. Claypool, Kosciusko Co. 23. Silver Lake—Silver Lake, Kosciusko Co. 24. Tippecanoe Lake—Oswego, Kosciusko Co. 25. Webster Lake—North Webster, Kosciusko Co. 26. Ridinger Lake—5 m. S. North Webster, Kosciusko Co. 27. Mud Creek—4½ m. E. Mechanicsburg, Boone Co. 28. West Fork White River—2 m. S. Noblesville, Hamilton Co. 29. Eel River—1 m. W. North Manchester, Wabash Co. 30. Trimble Creek—6½ m. W. Warsaw, Kosciusko Co. 31. Eddy Creek—2 m. N.E. Leitersford, Fulton Co. 32. Wawasee Lake—5 m. S.E. Syracuse, Kosciusko Co. 33. St. Joseph River—Elkhart, Elkhart Co. | <ol style="list-style-type: none"> 34. Kuhn Lake—3 m. S. North Webster, Kosciusko Co. 35. Clear Lake—4 m. E. Fremont, Steuben Co. 36. Sylvan Lake—Rome City, Noble Co. 37. Yellow River—3½ m. S.W. Nappanee, Marshall Co. 38. Turkey Creek—6 m. E. Nappanee, Elkhart Co. 39. Baugo Creek—Jamestown, Elkhart Co. 40. Elkhart River—Goshen, Elkhart Co. 41. Sheep Creek—5 m. W. Bristol, Elkhart Co. 42. Grassy Creek—3 m. S.W. Wilmot, Kosciusko Co. 43. Big Barbee Lake—2 m. S.W. North Webster, Kosciusko Co. *44. Deed's Creek—2 m. N. Winona Lake, Kosciusko Co. 45. Walnut Creek—2 m. S. Warsaw, Kosciusko Co. 46. Wolf Creek—2 m. S.E. Thorntown, Boone Co. 47. Kilmore Creek—2 m. S. Cambria, Clinton Co. 48. Raccoon Creek—Mansfield, Parke Co. 49. Wabash River—4 m. S.W. Prairietown, Vigo Co. 50. Little Eagle Creek—4 m. S.W. Sheridan, Hamilton Co. 51. Eagle Creek—Rosstown, Boone Co. 52. Fall Creek—Pendleton, Madison Co. 53. White River—8 m. N. Indianapolis, Marion Co. 54. White Lick Creek—Plainfield, Hendricks Co. 55. Jasper-Pulaski Game Preserve Pond—5 m. N. Medaryville, Pulaski Co. 56. Indiana Lake—3 m. N. Bristol, Elkhart Co. 57. Stoney Creek—Millersburg, Elkhart Co. 58. Bass Lake—5 m. S. Knox, Starke Co. |
| <h4 style="margin: 0;">1941 COLLECTIONS</h4> | |
| <ol style="list-style-type: none"> 100. Eel River—6 m. N. Wabash, Wabash Co. 101. Wabash River—Wabash, Wabash Co. 102. Salamonie River—Dora, Wabash Co. 103. Mississinewa River—5 m. S. Wabash, Wabash Co. 104. Pipe Creek—7 m. S.W. Somerset, Miami Co. 105. Deer Creek—3 m. N. Wapecong, Miami Co. 106. Deer Creek—5 m. N.W. Galveston, Cass Co. 107. Eel River—Adamsborough, Cass Co. 108. Wabash River—Peru, Miami Co. 109. South Fork Deer Creek—5 m. N. Kokomo, Howard Co. | |
| <p>* Not shown on map.</p> | |

110. Little Wildcat Creek—4 m. S. Kokomo, Howard Co.
111. Wildcat Creek—1 m. S. Greentown, Howard Co.
112. Mississinewa River—4 m. N. Marion, Grant Co.
113. Paw Paw Creek—5 m. N. Wabash, Wabash Co.
114. Tamarak Bog Outlet—Indiana Dunes State Park, Porter Co.
115. Little Calumet River—Chesterton, Porter Co.
116. Mink Lake—2 m. N. Flintville, Porter Co.
117. Salt Creek—6 m. E. Hobart, Porter Co.
118. Deep River—2½ m. S. Ainsworth, Lake Co.
119. Wolf Creek—4 m. S. Plymouth, Marshall Co.
120. Yellow River—2 m. S. Twin Lakes, Marshall Co.
121. Lake of the Woods—10 m. N.E. Plymouth, Marshall Co.
122. Pine Creek—7 m. W. Lapaz, Marshall Co.
123. Kankakee River—3 m. S.E. Union Center, LaPorte Co.
124. Mill Creek—4 m. N.E. Hanna, LaPorte Co.
125. Hawk Creek—3 m. S. Wanatah, LaPorte Co.
126. Pine Lake—LaPorte, LaPorte Co.
127. Little Kankakee River—5 m. E. LaPorte, LaPorte Co.
128. Trail Creek—4½ m. E. Michigan City, LaPorte Co.
129. Lake Michigan (shore)—Michigan City, LaPorte Co.
130. Potato Creek—1 m. W. North Liberty, St. Joseph Co.
131. Kankakee River—4½ m. N. North Liberty, St. Joseph Co.
132. St. Joseph River—½ m. N. Osceola, St. Joseph Co.
133. Emma Creek—3 m. N.W. Schrock, LaGrange Co.
134. Turkey Creek (Pigeon River)—1 m. N. Seybert, LaGrange Co.
135. Lake Shipshewana—Shipshewana, LaGrange Co.
136. Turkey Creek (Pigeon River)—1½ m. S.E. Mongo, LaGrange Co.
137. Pretty Lake—5 m. N.E. South Milford, LaGrange Co.
138. Nameless Creek—3½ m. S.E. Rome City, Noble Co.
139. North Branch Elkhart River—Springfield, Noble Co.
140. Elkhart River—1 m. W. Ligonier, Noble Co.
141. South Branch Elkhart River—1 m. W. Albion, Noble Co.
142. Nameless Creek—4½ m. S. Albion, Noble Co.
143. Blue River—3 m. N. E. Columbia City, Whitley Co.
144. Spring Creek—3 m. N. South Whitley, Whitley Co.
145. Sugar Creek—1 m. S. South Whitley, Whitley Co.
146. Eel River—3 m. S. Columbia City, Whitley Co.
147. Eel River—6 m. E. Columbia City, Whitley Co.
148. Cedar Creek—4 m. E. Hunterstown, Allen Co.
149. Twenty-six Mile Creek—Newville, DeKalb Co.
150. Maumee River—Ohio State Line, Allen Co.
151. St. Joseph River—1 m. W. Ohio State Line, Dekalb Co.
152. Maumee River—New Haven, Allen Co.
153. St. Joseph River—Cedarville, Allen Co.
154. St. Mary's River—6 m. S. Fort Wayne, Allen Co.
155. Yellow Creek—4 m. W. Decatur, Adams Co.
156. Nameless Creek—3½ m. S.E. Decatur, Adams Co.
157. St. Mary's River—Pleasant Mills, Adams Co.
158. Blue Creek—4 m. S. Pleasant Mills, Adams Co.
159. Blue Creek—3½ m. S. Munroe, Adams Co.
160. Limberlost Creek—Geneva, Adams Co.
161. Wilson Creek—5 m. S.E. Geneva, Jay Co.
162. Little Salamonie River—1 m. S. Portland, Jay Co.
163. Salamonie River—5 m. S.E. Pennville, Jay Co.
164. Brook's Creek—4 m. S. Pennville, Jay Co.
165. Nameless Creek—5 m. S.W. Hartford City, Blackford Co.
166. Scuffle Creek—1 m. S.W. Keystone, Wells Co.
167. Salamonie River—3 m. W. Keystone, Wells Co.
168. Lugar Creek—3 m. E. Marlon, Grant Co.
169. Deer Creek—4 m. S. Marlon, Grant Co.
170. Hummel Creek—1 m. N. Marlon, Grant Co.
171. Salamonie River—2 m. S. Warren, Huntington Co.
172. Rock Creek—1 m. N. Liberty Center, Wells Co.
173. Eight-mile Creek—½ m. S. Zanesville, Wells Co.
174. Little Wabash River—Roanoke, Huntington Co.
175. Bluff Creek—4 m. N.E. Huntington, Huntington Co.
176. Clear Creek—3 m. W. Huntington, Huntington Co.
177. Loon Creek—Andrews, Huntington Co.
178. Iroquois River—3 m. N. Kentland, Newton Co.
179. Wabash River—Independence, Warren Co.
180. Little Shawnee Creek—4 m. S. Attica, Fountain Co.
181. Wabash River—Perrysville, Fountain Co.
182. Coal Creek—6 m. E. Perrysville, Fountain Co.
183. Big Vermillion—4 m. N.W. Cayuga, Vermillion Co.
184. Little Vermillion River—4 m. S. Cayuga, Vermillion Co.

185. Wabash River—Mouth of Sugar Creek, Parke Co.
186. Sugar Creek,—3 m. N. Marshall, Parke Co.
187. East Fork Coal Creek—1 m. E. Hillsboro, Fountain Co.
188. Sugar Creek—1 m. N. Darlington, Montgomery Co.
189. Walnut Fork—5 m. E. Crawfordsville, Montgomery Co.
190. Sugar Creek—5 m. S. Yountsville, Montgomery Co.
191. Cornstalk Creek—2 m. W. Ladoga, Montgomery Co.
192. Raccoon Creek—2 m. E. Portland Mills, Putnam Co.
193. Raccoon Creek—6 m. S.W. Rockville, Parke Co.
194. Brouillette's Creek—2½ m. S.W. Clinton, Vermillion Co.
195. Coal Creek—2 m. S.W. New Goshen, Vigo Co.
196. Wabash River—1 m. S. Tecumseh, Vigo Co.
197. Blue Hole—2½ m. S.W. Prairietown, Vigo Co.
198. Birch Creek—1½ m. S.W. Ashboro, Clay Co.
199. Eel River—5 m. S. Clay City, Clay Co.
200. Lick Creek—¾ m. Hummel, Owen Co.
201. Prairie Creek—2 m. W. Prairie Creek, Vigo Co.
202. Eel River—Bowling Green, Clay Co.
203. West Fork White River—Freedom, Owen Co.
204. Eel River—2 m. W. Poland, Clay Co.
205. Big Walnut Creek—5 m. S.W. Greencastle, Putnam Co.
206. Little Walnut Creek—5½ m. W. Greencastle, Putnam Co.
207. Plumb Creek—8 m. N.E. Greencastle, Putnam Co.
208. Big Walnut Creek—2 m. N.W. Greencastle, Putnam Co.
209. Deer Creek—4 m. S. Greencastle, Putnam Co.
210. West Fork White River—McCormick's Creek State Park, Owen Co.
211. Sand's Creek—1 m. N.W. Scipio, Jennings Co.
212. North Branch Muskatatuck River—1 m. E. North Vernon, Jennings Co.
213. South Branch Muskatatuck River—2 m. S. Butlerville, Jennings Co.
214. Graham's Fork Muskatatuck River—2 m. S.W. San Jacinto, Jennings Co.
215. Vernon's Fork Muskatatuck River—2½ m. S.W. North Vernon, Jennings Co.
216. Big Creek—1 m. N. Deputy, Jefferson Co.
217. Big Creek—1 m. N. Lancaster, Jefferson Co.
218. Indian Kentuck Creek—China, Jefferson Co.
219. Nameless Creek—1 m. S. Scottsburg, Scott Co.
220. Ox Creek—2½ m. W. Scottsburg, Scott Co.
221. Stucker Fork—2 m. S.W. Austin, Scott Co.
222. Vernon Fork Muscatatuck River—2 m. S.W. Crothersville, Jackson Co.
223. Grassy Fork—1½ m. S.W. Tampico, Jackson Co.
224. East Fork White River—1½ m. N. Seymour, Jackson Co.
225. East Fork White River—Seymour, Jackson Co.
226. White Creek—4½ m. N. Brownstown, Jackson Co.
227. Tippecanoe River—2 m. N. Rochester, Fulton Co.
228. Lake Manitou—1½ m. S.E. Rochester, Fulton Co.
229. Mill Creek Ditch—2 m. S.W. Kewanee, Fulton Co.
230. Tippecanoe River—3 m. N.W. Delong, Fulton Co.
231. Little Mill Creek—2 m. S.W. Winamac, Pulaski Co.
232. Tippecanoe River—4 m. S.W. Pulaski, Pulaski Co.
233. Big Creek—2 m. N.W. Chalmers, White Co.
234. Monon Ditch—5 m. S.E. Francesville, Pulaski Co.
235. Wildcat Creek—1 m. N. Owasco, Carroll Co.
236. Wildcat Creek—2 m. N.W. Burlington, Carroll Co.
237. Deer Creek—Camden, Carroll Co.
238. Rock Creek—2½ m. N.E. Rockfield, Carroll Co.
239. Mud Creek—1½ m. S.W. Homer, Rush Co.
240. Big Flat Rock River—6 m. S.E. Rushville, Rush Co.
241. Flat Rock River—6 m. N.W. Greensburg, Decatur Co.
242. Clifty Creek—5½ m. W. Greensburg, Decatur Co.
243. Muddy Fork—3 m. S.W. Greensburg, Decatur Co.
244. Sand Creek—3 m. S.E. Westport, Decatur Co.
245. Little Graham's Creek—3 m. S.E. San Jacinto, Ripley Co.
246. Plumb Creek—2 m. E. Vevay, Switzerland Co.
247. Indian Creek—1½ m. W. Vevay, Switzerland Co.
248. Arnold Creek—1 m. S.W. Rising Sun, Ohio Co.
249. Laughery Creek—Milton, Ohio Co.
250. South Hogan Creek—5 m. W. Aurora, Dearborn Co.
251. Laughery Creek—5 m. S.E. Versailles, Ripley Co.
252. Laughery Creek—3 m. N.E. Osgood, Ripley Co.
253. Whitewater River—3 m. N.W. West Harrison, Dearborn Co.
254. Whitewater River—Cedar Grove, Franklin Co.
255. Pipe Creek—3 m. N.W. Oak Forest, Franklin Co.

256. Big Salt Creek—2 m. W. Pepperton, Franklin Co.
257. West Fork Whitewater River—1 m. S. Laurel, Franklin Co.
258. East Fork Whitewater River—2 m. S. Fairfield, Franklin Co.
259. Silver Creek—2 m. S.W. Liberty, Union Co.
260. Ellis Creek—2½ m. S. Dunlapville, Union Co.
261. East Fork Whitewater River—4 m. N. Fairfield, Union Co.
262. West Fork Whitewater River—1½ m. N. Alpine, Fayette Co.
263. East Fork Whitewater River—1½ m. N.E. Brownsville, Union Co.
264. West Fork Whitewater River—½ m. W. Waterloo, Fayette Co.
265. Shankitank Creek—3 m. N.E. Rushville, Rush Co.
266. Little Blue River—3 m. S.E. Arlington, Rush Co.
267. Lake Michigan (out in lake)—Michigan City, LaPorte Co.
268. Willow Creek—2 m. W. Laotto, Noble Co.
- *269. Winona Lake—Winona Lake, Kosciusko Co.
270. West Fork White River—Spencer, Owen Co.
271. Fooths Pond—5 m. N.E. Poseyville, Gibson Co.
272. Wabash River—Terre Haute, Vigo Co.
- *273. Shoe Lake—2 m. W. Oswego, Kosciusko Co.
- *274. Tippecanoe Lake—Oswego, Kosciusko Co.
- 1942 COLLECTIONS
300. Busseron Creek—1 m. W. Carlisle, Sullivan Co.
301. Turman Creek—2 m. W. Graysville, Sullivan Co.
302. Lattas Creek—2 m. N.W. Bloomfield, Greene Co.
303. Richland Creek—2 m. N.E. Bloomfield, Greene Co.
304. Bean Blossom Creek—7 m. N.E. Ellettsville, Monroe Co.
305. Salt Creek—Nashville, Brown Co.
306. Driftwood River—Columbus, Bartholomew Co.
307. Flat Rock River—2 m. N.E. Columbus, Bartholomew Co.
308. Haw Creek—½ m. E. Columbus, Bartholomew Co.
309. Clifty Creek—2 m. S. Columbus, Bartholomew Co.
310. East Fork White River—Azalla, Bartholomew Co.
311. White Creek—5 m. S.W. Cortland, Jackson Co.
312. South Branch Salt Creek—Freetown, Jackson Co.
313. Leatherwood Creek—1 m. S. Bedford, Lawrence Co.
314. East Fork White River—2 m. S.W. Bedford, Lawrence Co.
315. Twin Creek—9 m. N.W. Salem, Washington Co.
316. Blue River—1 m. W. Salem, Washington Co.
317. Blue River—5 m. S.W. Salem, Washington Co.
318. South Fork Blue River—3 m. E. Pekin, Washington Co.
319. Muddy Fork Silver Creek—Bennetsville, Clark Co.
320. Silver Creek—3 m. S. Sellersburg, Clark Co.
321. Buck Creek—2 m. S. New Middleton, Harrison Co.
322. Little Indian Creek—4 m. S.E. Corydon, Harrison Co.
323. Blue River—Milltown, Crawford Co.
324. Patoka River—10 m. S. Paoli, Orange Co.
325. Lost River—4 m. N.E. Paoli, Orange Co.
326. Lick Creek—2 m. E. West Baden, Orange Co.
327. Black Creek—2 m. S. Sanborn, Knox Co.
328. West Fork White River—2 m. W. Elnora, Daviess Co.
329. Prairie Creek—5 m. N.W. Washington, Daviess Co.
330. West Fork White River—3 m. W. Washington, Daviess Co.
331. East Fork White River—11 m. S. Washington, Daviess Co.
332. East Fork White River—9 m. N. Jasper, Dubois Co.
333. East Fork White River—Shoals, Martin Co.
334. Beaver Creek—1 m. E. Shoals, Martin Co.
335. Patoka River—Dubois, Dubois Co.
336. Hall Creek—2 m. S. Jasper, Dubois Co.
337. Indian Creek—2 m. E. Huntingburg, Dubois Co.
338. Hunley Creek—3 m. N. Huntingburg, Dubois Co.
339. Wabash River—Attica, Warren Co.
340. Big Pine Creek—5 m. N.W. Attica, Warren Co.
341. Mud Pine Creek—16 m. N.W. Attica, Warren Co.
342. Big Pine Creek—2 m. S.W. Pine Village, Warren Co.
343. Big Pine Creek—5 m. N.E. Oxford, Benton Co.
344. Wabash River—4 m. N. Lafayette, Tippecanoe Co.
345. Big Wea Creek—3 m. S.W. Lafayette, Tippecanoe Co.
346. Wildcat Creek—4 m. N.E. Lafayette, Tippecanoe Co.
347. South Fork Wildcat Creek—6 m. S.E. Lafayette, Tippecanoe Co.
348. South Fork Wildcat Creek—7 m. S.W. Rossville, Clinton Co.
349. Wabash River—Delphi, Carroll Co.
350. Wabash River—Logansport, Cass Co.
351. Pike Creek—3 m. N.E. Monticello, White Co.
352. Big Creek—4 m. S.W. Monticello, White Co.
353. Honey Creek—5 m. S. Monon, White Co.
354. Slough Creek—2½ m. S. Rensselaer, Jasper Co.

* Not shown on map.

355. Robbins Ditch—6 m. N. Knox, Starke Co.
 356. Yellow River—2 m. N.W. Knox, Starke Co.
 357. Pitner Ditch—2 m. E. Lacrosse, LaPorte Co.
 358. Reeve's Ditch—5 m. S.E. Kouts, Porter Co.
 359. Sandyhook Ditch—5 m. S.W. Kouts, Porter Co.
 360. Deep River—5 m. N.E. Crown Point, Lake Co.
 361. Lake Michigan—Ogden Dunes, Porter Co.
 362. West Creek Ditch—4 m. S.W. Lowell, Lake Co.
 363. Cedar Creek—4 m. S. Lowell, Lake Co.
 364. Singleton Ditch—5 m. S. Lowell, Lake Co.
 365. Beaver Lake Ditch—3 m. S. Lake Village, Newton Co.
 366. Beaver Creek—2 m. N. Morocco, Newton Co.
 367. Iroquois River—1 m. E. Rensselaer, Jasper Co.
 368. Oliver Ditch—6 m. N.E. Rensselaer, Jasper Co.
 369. Mississinewa River—10 m. N.E. Winchester, Randolph Co.
 370. Little Mississinewa River—2 m. N. Union City, Randolph Co.
 371. East Fork Whitewater River—1½ m. S.W. Lynn, Randolph Co.
 372. West Fork White River—4 m. E. Winchester, Randolph Co.
 373. West Fork White River—7 m. W. Winchester, Randolph Co.
 374. Little White River—12 m. W. Winchester, Randolph Co.
 375. Mississinewa River—5 m. S.E. Fairview, Randolph Co.
 376. Mississinewa River—5 m. S.W. Albany, Delaware Co.
 377. Kill Buck Creek—7 m. E. Alexandria, Delaware Co.
 378. Pipe Creek—1 m. E. Alexandria, Madison Co.
 379. Pipe Creek—12 m. S.W. Alexandria, Madison Co.
 380. West Fork White River—Anderson, Madison Co.
 381. Fall Creek—1 m. N.E. Pendleton, Madison Co.
 382. Lick Creek—3 m. S. Pendleton, Madison Co.
 383. Bell Creek—2 m. S.E. Yorktown, Delaware Co.
 384. West Fork White River—3 m. S.E. Selma, Delaware Co.
 385. Big Blue River—2 m. N.E. Newcastle, Henry Co.
 386. Flat Rock River—2 m. N.E. Newcastle, Henry Co.
 387. Flat Rock River—4 m. S. Newcastle, Henry Co.
 388. Big Blue River—3 m. N.E. Knightstown, Henry Co.
 389. Montgomery Creek—Knightstown, Henry Co.
 390. Brandywine Creek—5 m. S. Greenfield, Hancock Co.
 391. Sugar Creek—4 m. W. Greenfield, Hancock Co.
 392. Buck Creek—11 m. E. Greenfield, Hancock Co.
 393. Blue River—10 m. N. Shelbyville, Shelby Co.
 394. Little Blue River—3 m. N.E. Shelbyville, Shelby Co.
 395. Brandywine Creek—4 m. N.W. Shelbyville, Shelby Co.
 396. Blue River—6 m. S.W. Shelbyville, Shelby Co.
 397. Lewis Creek—5 m. E. Edinburg, Shelby Co.
 398. Sugar Creek—4 m. N.W. Edinburg, Johnson Co.
 399. Sugar Creek—5 m. E. Franklin, Shelby Co.
 400. Indian Creek—2 m. S. Martinsville, Morgan Co.
 401. West Fork White River—4 m. N. Martinsville, Morgan Co.
 402. Mill Creek—2 m. N.W. Eminence, Morgan Co.
 403. Mud Creek—4 m. N. Eminence, Morgan Co.
 404. Mill Creek—Stilesville, Hendricks Co.
 405. West Fork White Lick Creek—2 m. W. Plainfield, Hendricks Co.
 406. White Lick Creek—Plainfield, Hendricks Co.
 407. White Lick Creek—5 m. E. Danville, Hendricks Co.
 408. East Fork Walnut Creek—1½ m. S.E. North Salem, Hendricks Co.
 409. White Lick Creek—5 m. N. Brownsburg, Hendricks Co.
 410. Eagle Creek—1 m. E. Zionsville, Boone Co.
 411. West Fork White River—6 m. S. Noblesville, Hamilton Co.
 412. Cicero Creek—Cicero, Hamilton Co.
 413. Little Cicero Creek—1 m. W. Arcadia, Hamilton Co.
 414. Prairie Creek—5 m. S.W. Tipton, Tipton Co.
 415. Turkey Creek—6 m. N.E. Tipton, Tipton Co.
 416. West Fork White River—4 m. N.E. Noblesville, Hamilton Co.
 417. Fall Creek—3 m. N.W. Fortville, Hamilton Co.
 418. Fall Creek—Indianapolis, Marion Co.
 419. West Fork White River—Indianapolis, Marion Co.
 420. Eagle Creek—Trader's Point, Marion Co.
 421. Little Buck Creek—2 m. N. Glenn Valley, Marion Co.
 422. White Lick Creek—1 m. S. Mooresville, Morgan Co.
 423. West Fork White River—Gosport, Owen Co.
 424. Bean Blossom Creek—From headwaters to mouth, Brown and Monroe Cos.
 425. DeShee River—10 m. S. Vincennes, Knox Co.
 426. Little Patoka River—12 m. N.W. English, Crawford Co.
 427. Little Blue River—2 m. E. Sulphur, Crawford Co.

428. Ohio River—Leavenworth, Crawford Co.
 429. Big Blue River—Wyandotte, Crawford Co.
 430. Ohio River—Dexter, Perry Co.
 431. Ohio River—1 m. E. Cannelton, Perry Co.
 432. Anderson River—4 m. N. Troy, Spencer Co.
 433. Middle Fork—15 m. N. Tell City, Perry Co.
 434. Anderson River—St. Meinrad, Spencer Co.
 435. Crooked Creek—4 m. E. Newtonville, Spencer Co.
 436. Sandridge Ditch—6 m. W. Rockport, Spencer Co.
 437. Little Pigeon Creek—7 m. E. Newburgh, Warrick Co.
 438. Little Pigeon Creek—7 m. S.E. Boonville, Warrick Co.
 439. Little Pigeon Creek—10 m. N.E. Boonville, Warrick Co.
 440. Big Creek—5 m. W. Lynnville, Warrick Co.
 441. Big Pigeon Creek—1 m. E. Elberfeld, Warrick Co.
 442. Big Pigeon Creek—10 m. N.E. Evansville, Warrick Co.
 443. Ohio River—3 m. W. Newburgh, Warrick Co.
 444. Hovey Lake—10 m. S. Mt. Vernon, Posey Co.
 445. Wabash River—8 m. W. Mt. Vernon, Posey Co.
 446. Big Creek—7 m. N.W. Mt. Vernon, Posey Co.
 447. Rush Creek—5 m. S. New Harmony, Posey Co.
 448. Wabash River—3 m. S.W. New Harmony, Posey Co.
 449. Black River—2 m. E. Garrett, Posey Co.
 450. Black River—4 m. N.W. Poseyville, Posey Co.
 451. Big Creek—2 m. S. Cynthiana, Posey Co.
 452. Wabash River—5 m. N.W. Garrett, Gibson Co.
 453. McCarty Ditch—5 m. W. Princeton, Gibson Co.
 454. Wabash River and Bayous—11 m. W. Princeton, Gibson Co.
 455. Patoka River—Patoka, Gibson Co.
 456. Patoka River—1 m. E. Winslow, Pike Co.
 457. White River—Petersburg, Pike Co.
 458. White River—Hazelton, Gibson Co.
 459. Cypress Swamp—10 m. S.W. Hazelton, Knox Co.
 460. Wabash River—12 m. S.W. Vincennes, Knox Co.
 461. Wabash River—14 m. W. Sullivan, Sullivan Co.
 462. West Fork White River—4 m. S. Spencer, Owen Co.
- 1943 COLLECTIONS
500. Nameless Creek—5 m. N. Martinsville, Morgan Co.
 501. Jackson Creek—4 m. S. Bloomington, Monroe Co.
 502. Little Salt Creek—6 m. N. Bedford, Lawrence Co.
 503. Little Cedar Creek—4 m. S. Garrett, Dekalb Co.
 504. Cedar Creek—7 m. S. Garrett, Dekalb Co.
 505. Nameless Creek—3 m. E. Garrett, Dekalb Co.
 506. Cedar Creek—3 m. S. Waterloo, Dekalb Co.
 507. Cedar Creek—4 m. N.W. Waterloo, Dekalb Co.
 508. Hamilton Lake—Hamilton, Steuben Co.
 509. Fish Creek—3 m. S.E. Hamilton, Dekalb Co.
 510. Pigeon Creek—4 m. S.E. Angola, Steuben Co.
 511. Crooked Lake—3 m. N. Angola, Steuben Co.
 512. Nameless Creek—4 m. W. Angola, Steuben Co.
 513. Wall Lake—2 m. W. Orland, Lagrange Co.
 514. Lake of the Woods—6 m. W. Ashley, Lagrange Co.
 515. Tippecanoe River—6 m. N. Winamac, Pulaski Co.

APPENDIX C

Locality identification of numbers shown on MAP 3

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|--|--|
| 600. White River and tributaries—Indianapolis, Marion Co. | 645. St. Joseph River—Fort Wayne, Allen Co. |
| 601. Switz City Swamp—Switz City, Greene Co. | 646. St. Mary's River—Fort Wayne, Allen Co. |
| 602. Bean Blossom Creek—Monroe Co. | 647. Maumee River—Fort Wayne, Allen Co. |
| 603. Salt Creek—Brown and Monroe Cos. | 648. Hamilton Lake—Hamilton, Steuben Co. |
| 604. East Fork White River—Bedford, Lawrence Co. | 649. St. Mary's River—Decatur, Adams Co. |
| 605. Vicinity of Brookville, Franklin Co. | 650. Short Creek—Huntingburg, Dubois Co. |
| 606. Flat Rock River—Decatur Co. | 651. Patoka River—Near Huntingburg, Dubois Co. |
| 607. Clifty Creek—Decatur Co. | 652. Turkey Creek—Syracuse, Kosciusko Co. |
| 608. Tippecanoe River—Carroll Co. | 653. Syracuse Lake—Syracuse, Kosciusko Co. |
| 609. Wabash River—Delphi, Carroll Co. | 654. Shoe Lake—5 m. N.E. Warsaw, Kosciusko Co. |
| 610. Deer Creek—Camden, Carroll Co. | 655. Tippecanoe River—Oswego, Kosciusko Co. |
| 611. Deer Creek—Vicinity of Camden, Carroll Co. | 656. Kankakee River—Water Valley, Lake Co. |
| 612. Little Deer Creek—1 m. S. Carroll, Carroll Co. | 657. Big Lake—3 m. W. Merriam, Noble Co. |
| 613. Wildcat Creek—1 m. N. Burlington, Carroll Co. | 658. Blue River Lake—2 m. N.W. Churubusco, Whitley Co. |
| 614. Honey Creek—Russiaville, Howard Co. | 659. Round Lake—5 m. W. Churubusco, Whitley Co. |
| 615. Wabash River—New Harmony, Posey Co. | 660. Shriner Lake—6 m. W. Churubusco, Whitley Co. |
| 616. Wabash River—1½ m. N. Vincennes, Knox Co. | 661. Crooked Lake—3 m. S.W. Merriam, Noble Co. |
| 617. Tippecanoe River—Marshland, Fulton Co. | 662. Loon Lake—9 m. N.W. Columbia City, Noble Co. |
| 618. Lake Maxinkuckee—Culver, Marshall Co. | 663. Wawasee Lake—Syracuse, Kosciusko Co. |
| 619. Eel River—Logansport, Cass Co. | 664. Tippecanoe Lake—Oswego, Kosciusko Co. |
| 620. Blue River—Columbia City, Whitley Co. | 665. Webster Lake—North Webster, Kosciusko Co. |
| 621. Wabash River—7 m. W. Mt. Vernon, Posey Co. | 666. Lake Manitou—1½ m. S.E. Rochester, Fulton Co. |
| 622. Black River—New Harmony, Posey Co. | 667. Clear and Pine Lakes—LaPorte, LaPorte Co. |
| 623. Big Creek—6½ m. N. Mt. Vernon, Posey Co. | 668. Cedar Lake—14½ m. W. Churubusco, Whitley Co. |
| 624. Patoka River—Patoka, Gibson Co. | 669. Cherry Creek—Winona Lake, Kosciusko Co. |
| 625. Yellow River—Plymouth, Marshall Co. | 670. Clear Creek—Winona Lake, Kosciusko Co. |
| 626. St. Joseph's River—Mishawaka and So. Bend, St. Joseph Co. | 671. Winona Lake—Winona Lake, Kosciusko Co. |
| 627. Eel River—Cataract, Owen Co. | 672. Winona Lake Outlet—Winona Lake, Kosciusko Co. |
| 628. West Fork White River—Spencer, Owen Co. | 673. Tippecanoe River—Warsaw, Kosciusko Co. |
| 629. Cypress Swamp, 5 m. E. Mt. Vernon, Posey Co. | 674. Bass Lake—5 m. S. Knox, Starke Co. |
| 630. Wabash River—Terre Haute, Vigo Co. | 675. Lake Cicott—10 m. W. Logansport, Cass Co. |
| 631. Gresham's Creek—1½ m. E. New Harmony, Posey Co. | 676. Indiana University Farm—Mitchell, Lawrence Co. |
| 632. Big Pigeon Creek—Evansville, Vanderburgh Co. | 677. Fletcher Lake—12 m. N. Logansport, Fulton Co. |
| 633. Fourteen-Mile Creek—16 m. N.E. Jeffersonville, Clark Co. | 678. Wolf Lake—Roby, Lake Co. |
| 634. Laughery Creek—Near Milton, Ohio Co. | 679. Lake George—Hobart, Lake Co. |
| 635. Little Salt Creek—12 m. W. Brookville, Franklin Co. | 680. Lagoon on Lake Michigan—Buffington, Lake Co. |
| 636. Eel River—Wabash Co. | 681. Lagoon on Lake Michigan—Clark Junction, Lake Co. |
| 637. Paw-Paw Creek—Wabash Co. | 682. Deep River—Liverpool, Lake Co. |
| 638. Hellem's Creek—Wabash Co. | 683. Calumet River—Clark, Lake Co. |
| 639. Kentner Creek—Wabash Co. | 684. Lake Michigan—Pine, Lake Co. |
| 640. Cedar Creek—Waterloo, Dekalb Co. | 685. Lake Michigan—Millers, Lake Co. |
| 641. Mill Creek—S.E. Waterloo, Dekalb Co. | 686. Lake Michigan—Edgemoor, Lake Co. |
| 642. Cedar Lake—4 m. N.W. Waterloo, Dekalb Co. | 687. Lake Michigan—Whiting, Lake Co. |
| 643. Big Run—Butler, Dekalb Co. | |
| 644. Indian Lake—12 m. N.W. Waterloo, Dekalb Co. | |

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688. Huffman's Lake—1 m. N. Atwood, Kosciusko Co.
689. Maumee River—Allen Co.
690. West Fork White River—Gosport, Owen Co.
691. Big Blue River—Knightstown, Henry Co.
692. Trail Creek—LaPorte Co.
693. Lake Michigan—Michigan City, LaPorte Co.
694. Kankakee River—Riverside, LaPorte Co.
695. Lost River—Orangeville, Orange Co.
696. Pipe Creek—Madison Co.
697. Raccoon Creek—Mecca, Parke Co.
698. Tippecanoe River—Pulaski Co.
699. Foot's Pond—5 m. N.W. Poseyville, Gibson Co.
700. Vicinity of Richmond—Wayne Co.
- 701-720. 19 dots representing 41 collections of Shoemaker in Wayne Co.

APPENDIX D

List of collecting sites, classified by counties. Except where another author is cited, the collection was made by or has been examined by the writer.

- ADAMS COUNTY**
159. Blue Creek—3½ m. S. Munroe
 158. Blue Creek—4 m. S. Pleasant Mills
 160. Limberlost Creek—Geneva
 156. Nameless Creek—3½ m. S.E. Decatur
 157. St. Mary's River—Pleasant Mills
 649. St. Mary's River—Decatur (Kirsch, 1895b)
 155. Yellow Creek—4 m. W. Decatur
- ALLEN COUNTY**
148. Cedar Creek—4 m. E. Hunterstown
 152. Maumee River—New Haven
 150. Maumee River—Ohio State Line
 639. Maumee River (Eigenmann and Beeson, 1894)
 647. Maumee River—Fort Wayne (Kirsch, 1895b)
 153. St. Joseph River—Cedarville
 645. St. Joseph River—Fort Wayne (Kirsch, 1895b)
 154. St. Mary's River—6 m. S. Fort Wayne
 646. St. Mary's River—Fort Wayne (Kirsch, 1895b)
- BARTHOLOMEW COUNTY**
309. Clifty Creek—2 m. S. Columbus
 306. Driftwood River—Columbus
 310. East Fork White River—Azalia
 307. Flat Rock River—2 m. N.E. Columbus
 308. Haw Creek—½ m. E. Columbus
- BENTON COUNTY**
343. Big Pine Creek—5 m. N.E. Oxford
- BLACKFORD COUNTY**
165. Nameless Creek—5 m. S.W. Hartford City
- BOONE COUNTY**
51. Eagle Creek—Rosstown
 410. Eagle Creek—1 m. E. Zionsville
 27. Mud Creek—4½ m. E. Mechanicsburg
 20. Sugar Creek—2 m. E. Mechanicsburg
 21. Sugar Creek—1 m. E. Mechanicsburg
 46. Wolf Creek—2 m. S.E. Thorntown
- BROWN COUNTY**
424. Bean Blossom Creek—From headwaters to mouth.
 305. Salt Creek—Nashville
 603. Salt Creek (Gilbert, 1885a)
- CARROLL COUNTY**
237. Deer Creek—Camden
 610. Deer Creek—Camden (Evermann and Jenkins, 1892)
 611. Deer Creek—Vicinity of Camden (Jordan, 1890)
 612. Little Deer Creek—1 m. S. Carroll (Evermann and Jenkins, 1892)
 238. Rock Creek—2½ m. N.E. Rockfield
 608. Tippecanoe River (Evermann and Jenkins, 1892)
349. Wabash River—Delphi
 609. Wabash River—Delphi (Evermann and Jenkins, 1892)
 236. Wildcat Creek—2 m. N.W. Burlington
 235. Wildcat Creek—1 m. N. Owasco
 613. Wildcat Creek—1 m. N. Burlington (Evermann and Jenkins, 1892)
- CASS COUNTY**
106. Deer Creek—5 m. N.W. Galveston
 107. Eel River—Adamsborough
 619. Eel River—Logansport (Jordan, 1890)
 675. Lake Cicott—10 m. W. Logansport (Evermann and Clark, 1908)
 350. Wabash River—Logansport
- CLARK COUNTY**
633. Fourteen-mile Creek—16 m. N.E. Jeffersonville (Evermann and Jenkins, 1892)
 319. Muddy Fork of Silver Creek—Bennetsville
 320. Silver Creek—3 m. S. Sellersburg
- CLAY COUNTY**
198. Birch Creek—1½ m. S.W. Ashboro
 202. Eel River—Bowling Green
 199. Eel River—5 m. S. Clay City
 204. Eel River—2 m. W. Poland
- CLINTON COUNTY**
47. Kilmore Creek—2 m. S. Cambria
 348. South Fork Wildcat Creek—7 m. S.W. Rossville
- CRAWFORD COUNTY**
429. Big Blue River—Wyandotte
 323. Big Blue River—Milltown
 427. Little Blue River—1 m. E. Sulphur
 426. Little Patoka River—12 m. N.W. English
 428. Ohio River—Leavenworth
- DAVISS COUNTY**
331. East Fork White River—11 m. S. Washington
 329. Prairie Creek—4 m. N.W. Washington
 328. West Fork White River—2 m. W. Elnora
 330. West Fork White River—3 m. W. Washington
- DEARBORN COUNTY**
250. South Hogan Creek—5 m. W. Aurora
 253. Whitewater River—3 m. N.W. West Harrison
- DECATUR COUNTY**
242. Clifty Creek—5½ m. W. Greensburg
 607. Clifty Creek (Shannon, 1887)
 241. Flat Rock River—6 m. N.W. Greensburg
 606. Flat Rock River (Shannon, 1887)
 243. Muddy Fork—3 m. S.W. Greensburg
 244. Sand Creek—3 m. S.E. Westport

DEKALB COUNTY

643. Big Run—Butler (Kirsch, 1895b)
 506. Cedar Creek—3 m. S. Waterloo
 504. Cedar Creek—7 m. S. Garrett
 640. Cedar Creek—Waterloo (Kirsch, 1895b)
 507. Cedar Lake—4 m. N.W. Waterloo
 642. Cedar Lake—4 m. N.W. Waterloo (Kirsch, 1895b)
 509. Fish Creek—3 m. S.E. Hamilton
 644. Indian Lake—12 m. N.W. Waterloo (Kirsch, 1895b)
 503. Little Cedar Creek—4 m. S. Garrett
 641. Mill Creek—S.E. Waterloo (Kirsch, 1895b)
 505. Nameless Creek—3 m. E. Garrett
 151. St. Joseph River—1 m. W. Ohio State Line
 149. Twenty-six Mile Creek—Newville

DELAWARE COUNTY

383. Bell Creek—2 m. S.E. Yorktown
 377. Kill Buck Creek—7 m. E. Alexandria
 376. Mississinewa River—5 m. S.W. Albany
 384. West Fork White River—3 m. S.E. Salem

DUBOIS COUNTY

332. East Fork White River—9 m. N. Jasper
 336. Hall Creek—2 m. S. Jasper
 338. Hunley Creek—3 m. N. Huntingburg
 337. Indian Creek—2 m. E. Huntingburg
 335. Patoka River—Dubois
 651. Patoka River—Near Huntingburg (Moenkhaus, 1896a)
 650. Short Creek—Huntingburg (Moenkhaus, 1896a)

ELKHART COUNTY

39. Baugo Creek—Jamestown
 15. Christiana Creek—4 m. N. Elkhart
 13. Duck Pond of John Banks—7 m. N.E. Elkhart
 40. Elkhart River—Goshen
 14. Heaton Lake—4 m. N.E. Elkhart
 56. Indiana Lake—3 m. N. Bristol
 16. Little Elkhart River—1½ m. E. Bristol
 4. Sheep Creek—5 m. W. Bristol
 4. Simonton Lake—3 m. N. Elkhart
 33. St. Joseph River—Elkhart
 57. Stoney Creek—Millersburg
 38. Turkey Creek—6 m. E. Nappanee
 12. Yellow Creek—2 m. S.E. Elkhart

FAYETTE COUNTY

262. West Fork Whitewater River—1½ m. N. Alpine
 264. West Fork Whitewater River—½ m. W. Waterloo

FOUNTAIN COUNTY

340. Big Pine Creek—5 m. N.W. Attica
 182. Coal Creek—6 m. E. Perrysville
 180. Little Shawnee Creek—4 m. S. Attica
 187. East Fork Coal Creek—1 m. E. Hillsboro
 181. Wabash River—Perrysville

FRANKLIN COUNTY

256. Big Salt Creek—2 m. W. Peppertown
 258. East Fork Whitewater River—2 m. S. Fairfield
 635. Little Salt Creek—12 m. W. Brookville (Evermann and Jenkins, 1892)

255. Pipe Creek—3 m. N.W. Oak Forest
 605. Vicinity of Brookville (Evermann, 1886)
 257. West Fork Whitewater River—1 m. S. Laurel
 254. Whitewater River—Cedar Grove

FULTON COUNTY

31. Eddy Creek—2 m. N.E. Leitersford
 677. Fletcher Lake—12 m. N. Logansport (Evermann and Clark, 1910)
 228. Lake Manitou—1½ m. S.E. Rochester
 666. Lake Manitou—1½ S.E. Rochester (Eigenmann and Beeson, 1894)
 229. Mill Creek Ditch—2 m. S.W. Kewanee
 230. Tippecanoe River—3 m. N.W. Delong.
 227. Tippecanoe River—2 m. N. Rochester
 617. Tippecanoe River—Marshland (Jordan, 1890)

GIBSON COUNTY

271. Footh Pond—5 m. N.W. Poseyville
 699. Footh Pond—5 m. N.W. Poseyville (Hubbs and Lagler, 1942)
 453. McCarty Ditch—5 m. W. Princeton
 455. Patoka River—Patoka
 624. Patoka River—Patoka (Jordan, 1890)
 452. Wabash River—5 m. N.W. Garrett
 454. Wabash River and Bayous—11 m. W. Princeton
 458. White River—Hazelton.

GRANT COUNTY

169. Deer Creek—4 m. S. Marion
 170. Hummel Creek—1 m. N. Marion
 168. Lugar Creek—3 m. E. Marion
 112. Mississinewa River—4 m. N. Marion

GREENE COUNTY

302. Lattas Creek—2 m. N.W. Bloomfield
 303. Richland Creek—2 m. N.E. Bloomfield
 601. Switz City Swamp—Switz City (Gilbert, 1885a)

HAMILTON COUNTY

412. Cicero Creek—Cicero
 417. Fall Creek—3 m. N.W. Fortville
 413. Little Cicero Creek—1 m. W. Arcadia
 50. Little Eagle Creek—4 m. S.W. Sheridan
 28. West Fork White River—2 m. S. Noblesville
 411. West Fork White River—6 m. S. Noblesville
 416. West Fork White River—4 m. N.E. Noblesville

HANCOCK COUNTY

390. Brandywine Creek—5 m. S. Greenfield
 392. Buck Creek—11 m. S. Greenfield
 391. Sugar Creek—4 m. W. Greenfield

HARRISON COUNTY

321. Buck Creek—2 m. S. New Middletown
 322. Little Indiana Creek—4 m. S.E. Corydon

HENDRICKS COUNTY

408. East Fork Walnut Creek—2 m. S.E. North Salem
 404. Mill Creek—Stilesville
 405. West Fork White Lick Creek—2 m. W. Plainfield
 407. White Lick Creek—5 m. E. Danville.

409. White Lick Creek—5 m. N. Brownsburg
 406. White Lick Creek—Plainfield
 54. White Lick Creek—Plainfield

HENRY COUNTY

385. Big Blue River—2 m. N.E. New Castle
 388. Big Blue River—3 m. N.E. Knightstown
 691. Big Blue River—Knightstown (Eigenmann and Beeson, 1894)
 387. Flat Rock River—4 m. S. New Castle
 386. Flat Rock River—4 m. N.E. New Castle
 389. Montgomery Creek—Knightstown

HOWARD COUNTY

110. Little Wildcat Creek—4 m. S. Kokomo
 614. Honey Creek—Russiaville (Eigenmann and Jenkins, 1892)
 109. South Fork Deer Creek—5 m. N. Kokomo
 111. Wildcat Creek—1 m. S. Greentown

HUNTINGTON COUNTY

175. Bluff Creek—4 m. N.E. Huntington
 176. Clear Creek—3 m. W. Huntington
 174. Little Wabash River—Roanoke
 177. Loon Creek—Andrews
 171. Salamonie River—2 m. S. Warren

JACKSON COUNTY

225. East Fork White River—Seymour
 224. East Fork White River—1½ m. N. Seymour
 223. Grassy Fork—1½ m. S.W. Tampico
 312. South Branch Salt Creek—Freetown
 222. Vernon Fork Muscatatuck River—2 m. S.W. Crothersville
 311. White Creek—5 m. S.W. Cortland
 226. White Creek—4½ m. N. Brownstown

JASPER COUNTY

367. Iroquois River—1 m. E. Rensselaer
 368. Oliver Ditch—6 m. N.E. Rensselaer
 354. Slough Creek—2½ m. S. Rensselaer

JAY COUNTY

164. Brook's Creek—4 m. S. Pennville
 162. Little Salamonie River—1 m. S. Portland
 163. Salamonie River—5 m. S.E. Pennville
 161. Wilson Creek—5 m. S.E. Geneva

JEFFERSON COUNTY

216. Big Creek—1 m. N. Deputy
 217. Big Creek—1 m. N. Lancaster
 218. Indian Kentuck Creek—China

JENNINGS COUNTY

214. Graham's Fork Muskatatuck River—2 m. S.W. San Jacinto
 212. North Branch Muskatatuck River—1 m. E. North Vernon
 211. Sand's Creek—1 m. N.W. Scipio
 213. South Branch Muskatatuck River—2 m. S. Butlerville
 215. Vernon Fork Muskatatuck River—4½ m. S.W. North Vernon

JOHNSON COUNTY

398. Sugar Creek—4 m. N.W. Edinburg

KNOX COUNTY

327. Black Creek—2 m. S. Sanborn
 459. Cypress Swamp—10 m. S.W. Hazelton
 425. DeShee River—10 m. S. Vincennes
 460. Wabash River—12 m. S.W. Vincennes
 616. Wabash River—1½ m. N. Vincennes (Jordan, 1890)

KOSCIUSKO COUNTY

43. Big Barbee Lake—2 m. S.W. North Webster
 22. Carr Lake—2 m. N. Claypool
 18. Center Lake—Warsaw
 10. Chapman Lake—4 m. N.E. Warsaw
 2. Cherry Creek—Winona Lake
 669. Cherry Creek—Winona Lake (Blatchley and Ashley, 1901)
 670. Clear Creek—Winona Lake (Blatchley and Ashley, 1901)
 44. Deed's Creek—2 m. N. Winona Lake
 11. Dewart Lake—5 m. N.E. Leesburg
 42. Grassy Creek—3 m. S.W. Wilmot
 688. Huffman's Lake—1 m. N. Atwood (Scott, 1918)
 34. Kuhn Lake—3 m. S. North Webster
 19. Pike Lake—Warsaw
 26. Ridinger Lake—5 m. S. North Webster
 3. Shoe Lake—5 m. N.E. Warsaw
 273. Shoe Lake—5 m. N.E. Warsaw
 654. Shoe Lake—5 m. N.E. Warsaw (Eigenmann, 1896)
 23. Silver Lake—Silver Lake
 653. Syracuse Lake—Syracuse (Eigenmann, 1896)
 24. Tippecanoe Lake—Oswego
 664. Tippecanoe Lake—Oswego (Eigenmann, 1896; Kirsch, 1895b)
 274. Tippecanoe Lake—Oswego
 7. Tippecanoe River—1½ m. S.W. Oswego
 655. Tippecanoe River—Oswego (Eigenmann, 1896)
 8. Tippecanoe River—1½ m. N. Warsaw
 673. Tippecanoe River—Warsaw (Blatchley and Ashley, 1901)
 6. Tippecanoe River—3 m. N. Warsaw
 30. Trimble Creek—6½ m. W. Warsaw
 652. Turkey Creek—Syracuse (Eigenmann, 1896)
 45. Walnut Creek—2 m. S. Warsaw
 32. Wawasee Lake—5 m. S.E. Syracuse
 663. Wawasee Lake—Syracuse (Eigenmann, 1896)
 25. Webster Lake—North Webster
 665. Webster Lake—North Webster (Eigenmann, 1896)
 1. Winona Lake—Winona Lake
 269. Winona Lake—Winona Lake (Blatchley and Ashley, 1901)
 671. Winona Lake—Winona Lake (DeRyke and Scott, 1922)
 5. Winona Lake Outlet—Winona Lake
 672. Winona Lake Outlet—Winona Lake (Blatchley and Ashley, 1901)

LAGRANGE COUNTY

133. Emma Creek—3 m. N.W. Schrock
 514. Lake of the Woods—6 m. W. Ashley
 135. Lake Shipshewana—Shipshewana
 137. Pretty Lake—5 m. N.E. South Milford

136. Turkey Creek (Pigeon River)—1½ m. S.E. Mongo
134. Turkey Creek (Pigeon River)—1 m. N. Seybert
613. Wall Lake—2 m. W. Orland
- LAKE COUNTY
683. Calumet River—Clark (Meek and Hildebrand, 1910)
363. Cedar Creek—4 m. S. Lowell
360. Deep River—5 m. N.E. Crown Point
118. Deep River—2½ m. S. Ainsworth
682. Deep River—Liverpool (Meek and Hildebrand, 1910)
656. Kankakee River—Water Valley (Hay, 1896)
680. Lagoon on Lake Michigan—Buffington (Meek and Hildebrand, 1910)
681. Lagoon on Lake Michigan—Clark Junction (Meek and Hildebrand, 1910)
679. Lake George—Hobart (Meek and Hildebrand, 1910)
686. Lake Michigan—Edgemoor (Meek and Hildebrand, 1910)
685. Lake Michigan—Millers (Meek and Hildebrand, 1910)
684. Lake Michigan—Pine (Meek and Hildebrand, 1910)
687. Lake Michigan—Whiting (Meek and Hildebrand, 1910)
364. Singleton Ditch—5 m. S. Lowell
362. West Creek Ditch—4 m. S.W. Lowell
678. Wolf Lake—Roby (Meek and Hildebrand, 1910)
- LAPORTE COUNTY
667. Clear and Pine Lakes—LaPorte (Jordan, 1877b)
125. Hawk Creek—3 m. S. Wanatah
123. Kankakee River—3 m. S.E. Union Center
694. Kankakee River—Riverside (Eigenmann and Beeson, 1894)
129. Lake Michigan (shore)—Michigan City
267. Lake Michigan (out in lake)—Near Michigan City
693. Lake Michigan—Michigan City (Eigenmann and Beeson, 1894)
127. Little Kankakee River—5 m. E. LaPorte
124. Mill Creek—4 m. N.E. Hanna
126. Pine Lake—LaPorte
357. Pitner Ditch—2 m. E. Lacrosse
128. Trail Creek—4½ m. E. Michigan City
692. Trail Creek (Eigenmann and Beeson, 1894)
- LAWRENCE COUNTY
314. East Fork White River—2 m. S.W. Bedford
604. East Fork White River—Bedford (Gilbert, 1885a.)
676. Indiana University Farm — Mitchell (Hahn, 1909)
313. Leatherwood Creek—1 m. S. Bedford
502. Little Salt Creek—6 m. N. Bedford
- MADISON COUNTY
52. Fall Creek—Pendleton
381. Fall Creek—1 m. N.E. Pendleton
382. Lick Creek—3 m. S. Pendleton
378. Pipe Creek—1 m. E. Alexandria
379. Pipe Creek—12 m. S.W. Alexandria
696. Pipe Creek (Eigenmann and Beeson, 1894)
380. West Fork White River—Anderson
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420. Eagle Creek—Trader's Point
418. Fall Creek—Indianapolis
421. Little Buck Creek—2 m. N. Glenn Valley
419. West Fork White River—Indianapolis
53. West Fork White River—8 m. N. Indianapolis
600. West Fork White River and tributaries (Jordan, 1887a, 1877b, 1882)
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618. Lake Maxinkuckee—Culver (Jordan, 1890; Evermann and Jenkins, 1892); Blatchley and Ashley, 1901; Evermann and Clark, 1920)
121. Lake of the Woods—10 m. N.E. Plymouth
122. Pine Creek—7 m. W. Lapaz
9. Tippecanoe River—3 m. N.W. Mentone
119. Wolf Creek—4 m. S. Plymouth
37. Yellow River—3½ m. S.W. Nappanee
120. Yellow River—2 m. S. Twin Lakes
625. Yellow River—Plymouth (Jordan, 1890)
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334. Beaver Creek—1 m. E. Shoals
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105. Deer Creek—3 m. N. Wapecong
104. Pipe Creek—7 m. S.W. Somerset
108. Wabash River—Peru
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191. Cornstalk Creek—2 m. W. Ladoga
190. Sugar Creek—5 m. S. Yountsville
188. Sugar Creek—1 m. N. Darlington
189. Walnut Fork—5 m. E. Crawfordsville
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304. Bean Blossom Creek—7 m. N.E. Ellettsville
602. Bean Blossom Creek (Eigenmann and Fordice, 1886)
501. Jackson Creek—4 m. S. Bloomington
- MORGAN COUNTY
400. Indian Creek—2 m. S. Martinsville
402. Mill Creek—2 m. N.W. Eminence
403. Mud Creek—4 m. N. Eminence
500. Nameless Creek—5 m. N. Martinsville
422. White Lick Creek—1 m. S. Mooresville
401. West Fork White River—4 m. N. Martinsville
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366. Beaver Creek—2 m. N. Morocco
365. Beaver Lake Ditch—3 m. S. Lake Village
178. Iroquois River—3 m. N. Kentland
- NOBLE COUNTY
657. Big Lake—3 m. W. Merriam (Blatchley and Ashley, 1901)
661. Crooked Lake—3 m. S.W. Merriam (Kirsch, 1895a)
140. Elkhart River—1 m. W. Ligonier
662. Loon Lake—9 m. N.W. Columbia City (Kirsch, 1895a)

142. Nameless Creek—4½ m. S. Albion
 138. Nameless Creek—3½ m. S.E. Rome City
 139. North Branch Elkhart River—Springfield
 141. South Branch Elkhart River—1 m. W. Albion
 36. Sylvan Lake—Rome City
 268. Willow Creek—2 m. W. Laotto

OHIO COUNTY

248. Arnold Creek—1 m. S.W. Rising Sun
 249. Laughery Creek—Milton
 634. Laughery Creek—Near Milton (Evermann and Jenkins, 1892)

ORANGE COUNTY

326. Lick Creek—2 m. E. West Baden
 325. Lost River—4 m. N.E. Paoli
 695. Lost River—Orangeville (Eigenmann and Beeson, 1894)
 324. Patoka River—10 m. S. Paoli

OWEN COUNTY

627. Eel River—Cataract (Jordan, 1890)
 200. Lick Creek—½ m. E. Hummel
 210. West Fork White River—McCormick's Creek State Park
 203. West Fork White River—Freedom
 270. West Fork White River—Spencer
 628. West Fork White River—Spencer (Jordan, 1890)
 462. West Fork White River—4 m. S. Spencer
 423. West Fork White River—Gosport
 690. West Fork White River—Gosport (Eigenmann and Beeson, 1894)

PARKE COUNTY

48. Raccoon Creek—Mansfield
 193. Raccoon Creek—6 m. S.W. Rockville
 697. Raccoon Creek—Mecca (Eigenmann and Beeson, 1894)
 186. Sugar Creek—3 m. N. Marshall
 185. Wabash River—Mouth of Sugar Creek

PERRY COUNTY

433. Middle Fork—15 m. N. Tell City
 431. Ohio River—1 m. E. Cannelton
 430. Ohio River—Dexter

PIKE COUNTY

456. Patoka River—1 m. E. Winslow
 457. White River—Petersburg

PORTER COUNTY

361. Lake Michigan—Ogden Dunes
 115. Little Calumet River—Chesterton
 116. Mink Lake—2 m. N. Flintville
 358. Reeve's Ditch—3 m. S.E. Kouts
 117. Salt Creek—6 m. E. Hobart
 359. Sandyhook Ditch—5 m. S.W. Kouts
 114. Tamarak Bog Outlet—Indiana Dunes State Park

POSEY COUNTY

451. Big Creek—2 m. S. Cynthiana
 446. Big Creek—10 m. N.W. Mt. Vernon
 623. Big Creek—6½ m. N. Mt. Vernon (Jordan, 1890)
 449. Black River—2 m. E. Garrett
 450. Black River—4 m. N.W. Poseyville

622. Black River—New Harmony (Jordan, 1890)

629. Cypress Swamp—5 m. E. Mt. Vernon (Jordan, 1890)
 631. Gresham's Creek—1½ m. E. New Harmony (Jordan, 1890)
 444. Hovey Lake—10 m. S. Mt. Vernon
 447. Rush Creek—5 m. S. New Harmony
 445. Wabash River—8 m. W. Mt. Vernon
 448. Wabash River—3 m. S.W. New Harmony
 615. Wabash River—New Harmony (Jordan, 1890)
 621. Wabash River—7 m. W. Mt. Vernon (Jordan, 1890)

PULASKI COUNTY

55. Jasper-Pulaski Game Preserve Pond—5 m. N. Medaryville
 231. Little Mill Creek—2 m. S.W. Winamac
 234. Monon Ditch—5 m. S.E. Francesville
 232. Tippecanoe River—4 m. S.W. Pulaski
 515. Tippecanoe River—6 m. N. Winamac
 698. Tippecanoe River (Eigenmann and Beeson, 1894)

PUTNAM COUNTY

205. Big Walnut Creek—5 m. S.W. Greencastle
 208. Big Walnut Creek—2 m. N.W. Greencastle
 209. Deer Creek—4 m. S. Greencastle
 206. Little Walnut Creek—5½ m. W. Greencastle
 207. Plumb Creek—8 m. N.E. Greencastle
 192. Raccoon Creek—2 m. E. Portland Mills

RANDOLPH COUNTY

371. East Fork Whitewater River—1½ m. S.W. Lynn
 370. Little Mississinewa River—2 m. N. Union City
 374. Little White River—12 m. W. Winchester
 375. Mississinewa River—5 m. S.E. Fairview
 369. Mississinewa River—10 m. N.E. Winchester
 373. West Fork White River—7 m. W. Winchester
 372. West Fork White River—4 m. E. Winchester

RIPLEY COUNTY

251. Laughery Creek—5 m. S.E. Versailles
 252. Laughery Creek—3 m. N.E. Osgood
 245. Little Graham's Creek—3 m. S.E. San Jacinto

RUSH COUNTY

240. Flat Rock River—6 m. S.E. Rushville
 266. Little Blue River—3 m. S.E. Arlington
 239. Mud Creek—1½ m. S.W. Homer
 265. Shankitank Creek—3 m. N.E. Rushville

SCOTT COUNTY

219. Nameless Creek—1 m. S. Scottsburg
 220. Ox Creek—2½ W. Scottsburg
 221. Stucker Fork—2 m. S.W. Austin

SHELBY COUNTY

393. Blue River—10 m. N. Shelbyville
 396. Blue River—6 m. S.W. Shelbyville
 395. Brandywine Creek—4 m. N.W. Shelbyville
 397. Lewis Creek—5 m. E. Edinburg
 394. Little Blue River—3 m. N.E. Shelbyville
 399. Sugar Creek—5 m. E. Franklin

SPENCER COUNTY

432. Anderson River—4 m. N. Troy
 434. Anderson River—St. Meinrad
 435. Crooked Creek—4 m. E. Newtonville
 436. Sandridge Ditch—6 m. W. Rockport

STARKE COUNTY

58. Bass Lake—5 m. S. Knox (Blatchley and Ashley, 1901)
 674. Bass Lake—5 m. S. Knox (Ricker and Gottschalk, 1941)
 355. Robbin's Ditch—6 m. N. Knox
 356. Yellow River—2 m. N.W. Knox

STEBUEN COUNTY

35. Clear Lake—4 m. E. Fremont
 511. Crooked Lake—3 m. N. Angola
 17. Fawn River—1 m. W. Orland
 508. Hamilton Lake—Hamilton
 648. Hamilton Lake—Hamilton (Kirsch, 1895b)
 512. Nameless Creek—4 m. W. Angola
 510. Pigeon Creek—4 m. S.E. Angola

ST. JOSEPH COUNTY

131. Kankakee River—4½ m. N. North Liberty
 130. Potato Creek—1 m. W. North Liberty
 132. St. Joseph River—½ m. N. Osceola
 626. St. Joseph River—Mishawaka and South Bend (Jordan, 1890)

SULLIVAN COUNTY

300. Busseron Creek—1 m. W. Carlisle
 301. Turman Creek—2 m. W. Grayville
 461. Wabash River—14 m. W. Sullivan

SWITZERLAND COUNTY

247. Indian Creek—1½ m. W. Vevay
 246. Plumb Creek—2 m. E. Vevay

TIPPECANOE COUNTY

345. Big Wea Creek—3 m. S.W. Lafayette
 347. South Fork Wildcat Creek—6 m. S.E. Lafayette
 344. Wabash River—4 m. N. Lafayette
 346. Wildcat Creek—4 m. N.E. Lafayette

TIPTON COUNTY

414. Prairie Creek—5 m. S.W. Tipton
 415. Turkey Creek—6 m. N.E. Tipton

UNION COUNTY

261. East Fork Whitewater River—4 m. N. Fairfield
 263. East Fork Whitewater River—1½ m. N.E. Brownsville
 260. Ellis Creek—2½ m. S. Dunlapsville
 259. Silver Creek—2 m. S.W. Liberty

VANDERBURGH COUNTY

632. Big Pigeon Creek—Evansville (Jordan, 1890)

VERMILLION COUNTY

183. Big Vermillion River—4 m. N.W. Cayuga
 194. Brouillette's Creek—2½ m. S.W. Clinton
 184. Little Vermillion River—4 m. S. Cayuga

VIGO COUNTY

197. Blue Hole—2½ m. S.W. Prairietown
 195. Coal Creek—2 m. S.W. New Goshen
 201. Prairie Creek—2 m. W. Prairie Creek
 49. Wabash River—4 m. S.W. Prairietown
 272. Wabash River—Terre Haute

630. Wabash River—Terre Haute (Jordan, 1890)

196. Wabash River—1 m. S. Tecumseh

WABASH COUNTY

29. Eel River—1 m. W. North Manchester
 100. Eel River—6 m. N. Wabash
 636. Eel River (Ulrey, 1894)
 638. Hellem's Creek (Ulrey, 1894)
 639. Kentner Creek (Ulrey, 1894)
 103. Mississinewa River—5 m. S. Wabash
 113. Paw Paw Creek—5 m. N. Wabash
 637. Paw Paw Creek (Ulrey, 1894)
 102. Salamonie River—Dora
 101. Wabash River—Wabash

WARREN COUNTY

340. Big Pine Creek—5 m. N.W. Attica
 342. Big Pine Creek—2 m. S.W. Pine Village
 341. Mud Pine Creek—16 m. N.W. Attica
 339. Wabash River—Attica
 179. Wabash River—Independence

WARRICK COUNTY

440. Big Creek—5 m. W. Lynnville
 441. Big Pigeon Creek—1 m. E. Elberfeld
 442. Big Pigeon Creek—10 m. N.E. Evansville
 439. Little Pigeon Creek—10 m. N.E. Boonville
 438. Little Pigeon Creek—7 m. S.E. Boonville
 437. Little Pigeon Creek—7 m. E. Newburgh
 443. Ohio River—3 m. W. Newburgh

WASHINGTON COUNTY

317. Big Blue River—5 m. S.W. Salem
 316. Big Blue River—1 m. W. Salem
 315. Twin Creek—9 m. N.W. Salem
 318. South Fork Blue River—3 m. E. Pekin

WAYNE COUNTY

700. Vicinity of Richmond (Plummer, 1851)
 701-720. 19 dots representing 41 collections of Shoemaker (Shoemaker, 1942)

WELLS COUNTY

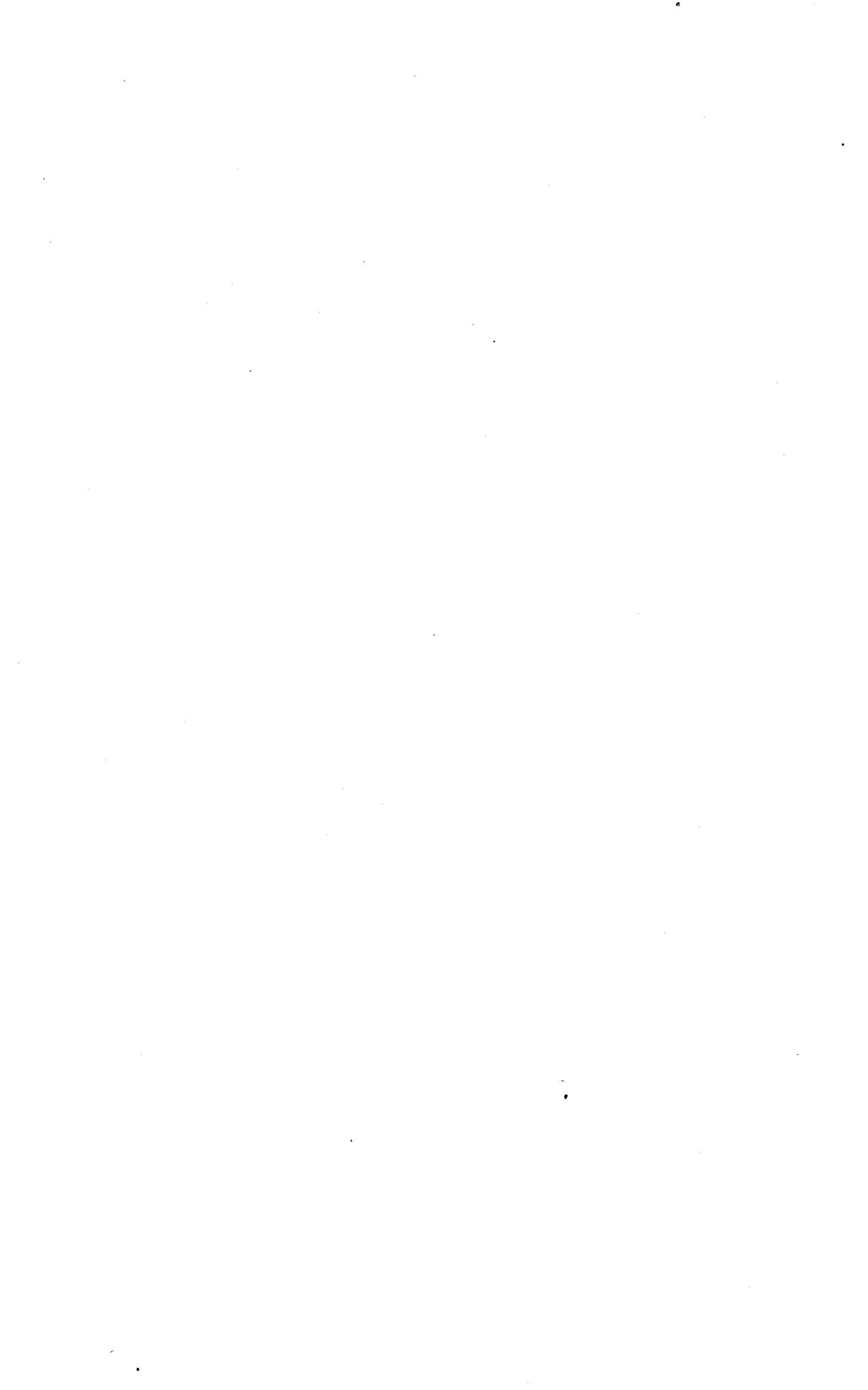
173. Eight Mile Creek—½ m. S. Zanesville
 172. Rock Creek—1 m. N. Liberty Center
 167. Salamonie River—3 m. W. Keystone
 166. Scuffle Creek—1 m. S.W. Keystone

WHITE COUNTY

352. Big Creek—4 m. S.W. Monticello
 233. Big Creek—2 m. N.W. Chalmers
 353. Honey Creek—5 m. S.W. Monon
 351. Pike Creek—3 m. N.E. Monticello

WHITLEY COUNTY

143. Blue River—3 m. N.E. Columbia City
 620. Blue River—Columbia City (Jordan, 1890)
 658. Blue River Lake—2 m. N.W. Churubusco (Kirsch, 1895a)
 668. Cedar Lake—14½ m. W. Churubusco (Kirsch, 1895a)
 147. Eel River—6 m. E. Columbia City
 146. Eel River—3 m. S. Columbia City
 659. Round Lake—5 m. W. Churubusco (Kirsch, 1895a)
 660. Shriner Lake—6 m. W. Churubusco (Kirsch, 1895a)
 144. Spring Creek—3 m. N. South Whitley
 145. Sugar Creek—1 m. S. South Whitley



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